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Association of tobacco dependence and quit attempt duration with Rasch-modeled withdrawal sensitivity using retrospective measures

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Abstract

Aim—To examine whether Rasch modeling would yield a unidimensional withdrawal sensitivity measure correlating with factors associated with successful smoking cessation.

Design—The psychometric Rasch modeling approach was applied to estimate an underlying latent construct (withdrawal sensitivity) in retrospective responses from 1,644 smokers who reported quitting for three or more months at least once.

Setting—Web-based, passcode-controlled self-administered computerized questionnaire.

Participants—Randomly selected convenience sample of $N=1,644$ adult members of an e-mail invitation-only Web panel drawn from consumer databases.

Measurements—Lifetime Tobacco Use Questionnaire, assessing tobacco use across the lifespan, including demographics and respondent ratings of the severity of withdrawal symptoms experienced in respondents' first and most recent quit attempts lasting three or more months.

Findings—Rasch-modeled withdrawal sensitivity was generally unidimensional and was associated with longer periods of smoking cessation. One latent variable accounted for 74% of the variability in symptom scores. Rasch modeling with a single latent factor fit withdrawal symptoms well, except for increased appetite, for which the fit was marginal. Demographic variables of education, gender, and ethnicity were not related to changes in sensitivity. Correlates of greater withdrawal sensitivity in cessation attempts of at least three months included younger age at first quit attempt and indicators of tobacco dependence.

Conclusion—The relationship between tobacco dependence symptoms and Rasch-model withdrawal sensitivity further defines the relationship between sensitivity and dependence. The

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findings demonstrate the utility of modeling to create an individual-specific sensitivity measure as a tool for exploring the relationships among sensitivity, dependence, and cessation.

Keywords

Rasch model; withdrawal symptoms; tobacco dependence; nicotine withdrawal; Lifetime Tobacco Use Questionnaire

Introduction

Nicotine dependence is believed to underlie tobacco users' difficulty in remaining tobacco-free when they attempt to quit¹. Managing the constellation of withdrawal symptoms is primary in preventing relapse and, ultimately, preventing the premature death of nearly five million people who die of tobacco-related causes per year². More than two dozen research-based questionnaires explore withdrawal symptoms^{3,4}. These instruments vary in wording and application; the symptoms can disrupt everyday functioning for about two weeks⁵, can recur for years^{6,7}, and can predict relapse⁸. Withdrawal symptoms often are rated on a Likert-type scale, from 1 (*none or low*) to 5 (*high or intense*). Symptom lists typically also include a total withdrawal score. The *Diagnostic and Statistical Manual (DSM-IV)*⁹ symptom list (irritability, restlessness, insomnia, anxiety, depression, increased appetite, and poor concentration) does not include cravings and urges for tobacco, as do many scales.

The framework and structure of withdrawal assessment tools have been examined individually and for clusters of scales. Cappelleri et al.¹⁰ found two multi-item domains in the Minnesota Nicotine Withdrawal Scale: Negative Affect (four items) and Insomnia (two items), as well as finding three individual items. Using a latent class analysis approach, Xian et al.¹¹ weighted the severity of nicotine withdrawal to produce a nicotine severity score that accounted for symptom count and the severity rating. Xian et al.¹² also used latent class analysis to determine that nicotine withdrawal in middle-aged men followed a severity continuum. Their findings were consonant with those of Madden et al.¹³, who identified three major classes representing such a continuum.

As discussed in Strong et al.¹⁴, limitations of traditional correlational approaches have led to wider interest in methods based on item-response theory¹⁵, including Rasch models. In the Rasch model, the probability of a specific rating for a withdrawal symptom is modeled as a function of a person parameter (i.e., a latent trait representing general withdrawal sensitivity, defined as the propensity to experience withdrawal symptoms such as irritability and depression when regular users of tobacco attempt abstinence) and symptom parameters (i.e., the difficulties of endorsing each symptom at various levels given the individual's latent withdrawal sensitivity). The Rasch model represents the structure that the data should exhibit to obtain measurements for latent traits and symptom parameters as measurement is generally understood in the physical and biological sciences^{16,17}.

Item-response models, and in some cases Rasch modeling, have been applied to nicotine dependence measures^{14,14,18,19}, risk behaviors²⁰, alcohol use and dependence^{21,22,23,24}, severity of drug use^{25,26}, and gambling²⁷. The use of Rasch modeling extends the latent class analysis approach with specific advantages: (1) The distribution of the latent variable (withdrawal sensitivity) can be non-normal. (2) The shape of the observed scale score distribution is influenced little by the distribution of item endorseability. (3) Symptoms can be rated on different scales. (4) Items can be added or subtracted from the battery without changing the underlying latent variable scaling.

Rasch techniques have not been applied previously to withdrawal symptom data. No previous study has examined whether withdrawal sensitivity is associated with eventual relapse or with subsequent quit attempts. The present study employed Rasch modeling to examine withdrawal symptoms reported by a randomly selected e-mail invitation Web consumer panel sample. We hypothesized that Rasch modeling would yield a withdrawal sensitivity measure that (1) measures a unidimensional construct within a standard list of withdrawal symptoms, (2) facilitates quantification of the between- and within-person variability in withdrawal symptoms, (3) correlates with factors associated with the probability of successful smoking cessation, and (4) is associated with eventual success in quitting. Since the study is cross-sectional and involves retrospective measures, we examined associations with withdrawal sensitivity, without inferring that withdrawal sensitivity can predict future outcomes.

Method

The study was approved by the Institutional Review Board of SRI International of Menlo Park, California. SRI researchers received all data without personal identifiers. The panel provider (eRewards Inc., Dallas, TX), maintained the identities of respondents from their eRewards panel, but lacking access to the questionnaire data, could not connect the respondents' identities with their responses. Respondents were paid US\$10 each in eRewards electronic scrip for participating.

Procedures

Participants—E-mail invitations to participate in a tobacco questionnaire were sent to a random sample of a consumer panel hosted by eRewards, a commercial sample provider whose panels are drawn from consumer databases. The investigators did not have access to the demographics of nonresponders to the invitation. Reminder invitations were sent one week later to invitees who had not yet completed the questionnaire. Respondents self-administered the questionnaire through a secure, passcode-controlled Web site.

Responses were evaluated for straight-line responding other than *unsure/don't recall* options. Forty-seven cases were excluded for test-retest demographic mismatches for unreasonably short response times on grid questions. These are among known indices of inadequate responding²⁸.

The questionnaire was completed by 3,143 individuals. Withdrawal symptom data were available from 1,644 of 1,682 individuals reporting one or more quit attempts of three months or longer duration. These individuals provided data for a total of 2,700 quit attempts (1,644 first quit attempts and 1,056 most recent quit attempts). Data on both quit attempts were obtained from 1,049 respondents.

Demographic characteristics: Respondents ($N = 1,644$) whose data were included in the Rasch analyses were 55.5% females. Self-reported race was White, 89.1%; Asian/Pacific Islander, 3.6%; and Black, 0.9%; 2.8% reported Hispanic ethnicity. Mean current age was 44.4 years ($SD = 12.1$; range, 20 to 82). Education levels were self-reported as 43.5% some college, 30.5% bachelor's degree, 16.5% graduate degree, and 8.4% high school.

Respondents included in the analyses were from 47 U.S. states, the District of Columbia, and the U.S. military (APO Zip codes). The eight states with the highest percentage of respondents were also the eight most populous in the United States²⁹. Since this was a convenience sample rather than a population-based sample, it was not drawn randomly from throughout the United States; the sample was not weighted to be proportionally equivalent either to the U.S. population or to U.S. tobacco users.

Lifetime quit attempts: Of participants included in the Rasch analysis, 93.9% reported using cigarettes at least daily for one month or longer, with 36.5% reporting more than two quit attempts lasting at least three months. Of those reporting 10 or fewer quit attempts, the average number of quit attempts was 2.4 ($SD = 1.7$). For participants reporting 100 or fewer lifetime quit attempts of any duration, the lifetime average was 5.9 ($SD = 7.0$). Those reporting 100 or more lifetime quit attempts may have been indicating difficulty quitting, but were not necessarily reporting an accurate count.

The Lifetime Tobacco Use Questionnaire

Development and description: The Web-based Lifetime Tobacco Use Questionnaire (LTUQ)³⁰ retrospectively assesses the use of all forms of tobacco and nicotine across the lifespan. The core questionnaire directly assesses initial use, transition to regular use, regular use, quit attempts, and abstinence. Additional questions for this application included quit attempt history, and tobacco dependence. The LTUQ incorporates existing, well-studied, standard withdrawal symptom questions into the context of a comprehensive retrospective self-report of tobacco use across the respondent's lifetime. The LTUQ is programmed to shorten testing time, randomize response options, reduce sequence effects and carryover/practice effects, and monitor response consistency and data integrity

Psychometric properties: Reliability of the LTUQ has been examined in a series of analyses and reports. Test-retest analysis of lifetime tobacco use data collected from a Web sample ($N = 236$) at a two-year interval³⁰ showed high reliability for salient tobacco-use questions such as age of first use of tobacco. Two-month test-retest reliability analyses on a larger sample ($N = 1,294$; J. Brigham, unpublished results) indicated high reliability on recall of tobacco use milestones. Reliability of recalled withdrawal symptoms was moderately high. Convergent validity of the LTUQ is being analyzed in two groups previously followed as adolescents and then given the LTUQ as adults.

Withdrawal measures: The LTUQ includes scaled withdrawal questions common to withdrawal symptom instruments including the Cigarette Withdrawal Scale³¹, the Minnesota Nicotine Withdrawal Scale³², the Minnesota Withdrawal Form^{32,33}, The Mood and Physical Symptoms Scale³⁴, the Wisconsin Smoking Withdrawal Scale³⁵, *DSM-IV*⁹, and *ICD-10*². The wording of symptom description varies somewhat among the instruments but is sufficiently similar to allow comparison across instruments. The LTUQ's eight withdrawal symptom items were drawn from these instruments; exact wording of all withdrawal items from all eight instruments is presented in the online-only supplemental material. The advantage to including the withdrawal items in the LTUQ was that it incorporated symptom measurement into a comprehensive, reliable²⁸, assessment of tobacco use across the lifespan. Thus, standard withdrawal symptoms were assessed retrospectively for quit attempts across a smoker's life.

Participants were asked, "During the first few days after you quit smoking cigarettes (the first time or the most recent time) for at least three months, did you feel or experience any of the following?" Items, presented in a response grid, were: irritable or angry, restless, increased appetite, depressed, difficulty sleeping, craving to use tobacco, anxious, and difficulty concentrating. The symptoms were presented in random order with symptoms listed vertically at the left of the grid, and with the five-point response scale (*none to extremely*, plus *don't recall/unsure*) listed horizontally across the top of the grid.

Statistical analyses—Polychoric correlations to respondent ratings of eight withdrawal symptoms on 2,700 quit attempts were factor analyzed to examine the extent to which the correlation matrix could be explained by a single underlying factor. The symptom responses for these quit attempts were subsequently Rasch analyzed using the Conquest program³⁶

and the unidimensional rating scale model^{37,38,39,40}. The Rasch analysis simultaneously produced estimates for the sensitivity of each individual at each quit attempt, parameters that could be used to compute the probability of a response of 1 through 5 for each withdrawal symptom as a function of the individual's sensitivity, and statistics (infit and outfit) to examine the fit of the model to each symptom. For one symptom with marginal fit statistics, the latent variable distribution was divided into intervals, and the number of individuals in each interval who endorsed each response category was compared with the expected number and the 95% prediction interval for the expected number. The correlation between the estimated withdrawal sensitivities of the first and most recent quit attempt was calculated, and the distribution of the difference in withdrawal sensitivities at these two time points was examined. Regression analyses were conducted to determine: (1) the proportion of variance in withdrawal symptoms attributable to between person variance, (2) the extent to which demographic and tobacco usage variables were associated with changes in withdrawal sensitivity, (3) the extent to which withdrawal sensitivity at the first quit attempt was associated with subsequent ability to quit, and (4) the extent to which measures of tobacco and alcohol dependence were associated with withdrawal sensitivity at the first quit attempt.

Results

Testing duration

Completing the LTUQ online took respondents an average 19.8 min ($SD = 12.1$ min), including respondents who apparently let the LTUQ sit idle for a while. Median completion time was 16.5 min.

Rasch modeling

The most common Rasch models assume that an underlying latent variable (which we labeled *sensitivity*) is responsible for withdrawal symptom responses. The polychoric correlations matrix on the 2,700 quit attempts is presented in Table 1. Principal components analysis showed a single factor accounting for 74% of the variability; other factors had eigenvalues less than 1.0. All symptoms loaded on this factor with a coefficient of at least 0.75, with only craving and hunger loading at less than 0.85.

Sensitivity estimates

Expected *a posteriori* (EAP) estimates of sensitivity⁴¹ demonstrated a moderately bell-shaped distribution ($M = 0.0$, $SD = 1.7$) with a number of quit attempts at the extremes of the range. These quit attempts represented individuals who provided responses of 1 or 5 for all symptoms. The relationship of the total symptom score (for individuals who rated all symptoms) and the estimated sensitivity score was monotonic, increasing, and curvilinear. Each estimate had an associated standard error, which was a function of responses for that quit attempt. Figure 1 shows a plot of the standard error of estimates versus the estimated sensitivity. For sensitivity estimates in the range -2.0 to +2.0, the standard errors were between 0.35 and 0.50 whenever all symptom scores were present. This represented a moderate degree of uncertainty, given the range covered. Outside that range, the uncertainty was sufficiently large that sensitivity values for individuals could not be ascertained reliably; the average sensitivity values for groups would have substantially smaller standard errors.

Endorsement probabilities

Rasch model parameters were used to estimate the probability of endorsement of different responses for each symptom as a function of the individual's withdrawal sensitivity. Table 2 shows the median sensitivity values. The symptoms are sorted in approximate order from easiest to hardest to endorse. For the symptom craving to use tobacco, individuals close to the

median sensitivity of 0.0 had a 50% chance of reporting intense craving (i.e., endorsing a value of 5). Symptoms of increased appetite, anxiety, restlessness, and irritability or anger had similar endorseability. The symptoms of difficulty concentrating, difficulty sleeping, and depression displayed increased difficulty in endorsement. Although the majority of sensitivity values were high enough for a 50% or greater probability of endorsement of some amount of depression, only individuals who had sensitivity values of 2.43 had a 50% probability of reporting intense depression. Table 3 suggests that this set of withdrawal symptoms presented difficulty for estimating sensitivities much below -2.0 or above 2.0, due to lack of items that discriminated in those regions, which is in agreement with the estimates of the standard errors of withdrawal sensitivity.

Model fit

We examined the fit of the Rasch model for each symptom using infit and outfit mean-square error, as listed in Table 3. Both of these statistics measured the extent to which observed responses by individuals differed from expected responses. The outfit mean square is an outlier-sensitive fit statistic that is sensitive to unexpected observations on items that are relatively very easy or very hard for respondents to endorse. The infit mean square weighted observations by their information content; this statistic was less influenced by outliers than the outfit mean square (although such outliers can increase infit mean square). Values greater than 1.0 indicate unmodeled noise or other sources of variance in the data. Values less than 1.0 indicate that the model predicts the data better than expected.

Infit and outfit have no generally accepted thresholds, although some rules of thumb can be applied^{42,43}. Generally, values outside a range of 1.33 to 1.50 are considered to indicate some lack of fit, and values above 2.0 are of concern. Values below a range of 0.70 to 0.40 indicate overfitting. Lack of adequate infit is considered to be more serious than lack of outfit. Among the withdrawal symptoms, increased appetite was the only symptom that did not fit the Rasch model adequately, although the lack of fit was marginal.

To further examine fit of the symptom increased appetite, we examined the goodness of fit assuming that the estimated withdrawal sensitivity for each quit attempt was the true sensitivity. We divided the sensitivity axis into 15 intervals of width 0.5. For each interval, we identified the quit attempts with sensitivity values in that interval. Quit counts in intervals ranged from 11 to 420. For each quit attempt, we calculated the probability that the individual associated with that attempt would respond 1 through 5. We summed those probabilities to obtain the expected number of responses of 1 through 5 in the interval. We divided the expected number by the number of quit attempts in that interval to obtain the expected percent responses of 1 through 5. For each expected percent, we calculated 95% association intervals using the formula $p \pm 2 \times [p(1-p)/n]^{1/2}$ where p was the expected percent of quit attempts with a particular response value and n was the number of quit attempts in the interval. Finally, we calculated the observed percent responses of 1 through 5 in each interval.

Figure 2 displays the fit for the withdrawal symptom increased appetite (which had the least acceptable goodness of fit) for responses of 1, 3, and 5. For example, in the lowest interval, with an average sensitivity value of approximately -3.4, the analysis included 176 quit attempts, all of which were associated with responses of 1 (*not at all*), although the Rasch model indicated that only $90\% \pm 5\%$ of those quit attempts would yield that response. A similar figure (not shown) was developed for responses of 2 and 4. Although the observed responses were not within the prediction intervals for some intervals of sensitivity, the lack of fit was not, in general, severe.

Comparison of sensitivities at first and most recent quit attempts

The correlation between the sensitivities of the first and most recent quit attempt was $r = .80$; the correlation was $r = .83$ for those who had relapsed from the most recent quit attempt and was $r = .76$ for those who had not yet relapsed. Although sensitivity decreased over time more often (57.6%) than it increased, the average decrease was relatively small (-0.16 , $SD = 1.08$), and slightly more than half (53%) of the changes were in the interval -0.4 to $+0.4$. A minority of respondents exhibited substantial changes.

Within- and between-person variance components

Hierarchical linear modeling estimated that the proportion of variance in withdrawal sensitivity attributable to between-person variability was 79.8%. The remaining 11.2% of variability was within-person and represented the variability in withdrawal sensitivity between the first and most recent quit attempts.

Variables associated with change in sensitivities

Stepwise linear regression was used to examine whether demographic or tobacco usage information would identify individuals whose sensitivity increased or decreased from the first to the most recent quit attempts. The dependent variable was the change in sensitivity. Independent variables were the total number of quit attempts, race and ethnicity (categorized as White, Hispanic, Black, Native American, Asian, other, and unstated); gender (female, male, and unstated), education (seven levels and unstated), age at first quit, and number of cigarettes per week just before the first quit attempt of at least three months' duration. Only two terms were statistically significant: the age at the first quit attempt ($\beta = -.0152$, $p < .001$), and number of cigarettes per week just before the first quit attempt ($\beta = -.00138$, $p = .004$). Together, these two covariates accounted for only 1.7% of the variance of the change in sensitivity.

Survival analysis was used to examine whether withdrawal sensitivity at the first and most recent quit attempt lasting 3 or more months was associated with the duration of those attempts. For the first quit attempt, the hazard ratio of withdrawal sensitivity was 1.107 ($CI = 1.074, 1.141$, $p < .001$) and for the most recent quit attempt the hazard ratio was 1.095 ($CI = 1.052, 1.141$, $p < .001$).

Linear regression identified many indicators of tobacco use and dependence (e.g., extent of tobacco use, age of initiation, quit attempt features, and time to first cigarette) that were statistically significant correlates of greater withdrawal sensitivity at the first or most recent quit attempt. (See Table 4.) Withdrawal sensitivity was not statistically significantly related to whether the respondent reported currently smoking or reported being tobacco-free for one or more years, or to self-reports of alcohol consumption (age when first drank alcohol, frequency or amount of usual alcohol consumption, and most alcohol consumed in 24 hours).

Discussion

The Rasch model analytic approach resulted in a measure of a unidimensional construct of withdrawal sensitivity within a standard list of withdrawal symptoms. The model analyses allowed quantification of the between- and within-person variability in withdrawal symptoms. Withdrawal sensitivity was associated directly with tobacco dependence and appeared to be associated inversely with duration of quit attempts, which is consonant with prior and current studies examining the relationship between withdrawal symptoms and relapse^{44,45}. The nature and extent of the connection between withdrawal sensitivity and success in quitting await prospective analyses.

One dominant factor emerged from the factor analysis; also, retrospective self-report of withdrawal symptoms fit a univariate Rasch model (with the possible exception of increased appetite). The primary factor accounted for 74% of the variance, in contrast with findings by Etter⁴⁶, who reported that the factor with the largest eigenvalue accounted for only 42.3% of the variance. Reasons for this discrepancy are not evident and invite further study.

The withdrawal symptoms examined in the present study provide a reasonably precise estimate of withdrawal sensitivity for individuals with sensitivities in the range of -2 to +2 logits. However, it would be desirable to add symptoms at both ends of the scale due to the increased standard error in sensitivity outside the interval from -2 to +2 logits, and the proportion who endorsed all symptoms at their extreme values (6.6% endorsed minimum values for all withdrawal symptoms and 6.6% endorsed maximum values).

The intraclass correlation for the withdrawal sensitivities of the first and most recent quit attempts was 79.8%, indicating that between-person variability is substantially larger than within-person variability over time. This suggests that the reliability of the Rasch measure is relatively high, since the remaining variability was the sum of variability-associated changes over time and error in recall. However, both quit attempts were measured cross-sectionally at the same occasion, and errors in recall would therefore be expected to correlate. For the substantial majority of individuals, withdrawal symptoms appeared to be relatively stable but did vary modestly from the first to most recent quit attempts for a small minority. In addition, the demographic variables examined in relation to sensitivity change either were not statistically significant, or accounted for a small percentage of its variability.

The relationship between tobacco dependence symptoms and Rasch-model withdrawal sensitivity likely reflects internal validity of the standard withdrawal items used in the LTUQ and other instruments, and further defines the relationship between sensitivity and dependence, “a hypothetical construct invoked to explain smoking relapse, heavy drug use, and severe withdrawal symptoms...among other phenomena”⁴⁷. The Rasch-modeled sensitivity rating, by providing an individual score, is a metric worth exploring in relation to cessation techniques and relapse prevention.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Estimated sensitivity was generated from the Rasch model, which also generated the standard errors for those estimates. Sensitivity was relatively precise for those points plotted at a standard error below 0.5 and lower. Quit attempts on the lower arc were rated on all sensitivity withdrawal questions. Points along the bottom arc represent 2,569 quit attempts for which responses of 1 to 5 were available for all symptoms. Points above the bottom arc represent 131 quit attempts for which one or more responses were *decline/unsure* or not provided (missing)

Figure 2.

Fit of responses of 1 (*not at all*), 3, and 5 (*intense*) to the withdrawal symptom increased appetite.[†]

[†]Fit of responses of 1 (*not at all*), 3, and 5 (*intense*) to the withdrawal symptom increased appetite. This figure compares the empirical probabilities of ratings of 1, 3, or 5 (dotted lines) for individuals with modeled withdrawal sensitivity in a series of ranges with the theoretical probabilities (solid lines) of corresponding ratings for the withdrawal symptom of increased appetite. Vertical bars represent 95% confidence intervals for populations for which withdrawal sensitivity was completely known. This withdrawal symptom was selected because the infit and outfit statistics showed the least satisfactory fit with the Rasch model. However, considering that the modeled withdrawal sensitivity is measured with error, the empirical and theoretical probability curves appear to be reasonably similar.

Table 1

Polychoric correlations among LTUQ withdrawal symptoms for 2,700 quit attempts.*

Symptom	Irritable or angry	Restless	Increased appetite	Depressed	Difficulty sleeping	Craving to use tobacco	Anxious
Irritable or angry	1						
Restless	.79	1					
Increased appetite	.63	.64	1				
Depressed	.73	.74	.58	1			
Difficulty sleeping	.71	.76	.57	.77	1		
Craving to use tobacco	.71	.68	.58	.54	.53	1	
Anxious	.80	.90	.64	.75	.73	.70	1
Difficulty concentrating	.78	.80	.61	.78	.77	.62	.80

* All correlations are statistically significant at $p < .01$. Polychoric correlations were conducted because all symptoms were rated on a five-point scale. All correlations were calculated with pairwise deletion. Only correlations in the bottom triangular region are shown; the full matrix is symmetric.

Table 2

Estimated sensitivity values for median endorsements of LTUQ withdrawal symptoms.*

Symptom	Sensitivity if probability is 50%			
	≥2	≥3	≥4	≥5
Craving to use tobacco	-2.53	-1.78	-0.7	0.21
Increased appetite	-1.68	-0.92	0.05	1.29
Anxious	-1.42	-0.71	0.22	1.42
Restless	-1.34	-0.67	0.25	1.52
Irritable or angry	-1.38	-0.65	0.22	1.28
Difficulty concentrating	-0.77	-0.06	0.82	1.81
Difficulty sleeping	-0.37	0.37	1.16	2.14
Depressed	-0.34	0.56	1.55	2.43

* The first data column lists withdrawal sensitivity at which there is a 50% probability of rating each withdrawal symptom as 2 or more. Subsequent columns show withdrawal sensitivities at which the probability is 50% of rating each symptom as 3 or more, 4 or more, or 5, respectively. Withdrawal symptoms listed at the top are those that more effectively differentiate individuals with lower withdrawal sensitivities; those at the bottom more effectively differentiate individuals with higher withdrawal sensitivities.

Table 3

Infit and outfit mean square errors.*

Symptom	Infit mean square	Outfit mean square
Restless	0.77	0.70
Anxious	0.79	0.69
Difficulty concentrating	0.81	0.70
Irritable or angry	0.86	0.76
Depressed	1.07	0.94
Difficulty sleeping	1.16	1.01
Craving to use tobacco	1.33	1.18
Increased appetite	1.57	1.71

* Infit and outfit are two standard measures of the adequacy of the fit of the Rasch model, with generally more emphasis placed on infit. Values above the range of 1.33 to 1.5 indicate some lack of fit, with values above 2.0 being of concern. Values less than the range of 0.4 to 0.7 indicate overfitting.

Table 4

Conditions associated with withdrawal sensitivity at the first or most recent quit attempt, as identified by linear regression.

Variable	First quit attempt		Most recent quit attempt	
	<i>p</i> value	<i>R</i> ²	<i>p</i> value	<i>R</i> ²
Current weekly cigarettes	< .001	.063	< .001	.069
Most cigarettes ever smoked in one day	< .001	.034	< .001	.020
Younger age when first smoked	.009	.004	.014	.005
More quit attempts, any duration	.003	.005	.002	.008
Use of cessation medication at quit attempt	.001	.028	.001	.051
Shorter time to first cigarette in the morning	< .001	.016	< .001	.016