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Authors
Tucker, Joan S
Shadel, William G
Edelen, Maria Orlando
et al.

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ORIGINAL INVESTIGATION

Development of the PROMIS® Positive Emotional and Sensory Expectancies of Smoking Item Banks

Joan S. Tucker PhD[1], **William G. Shadel** PhD[2], **Maria Orlando Edelen** PhD[3], **Brian D. Stucky** PhD[1], **Zhen Li** MS[4], **Mark Hansen** MPH[4], **Li Cai** PhD[4]

[1]*RAND Health, RAND Corporation, Santa Monica, CA;* [2]*RAND Health, RAND Corporation, Pittsburgh, PA;* [3]*RAND Health, RAND Corporation, Boston, MA;* [4]*CSE/CRESST, Graduate School of Education and Information Studies, University of California, Los Angeles, Los Angeles, CA*

Corresponding Author: Joan S. Tucker, PhD, RAND Health, RAND Corporation, 1776 Main Street, Santa Monica, CA 90407-2138, USA. Telephone: 310-393-0411, ext. 7519; Fax: 310-260-8175; E-mail: jtucker@rand.org

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ABSTRACT

Introduction: The positive emotional and sensory expectancies of cigarette smoking include improved cognitive abilities, positive affective states, and pleasurable sensorimotor sensations. This paper describes development of Positive Emotional and Sensory Expectancies of Smoking item banks that will serve to standardize the assessment of this construct among daily and nondaily cigarette smokers.

Methods: Data came from daily (N = 4,201) and nondaily (N =1,183) smokers who completed an online survey. To identify a unidimensional set of items, we conducted item factor analyses, item response theory analyses, and differential item functioning analyses. Additionally, we evaluated the performance of fixed-item short forms (SFs) and computer adaptive tests (CATs) to efficiently assess the construct.

Results: Eighteen items were included in the item banks (15 common across daily and nondaily smokers, 1 unique to daily, 2 unique to nondaily). The item banks are strongly unidimensional, highly reliable (reliability = 0.95 for both), and perform similarly across gender, age, and race/ethnicity groups. A SF common to daily and nondaily smokers consists of 6 items (reliability = 0.86). Results from simulated CATs indicated that, on average, less than 8 items are needed to assess the construct with adequate precision using the item banks.

Conclusions: These analyses identified a new set of items that can assess the positive emotional and sensory expectancies of smoking in a reliable and standardized manner. Considerable efficiency in assessing this construct can be achieved by using the item bank SF, employing computer adaptive tests, or selecting subsets of items tailored to specific research or clinical purposes.

INTRODUCTION

The PROMIS® Smoking Initiative is developing, evaluating, and making available a set of psychometrically sound item banks that can form the basis for standardized assessment of cigarette smoking behavior and biopsychosocial constructs associated with smoking. In this paper, we describe the development of the Positive Emotional and Sensory Expectancies item banks for daily and nondaily smokers. Guided by a conceptual framework of smoking behavior and related constructs, in the initial phase of this project we identified items through a rigorous qualitative item pool development process, including systematic literature review and classification, focus groups, and cognitive interviews (Edelen, Tucker, Shadel, Stucky, & Cai, 2012). These items were field tested on a sample of more than 3,000 daily smokers and six distinct preliminary item banks were identified through exploratory factor analyses. One of these banks was comprised primarily of items having to do with expectancies that cigarette smoking: (a) improves cognitive abilities; (b) increases positive affective states, such as by making a person feel more relaxed or stimulated; and (c) provides pleasurable sensorimotor sensations from the ritual of lighting up a cigarette, smelling or tasting the cigarette, inhaling the smoke, or handling the cigarette. We use the label Positive Emotional and Sensory Expectancies of Smoking (heretofore referred to simply as Emotional and Sensory Expectancies) to characterize this set of items.

Outcome expectancies, such as those just mentioned, are learned, in part, by smokers' direct and vicarious experiences with smoking and also their experience of the direct effects of nicotine on improving their cognitive performance (e.g., Heishman, Kleykamp, & Singleton, 2010), regulating their emotion and affect (e.g., Kassel, 2008), and stimulating their gustatory or olfactory systems (e.g., Rose, Behm, & Levin, 1993). As such, emotional and sensory expectancies are

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central to conceptual models of cigarette smoking (e.g., Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Brandon, Herzog, Irvin & Gwaltney, 2004; Niaura, Goldstein, & Abrams, 1991; Witkiewitz & Marlatt, 2004). A number of studies have found that having higher positive outcome expectancies for smoking having to do with its stimulating, state enhancement, taste, and sensorimotor properties is associated with nicotine dependence (e.g., Copeland, Brandon, & Quinn, 1995; Kristjansson et al., 2011; Piper et al., 2004; Rohsenow et al., 2003; Vidrine et al., 2009), as well as withdrawal severity even after controlling for dependence (Vidrine et al., 2009). Further, there is some evidence that smokers with these types of expectancies tend to experience a higher likelihood of lapse or relapse after quitting (Bello, Robles, Sarmiento, Tuliao, & Reyes, 2011; Gwaltney, Shiffman, Balabanis, & Paty, 2005; Vidrine et al., 2009; see also Shiffman, Ferguson, & Gwaltney, 2006). Given the importance of this construct to understanding smoking behavior and cessation, it is important for researchers and practitioners to be able to assess the emotional and sensory expectancies of smoking in a reliable, efficient, and standardized manner.

Currently, certain aspects of the emotional and sensory expectancies of smoking are captured in a wide array of different instruments assessing outcome expectancies, smoking motives, and so forth. For example, the Smoking Consequences Questionnaire for adults (Copeland et al., 1995) includes subscales assessing Stimulation/State Enhancement (sample items: "Smoking a cigarette stimulates me;" "Cigarettes can really make me feel good") and Taste/Sensorimotor Manipulation ("I enjoy the taste sensations while smoking;" "I enjoy the steps I take to light up"). The Smoking Effects Questionnaire (Rohsenow et al., 2003) has a similar Stimulation subscale that includes items such as "Smoking keeps me from slowing down" and "Smoking stimulates me, perks me up." The Wisconsin Inventory of Smoking Dependence (WISDM; Piper et al., 2004) assesses motives for smoking that are intended to reflect mechanisms underlying dependence, with subscales including Cognitive Enhancement (e.g., "I smoke when I really need to concentrate;" "I frequently smoke to keep my mind focused"), Positive Reinforcement (e.g., "Smoking makes a good mood better;" "Smoking makes me feel content"), and Taste and Sensory Properties (e.g., "I enjoy the taste of cigarettes most of the time;" "I love the feel of inhaling the smoke into my mouth"). The Perceived Risks and Benefits Questionnaire (McKee, O'Malley, Salovey, Krishnan-Sarin, & Mazure, 2005) takes a somewhat different tack by assessing smokers' perceived risks of quitting, with separate subscales labeled Attend/Concentrate (e.g., "I will have a shorter attention span" and "I will be less able to concentrate") and Loss of Enjoyment (e.g., "I will miss the taste of cigarettes;" "I will miss the pleasure I get from cigarettes").

Although each of these existing instruments includes items relevant to a particular aspect of the emotional and sensory expectancies of smoking, none fully captures the multifaceted nature of this construct. However, selected items from each of these instruments, taken together, cover a broad range of the content relevant for this domain. The PROMIS Positive Emotional and Sensory Expectancies of Smoking item banks address this gap by providing a psychometrically sound assessment tool that can be used in flexible ways to meet the specific needs of researchers and practitioners. The content of these item banks was drawn from existing measures. In this paper, we first describe the item factor analyses, item response theory (IRT) analyses, and the differential item functioning (DIF) analyses (according to gender, age, and race/ethnicity) we conducted to arrive at a unidimensional set of items assessing the emotional and sensory expectancies of smoking among daily and nondaily smokers. We then describe how we developed and evaluated the performance of short forms (SFs) and computer adaptive tests (CATs) to efficiently, yet reliably assess this domain. Our analysis plan follows closely the procedures described by Reeve et al. (2007) to psychometrically evaluate and calibrate health-related quality of life item banks for PROMIS. More details of the analytic process used to develop the daily and nondaily smoker Emotional and Sensory Expectancies item banks can be found in this supplement (Hansen et al.).

METHODS

Sample and Procedure

A national sample of cigarette smokers ($N_{(total)}$ = 5,384; $N_{(daily)}$ = 4,201; $N_{(nondaily)}$ = 1,183) was recruited by Harris Interactive through their online panel membership, and all assessments were completed via the Internet. All procedures were institutional review board approved. Individuals were eligible if they were 18 years or older, had been smoking cigarettes for at least a year, had smoked cigarettes in the past 30 days, and did not have plans to quit smoking cigarettes in the next 30 days. Potential participants were not excluded for other substance abuse or comorbid psychopathology. Based on their response to number of days smoked in past 30 days, those participants indicating smoking 28–30 days of the past 30 days were classified as daily smokers; respondents smoking less than 28 days of the past 30 days were classified as nondaily smokers. Similar grouping have been used previously (see Fish et al., 2009; Shiffman, Kirchner, Ferguson, & Scharf, 2009), although alternative definitions of smoker type are possible. Sample recruitment was targeted to reflect the demographic composition of U.S. adult smokers in terms of gender, race/ethnicity, and age. The survey was fielded between July and September 2011 via a randomized block design (Reeve et al., 2007). The block design was constructed to minimize respondent burden while maximizing the interitem covariance coverage. To cross-validate the dimensionality of the Emotional and Sensory Expectancies item bank, the daily smoker sample was randomly split into exploratory ($N_{(exploratory)}$ = 3,021) and confirmatory ($N_{(confirmatory)}$ = 1,180) subsamples.

Measures

Smoking Items

A total of 277 unique smoking items were administered. These items were developed according to PROMIS procedures from extant items in the literature as well as direct feedback from smokers. This process, described in more detail in Edelen et al. (2012), employed a rigorous qualitative approach that included systematic literature review, binning and winnowing of items, item standardization, solicitation of feedback from cigarette smokers via focus groups and cognitive interviews, and final item revisions. All respondents completed 13 of the 277 smoking items that assessed their smoking behavior and quitting history. The remaining 264 items were candidate items that were being considered for inclusion in one of the smoking item banks. These items were distributed across

26 overlapping forms containing an average of 147 items (range = 134–158); each respondent was randomly assigned one of the 26 forms.

Other Measures

All respondents supplied basic demographic information and completed one of eight PROMIS health-related quality of life SF measures (alcohol consumption, anger, anxiety, depression, fatigue, physical functioning, sleep disturbance, and global health; Cella et al., 2007). These PROMIS measures were collected to provide preliminary validity evidence and results are reported elsewhere in this supplement (Edelen, Stucky, et al.).

Item Factor Analyses

Previous analyses of the daily smoker exploratory subsample identified a set of 40 items to be considered for inclusion in the Emotional and Sensory Expectancies item bank for daily smokers (Edelen et al., 2012). These items were drawn from established scales that included: the Questionnaire on Smoking Urges (Tiffany & Drobes, 1991); the Smoking Consequences Questionnaire for adults (Copeland et al., 1995); the Smoking Effects Questionnaire (Rohsenow et al., 2003); the Temptation Inventory (Velicer, DiClemente, Rossi, & Prochaska, 1990); and the WISDM (Piper et al., 2004). After some initial exploratory analysis, three items were removed, leaving a set of 37 candidate items for the daily smoker item bank. The same items were also considered for nondaily smokers, along with one additional item deemed to have content potentially relevant for nondaily smokers ("Smoking helps me control my weight"). Note that this weight control item was also considered initially for inclusion in the daily smoking item bank. However, the item performance in preliminary analyses (see Edelen et al., 2012) indicated that it was not a good fit with the rest of the items in this set and it was dropped from further consideration for the daily smokers.

Using the exploratory subsample of daily smokers (N = 3,021) and the full sample of nondaily smokers (N = 1,183), we examined the underlying factor structures of the 37- and 38-item sets with the software IRTPRO (Cai, du Toit, & Thissen, 2011). Local dependence (LD) diagnostic indices (Chen & Thissen, 1997) and high-dimensional exploratory item factor analyses (Cai, 2010) were used to identify clusters of related items, or LD departures from unidimensionality. Item bifactor models (e.g., Cai, Yang, & Hansen, 2011; Gibbons & Hedeker, 1992) were then specified to account for these LD clusters.

Examining model results for each smoker type, study team members evaluated items within each specific factor in order to select subsets of items that would collectively be more unidimensional than the initial sets of 37 and 38 items. We considered each item's loading on the emotional and sensory expectancies factor, the percentage of common variance accounted for by the emotional and sensory expectancies factor (i.e., item explained common variance [I-ECV]; Stucky, Thissen, & Edelen, 2013), and substantive content. Small numbers of items were selected from each item cluster (or specific factor). The two resulting item subsets for daily and nondaily smokers were selected to more closely conform to the unidimensional structure assumed in the final IRT models.

After selecting items for inclusion and removal in this way, the dimensionality of the two resultant item sets was reevaluated by testing the fit of a one-factor model using the Mplus software (Muthén & Muthén, 1998–2010) with weighted least squares mean- and variance-adjusted (WLSMV) estimation for categorical response items and standard model fit indices and criteria (root mean squared error of approximation [RMSEA] ≤ 0.08, Tucker–Lewis index [TLI] ≥ 0.95, comparative fit index [CFI] ≥ 0.95; Browne & Cudeck, 1993; Hu & Bentler, 1999). For daily smokers, model fit was assessed first in the exploratory subsample (N = 3,021) and then confirmed using the validation subsample (N = 1,180); the analysis for nondaily smokers used the full nondaily sample (N = 1,183).

Differential Item Functioning

After identifying and confirming two sufficiently unidimensional item sets to represent emotional and sensory expectancies, the item sets were further evaluated for DIF. These evaluations were conducted using the full daily (N = 4,201) and nondaily (N = 1,183) smoker samples with IRTPRO (Cai et al., 2011). DIF was evaluated for significance according to gender, race/ethnicity (White, Black, Hispanic), and age (18–30, 31–50, 51+) using established procedures (Edelen, Thissen, Teresi, Kleinman, & Ocepek-Welikson, 2006; Hansen et al., 2014; Orlando & Marshall, 2002). Items with significant DIF were further evaluated for "impact" by considering the *w*eighted *a*rea *b*etween the expected score *c*urves ("wABC") and the expected *d*ifference in *e*xpected *a* *p*osteriori score ("dEAP") indices described in more detail in Hansen et al. Items with wABC values greater than 0.30 were screened for potential removal by evaluating graphical illustrations of the subgroups' expected scores curves, along with the values of the wABC and dEAP indices. Items judged to have nonignorable DIF were removed from further consideration in their respective item banks (i.e., daily or nondaily).

Calibration of Item Banks

The Emotional and Sensory Expectancies item banks for daily and nondaily smokers were concurrently calibrated using data from the full combined sample (N = 5,384, $N_{(daily)}$ = 4,201, $N_{(nondaily)}$ = 1,183). We estimated a two-group IRT model with groups distinguishing daily and nondaily smokers. This calibration, which specified the daily smokers as the reference group, fixed the daily emotional and sensory expectancies mean to 0 and the *SD* to 1 and estimated unique nondaily mean and *SD*. Following PROMIS standards, IRT scores were subsequently rescaled using the T-score metric to have a mean of 50 and a *SD* of 10 for daily smokers. The scale for the daily – nondaily group difference was set based on pre-identified anchor items whose parameter estimates were constrained to be equal across the groups. Item parameters for nonanchor items were estimated separately for the two groups (see Hansen et al.). The utility of the item banks was determined using IRT-based test information, score precision, and marginal reliability (MR).

Short Form Development

Item parameters from the final calibration were used in the development of an emotional and sensory expectancies fixed-item SF. In order to simplify the administration and scoring of this form, only those items with equal parameters for daily

and nondaily smokers (i.e., anchor items in the two-group calibration) were considered for SF inclusion. Among all the possible combinations of eligible items, candidate SFs were identified using selection criteria related to overall content balance, inclusion of items favored by the study team, and the reliability of score estimates across a broad range of emotional and sensory expectancies (see Hansen et al. for a more detailed description of this process). Following PROMIS procedures, SF scoring was based on a transformation of the sum of responses to SF items. The use of summed scores has the particular advantage of allowing for the creation of translation tables by which researchers may convert an observed sum into an IRT-scaled score (Thissen, Nelson, Rosa, & McLeod, 2001). The performance of the SFs was evaluated using simulated data. For both the daily and nondaily item banks, we examined the reliability of each SF and obtained correlations of SF scores with scores based on the patterns of responses to the full sets of items.

CAT Simulation

CATs utilize item selection algorithms to administer items that are tailored to the respondent's estimated standing on the measured construct, often resulting in reductions in test length and respondent burden. We conducted CAT simulations using Firestar (Choi, 2009) to evaluate the utility of computer adaptive administration of the daily and nondaily smoker Emotional and Sensory Expectancies item banks. These simulations: (a) provide an indication of the average number of items from the Emotional and Sensory Expectancies item banks that would be administered under typical CAT conditions, (b) indicate which items would be most routinely selected for CAT administration, and (c) characterize the expected CAT-based score reliability.

RESULTS

Mean age was 46.4 years for daily (D) smokers and 44.1 years for nondaily (ND) smokers. Females comprised about half the sample (D: 54.8%, ND: 47.0%). Most participants were employed full time (D: 52.9%, ND: 60.6%) or part time (D: 12.2%, ND: 14.4%). The racial/ethnic composition was primarily non-Hispanic White (D: 72.2%, ND: 55.2%), African American (D: 12.1%, ND: 15.5%), and Hispanic (D: 11.3%, ND: 24.4%). Most participants had attended at least some college (D: 80.5%, ND: 84%), and many had earned a bachelors or graduate degree (D: 29.8%, ND: 42.1%). More than half were currently married or cohabitating (D: 57.7%, ND: 55.1%), with fewer being divorced/separated/widowed (D: 21.8%, ND: 18.7%) or never married (D: 20.5%, ND: 26.1%). Although most differences are not large, chi-square tests (and *t*-test for age) indicated that daily and nondaily smokers significantly differed on each of these characteristics ($p < .001$). Most notably, relative to daily smokers, nondaily smokers were less likely to be non-Hispanic White, and more likely to be employed and further educated. Table 1 compares these groups on smoking patterns. As expected, daily smokers had a longer smoking history, smoked more heavily, and reported fewer quit attempts compared to nondaily smokers ($p < .0001$).

Item Factor Analyses

Bifactor models, each with nine specific factors, were selected to characterize the structure of both the 37 daily smoker items (using the exploratory daily smoker sample) and the 38 nondaily smoker items. In both cases, these models were selected based on their interpretability, comparisons of fit indices, and LD chi-squares. The specific factors identified in the bifactor model represent the content "clusters" in the emotional and sensory expectancies item sets. Table 2 includes the general and specific factor loadings for items comprising the nine specific factors in the daily smoker solution.

The study team reviewed the bifactor model results for all 37 daily smoker and 38 nondaily smoker items and selected at least one item per specific factor to retain for further consideration in the item banks. Item selection was based on the strength of the general factor loading and item content. Retained items for daily smokers are indicated with a footnote cue ([a]) in Table 2. For some specific factor item clusters, the I-ECV indicated a strongly unidimensional item loading on the general factor. In these cases, additional items per specific factor were selected.

This process led to the selection of 19 daily smoker items, and 17 nondaily smoker items that balanced item content and closely represented the emotional and sensory expectancies dimension. Next, one-factor models were fit to the selected item sets to confirm that they were sufficiently unidimensional. Relative to the original 37 daily smoker items (CFI = 0.905, TLI = 0.900, RMSEA = 0.068), the reduced set of 19 daily smoker items showed improved fit

Table 1. Smoking Characteristics of Daily and Nondaily Smokers

Smoking variable	Daily smokers ($N = 4,201$)	Nondaily smokers ($N = 1,183$)
Years smoked, %		
1–10 years	11.7	29.2
More than 10 years	88.3	70.8
Number of days smoked in past 30 days, %		
1 or 2 days	0.0	15.8
3–5 days	0.0	9.6
6–9 days	0.0	9.6
10–19 days	0.0	23.2
20–27 days	0.0	41.9
28–30 days	100.0	0.0
Average number of cigarettes per day in past 30 days, %		
<1 per day	0.2	13.0
1–5	8.0	48.3
6–10	22.0	22.3
11–20	47.3	13.5
20+	22.6	3.9
Number of times quit for at least 24 hr, %		
Never	18.0	14.7
1 time	12.3	6.2
2–3 times	30.7	19.1
4–5 times	19.7	12.7
6–9 times	7.4	7.8
10 or more times	12.0	40.1
Quitting contemplation, %		
Not thinking about quitting	40.1	42.3
Thinking about quitting, but no plans to quit	37.1	29.0
Plans to quit in next 6 months	22.7	28.7

Table 2. Items and Loadings From the 37-Item Emotional and Sensory Expectancies Bifactor Model for Daily Smokers

Item stem	General factor	Specific factors									
		1	2	3	4	5	6	7	8	9	I-ECV
I enjoy the steps I take to light up a cigarette[a]	0.58	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52
I enjoy the sensations of a long, slow exhalation of smoke[a]	0.69	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73
I enjoy the smell of a cigarette when I pull it out of the pack[a]	0.56	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69
I love the feel of inhaling the smoke into my mouth[a]	0.75	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83
When I smoke, part of the enjoyment is watching the smoke as I exhale it	0.47	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35
I enjoy feeling a cigarette on my tongue and lips	0.68	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65
Handling a cigarette is part of the enjoyment of smoking it	0.60	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62
I am tempted to smoke in the morning when facing a tough day	0.43	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
I am tempted to smoke when I am craving a cigarette	0.44	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35
I am tempted to smoke when I feel I need a lift	0.59	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57
I am tempted to smoke when I am celebrating	0.48	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Smoking helps me concentrate[a]	0.75	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.64
Smoking helps me think more clearly	0.75	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.66
Smoking helps me stay focused	0.76	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.68
Smoking helps me do better work	0.72	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.70
Smoking stimulates me[a]	0.77	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.85
Smoking makes me feel less tired	0.64	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.55
Smoking a cigarette energizes me	0.76	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.68
Smoking keeps me from slowing down	0.69	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.68
Smoking perks me up	0.80	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.80
I smoke because smoking feels good[a]	0.83	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.91
I like the way a cigarette makes me feel physically[a]	0.69	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.92
Smoking is pleasant	0.73	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.66
The flavor of a cigarette is pleasing	0.71	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.74
I enjoy smoking too much to give it up	0.62	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.74
When I stop what I'm doing to have a cigarette it feels like "my time"[a]	0.67	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.79
Smoking is the fastest way to reward myself[a]	0.76	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.83
When I'm alone, a cigarette can help me pass the time	0.57	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.74
I smoke because it is self-satisfying[a]	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.88
Smoking makes me feel content[a]	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.92
Smoking makes me less depressed[a]	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.94
Even when I feel good, smoking helps me feel better[a]	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.97
Smoking is relaxing[a]	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.96
I smoke to get a sense of pleasure[a]	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.97
I feel better after smoking a cigarette[a]	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
If I quit smoking I will miss the pleasure I get from cigarettes[a]	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Smoking is an important part of my life[a]	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Note. I-ECV = item explained common variance.
[a]Indicates items selected to form the preliminary Emotional and Sensory Expectancies item bank for daily smokers.

in both the exploratory and confirmatory subsamples (exploratory: CFI = 0.965, TLI = 0.961, RMSEA = 0.056; confirmatory: CFI = 0.966, TLI = 0.962, RMSEA = 0.058) with only a trivial reduction in reliability (MR went from 0.97 to 0.95). Furthermore, in the exploratory subsample, the test level ECV (Reise, 2012) associated with the emotional and sensory expectancies (general) factor increased substantially from 0.733 to 0.855 indicating a more strongly unidimensional model. Fit indices for the nondaily smokers also suggest a strongly unidimensional item set (CFI = 0.958, TLI = 0.952, RMSEA = 0.072), with improvement in fit compared to the 38-item set (CFI = 0.920, TLI = 0.915, RMSEA = 0.061) and minimal loss in precision (MR went from 0.97 to 0.95). Similar to daily smoker results, the ECV associated with the emotional and sensory expectancies (general) factor in the nondaily sample solution increased from 0.764 to 0.871.

Differential Item Functioning

Next, the 19 daily and 17 nondaily smoker items underwent DIF testing according to gender, race/ethnicity (White, Black, Hispanic), and age (18–30, 31–50, 51+). For the daily smokers, across all comparisons, five items met the wABC criterion for consideration of removal (i.e., at least one DIF comparison with wABC > 0.30), and three items were ultimately removed because of DIF. Removed items had wABCs ranging from 0.37 to 0.51. For the nondaily smokers, only one item had wABC > 0.30, and it was ultimately retained after closer examination.

Figure 1 provides a graphical representation of the identified DIF for each of the items removed from the daily smoker item set. The top panel shows that relative to Black respondents, Whites are likely to endorse the sentiment of missing the pleasure of smoking upon quitting at lower levels of the emotional and sensory expectancies construct, and this item is slightly more salient (higher slope parameter) for Whites relative to Blacks. The second panel shows a similar pattern of DIF for males relative to females; male respondents endorse enjoying the smell of the cigarette at lower levels of the construct than do females. Finally, the DIF pattern in the bottom panel shows that the statement that smoking is an important part of daily life is a much more salient aspect of emotional and sensory expectancies to respondents over age 50 relative to respondents aged 18–30.

Calibration of Item Banks

Using the two-group IRT model with daily smokers as the reference group, 18 total items were calibrated. Within this set, all 15 common items were anchor items (identical item parameters for daily and nondaily smokers). In addition, there was one item that was unique to the daily bank and two items unique to the nondaily bank (for a total of 18 items in simultaneous calibration). This process resulted in two Emotional and Sensory Expectancies item banks (one for daily and one for nondaily smokers) with a total of 16 and 17 items, respectively. Results from this final calibration are shown in Table 3.

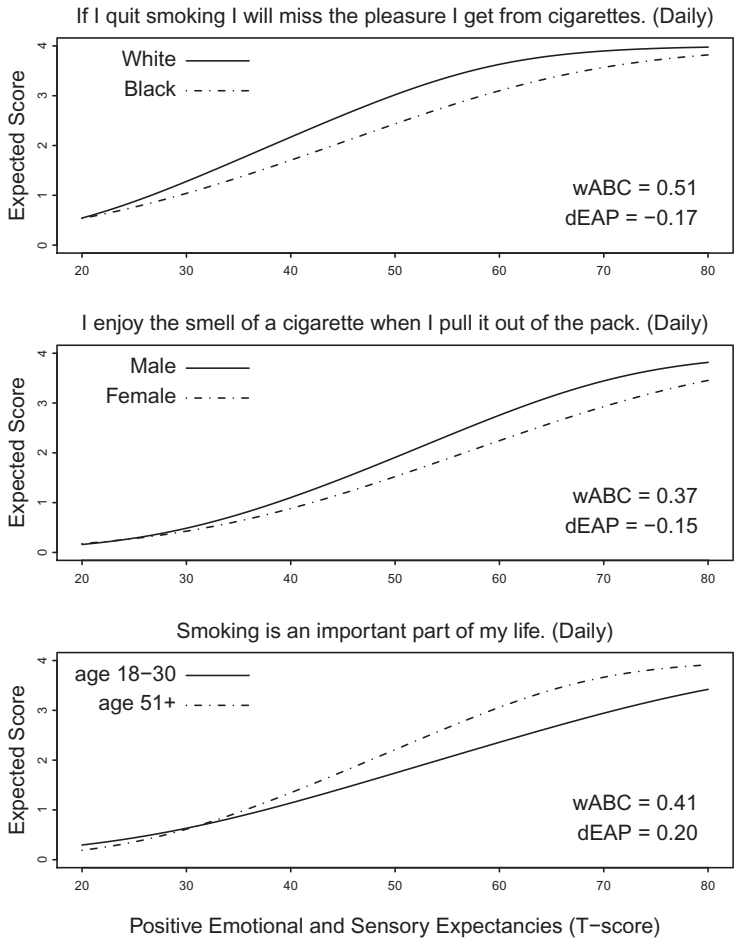

Figure 1. Items removed due to differential item functioning from the daily smoker Emotional and Sensory Expectancies item banks.

Table 3. Emotional and Sensory Expectancies Item Banks for Daily and Nondaily Smokers

Item	D/ND	CAT		Item parameters				
		D	ND	*a*	b_1	b_2	b_3	b_4
I feel better after smoking a cigarette (SF)	Both	0.98	0.99	2.37	−1.76	−0.62	0.33	1.24
I love the feel of inhaling the smoke into my mouth (SF)	Both	0.97	0.98	2.11	−1.58	−0.48	0.40	1.35
Smoking is relaxing (SF)	Both	0.51	0.62	2.06	−2.86	−1.48	−0.48	0.56
Smoking helps me concentrate (SF)	Both	0.26	0.21	1.93	−0.79	−0.01	0.93	1.80
Smoking stimulates me (SF)	Both	0.19	0.19	1.92	−1.32	−0.27	0.81	1.74
When I stop what I'm doing to have a cigarette it feels like "my time" (SF)	Both	0.03	0.06	1.66	−1.62	−0.70	0.20	1.06
I smoke because smoking feels good	Both	1.00	1.00	2.60	−1.58	−0.64	0.22	1.07
I smoke to get a sense of pleasure	Both	1.00	1.00	2.51	−1.75	−0.81	0.12	1.01
Even when I feel good, smoking helps me feel better[a]	Both	1.00	0.99	2.35	−1.44	−0.59	0.75	1.72
Smoking makes me feel content	Both	0.99	1.00	2.31	−1.50	−0.51	0.49	1.36
Smoking is the fastest way to reward myself	Both	0.32	0.24	1.92	−0.75	0.00	0.87	1.61
I enjoy the sensations of a long, slow exhalation of smoke	Both	0.07	0.09	1.85	−1.39	−0.45	0.52	1.46
I smoke because it is self-satisfying	Both	0.06	0.12	1.78	−2.32	−1.12	−0.09	0.93
I like the way a cigarette makes me feel physically	Both	0.05	0.03	1.76	−0.98	−0.14	0.91	1.82
Smoking makes me less depressed	Both	0.02	0.01	1.69	−0.70	0.00	1.05	1.87
I enjoy the steps I take to light up a cigarette	D	0.01		1.42	−0.76	0.28	1.38	2.22
I enjoy the smell of a cigarette when I pull it out of the pack	ND		0.01	1.52	−1.53	−0.34	0.56	1.43
When I'm alone, a cigarette can help me pass the time[a]	ND		0.03	1.38	−1.95	−0.97	0.37	1.72

Note. SF = short form; CAT = computer adaptive test. D/ND column indicates if the item parameters were identical in daily and nondaily groups (both), unique to the daily group (D), or unique to the nondaily group (ND). CAT column indicates the rate of item administration for the 10-item maximum condition. Item slope and threshold parameters were obtained through calibrations of the full item banks.

[a]Indicates items that used the following response options: 0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always. All other items used the following response options: 0 = not at all, 1 = a little bit, 2 = somewhat, 3 = quite a bit, 4 = very much.

These results demonstrate that the items tended to be strongly related to the underlying emotional and sensory expectancies construct (*a* parameters for items in both banks ranged from 1.66 to 2.60) and covered a wide range of the emotional and sensory expectancies continuum (*b* parameters ranged from −2.86 to 1.87) that is fairly symmetric around the emotional and sensory expectancies mean.

Figure 2 illustrates the score reliability for the daily and nondaily smoker Emotional and Sensory Expectancies item banks (and SF) on a standard T-score scale. Full bank scores have reliability values greater than 0.80 from nearly three *SD* below and above the mean (i.e., from 20 to 80, in the T-score scale). Nondaily smokers had a mean value of 46.6, 0.34 *SD* below the daily smoker mean of 50. In addition, the nondaily smoker sample had slightly more emotional and sensory expectancies variability (*SD* = 10.36) compared to daily smokers (*SD* = 10).

Emotional and Sensory Expectancies Short Form

Evaluation of candidate item sets indicated that six items would provide adequate content coverage and reliability across the emotional and sensory expectancies continuum. The items comprising the six-item SF were selected from several candidate sets and are indicated in Table 3; the summed score to IRT score translation table for the SF is contained in Table 4. Figure 2 shows the reduction in score reliability when going from the complete item banks (of 16 and 17 items) to the SF. Despite this reduction, the marginal reliability of the SF scores remains quite good (0.86). In addition, these scores correlate strongly (0.95) with those obtained from the complete banks. The results suggest that the six-item SF provides an efficient and reliable measure of the emotional and sensory expectancies construct.

CAT Simulations

CAT simulations were conducted on the daily and nondaily smoker Emotional and Sensory Expectancies item banks. Table 5 provides the results of simulations that used a *SE* of 3.0 (in the T-score metric) as the CAT stopping criterion, which corresponded to a reliability of slightly greater than 0.90, and a range of limits on the maximum number of items allowed to be administered (4, 6, 8, 10, 12). To summarize these results, the correlation between CAT and full bank scores was greater than 0.95, and the average CAT will terminate with a *SE* of 3 when about eight items have been administered. Table 3 shows the rate of administration for each item in both daily and nondaily

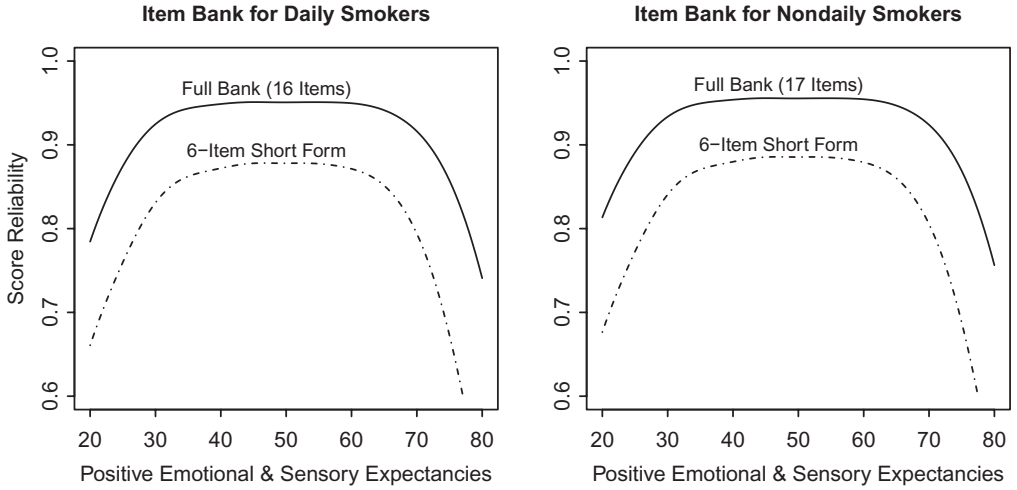

Figure 2. Score reliability for the daily and nondaily smoker Emotional and Sensory Expectancies item banks.

Table 4. Emotional and Sensory Expectancies Summed Score to Scaled Score Translation Table for the Six-Item Short Form

	Six-item short form	
Summed score	Scaled score (*T*)	*SE*
0	23.6	5.3
1	27.9	4.5
2	31.1	4.2
3	33.7	4.0
4	35.8	3.9
5	37.8	3.8
6	39.6	3.8
7	41.3	3.7
8	42.9	3.7
9	44.5	3.7
10	46.0	3.7
11	47.5	3.6
12	48.9	3.6
13	50.4	3.6
14	51.9	3.6
15	53.4	3.7
16	54.9	3.7
17	56.4	3.7
18	58.0	3.7
19	59.7	3.8
20	61.5	3.9
21	63.5	4.0
22	65.7	4.2
23	68.4	4.4
24	72.5	5.2

CAT simulations under the stopping rule of a 10-item maximum. As can be seen from these numbers, the rates of item administration were very similar across the two smoker types. Six items were administered almost 100% of the time, four items were administered at moderate frequency (0.19–0.62), and the remaining items were administered at relatively low rates. Notably, the items with the higher CAT administration rates were not necessarily those that were selected for the emotional and sensory expectancies SF. This is because the SF selection considered breadth of content in addition to empirical information.

DISCUSSION

A core set of 18 items were calibrated for the PROMIS Positive Emotional and Sensory Expectancies of Smoking item banks: 15 items were common across daily and nondaily smokers, one item was unique to daily smokers, and two items were unique to nondaily smokers. The content of these item banks covers the multiple facets of the emotional and sensory expectancies of cigarette smoking that have not been fully captured by any single existing instrument, such as improved cognitive functioning (e.g., concentration), increased positive affective states (e.g., relaxation, stimulation), and pleasurable sensorimotor sensations (e.g., from smelling, tasting, or handling a cigarette). For both daily and nondaily smokers, the item banks were found to be strongly unidimensional, highly reliable, and to perform similarly across key demographic subgroups.

These item banks provide researchers and practitioners with considerable flexibility in assessing the emotional and sensory expectancies of smoking. For example, we developed a six-item SF that demonstrated excellent reliability, and results from the simulated CATs indicated that, on average, less than eight items are needed to assess this construct with adequate precision using the item banks. In addition, it is possible to select a tailored set of items from the banks for specific research or clinical purposes. Because IRT was used to develop the item banks, these tailored subsets will all provide comparable scores to one another, as well as to the full bank score, SF score, and any CAT. The Emotional and Sensory Expectancies item banks and SF are available for public use via the project Web site (http://www.rand.org/health/projects/promis-smoking-initiative.html) as well as through inclusion in the larger PROMIS library, and a free online tool for administering adaptive tests is available through the PROMIS Assessment Center (www.assessmentcenter.net).

Table 5. Simulated Adaptive Tests for the Emotional and Sensory Expectancies Item Banks

	Maximum no. of items					
	4	6	8	10	12	All items
Daily smokers						
Average items administered	4.00	5.99	7.12	7.47	7.61	16
Proportion receiving maximum items	1.00	0.99	0.41	0.12	0.06	1
Marginal reliability	0.83	0.88	0.90	0.90	0.90	0.95
$r\ (T_{CAT},T_{full})$	0.95	0.97	0.98	0.98	0.98	1.00
Nondaily smokers						
Average items administered	4.00	5.99	7.18	7.56	7.72	17
Proportion receiving maximum items	1.00	0.99	0.44	0.14	0.07	1
Marginal reliability	0.84	0.89	0.90	0.91	0.91	0.95
$r\ (T_{CAT},T_{full})$	0.95	0.97	0.98	0.98	0.98	1.00

Note. CAT = computer adaptive test.

It is important to emphasize that the Emotional and Sensory Expectancies item banks were developed and tested for use with current smokers with no concrete plans to quit in the near future. As a result, the reliability and validity information that is available to date is not generalizable to smokers who are interested in or in the process of quitting, or to special clinical populations such as smokers with substance abuse, mental health, or physical health problems. To enhance the clinical and research applicability of these item banks, future research is needed to expand the banks to be relevant to other target populations.

The PROMIS Smoking Initiative is currently conducting preliminary analyses to examine how responses to the Emotional and Sensory Expectancies item banks are associated with smoking and quitting history and current motivation to quit in both a national Internet sample and smokers recruited from a community setting. If smokers who score higher on this construct are less motivated to quit, for example, then efforts to increase readiness to quit may benefit from incorporating strategies that directly address their expectancies about the emotional and sensory benefits of smoking. Weighing the disadvantages of smoking against the positive affective and sensory expectancies of smoking, such as through a decisional balance exercise (Janis & Mann, 1977), might be an effective approach (see Miller & Rollnick, 2002; Prochaska et al., 1994). In addition, the item banks may be useful in identifying cutoff scores for identifying smokers who are amenable to engaging in brief smoking interventions. Even more applications come to mind once we extend the banks' generalizability to smokers who are in the process of quitting. For example, cessation programs might be enhanced by providing individuals with alternatives for obtaining emotional and sensory benefits in ways that do not involve smoking. For example, a recent systematic review of the literature on mind–body practices for smoking cessation concluded that yoga and meditation-based therapies show promise (Carim-Todd, Mitchell, & Oken, 2013), perhaps because they afford many of the same emotional and sensory benefits as smoking. The positive emotional and sensory expectancies of smoking are not currently a primary target for smoking interventions (Schlam & Baker, 2013), but addressing these expectancies may further enhance the efficacy of psychosocial interventions. These item banks could also be used to examine the extent to which reductions in the positive emotional and sensory expectancies of smoking mediate cessation program effects on smoking-related outcomes (cf., Shiffman et al., 2006). Of course, the item banks will also serve their more general intended function of providing researchers and practitioners with an efficient and flexible measurement tool for the reliable, valid, and standardized assessment of this key smoking-related construct.

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DECLARATION OF INTERESTS

None declared.

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