Categorical or Dimensional: A Reanalysis of the Anxiety Sensitivity Construct

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Anxiety sensitivity, or the fear of anxiety sensations, has been implicated in the etiology of anxiety disorders, particularly panic disorder. Recently, inconsistent findings have been reported regarding the latent structure of anxiety sensitivity. Whereas some taxometric studies of anxiety sensitivity have reported evidence of categorical latent structure, others have found evidence of a latent dimension. The purpose of the present research was to further examine the latent structure of anxiety sensitivity using taxometric procedures and commonly utilized measures of anxiety sensitivity. To this end, three mathematically independent taxometric procedures (MAXEIG, MAMBAC, and L-Mode) were applied to data collected from two large nonclinical samples (n’s = 1,171 and 2,173) that completed the Anxiety Sensitivity Index and the Anxiety Sensitivity Index–Revised. Results from both studies converged in support of a dimensional conceptualization of anxiety sensitivity. A third study was conducted using indicators derived from the newly revised Anxiety Sensitivity Index–3 in a separate sample of 1,462 nonclinical participants. Results of these analyses provided further support for a dimensional anxiety sensitivity solution. The implications of these results for anxiety sensitivity research are discussed, and several potential directions for future research are considered.

Anxiety sensitivity (AS), or the fear of anxiety and anxiety-related sensations, is conceptualized as a stable, traitlike variable that, when experienced at high levels, predisposes individuals to develop panic
attacks and other anxiety pathology (Reiss & McNally, 1985). Consistent with this notion, individuals with high AS have been shown to be at a significantly greater risk for the development and maintenance of panic attacks and other Axis I disorders (Ehlers, 1995; Maller & Reiss, 1992; Schmidt, Lerew, & Jackson, 1997; Schmidt, Zvolensky, & Maner, 2006) than their low AS counterparts. Research also indicates that individuals with high AS are more likely to avoid arousal-inducing activities (e.g., McWilliams & Asmundson, 2001) and respond with greater anxiety to arousal induction (e.g., Donnell & McNally, 1990; Rapee & Medoro, 1994; Telch, Silverman, & Schmidt, 1996). Although the specific variables that contribute to the etiology of AS remain unclear, individual differences in AS appear to be associated with a combination of genetic and environmental influences (e.g., Reiss & Havercamp, 1998).

A general assumption underlying the vast majority of research to date is that AS is experienced by all people, with individuals varying in degree rather than type of AS experienced (Reiss & McNally, 1985). This assumption is evident in language used by researchers and the instruments that have been developed to measure AS. Specifically, researchers frequently refer to individuals as possessing various degrees of AS (e.g., high, moderate, low; Broman-Fulks, Berman, Rabian, & Webster, 2004; Gardenswartz & Craske, 2001; Zvolensky, Kotov, Antipova, Leen-Feldner, & Schmidt, 2005), rather than representing categorically distinct types of AS (i.e., normal versus pathological). Furthermore, although many researchers have used methodological designs involving a dichotomization of the AS construct (e.g., comparing high versus low AS groups) to maximize power to detect differences, the criterion for creating groups has varied substantially across studies. For example, some researchers (e.g., Watt, Stewart, Birch, & Bernier, 2006) have created groups based on scores 1 SD above versus below the mean on the Anxiety Sensitivity Index (ASI; Peterson & Reiss, 1992), whereas others have used 0.5 SD units as cutoffs (e.g., Sturges, Goetsch, Ridley, & Whittal, 1998). Thus, the group comparison approach appears to be more a matter of methodological convenience than an attempt to accurately classify individuals into naturally occurring classes. Furthermore, these cutoffs have not been used to purportedly distinguish individuals with qualitatively different types of AS. Finally, the vast majority of AS measures are designed to locate a point on the continuum of fears of anxiety sensations at which a particular individual falls (e.g., ASI) rather than categorizing individuals based on the type of AS they are experiencing. Although knowledge regarding the latent structure of AS is important for an accurate understanding of the construct and can help to inform etiological research, as well as the development and selection of the most appropriate assessment tools and research designs, research into AS latent structure has produced inconsistent findings.

Taxometrics, a set of statistical procedures designed to uncover the latent structure (i.e., categorical versus continuous distribution) of phenomena (Meehl & Golden, 1982), has been a useful tool for examining the underlying structure of AS. Taxometric procedures differ substantially from other popular classification methods, such as cluster analysis methods, in that taxometric procedures only expose patterns in data that already exist without forcing structure on data when none is present. Taxometric procedures have been applied to the study of other psychological phenomena as well, including depression (e.g., A. M. Ruscio & Ruscio, 2002), schizotypy (e.g., Lenzenweger & Korffmeier, 1992), disgust (Olatunji & Broman-Fulks, 2007), and posttraumatic stress disorder (e.g., Broman-Fulks et al., 2006; A. Ruscio, Ruscio, & Keane, 2002). However, the attempts to empirically evaluate the latent structure of AS via taxometrics have yielded inconsistent results.

The first published attempt to use taxometric procedures to evaluate the latent structure of AS generated relatively ambiguous results, though the authors initially interpreted the findings as supportive of dimensional latent structure (Taylor, Rabian, & Fedoroff, 1999). A second taxometric study, though not a direct test of the latent structure of AS per se, reported evidence of a psychopathological category underlying a cognitive vulnerability to panic (which include ASI total scores as an indicator) (Schmidt, Kotov, Lerew, Joiner, & Ialongo, 2005). However, it was a series of taxometric studies conducted by Bernstein and colleagues that directly challenged the dimensional conceptualization of AS. Specifically, the authors reported taxometric evidence across a variety of nonclinical samples that AS is categorical, or taxonic, at the latent level, though the two forms (i.e., taxon and nontaxon types) of AS appear to have dimensional qualities (e.g., Bernstein, Zvolensky, Kotov, et al., 2006; Bernstein, Zvolensky, Stewart, & Comeau, 2007; Bernstein, Zvolensky, Stewart, Comeau, & Leen-Feldner, 2006; Bernstein, Zvolensky, Weems, Stickle, & Leen-Feldner, 2005). Refer to Table 1 for a summary of the published AS taxometric research to date. Based on findings indicating that the AS construct has taxonic properties, researchers began to move forward with
integrating a categorical conceptualization of AS into the literature (e.g., Bernstein, Zvolensky, Norton, et al., 2007). For example, authors attempted to identify items from existing AS measures that would most accurately discriminate members and non-members of the AS taxon group, leading to the development and use of an 8-item Anxiety Sensitivity Index Taxon Scale in several studies (e.g., Bernstein, Zvolensky, Feldner, et al., 2005; Zvolensky, Forsyth, Bernstein, & Leen-Feldner, 2007). However, recent research has raised concerns about the reliability of the evidence supporting a discontinuous perspective of AS. Specifically, an independent research group was unable to duplicate the categorical findings of Bernstein and colleagues (Broman-Fulks et al., 2008). Rather, the results of several taxometric procedures applied to AS data collected from two large nonclinical samples failed to uncover any

Table 1
Taxometric Analyses of the Anxiety Sensitivity Construct

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Size</th>
<th>Sample</th>
<th>Indicators</th>
<th>Taxometric Procedures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernstein, Zvolensky, Stewart, Comeau (2007)</td>
<td>4,462</td>
<td>Canadian adolescents</td>
<td>CASI</td>
<td>MAXEIG MAMBAC</td>
<td>Taxonic</td>
</tr>
<tr>
<td>Bernstein, Zvolensky, Stewart, Comeau, Leen-Feldner (2006)</td>
<td>4,462</td>
<td>Canadian adolescents (across gender)</td>
<td>CASI</td>
<td>MAXEIG MAMBAC</td>
<td>Taxonic</td>
</tr>
<tr>
<td>Broman-Fulks, Green, Olatunji, et al. (2008)</td>
<td>1,025 &amp; 744</td>
<td>2 samples of North American young adults</td>
<td>ASP &amp; ASI-R</td>
<td>MAXEIG MAXCOV MAMBAC</td>
<td>Dimensional</td>
</tr>
</tbody>
</table>

* Schmidt, Kotov, Lerew, Joiner, Ialongo (2005) | 1,224 | Unite States Air Force Academy cadets | ASI, BSQ, BVS | MAXCOV MAXEIG | Taxonic |
| Taylor, Cox, Freeman, McNally, Stewart, Swinson (as reported in Taylor, Rabian, & Fedoroff, 1999) | 1,092 | 50% panickers & 50% young adult controls | ASI | MAXCOV | Ambiguous/ Dimensional |

Note. ASI = Anxiety Sensitivity Index, ASI-R = Anxiety Sensitivity Index – Revised, CASI = Childhood Anxiety Sensitivity Index, ASP = Anxiety Sensitivity Profile, BSQ = Body Sensations Questionnaire, BVS = Body Vigilance Scale, CCFI = Comparison Curve Fit Index.

* = not a direct taxometric study of AS, though ASI scores were included as an indicator.
† = denotes a book chapter (not peer reviewed).
^ = integrated taxometric and factor analytic approaches, which suggested that the separate taxon and complement groups may be comprised of latent dimensions. Only taxometric procedures reported in the main text of publications and deemed to be suitable for taxometric analysis by the authors are listed in Table 1.
evidence of latent discontinuity in AS. Rather, results provided evidence supporting a dimensional conceptualization of the AS construct.

Although the source of the discrepant findings between previous AS taxometric reports remains unclear, a number of methodological limitations of previous research have been identified. For example, it is possible that the specific measures used to assess AS in the Broman-Fulks et al. (2008) study (i.e., the Anxiety Sensitivity Profile and ASI–Revised) may have limited their ability to detect an AS taxon. Psychometric studies of the ASI-R appear to indicate it has a relatively unstable factor structure (e.g., Deacon et al., 2003; Taylor & Cox, 1998; Zvolensky et al., 2003), which may impact the selection of appropriate indicators of a potential AS taxon. In addition, some studies have relied heavily on MAXCOV as the primary method of analysis (e.g., Bernstein, Zvolensky, Kotov, et al., 2006; Bernstein, Zvolensky, Weems, et al., 2005), despite previous research suggesting that MAXCOV may produce pseudotaxonic results when applied to data with positively skewed distributions (J. Ruscio & Ruscio, 2002; J. Ruscio, Ruscio, & Keane, 2004). Self-report AS data collected from nonclinical samples tends to be positively skewed and when submitted to MAXCOV could produce plots that appear taxonic even if the data are dimensional. In other research, MAXEIG has served as the primary or sole consistency test for the MAXCOV procedure when other taxometric procedures could not effectively discriminate taxonic from dimensional structure (e.g., Bernstein et al., 2007; Bernstein, Zvolensky, Feldner, et al., 2005; Schmidt et al., 2005). However, MAXEIG is the multivariate extension of MAXCOV (Wall & Meehl, 1998), and it is generally accepted that the two procedures should not be used as consistency tests for one another (e.g., Bernstein et al., 2006). In addition, MAMBAC has been implemented on several occasions despite not appearing to pass initial suitability tests, indicating that MAMBAC may not have been able to effectively discriminate between a taxon and dimension (e.g., Bernstein, Zvolensky, Feldner et al., 2005; Bernstein, Zvolensky, Stewart, et al., 2007; Bernstein, Zvolensky, Kotov, et al., 2006; Bernstein, Zvolensky, Stewart, Comeau, & Leen-Feldner, 2006). Finally, previous AS taxometric studies reporting a taxonic latent structure have relied predominately on “subjective” methods of interpreting data plots. However, objective methods of interpreting taxometric curves have recently been developed, and recent research suggests that the objective interpretation techniques may be as valid as or better than alternative approaches to interpreting taxometric data plots (J. Ruscio & Marcus, 2007; J. Ruscio, Ruscio, & Meron, 2007). Thus, it is important to determine whether objective analytic techniques support a taxonic interpretation of AS data.

Clearly, additional work is needed to clarify the most accurate conceptualization of the latent structural nature of AS. The present research was designed to further investigate the latent structure of AS using multiple measures of AS. Several steps were taken to address some of the potential sources of the discrepancy noted in previous AS taxometric research. Specifically, to increase the chances of detecting a taxon if present, yet minimize the potential of detecting a pseudotaxon due to insufficient indicator range (i.e., indicators consisting of a relatively small number of data points), the present research utilized the MAXEIG procedure with overlapping windows as the primary method of taxometric analysis. The use of overlapping windows generates a far greater number of potential data points than cuts, thereby increasing the reliability of the resulting curves, which has been shown to be particularly beneficial when running analyses on indicators that have skewed distributions (J. Ruscio et al., 2004). In addition, to address measurement issues as a potential source of the inconsistency noted in the findings of previous AS taxometric analyses, data were first collected from two large samples using the two most commonly used measures of AS (i.e., the ASI and ASI-R). Whereas many of the taxometric studies reporting taxonic findings have involved the use of ASI derived indicators, the dimensional findings reported by Broman-Fulks and colleagues (2008) were based on the ASP and ASI-R. A third study was conducted to extend previous taxometric findings to indicators derived from the recently published ASI-3, which has improved psychometric properties compared to the previous versions of the ASI (Taylor et al., 2007). Finally, the present research included an objective index of whether the resulting taxometric data plots were consistent with a taxon or dimension. Based on the conflicting reports of previous taxometric analyses of AS, no a priori hypothesis regarding latent structure was made.

**Study 1**

**Method**

**Participants**

Study 1 participants consisted of a large sample of 1,171 undergraduates from a large southern university. Participants ranged in age from 18 to 70 (M = 20.88, SD = 4.65) and were predominately female (58%) and Caucasian (75%). Participants completed the ASI as part of a larger battery of questionnaires and were given course credit in
exchange for their participation. Previous AS taxometric investigations that have reported taxonic AS latent structure have estimated the AS taxon base rate to be approximately 11% to 22% in nonclinical young adult populations (e.g., Bernstein, Zvolensky, Kotov et al., 2006; Bernstein et al.,

FIGURE 1  Averaged MAXEIG (top), MAMBAC (middle), and L-Mode (bottom) plots for the Anxiety Sensitivity Index data, simulated taxonic data (center), and simulated dimensional data (right).
Thus, if an AS taxon exists, the nonclinical samples used in the present research should provide sufficient numbers of taxon members to allow for the detection of a latent AS taxon.

Measure

ASI. The ASI (Peterson & Reiss, 1992) is a 16-item measure that has been the most widely used measure of AS. The ASI is believed to assess a general AS factor and three lower-order factors: (1) Physical Concerns, (2) Cognitive Concerns, and (3) Social Concerns (Zinbarg, Barlow, & Brown, 1997). The psychometric properties of the ASI are well-established and only briefly mentioned here. The ASI has good internal consistency and is relatively stable across 2 weeks, with a test-retest correlation of .75. The ASI has also been shown to possess adequate criterion-related validity and discriminates individuals with anxiety disorders from non-cases (Reiss, Peterson, Gursky, & McNally, 1986).

PROCEDURE

Data Analytic Strategy

Taxometric procedures do not rely on traditional statistical significance testing. Rather, a multiple hurdles consistency testing approach is used to protect against spurious results (Meehl, 1995; Waller & Meehl, 1998). If a taxon exists, multiple independent taxometric procedures should provide convergent evidence in support of a taxon. The present study used three independent taxometric procedures—MAXEIG (maximum eigenvalue), MAMBAC (mean above minus below a cut), and L-Mode (latent-mode factor analysis)—to analyze the latent structure of AS. These three procedures were selected because they are mathematically independent and offer nonredundant evidence of latent structure. The algorithms for the taxometric procedures were obtained from John Ruscio (2006) and analyzed using R statistical software (2005). Simulated taxonic and dimensional data plots

### Table 2

<table>
<thead>
<tr>
<th>Study 1 – ASI Indicators</th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Alpha</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AS – Physical Concerns</td>
<td>9.64 (6.03)</td>
<td>0.00-30.00</td>
<td>.84</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. AS – Cognitive Concerns</td>
<td>2.32 (2.82)</td>
<td>0.00-16.00</td>
<td>.78</td>
<td>.55</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>3. AS – Social Concerns</td>
<td>6.77 (2.61)</td>
<td>0.00-16.00</td>
<td>.67</td>
<td>.45</td>
<td>.41</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study 2 – ASI-R Indicators</th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Alpha</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fear of Respiratory Symptoms</td>
<td>11.80 (8.97)</td>
<td>0.00-48.00</td>
<td>.89</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Fear of Publicly Observable Anxiety Reactions</td>
<td>7.44 (6.11)</td>
<td>0.00-28.00</td>
<td>.84</td>
<td>.60</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Fear of Cardiovascular Symptoms</td>
<td>7.37 (7.42)</td>
<td>0.00-44.00</td>
<td>.87</td>
<td>.71</td>
<td>.47</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>4. Fear of Cognitive Dyscontrol</td>
<td>3.03 (4.15)</td>
<td>0.00-24.00</td>
<td>.85</td>
<td>.58</td>
<td>.51</td>
<td>.69</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study 3 – ASI-3 Indicators</th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Alpha</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical Concerns</td>
<td>3.41 (3.99)</td>
<td>0.00-24.00</td>
<td>.83</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cognitive Concerns</td>
<td>2.69 (3.87)</td>
<td>0.00-23.00</td>
<td>.88</td>
<td>.62</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>3. Social Concerns</td>
<td>6.92 (4.90)</td>
<td>0.00-24.00</td>
<td>.81</td>
<td>.53</td>
<td>.54</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. All correlation coefficients significant at p < .001.
MAXEIG. MAXEIG (Waller & Meehl, 1998) is a multivariate procedure that calculates and plots eigenvalues from all indicators across successive intervals of an input indicator. Each indicator serves as the input indicator once, thus generating one MAXEIG plot per indicator. Categorical, or taxonic, data typically yield plots with peaked curves, whereas dimensional data produce plots that are relatively flat. MAXEIG analyses were conducted with the Inchworm Consistency Test (ICT), which performs MAXEIG analyses on the research data with an increasing number of overlapping windows. The ICT increases the interpretability of MAXEIG plots and is particularly beneficial for elucidating the presence of a low base-rate taxon (see Waller & Meehl, 1998, for a detailed explanation of the mathematical rationale underlying the ICT). The ICT was performed in the present research using a minimum of 100 windows with .90 overlap and steadily increasing the number of overlapping windows by 100 until a minimum of 20-25 cases existed per window.

MAMBAC. The MAMBAC (Meehl & Yonce, 1994) procedure plots mean differences of scores on one indicator above and below successive cuts on a separate indicator. Categorical constructs tend to produce peaked plots at the point that best discriminates the two groups, whereas dimensional constructs tend to produce bowl-shaped plots. MAMBAC analyses were conducted using 100 evenly spaced cuts beginning 25 cases from either extreme.

L-Mode. L-Mode (Waller & Meehl, 1998) conducts a factor analysis on the proposed indicators. When the distribution of scores on the first principal factor is plotted, taxonic constructs produce a bimodal distribution of factor scores. In contrast, the factor scores of dimensional variables tend to be unimodally distributed.

ASI Indicator Selection
As noted above, research has indicated that the ASI assesses a general AS factor and three lower-order factors consisting of fears of physical, cognitive, and social symptoms of anxiety (Zinbarg, Barlow, & Brown, 1997). Thus, to ensure adequate coverage of the AS construct in the taxometric analyses, three composite indicators were created by separately summing items on the ASI physical, psychological, and social concerns subscales. This approach to indicator selection also has the advantage of yielding more reliable indicators than would be obtained if individual item responses were used as indicators. To determine whether the three ASI indicators were suitable for taxometric analysis, the validity and nuisance covariance of the indicators were examined. For the purposes of estimating within-group correlations and between-group validities, cases were assigned to putative taxon and nontaxon groups using the grand mean base rate estimate from each taxometric procedure (Table 5). Nuisance correlations among the ASI composite

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Procedure</th>
<th>Taxonic</th>
<th>Dimensional</th>
<th>Ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASI</td>
<td>MAXEIG</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MAMBAC</td>
<td>0</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>L-Mode</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ASI-R</td>
<td>MAXEIG</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MAMBAC</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>L-Mode</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ASI-3</td>
<td>MAXEIG</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>MAMBAC</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>L-Mode</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. ASI = Anxiety Sensitivity Index, ASI-R = Anxiety Sensitivity Index – Revised, ASI-3 = Anxiety Sensitivity Index – 3. Only ratings for the highest number of MAXEIG windows are presented.

<table>
<thead>
<tr>
<th>Study</th>
<th>CCFI Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MAXEIG</td>
</tr>
<tr>
<td>Study 1 – ASI</td>
<td>.37</td>
</tr>
<tr>
<td>Study 1 - SS-ASI (without Social Concerns items)</td>
<td>.36</td>
</tr>
<tr>
<td>Study 2 – ASI-R</td>
<td>.39</td>
</tr>
<tr>
<td>Study 2 – ASI-R (without Publicly Observable Anxiety Reaction scale)</td>
<td>.42</td>
</tr>
<tr>
<td>Study 3 – ASI-3</td>
<td>.41</td>
</tr>
<tr>
<td>Study 3 – SS-ASI-3</td>
<td>.35</td>
</tr>
</tbody>
</table>

Note. ASI = Anxiety Sensitivity Index, ASI-R = Anxiety Sensitivity Index – Revised, ASI-3 = Anxiety Sensitivity Index – 3, SS = Short Scale.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>MAXEIG</th>
<th>MAMBAC</th>
<th>L-Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASI</td>
<td>.14 (.06)</td>
<td>.32 (.06)</td>
<td>.54</td>
</tr>
<tr>
<td>ASI-R</td>
<td>.07 (.02)</td>
<td>.22 (.06)</td>
<td>.51</td>
</tr>
<tr>
<td>ASI-3</td>
<td>.13 (.04)</td>
<td>.25 (.05)</td>
<td>.49</td>
</tr>
</tbody>
</table>

Note. ASI = Anxiety Sensitivity Index, ASI-R = Anxiety Sensitivity Index – Revised, ASI-3 = Anxiety Sensitivity Index – 3.
indicators were low (average correlation of .22 for the putative taxon class and .24 for the non-taxon class), and, as is desirable, the average correlation among the indicators in the full sample was significantly higher ($r = .61$). Indicator validities were examined to determine the ability of each indicator to distinguish between groups. Previous research has suggested that indicator validities of 1.25 SD or higher are suitable for taxometric analysis (Meehl, 1995). The validity estimates (Cohen’s $d$) for the three ASI composite indicators were high ($M = 2.10$, range $= 2.01–2.24$).

**RESULTS**

**Suitability Test**

As a preliminary test of the suitability of the three ASI indicators for taxometric analysis, simulated taxonic and dimensional plots were generated to ensure that the data parameters were capable of producing distinguishable results (J. Ruscio et al., 2004). Previous research has suggested that if plots produced by simulated taxonic and dimensional data with similar characteristics to the research data are not differentiable (i.e., both sets appear taxonic or dimensional), then it is unlikely that the research data will be able to provide a clear answer regarding taxonicity. Results of the suitability test revealed that the simulated taxonic data produced plots that were characteristically taxonic in appearance (e.g., peaked distributions in MAXEIG and MAMBAC, bimodal distribution in L-Mode), whereas the simulated dimensional data did not (refer to Figure 1 for examples of simulated taxonic and dimensional plots based on the ASI data). Thus, the three ASI indicators appear to possess good psychometric properties and should yield reliable and interpretable plots when submitted to taxometric analysis.

**ASI Results**

Descriptive statistics for the three ASI indicators are reported in Table 2. The curves generated by the ASI data were highly consistent with dimensional latent structure. MAXEIG and MAMBAC analyses failed to yield plots with clear peaks that would be expected of a taxonic variable, and L-Mode generated a plot with a clear unimodal distribution. Refer to Table 3 for a summary of the number of individual data plots that were rated as taxonic, dimensional, or ambiguous for each taxometric procedure. A comparison of the ASI data plots with simulated taxonic and dimensional plots revealed that the graphical output for the ASI data strongly resembled the simulated dimensional output. The averaged graphical curves for MAXEIG, MAMBAC, and L-Mode analyses of the ASI indicators are presented in Figure 1. An examination of the MAXEIG and MAMBAC CCFI scores provided objective support for a latent dimension (see Table 5). The MAXEIG ICT provided additional evidence of a dimension with the failure of peaks to emerge with higher numbers of overlapping windows. Thus, the results of three mathematically independent taxometric procedures failed to yield any evidence of a latent AS taxon. Rather, the collective results of Study 1 suggest that AS, as measured by the three ASI indicators, is dimensional at the latent level.

**Study 2**

Although the psychometric properties of the indicators derived from the ASI in Study 1 appeared to be strong and the results were clearly supportive of a latent AS dimension, recent research has suggested that the ASI may not reliably assess the full AS construct. For example, the Social Concerns and Cognitive Concerns subscales of the ASI may contain too few items to reliably assess these fears. In addition, some ASI items do not directly target a single dimension, thus raising concerns regarding the content validity of the scale (Taylor et al., 2007). To address these concerns, researchers developed the ASI-R, which contains more than twice as many items as the original ASI. Thus, to ensure that the dimensional findings of Study 1 could not be attributed to potential limitations of the ASI indicators, a second study was conducted in another large nonclinical sample using indicators derived from the ASI-R.

**METHOD**

**Participants**

Participants consisted of 2,173 undergraduates from a large university. Participants ranged in age from 18 to 72 ($M = 20.99$, $SD = 6.92$) and were predominately female (65%) and Caucasian (73%). Participants were given course credit in exchange for completing a series of psychological assessment instruments, which included the ASI-R.

**Measure**

ASI-R. The ASI-R is a self-report questionnaire that assesses fear of anxiety and anxiety-related sensations. The revised version of the ASI consists of 36 questions (including 10 items from the original ASI), and assesses in greater depth the major subcomponents of AS. Exploratory factor analysis has provided evidence for a hierarchical structure of the ASI-R, assessing a general AS factor and four lower-order factors (Deacon et al., 2003; Taylor & Cox, 1998). Construct validity for the
FIGURE 2  Averaged MAXEIG (top), MAMBAC (middle), and L-Mode (bottom) plots for the Anxiety Sensitivity Index - Revised data, simulated taxonic data (center), and simulated dimensional data (right).
ASI-R has been established based on significant correlations with the original version of the ASI ($r=.94$; Taylor & Cox, 1998). The ASI-R has also been shown to display adequate criterion validity, in that patients with anxiety disorder diagnoses tend to score higher than nonpatients (e.g., Deacon & Abramowitz, 2006).

**ASI-R Indicator Selection**

Factor analytic studies have indicated that the ASI-R assesses four lower-order factors: (1) fear of respiratory symptoms; (2) fear of publicly observable anxiety reactions; (3) fear of cardiovascular symptoms; (4) fear of cognitive dyscontrol (Taylor & Cox, 1998). At least two previous AS taxometric studies have employed indicators that were created by summing items that loaded on each of these four lower-order factors (e.g., Bernstein et al., 2006; Broman-Fulks et al., 2008). Although these studies used indicators derived from similar methods, Bernstein and colleagues (2006) reported evidence of taxonic latent structure, whereas Broman-Fulks et al. (2008) concluded that AS was dimensional in nature. Thus, in an attempt to address the discrepant findings of previous research, Study 2 also employed four ASI-R indicators representing total scores on each of the four lower-order factors.

Nuisance correlations among the ASI-R composite indicators were acceptable and evenly distributed across the putative taxon ($r=.28$) for the taxon and nontaxon ($r=.27$) groups. Furthermore, the average correlation among indicators in the total sample was substantially higher ($r=.59$), and the indicators appeared to be highly valid ($M=2.20$, range $=1.82–2.35$).

**RESULTS**

The results of the suitability test supported the ability of the four ASI-R indicators to discriminate between taxonic and dimensional data in MAXEIG and L-Mode. Simulated taxonic data yielded peaked MAXEIG plots and a bimodal L-Mode distribution, whereas the simulated dimensional plots did not. However, the simulated taxonic and dimensional MAMBAC plots were not readily distinguishable, and thus caution is warranted in interpreting MAMBAC output. Refer to Table 2 for descriptive statistics of the four ASI-R indicators and Figure 2 for the averaged graphical curves for MAXEIG, MAMBAC, and L-Mode analyses of the ASI-R data. Consistent with the results of Study 1, data plots generated by the ASI-R indicators closely matched the simulated dimensional plots and failed to produce any peaks that would be indicative of a taxon (see Table 3). All of the MAXEIG and MAMBAC plots were rated as consistent with a latent dimension. However, the L-Mode plot was rated as ambiguous as it was not clearly consistent taxonic or dimensional in shape. The MAXEIG ICT provided further evidence of dimensional structure, with MAXEIG plots failing to peak with increasing numbers of windows. In addition, the MAXEIG and MAMBAC CCFI scores for the ASI-R data provided objective support for a latent dimension (see Table 4). Thus, these findings complement those of Study 1 in suggesting that AS is a dimensional construct.

**Study 3**

Although the ASI-R has more than double the number of items than the original ASI and is believed to more thoroughly assess the subcomponents of AS, the ASI-R also had several notable limitations. For example, some research suggests that the factor structure of the ASI-R is relatively unstable, with several studies reporting different factor structures (e.g., Deacon et al., 2003; Zvolensky et al., 2003). To address these issues, researchers recently developed the ASI-3 via factor analysis to assess the three facets of AS that have been most frequently replicated in the literature: Physical, Cognitive, and Social Concerns (Taylor et al., 2007). Results from an initial evaluation of the psychometric properties of the ASI-3 indicate that the ASI-3 has good reliability and validity, and is superior to the original ASI in several ways (e.g., better internal consistency and factorial validity). Despite the improved psychometric properties of the ASI-3, researchers have yet to apply taxometric procedures to the ASI-3. Thus, the purpose of Study 3 was to extend previous taxometric research by examining the latent structure of AS using indicators representing physical, cognitive, and social concerns as assessed by the ASI-3.

**METHOD**

**Participants**

Participants consisted of a large university sample of 1,462 students. Participants ranged in age from 18 to 49 ($M=19.35$, $SD=2.61$) and were predominately female (59%) and Caucasian (85%). Participants completed the ASI-3 as part of a battery of questionnaires and received course credit for their participation.

**Measure**

ASI-3. The ASI-3 (Taylor et al., 2007) is the third in a series of ASI revisions. The ASI-3 consists of 18 items empirically selected from the ASI-R to most effectively and efficiently assess a general AS factor and the three lower order
factors. Initial evaluation of the ASI-3 has demonstrated that it possesses good psychometric properties, including convergent, discriminant, and criterion-related validity (refer to Taylor et al. for a detailed discussion of the ASI-3’s psychometric properties).

**FIGURE 3** Averaged MAXEIG (top), MAMBAC (middle), and L-Mode (bottom) plots for the Anxiety Sensitivity Index - 3 data, simulated taxonic data (center), and simulated dimensional data (right).
ASI-3 Indicator Selection

Three indicators were created by summing the items that loaded on each subscale (Physical Concerns, Social Concerns, and Psychological Concerns). Analysis of the nuisance covariance of ASI-3 indicators revealed low correlations across the putative taxon ($r = .12$) for the taxon and nontaxon ($r = .20$) groups, with a substantially higher total sample correlation ($r = .56$). In addition, the indicators appeared to be highly valid ($M = 2.23$, range = 2.12–2.35).

RESULTS

The results of the suitability test revealed that the simulated taxonic and dimensional data plots were clearly distinguishable, thus confirming the appropriateness of the ASI-3 data for taxometric analysis. Refer to Table 2 for the descriptive statistics of the three ASI-3 indicators and Figure 3 for the averaged MAXEIG, MAMBAC, and L-Mode curves. Results were consistent with Study 1 and Study 2. The ASI-3 data plots took a characteristically dimensional shape and were highly consistent with the simulated dimensional plots (refer to Table 3). The ICT and CCFI scores also provided consistent support for a dimensional solution (Table 5). Thus, the cumulative findings of Studies 1, 2, and 3 provide convergent evidence that AS is dimensional at the latent level.

Taxometric Analyses Without Social Concerns Items

Several previous AS taxometric studies have suggested that items designed to assess the social concerns facet of AS do not discriminate well between putative AS taxon and nontaxon classes (e.g., Bernstein, Zvolensky, Stewart, et al., 2007; Bernstein, Zvolensky, Weems, et al., 2005). To ensure that the dimensional findings presented in Studies 1–3 (above) were not attributable to the inclusion of a problematic indicator, additional analyses were conducted on each dataset with social concerns items excluded from the analyses. Because a minimum of three manifest indicators are required to conduct multiple taxometric analyses, a short scale approach was taken with the ASI data from Study 1 and ASI-3 data from Study 3. Specifically, after extracting items representing the social concerns subscales of the ASI and ASI-3, taxometric analyses were conducted using the remaining items as individual indicators. In contrast, the ASI-R has four subscales, and thus the indicator representing the Publicly Observable Anxiety Reactions scale was simply removed, and taxometric analyses were conducted on the three remaining ASI-R subscale indicators from the Study 2 data. The results of the analyses that excluded social concerns items were highly consistent with the findings from Studies 1–3 that included these items. Specifically, the shapes of the plots generated by the research data did not substantially change. Refer to Figures 4–6 for averaged MAXEIG, MAMBAC, and L-Mode curves based on the research data, as well as those generated by simulated taxonic and dimensional data for comparison. In addition, the objective CCFI scores continued to support a dimensional solution (see Table 5). Thus, the dimensional findings reported in Studies 1–3 do not appear to be attributable to the inclusion of indicators representing AS social concerns.

General Discussion

Three taxometric studies of AS were conducted using three mathematically independent taxometric procedures applied to AS data collected from several large samples using three of the most popular measures of AS. The collective results from these studies yielded consistent evidence that AS is dimensional, rather than categorical, at the latent level. These findings are consistent with the results of a recent study by Broman-Fulks et al. (2008), but contradict the taxonic findings reported in a series of studies by Bernstein and colleagues. Although the exact source of the discrepant findings among the studies reporting taxonic versus dimensional structure remains unclear, several methodological limitations of previous AS taxometric studies have been identified and may help to provide some insight.

Several previous AS taxometric studies reporting taxonic findings have implemented the MAXCOV procedure with nonoverlapping windows as the primary method of analysis (e.g., Bernstein, Zvolensky, Feldner, et al., 2005; Bernstein, Zvolensky, Weems, et al., 2005). However, the use of MAXCOV with nonoverlapping intervals constrains the number of data points on resulting MAXCOV plots, thereby raising concerns about the interpretability of the plots. In addition, previous research has suggested that the MAXCOV procedure can generate pseudotaxonic results when applied to dimensional data represented by indicators with skewed distributions (J. Ruscio & Ruscio, 2002). In contrast, the MAXEIG procedure (the multivariate extension of MAXCOV) with overlapping windows produces a far greater number of data points, and thus may increase the ability to distinguish between a taxon and dimension when skewed indicators are used (J. Ruscio et al., 2004).

A second notable limitation in the AS taxometric literature lies in the consistency tests that have or have not been implemented to support the primary method of taxometric analysis. For example, although a number of taxometric procedures exist that could potentially serve as consistency...
tests, some previous AS taxometric studies have elected to use MAXCOV and MAXEIG as consistency tests for one another (e.g., Bernstein, Zvolensky, Norton, et al., 2007; Schmidt et al., 2005). MAXEIG is generally recognized as an inappropriate consistency test for MAXCOV due

FIGURE 4 Averaged MAXEIG (top), MAMBAC (middle), and L-Mode (bottom) plots for the short scale Anxiety Sensitivity Index data which did not include items on the Social Concerns subscale, accompanied by simulated taxonic data (center) and simulated dimensional data (right).
FIGURE 5  Averaged MAXEIG (top), MAMBAC (middle), and L-Mode (bottom) plots for the Anxiety Sensitivity Index - Revised data after extracting the Publicly Observable Anxiety Reactions subscale indicator, accompanied by simulated taxonic data (center) and simulated dimensional data (right).
to the high degree of overlap among the procedures (MAXEIG is a multivariate extension of MAX-COV; Bernstein, Zvolesnky, Feldner, et al., 2005; Waller & Meehl, 1998). When MAMBAC has been used as a consistency test for MAXEIG or MAXCOV, the simulated taxonic and dimensional data.
MAMBAC curves have rarely been distinguishable (e.g., Bernstein, Zvolensky, Feldner, et al., 2005; Bernstein, Zvolensky, Kotov, et al., 2006; Bernstein, Zvolensky, Stewart, et al., 2006; Bernstein, Zvolensky, Stewart, & Comeau, 2007; Schmidt et al., 2005), suggesting that in those cases MAMBAC may not have been able to effectively discriminate between a low base rate taxon and a dimension. In some instances, researchers have noted the apparent unsuitability of MAMBAC tests and omitted these results from their reports. However, numerous other consistency tests, both within and across procedures, are available in the literature. For example, in confirming the presence of a taxon using the MAXCOV procedure alone, one could examine the consistency of the estimated Hitmax cut values on a given input variable as function of every possible output variable or evaluate the consistency of the estimated taxon and nontaxon group means or variances on an output variable as function of every possible input variable. For a more stringent test of a proposed taxon, Meehl (1995) recommended comparing the results of different indicator sets through different taxometric procedures and looking for coherence. Clearly, more rigorous consistency testing procedures are warranted among AS taxometric studies, particularly those attempting to confirm the presence of a taxon.

Most notably, objective measures of the output curve shapes (e.g., CCFI scores) have not been implemented in previous AS taxometric studies reporting taxonic findings, likely due to the relatively recent development of such procedures. Yet, objective analytic procedures have the potential to serve as powerful tools in improving the reliability of taxometric output interpretation by minimizing the risk of errors associated with subjective interpretation strategies (e.g., interpreter biases). For example, recent research suggests that the CCFI classification technique is as good as or better than alternative approaches to interpreting taxometric data plots (J. Ruscio, 2007; J. Ruscio et al., 2007), and it is highly effective in discriminating small base rate taxa (J. Ruscio & Marcus, 2007). To date, both taxometric analyses of AS that have implemented the objective index of plot shape have reported consistent evidence supportive of a dimensional solution. Thus, it is possible that had objective plot interpretation strategies been implemented in previous research, evidence contraindicating a taxonic solution may have emerged.

A dimensional conceptualization of AS has several important implications for our understanding of the phenomenon. For example, dimensional findings indicate that researchers should avoid attempting to classify participants and patients into categories (e.g., pathological versus normal AS) based on AS scores. Based on initial research suggesting that AS may be taxonic, researchers developed and examined the utility of several ASI Taxon Scales, which consist of different combinations of eight of the original 16 items extracted from the ASI (Bernstein, Zvolensky, Feldner, Lewis, et al., 2005), in predicting psychosocial outcomes (e.g., PTSD; Bernstein et al., 2005). Although results have suggested these ASI Taxon Scales (8 items from the ASI) may account for significant variance beyond full scale ASI scores in predicting PTSD-related symptomology, these findings do not necessarily support the existence of an AS taxon. Rather, some of the items that make up the ASI Taxon Scales may simply be the more sensitive ASI items for evaluating the negative outcomes that have been theoretically linked with AS (e.g., panic, PTSD). Indeed, recent research using Item Response Theory (IRT) methodology suggests that five of the eight items used to form the various ASI Taxon Scales performed well in the IRT analyses of a sample of adult smokers (Zvolensky, Strong, Bernstein, Vujanovic, & Marshall, 2009). Additional IRT analyses using other nonclinical and clinical samples would be useful in further evaluating the discriminant ability of specific AS items and their ability to predict negative psychosocial outcomes.

A dimensional formulation of AS would suggest that measures designed to dichotomize individuals into groups based on AS scores would be inappropriate. Rather, AS assessment instruments should be designed to be equally reliable and discriminating across the full spectrum of AS. Furthermore, if AS is indeed dimensional at the latent level, any categorical classification made based on AS scores would represent an artificial dichotomization of a continuous variable and may result in distorted findings or a loss of potentially important information (Cohen, 1983). AS researchers would be better served by implementing research designs that include the full continuum of AS and statistical procedures that do not necessitate the artificial dichotomization of a dimensional variable. Further research will be needed to clarify the utility of the ASI Taxon Scale as a general measure of AS, particularly as it compares to the traditional measures of AS (e.g., ASI, ASI-R, ASI-3).

A dimensional conceptualization of AS also provides some direction for investigations into the etiology of AS. If AS is not comprised of underlying latent categories, then etiological models that posit discontinuity (e.g., experiencing a dichotomous causal factor means having the pathological form
of AS) would be inadequate (Haslam et al., 2006). Rather, dimensional variables are generally characterized by a multifactorial etiology (Haslam, 1997). Thus, etiological models of AS should focus on identifying the various environmental and/or genetic factors that contribute to a person’s position on an AS continuum.

In sum, the present research provided convergent evidence that individuals differ quantitatively, rather than qualitatively, in their experience of anxiety symptom fears. However, additional research is clearly warranted to resolve the emerging controversy in the AS literature over the most accurate conceptualization of the latent structure of AS. The importance of such research should not be underestimated, as it will have important implications for the design, selection, and use of appropriate assessment instruments, and help to inform AS research methodology and the search for variables associated with the etiology of AS.

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