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Examining the Latent Structure of Anxiety Sensitivity in Adolescents using Factor Mixture Modeling

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Abstract

Anxiety sensitivity has been implicated as an important risk factor, generalizable to most anxiety disorders. In adults, factor mixture modeling has been used to demonstrate that anxiety sensitivity is best conceptualized as categorical between individuals. That is, whereas most adults appear to possess normative levels of anxiety sensitivity, a small subset of the population appears to possess abnormally high levels of anxiety sensitivity. Further, those in the high anxiety sensitivity group are at increased risk of having high levels of anxiety and of having an anxiety disorder. This study was designed to determine whether these findings extend to adolescents. Factor mixture modeling was used to examine the best fitting model of anxiety sensitivity in a sample of 277 adolescents (M age = 11.0, SD = .81). Consistent with research in adults, the best fitting model consisted of two classes, one containing adolescents with high levels of anxiety sensitivity (n = 25), and another containing adolescents with normative levels of anxiety sensitivity (n = 252). Examination of anxiety sensitivity subscales revealed that the social concerns subscale was not important for classification of individuals. Convergent and discriminant validity of anxiety sensitivity classes were found in that membership in the high anxiety sensitivity class was associated with higher mean levels of anxiety symptoms, controlling for depression and externalizing problems, and was not associated with higher mean levels of depression or externalizing symptoms controlling for anxiety problems.

Keywords

anxiety sensitivity; factor mixture modeling; adolescent; anxiety symptoms

Prevalence rates of anxiety disorders in epidemiological child and adolescent samples are estimated to range from 10 to 20%, rates that are at or near the top for psychopathological disorders present across childhood (Achenbach, Howell, McConaughy, & Stanger, 1998; Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Shaffer et al., 1996). Developing an anxiety disorder in childhood increases the likelihood of developing later anxiety and depression problems (e.g., Costello et al., 2003). Further, well-documented difficulties in

social and academic settings accompany anxiety symptoms in childhood (Albano, Chorpita, & Barlow, 2003; Copeland, Shanahan, Costello, & Angold, 2009; Rapee, Schniering, & Hudson, 2009). The high prevalence and impairment associated with these disorders highlight the importance of identifying malleable anxiety related risk factors. Anxiety sensitivity (AS), the fear of experiencing anxiety or anxiety-related physiological sensations, and the social, psychological, or physical consequences that accompany these sensations (McNally, 2002; Reiss & McNally, 1985; Taylor, 1995), appears to be such a risk factor.

The Latent Structure of Anxiety Sensitivity

The identification of AS as a risk factor has spurred efforts to ensure that the measurement model of AS closely approximates the underlying latent structure of AS. Researchers have typically approached the task of identifying the latent structure of AS in two non-overlapping approaches (Bernstein, Zvolensky, Stewart, Comeau, & Leen-Feldner, 2006). Factor analytic research has been used to determine the relation between a set of observed indicators (i.e., test items) and latent variables believed to represent the construct of interest (Brown, 2006). Confirmatory factor analyses (CFAs) conducted on diverse child, adolescent, and adult samples using multiple measures have converged upon a hierarchical model of AS, consisting of a general “fear of anxiety” factor at the apex and several distinct but related lower-order factors (e.g., Lilienfeld, Turner, & Jacob, 1993; Silverman, Goedhart, Barrett, & Turner, 2003; van Widenfelt, Sieblink, Goedhart, & Treffers, 2002). The preponderance of evidence supports three lower-order dimensions, cognitive concerns, physical concerns, and social concerns (e.g., Essau, Sasagawa, & Ollendick, 2010; Silverman, Ginsburg, & Goedhart, 1999; van Widenfelt et al., 2002), with some debate as to whether physical concerns is best conceptualized as a single dimension or as multiple dimensions (e.g., Silverman et al., 2003; Taylor, Rabian, & Federoff, 1999). Therefore, for the most part, research on AS has arrived on a generally agreed upon hierarchical factor structure (Zinbarg, Barlow, & Brown, 1997).

There is less consensus regarding the structure of AS within individuals (i.e., dimensional or categorical). Using taxometrics methods, researchers attempted to determine whether AS comprises qualitatively different classes of individuals (e.g., Asmundson, Weeks, Carleton, Thibodeau, & Fetzner, 2011; Bernstein, Zvolensky, Kotov et al., 2006; Broman-Fulks et al., 2008). In taxometric studies including adult and child samples, Bernstein and colleagues reported that AS was comprised of two classes (taxons), a normative AS class, consisting of 82 to 91% of individuals with adaptive levels of AS, and a high AS class, consisting of 9 to 18% with elevated and presumably maladaptive levels of AS. These findings have been replicated in diverse samples, including those representing different cultures and geographical locations and in specialized samples, such as military cadets (Bernstein, Zvolensky, Kotov et al., 2006; Schmidt, Kotov, Lerew, Joiner, & Ialongo, 2005; Bernstein, Leen-Feldner, Kotov, Schmidt, & Zvolensky, 2006; Bernstein, Zvolensky, Stewart, & Comeau, 2007). In contrast to these findings, several researchers, also using taxometrics, failed to find evidence for distinct AS classes in adult samples (e.g., Asmundson et al., 2011; Broman-Fulks et al., 2008, 2010).

There are several methodological shortcomings of the taxometrics approach, particularly when the theorized structure of AS is considered, that may account for the discrepant findings across studies. Factor mixture modeling (FMM; Bauer & Curran, 2004; Lubke & Muthén, 2005), is a relatively new methodological procedure capable of addressing some of the shortcomings present in methods such as taxometrics. For example, taxometric analyses assume local independence, meaning that once individuals are placed within a class, scores are assumed invariant between individuals within the class (Bauer & Curran, 2004). In contrast, FMM allows for variability in scores within as well as between classes (Lubke & Muthén, 2005). Relevant to AS, FMM does not operate under the assumption that individuals classified in the high AS class have identical factor scores, though it has the flexibility to allow invariance if it was supported by the data. Taxometric analyses also assume no associations between indicators once class membership has been accounted for. In contrast, FMM allows for the modeling of the underlying dimensionality of AS which is reflected by the lower-order social concerns, cognitive concerns, and physical concerns dimensions. Finally, whereas the application and interpretation of taxometrics can be arbitrary to some degree (Bauer & Curran, 2004; Ruscio, Haslam, & Ruscio, 2006), FMM is founded within the structural equation modeling (SEM) framework, and as such, application and interpretation of models are conducted in a highly standardized manner, using model fit indices to compare different class structures (Lubke & Muthén, 2005). The only simulation study to date comparing these methods provided support for the value of FMM over taxometrics in that FMM outperformed taxometrics analysis in determining factor structure and class assignment (Lubke & Tueller, 2010). In sum, FMM offers specific advantages over taxometrics methods in the examination of the structure of AS.

To date, there are only two studies that have used FMM to determine the underlying structure of AS. In a sample of 634 young adults, predominantly university students (M age = 21.3 years, SD = 5.4 years), Bernstein et al. (2010) evaluated the factor structure of the Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007). They found that a two-class, three-factor model best fit the data. The three factors, physical concerns, cognitive concerns, and social concerns, were consistent with previous CFAs of the ASI-3 and other measures of AS (e.g., Essau et al., 2010; Silverman et al., 1999; Zinbarg et al., 1997). The first class, consisting of individuals with elevated levels of AS (high AS class) comprised 12% of the sample (n = 78). The second class, consisting of individuals with non-elevated levels of AS (normative AS class) comprised the remainder of the sample (88%; n = 556). Bernstein, Stickle, and Schmidt (2013) evaluated the factor structure of the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986) in an outpatient sample of 481 adults (M age = 36.6 years, SD = 15.0 years). This study also found that a two-class, three-factor model best fit the data. Once again, there was evidence for a class of individuals with elevated levels of AS, comprising 19% (n = 91) of the sample, and a class of individuals with normative levels of AS, comprising 81% (n = 399) of the sample. These studies provide further support that individuals are best classified categorically as high or normal AS classes. However, because there are only two studies, and both of these studies were conducted on adult samples, research is needed to determine whether this class structure emerges in children and adolescents.

AS and Psychopathology

A greater understanding of how best to conceptualize AS structurally should prove useful in refining the relations between AS and psychopathology. There is evidence that AS is a risk factor, specific to anxiety in children and adolescents. A recent meta-analysis of AS in children and adolescents by Noël and Francis (2011) found that, controlling for comorbid depression symptoms, gender, and either state or trait anxiety or physiological symptoms, higher levels of AS were associated with higher levels of anxiety symptoms. Further, mean AS levels in youth diagnosed with an anxiety disorder were higher than mean levels of AS in youth without an anxiety disorder diagnosis. Several prospective studies in child and adolescent samples have reported that AS influences the development of anxiety symptoms and disorders over time, controlling for depression, and not the development of major depressive disorder (MDD) and depression symptoms, controlling for anxiety (e.g., Hayward, Killen, Kraemer, & Taylor, 2000; McLaughlin & Hatzenbuehler, 2009). There are few studies that have examined the relations between AS and other psychopathology in children and adolescents. Rabian, Peterson, Richters, and Jensen (1993) compared mean AS levels in children diagnosed with an anxiety disorder, children diagnosed with an externalizing disorder, and nondiagnosed control children. Whereas they found that children diagnosed with an anxiety disorder had higher mean-level AS scores than did children in the control group, they did not find mean differences between those with an anxiety disorder and those with an externalizing disorder. In contrast, using SEM, Bilgiç et al. (2013) found few relations between AS and externalizing problems, including inattention, hyperactivity, oppositional defiant behavior, and conduct problems in a sample of children diagnosed with attention-deficit hyperactivity disorder (ADHD). Whereas there is ample evidence linking AS and anxiety, the relations between AS and depression and externalizing behaviors are less clear.

Given the relations between AS and anxiety, categorizing individuals in classes using FMM may provide incremental utility, beyond that provided by classifying individuals continuously, in exploring the relations between AS and anxiety. Only one study, in an adult sample, has examined the relations between FMM-derived classes and anxiety. Because their sample was recruited to be a clinical sample, Bernstein et al. (2013) had a large proportion of individuals with Axis I diagnoses. They used logistic regression to examine risk for anxiety disorders as a function of FMM-derived AS class. Bernstein et al. found that the odds of having current panic disorder (PD), post-traumatic stress disorder (PTSD), social anxiety disorder (SAD), obsessive compulsive disorder (OCD), generalized anxiety disorder (GAD), and specific phobia was increased compared to the odds of being undiagnosed, in the high AS class relative to the normative AS class. Currently, this is the only study directly examining the utility of FMM-derived AS classes for predicting anxiety symptoms.

There are a few studies in adults that have demonstrated the utility of the high AS class, as derived from taxometrics, in that high AS class has been linked to elevated PTSD and panic symptoms (e.g., Bernstein, Leen Feldner, Kotov, Schmidt, & Zvolensky, 2006; Schmidt et al., 2005; Zvolensky, Forsyth, Bernstein, & Leen-Feldner, 2007; Bernstein, Zvolensky, Feldner, Lewis, Fauber, et al., 2005). Two studies have used scores based on the FMM classification to examine convergent validity (e.g., Bernstein, Cárdenas, Coy, & Zvolensky,

2011; Zvielli, Bernstein, & Berenz, 2012). Bernstein et al. (2011) used a FMM-derived cut-score from the aggregated cognitive concerns and physical concerns subscales of the ASI-3 (from Bernstein et al., 2010) to classify individuals into a high AS class and a normative AS class. They compared base rates of high AS class status between a university sample and a clinical sample for which all participants had received an anxiety disorder diagnosis and found a much higher base rate among the clinical sample ($n = 118$ out of 150, 78%) as compared to the university sample ($n = 32$ out of 150, 21%). Using a more conservative method of estimating high and normative AS by excluding an “in-between” class, 17.3% ($n = 24$) of the university sample and 67% ($n = 87$) of the clinical sample were classified in the high group. Classification in the high AS group was associated with an increased risk for panic attacks as compared to those classified in the normative AS class. Zvielli et al. (2012) also used FMM-derived cut-scores (also from Bernstein et al., 2010) of the ASI-3 cognitive concerns and physical concerns subscales to form high ($n = 28$) and normative ($n = 70$) AS classes in a sample of trauma-exposed adults. They found that, compared to the normative AS class, the high AS class had elevated instances of PD, MDD, and PTSD diagnoses and past-month MDD, GAD, PTSD, and panic attacks were found almost exclusively in the high AS class. Currently, no studies have examined the validity for the high AS class in children and adolescents when the class is derived directly from FMM methods.

Latent Structure Differences across Anxiety Sensitivity Dimensions

Further investigation regarding the latent structure of AS should also be considered in light of research indicating that the social concerns dimension of AS may have a different underlying latent structure within individuals than the cognitive concerns and physical concerns dimensions. Using taxometrics in a sample of 4,462 adolescents, Bernstein et al. (2007) found that AS social concerns did not discriminate between AS classes. Other taxometric studies in adult and youth samples have similarly reported that social concerns items do not discriminate between classes (Bernstein, Zvolensky, Weems, Stickle, & Leen-Feldner, 2005; Zvolensky et al., 2007). In a sample of university students, Bernstein et al. (2010) determined that both cognitive concerns and physical concerns predicted FMM-derived AS class membership, but that social concerns did not. In contrast, Bernstein et al. (2013) found that all three dimensions predicted AS class membership in a sample of adult outpatients. However, they speculated that this may relate to the elevated rates of SAD in their sample generally, and particularly in those classified in the high AS class. Support for this supposition is provided in that there is some evidence that individual differences in the AS social concerns dimensions are specific to social anxiety symptoms (e.g., Zinbarg et al., 1997). Although these findings suggest that AS social concerns may not play an important role in the classification of individuals into high and normative AS classes, more work is needed, especially in adolescents, given the lack of FMM studies in this population.

The Current Study

The primary objective of the current study was to validate the FMM-based latent class model of AS in adolescents. Currently, only two studies have examined the class structure of AS using FMM, and both of these studies were in adult samples. This study was the first to use FMM to classify adolescents by AS levels. Based on past taxometrics studies in children

and adults, as well as FMM studies specific to adults, (e.g., Bernstein, Leen-Feldner, et al., 2006; Bernstein et al., 2007, 2010) it was expected that a two-class model of AS would emerge. The first class was hypothesized to comprise adolescents high in AS, with a prevalence rate of roughly 9 to 18% of the sample. The second class was hypothesized to comprise adolescents with normative levels of AS, containing the majority of adolescents in the sample. This study was also concerned with determining whether all AS subscales were categorical within individuals. Bernstein et al. (2010) found that AS social concerns was not a significant predictor of AS class membership in a sample of university students. Therefore, it was expected that levels of social concerns would not differ across AS classes, but that levels of cognitive concerns and physical concerns would.

To provide convergent and discriminant validity for the AS classes, concurrent levels of anxiety psychopathology, depressive symptoms, and externalizing symptoms were compared between classes. Based on the previous FMM study in adults (e.g., Bernstein et al., 2013), and studies that have found significant relations between AS and anxiety and between AS class and anxiety (e.g., Noël and Francis, 2011; Zvielli et al., 2012), it was hypothesized that there would be significant differences in anxiety symptom levels, controlling for other psychopathology, such that adolescents in the high AS class would have significantly higher anxiety symptom levels than would adolescents in the normative AS class. Based on the discriminant validity that has been demonstrated for AS (e.g., Bernstein et al., 2013; McLaughlin & Hatzenbuehler, 2009), it was further hypothesized that there would not be significant differences in levels of depression symptoms and externalizing symptoms between the high and normative AS classes, controlling for other psychopathology.

Method

Participants

Participants were a community sample of 277 early adolescents (M age = 11.0 years, SD = .81) and their primary caregivers (80.5% mothers) recruited through media outreach and mailings to local schools, libraries, and Boys and Girls Clubs in a large northeast metropolitan area. Participants were recruited to participate in a prospective study advertised as investigating youth health-related behaviors. The sample consisted of 156 male and 121 female participants, and was 48.9% Caucasian, 35.5% African American, 2.9% Hispanic, 1.4% Asian, 0.4% Native American, 10.9% biracial or other, and 0.4% failing to report. Mean income reported by parents (N = 264) was \$93,700 (SD = \$74,019). Of the data used for classifying adolescents into classes, one adolescent was missing data for one variable. Because Full Information Maximum Likelihood (FIML) was used as the estimator in analysis, which can handle missing data, this adolescent was included. For the outcome variables, from 0 to 5 adolescents had missing data.

Measures

A demographic form was completed by each child's parent or guardian. The forms contained personal information as well as information about the child. These forms included

gender, age, race, family income, as well as status of biological father's presence in the home.

The Childhood Anxiety Sensitivity Index (CASI; Silverman, Fleisig, Rabian, & Peterson, 1991)—The Childhood Anxiety Sensitivity Index (CASI; Silverman et al., 1991) is an 18-item self-report measure of AS in children adapted from the 16-item adult version (Reiss et al., 1986), consisting of three subscales, cognitive concerns, physical concerns, and social concerns. There are four items comprising both the cognitive concerns (e.g., “When I am afraid, I worry that I might be going crazy”) and the social concerns subscales (e.g., “I don’t want people to know I’m afraid”). There are ten items comprising the physical concerns subscale (e.g., “It scares me when my heart beats fast”). Items are rated on a 3-point Likert-like scale (none, some, and a lot). The scale was adapted for and validated with a child and adolescent population and has demonstrated adequate reliability and validity in these populations, with reliability estimates ranging from .82 to .84 across subscales (Silverman et al., 1991; Walsh, Stewart, McLaughlin, & Comeau, 2004). In the current sample, reliability estimates were low for the cognitive concerns ($\alpha = .66$) and social concerns subscale ($\alpha = .48$). Reliability was adequate for the physical concerns subscale ($\alpha = .81$).

The Revised Child Anxiety and Depression Scales (RCADS; Chorpita & Daleiden, 2000)—The RCADS measures Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV text revision; American Psychiatric Association, 2000) symptoms of anxiety disorders and MDD. The RCADS contains ten items measuring MDD (e.g., “I feel sad or empty”), nine items measuring SP (e.g., “I am afraid of looking foolish in front of people”) and PD (e.g., “My heart suddenly beats too quickly for no reason”), seven items measuring SAD (e.g., “I fear being away from my parents”) and six items measuring GAD (e.g., “I worry that bad things will happen to myself”) and OCD (e.g., “I have to do things just right to stop bad things”). Children are asked to rate their symptoms on a 4-point Likert-like scale (never, sometimes, often, and always). A Total Anxiety score was obtained by aggregating the individual anxiety disorder items. A score for MDD was obtained by aggregating all MDD items. Convergent validity with similar symptom measures of anxiety and depression as well as anxiety disorders has been demonstrated (Chorpita & Daleiden, 2000). In the current sample, reliability estimates were adequate (α 's = .93 for Total Anxiety and .82 for MDD).

The Disruptive Behavior Disorder scale (DBD; Pelham, Gnagy, Greenslade, & Milich, 1992)—The DBD measures DSM-IV symptoms of attention-deficit/hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), and conduct disorder (CD). The DBD contains 45 items measuring externalizing behavior problems. According to the authors, factor scores can be created from eight items for oppositional/defiant behavior (i.e., often argues with adults), and nine items each for inattention (i.e., is often easily distracted by extraneous stimuli), and impulsivity/overactivity (i.e., often talks excessively). Parents were asked to rate their children's symptoms on a 4-point Likert-like scale (not at all, just a little, pretty much, and very much). A total externalizing behavior score was created by aggregating items for oppositional/defiant behavior, inattention, and impulsivity/overactivity

factors. Reliability and validity has been demonstrated in previous research, and there is evidence that parent report may provide more valid information than child report (Pelham, Fabiano, & Massetti, 2005; Smith, 2007). In the current sample, reliability was excellent ($\alpha = .95$).

Procedure

Informed consent was obtained from parents and children provided assent prior to completing a series of self-report questionnaires as part of a larger battery of assessments (see Daughters et al., 2009) in a private room. Systematic order effects were limited by random ordering of the questionnaires. The assessment session, which also included additional measures not relevant to this study, lasted approximately 1 hour. Participants and their parents were compensated \$25 for their participation.

Data Analytic Procedure

FMM was conducted using MPLUS version 5.1 (Muthén & Muthén, 2008) using FIML to account for missing data and the Yuan-Bentler scaled chi-square ($Y-B \chi^2$) for adjustments to correct standard errors for nonnormality and nonindependence (Yuan & Bentler, 2000). The baseline model was a one-class model consisting of an AS factor represented by cognitive concerns, physical concerns, and social concerns subscales treated as continuous indicators, which is consistent with the factor structure typically reported for the CASI (i.e., comprised of cognitive concerns, physical concerns, and social concerns subscales; Walsh et al., 2004; Wright et al., 2010). Increasingly complex models were modeled, by including more classes as well as by examining measurement invariance. Measurement invariance was examined because restricting factor loadings and intercepts to be invariant across classes when there are actual differences between classes could lead to incorrect classification of some individuals within classes as well as acceptance of more classes than are necessary to explain the data (e.g., Bauer & Curran, 2004). Although only two classes were hypothesized to emerge, models were examined until the fit indices indicated that a model did not provide improved fit over a model with fewer classes. Measurement invariance was then evaluated in the most parsimonious model, beginning with the fully invariant model (i.e., holding intercepts and loadings to equality across classes). In line with Meredith (1993) and Lubke and Muthén (2005), models were tested stepwise, first by allowing factor intercepts to be free across classes while restricting factor loadings to equality, then allowing factor loadings to be free across classes while restricting factor intercepts to equality, and finally by allowing both factor loadings and intercepts to be free across class.

Class enumeration was assessed using empirical and theoretical justification. The Bayesian Information Criterion (BIC; Schwarz, 1978) was used. Smaller BIC values, with differences of 10 or more considered substantive (Raftery, 1995), indicated improved model fit. Akaike's Information Criterion (AIC) was also used, with smaller values indicating better model fit. The Lo-Mendell-Rubin test (LMR-LRT; Lo, Mendell, & Rubin, 2001) provides an analytic approximation of the likelihood ratio test comparing a model with k classes to a model with $k - 1$ class finite mixture model differing only in mean structure. Significant LMR-LRT indicates that the number of classes in the current model is favored over the model with one less class than the current model. The parametric bootstrapped likelihood

ratio test (BLRT; McLachlan & Peel, 2000) uses bootstrapped samples and similarly compares a model with k classes to a model with $k - 1$ classes. Again, a significant BLRT indicates that the model with one less class fits significantly worse than the current model. Finally, entropy is provided, which is a useful assessment of the value and utility of the classes that are extracted (Ramaswamy, Desarbo, Reibstein, & Robinson, 1993). Entropy ranges from 0 to 1 and is a function of the posterior probability values. Higher values indicate that there is better separation between classes (Petras & Masyn, 2010) and that individuals are properly classified (Lubke & Muthén, 2007).

Following selection of the optimal number of classes, all values were exported from MPLUS and CASI subscale scores as well as anxiety, depression, and externalizing symptom levels were compared across classes using analyses of variance (ANOVAs) and analyses of covariance (ANCOVAs) in models including covariates. Analyses for anxiety, depression, and externalizing symptom levels were conducted with covariates included. Anxiety symptoms were examined controlling for age, gender, and depression and externalizing symptoms. Depression symptoms were examined controlling for age, gender, and externalizing and anxiety symptoms. Finally, externalizing symptoms were examined controlling for age, gender, and anxiety and depression symptoms.

Results

Descriptives

Means and standard deviations are provided in the bottom panel of Table 1. Skewness and kurtosis were examined within variables. Based on the recommendations of Kline (2011), skew values were considered problematic if their absolute values were greater than 3 and kurtosis values were considered problematic if their absolute values were greater than 10. No variables were deemed overly skewed or kurtotic for SEM analysis and no corrections were made. Correlations between all variables are provided in Table 1.

Factor Mixture Modeling

We hypothesized that a two-class model of CASI scores would be the best fitting model. Fit indices for models with one through five classes enumerated are provided in Table 2. Models were compared in a stepwise process. First, the best-fitting fully invariant class model was determined. Then, measurement invariance was tested in this best-fitting model by progressively loosening the intercepts and loadings. The two-class model provided improved fit to the data as compared to the one-class model as indicated by the lower AIC and BIC values and the significant LMR-LRT and BLRT values. Further, the entropy value of .95 indicated that much of the population heterogeneity could be explained by this model. The three-class model did not fit better than the two-class model. The AIC was not substantively different between models, the BIC was higher in this model as compared to the two-class model, and the LMR-LRT and BLRT were nonsignificant. Therefore, the two-class model was accepted as the best-fitting model for the underlying class structure of CASI scores. We further examined the fit of the two-class model with increasing freedom of measurement parameters across classes (i.e., intercepts, loadings, and intercepts and loadings). Comparing models revealed that the two-class model with intercepts freed across

classes provided the best fit to the data, as indicated by the lowest AIC and BIC values. There were 25 children (11 girls, 14 boys) classified in the high AS class with a posterior probability of .94. There were 252 children (110 girls, 142 boys) classified in the normative AS class with a posterior probability of .99.

Comparison of CASI subscale scores and Anxiety, Depression, and Externalizing Behavior scales by Class Membership

Table 3 contains comparisons between high AS and normative AS classes across CASI total scale and subscales, anxiety symptoms, depression, and externalizing behaviors. Effect sizes, using partial eta-squared (η^2), with values greater than .01 considered “small”, values greater than .06 considered “medium”, and values greater than .14 considered “large” (Cohen, 1988) are also provided. There were significant differences for CASI total scale scores, $F(1, 276) = 59.43, p < .001$, such that adolescents in the high AS class had higher scores than did adolescents in the normative AS class. A medium effect was found for this difference ($\eta^2 = .18$). To test the hypothesis that CASI cognitive concerns and physical concerns, but not CASI social concerns would be different between classes, subscale scores were compared by class membership to determine if there were significant mean differences in AS subscale scores. There were significant mean differences for CASI cognitive concerns, $F(1, 276) = 354.21, p < .001$, such that adolescents in the high AS class had higher scores than did adolescents in the normative AS class. There were also significant mean differences for CASI physical concerns, $F(1, 276) = 28.55, p < .05$, again, such that adolescents in the high AS class had higher scores than did adolescents in the normative AS class. Large effects were found for CASI cognitive concerns ($\eta^2 = .56$) and medium effects were found for CASI physical concerns ($\eta^2 = .09$). Supporting the hypothesis that the CASI social concerns subscale is a continuous dimension within individuals, there were no significant differences between adolescents by class for this subscale.

To test the hypothesis that inclusion in the high AS class would be associated with higher levels of anxiety symptoms, and not higher levels of depression and externalizing behaviors when controlling for comorbid psychopathology the relation between AS class and anxiety symptoms, total anxiety, depression, and externalizing scale scores were examined controlling for each other as well as age and gender. The relation between AS class and depression and externalizing scale scores were first examined including only age and gender as covariates. As hypothesized, the association between class status was specific to anxiety symptoms when controlling for comorbid psychopathology. Mean levels of anxiety symptoms were higher in adolescents classified as high AS, compared to mean levels of anxiety symptoms in adolescents classified as normative AS. Further, a small effect size for this difference, controlling for the effects of depression and externalizing behaviors, was found ($\eta^2 = .03$).

Discussion

The present study adds to a small body of research using FMM to examine the latent structure of AS. Consistent with previous work in adults, two classes of adolescents emerged, one containing adolescents with high levels of AS, and another containing

adolescents with lower and more normative levels of AS. This study demonstrated that AS class status was associated with anxiety symptoms, such that classification in the high AS class was indicative of higher levels of anxiety symptoms. This study provided further evidence that not all subdimensions of AS appear to be categorical. Whereas cognitive concerns and physical concerns were important in classifying adolescents in either high AS or normative AS groups, social concerns did not differ between adolescents in the high AS versus the normative AS group. Altogether, this suggests that whereas most children possess normative and adaptive levels of AS, there is an important class of children with elevated levels of AS that are also likely to have elevated levels of anxiety symptoms, even after controlling for comorbid depression and externalizing symptoms.

The Latent Structure of Anxiety Sensitivity in Adolescents

The current study is the first to use FMM to determine the class structure of AS in adolescents. According to our findings, AS in adolescents is best represented by two classes, a high AS class, comprising 8.7% of the sample, and a normative AS class, comprising 91.3% of the sample. A two class solution is consistent with the two prior studies that used FMM in adult populations (e.g., Bernstein et al., 2010; Bernstein et al., 2013). Further, point-prevalence rates were similar in our sample and that of Bernstein et al. (2010). They reported that the high AS class comprised 12% of their sample. The high-AS class in Bernstein et al. (2013) was somewhat higher, at 19%; however, this sample included a large majority of individuals seeking treatment for services related to psychological health, and was, therefore a biased sample in that regard. Given the different factors that could result in over- or under-extraction of classes using FMM, and the low likelihood of replicating sample-specific class structures, (Lubke & Spies, 2008), a third study finding a similar two-class model representing AS, using an alternate measure (i.e., the CASI), in a different population (i.e., a community sample of adolescents), provides strong support for the presence of two AS classes.

The finding that there are two classes of AS in adolescents can inform developmental theories of this construct. There are two separate (though not necessarily opposing) theories regarding the development of AS across childhood. The predisposition or trait model of AS posits that AS is a moderately heritable, stable trait (e.g., Reiss & Havercamp, 1992; Stein, Jang, & Livesley, 1999). In this model, adolescents in the high AS class would remain in the high AS class, and children in the normative AS class would remain in the normative AS class. The learning model posits that AS either increases or decreases as a function of “learning” about the consequences of anxiety (e.g., Reiss & McNally, 1985; Schmidt, Lerew, & Joiner, 2000). In this model, the likelihood of children with high levels of AS maintaining these high levels would likely be a function of environmental variables, and not necessarily a function of past AS levels. Whereas our findings do not necessarily rule out a learning model of AS, especially in the normative AS class, the consistent findings of an elevated AS class in this study and in the previous FMM studies in adults (e.g., Bernstein et al., 2010, 2013) provide rudimentary support for the predisposition model, at least in regards to the presence of a high AS class.

Relations between Anxiety Sensitivity Class Status and Psychopathology

In this study, class membership was an important predictor of anxiety symptoms. Although the effect was small, adolescents in the high AS class possessed higher levels of anxiety symptoms, robust to the effects of comorbid depression symptoms and externalizing behaviors. Further, levels of anxiety on the RCADS in the high AS class ($M = 30.27$) were similar to levels of anxiety on the RCADS ($M = 33.02$) in children diagnosed with an anxiety disorder (Chorpita, Moffitt, & Gray, 2005). These findings replicate past studies that examined the relations between FMM-derived classes or classes created from FMM-derived cut-scores and anxiety in adults (e.g., Bernstein et al., 2013; Zvielli et al., 2012). Weems, Hayward, Killen, and Taylor (2002) also provide support for these findings in adolescents. Using cluster analysis to examine the trajectory of AS over four years, Weems et al. reported four trajectories, including a stable high trajectory comprising 6% of their sample, and a stable low trajectory, comprising 54% of their sample. Further, they reported that adolescents classified in the high stable AS group were more likely to have ever experienced a panic attack than were adolescents classified in the low stable AS group.

In the current study, class membership was a specific predictor of anxiety symptoms, as adolescents in the high AS class did not possess higher levels of depression or externalizing symptoms, controlling for anxiety symptoms. Similar specificity for anxiety over externalizing disorders was not found in a study conducted by Rabian et al. (1993). However, whereas Rabian et al. (1993) found that children with anxiety disorders had levels of AS similar to those in children with externalizing disorders, they did not control for undiagnosed anxiety disorders or subthreshold anxiety symptoms in the children with externalizing disorders. Whereas Zvielli et al. (2012) did find higher levels of MDD in adults classified in the high AS class, they only controlled for PD in their analysis. Further, it is possible that the relations between AS and depression do not emerge until adulthood. In support of this, several recent studies have found evidence that AS is not uniquely related to depression in children and adolescents, accounting for comorbid anxiety (McLaughlin & Hatzenbuehler, 2009; Muris, Schmidt, Merckelbach, & Schouten, 2001). These findings underlie the importance of targeted interventions on AS in an effort to reduce anxiety disorders in children and adolescents.

Research on AS has flourished, in part, because there is evidence that AS is a malleable risk factor. That is, prevention and intervention programs can be developed to reduce AS levels (e.g., Balle & Tortella-Feliu, 2010; Gardenswartz & Craske, 2001; Schmidt et al., 2007). In adults, programs aimed at targeting AS have resulted in significant AS reductions and lower incidence rates of PD and psychopathology generally at follow-up (Gardenswartz & Craske, 2001; Schmidt et al., 2007). Only a single prevention study has focused on AS reductions in children and adolescents with elevated AS levels. Balle and Tortella-Feliu (2010) found that children and adolescents receiving an intervention targeting AS demonstrated lower rates of AS at 6-month follow-up than did individuals in a wait-list control group. Further, at the 6-month follow-up, rates of AS in the intervention group were similar to rates of AS in a control group who did not possess initial elevated AS levels. Identifying children and adolescents for these programs can be aided by FMM research that provides consistent cut-scores that demonstrate a high degree of sensitivity and specificity for capturing individuals

high in AS. There is already preliminary evidence that simple and brief interventions can reduce AS symptoms in children and adolescents with AS levels 80% above the mean (Balle & Tortella-Feliu, 2010). Future studies are needed to examine the efficacy of these interventions over longer periods of time as the identification of a high and stable class of adolescents with AS may indicate that some children may have less malleable AS or may be more likely to return to their base level of AS. If this is the case, and methods such as FMM can be used to identify cut-scores that identify these children with a reasonable rate of accuracy, then targeted interventions could be implemented that are more stringent and that include booster sessions over time.

Latent Structural Differences across Anxiety Sensitivity Dimensions

Whereas it appears that AS can be considered a dimensional-categorical construct (Bernstein et al., 2010) in that AS consists of three separate but related lower-order dimensions (i.e., cognitive concerns, physical concerns, and social concerns), and that individual scores across these dimensions can be used to classify individuals in either high AS or normative AS groups, not all lower-order dimensions appear to operate as categorical between individuals. In this study, cognitive concerns and physical concerns discerned between the high AS and normative AS class in that levels of cognitive concerns and physical concerns were significantly elevated in the high AS class as compared to levels of cognitive concerns and physical concerns in the normative AS class. In contrast, there were no differences across classes in mean levels of social concerns. In their FMM study of an adult sample, Bernstein et al. (2010) found similar results, in that an exploratory logistic regression analysis revealed that only cognitive concerns and physical concerns uniquely predicted class membership. Other researchers, using taxometrics methods in adults and children have similarly demonstrated that the social concerns dimension does not affect AS class status in adults or children (e.g., Bernstein et al., 2007; Zvolensky et al., 2007). One possible explanation is that the social concerns subscale of the CASI does not fully capture the AS social concerns dimension, as evidenced by an unacceptably low internal consistency (i.e., $\alpha = .48$; e.g., Silverman et al., 2003). The CASI was scaled down for children from the ASI (Silverman et al., 1991), which was revised, partially because of the shortcomings of the AS social concerns subscale (e.g., Taylor et al., 2007). This would suggest that the AS social concerns subscale of the CASI may need revisions in line with those made to the ASI in creating the ASI-3, such as including additional content-valid items and removing content-invalid items. However, given that Bernstein et al. (2010), using the ASI-3 did not find the AS social concerns subscale to predict class membership, it is also possible that AS social concerns operates as a continuous and not discrete within-person dimension of AS.

There are potential considerations for further use and interpretation of the CASI and other measures of AS. An important feature of FMM is that the dimensionality of AS is not constrained within class. Zvielli et al. (2012) provided preliminary evidence that this within-class dimensionality was present and useful. Although they did not derive their groups from FMM, but rather from cut-scores from a past FMM study (Bernstein et al., 2010), Zvielli et al. examined the relations between continuous scores on a composite of AS cognitive concerns and physical concerns and levels of panic attack and PTSD symptoms. In this report, higher levels of AS were significantly associated with higher levels of panic attack

and PTSD symptoms. Therefore, it is plausible that beyond the importance of classification within high or normative AS classes, the variability within AS class may be further associated with anxiety symptomatology. However, as Bernstein et al. (2010) suggested, optimizing AS measures to reflect the categorical-dimensional nature of this construct should include cognitive concerns and physical concerns, but not social concerns. Future research is needed to explain what separates social concerns from cognitive concerns and physical concerns subscales.

Limitations

There are several limitations that should be considered when interpreting our findings. The relatively modest sample size limited the follow-up analyses that could be conducted such as examining the effects of potential moderating effects of gender and SES. Given that gender and SES effects have been reported for anxiety in children and adolescents (e.g., Hale, Raaijmakers, Muris, Van Hoof, & Meeus, 2008; Miech et al., 1999), it is possible that the relations between the high AS class and anxiety might be moderated by gender or SES. We conducted our analysis at the scale-level, and not the item-level like Bernstein et al. (2010). Whereas our analyses produced similar classes, we were unable to assess whether items functioned differently in the high AS versus normative AS class. In addition, self-report data was used for all measures, implicating method variance as a possible confound. A larger sample size, with multiple informants rating children's behavior would address these concerns. This study was conducted in a community sample, and as such, we did not have diagnostic status. The inclusion of diagnostic status could provide further support for classes. Finally, this study was conducted cross-sectionally. Longitudinal analyses would be useful for examining the stability of AS classes as well as for examining the role of AS class as a risk factor for the development of anxiety.

Conclusions

The current study demonstrated that, similar to research in AS in adults, there were two classes of children based on their levels of AS. The identification of a high AS class and the higher rates of anxiety symptoms within this class as compared to the normative AS class provides some evidence that there is a subset of adolescents who possess elevated levels of anxiety, possibly by virtue of their levels of AS. Given FMM research in adults (e.g., Bernstein et al., 2010, 2013), it appears that a similar class of individuals is present in adults, suggesting that levels of AS might not desist in this class over time. However, future prospective work, using methods similar to FMM should be used to determine this. Intervention and prevention efforts aimed at targeting AS also should consider whether identifying children in this high AS class has important ramifications for long-term outcome status. Finally, because of the findings that not all AS subscales are relevant for classification, research should focus on what factors may account for the discrepancies between social concerns AS and cognitive concerns and physical concerns AS.

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Table 1
Descriptive Statistics for CASI Subscales, RCADS Total Anxiety, RCADS Depression, Externalizing Behaviors, and Descriptors

	1	2	3	4	5	6	7	8	9
1. CASI Cognitive	--								
2. CASI Social	.27*	--							
3. CASI Physical	.47*	.40*	--						
4. RCADS ANX	.45*	.41*	.61*	--					
5. RCADS MDD	.35*	.39*	.41*	.79*	--				
6. Externalizing	.004	.03	.03	.12*	.20*	--			
7. Income	-.14*	-.08	-.18*	-.10	-.06	.03	--		
8. Age	-.15*	-.02	-.09	-.11	-.15*	-.06*	.05	--	
9. Gender	.03	-.03	-.13*	-.10	-.09	.12	.09	.07	--
Mean (% Male)	2.44	2.77	6.38	25.36	6.61	15.80	93700	11.00	56%
SD	1.48	1.52	4.46	15.36	4.57	11.85	74019	.81	

Note. N's from 259 to 277 for correlations. CASI = Childhood Anxiety Sensitivity Index. Cognitive = Cognitive Concerns subscale. Social = Social Concerns subscale. Physical = Physical Concerns subscale. RCADS = Revised Child Anxiety and Depression Scales. ANX = Anxiety scale score. MDD = Depression scale score. Externalizing = Disruptive Behavior Disorder scale total score.

* p < .05.

Table 2
Fit Indices for Alternative Factor Mixture Models of CASI Subscales as Indicators of Anxiety Sensitivity

Model	-2LL	df	AIC	BIC	Entropy	LMR-LRT	BLRT
1-Class	-1755	9	3529	3561	--	--	--
2-Class (Invariant) ^a	-1731	10	3483	3519	.95	71.92***	78.32***
2-Class (<i>Intercepts Free</i>)	-1713	13	3452	3499	.95	81.15***	84.76***
2-Class (Loadings Free)	-1721	13	3469	3516	.95	65.20**	68.10***
2-Class (Intercepts and Loadings Free)	-1712	15	3454	3509	.95	83.82***	86.30***
3-Class (Invariant)	-1729	13	3484	3531	.83	3.83	4.17
4-Class (Invariant)	-1720	15	3469	3524	.86	17.21*	18.74***
5-Class (Invariant)	-1709	17	3452	3514	.97	19.77	21.52***

Note. -2LL = -2LogLikelihood. AIC = Akaike's Information Criterion. BIC = Bayesian Information Criterion. LMR-LRT = Lo-Mendell-Rubin Likelihood Ratio Test.

^a A nonsignificant negative residual variance for CASI Cognitive was fixed to zero across all classes. The best-fitting model is in italics.

 $p < .001$,

**
 $p < .01$,

*
 $p < .05$.

Table 3

ANCOVAS Comparing CASI Subscales, RCADS Total Anxiety, RCADS Depression, and Externalizing Behaviors with Control Variables between High and Normative Anxiety Sensitivity Classes

Scale and Subscale Scores		High AS		Normative AS		F	η^2 ^a
CASI Scale and Subscales		Mean ^a	SE	Mean ^a	SE		
Total Score		19.69	1.11	10.75	.35	59.43***	.18
Cognitive Concerns		5.96	.20	2.09	.06	354.21***	.56
Social Concerns		3.01	.30	2.75	.10	.67	.002
Physical Concerns		10.71	.85	5.95	.27	28.55***	.09
Psychopathology Scales							
Total Anxiety		30.27	1.95	24.86	.60	6.95**	.03
Depression ^b		9.33	.91	6.34	.28	9.81**	.04
Depression		6.60	.58	6.63	.18	.002	.00
Externalizing ^b		15.68	2.42	15.81	.75	.003	.00
Externalizing		14.43	2.43	15.85	.74	.31	.00

Note. AS = Anxiety Sensitivity. *N* = 25 for High AS class. *N* = 252 for Normative AS class. CASI = Childhood Anxiety Sensitivity Index. *F* includes control variables for the Total Anxiety, Depression, and Externalizing scales. Reported means are estimated means, accounting for the covariates.

^a Anxiety symptoms were examined controlling for age, gender, and depression and externalizing symptoms. Depression symptoms were examined, first controlling for age and gender, and then controlling for age, gender, and externalizing and anxiety symptoms.

^b Externalizing symptoms were examined, first controlling for age and gender, and then controlling for age, gender, and anxiety and depression symptoms. η^2 = partial eta squared for class membership.

*** *p* < .001,

** *p* < .01,

* *p* < .05.