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# Anxiety sensitivity and smoking variability among treatment seeking smokers

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## Abstract

**Objectives—**Anxiety sensitivity (AS) is associated with poor smoking cessation outcomes. One reason may be that smokers with high AS smoke differently (i.e., to manage negative affect and uncomfortable bodily sensations) than other smokers, leading to stronger addiction (due to an affect/sensation based and thereby highly variable rather than a regular smoking routine). Thus, we examined the relationship between AS and smoking variability in a group of treatment-seeking smokers.

**Methods—**Participants ($N$ = 136; 52.2% female; $M_{age}$ = 44.19 years, SD = 11.29) were daily smokers with elevated AS (AS≥20 on the Anxiety Sensitivity Index 16-item at prescreen) recruited as part of a larger randomized controlled trial for smoking cessation. Most participants were Caucasian (73%), educated (with 76% attending some college), unmarried (73%), and employed full-time (56%). They smoked, on average, 17 cigarettes per day.

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**Results—**Consistent with prediction, a regression analysis of baseline assessments and a longitudinal analysis with multilevel modeling (MLM) both showed higher AS was associated with greater variability in cigarettes smoked per day while controlling for gender, age, ethnicity, and income.

**Conclusions—**This finding encourages investigation of how AS might interact with clinical strategies using a fixed smoking taper as part of quit attempts.

### Keywords

Anxiety Sensitivity; Smoking; Variability

## Introduction

There is broad-based recognition that smokers are more likely to have a psychiatric disorder than are non-smokers.[1] Additionally, smokers with psychiatric symptoms and conditions consume a disproportionately higher number of cigarettes in the overall population relative to their prevalence.[2] Among the various psychiatric disorders implicated in smoking, depressive and anxiety syndromes are particularly important to study because they are highly prevalent in the general population and remarkably comorbid with smoking.[3,4]

Despite the empirically-robust and clinically-significant relation between emotional disorders and smoking, remarkably little is known about the core mechanisms underlying this association. Anxiety sensitivity is a cognitive-affective transdiagnostic factor that has been most commonly conceptualized as an individual difference factor related to sensitivity to aversive internal states of anxiety (i.e., how one reacts to aversive internal states).[5] Anxiety sensitivity is implicated in the increased development and maintenance of various emotional symptoms and disorders (e.g., panic attacks, depressive symptoms, panic disorder, posttraumatic stress disorder),[6–10] and is distinguishable empirically and theoretically from anxiety *symptoms* and other negative affect states like depressive symptoms.[9, 11]

Research also indicates AS is related to smoking behavior. For example, AS is positively correlated with smoking motives to reduce negative affect,[12, 13] beliefs (i.e., expectancies) that smoking will reduce negative affect,[14] negative urgency and smoking expectancies,[15] smoking inflexibly in response to negative affect states,[16] as well as increased expectations for adverse emotional distress during smoking deprivation.[17] Higher levels of AS also have been predictive of greater increase in positive affect,[18] and are associated with reductions in subjective anxiety during stressful situations[19,20] after cigarette smoking.

From a cessation perspective, smokers higher in AS, relative to those lower in AS, perceive quitting as more difficult[21] and experience more intense nicotine withdrawal during early phases in quitting (i.e., one week post quit).[22, 23] Moreover, higher levels of AS are related to greater odds of early smoking lapse[24] and relapse during quit attempts.[25–27] High anxiety sensitive smokers experience more intense nicotine withdrawal and craving during early phases of quitting, as well as during laboratory-induced periods of smoking abstinence.[28] Moreover, although Axis I emotional disorders (anxiety and depressive conditions) are predictive of higher levels of nicotine dependence, greater perceived barriers to cessation,

and greater severity of problematic symptoms while quitting; each of these relations are accounted for by the association of these Axis I disorders with AS.[29] Thus, AS may be an important transdiagnostic construct in explicating the nature of the relations between emotional disorders and various smoking processes.

Although high AS is clearly related to various aspects of smoking, little empirical information is available about variability in smoking patterns among individuals high in AS. For example, do smokers with high AS adhere to a consistent routine (i.e., smoke the same number of cigarettes each day) to help prevent uncomfortable withdrawal sensations that can follow irregular smoking regimens? Conversely, do they actually smoke erratically "as circumstances dictate" (pro re nata [prn]) following stressors and uncomfortable bodily sensations to manage these sensations? Although smoking variability has not previously been directly examined, there are data that suggest smokers are more likely to report relying on smoking to manage negative affect rather than prevent it.[12–14] If true, we would expect high AS smokers to smoke more variably. More variable smoking, in turn, could lead to greater more difficulty in smoking cessation. There is a long history of studies showing that prn/variable substance delivery is more addictive compared to fixed or scheduled delivery.[30,31]

The primary aim of the current study was to examine the relation between variability in daily number of cigarettes and AS. Based on previous findings, we hypothesized that higher AS would be associated with greater smoking variability.

## Materials and Methods

### Participants

Participants ($N$ = 136) were enrolled in a randomized controlled trial evaluating the efficacy of exercise as an aid to smoking cessation.[32] Participants were between the ages of 18 and 65, daily smokers for at least 1 year, and currently smoking on average of at least 10 cigarettes per day. They were also classified as high in AS (with a score of ≥20 on the Anxiety Sensitivity Index 16-item at prescreen), sedentary (participating in moderate-intensity exercise less than 2 days/week of a duration less than 30 minutes as defined in previous studies,[33] and motivated to quit smoking (reporting a motivation to quit of at least a 5 or higher on a 10-point scale). Further inclusion and exclusion criteria for this study are reported in Smits et al.[32]

### Procedures

The study was performed after approval by the institutional review board at Southern Methodist University. Written informed consent was obtained from each participant. Participants were recruited through the community and physician referrals with recruitment techniques including post paid newspaper, radio advertisements, fliers in community-based organizations, and internet-based advertising (including our laboratory website and Craigslist). Financial incentive was advertised as providing $25 for attending the baseline assessment.

Study eligibility was assessed through (1) an initial prescreen (both online and via telephone), (2) an in-person psychiatric diagnostic screening visit, and (3) an in-person medical examination. The online prescreen was the first point of contact with the participants and allowed us to assess for study eligibility. If persons appeared eligible based on online screen, a follow-up telephone call was made to verify prescreen eligibility. Those still deemed eligible were invited to our site for the diagnostic screening interview and medical examination to assess for the presence of exclusion criteria. Eligible participants completed the baseline assessment within 3 weeks of completing their screening visits. Participants completed assessment measures weekly until quit week in the trial (week 6).

## Measures

**Smoking History—**Smoking history was assessed at prescreen using indices agreed upon by a National Institute consensus panel.[34] These indices included but were not limited to: rate of smoking, number of previous quit attempts, and age of onset of smoking. This measure has been successfully implemented in previous work.[35]

**Structured Clinical Interview for DSM-IV Non-Patient Version—**At the diagnostic screening visit, diagnostic exclusions and lifetime prevalence of Axis I diagnoses were determined by the administration of the Structured Clinical Interview for DSM-IV Non-Patient Version (SCID-NP).[36] The SCID was administered by trained interviewers who were supervised by the senior investigators (JAJS and MBP), as had been done successfully in previous trials.[37]

**Anxiety Sensitivity—**The 16-item Anxiety Sensitivity Index (ASI-16)[5] was used to assess sensitivity to and discomfort with physical sensations at prescreen as an eligibility assessment. The ASI demonstrates good retest reliability and internal consistency, and excellent convergent validity with other established measures.[38,39] The mean for the ASI across 12 studies with more than 4,500 participants was 19.01 ($SD$ = 9.11).[40] High AS was defined by a score of 20 or greater on the 16-item Anxiety Sensitivity Index (that is, above the community norm and a cut-off point shown to be associated with increased risk of future panic and other anxiety problems.[41] The newer and longer version of the Anxiety Sensitivity Index (ASI-3) was administered at the baseline assessment as the primary measure of AS. It is an 18-item measure in which respondents indicate the degree to which they are concerned about possible negative consequences of anxiety-related symptoms.[42] These items were derived, in part, from the original ASI[5] and the Anxiety Sensitivity Index-Revised (ASI-R).[43] The ASI-3 and its subscales show improvements over previous measures of the construct regarding reliability and factorial validity; as well as convergent, discriminant, and criterion-related validity.[42]

**Smoking Variability—**Smoking variability was calculated at each assessment from baseline through quit week (week 6) using a 7-day timeline follow-back (TLFB) questionnaire. The TLFB procedure demonstrates good reliability and validity.[44] Smoking variability was then computed as the variance of the 7-day data for each participant using the variance equation: $S^2=\frac{\sum (X-\overline{X})^2}{n-1}$ where $x$ is the number of cigarettes smoked each

day.[45] To provide a more accurate estimate of variability, we only calculated smoking variability for weeks for which smoking data was reported for at least ½ of the days in that week (i.e., at 4 or more days during the preceding week). Only 9 assessments (1.1%) out of 794 collected failed to meet this criterion.

## Results

After completing screening visits, 136 participants were deemed eligible to participate in the study. Most participants were Caucasian (73%), educated (with 76% attending some college), unmarried (73%), and employed full-time (56%). They smoked, on average, 17 cigarettes per day. Though participants all evidenced an ASI-16 score at prescreen of 20 or higher, by baseline their average (using the 18-item ASI-3) was 18.32 ($SD$ = 11.62). Seventy percent of our sample was diagnosed with at least one Axis I diagnosis at the diagnostic screening visit, and 73% of those with an Axis I diagnosis also had at least one comorbid diagnosis. A detailed overview of participant characteristics at baseline can be seen in Table 1.

We examined the relationship between ASI and the variability in cigarettes smoked per day in two ways: first, we looked at the relation between ASI and smoking variability at baseline. Then we examined their relation within participants, over time, during the 6 weeks before quit day. Mean smoking variability for the sample was 9.92 (SD=22.2) at baseline, and 11.32 (SD=25.6) across the 6 weeks before quit week. However, the variance in number of cigarettes smoked was highly skewed (skewness=4.48 at baseline, 6.35 over the 6 weeks before quit week). Thus, smoking variability was log transformed, which reduced skewness to acceptable levels, .60 at baseline and .50 over the 6 weeks. All references to smoking variability hereafter refer to log transformed smoking variability.

### Baseline

To examine the relation between AS and smoking variability at baseline, we performed a regression in which AS predicted smoking variability, controlling for gender, ethnicity, education, and income. Consistent with prediction, higher AS (on the ASI-3) was associated with greater variability in cigarettes smoked per day while controlling for gender, age, ethnicity, and income ($\beta$ = .22; $t$ = 2.17; $p$ = .032; semi partial $r^2$=.04).

### Within-person relation between AS and smoking variability during the 6 weeks prior to quit week

Multilevel modeling (MLM) was used to examine the relation between ASI and smoking variability within-persons over time. Participants provided up to 7 assessments of ASI and smoking from baseline to week 6. AS was used as a level-1, time varying predictor of smoking variability over time, while controlling for gender, ethnicity, education, and income. Also, since participants were assigned to either the exercise or wellness condition, we included treatment condition and the treatment condition × AS interaction to determine if the relation between AS and smoking variability differed between conditions. The analysis indicated that treatment condition did not affect relation of AS with smoking variability

(ps>.94). Results also indicated that higher within-person levels of AS were associated with higher levels of smoking variability that week, $b$=.02, $t$ (358)=3.13, $p$=,002.

## Discussion

Participants with higher AS showed greater variability in their daily smoking amount. Greater variability in cigarettes smoked per day is consistent with a prn style of smoking in response to stressors and bodily sensations rather than smoking more regularly in an attempt to prevent feared withdrawal sensations. Although we found that higher AS predicted greater variability in smoking, the design of our study did not permit testing the next hypothesis, which is that this variability would lead to greater difficulty in cessation attempts. If our findings are replicated and extended in this way, it may suggest greater confidence in interventions where participants high in AS are encouraged to move from a prn to a fixed schedule of smoking with a subsequent taper schedule to reduce conditioned responding.

The mean variability in the number of cigarettes smoked per day was 3.14 ($SD$ = 2.41). It is difficult to compare this level of variability to earlier studies given they only reported the between participant standard deviations on the TLFB with the notable exception of the Lewis-Esquerre et al.[46] trial. Lewis-Esquerre and collegues[46] reported a standard deviation on the TLFB of 3.7 ($SD$ = 2.8) among smoking adolescents, which is in the same range as our finding (the means are less than 1 SD apart). It should be noted, however, our sample included adults 18–65, and the Lewis-Esquerre sample (adolescents only) should not be considered exactly comparable given previous research has indicated that adolescent smoking patterns are highly variable.[47]

Our study has several limitations. First, wepre-selected smokers with elevated AS, thus, these results may not apply to smokers with lower scores on the ASI. In addition, although we selected for elevated AS, our sample was not in the high/severe range. Therefore, future studies may benefit from examining the impact of a fuller range of AS scores. Another limitation is that AS ratings dropped from screening to the baseline visit, over the 2–3 week waiting period between these visits. This is not an unusual finding, given that self-report and behavioral measures of AS do have some context specific variability.[48] Additionally, variable scores may have resulted from using the shorter ASI (16 item) at prescreen and the ASI-3 (18 item) at baseline. Given this variability, we examined the relationship between AS and smoking characteristics as assessed during the same baseline visit; the role of AS in predicting smoking characteristics over time also needs to be examined. Finally, contrary to a prn hypothesis for smoking variability among those with high AS, it is also possible that people with higher vs. lower AS may approach the time line follow back 7-day point prevalence abstinence interview differently. For example, people with lower AS may tend to simply state the same number each day for their cigarette count while those with higher AS may be more careful to accurately record the slight variations in day to day smoking due to fears associated with either smoking or not smoking and a resulting greater attention bias. Future studies might build upon these findings by examining both smoking variability and its relation to AS within a less restricted sample to determine whether smoking variability may be an important predictor of nicotine dependence which should be addressed in smoking cessation attempts.

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**Table 1**

Baseline Characteristics

| | N | Mean | SD |
|---|---|---|---|
| Age | 136 | 44.19 | 11.29 |
| Cigarettes/day (PPA) | 130 | 16.85 | 8.13 |
| Cigarettes/day variance (baseline) | 130 | 9.92 | 22.2 |
| ASI (16 item) | 136 | 31.56 | 10.05 |
| ASI-3 (18 item) | 130 | 18.32 | 11.62 |
| Age of first Cigarette | 125 | 16.02 | 4.90 |
| Years of Regular Smoking | 125 | 22.99 | 11.48 |
| Quit Attempts | 125 | 4.76 | 2.75 |
| | | *N* | *%* |
| Sex (female) | | 71 | 52.2 |
| Education (some college) | | 103 | 75.7 |
| Employed full-time | | 76 | 55.9 |
| Married | | 37 | 27.2 |
| Ethnicity (Hispanic or Latino) | | 11 | 8.1 |
| Race | | | |
| White | | 100 | 73.5 |
| Black or African American | | 28 | 20.6 |
| Asian | | 3 | 2.2 |
| Other | | 4 | 2.9 |
| Not reported | | 1 | 0.7 |
| Axis I Diagnoses | | | |
| At least 1 diagnosis | | 105 | 77.0 |
| Comorbid diagnoses (>1) | | 99 | 73.0 |
| Lifetime mood diagnosis | | 52 | 38.0 |
| Lifetime anxiety disorder diagnosis | | 35 | 26.0 |
| Lifetime alcohol use disorder | | 68 | 50.0 |
| Lifetime substance use disorder | | 53 | 39.0 |

ASI-3 = Anxiety Sensitivity Index – 3