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Evaluation of Anxiety Sensitivity among Daily Adult Smokers using Item Response Theory Analysis

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Abstract

The present investigation applied Item Response Theory (IRT) methodology to the 16-item Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986) for a sample of 475 daily adult smokers (52% women; $M_{age} = 26.9$, $SD = 11.1$, $Range = 18 – 65$). Using nonparametric item response analysis, all 16 ASI items were evaluated. Evaluation of the Option Characteristic Curves for each item revealed 4 poorly discriminating ASI items (1: “It is important not to appear nervous;” 5: “It is important to me to stay in control of my emotions;” 7: “It embarrasses me when my stomach growls;” 9: “When I notice my heart beating rapidly, I worry that I might be having a heart attack”), which were dropped from analysis. Upon repeat analysis, the remaining items appeared to make adequate separations within levels of anxiety sensitivity in this sample. Graded response modeling data indicated important differences in ASI items’ capacity to discriminate between, and provide information about, latent levels of anxiety sensitivity. Specifically, three items best discriminated and provided the most information regarding latent levels of AS - items 3, 15, and 16. Items 1, 5, 7, and 9 were omitted due to their limited capacity to discriminate between latent levels of anxiety sensitivity; items 8, 12, and 13 also performed poorly. Overall, current findings suggest that evaluation of anxiety sensitivity among adult smokers using the 16-item ASI may usefully choose to focus on items that performed well in these IRT analyses (items: 2, 3, 4, 6, 10, 11, 14, 15, and 16).

Keywords

Anxiety Sensitivity; Smoking; Item Response Theory; Latent Structure; Psychological Assessment

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Anxiety sensitivity reflects individual differences in the fear of anxiety and arousal-related sensations (McNally, 2002; Taylor, 1999). When anxious, individuals high in anxiety sensitivity become acutely fearful due to beliefs that these interoceptive sensations have harmful physical, psychological, or social consequences (Taylor et al., 2007). Anxiety sensitivity is conceptually and empirically unique from, and demonstrates incremental validity relative to, trait anxiety (Rapee & Medoro, 1994) as well as negative affectivity/neuroticism (Zvolensky, Kotov, Antipova, & Schmidt, 2005).

Anxiety sensitivity has been predominantly studied in relation to better understanding the etiology and maintenance of anxiety and its disorders (Feldner, Zvolensky, Schmidt, & Rose, in press; Hayward, Killen, Kraemer, & Taylor, 2000; Li & Zinbarg, 2007; Maller & Reiss, 1992; Schmidt, Lerew, & Jackson, 1997, 1999; Schmidt, Zvolensky, & Maner, 2006), although this cognitive construct has been increasingly linked to substance use disorders (Lejuez, Paulson, Daughters, Bornovalova, & Zvolensky, 2006; Norton, Rockman, Luy, & Marion, 1993; Stewart, Karp, Pihl, & Peterson, 1997; Stewart & Kushner, 2001). Of the substance use disorders, anxiety sensitivity has most frequently been studied in relation to cigarette smoking (Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001; Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007; Zvolensky & Bernstein, 2005; Zvolensky, Schmidt, & Stewart, 2003).

There is a number of interrelated streams of empirical work that have highlighted the clinical and theoretical relevance of anxiety sensitivity to the study of cigarette smoking and nicotine dependence. For example, cigarette smokers with higher compared to lower levels of anxiety sensitivity are more apt to endorse smoking motives principally aimed at negative affect reduction (Brown et al., 2001; Comeau, Stewart, & Loba, 2001; Gonzalez, Zvolensky, Vujanovic, Leyro, & Marshall, in press; Leyro, Zvolensky, Vujanovic, & Bernstein, in press; Novak, Burgess, Clark, Zvolensky, & Brown, 2003; Stewart et al., 1997; Zvolensky, Bonn-Miller et al., 2006b). A conceptually similar and related line of work has indicated that anxiety sensitivity is related to outcome expectancies for negative affect reduction (beliefs smoking will reduce negative affect; Brown, Kahler, et al., 2001; Gregor, Zvolensky, McLeish, Bernstein, & Morissette, in press; Zvolensky, Feldner, Leen-Feldner et al., 2004). Additionally, smokers high compared to low in anxiety sensitivity report perceiving quitting as more of a personally threatening and stressful experience (Gonzalez et al., in press; Zvolensky, Vujanovic et al., 2007). Other work suggests that high relative to low AS smokers may be hypersensitive to aversive internal sensations that routinely occur during the early stages of a quit attempt (e.g., negative affect, nicotine withdrawal; Mullane, Stewart, Rhyno, Steeves, Watt, & Eisner, in press; Zvolensky, Baker, et al., 2004). And finally, anxiety sensitivity is associated with an increased rate of smoking lapse (any smoking behavior) and relapse during quit attempts (Brown, Kahler et al., 2001; Mullane et al., in press; Zvolensky, Bernstein, Jurado, Colotla, Marshall, & Feldner, 2007; Zvolensky, Bonn-Miller, Bernstein, & Marshall, 2006a; Zvolensky, Stewart, Vujanovic, Garvic, & Steeves, 2008).

Anxiety sensitivity has most commonly been measured with the 16-item Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986) among smokers and other populations. Although a number of other anxiety sensitivity scales have appeared in recent years (Taylor & Cox, 1998; Taylor et al., 2007), the 16-item ASI has been, and continues to be, the most commonly employed measure to assess the construct (Bernstein & Zvolensky, 2007; Taylor, 1999). The 16-item ASI has generally well-established psychometric properties, as exemplified by research involving the application of classical test theory methods (Peterson & Reiss, 1992). Factor analytic work on the 16-item ASI, for example, has suggested that the construct is multi-dimensional and hierarchical in nature; comprised of a higher-order factor with a number of specific lower-order facets (Zinbarg, Mohlman, & Hong, 1999). Though many different factor solutions have been previously reported, generally ranging from two to four lower-order dimensions (e.g., Carter, Miller, Sbrocco, Suchday, & Lewis, 1999; Cox, Parker,

& Swinson, 1996; Schmidt & Joiner, 2002; Telch, Schermis, & Lucas, 1989; Vujanovic, Arrindell, Bernstein, Norton, & Zvolensky, 2007; Zinbarg, Barlow, & Brown, 1997), the most compelling evidence has supported a hierarchical three-factor structure. The 16-item ASI is typically conceptualized as being comprised of one higher-order factor (ASI Total Score) and three lower-order factors: physical (e.g., "It scares me when my heart beats rapidly"), psychological (e.g., "When I cannot keep my mind on a task, I worry that I might be going crazy), and social Concerns (e.g., "Other people notice when I feel shaky") (Zinbarg, Barlow, & Brown, 1997; Stewart, Taylor, & Baker, 1997; Rodriguez, Bruce, Pagano, Spencer, & Keller, 2004). The 16-item ASI total and subfactor scores have shown adequate internal consistency, test-retest reliability, and construct validity (McNally & Lorenz, 1987; Reiss et al., 1986; Rodriguez et al., 2004; Zinbarg et al., 1997). More recently, latent structural study integrating Coherent Cut Kinetic taxometric procedures and factor analysis has indicated that individual differences in anxiety sensitivity may best be characterized by first deciding whether individuals belong to a high or low anxiety sensitivity subgroup and then indexing variability within these latent classes (Bernstein, Zvolensky, Norton et al., 2007a; Bernstein, Zvolensky, Stewart, & Comeau, 2007b). Specifically, the distribution of anxiety sensitivity scores may demonstrate both a dichotomous latent class structure (taxonic) as well as continuous within-class continuity (taxonic-dimensionality; Bernstein et al., 2007a). Consequently, there may be taxonic group differences in anxiety sensitivity between individuals and continuous differences between individuals along a dimension(s) within each anxiety sensitivity group (Bernstein, Zvolensky et al., 2007b).

Although the 16-item ASI has indeed been a promising instrument, it is noteworthy that extant work has principally evaluated this instrument using classical test theory methodologies, which have yielded somewhat discrepant findings regarding the factor structure of the instrument (Taylor et al., 2007). As another example, the validity of inferences from taxometric research is dependent on the validity of observable indicators to index the latent construct (e.g., Bernstein, Zvolensky, 2007a, b). Classical test theory has a number of limitations, including item-dependent estimates, unconditional standard errors of measurement, among others (see Emberton, 1996; Emberton & Reise, 2000, for expanded discussions). Similarly, taxometric methodology is not designed to identify the psychometric capacity of observable indicators (at the item-level) to best discriminate between anxiety sensitivity taxonic groups or continuously across the range of the latent anxiety sensitivity dimension(s) (Emberton & Reise, 2000).

To address these types of concerns, Item Response Theory (IRT) has proven valuable. Indeed, IRT has been successfully employed to refine the assessment of a number of psychopathological constructs (e.g., Beevers, Strong, Meyer, Pilkonis, & Miller, 2007; Cole, Rabin, Smith, & Kaufman, 2004; Gomez, Cooper, & Gomez, 2005; Kahler, Strong, Read, Palfai, & Wood, 2004). Compared to class test theory, IRT offers some unique advantages (see Emberton, 1996). For example, IRT defines a true score on the basis of the latent trait (e.g., anxiety sensitivity), whereas classical test theory defines a true score on the basis of the test itself (Emberton, 1996). As another example, IRT has led to development of useful tools for evaluating the performance of items within an established measure through item bias analysis. Thus, there is the ability to evaluate a given item of a measure (e.g., 16-item ASI) in terms of its performance across diverse groups of individuals (e.g., males/females). As a final example, methods based in IRT allow efficient evaluation of the adequacy of response options and facilitate identification of effective scaling for each specific item of a scale to increase reliable discriminations among individuals (Emberton, 1996). Thus, with regard to the 16-item ASI, methods based in IRT may be utilized to isolate items that are less than ideally useful in terms of defining the latent construct, and thereby, may facilitate a more efficient and targeted assessment of anxiety sensitivity.

With this background, the aim of the current investigation was to employ IRT methods to examine the 16-item ASI among a large sample of adult daily smokers. Due to the growing volume of research focused on the theoretically and clinically pertinent associations between anxiety sensitivity and nicotine use and dependence (Bernstein & Zvolensky, 2007; Zvolensky & Bernstein, 2005), the need for more refined assessment of anxiety sensitivity is increasingly apparent. When modeling psychological constructs, such as anxiety sensitivity, responses to items can be modeled using either parametric (cf. Rasch, 1960; Birnbaum, 1968) or non-parametric approaches (cf. Mokken, 1982; Molenaar, 1997; Ramsey, 2000). These two broad classes of models differ primarily in the assumptions about the underlying relationship between levels of anxiety sensitivity and the probability of responding to higher response options for each item. Non-parametric approaches are much less restrictive and do not require that response probabilities conform to a particular model or that all items 'behave' in the same way. Nonparametric methods can be used to examine item response characteristics prior to fitting parametric models. Parametric models begin with an assumption of how the relationship between the probability of an item response and an individual's level of the underlying trait should 'look,' and then, tests how the available data conform using various model-fit statistics to ensure assumptions are met.

In the present study, we chose to first use an exploratory nonparametric model, given the dearth of research evaluating response distributions of the 16-item ASI using IRT. We had no *a priori* reasons to expect a particular form for response distributions and wanted to allow items with non-monotonic item response functions to be identified. Monotonically and steeply increasing curves indicate that likelihood of higher item responses increases in close relation to increasing levels of anxiety sensitivity (good discrimination). Relatively flat curves or curves that do not show a consistent increasing linear trend indicate poor discrimination. Based on examination of the Option Characteristic Curves (OCC), items with poor discrimination were identified when only a single discrimination was made between the 5th and 95th percentiles for this sample. Poorly discriminating items were dropped from further analysis. Items making 2 or more discriminations between 5th and 95th percentiles of anxiety sensitivity were then examined using Samejima's Graded Response Model (Samejima, 1969). Gender differences in responses to individual ASI items were then evaluated, using the remaining ASI items, to determine qualitative differences in item responses between men and women (irrespective of anxiety sensitivity levels), using the Likelihood Ratio Testing (LRT) approach (Thissen, 1991).

Method

Participants

Participants were 475 daily adult smokers (52% women; M_{age} = 26.9, *SD* = 11.1, *Range* = 18 – 65) from the greater Burlington, VT community. The racial distribution of the sample generally reflected that of the state of Vermont (State of Vermont Department of Health, 2007): 93.9% of participants identified as white/Caucasian, 2.1% identified as Hispanic, 1.9% identified as black/African-American, 0.6% identified as Asian, and 1.5% identified as "other." Participants reported currently smoking an average of 11.9 cigarettes per day (*SD* = 13.2) for an average of 10.1 years (*SD* = 10.3). Participants reported a mean age of smoking initiation of 13.8 years (*SD* = 3.5) and a mean age of onset of regular daily smoking of 16.4 years (*SD* = 3.9). The mean score of the sample on the Fagerstrom Test for Nicotine Dependence (*FTND*; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) was 3.17 (*SD* = 1.90), indicating relatively low levels of nicotine dependence. Approximately 62% of participants reported drinking alcohol at least 2–4 times per month, and participants, on average, drank 3–4 drinks per occasion. Additionally, the sample scored a mean of 10.66 (*SD* = 7.58) on the Alcohol Use Disorders Identification Test (AUDIT; Babor, De La Fuente, Saunders, & Grant, 1989), with 52.4% of the sample meeting criteria for at least moderate alcohol problems (i.e., a score of 8 or greater on the AUDIT).

Measures

Smoking History Questionnaire (SHQ)—The SHQ (Brown, Lejuez, Kahler, & Strong, 2002) is a self-report questionnaire used to assess smoking history and pattern. The SHQ includes items pertaining to smoking rate, age of onset of smoking initiation, and years of being a daily smoker. The SHQ has been successfully used in previous studies as a measure of smoking history and pattern (Zvolensky, Leen-Feldner et al., 2004; Zvolensky, Lejuez, Kahler, & Brown, 2004).

Fagerström Tolerance Questionnaire (FTQ)—The FTQ (Fagerström, 1978) was used as a continuous self-report measure of nicotine dependence. Specifically, the FTQ was administered and scored as the Fagerstrom Test for Nicotine Dependence (FTND; *Test for Nicotine Dependence (FTND).* The FTND is a 6-item scale designed to assess gradations in tobacco dependence (Heatherton et al., 1991). Two items are rated on a four-point Likert-style scale (0–3); and four items are rated dichotomously (yes/no). Sample items include, *"How soon after you wake up do you smoke your first cigarette?"* and *"Do you find it hard to refrain from smoking in places where it is forbidden?"* The FTND has shown good internal consistency, positive relations with key smoking variables (e.g., saliva cotinine; Heatherton et al., 1991; Payne, Smith, McCracken, McSherry, & Antony, 1994), and high degrees of test-retest reliability (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994).

Alcohol Use Disorders Identification Test (AUDIT)—The AUDIT is a 10-item screening measure developed by the World Health Organization to identify individuals with alcohol problems (Babor et al., 1992). Major areas of problematic drinking that are assessed include: alcohol consumption, drinking behavior (dependence), adverse psychological reactions, and alcohol-related problems. There is a large body of literature indicating the AUDIT has well-established psychometric properties (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993).

Anxiety Sensitivity Index (ASI)—The ASI (Reiss et al., 1986) is a 16-item measure on which respondents indicate, on a 5-point Likert-type scale (0 = *"very little"* to 4 = *"very much"*), the degree to which they fear the potential negative consequences of anxiety-related symptoms and sensations (e.g., *"It scares me when my heart beats fast"*). The ASI has high levels of internal consistency for the global score (range of alpha coefficients: 0.79 to 0.90) and good test-retest reliability (r = .70 for 3 years; Peterson & Reiss, 1992).

Procedure

Participants were recruited from the greater Burlington, Vermont community via placement of flyers targeting smokers throughout local universities and colleges, marketplaces, and well-traveled locations, and postings of printed advertisements in local newspapers. All studies were approved by the University of Vermont Institutional Review Board. Upon arrival to the laboratory, participants across all studies (n = 3), integrated into the present report, provided verbal and written informed consent and completed a battery of self-report assessments. Participants were compensated between $20 and $40. All measures reported in this study were completed at the baseline session for the studies. None of the data included in the present report have been the subject of an IRT analysis.

Analytic Overview

Item response models have two primary assumptions. First, item responses arise from a primary single common dimension (e.g., essentially unidimensional); in the current study, this latent primary dimension is thought to reflect overall levels of anxiety sensitivity. Second, item responses are statistically independent of one another after taking into account the influence from the primary common dimension (e.g., local independence). Violations of the second assumption can arise from influences such as overly similar item contents or common phrasings among items. The construct of anxiety sensitivity is conceptually broad and has been operationalized as tapping fears of cognitive and physical anxiety-relevant symptoms as well as corresponding social concerns (Taylor & Cox, 1998; Taylor et al., 2007). The conceptual breadth of anxiety sensitivity domains can impact the selection of an item response model. In this study, we were interested in scaling individuals on the general anxiety sensitivity continuum. The key issue is whether the primary dimension of anxiety sensitivity is strong enough to provide a common dimension for scaling individual levels of anxiety sensitivity using a single score (Reise, Morizot, & Hays, 2007). Although multiple domains are present within measures of anxiety sensitivity, there has been consistent support for a strong primary higher-order dimension underlying response to each of the three lower-order domains (Zinbarg et al., 1997). Finally, we evaluated a hierarchical multi-dimensional bifactor model (Holzinger & Swineford, 1937; Yung, Thissen, & McLeod, 1999).

In the hierarchical bifactor model, each item is allowed to load on the primary dimension of anxiety sensitivity and one of the sub-domains. Each of the anxiety sensitivity sub-domains is forced to be independent from the primary dimension of anxiety sensitivity and from the other sub-domains. Fitting a series of three models is useful in: a) determining the potential for distorting the inter-relationship of anxiety sensitivity when using a unidimensional model and thereby guiding selection of a unidimensional vs. a multidimensional item response model, and b) empirically determining the unique influence of the four sub-domains after controlling for a shared relationship with the general anxiety sensitivity dimension. The hierarchical bifactor model has been used extensively in cognitive domain analyses (Holzinger, 1949) and increasingly has been useful in describing relationships among psychopathological and personality constructs (Patrick, Hicks, Nichol, & Krueger, 2007). We used confirmatory factor analysis of polychoric correlations to specify the models. Robust Weighted Least Squares estimations allowed for use of three fit indices in testing the fit of each of three models: the Comparative Fit Index (CFI: Bentler, 1990), the Tucker Lewis Index (TLI: Bentler & Bonett, 1980), and the root mean square error of approximation (RMSEA: Steiger, 1990). Cut-offs for model fit have been suggested to be CFI ≥ .96, TLI ≥ .95, and RMSEA ≤ .05 (Yu, 2002). Browne and Cudeck (1993) suggested guidelines for approximate fit values and proposed that RMSEA values of .05 or less indicate a ‘close fit’, values between .05 – .09 indicate ‘reasonable fit’, and values of .10 and greater demonstrate ‘poor fit.’ The extent to which ASI scores generalize to a single common latent variable underlying anxiety sensitivity was evaluated using an Omega index based on a hierarchical bifactor model (Zinbarg, Yovel, Revelle, & MacDonald, 2006). This quantitative index reflects the degree to which the ASI measures a single primary latent variable.

With support for a strong primary dimension underlying anxiety sensitivity (cf. multiple related lower-order dimensions or a hierarchical bifactor model), we used a nonparametric kernel smoothing method and software (TESTGRAF) developed by Ramsay (2001). These methods have been used previously in several papers on the performance of scales measuring depression (Santor & Coyne, 2001; Santor & Coyne, 1997; Santor, Zuroff, Ramsay, Cervantes, & Palacios, 1995). Individuals are ranked according to total scores on each instrument, and these ranks are then converted to standard normal scores. Probability of endorsing every increasing option for each ASI item is estimated at each of 51 specified evaluation points within these standard normal scores by using a nonparametric smoothing kernel (Ramsay, 1991). The ability to model item-responses allows us to evaluate the reliability of the ASI as a function of varying levels of anxiety sensitivity (Ramsay, 2000). We considered items to have good response properties if the probability of endorsing increasingly severe response options increased with increasing levels of anxiety sensitivity. The probability of endorsing each response option was plotted as a function of standard normal scores. A visual inspection of these OCC reveals, graphically, the threshold level of anxiety sensitivity where individuals would be expected to be more likely to endorse a higher option and this can be observed as the point where the OCC intersect. Number of observed intersections suggests the efficiency of an item by displaying the number of separations provided by the full response format and suggests whether item options retain their pre-specified order. For example, with a five-level response format an item has the potential to separate respondents along four thresholds for levels of anxiety sensitivity. Effective anxiety sensitivity items were identified if the OCC for at least two of the response options intersected between the 5th and 95th percentiles suggesting a minimum of efficiency in separating individuals from the majority of this sample across levels of estimated anxiety sensitivity. With identification of effective OCC that retain pre-specified order, a parametric item response model will be fit. We chose a graded response model (Samejima, 1969) because it allows estimation of each item response option (OCC) threshold, or level of anxiety sensitivity where each separation occurs. Thus, it allows for estimation of each item's relative ability to discriminate among levels of anxiety sensitivity, and provides an index of the amount of information about levels of anxiety sensitivity contained within each item.

Results

Dimensionality

We conducted confirmatory factor analysis of polychoric correlations for the 16 ASI items. We examined three solutions for comparison: a) a model with a single primary dimension; b) a model with four correlated dimensions; and c) a hierarchical bifactor model that allowed items to load both on a primary dimension and on one of four orthogonal dimensions. Fit indices suggested that both models that allowed multiple dimensions increased model fit over the single dimension model (See Table 1). For example, the CFIs were 0.875, 0.912, and 0.937 for models with a single dimension, four-dimensions, and a hierarchical model with both a primary dimension and four sub-dimensions, respectively. The Standardized Root Mean Square Residuals (SRMR) were 0.064, 0.055, and 0.45, respectively. Although a model with four dimensions evidence improved fit over a single dimension, factor inter-correlations were high (*M* = .82; *SD* = 0.07), suggesting significant overlap among sub-dimensions, and a hierarchical model also provided adequate fit to the data. Only the bifactor model generated a RMSEA < 0.10 indicating only marginally adequate fit to the data. Overall, there was support for a strong primary dimension of anxiety sensitivity.

Local Dependence

Given the support for continuing to examine a model with a single primary dimension, we examined the impact of smaller factors on estimation of the relationship between each item and the primary dimension. Local dependence was assessed using change in factor loadings on the primary dimension after controlling for loadings on the four smaller factors. Change in loadings for each item was computed by subtracting loadings on a primary dimension in a unidimensional model from the same loadings in the context of the hierarchical model (e.g., from model A to Model C). Loadings were quite similar, with an average change of 0.02 (*SD* = .03). The primary dimension accounted for 61% of the total variance and the Omega index of saturation of the first primary dimension was 0.81. After controlling for the four sub-factors, all 16 items retained loadings on the primary dimension > .30 with a range from .40 – .83. There were only four items (items 1, 5, 7, and 9) that had loadings less than 0.70. These results suggest a strong primary factor underlying responses to the ASI in this sample of adult smokers and indicate influence from additional sub-factors would not be large enough to distort results from a unidimensional item response model.

Exploratory Nonparametric Item Response Analysis

We then submitted all 16 ASI items to nonparametric item response analysis. Analyses are designed to be iterative in that items that failed to meet our criteria for inclusion were dropped and analyses were repeated with the remaining items. In the analysis of the full set of 16 items, inspection of the OCC for items revealed that 4 items (1, 5, 7, and 9; please see Table 2 for item content) failed to make > 1 levels of separation between the 5^{th} and 95^{th} percentiles. Figure 1 displays an example of two items, one item (item 3) that met inclusion criteria and one item (item 5) that failed to make levels of separation > 1. The 4 items were dropped and the remaining 12 items were resubmitted to analyses. Upon repeat analysis, all 12 items appeared to make adequate separations.

Fitting the Graded Response Model

With assurance of adequate performance of ASI items in making multiple separations within levels of anxiety sensitivity in this sample, we fit a graded response model (Samejima, 1969). Use of a parametric model has the advantage of providing an efficient numeric estimate to reflect the level of anxiety sensitivity associated with each of the ASI items rather than using a visual inspection of nonparametric option characteristic curves. Parametric models also provide an efficient estimate of the discrimination of each item. Further, the model allows for evaluating the degree to which ASI items provide unique information about latent anxiety sensitivity and the typical pattern of ASI items that are associated with each individual score.

To select a graded model, we first tested whether items differed significantly in their ability to discriminate across levels of anxiety sensitivity. To accomplish this objective, we fit successive models that first constrained all items to be equally discriminating and then fit an additional model that allowed discrimination parameters to be estimated freely. A likelihood ratio test (LRT) of these models suggested that a model that suggested all item discriminations were the same did not fit the data better than the model that allowed items to have differences in discrimination ability (*LRT (−2 log likelihood)* = 53.32, $df = 11$, $p < 0.001$). Table 2 lists the items along with the thresholds for each response option. Figure 2 displays the relative information for each item. Items 3, 15, and 16 had the highest discrimination ability and provided the most information overall about levels of anxiety sensitivity. Although the majority of the remaining items performed similarly, items 8, 12, and 13 provided the least amount of total information across a full range of anxiety sensitivity; and within the regions of anxiety sensitivity where these items were contributing information, they had the lowest discrimination. Items 2, 8, 11, 13, 14, and 15 provided information primarily in the top 50% of anxiety sensitivity scores and these contents appear to be only relevant among those with the highest levels of anxiety sensitivity. In contrast, items 3, 4, 6, 8, 10, and 16 all provided some information across the full continuum of anxiety sensitivity scores. However, differences in the discrimination of these items also suggested that the content of certain items (e.g. item 3: ‘feeling shaky’ discrimination = 2.96 vs. item 8: ‘feeling nauseous’ discrimination = 1.83) was more consistently related to a broad range of anxiety sensitivity.

Gender Differences in Item Responses

Using the Graded Response Model, we examined whether men and women with the same level of anxiety sensitivity might evidence significant differences in the way that they responded to the 12 ASI items. To check whether the model we selected to relate levels of anxiety sensitivity and response to ASI items was the same for men and women, we used a Likelihood Ratio Testing approach to evaluate gender differences (Thissen, 1991) and used IRTLDIF (Thissen,

1991) software for all analyses. LRT analyses proceed by constraining each of the item parameters systematically and thereby evaluating each of the item's thresholds and the item's discrimination while keeping all other item thresholds and item discriminations fixed to be equal for men and women. This allows each item to be considered in isolation. LRT is conducted to evaluate models in which thresholds for each item are allowed to be different and models in which the item parameters are fixed to be equal. A difference in the −2 log likelihood between the two models (G^2) was used to evaluate significant differences in model fit. Significant differences between men and women suggested qualitatively different responses to ASI items. For example, ASI items may be endorsed differently not because of quantitative differences in the level of anxiety sensitivity, but due to the respondent's gender.

Overall, women were estimated to have a higher level of anxiety sensitivity than men ($d = -0.30$). Of the 12 ASI items, three items had significant LRT values ($p < .05$), indicating differences in item functioning for men and women. After controlling for the level of anxiety sensitivity, women were more likely to report, "It scares me when I feel faint," as compared to men (Item 4: $G^2 = 19.1$, $df = 4$, $p < .001$; mean difference in thresholds = −0.40, $SD = 0.12$). Conversely, women were less likely to report, "When my stomach is upset, I worry that I might be seriously ill" (Item 11: $G^2 = 20.4$, $df = 4$, $p < .001$; mean difference in thresholds = 0.34, $SD = 0.10$), and to report "It scares me when I am unable to keep my mind on a task" (Item 12: $G^2 = 13.3$, $df = 4$, $p < .02$; mean difference in thresholds = .28, $SD = 0.10$). There were no significant differences in the discrimination of items among men and women (*p's > .10).* The observed differences in thresholds are expressed in standardized units ($M = 0$, $SD = 1$) and thus can be interpreted directly to gauge the magnitude of these effects using existing standards of . 2, .5. and .8 for small, medium and large effects (Cohen, 1992). All of the observed differences in thresholds were considered to be small effects.

Discussion

Due to the importance of the relations between anxiety sensitivity and smoking (Zvolensky & Bernstein, 2005), refined assessment of the anxiety sensitivity construct among smokers is theoretically and clinically important. Thus, the present investigation sought to extend current classic test theory methodology and taxometric work relevant to anxiety sensitivity by employing IRT methods to examine the 16-item ASI among a large sample of adult daily smokers so as to refine assessment of the cognitive construct among this population.

Using nonparametric item response analysis, all 16 ASI items were evaluated. Evaluation of the OCC for items revealed 4 poorly discriminating ASI items (1: "It is important not to appear nervous;" 5: "It is important to me to stay in control of my emotions;" 7: "It embarrasses me when my stomach growls;" 9: "When I notice my heart beating rapidly, I worry that I might be having a heart attack"), which were dropped from analysis. Upon repeat analysis, the remaining items appeared to make adequate separations within levels of anxiety sensitivity in this sample. Notably, three of the dropped items (1, 7, 9) are relevant to anxiety sensitivity - social concerns, whereas one item (9) refers to physical concerns. In past work using classical test theory methodologies, item 7 also was identified as a poorly-fitting (Zinbarg et al., 1997).

Graded response modeling indicated important differences in ASI items' capacity to discriminate between and provide information about various latent levels of anxiety sensitivity. Specifically, three items best discriminated and provided the most information regarding latent levels of anxiety sensitivity - items 3, 15, and 16. These items reflect anxiety sensitivity – physical and psychological concerns (Zinbarg et al., 1999). In addition to items 1, 5, 7, and 9 which were omitted due to their limited capacity to discriminate between latent levels of anxiety sensitivity in this sample (as noted above), items 8, 12, and 13 also performed poorly among smokers. Notably, all anxiety sensitivity – social concerns items (1, 5, 7, and 13) performed poorly in terms of their capacity to measure (and reflect) latent levels of anxiety sensitivity. These findings are in agreement with previous work suggesting that anxiety sensitivity physical and psychological concerns, rather than social concerns, demonstrate the most predictive power and utility in terms of anxiety psychopathology (e.g., Schmidt et al., 1999) and substance-related problems (Zvolensky, Feldner et al., 2004). In light of these data, anxiety sensitivity social concerns items may possibly represent only normative anxiety sensitivity-relevant cognitions, as also indicated by taxometric research (e.g., Bernstein et al., 2007b). Alternatively, it is possible that these items, and perhaps the social concerns facet of the ASI, simply do not reflect the *latent* anxiety sensitivity variable as strongly as the others.

The remaining ASI items performed adequately and similarly to one another. However, certain items provided information across the full range of latent levels of anxiety sensitivity (i.e., items 3, 4, 6, 10), whereas other items provided information primarily in the higher-range (top 50%) of latent levels of anxiety sensitivity (2, 11, 14, 15). It is noteworthy that items 3, 4, 6, and 10 – namely, those that provide information across the full range of latent levels of anxiety sensitivity and perform well in IRT analyses – also are all anxiety sensitivity - physical concerns items. Furthermore, items 2, 11, 14, and 15 – those providing information at the higher-end of anxiety sensitivity variability and perform well in IRT analyses – reflect anxiety sensitivity - physical and psychological concerns items. Consequently, certain facets of anxiety sensitivity may be associated with more normative or more abnormal/maladaptive domains of the anxiety sensitivity distribution. One interpretation of these data is that psychological concerns, and certain aspects of physical concerns, may reflect elevated levels or an abnormal/maladaptive form of anxiety sensitivity, whereas other physical concerns may be more relevant to normative levels or a normative form of anxiety sensitivity. This perspective is consistent with taxometric research documenting a taxonic-dimensional model of anxiety sensitivity; specifically, lower and higher levels of anxiety sensitivity are dimensionally and qualitatively different from one another (Bernstein, Zvolensky, Norton et al., 2007a, b).

After examining the potential for bias in evaluating levels of anxiety sensitivity among men and women, we came to two conclusions. First, women demonstrated higher mean levels of anxiety sensitivity than men. This finding is consistent with past theory and research (Stewart, Conrod, Gignac, & Phil, 1998; Stewart, Taylor, & Baker, 1997). Second, men and women with the same level of anxiety sensitivity did differ in how they responded to certain ASI items, but these differences were generally minor and are unlikely to unduly bias overall assessments. For example, women were more likely to report, "It scares me when I feel faint," than men. In contrast, men were more likely to report, "When my stomach is upset, I worry that I might be seriously ill" and "It scares me when I am unable to keep my mind on a task." These data suggest that while there are overall differences in anxiety sensitivity, such variability was not uniformly present for all items measured by the 16-item ASI. This finding broadly illustrates the importance of item-level analyses of the anxiety sensitivity construct.

It is noteworthy that results of the current investigation offered a high degree of agreement with latent structural research on anxiety sensitivity involving taxometric methodology. Here, there was a high degree of concordance between the present IRT results, in regard to the item-level ability to discriminate and provide information about levels of anxiety sensitivity, and findings from previous taxometric investigations, in terms of the degree to which ASI items discriminate between unobserved/latent heterogeneous (taxonic) anxiety sensitivity sub-groups (Bernstein et al., 2007a; Bernstein, Zvolensky, Feldner et al., 2005; Zvolensky, Forsyth, Bernstein, Leen-Feldner, 2007). Specifically, like the present IRT data, previous taxometric investigations have indicated that ASI items 1, 5, 7, 8, 12, and 13 either do not discriminate well between anxiety sensitivity taxonic groups or do not reflect dimensional individual differences between individuals within the AS taxon (e.g., Bernstein et al., 2007a). Thus, 6 of the 7 ASI items were identified as poorly performing by both IRT and taxometric methodologies. The sole exception to this pattern of results is item 9, which has performed well in taxometric investigations (e.g., Bernstein et al., 2007a). This finding pertaining to item 9 is likely due to the fact that although the item does not discriminate well across the range of latent levels of anxiety sensitivity, at least two of the item 9 thresholds fall at the high-end of anxiety sensitivity distribution. Thus, item 9 may provide some effective discrimination within this high-end of the continuum where the putative taxon and complement groups may be admixed (e.g., Bernstein et al., 2007a, b). Additionally, like the present IRT data, previous taxometric investigations have indicated that ASI items 3, 15, and 16 discriminate well between the anxiety sensitivity taxon and complement groups and reflect dimensional individual differences between individuals within the anxiety sensitivity taxon (e.g., Bernstein et al., 2007a). Furthermore, in terms of items that performed adequately in IRT analyses (items 2, 4, 6, 10, 11, and 14), all also were identified in previous taxometric investigations as either discriminating well between taxonic groups or loaded onto the anxiety sensitivity taxon (e.g., Bernstein et al., 2007a).

The present results have implications for anxiety sensitivity measurement and clinical assessment. Researchers and clinicians evaluating anxiety sensitivity (among smokers) using the 16-item ASI may choose to focus only on items that performed well in these IRT analyses (items: 2, 3, 4, 6, 10, 11, 14, 15, and 16). For example, this assessment approach may involve generating a global score that reflects overall levels of anxiety sensitivity and operationalizing anxiety sensitivity physical and psychological concerns sub-scales using only the well-performing items. This novel scoring strategy omits poorly performing items and is comprised of items that reflect anxiety sensitivity physical and psychological concerns. Future studies may benefit by incorporating a shortened version of the ASI based on the items that performed well in the IRT analyses. For example, abbreviating the measure in a meaningful way could increase reliability of assessment in research settings as well as offer a more efficient approach to measuring anxiety sensitivity in primary care and other clinical settings. In terms of social concerns items, specifically, the present data suggest that this putative facet of the construct (and these specific items) may not contribute to individual differences in anxiety sensitivity among smokers. To inform this area of study, future work should attempt to replicate and extend the current results using alternative measures of the anxiety sensitivity construct, such as the ASI-III (Taylor et al., 2007).

There are several caveats that warrant consideration in the interpretation of the present findings and highlight useful targets for future research. First, the present sample is limited in that it is comprised of a relatively homogenous (e.g., primarily Caucasian) group of adult smokers who volunteered to participate in the study for monetary reward. To rule out potential self-selection bias among persons with these characteristics and increase the generalizability of these findings, it will be important for researchers to draw from other populations (e.g., adolescents, older adults) and to utilize recruitment tactics other than those used in the present study. Second, we sampled community-recruited daily smokers. Inspection of the level of nicotine dependence among this sample was relatively low. To enhance the generalizability of the results, it may therefore be useful to replicate and extend the present findings to heavier smoking samples and evaluate whether similar patterns emerge. Third, the present study was focused expressly on adult daily smokers. Although there is no reason to expect the current findings not to generalize to non-smoking populations, future research should nevertheless replicate and extend the current findings to such non-smoking groups. Finally, we were not able to evaluate the proposed ASI measurement model with respect to smoking-relevant characteristics, such as smoking cessation outcomes. Future research may evaluate whether the proposed ASI measurement model improves prediction of smoking cessation outcomes and helps to illuminate anxiety sensitivity-smoking relations more generally.

Overall, the present study offers novel information pertaining to the anxiety sensitivity construct, as measured by the 16-item ASI, through the application of IRT methodology to adult daily smokers. Results suggest that assessment of anxiety sensitivity among adult smokers may be more reliable and valid by focusing on a select subset of well-performing items. This knowledge can be applied to offer a more robust and clinically meaningful approach to psychological assessment of cognitive-based anxiety vulnerability and the study of anxiety sensitivity-smoking relations.

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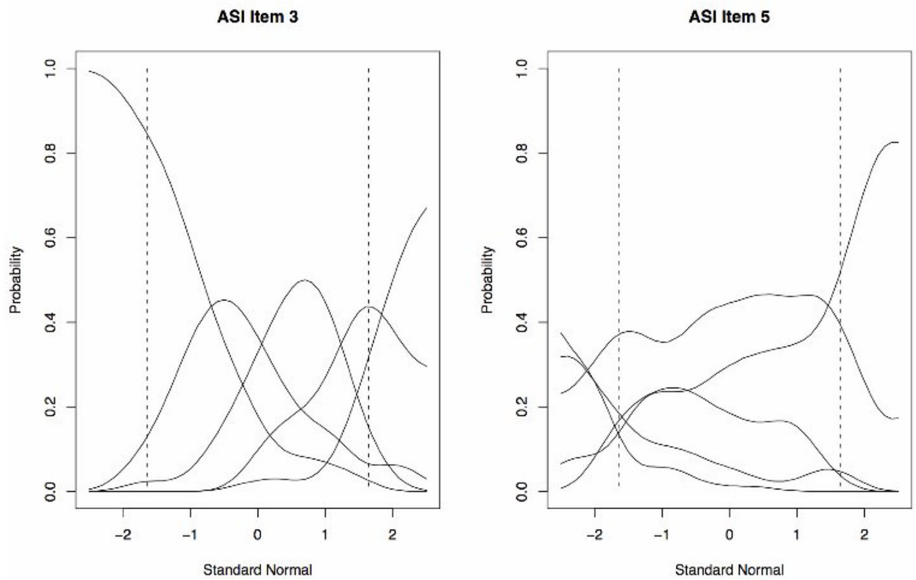

Figure 1.

Option Characteristic Curves obtained from the nonparametric item response model. Item 3 demonstrated good psychometric properties in that each response option was effective in making a unique discrimination across levels of AS. Item 5, in comparison, is dominated by a single response option throughout most of the distribution of scores. Vertical dashed lines indicate the 5th and 94th percentiles of levels of AS for this sample.

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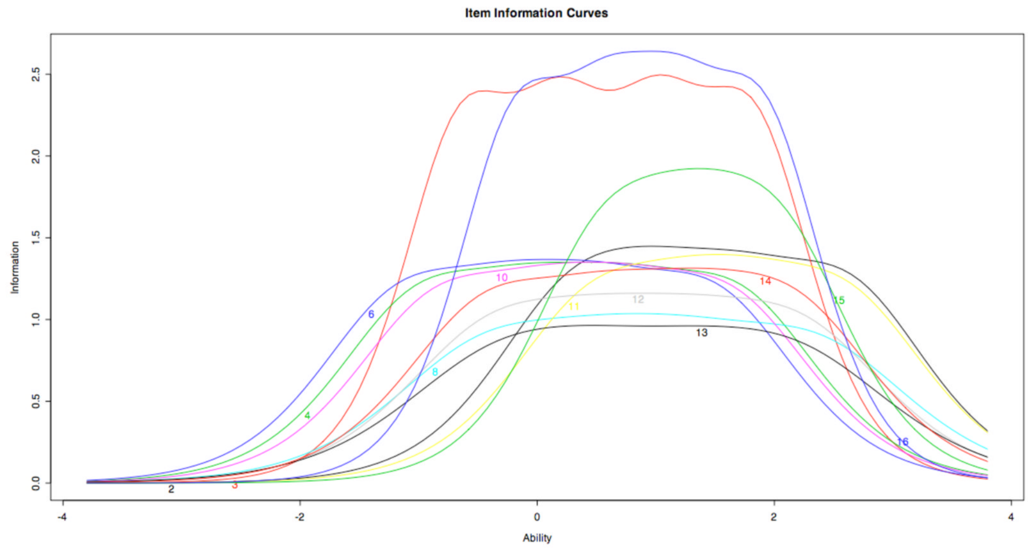

Figure 2.
Item Information Curves for the 12 retained ASI items. Items with higher curves provide more information than items with lower curves.

Table 1

Fit indices from confirmatory factor analysis.

	Unidimensional	4-factor	Bi-factor
CFI	0.875	0.912	0.937
TLI	0.969	0.978	0.983
RMSEA (Root Mean Square Error Of Approximation)	0.130	0.109	0.095
SRMR (Standardized Root Mean Square Residual)	0.064	0.055	0.045
WRMR (Weighted Root Mean Square Residual)	1.927	1.569	1.310

Table 2

Item means, level of AS where each item option is expected to be observed, and each item's level of discrimination estimated by the Graded Response Model.

ASI Item	Item Content	*M* (*SD*)	Some Threshold1	A Little Threshold 2	Much Threshold 3	Very Much Threshold	Discrimination
1	It is important not to appear nervous.	2.20(1.23)	--	--	--	--	--
2	When I cannot keep my mind on a task, I worry that I might be going crazy.	0.76(1.08)	0.316	0.968	1.718	2.627	2.169
3	It scares me when I feel shaky.	1.41(1.21)	−0.631	0.197	1.022	1.816	2.960
4	It scares me when I feel faint.	1.71(1.21)	−0.988	−0.065	0.757	1.692	2.117
5	It is important to me to stay in control of my emotions.	2.87(1.06)	--	--	--	--	--
6	It scares me when my heart beats rapidly.	1.89(1.31)	−1.147	−0.238	0.537	1.494	2.123
7	It embarrasses me when my stomach growls.	1.15(1.29)	--	--	--	--	--
8	It scares me when I am nauseous.	1.20(1.21)	−0.417	0.537	1.295	2.353	1.831
9	When I notice my heart beating rapidly, I worry that I might be having a heart attack.	0.88(1.21)	--	--	--	--	--
10	It scares me when I become short of breath.	1.66(1.32)	−0.844	0.065	0.768	1.635	2.096
11	When my stomach is upset, I worry that I might be seriously ill.	0.64(1.03)	0.479	1.263	1.803	2.607	2.113
12	It scares me when I am unable to keep my mind on a task.	1.19(1.22)	−0.364	0.514	1.313	2.203	1.944
13	Other people notice when I feel shaky.	1.21(1.25)	−0.301	0.446	1.360	2.176	1.766
14	Unusual body sensations scare me.	1.89(1.20)	−0.417	0.540	1.352	2.152	2.077
15	When I am nervous, I worry that I might be mentally ill.	0.67(1.14)	0.559	1.131	1.540	2.047	2.461

ASI Item	Item Content	*M* (*SD*)	Some Threshold1	A Little Threshold 2	Much Threshold 3	Very Much Threshold	Discrimination
16	It scares me when I am nervous.	1.10(1.22)	−0.175	0.584	1.189	1.907	2.974

Note: ASI scores range from 0 – 4 corresponding to options ‘Not at all’, ‘Some’, ‘A little’, ‘Much’, and ‘Very Much’. Threshold 1 corresponds to the level of AS where smokers begin to report ‘Some’ rather than ‘Not at all’. Thresholds 2–4 correspond to the level of AS where smokers begin to report the next highest response category.