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The latent structure of generalized anxiety disorder in midlife adults

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ABSTRACT

Generalized anxiety disorder (GAD) is identified as a discrete disorder in the DSM-5, but evidence suggests that GAD and the related construct of pathological worry possesses a dimensional latent structure. The objective of this study was to ascertain the latent structure of GAD using taxometric methods. A subsample of adults ($N=2061$) from the Midlife in the United States Study, a national sample of Americans, provided the data. Additional data from individuals who were re-interviewed 10 year later ($n=1228$) were also analyzed. Items corresponding to the DSM-IV-TR diagnostic criteria for GAD were used to generate indicators for the taxometric analyses. Multiple taxometric procedures provided no evidence that GAD has a categorical or taxonic latent structure. Instead, the results were more consistent with the proposition that GAD exists on a continuum. Evidence that GAD is dimensional suggests that dichotomizing individuals into GAD versus non-GAD groups will typically result in decreased statistical power. They also suggest that any diagnostic thresholds for identifying GAD are likely to be arbitrary. The findings are consistent with models that locate GAD within the framework of extant dimensional models of personality and with research that emphasizes a multifactorial etiology for GAD.

1. Introduction

The question of whether psychiatric disorders represent qualitatively distinct conditions (analogous to strep throat) or whether they identify the extreme ends of dimensional continua (analogous to most forms of Type II diabetes) is fundamental to psychiatric taxonomy. This question is especially pertinent to the diagnosis of generalized anxiety disorder (GAD) because it is defined by an excess of symptoms that are common in everyday life, such as anxiety, worry, and tension. Do individuals with GAD represent a unique taxon who suffer from a qualitatively distinct/pathological form of anxiety and worry, or are they at the far end of a continuum of anxiety and worry? In the latter instance, GAD may be the manifestation of high trait anxiety (Rapee, 1991) or neuroticism (Hettema et al., 2004). This question of latent structure can be addressed directly using a set of taxometric procedures developed by Meehl and colleagues (Meehl and Yonce, 1994; Waller and Meehl, 1998). Although two published studies have used taxometric methods to examine the latent structure of worry, a review commissioned by the DSM-5 Anxiety, Obsessive–compulsive Spectrum, Posttraumatic, and Dissociative Disorders Work Group found that “there have been no published studies of the latent structure of GAD” and recommended that “the structure of the full syndrome will need to be evaluated directly” (Andrews et al., 2010, p. 143). Similarly, in his review of taxometric studies of psychiatric disorders, Haslam (2007) concluded that it was uncertain whether generalized anxiety was dimensional or taxonic. Most recently, a comprehensive review of 177 taxometric studies of psychopathology and personality found 60 taxometric findings regarding anxiety disorders, including studies that examined the latent structure of worry, but none specifically examined GAD (Haslam et al., 2012).

Most taxometric studies that have examined the latent structure of anxiety-related constructs have yielded dimensional findings (Haslam et al., 2012). Three papers examined constructs more closely related to GAD. Ruscio et al. (2001) examined the latent structure of worry in a large sample of college students. Items from the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990) and the worry-related items from another measure of GAD served as the indicators of worry. Their analyses yielded consistent evidence that worry has a dimensional latent structure. Olatunji et al. (2010) examined the latent structure of worry in both a large community sample and a large undergraduate sample, using indicators drawn from the PSWQ and other measures of worry and anxiety. Consistent with the findings from Ruscio et al. (2001), Olatunji et al. (2010)found that worry had a dimensional latent structure in both samples. Somewhat complicating these findings, a taxometric study of a large sample of military recruits reported finding evidence of an anxiety taxon (Kotov et al., 2005). However, the indicators used for these analyses were drawn from the Beck Anxiety Inventory (BAI; Steer et al., 1993), the Vulnerability Scale (Schmidt et al., 1995), and an Anxiety Impairment Scale that the authors designed for their study. The BAI, which provided two of the four indicators for the taxometric analyses, primarily assesses autonomic arousal symptoms and panic (Cox et al., 1996), which are not central features of GAD (Brown et al., 1998). Furthermore, none of these

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measures focused on the primary symptoms of GAD, such as worry, tension, and fatigue. Therefore, even if an anxiety taxon exists, it is unlikely that this taxon is isomorphic with GAD.

Although excessive worry is the cardinal symptom of anxiety, most individuals who report high levels of worry do not meet the diagnostic criteria for GAD (Ruscio, 2002). Therefore, it is possible that whereas worry may have a dimensional structure, GAD may be categorical (i.e., in the same way that influenza is a taxonic condition even though one of its hallmark symptoms, elevated body temperature, is dimensional). Additionally, with the exception of one community sample with a mean age of 33.5 (Olatunji et al., 2010, Study 1), all of these other taxometric studies have assessed samples of college students and other young adults. However, GAD prevalence rates appear to peak between the ages of 35 and 54 (Hunt et al., 2002). Therefore, a taxometric study using a mid-life sample may be most appropriate for determining the latent structure of GAD. If GAD is taxonic, a study of middle-aged individuals would be most likely to identify this putative taxon and dimensional results from such a study would carry greater probative weight than studies with young adult samples.

A related issue is that because GAD has a relatively low prevalence rate, taxometric studies with non-clinical samples run the risk of missing a low base rate taxon. Previous studies have somewhat mitigated this risk by using large samples ($N > 1000$). In the current study, we not only used a very large sample ($N > 2000$), but also limited the sample to individuals who reported excessive worry. These sampling procedures increased the base rate of GAD in the sample and reduced the likelihood of failing to identify a GAD taxon if one was present. Finally, if GAD is taxonic, it is reasonable to expect taxon membership to remain relatively stable over time (cf. Watson, 2003). Using a longitudinal data set, in which respondents were re-assessed 10 years after their initial interviews, allowed us to examine whether the latent structure of GAD was consistent at both time points. Furthermore, if GAD was taxonic, we would be able to examine whether taxon membership remained consistent over 10 years. Thus, as the first study to examine the latent structure of GAD in a longitudinal sample of middle-age adults who reported excessive worry, the current study may provide more definitive conclusions about the latent structure of GAD.

2. Methods

2.1. Subjects

This study used archival data collected in the National Survey of Midlife Development in the United States (MIDUS) in 1995–1996 and the follow up MIDUS 2 study in 2004–2006. The MIDUS is a national survey conducted by a multi-disciplinary team examining the influence of physiological, behavioral, psychological, and social factors in accounting for variations across age groups in health and wellness. The original MIDUS 1 study consisted of 7108 non-institutionalized, English-speaking adults between the ages 25–74. Additional details about the survey and sample are available at http://www.midus.wisc.edu.

The subsample used in this study was composed of 2061 individuals who were administered the full GAD telephone questionnaire because they affirmed that they worry a lot more than most people, they worry every day or most days, and they worry about “more than one thing or worry about different things at the same time.” The sample included 1141 women (55.4%) and 883 men (42.8%); 38 participants did not report their sex. The mean age was 42.89 years (S.D. = 11.51 years). Participants were predominantly white ($n = 1598$, 77.5%). In terms of marital status, 63.6% ($n = 1310$) of the participants were married, 3.4% ($n = 71$) separated, 15.3 divorced ($n = 316$), 3.0% ($n = 61$) widowed, and 14.6% ($n = 301$) never married.

2.2. Measures

Both the MIDUS 1 and MIDUS 2 utilized screening versions of the World Health Organization's (WHO) Composite International Diagnostic Interview, Version 10 (CIDI; World Health Organization (1990)). The CIDI has good test–retest reliability and clinical validity (Wittchen, 1994). The telephone questionnaire derived from the CIDI assessed GAD symptoms over the past 12 months.

2.3. Taxometric analyses

We used three nonredundant taxometric procedures: Mean Above Minus Mean Below A Cut (MAMBAC; Meehl and Yonce, 1994), MAXimum EIGenvalue (MAXEIG; Waller and Meehl, 1998), and Latent-Mode (L-Mode; Waller and Meehl, 1998). MAMBAC requires an input and output indicator, with the input data sorted along the x-axis. A series of cuts are made along this axis (50 in the current study), and at each cut the difference between the mean above the cut and the mean below the cut of the output variable is plotted along the y-axis. If the construct is taxonic, the graph has an inverse U-shape, and the peak of the graph represents the taxon base-rate. A dimensional construct prototypically yields a U-shaped curve. Because the current study included seven indicator variables, one variable served as the output indicator and the other six were summed to create the input variable (Walters and Ruscio, 2009), yielding seven MAMBAC curves.

For MAXEIG, the sample is divided into series of overlapping windows along the input indicator (25 windows with 0.90 overlap in the current study, Walters and Ruscio, 2010). The output indicator is the eigenvalue of the first principle component from a principal component analysis of the remaining variables. A prototypical MAXEIG graph for a taxonic construct has an inverse U-shape, which peaks at the window with the maximum eigenvalue where there is a roughly equal number of taxon and complement members. A dimensional MAXEIG graph may be flat, U-shaped, or irregular. In L-Mode, all of the indicators are factor analyzed and the distribution of scores on the first principal factor is graphed. A bimodal graph indicates a taxonic structure and a unimodal graph indicates a dimensional structure.

Because factors such as skew or the correlations among the indicators can influence the shape of taxometric graphs, it is sometimes difficult to visually interpret the results of these taxometric procedures. One solution is to create simulated data sets that reproduce essential features of the data while varying whether the simulated sets are taxonic or dimensional, analyzing these data sets using MAMBAC, MAXEIG, and L-Mode, and then comparing the graphs from the actual data to the graphs of the simulated data (Ruscio et al., 2007). We generated 100 samples of simulated taxonic and dimensional data and used comparison curve fit indices (CCFI) to assess goodness-of-fit between the graphs of the actual data and the simulated taxonic and dimensional graphs. CCFI values less than 0.45 are consistent with a dimensional structure and those greater than 0.55 support a taxonic structure. These CCFI values can be averaged across the three taxometric procedures and the dual-threshold criteria (< 0.45 or > 0.55) can be applied to this mean CCFI value. Monte Carlo studies (e.g., Ruscio et al., 2010) have found that this method is highly accurate for identifying a construct's latent structure, even when the taxon base rate is small (Ruscio and Marcus, 2007). The analyses were conducted using Ruscio's (2012) program for R.

3. Results

3.1. Indicators and base rates

The seven indicators for the taxometric analysis corresponded to the Diagnostic and Statistical Manual of Mental Disorders (4th ed.—text revision; DSM-IV-TR; American Psychiatric Association, 2000) GAD criteria B (difficult to control worry) and C (restlessness, fatigue, difficulty concentrating, irritability, muscle tension, and sleep disturbance). Because the MIDUS study used criterion A (excessive worry) to screen whether the GAD module should be included, all of the respondents in these samples endorsed this criterion. There was one interview question corresponding to each of two of the symptoms (irritability and muscle tension), and there were two interview questions for each of the other five symptoms (e.g., trouble falling asleep and trouble staying asleep for sleep disturbance). For these five symptoms the indicators were created by averaging the two items. Scores on each item ranged across a four-point scale from 0 (never) to 3 (most days). A list of the items and their psychometric properties are provided in Table 1.

To estimate the base rate of GAD in the subsamples of respondents, we calculated the number who endorsed experiencing at least three of the six criterion C symptoms on “most days.” The base rate estimate for the original MIDUS subsample was 21.3% (439 of 2061) and in the follow-up subsample it was 19.5% (240 of 1228). Both of these estimates are consistent with Ruscio's (2002) report of the rates of GAD among college students who were high worriers, which ranged from 17.1% to 21.5% across three samples.

The indicators used for a taxometric analysis should be valid and capable of distinguishing between a presumptive taxon and a

Table 1
Descriptive statistics for indicator variables.

Indicator variable	*M*	S.D.	Skew	Kurtosis	*d*
Difficult to control worry Worry so strong you can't put it out of your mind Difficult to control worry	1.61/1.59	0.77/0.76	0.02/−0.03	−0.60/−0.52	1.48/1.49
Restless or keyed up Restless due to worry Keyed up due to worry	1.45/1.32	0.79/0.76	0.43/0.52	−0.54/−0.28	1.80/1.71
Fatigued Low on energy due to worry Tire easily due to worry	1.27/1.26	0.94/0.99	0.45/0.42	−0.78/−0.95	1.80/2.03
Difficulty concentrating Trouble concentrating due to worry Trouble remembering due to worry	1.08/1.11	0.82/0.84	0.72/0.68	−0.15/−0.27	1.98/1.89
Irritable due to worry	1.50/1.36	0.87/0.88	0.41/0.47	−0.69/0.46	1.61/1.78
Sore or aching due to worry	1.11/1.08	1.07/1.08	0.57/0.61	−0.93/−0.93	1.47/1.79
Sleep Disturbance Trouble falling asleep due to worry Trouble staying asleep due to worry	1.26/1.30	0.93/0.95	0.49/0.45	−0.76/−0.85	1.79/1.67

Note: Scores on each item ranged from 0 (never) to 3 (most days). Values before the slash are from the MIDUS 1 data set and those following the slash are from MIDUS 2. d=indicator validity in S.D. units.

complement group. Specifically, Meehl (1995) recommended that the taxon and complement group differ by at least 1.25 standard deviation units (SDU) on each indicator. Using the 21.3% base rate estimate for the MIDUS 1 sample, the seven indicators all exceeded the 1.25 threshold, with an average indicator validity of 1.71 SDU (range 1.47–1.98). The results were similar using the 19.5% base rate estimate for the MIDUS 2 sample (M=1.77, range 1.49–2.03). Additionally, there was little evidence of nuisance covariance in either sample, with average correlations among the seven indicators in the full sample (MIDUS 1=0.45; MIDUS 2=0.47), considerably larger than the average correlations among those who met the GAD criteria (MIDUS 1=0.01; MIDUS 2=0.04) and those who did not (MIDUS 1=0.24; MIDUS 2=0.25).

3.2. *Taxometric analyses*

Six of the seven MAMBAC curves from the MIDUS 1 data set had a rising cusp on the right side of the graph, which could result from positively skewed indicators or a low base-rate taxon.[1] The other MAMBAC curve peaked on the right side, which could indicate a low base-rate taxon. However, the average of the seven curves was much more consistent with the simulated dimensional data than with the simulated taxonic data with a CCFI of 0.35 (Fig. 1). The MAMBAC results were similar for the MIDUS 2 data, with seven individual curves that had rising cusps that did not peak, which could signify positively skewed indicators or a low base-rate taxon. Again, the average curve was more similar to the dimensional simulation than to the taxonic simulation (CCFI=0.38).

The seven MAXEIG curves from the MIDUS 1 data set were all flat, which is consistent with a dimensional latent structure. Additionally, the average curve was much more similar to the dimensional simulation than to the taxonic simulation (CCFI=0.25; Fig. 2). The MAXEIG results were the same for the MIDUS 2 data, including a CCFI of 0.25.

The L-Mode graph for the MIDUS 1 data was unimodal, consistent with a dimensional structure. As expected, the simulated dimensional data was also unimodal, whereas the simulated taxonic data was bimodal. Because of some overlap in other regions of the graphs, the CCFI was ambiguous (0.54); however these results appear more consistent with a dimensional latent structure (Fig. 3). The L-Mode results for the MIDUS 2 data were similar, but here the CCFI of 0.42 was more consistent with a dimensional structure. The average CCFI for the MIDUS 1 and MIDUS 2 data sets were respectively, 0.38 and 0.35. Both of these values are below the 0.45 threshold for inferring a dimensional latent structure.

4. Discussion

Consistent with prior taxometric studies that examined GAD-related worry primarily in college student samples and young adults, the current study yielded clear evidence that GAD has a dimensional latent structure. These findings are noteworthy because (a) the data were drawn from a large nationally representative sample of midlife adults, (b) all of the respondents endorsed experiencing excessive worry, raising the base rate estimates of GAD to levels that should facilitate the identification of a taxon if GAD were to have a categorical latent structure, and (c) they were consistently dimensional over the course of a ten-year longitudinal study.

These dimensional results are consistent with prior research demonstrating how GAD may be conceptualized using dimensional models of personality (Rosellini and Brown, 2011). Specifically, within a five-factor model framework, GAD is characterized by high levels of neuroticism, especially the lower-order facets of anxiety, depression, and vulnerability (Bienvenu et al., 2004). Similarly, behavioral genetic research has found that the genetic factors associated with neuroticism and GAD are “nearly indistinguishable” (Hettema et al., 2004, p. 1585), although different environmental risk factors may be associated with each construct.

Information about the latent structure of a disorder can offer clues about the etiology of the disorder. Although taxonic conditions may arise from a convergence of multiple risk factors (i.e., tipping point conditions), some taxonic conditions may be due to a single causal factor (e.g., Rett's Disorder). In contrast, dimensional conditions are highly likely to have a multifactorial etiology, which is consistent with current research that suggests that GAD

[1] Copies of the individual curves and all the graphs from the MIDUS 2 analyses are available from the first author.

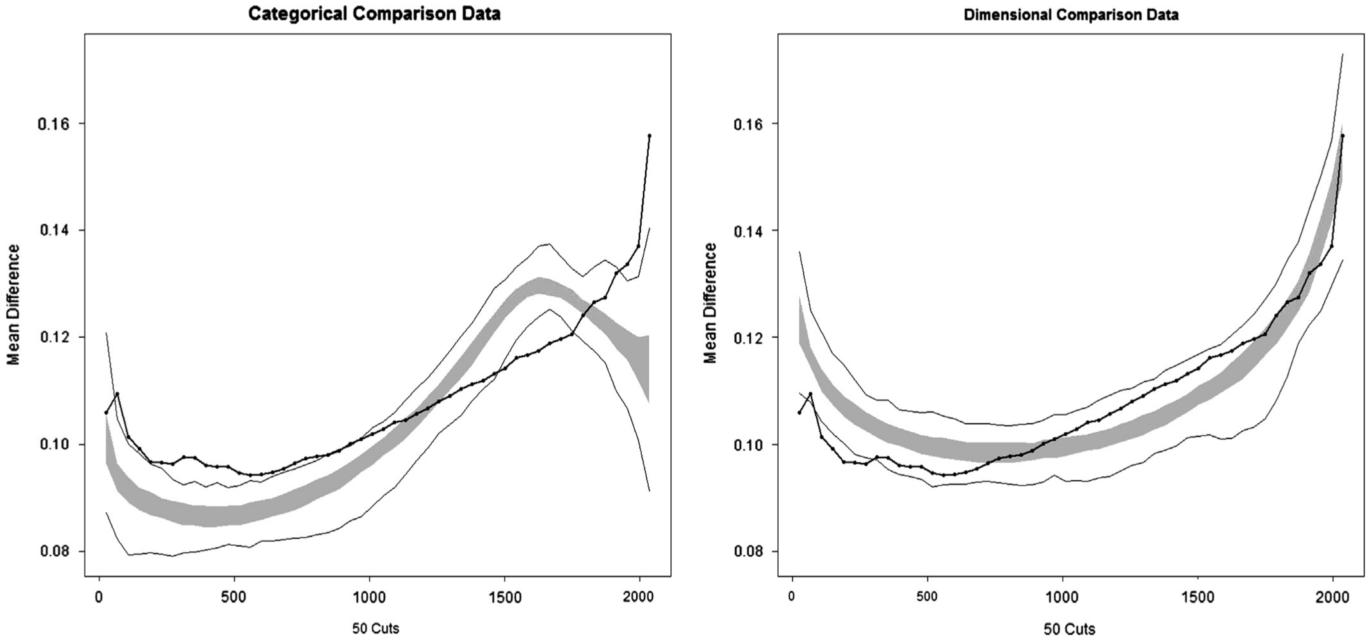

Fig. 1. Average MAMBAC curves for the MIDUS 1 data, simulated taxonic data, and simulated dimensional data for the seven GAD indicators. For each curve, 50 cuts were made along the input indicator. Dark lines on the curves represent the MIDUS 1 data and the lighter lines represent the minimum and maximum values from the simulations. The shaded region contains the middle 50% of the values for all of the simulated data sets.

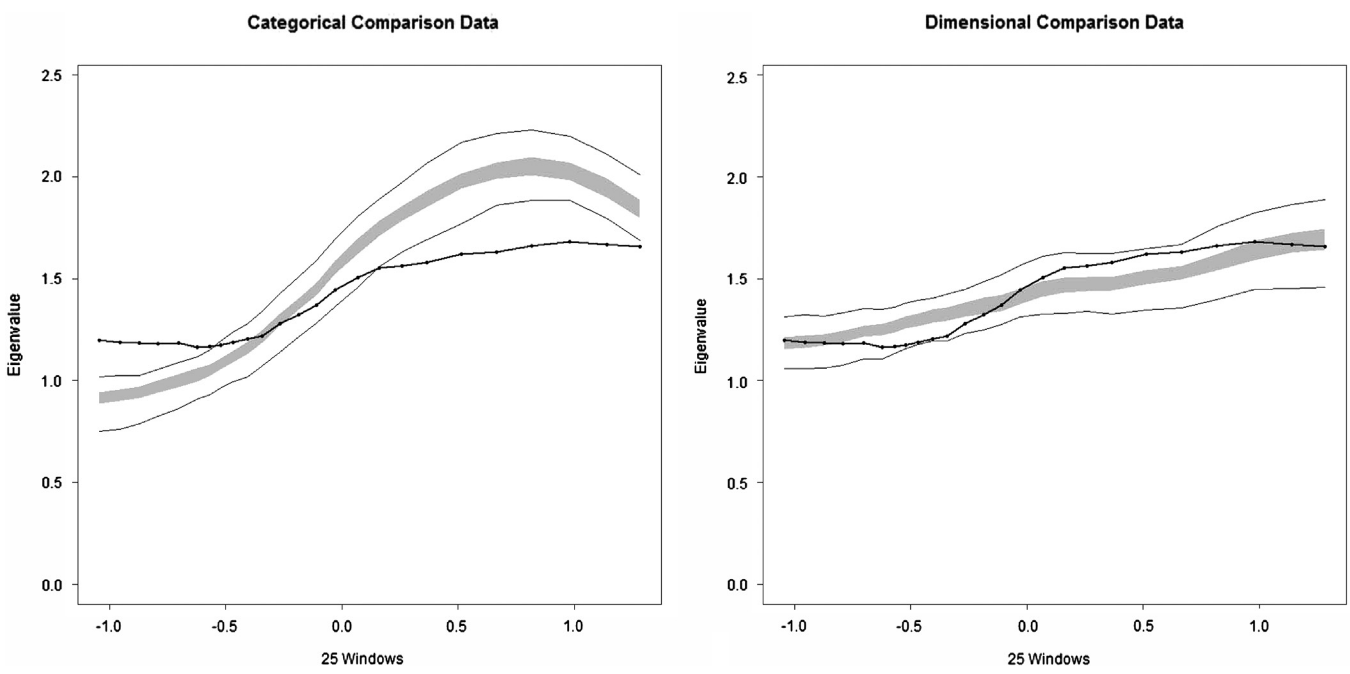

Fig. 2. Average MAXEIG curves for the MIDUS 1 data, simulated taxonic data, and simulated dimensional data for the seven GAD indicators. For each curve, the data were sorted along the *x*-axis by the scores on the input indicator and then grouped into 25 subsamples using overlapping windows (0.90 overlap). Dark lines on the curves represent the MIDUS 1 data and the lighter lines represent the minimum and maximum values from the simulations. The shaded region contains the middle 50% of the values for all of the simulated data sets.

results from the complex interaction between biological and environmental causal factors. Specifically, genetic risk factors that result in neurobiological variations, such as heightened activity in the amygdala, may serve as a diathesis for GAD (Schienle et al., 2011). This increased biological vulnerability can then interact with environmental factors such as neglect, low care, high over-protection, and abuse during childhood to predispose individuals to develop GAD (Goldberg, 2008). Additionally, cognitive factors such as avoidance may serve to maintain or exacerbate GAD symptomology (Borkovec et al., 2004). Thus, consistent with a dimensional latent structure, the severity of GAD symptoms is likely to vary from subclinical to severe levels depending on the number and degree of etiological factors present.

These dimensional findings call into question the DSM practice of treating GAD as a categorical disorder that is present when a certain diagnostic threshold is met and is absent otherwise. However, even when a disorder has a dimensional latent structure, a theoretical or practical rationale may exist for diagnosing the

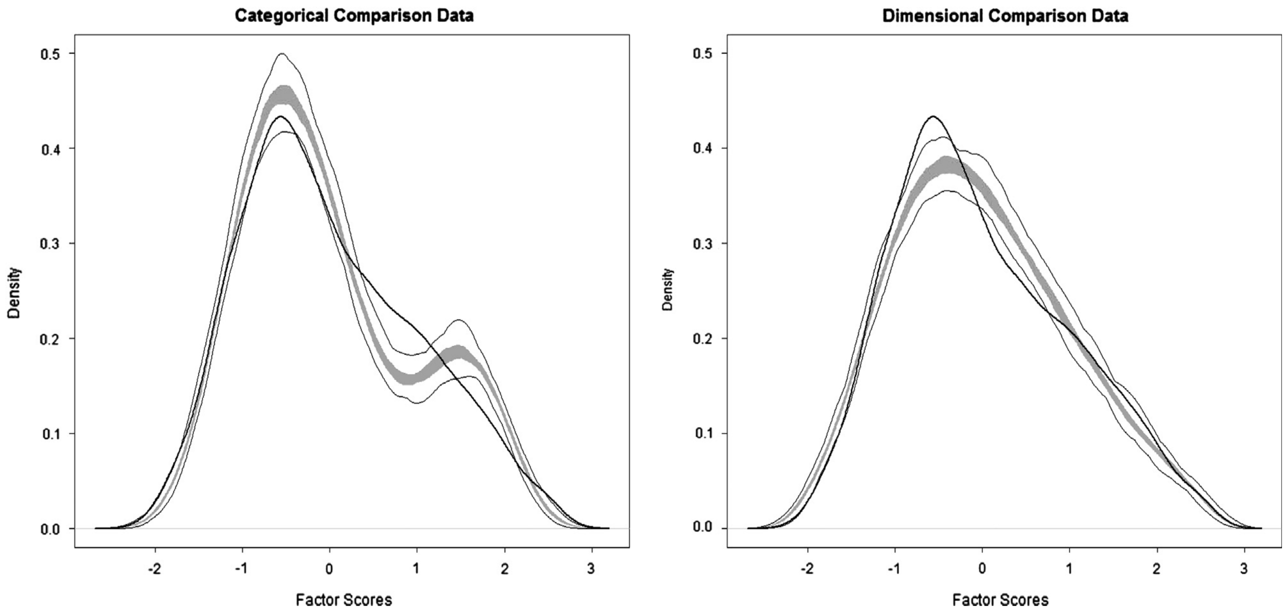

Fig. 3. Latent mode (L-Mode) factor analysis curves for the MIDUS 1 data, simulated taxonic data, and simulated dimensional data for the seven GAD indicators. Dark lines on the curves represent the MIDUS 1 data and the lighter lines represent the minimum and maximum values from the simulations. The shaded region contains the middle 50% of the values for all of the simulated data sets.

disorder categorically. For example, the symptoms of the disorder may relate to impairment in a nonlinear association such that an increase in symptoms leads to a rapid acceleration in impairment (Markon, 2010), as might occur when small increases in blood pressure lead to significant increases in morbidity and mortality. However, at least with respect to the broader construct of internalizing, the evidence suggests that increases in internalizing symptoms are associated with increasing impairment in a linear manner (Markon, 2010). Thus, although future research might find that a certain degree of GAD symptoms triggers more severe levels of impairment, currently the findings from the present study and related studies call into question treating GAD as a dichotomous diagnosis based on an arbitrary threshold.

Because GAD and worry appear to have a dimensional latent structure, researchers who use measures of generalized anxiety or worry should treat the scores on these measures as continuous variables and not dichotomize them. For example, although there have been attempts to identify cut scores on the PSWQ that would be diagnostic of GAD (Molina and Borkovec, 1994), because GAD has a dimensional latent structure the diagnostic threshold for GAD is itself arbitrary. There are strong statistical arguments against artificially dichotomizing continuous variables because this analytic strategy typically leads to decreased statistical power and an increased risk of Type II error (McCallum et al., 2002). A better alternative is to treat scores on the PSWQ and other GAD-related measures as continuous and examine their correlations with other relevant constructs (e.g., Palm et al., 2011).

The current study had a number of strengths, including the use of a large community sample of individuals who reported excessive levels of worry, the use of valid indicators that correspond to the current diagnostic criteria for GAD, and the relatively high base rate of respondents who met the diagnostic criteria for GAD. However, it was not without limitations. Although the DSM-5 (American Psychiatric Association, 2013) did not make significant revisions to the GAD diagnosis, experts in the field (Andrews et al., 2010) had recommended that a greater emphasis on worry-related behavior could improve the validity of the diagnosis. Therefore, additional taxometric research using indicators that assess worry-related changes in behavior (e.g., avoidance, excessive reassurance seeking) in combination with DSM diagnostic criteria may be warranted.

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