The Role of the Subjective Importance of Smoking (SIMS) in Cessation and Abstinence

Daniel Rodriguez1, Tiffanie Goulazian1, Andrew A. Strasser2, Jennifer O’Loughlin3, Erika N. Dugas4, Chol Kuoiloi1, Brian L. Hitsman5, Robert Schnoll6
1Urban Public Health and Nutrition, La Salle University, Philadelphia, Pennsylvania
2Psychiatry, University of Pennsylvania, Philadelphia, Pennsylvania
3Centre de recherche du centre hospitalier de l’Université de Montréal (CRCHUM), Montreal, QC, Canada; Department of Social and Preventive Medicine, Université de Montréal, Montreal, QC, Canada; Institut national de sante publique du Quebec, Montreal, Quebec, Canada
4Centre de recherche du centre hospitalier de l’Université de Montréal (CRCHUM), Montreal, QC, Canada
5Department of Preventative Medicine, Northwestern University, Chicago, Illinois
6Department of Psychiatry, University of Pennsylvania, Philadelphia, Pennsylvania

Abstract

Introduction: Each year about two thirds of U.S. smokers make a quit attempt. Yet, less than 5% remain abstinent three months post-quit date. One factor that may affect abstinence is negative feelings about the self-associated with being a smoker (disequilibrium), particularly if smoking is important to the sense of self and one is trying to quit.

Aims: We evaluated a multivariate structural equation model proposing that smoking’s subjective importance to a smoker would influence carbon monoxide verified smoking abstinence at 24 weeks (post-quit date). Further, we assessed whether the relation would be moderated by the smoker’s experience of disequilibrium.

Methods: Participants were 440 regular smokers taking part in a clinical trial assessing the effectiveness of different durations of nicotine replacement therapy use. Participants completed the subjective importance of smoking survey at baseline and were assessed for carbon monoxide verified seven-day point prevalence abstinence at 24 weeks.
Results: Using exploratory structural equation modelling, the subjective importance of smoking was associated with point prevalence abstinence at 24 weeks, but only for smokers with high disequilibrium.

Conclusions: The results of this study suggest that experiencing negative feelings about being a smoker could motivate smokers to remain abstinent, despite the importance of smoking to the smoker’s sense of self.

Despite vast evidence and public information concerning its consequences, and the proliferation of policies limiting access, cigarette smoking remains the leading preventable cause of death and disease in the United States (Danaei et al., 2009; Grunberg & Barry, 2015; Islami, Ward et al., 2015). Indeed, smoking prevalence is 15% among U.S. adults, and as high as 26% among adults living below the poverty line (CDC, 2015). Each year about two thirds of U.S. smokers make a quit attempt (Agaku, King, Dube, Control, & Prevention, 2014; Lavinghouze & Malarcher, 2016; Rafful et al., 2013). Of those, less than 5% remain abstinent three-months post quit (Rafful et al., 2013; Zhu, Lee, Zhuan, Gamst, & Wolfson, 2012; Zhuang, Gamst, Cummins, Wolfson, & Zhu, 2015).

Factors associated with unsuccessful quitting include nicotine dependence, poor mental health, low social support for quitting, stress and lower self-efficacy beliefs about quitting (Cobb et al., 2014; Hiscock, Bauld, Amos, Fidler, & Munafo, 2012; Lukowski, Morris, Young, & Tinkelman, 2015; Raupach, Brown, Herbec, Brose, & West, 2014; Smit, Hoving, Schelleman-Offermans, West, & de Vries, 2014). Another factor that may influence abstinence is the subjective importance of cigarettes and cigarette smoking to a smoker’s conception of self (self-concept). If cigarette smoking is experienced as an essential characteristic of the self-concept, this belief may affect readiness to quit, quit attempts and successful quitting, as quitting smoking would be akin to losing a significant facet of who one conceives the self to be as a person. The results of research suggest that smokers’ self-conceptions of cigarettes and smoking affect success in quitting, and abstinence (Berg et al., 2010; Gibbons & Gerrard, 1995; Lindgren, Neighbors, Gasser, Ramirez, & Cvencek, 2016; Pulvers et al., 2013; Shadel & Mermelstein, 1996; van den Putte, Yzer, Willemsen, & de Bruijn, 2009). Indeed, findings of such research suggest that becoming a non-smoker involves adopting a non-smoker identity (Lindgren et al., 2016; Tombor, Shahab, Brown, & West, 2013; Tombor et al., 2015; Vangeli & West, 2012). This task is especially salient given the increased prevalence of smoking bans (Meijer, Gebhardt, Dijkstra, Willemsen, & Van Laar, 2015). Thus, given the public health burden (Jha & Peto, 2014) and the high rate of relapse, along with the relation of self-concept to behaviour change (Dudovitz, Li, & Chung, 2013; Frazier et al., 2015; Hensel, Fortenberry, O’Sullivan, & Orr, 2011; Stephens, Markus, & Fryberg, 2012; Thomas, 2007), we sought to better understand how smokers’ conceptions of cigarettes and cigarette smoking, in relation to self-concept, affect abstinence in a cohort of smokers participating in a smoking cessation study.

Variable selection was guided by theory proposing that a key function of the self is to adapt self-conceptions and behaviour to the social rules (constraints) of one’s contexts in order to minimize psychological distress (Rodriguez, 2000). Motivated by the work of Piaget (Piaget, 1951) and Epstein (Epstein, 1973), Rodriguez proposed that when behaviour and self-
concept fit contextual constraints, the individual experiences equilibrium and change is perceived as unnecessary, such as when a smoker who attributes great importance to smoking is in a smoking-friendly setting. Conversely, when fit is poor, it is proposed that the individual experiences psychological distress (disequilibrium), such as when the contradiction between a high subjective importance of smoking (SIMS) and the health and social consequences of smoking is made salient. It is the experience of disequilibrium that is proposed to be a key motivator for change, and it is the ability to tolerate disequilibrium that is proposed to be responsible for the maintenance of behaviour change, a process termed psychoadaptation.

Consistent with the role of disequilibrium in psychoadaptation, the purpose of this study was to assess whether disequilibrium moderates the relation between the SIMS to a cigarette smoker’s self-concept and smoking abstinence at 24 weeks post quit. We proposed that for smokers experiencing higher versus lower disequilibrium at baseline (greater understanding of the contradiction between high SIMS and smoking’s health and social consequences), SIMS would be associated with higher abstinence 24 weeks post quit.

**Methods**

**Participants**

Participants were 447 adult smokers (Mean age = 47 years, SD = 11.92; 51% Female; 44% White), smoking on average 17 cigarettes/day (SD = 8.36) pre quit, taking part in a randomized controlled trial evaluating the efficacy of long-versus short-term nicotine replacement therapy (NRT) using nicotine patches (Schnoll et al., 2015). Sample demographics for the n = 440 participants with complete data on all predictor variables are presented in (Table 1).

**Procedures**

At baseline (prior to randomisation to one of three NRT durations) (see main study for details, Schnoll et al., 2015), all participants completed a battery of measures assessing demographics, smoking and nicotine dependence, prior quit attempts and psychological traits and states (anhedonia, anxiety and positive and negative affect), along with the SIMS measure.

**Instrumentation**

**The subjective importance of smoking (SIMS).**—The SIMS is a 14-item measure developed to assess the psychological importance of cigarettes and cigarette smoking to a smoker. Its development followed from prior research demonstrating relations between smoking up-take and specific facets of self-concept (Rodriguez & Audrain-McGovern, 2005; Rodriguez, Dunton, Tscherne, & Sass, 2008), and theory suggesting the role of self-concept in the regulation of behaviour and affect (Epstein, 1973; Masterson, 1985; Piaget, 1951; Rodriguez, 2000).

Development of the SIMS took place in three phases. In the first, 17 items were generated based on unstructured interviews with adults smoking ≥20 cigarettes/day, and in
consultation with other University of Pennsylvania tobacco researchers. The SIMS was then administered to a convenience sample of 94 young adult smokers in Quebec, Canada (50% female; 83% White; mean age 21, SD = 0.45; cigarettes/week = 57, SD = 34.83; age first smoked = 14, SD = 2.04) (O’Loughlin et al., 2015). Results suggested that the SIMS is poorly suited for smokers smoking < 10 cigarettes/day.

The SIMS was next administered to a sample of 202 Southeastern Pennsylvania adult daily cigarette smokers with no intention to quit (Mean age 31 years, SD = 8.07) taking part in a study to better understand their opinions on tobacco product advertising (Strasser et al., 2011). The SIMS was administered once as part of a baseline smoking history battery. The aim of this phase was to assess the distribution of the SIMS in a sample of smokers smoking more cigarettes per day and for longer than the Quebec sample (cigarettes/day = 17, SD = 5.72; years smoked 13, SD = 6.81). Although there was greater variability than the Quebec sample, the response probabilities for several items were highly skewed to ‘False’ (six-point False-True scale). Discussion with two co-authors (AS & RS) resulted in revising or removing several items. The present study represents the third phase of testing, and includes 14 of the 17 original items, and revisions. See (Tables 3 and 4) for the items.

**Nicotine dependence.**—Nicotine Dependence was assessed with the 7-item Fagerstrom Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & FAGER-STROM, 1991); Cronbach’s Coefficient Alpha (Alpha) = 0.540. We assessed nicotine dependence as it should be positively and strongly correlated with SIMS given cigarettes are nicotine delivery devices.

**Psychological correlates.**—The Positive and Negative Affect Scale (20 items) was used to assess positive and negative affect (Watson, Clark, & Tellegen, 1988), Alpha = 0.823; the Snaith-Hamilton Pleasure Scale (14 items) was used to assess anhedonia (inability to experience pleasure) (Snaith et al., 1995), Alpha = 0.933; The 21-item Beck Anxiety Inventory was used to assess Anxiety symptoms (Beck, Epstein, Brown, & Steer, 1988), Alpha = 0.885. These variables were selected for their possible positive and negative relations to SIMS, and for assessment of construct validity.

**Demographic variables.**—We controlled for the demographic variables sex, race, education, marital status and income.

**Point prevalence abstinence.**—Our outcome variable was carbon monoxide (CO) verified 7-day point prevalence abstinence (PPA) at 24 weeks (Schnoll et al., 2015). We used this PPA measure as it was the more proximal (to quit date) of two measures taken (24 weeks and 52 weeks). Given that the SIMS was only measured at baseline, and the SIMS would likely change over time, it would be more likely to represent how the smoker feels about smoking (with respect to the Self) at a 24 than 52 weeks.

**Disequilibrium.**—We employed the single item ‘Smoking makes me feel bad about myself’ as an indicator of disequilibrium. We used a single indicator for purposes of parsimony. Further, it allowed us to efficiently divide our sample into higher and lower levels of disequilibrium, permitting for the assessment of moderation; does the effect of the
SIMS on PPA differ by disequilibrium? As this item had a six-point rating scale (False, Mostly False, More False than True, More True than False, Mostly True, True), we considered participants selecting a ‘False’ option to have low disequilibrium, whereas participants selecting a True option to have high disequilibrium. To assess the item’s validity as a measure of disequilibrium, we conducted bivariate correlation analysis between disequilibrium and nicotine dependence and positive affect (discriminant validity) and negative affect and anxiety (convergent validity). As expected, disequilibrium was significantly and positively associated with negative affect ($r = 0.185$, $p > 0.0001$) and anxiety ($r = 0.218$, $p < 0.0001$). By contrast, it was uncorrelated with nicotine dependence ($r = -0.055$, $p = 0.244$) and positive affect ($r = 0.012$, $p > 0.807$). These findings support the construct validity of our indicator of disequilibrium.

Other covariates.—We also controlled for prior quit attempts lasting at least 24 hours (a proxy for motivation to quit smoking; binary 0 = none, 1 = at least one) and treatment assignment (binary 0 = standard, 1 = extended).

Analysis

We employed exploratory structural equation modelling (ESEM) to analyse the data. ESEM is a structural equation modelling (SEM) method that allows researchers to combine exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) in a single model (Asparouhov & Muthén, 2009; Marsh et al., 2009). As such, it permits assessment of the internal EFA and cross structure (discriminant and convergent validity) of a measure in a single study. ESEM is a hybrid method that borrows from EFA and CFA, along with SEM (Asparouhov & Muthén, 2009; Marsh et al., 2009). Unlike CFA which restricts items to load on a single factor, ESEM allows items to load on multiple factors, which is a more realistic assumption (Marsh et al., 2009). The process involves several steps. In the first, EFA is conducted to identify the number of factors best representing the relations amongst the measured variables. We will consider a factor reliable if it contains ≥ four loadings ≥ 0.60 (Stevens, 2002). In the second step, covariates are added to the model to assess convergent and discriminant validity. In the third, one may assess the association of covariates to the measured variables (i.e., factor indicator variables) using model modification indices. (Figure 1) is a general description of our ESEM. We used SPSS 24 software for descriptive statistics and Mplus 7.0 software for the ESEM analysis.

Given the ordinal nature of the SIMS variables, model parameter estimation employed a weighted least squares estimation technique (WLSMV) with robust standard errors, and a mean and variance adjusted chi-square ($\chi^2$) test statistic (Muthén, du Toit, & Spisic, 1997; Muthén & Muthén, 1998–2004). We evaluated our multivariate models for fit to the observed data using multiple indicators of model performance, including the $\chi^2$ test, comparative fit index (CFI), weighted root mean square residual (WRMR), standardized root mean squared residual (SRMR) and root mean squared error of approximation (RMSEA) (Jackson, Gillaspy, & Purc-Stephenson, 2009), along with substantive criteria (e.g., interpretability of factors). Heuristics for acceptable fit were: CFI, WRMR, SRMR and RMSEA, > 0.95, < 0.90, < 0.08, and < 0.10, respectively (Kenny, 2015). To account for missing data, Mplus estimates mean, variance and covariance parameters using a full
information maximum likelihood (FIML) estimating procedure which employs the expectation maximization (EM) algorithm, assuming data are missing at random (Muthén, 1998–2004a; 1998–2004b). This only accounts for missing data on the dependent variables. Thus, cases with missing data on the covariates are not included in the analysis.

Results

Descriptive Statistics

Means and standard deviations for continuous variables, and frequency distributions and proportions for categorical variables are presented in (Table 1). Independent samples t-tests and $\chi^2$ analyses were employed to assess differences between participants with high ($n = 212$) and low ($n = 228$) disequilibrium. Of note, females reported greater disequilibrium than males, $\chi^2(1, n=440) = 12.166, p < 0.0005$. Further, those reporting greater disequilibrium scored significantly higher on anxiety ($t(421.94) = -3.88, p=0.0001$) and negative affect ($t(441) = -3.72, p = 0.0002$), but lower on anhedonia ($t(435.65) = 2.69, p = 0.0074$).

Multivariate Modelling

Exploratory factor analysis (EFA).—The EFA was assessed using models with one to four factors to represent the 14 ordinal SIMS observed variables, using a Geomin oblique rotation method (Table 2). The $\chi^2$ statistic dropped with the addition of each factor to the model, although remaining significant across all models. However, the interpretability of the factor loadings beyond a single factor was difficult as several items loaded high on the multiple factors (See Table 3 for factor loadings, items, and their communalities for the four factor solution). Given only one eigenvalue > 1 ($\lambda_1=8.339$) accounting for 60% of the variance, along with a scree plot (eigenvalue plot) elbow at 2 (also suggesting one factor), and 12 loadings ≥ 0.60, we selected the single factor solution as the best solution for these data. This model fit the data fairly well, $\chi^2(n=447, df=77) = 457.928, p < 0.0001; CFI = 0.957, RMSEA = 0.105 (95%CI = 0.096, 0.115), SRMR = 0.053$, with CFI and SRMR indicating good fit but RMSEA suggesting less than adequate fit (Kenny, Kaniskan, & McCoach, 2015). Assessing the source of model misspecification (separate EFA for levels of disequilibrium) suggests the misfit is due to the item ‘cigarettes help me get through hard times’, which did not load significantly for higher disequilibrium. RMSEA for high disequilibrium was 0.122 (90% CI = 0.087, 0.155), whereas RMSEA for low disequilibrium was 0.069 (90% CI = 0.046, 0.091). Nevertheless, we believe the one factor solution is optimal for these data based on substantive and empirical criteria. The items, factor loadings, and communalities for the single-factor solution are presented in (Table 4).

Exploratory Structural Equation Modelling (ESEM)

We next added covariates to the multivariate model to assess their relations to SIMS and PPA at 24 weeks, and to test whether relations differ by disequilibrium. This also allowed us to measure the convergent and discriminant validity of the SIMS, a weighted factor score. The two-group model also fit the data fairly well, $\chi^2(n=443, df=560) = 782.243, p < 0.0001; CFI = 0.974, RMSEA = 0.042 (90%CI = 0.035, 0.049; probability RMSEA ≤0.05 = 0.965), WRMR = 1.259$. The model results with unstandardized path coefficients, standard errors, z-statistics, and $p$ values are presented in (Table 5). Standardized path coefficients for
significant model effects are presented graphically in (Figure 2). We present significant effects only for sake of parsimony.

**Subjective Importance of Smoking (SIMS)**

Nicotine dependence was associated with an increase in SIMS among smokers reporting both high \( b = 0.132, z = 3.049, p = 0.002 \) and low \( b = 0.165, z = 4.337, p < 0.0001 \) disequilibrium, with no difference in the effect \( p > 0.05 \). However, negative affect was associated with higher SIMS for participants reporting high disequilibrium \( b = 0.041, z = 2.495, p = 0.013 \), and not related to SIMS among participants reporting low disequilibrium \( p = 0.748 \). This between-group difference in effects was significant, \( \chi^2(1, n = 561) = 5.062, p = 0.0245 \), suggesting that disequilibrium moderates the relation between negative affect and SIMS. There were no other significant relations between any of the remaining covariates and SIMS, when exploring group differences. Although SIMS is not a specific measure of nicotine dependence, the stronger relation between SIMS and nicotine dependence supports its construct validity as individuals who place a high subjective importance on smoking are likely to have higher nicotine dependence. Further, the significant relation of negative affect with SIMS amongst participants experiencing high versus low disequilibrium supports the construct validity of the proposed role of disequilibrium as a possible mechanism of change in the smoking cessation process, as predicted by psychoadaptation.

**Point prevalence abstinence (PPA).**—For participants reporting high disequilibrium, SIMS was positively associated with PPA at 24 weeks \( b = 0.203, z = 2.114, p = 0.034 \), whereas the relation was not significant \( p = 0.753 \) for participants reporting low disequilibrium. This difference in the effect of SIMS on PPA was significant, \( \chi^2(1, N = 440) = 4.416, p = 0.0356 \), suggesting that disequilibrium moderates the effect of the SIMS on abstinence at 24 weeks; individuals experiencing greater disequilibrium are more likely to have remained abstinent at 24 weeks than individuals with lower disequilibrium. There were no significant between-group differences for the relations of the covariates and PPA at 24-weeks.

**Discussion**

The purpose of the present study was to assess whether negative feelings about the self, associated with smoking, moderated the effect of the SIMS on PPA at 24 weeks post quit in a sample of participants involved in a NRT treatment study. Guided by theory proposing that behaviour change is motivated by a desire to reduce the psychological distress resulting from experiences contradicting beliefs about the self (Rodriguez, 2000), we proposed that when cigarette smokers encounter such information (whether voluntarily or serendipitously), the consequence is a feeling of negativity about the self (disequilibrium in Piagetian vernacular, Piaget, 1951) and motivation to either adapt one’s conceptions and behaviour to fit the new information or eschew such disconfirming information and continue smoking.

We conducted the present analysis in two phases. We first assessed the factor structure of the measure we developed to better understand the SIMS, and then assessed whether disequilibrium moderated the relation between smoking’s subjective importance and abstinence 24-weeks post quit. The results support the plausibility of the theoretical model.
tested in relation to smoking and abstinence. Indeed, it appears that although smoking may have a greater subjective importance for smokers higher in nicotine dependence, the experience of disequilibrium could motivate smokers to remain abstinent despite smoking’s subjective importance. When coupled with other findings supporting the possible role of self-conceptions and identity in the smoking cessation process (Berg et al., 2010; Gibbons & Gerrard, 1995; Lindgren et al., 2016; Pulvers et al., 2013; Shadel & Mermelstein, 1996; Tombor et al., 2013; Tombor et al., 2015; van den Putte et al., 2009; Vangeli & West, 2012), this finding supports recommendations for a more comprehensive program of research to identify the role of self-conceptions related to substance use behaviours (Lindgren et al., 2016). Such research may not only validate these findings, but suggest directions for incorporating self-concept into smoking cessation initiatives.

Self-concept formation involves identifying with activities that become important to the individual (Wigfield & Karpathian, 1991). These activities come to define who one is, not just what one can do. Self-concept formation is a continuing process that is particularly salient during significant life change, such as quitting smoking (Tombor et al., 2013; Tombor et al., 2015; Vangeli & West, 2012). As smoking cessation involves the loss of a key facet of the smoker’s sense of self, identification of alternatively rewarding activities to replace cigarettes and cigarette smoking and to help re-define the self as a non-smoker would be essential to a smoking cessation initiative. Our findings support this supposition, as individuals with high SIMS and who experienced greater disequilibrium were more likely to remain abstinent at 24-weeks post quit. This suggests that efforts to personalize the negative consequences as smoking may trigger disequilibrium and that this may result in the smoker being more likely to remain abstinent post quit. However, without replacing the void left by the absence of cigarettes with alternatively rewarding activities (e.g., exercise and hobbies), relapse is highly likely. Only carefully designed and controlled studies can assess the validity of these speculations. Given the current high relapse rate (Rafful et al., 2013; Zhu et al., 2012; Zhuang et al., 2015), and smoking-related morbidity and mortality (Danaei et al., 2009; Grunberg & Barry, 2015; Islami, Torre, & Jemal, 2015; Islami, Ward et al., 2015), this research is essential.

**Limitations**

There are several limitations to the results of this study. First, the SIMS was only measured at baseline, precluding exploration of change with changes in smoking behaviour. Second, the SIMS was added to an existing study designed to assess the effectiveness of prolonged NRT use, and not specifically to assess its validity and reliability. Indeed, in all three studies reported here, the SIMS was added to ongoing smoking cohort studies. Future studies assessing the SIMS and its role in smoking cessation need to be designed and conducted specifically for this purpose. Third, as the SIMS was added to an existing study, we could not include other measures related to cessation success and SIMS, including self-efficacy and motivation to quit. However, we used prior quit attempts as a proxy for motivation to quit. Finally, this study employed weighted not summated SIMS factor scoring, which makes clinical use difficult.
Conclusions

The findings of this study suggest the need for further research to evaluate how the SIMS may impact smoking cessation interventions. Including the SIMS in the battery of tests administered at baseline and follow up may allow for a better understanding of how self-conceptions alter or are altered by changes in smoking status.

Acknowledgements

We would like to thank the staff of the University of Montreal and the University of Pennsylvania who provided time and effort to the studies used in the validation process of the SIMS.

Financial Support

This research was supported by a grant from the National Institute on Drug Abuse to Dr. Schnoll (R01 DA025078).

References

Agaku IT, King BA, Dube SR, Control, C. f. D., & Prevention. (2014). Current cigarette smoking among adults-United States, 2005–2012. Morbidity and Mortality Weekly Report, 63(2), 29–34. [PubMed: 24430098]

Asparouhov T, & Muthén B (2009). Exploratory structural equation modeling. Structural Equation Modeling, 16, 397–438.

Beck AT, Epstein N, Brown G, & Steer RA (1988). An inventory for measuring clinical anxiety: Psychometric properties. Journal of Consulting and Clinical Psychology, 56(6), 893. [PubMed: 3204199]

Berg CJ, Parelkar PP, Lessard L, Escoffery C, Kegler MC, Sterling KL et al. (2010). Defining “smoker”: College student attitudes and related smoking characteristics. Nicotine & Tobacco Research, 12, 963–969. [PubMed: 20675365]

CDC. (2015, 01/23/2015). Current cigarette smoking among adults in the United States. Retrieved 07/03/2015, from http://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/.

Cobb LK, McAdams-DeMarco MA, Huxley RR, Woodward M, Koton S, Coresh J et al. (2014). The association of spousal smoking status with the ability to quit smoking: The atherosclerosis risk in communities study. American Journal of Epidemiology, 179(10), 1182–1187. doi: 10.1093/aje/kwu041. [PubMed: 24699782]

Danaei G, Ding EL, Mozaffarian D, Taylor B, Rehm J, Murray CJ et al. (2009). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. PLoS Medicine, 6(4), 28.

Dudovitz RN, Li N, & Chung PJ (2013). Behavioral self-concept as predictor of teen drinking behaviors. Academic Pediatrics, 13(4), 316–321. [PubMed: 23707688]

Epstein S (1973). The self-concept revisited: Or a theory of a theory. American Psychologist, 28(5), 404.

Frazier LD, Vaccaro JA, Garcia S, Fallahazad N, Rathi K, Shrestha A et al. (2015). Diet self-efficacy and physical self-concept of college students at risk for eating disorders. J Behav Health, 4(4), 97–100.

Gibbons FX, & Gerrard M (1995). Predicting young adults’ health risk behavior. Journal of Personality and Social Psychology, 69(3), 505. [PubMed: 7562392]

Grunberg NE, & Barry ES (2015). Tobacco use. In Whitbourne SK (Ed.), The encyclopedia of adulthood and aging (pp. 1402–1426). Hoboken, NJ: John Wiley & Sons, Inc.

Heatherton TF, Kozlowski LT, Frecker RC, & FAGERSTROM KO (1991). The Fagerstrom test for nicotine dependence: A revision of the Fagerstrom Tolerance Questionnaire. British Journal of Addiction, 86(9), 1119–1127. [PubMed: 1932883]
Hensel DJ, Fortenberry JD, O’Sullivan LF, & Orr DP (2011). The developmental association of sexual self-concept with sexual behavior among adolescent women. Journal of adolescence, 34(4), 675–684. [PubMed: 20970178]

Hiscock R, Bauld L, Amos A, Fidler JA, & Munafo M (2012). Socioeconomic status and smoking: A review. Annals of the New York Academy of Sciences, 1248, 107–123. doi: 10.1111/j.1749-6632.2011.06202.x. [PubMed: 22092035]

Islami F, Torre LA, & Jemal A (2015). Global trends of lung cancer mortality and smoking prevalence. Translational Lung Cancer Research, 4(4), 327. [PubMed: 26380174]

Islami F, Ward EM, Jacobs EJ, Ma J, Goding Sauer A, Lorret-Tieulent J et al. (2015). Potentially preventable premature lung cancer deaths in the USA if overall population rates were reduced to those of educated whites in lower-risk states. Cancer Causes & Control, 26(3), 409–418. doi: 10.1007/s10552-014-0517-9. [PubMed: 25555993]

Jackson DL, Gillaspy JA, & Purc-Stephenson R (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. Psychological Methods, 14(1), 6–23. doi: 10.1037/a0014694. [PubMed: 19271845]

Jha P, & Peto R (2014). Global effects of smoking, of quitting, and of taxing tobacco. New England Journal of Medicine, 370(1), 60–68.

Kenny DA (2015). Measuring model fit. Retrieved November 9, 2017, 2017, from http://davidakenny.net/cm/fit.htm.

Kenny DA, Kaniskan B, & McCoach DB (2015). The performance of RMSEA in models with small degrees of freedom. Sociological Methods & Research, 44(3), 486–507.

Lavinghouze SR, & Malarcher A (2016). Cancer-related news from the CDC: Trends in quit attempts among adult cigarette smokers in the United States. Oncology Times, 38(1), 36–38.

Lindgren KP, Neighbors C, Gasser ML, Ramirez JJ, & Cvencek D (2016). A review of implicit and explicit substance self-concept as a predictor of alcohol and tobacco use and misuse. The American Journal of Drug and Alcohol Abuse, 1–10. doi: 10.1080/00952990.2016.1229324.

Lukowski AV, Morris CD, Young SE, & Tinkelman D (2015). Quitline outcomes for smokers in 6 states: Rates of successful quitting vary by mental health status. Nicotine & Tobacco Research, 17(8), 924–930. [PubMed: 26180216]

Marsh HW, Muthén B, Asparouhov A, Ludtke O, Robitzsch A, Morin AJS et al. (2009). Exploratory structural equation modeling, integrating CFA and EFA: Application to students’ evaluations of university teaching. Structural Equation Modeling, 16, 439–476.

Masterson JF (1985). The real self: A developmental, self and object relations approach. New York: Brunner/Mazel.

Meijer E, Gebhardt WA, Dijkstra A, Willemse MC, & Van Laar C (2015). Quitting smoking: The importance of non-smoker identity in predicting smoking behaviour and responses to a smoking ban. Psychology & Health, 30(12), 1387–1409. [PubMed: 25959600]

Muthén BO (1998–2004a). Mplus technical appendices. Los Angeles, CA: Muthén & Muthén.

Muthén BO (1998–2004b). Mplus technical appendices. Los Angeles, CA: Muthén & Muthén.

Muthén BO, du Toit SHC, & Spisic D (1997). Robust inference using weighted least squares and quadratic estimating equations in latent variable modeling with categorical and continuous outcomes. Unpublished manuscript.

Muthén LK, & Muthén BO (1998–2004). Mplus user’s guide (3rd ed.). Los Angeles, CA: Muthén & Muthén.

O’Loughlin J, Dugas EN, Brunet J, DiFranza J, Engert JC, Gervais A et al. (2015). Cohort profile: The nicotine dependence in teens (NDIT) study. International Journal of Epidemiology, 44(5), 1537–1546. [PubMed: 25022274]

Piaget J (1951). Organization and Pathology of thought. In Rapaport D (Ed.), Selected sources (pp. 176–192). New York and London: Columbia University Press.

Pulvers K, Scheuermann TS, Romero DR, Basora B, Luo X, & Ahluwalia JS (2014). Classifying a Smoker scale in adult daily and nondaily smokers. Nicotine & Tobacco Research, 16(5), 591–599. [PubMed: 24297807]
Rafful C, García-Rodríguez O, Wang S, Secades-Villa R, Martínez-Ortega JM, & Blanco C (2013). Predictors of quit attempts and successful quit attempts in a nationally representative sample of smokers. Addictive Behaviors, 38(4), 1920–1923. [PubMed: 23380497]

Raupach T, Brown J, Herbec A, Brose L, & West R (2014). A systematic review of studies assessing the association between adherence to smoking cessation medication and treatment success. Addiction, 109(1), 35–43. doi: 10.1111/add.12319. [PubMed: 23919621]

Rodríguez D (2000). Self and adaptation: Defining the healthy self. Paper presented at the Self-Concept Theory, Research and Practice: Advances from the New Millenium, Sydney, Australia.

Rodríguez D, & Audrain-McGovern J (2005). Physical activity, global physical self-concept, and adolescent smoking. Annals of Behavioral Medicine, 30(3), 251–259. doi: 10.1207/s15324796abm3003_9. [PubMed: 16336076]

Rodríguez D, Dunton GF, Tschere J, & Sass J (2008). Physical activity and adolescent smoking: A moderated mediation model. Mental Health and Physical Activity, 1(1), 17–25.

Schnoll RA, Goelz PM, Veluz-Wilkins A, Blazekovic S, Powers L, Leone FT et al. (2015). Long-term nicotine replacement therapy: A randomized clinical trial. JAMA Internal Medicine, 175(4), 504–511. [PubMed: 25705872]

Shadel WG, & Mermelstein R (1996). Individual differences in self-concept among smokers attempting to quit: Validation and predictive utility of measures of the smoker self-concept and abstainer self-concept. Annals of Behavioral Medicine, 18(3), 151–156. [PubMed: 24203766]

Smit ES, Hoving C, Schelleman-Offermans K, West R, & de Vries H (2014). Predictors of successful and unsuccessful quit attempts among smokers motivated to quit. Addictive Behaviors, 39(9), 1318–1324. doi: 10.1016/j.addbeh.2014.04.017. [PubMed: 24837754]

Snith RP, Hamilton M, Morley S, Humayan A, Hargreaves D, & Trigwell P (1995). A scale for the assessment of hedonic tone the Snaith-Hamilton Pleasure Scale. British Journal of Psychiatry, 167(1), 99–103.

Stephens NM, Markus HR, & Fryberg SA (2012). Social class disparities in health and education: Reducing inequality by applying a sociocultural self model of behavior. Psychological Review, 119(4), 723–744. doi: 10.1037/a0029028. [PubMed: 23088339]

Stevens JP (2002). Applied multivariate statistics for the social sciences (4th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Strasser AA, Orom H, Tang KZ, Dumont RL, Cappella JN, & Kozlowski LT (2011). Graphic-enhanced information improves perceived risks of cigar smoking. Addictive Behaviors, 36(8), 865–869. [PubMed: 21481542]

Thomas CM (2007). The influence of self-concept on adherence to recommended health regimens in adults with heart failure. Journal of Cardiovascular Nursing, 22(5), 405–416.

Tombor I, Shahab L, Brown J, & West R (2013). Positive smoker identity as a barrier to quitting smoking: Findings from a national survey of smokers in England. Drug and Alcohol Dependence, 133(2), 740–745. doi: 10.1016/j.drugalcdep.2013.09.001. [PubMed: 24075070]

Tombor I, Shahab L, Herbec A, Neale J, Michie S, & West R (2015). Smoker identity and its potential role in young adults’ smoking behavior: A meta-ethnography. Health Psychology, 34(10), 992–1003. doi: 10.1037/hea0000191. [PubMed: 25622078]

Van den Putte B, Yzer M, Willemsen MC, & de Bruin G-J (2009). The effects of smoking self-identity and quitting self-identity on attempts to quit smoking. Health Psychology, 28(5), 535. [PubMed: 19751079]

Vangeli E, & West R (2012). Transition towards a ‘non-smoker’ identity following smoking cessation: An interpretative phenomenological analysis. British Journal of Health Psychology, 17(1), 171–184. doi: 10.1111/j.2044-8287.2011.02031.x. [PubMed: 22107052]

Watson D, Clark LA, & Tellegen A (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54(6), 1063. [PubMed: 3397685]

Wigfield A, & Karpathian M (1991). Who am I and what can I do? Children’s self-concepts and motivation in achievement situations. Educational Psychologist, 26(3–4), 233–261.
Zhu S-H, Lee M, Zhuang Y-L, Gamst A, & Wolfson T (2012). Interventions to increase smoking cessation at the population level: How much progress has been made in the last two decades? Tobacco Control, 21(2), 110–118. [PubMed: 22345233]

Zhuang Y-L, Gamst AC, Cummins SE, Wolfson T, & Zhu S-H (2015). Comparison of smoking cessation between education groups: Findings from 2 US National Surveys over 2 decades. American Journal of Public Health, 105(2), 373–379. [PubMed: 25521868]
Figure 1.
General ESEM model in this study. Paths from all predictor variables to the latent SIMS variable and the measured point prevalence abstinence (24 weeks) variable are estimated and tested for significance for participants with low and for participants with high disequilibrium. Any differences in effects between the two levels of disequilibrium are tested for significance using a chi-square difference test (applicable to categorical outcome variables).

Paths from the SIMS latent variable to the 14 SIMS variables (S1–S14) are factor loadings resulting from the exploratory factor analysis. Thus, the SIMS is a non-measured variable, and its score for any participant is inferred through scores on the 14 indicator variables.
Figure 2.
ESEM with standardized path coefficients for significant model effects. Values above the dividing line represent standardized path coefficients for participants with lower disequilibrium, whereas values below the dividing line are standardized path coefficients for participants with higher disequilibrium.

aSignificant p ≤0.05.
bSignificant between group difference.
Table 1

Descriptive statistics

| Variable                         | Level                      | Low (n = 230) |       | High (n = 213) |       |
|----------------------------------|----------------------------|---------------|-------|----------------|-------|
|                                  |                            | N  | %  | N  | %  |
| Sex                              | Male                       | 131 | 60 | 86 | 40 |
|                                  | Female                     | 102 | 44 | 128 | 56 |
| Ethnicity **                     | Non-European-American      | 138 | 60 | 91 | 40 |
|                                  | European-American          | 94 | 43 | 123 | 57 |
| Married                          | Not Married                 | 191 | 53 | 169 | 47 |
|                                  | Married                     | 42 | 48 | 45 | 52 |
| Income                           | Lower Income               | 133 | 54 | 140 | 51 |
|                                  | Higher Income              | 99 | 46 | 73 | 42 |
| Education **                     | > High School               | 134 | 43 | 175 | 57 |
|                                  | ≤ High School               | 99 | 57 | 39 | 28 |
| Point Prevalence Abstinence - 24 weeks | Not abstinent at 24 weeks | 178 | 54 | 153 | 46 |
|                                  | Abstinent at 24 weeks      | 55 | 47 | 61 | 53 |
| Nicotine Dependence (FTND)       |                            | 5.28 | 2.00 | 4.93 | 1.95 |
| Anxiety *                        |                            | 3.44 | 5.80 | 5.75 | 6.64 |
| Anhedonia *                      |                            | 23.41 | 7.82 | 21.58 | 6.48 |
| Positive affect                  |                            | 35.16 | 8.43 | 34.84 | 7.70 |
| Negative affect **               |                            | 14.40 | 5.45 | 16.34 | 5.57 |

*, ** p < 0.05.

*, ** p < 0.01.
### Table 2

Model comparisons exploratory factor analysis

| Model      | X²(df), p value | CFI   | RMSEA (90% CI)       | SRMR |
|------------|----------------|-------|----------------------|------|
| One Factor | 457.928(77), p < 0.0001 | 0.957 | 0.105 (0.096, 0.115) | 0.053 |
| Two factors | 357.158(64), p < 0.0001 | 0.967 | 0.101 (0.091, 0.112) | 0.045 |
| Three Factors | 259.633(52), p < 0.0001 | 0.977 | 0.095 (0.083, 0.106) | 0.037 |
| Four Factors | 159.396(41), p < 0.0001 | 0.987 | 0.080 (0.067, 0.094) | 0.024 |
## Table 3

Factor loadings and communalities for the four factor solution

| Statement                                           | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Communalities |
|-----------------------------------------------------|----------|----------|----------|----------|---------------|
| Cigarettes help me get through hard times           | 0.001    | 0.588    | 0.275    | 0.022    | 0.544         |
| Smoking helps me meet new people                    | 0.049    | 0.035    | 0.482    | 0.015    | 0.288         |
| I cannot cope without cigarettes                   | 0.398    | 0.477    | 0.001    | −0.251   | 0.639         |
| Being a smoker is important to me                   | 0.672    | −0.013   | 0.161    | −0.053   | 0.658         |
| I cannot see myself not smoking                     | 0.803    | −0.154   | 0.025    | −0.16    | 0.64          |
| Cigarettes are a big part of my identity            | 0.922    | 0.015    | −0.077   | 0.104    | 0.744         |
| Without cigarettes, I couldn’t make it              | 0.48     | 0.091    | 0.293    | −0.278   | 0.739         |
| When I am holding a cigarette I feel really competent, like I can do anything | 0.156    | 0.058    | 0.706    | −0.086   | 0.769         |
| When I can’t smoke I feel like a nobody             | −0.001   | −0.039   | 0.86     | −0.188   | 0.782         |
| I would feel really empty without smoking, like I lost an important part of my life | 0.4      | 0.026    | 0.446    | −0.004   | 0.674         |
| Cigarettes make me feel at ease in new situations   | 0.016    | 0.283    | 0.549    | 0.199    | 0.537         |
| Being a smoker means a lot to me                    | 0.684    | −0.051   | 0.253    | 0.099    | 0.768         |
| Holding a cigarette makes me feel like I’m in control | 0.006    | −0.017   | 0.904    | 0.292    | 0.846         |
| Smoking is a big part of who I am                   | 0.869    | 0.048    | 0.011    | 0.407    | 0.906         |
Table 4

Distribution of responses to SIMS items divided by disequilibrium, and factor loadings and eigenvalues

| Statement                                                                 | Disequilibrium |       |       |       |       |       | Loadings | Communalities |
|---------------------------------------------------------------------------|----------------|-------|-------|-------|-------|-------|----------|---------------|
|                                                                           | Lower          | Higher| Lower | Higher| Lower | Higher|          |               |
| Cigarettes help me get through hard times *                               | 9.4            | 3.3   | 6.4   | 7.9   | 15.9  | 24.0  | 22.7     | 5.60          | 0.314         |
| Smoking helps me meet new people *                                        | 55.4           | 38.3  | 12.0  | 21.0  | 16.7  | 14.0  | 21.5     | 0.516         | 0.266         |
| I cannot cope without cigarettes **                                       | 23.2           | 14.5  | 16.3  | 9.8   | 21.9  | 18.9  | 10.7     | 0.644         | 0.415         |
| Being a smoker is important to me                                         | 49.4           | 43.5  | 16.3  | 18.0  | 6.9   | 5.2   | 4.3      | 0.796         | 0.634         |
| I cannot see myself not smoking                                          | 54.1           | 43.0  | 11.6  | 16.4  | 13.7  | 8.6   | 6.0      | 0.732         | 0.536         |
| Cigarettes are a big part of my identity                                  | 45.1           | 32.7  | 12.4  | 22.9  | 15.5  | 12.4  | 6.4      | 0.829         | 0.687         |
| Without cigarettes, I couldn’t make it ***                               | 63.9           | 43.5  | 14.2  | 15.0  | 11.2  | 6.4   | 5.6      | 0.506         | 0.256         |
| When I am holding a cigarette I feel really competent, like I can do anything ** | 59.2           | 42.7  | 10.7  | 19.2  | 12.4  | 11.2  | 1.7      | 0.849         | 0.721         |
| When I can’t smoke I feel like a nobody ***                              | 80.7           | 62.1  | 9.4   | 13.6  | 7.3   | 7.3   | 3.3      | 0.808         | 0.653         |
| I would feel really empty without smoking, like I lost an important part of my life *** | 60.9           | 33.2  | 12.9  | 19.6  | 11.2  | 7.3   | 3.4      | 0.816         | 0.666         |
| Cigarettes make me feel at ease in new situations **                     | 26.6           | 11.2  | 8.6   | 11.7  | 14.2  | 19.7  | 23.4     | 0.662         | 0.438         |
| Being a smoker means a lot to me                                          | 58.4           | 47.2  | 13.7  | 19.6  | 14.2  | 7.7   | 3.0      | 0.865         | 0.748         |
| Holding a cigarette makes me feel like I’m in control **                 | 61.8           | 43.0  | 9.0   | 14.0  | 12.6  | 9.3   | 7.0      | 0.816         | 0.666         |
| Smoking is a big part of who I am **                                     | 51.1           | 43.0  | 9.9   | 14.5  | 12.0  | 10.7  | 7.5      | 0.849         | 0.721         |
| Statement      | Disequilibrium | False | Mostly False | More False than True | Mostly True | True | Loadings | Communalities |
|----------------|----------------|-------|--------------|----------------------|-------------|------|----------|---------------|
| Higher         | 34.6           | 14.5  | 17.3         | 11.2                 | 12.6        | 9.8  |          |               |

* $p \leq 0.05$

** $p \leq 0.01$

*** $p \leq 0.0001$
### Table 5

Non-standardized results of exploratory structural equation modelling

| SIMS | Lower Negativity<sup>a</sup> | Higher Negativity<sup>a</sup> |
|------|-----------------|-----------------|
|      | b               | SE              | z-statistic | p value | B    | SE    | z-statistic | p value |
| Female | 0.103          | 0.158          | 0.651       | 0.515   | 0.15 | 0.151 | 0.994       | 0.32    |
| White  | 0.336          | 0.164          | 2.047       | 0.041   | −0.005 | 0.157 | −0.031      | 0.975   |
| Married | −0.257         | 0.206          | −1.243      | 0.214   | 0.096 | 0.181 | 0.531       | 0.595   |
| FTND   | 0.165          | 0.088          | 4.337       | <0.0001 | 0.132 | 0.043 | 3.049       | 0.002   |
| Anxiety | 0.028          | 0.017          | 1.582       | 0.114   | −0.004 | 0.013 | −0.286      | 0.775   |
| Anhedonia | 0.009          | 0.009          | 0.948       | 0.343   | 0.015 | 0.011 | 1.364       | 0.173   |
| Positive affect | −0.012         | 0.009          | −1.396      | 0.163   | −0.012 | 0.011 | −1.115      | 0.265   |
| Negative affect | −0.006         | 0.018          | −0.321      | 0.748   | 0.041 | 0.016 | 2.495       | 0.013   |
| Prior quit attempt | 0.117          | 0.161          | 0.727       | 0.467   | −0.363 | 0.209 | −1.737      | 0.082   |
| Treatment | −0.014         | 0.151          | −0.095      | 0.924   | 0.07  | 0.17  | 0.414       | 0.679   |
| Low income | 0.003          | 0.169          | 0.018       | 0.986   | −0.09 | 0.19  | −0.474      | 0.636   |
| sHigh School | −0.265         | 0.172          | −1.545      | 0.122   | −0.036 | 0.193 | −0.187      | 0.851   |

| Point Prevalence Abstinence (PPA)<sup>b</sup> | Lower Negativity<sup>a</sup> | Higher Negativity<sup>a</sup> |
|-----------------------------------------------|-----------------|-----------------|
| SIMS                                         | b               | SE              | z-statistic | p value | B    | SE    | z-statistic | p value |
| Female                                       | −0.027          | 0.085          | −0.314      | 0.753   | 0.203 | 0.096 | 2.114       | 0.034   |
| White                                        | 0.183          | 0.224          | 0.816       | 0.414   | 0.034 | 0.202 | 0.166       | 0.868   |
| Married                                      | −0.221          | 0.228          | −0.972      | 0.331   | −0.175 | 0.222 | −0.788      | 0.431   |
| FTND                                         | −0.375          | 0.283          | −1.325      | 0.185   | 0.033 | 0.25  | 0.132       | 0.895   |
| Anxiety                                      | −0.083          | 0.086          | −1.485      | 0.137   | −0.02 | 0.054 | −0.368      | 0.713   |
| Anhedonia                                    | −0.007          | 0.028          | −0.255      | 0.799   | 0.001 | 0.02  | 0.045       | 0.964   |
| Positive affect                              | −0.039          | 0.013          | −2.943      | 0.003   | −0.024 | 0.013 | −1.904      | 0.057   |
| Negative affect                              | 0.016          | 0.025          | 0.653       | 0.514   | −0.018 | 0.021 | −0.861      | 0.389   |
| Prior quit attempt                           | −0.075          | 0.215          | −0.349      | 0.727   | 0.204 | 0.283 | 0.722       | 0.47    |
|                       | 0.352 | 0.223 | 1.576 | 0.115 | -0.016 | 0.201 | -0.08 | 0.936 |
|-----------------------|-------|-------|-------|-------|--------|-------|-------|-------|
| Treatment             |       |       |       |       |        |       |       |       |
| Low Income            | -0.654| 0.22  | -2.972| 0.003 | -0.048 | 0.236 | -0.203| 0.839 |
| ≤ High School         | 0.069 | 0.231 | 0.301 | 0.764 | -0.309 | 0.301 | -1.029| 0.304 |

\[ a \]
The smoking-related negativity binary variable was generated by cutting the single item 'Smoking makes me feel bad about myself' into a lower half and a higher half (responses 1–3 were lower negativity; responses 4–6 were higher negativity).

\[ b \]
The outcome point prevalence abstinence variable (biochemically verified) is binary (1 = abstinant at 24 weeks; 0 = not abstinant at 24 weeks). As such, the \( b \) values represent the log odds of change (i.e., logistic regression).

\[ c \]
This difference in the effect of the SIMS factor on PPA at 24 weeks is significant, \( p = 0.0405 \).