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Impulsiveness and cigarette smoking

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Abstract

Objective—Varying aspects of impulsive personality have been associated with tobacco use in cross-sectional and prospective studies, including novelty seeking and (low) constraint but most studies have not examined more than one tobacco use phenotype (e.g., any tobacco use versus dependence) or considered more than one variety of impulsiveness simultaneously.

Methods—The current study was conducted to evaluate the association of impulsive personality features with multiple tobacco use phenotypes including smoking status, lifetime tobacco consumption and dependence in a sample of 1284 adults between the ages of 30 and 54. Participants completed multiple self-report measures of impulsive personality and were interviewed regarding lifetime tobacco use.

Results—Results revealed that reward seeking and disinhibitory traits were both associated with smoking status but only disinhibition was associated with tobacco dependence, after controlling for reward seeking.

Conclusions—The results reported here may aid investigations aimed at identifying neurobiological, including genetic, correlates of tobacco use and dependence by providing potential behavioral correlates of the diversity of tobacco use phenotypes. Moreover, successful efforts to prevent tobacco-related disease through prevention or cessation programs will be facilitated by the identification of factors that are differentially associated with different smoking phenotypes.

Keywords

disinhibition; impulsiveness; reward seeking; tobacco use

Introduction

Tobacco use is the leading cause of preventable death in the United States, resulting in more than 250,000 premature deaths between 1997–2001(1,2). Despite widespread recognition of this risk, a significant portion of the population uses or has used tobacco products. Cigarette smoking can be conceptualized along a continuum of behavior ranging from initial to regular use, (i.e., initiation and maintenance), cessation, and among people who quit, relapse. Thirty to fifty percent of people who try smoking go on to daily smoking (1,3), which frequently precedes nicotine dependence (4). Relapse is an unfortunate probability as a large number of quitters begin smoking again within one year (5). Although tobacco use and dependence are demonstrated heritable phenotypes (6), attempts to identify molecular genetic determinants have not yielded consistent candidates. Successful efforts to identify such determinants may

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be facilitated by the identification of dimensional covariates that are differentially associated with each of these smoking phenotypes.

A large body of research has examined the association of cigarette use with individual differences in the major dimensions of personality, including cross-sectional surveys that evaluate group differences between smokers and non-smokers and/or ex-smokers on widely-used trait measures of broad dimensions of personality (7). A review of this literature suggests that the evidence is mixed with respect to the association of tobacco use with Neuroticism and Extraversion (8,9), but more consistent with measures that tap impulsiveness, a multidimensional construct that subsumes aspects of reward seeking (i.e., novelty or sensation seeking) and disinhibition (i.e., constraint or unplanned behavior) (10).

Cross sectional research indicates that self-reported novelty or sensation seeking (10–13) and disinhibition (10,13–15) are associated with smoking status in adolescents and adults and with daily smoking and tobacco dependence in an epidemiological sample of young adults (16). Novelty seeking is linked to the development of tobacco dependence in a prospective study of college students (17) and with different tobacco use trajectories in longitudinally collected data with adolescents, including progression to daily smoking (18,19) and early onset nicotine dependence with rapid remission (19). Measures of disinhibition assessed in childhood or adolescence are also associated prospectively with becoming a smoker (20,21) and with the development of tobacco dependence in young adulthood (22). Finally, self-reported disinhibitory impulsiveness is related to smoking relapse among adults (23) but not adolescents (24).

Review of the above literature suggests two important considerations. First, most research focuses on the association of impulsiveness with a single smoking phenotype, typically smoking status or dependence, but current views of addiction suggest that different stages of drug use (e.g., initiation of use to addiction) may be associated with different personality factors (25). Second, as noted above, impulsiveness is a multidimensional construct and although some studies administer more than one measure of impulsiveness (10,13), very few studies evaluate whether specific aspects of impulsiveness are related to smoking after statistically controlling for other aspects. Although several multidimensional models of impulsiveness have been proposed (e.g., 26,27), a two-factor model that includes reward seeking and disinhibition is supported by neurobiological theories of addiction (28–31). These models propose that initial drug use is associated with increased dopaminergic activity in the mesolimbic reward system, but repeated or chronic use (i.e., compulsive drug taking) is related to a lack of inhibitory control or constraint and corresponding activity in the frontostriatal system.

The current research was conducted to evaluate the association of indices of impulsiveness with multiple tobacco use phenotypes in a large, middle-aged sample. The number of possible measures of impulsiveness is large and includes self-report measures and laboratory tasks (10,32). In order to limit the number of analyses to be conducted, only self-report measures were selected for study and subscale scores were subjected to an exploratory factor analysis with the aim of creating a smaller number of impulsivity dimensions that would capture common variance. Although the design is cross-sectional, this research builds upon prior work by using a multivariate approach to evaluate the unique association of different aspects of impulsiveness to a broad range of smoking phenotypes in a large sample of middle-aged adults. We expected that measures of reward seeking and disinhibitory impulsivity would both be associated with smoking status, but only disinhibitory impulsivity would be associated with tobacco dependence.

Method

Participants

Participants were 1284 adults between the ages of 30 and 54 enrolled in the Adult Health and Behavior (AHAB) project, a registry of behavioral and biological phenotypes among community volunteers. Recruitment and initial screening were conducted by the Recruitment Office in the Department of Epidemiology in the School of Public Health at the University of Pittsburgh by mass-mail solicitation from Western Pennsylvania (principally Allegheny County). Data were collected between 2001 and 2005. To be eligible, participants had to report being in good general health and were excluded on the basis of significant cardiovascular disease (e.g., myocardial infarction, coronary revascularization, angina), chronic renal or liver disease, neurological or autoimmune disorder (e.g., epilepsy, multiple sclerosis), treatment for cancer in the past year, psychosis, or bipolar (Type I) affective disorder. People reporting use of the following medications were not eligible for participation: cardiovascular (except antihypertensives and lipid lowering medications), psychotropic, glucocorticoid, diabetes, or prescription weight-loss drugs. Women who were pregnant were also ineligible. Additionally, AHAB participants were excluded from the current analyses if they reported current use of tobacco products other than cigarettes (e.g., cigars, pipe smoking) and if they had an IQ less than 80 on the two scale subtest of the Wechsler Abbreviated Scale of Intelligence (33). Subjects provided written informed consent, and the protocol was approved by the University of Pittsburgh Institutional Review Board.

Measures

Smoking History. Participants were interviewed regarding their lifetime history of tobacco use using a timeline as prompt. Following the interview, all subjects were classified according to smoking status based on lifetime cigarette consumption including never smokers (n=246, 19%), who had never tried smoking (i.e., not even one puff), “triers”, whose use ranged from one puff to 200 cigarettes (n=505, 39%); ex-smokers (n=317, 25%) who had not smoked in the six months prior to interview; and current smokers (n=214; 17%). Ex-smokers and current smokers were also classified according to whether they had ever initiated daily smoking, which included 289 (91%) of the ex-smokers and 206 (95%) of the current smokers. Analyses involving ex-smokers and current smokers included only daily smokers because sporadic use (i.e., “chipping”) has been linked to a unique pattern of disinhibitory traits relative to daily use (34).

Other variables determined from the smoking interview included packyears, which was calculated using lifetime exposure of cigarettes / 7300 (20 cigarettes/pack * 365), age at first cigarette and age at daily smoking. Additionally, because people who begin smoking as adolescents appear to be more vulnerable to tobacco addiction than people who start later (4, 35), ex-smokers and current smokers were classified according to whether their first use occurred prior to the age of 19. Eighty-seven percent of ex- and current daily smokers began use prior to age 19 (i.e., adolescent onset). Tobacco dependence was measured with the Fagerstrom Test of Nicotine Dependence (FTND) (36) although total scores were unavailable for 57 ex-smokers.

In addition to the smoking interview, participants completed three self-report measures to assess aspects of Impulsiveness. The Temperament and Character Inventory (TCI) (37) includes 107 true/false items assessing four higher order dimensions of personality including novelty seeking, harm avoidance, reward dependence and persistence. Only the Novelty Seeking (NS) scales were examined in the analyses presented here. The four subscales of this dimension include Exploratory Excitability versus Stoic Rigidity (e.g., I like to explore new ways to do things), Impulsiveness versus Reflection (e.g., I often do things based on how I feel

at the moment without thinking about how they were done in the past), Extravagance versus Reserve (e.g., I often spend money until I run out of cash or get into debt from using too much credit) and Disorderliness versus Regimentation (e.g., I like it when people can do whatever they want without strict rules and regulations) (alpha coefficient for total NS scale = .80).

The Zuckerman Sensation Seeking Scale (ZSS – V) (38) is a 40 item, true/false scale that measures an individual's preference to seek novel and complex experiences. In the absence of these experiences, individuals scoring higher on this scale will engage in high-risk behaviors to obtain them (i.e., by taking illicit substances). The scale has four subscales, named Thrill and Adventure Seeking (e.g., I often wish I could be a mountain climber), Experience Seeking (e.g., I like to explore a strange city or section of town by myself, even if it means getting lost), Boredom Susceptibility (e.g., The worst social sin is to be a bore) and Disinhibition (e.g., I like to get high by drinking liquor or smoking marijuana). Alpha coefficient for the total scale was .85.

The Barratt Impulsiveness Scale (BIS) (39,40) contains 30 questions regarding individuals' control of thoughts and behaviors. This scale is comprised of three subscales including nonplanning (e.g., I spend or charge more than I earn), motor impulsiveness (e.g., I do things without thinking) and cognitive impulsiveness (e.g., I am a steady thinker). The alpha coefficient for the total scale was .83.

Statistical Analyses

Given the stated interest in examining common variance across the self-reported indices of impulsiveness, an exploratory factor analysis with oblique rotation was conducted using the 11 subscale personality scores described above. Examination of the scree plot and eigenvalues suggested a 3 factor solution, but inspection of the factor loadings indicated that the Boredom Susceptibility scale of the ZSS scale loaded onto two factors (loadings = .35 and −.27). The analysis was repeated omitting this scale and results revealed a two factor solution accounting for 50% of the variance. The Kaiser-Meyer-Olkin measure of sampling adequacy was .76, indicating that a factor analysis would be a useful way of reducing the data. The first component consisted of high loadings on the three Barratt Impulsiveness subscales and two TCI NS subscales (i.e., Impulsiveness versus Reflection and Extravagance versus Reserve) subscales. (See Table 1 for factor loadings). The second component included the three remaining subscales of the ZSS (Disinhibition, Thrill and Adventure Seeking and Experience Seeking) and two TCI NS scales (Exploratory Excitability versus Stoic Rigidity and Disorderliness versus Regimentation). Factor scores were created using linear regression and were named Disinhibition and Reward Seeking respectively. The first factor was labeled Disinhibition to reflect the fact that the items tap into a construct that involves a lack of reflection or an inability to constrain an impulse (see item examples listed above from the TCI and BIS instruments). The second factor was labeled Reward seeking to indicate that the items encompass novelty and sensation seeking and reflect an approach orientation (see items above for the TCI and ZSS scales). The two factors were moderately related ($r=.38$, $p<.001$).

A series of logistic and linear regression analyses was conducted to examine associations of Disinhibition and Reward Seeking with a range of dichotomous (e.g., smoking status) and dimensional smoking phenotypes (e.g., age at first use). In these analyses, race (1=Caucasian; 0=other racial/ethnic groups), sex (coded as 1=male, 2=female), years of education and age were entered in the first step as covariates. In the second step, both personality factor scores were entered. Dependent variables that did not follow a normal distribution were transformed prior to analysis (e.g., natural log, square root) for linear regression analyses. Given that results using factor scores cannot be compared easily to prior tobacco use literature that has examined these three scales (and their subscales), scores on all of the subscales (and total scores) were compared in never smokers versus ever smokers and the results are presented in Table 2. As

can be seen from the table, never smokers reported lower impulsivity total scores on all three scales, but not all subscale score means differed by group, considering a conservative level of statistical significance ($p \leq .005$).

Results

The sample averaged 44.5 years of age (s.d.= 6.8) and 15.7 years of education (s.d.=2.9). Eighty-two percent of the sample was Caucasian, 16% were African American, 1% were Asian and 1% reported mixed racial ancestry. Slightly over half of the sample (54%) was women. Sixty-five percent were married or living with a partner and 78% were employed full or part-time. Socioeconomic status as measured by the Hollingshead Index (41) ranged from 9 to 66, with an average of 41.5 (s.d. = 15.8). As noted above, 19 percent of the sample had never smoked tobacco, 39 percent was classified a "trier and 25 percent and 17 percent of the sample was classified as an ex- or current smoker, respectively. Never smokers tended to be female ($X^2(3)= 17.9$, $p<.001$) and Caucasian ($X^2(3)=56.6$, $p<.001$). Never smokers were younger than ex-smokers, but there were no other age differences by smoking status group, ($F(3,1280)=3.24$, $p=.021$). The four groups differed by years of education, with current smokers reporting 14 years, triers and ex-smokers reporting 16 years and never smokers reporting 17 years, on average ($F(3,1280)=28.4$, $p<.001$). Current smokers reported lower family income relative to the other three groups ($F(3,1272)=20.0$, $p<.001$).

Dispositional correlates of smoking

Results indicated that both Disinhibition and Reward Seeking were associated with the initiation (i.e., trying) of cigarette smoking (see Table 3). In this analysis, never smokers were compared to anyone who had ever tried cigarettes, including those who had only tried smoking one time. Among the group of people who became daily smokers, ex-smokers reported lower Reward seeking scores relative to current smokers (See Table 4). Partial correlation analyses indicated that ZSS Thrill and Adventure Seeking ($r=-.10$, $p=.02$) and Disinhibition subscales ($r=-.14$, $p=002$) were associated with cessation after controlling for the Disinhibition subscale scores, race, sex, age, and years of education). When the regression analysis was restricted to adolescent onset smokers, the association between Reward Seeking and quitting smoking was similar and remained significant. Reward Seeking was also associated with an inability to quit smoking on the first attempt, ($B=-.34$, $p=.046$; OR=.71, .50–.99, 97% CI).

The age when smokers began smoking on a daily basis was not related to Disinhibition or Reward Seeking in the full sample of smokers, but when restricted to adolescent onset smokers only, higher Disinhibition was associated with a lower age at daily smoking (see Table 5). The results showing the association between Disinhibition and age of onset are consistent with results reported in Table 6, showing that smokers scoring higher on Disinhibition were also more likely to become dependent on tobacco as demonstrated by higher scores on the FTND. Nonplanning impulsiveness from the BIS ($r=.10$, $p=.04$) and Impulsiveness versus Reflection from the TCI NS ($r=.13$, $p=.01$) were associated with tobacco dependence after partialling out the Reward Seeking scale scores and years of education. The results of the regression analysis were replicated in the adolescent onset sample. Neither Reward Seeking nor Disinhibition made a significant contribution to the model that examined lifetime cigarette consumption ($\Delta R^2 < .01$, $\Delta F = 2.54$, p. =.08) or age at first use ($\Delta R^2 < .01$, $\Delta F = 2.03$, p. =.13) in the total sample. Results were unchanged when restricted to the sample of adolescent onset smokers.

Discussion

Results showed that aspects of personality associated with smoking tobacco in prior work could be represented by two underlying dimensions, which we termed Disinhibition and Reward Seeking. Inspection of the items on the subscales that loaded onto these factors indicated that

the Disinhibition factor tapped aspects of constraint or control of thoughts and behavior, while Reward Seeking tapped aspects of appetitive drive. These results are consistent with a recent factor analysis that included self-reported and behavioral measures of impulsiveness, i.e., the total BIS score and two ZSS subscales loaded onto separate factors (42). In this study, only two ZSS subscales were administered and the TCI NS was not administered.

As expected, both Reward Seeking and Disinhibition emerged as important correlates of tobacco use and in only one case –initiation of tobacco use -- were both factors related to the same phenotype. Reward Seeking was associated with the persistence of smoking, indicating that people with higher scores on this factor continued smoking after their first use, but it was not associated with tobacco dependence. On the other hand, Disinhibition was associated with tobacco dependence among daily smokers and a lower age at daily smoking among adolescent onset smokers. Because daily smokers are at risk for tobacco dependence, Disinhibition may underlie a more pernicious form of tobacco use, in which people become addicted to cigarettes more readily and at a younger age.

Previous research using the measures reported here (e.g., BIS, ZSS and TCI) points to potential biobehavioral mechanisms linking Reward seeking versus Disinhibition to tobacco use phenotypes. For example, the total BIS score is associated with cigarette craving and a preference for immediate hypothetical (money) and actual (cigarettes) rewards over larger, delayed rewards (43). We have also reported previously that the preference for immediate rewards is correlated with the nonplanning subscale of the BIS (44) and with tobacco dependence (45). Higher novelty seeking, including the Experience Seeking and Disinhibition subscales from the ZSS, is related to initial nicotine sensitivity in nonsmokers (46) and a novelty seeking factor score (included total TCI NS and ZSS Experience seeking and Disinhibition subscales) was correlated with nicotine reinforcement and reward in male, but not female, nonsmokers (42). Although higher total TCI NS scores has been linked prospectively to tobacco dependence (17), these results cannot be directly compared to the current study because the four TCS NS scores loaded onto two separate factors. Notably, Leventhal and colleagues (47) evaluated the relationship between tobacco withdrawal symptoms and the four TCI NS subscales and reported that only the Impulsiveness vs. Reflection and Extravagance vs. Reserve subscales, (i.e., Disinhibition factor), were correlated with several acute tobacco withdrawal symptoms (e.g., anger, anxiety, concentration difficulty) and the urge to smoke to relieve negative affect. The other two TCI NS subscales (i.e., Reward Seeking factor), were not associated with these symptoms.

The differential association between tobacco dependence and Disinhibition, but not Reward Seeking, is consistent with the notion that initial drug use may be influenced by a variety of factors, including availability and the rewarding properties of its use, but that drug addiction represents an inability to control use once it has begun (28–30). These neurobiological theories of addiction propose that while increased dopaminergic activity in the mesolimbic reward system underlies initial drug use, repeated or chronic use results in a loss of inhibitory control (i.e., compulsive drug taking) that is due, in part, to neuroplastic changes to the frontostriatal system. Although there may be an accompanying change in self-reported Disinhibition with use, an alternative view is that the inability to constrain or inhibit drug use and drug seeking behavior represents individual differences in frontal cortex functioning that may predate the initiation of drug use (31). Animal data indicate that these constructs may be orthogonal (48).

Family and twin data also support the idea that different factors predispose individuals to initial versus continued (i.e., compulsive) use of tobacco. That is, although genetic factors are substantially related to both smoking initiation and tobacco persistence/dependence, heritability estimates are higher for tobacco persistence and shared environmental factors have little influence. A meta analysis indicated that persistent smoking, here used as a proxy for

tobacco dependence, had an average heritability of about 70% (6). In contrast, shared environmental factors play a larger role with respect to initiation of tobacco use, particularly in adolescence (49,50). The same meta-analysis indicated that smoking initiation had an average heritability of 60% and a shared environmental influence of about 20%. Notably, Audrain-McGovern and colleagues (51) reported that adolescents with higher novelty seeking scores were more receptive to tobacco advertising than low scorers, suggesting one possible mechanism for these shared environmental effects.

Molecular genetic studies of tobacco use, including association and linkage, have implicated a large number of biologically reasonable candidate genes and regions (e.g., implicating dopaminergic function, nicotine metabolism) but there are few consistencies across studies (e.g.,52, see 53 for a meta analysis). The lack of consistency has been attributed to varying phenotypic definitions of tobacco use as well as the underlying complexity of the phenotype, which has multiple genetic and environmental determinants. One potentially useful strategy for evaluating genetic risk markers for tobacco use that has been applied successfully to anorexia nervosa is to incorporate dimensional correlates of temperament or personality with broad tobacco use categories in linkage or whole genome association studies (54). The results reported here provide some potential behavioral correlates of tobacco use initiation and dependence for this approach, which is bolstered by evidence that these traits have been associated with the same candidate genes associated with tobacco use phenotypes (55).

The representativeness of these results to the general population is limited by the fact that people who may have had smoking-related illnesses (e.g., cancer in the past year, early-onset cardiovascular disease) were excluded from participation. An obvious limitation of the current study is that several of the smoking phenotypes, including age at daily use, were assessed retrospectively. For that reason, we limited our analyses to variables that were considered to be particularly salient, and also used the timeline prompt in the interview to aid recollection. However, as we have noted above, neurobiological and genetic theories of substance dependence are mixed with respect to whether aspects of addiction are the result of pre-existing characteristics or damage to key neural circuitry associated with chronic drug use, or some combination of both factors. The limitations of cross sectional studies for evaluating these alternative hypotheses provide a persuasive argument for studying drug use longitudinally, beginning in early childhood prior to initial use.

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Abbreviations

FTND, Fagerstrom Test of Nicotine Dependence; TCI, Temperament and Character Inventory; NS, Novelty Seeking; ZSS, Zuckerman Sensation Seeking Scale; BIS, Barratt Impulsiveness Scale.

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Table 1

Factor loadings from the exploratory principal factor analysis

	Disinhibition	Reward Seeking
BIS-Cognitive	.81	−.26
TCI-NS2	.64	--
BIS-Motor	.59	.17
BIS-Nonplanning	.58	--
TCI-NS3	.39	.20
SS-Experience seeking	--	.71
SS-Thrill and adventure seeking	−.12	.61
SS-Disinhibited behavior	.13	.50
TCI-NS1	--	.50
TCI-NS4	.18	.48

Note: Factor loadings ≤.10 are not presented. BIS=Barratt Impulsiveness Scale; CI-NS=Temperament and Character Inventory-Novelty Seeking; NS1=Exploratory Excitability vs. Stoic Rigidity; NS2=Impulsiveness vs. Reflection; NS3=Extravagance vs. Reserve; NS4=Disorderliness versus egimentation; SS=Sensation Seeking

Table 2

Mean (± s.d.) of impulsiveness measures in never smokers versus ever mokers (triers, ex-smokers and current smokers

	Never Smoker (n=246)	Ever Smoker (n=1038)
TCI-NS1	5.99 (2.47)	6.17 (2.41)
TCI-NS2	3.09 (2.40)	3.50 (2.46)
TCI-NS3	4.05 (2.47)	4.64 (2.35)*
TCI-NS4	4.38 (2.01)	4.63 (1.98)
TCI-Total	17.52 (6.43)	18.95 (6.15)*
BIS-Cognitive	15.57 (3.19)	16.69 (3.42)*
BIS-Motor	19.52 (3.69)	20.01 (3.75)
BIS-Nonplanning	23.20 (4.79)	24.62 (5.29)*
BIS-Total	58.28 (9.31)	61.39 (9.70)*
SS-Experience seeking	4.78 (2.17)	5.21 (2.21)*
SS-Thrill and adventure seeking	4.74 (3.06)	5.09 (3.06)
SS-Disinhibited behavior	2.80 (2.51)	3.40 (2.59)*
SS-Boredom susceptibility	1.92 (1.84)	2.00 (1.68)
SS-Total	14.23 (7.09)	15.70 (6.76)*

* $p \leq .005$

Note: BIS=Barratt Impulsiveness Scale; TCI-NS=Temperament and Character Inventory-Novelty Seeking; NS1=Exploratory Excitability vs. Stoic Rigidity; NS2=Impulsiveness vs. Reflection; NS3=Extravagance vs. Reserve; NS4=Disorderliness versus Regimentation; SS=Sensation Seeking

Table 3

Hierarchical logistic regression analysis for smoking initiation

Ever smoker (1=ever smoker, 0=never smoker) n=1284	**B**	**SE**	**Wald test**	**p**	**e^b**	**CI**
Step 1						
Age	.01	.01	1.6	.20	1.0	.99–1.2
Gender	−.07	.15	0.2	.63	.93	.70–1.2
Years of education	−.13	.03	28.1	<.0001	.88	.83–.92
Race	−.31	.21	2.17	.14	.73	.49–1.1
Step 2						
Disinhibition	.26	.10	7.2	.007	1.3	1.1–1.6
Reward Seeking	.29	.10	8.7	.003	1.6	1.1–1.6

Table 4

Hierarchical logistic regression analyses for smoking cessation among daily smokers

Quitter (1=ex-smoker; 0=current smoker) n=495	**B**	**SE**	**Wald test**	**p**	**e[b]**	**CI**
Step 1						
Age	.03	.02	5.3	.02	1.0	1.0–1.1
Gender	.89	.20	20.5	<.0001	2.6	1.7–3.6
Years of education	.12	.04	9.4	.002	1.1	1.0–1.2
Race	.97	.23	18.2	<.0001	2.4	1.7–4.1
Step 2						
Disinhibition	.02	.13	0.01	.91	1.0	.79–1.3
Reward Seeking	−.41	.14	8.4	.004	0.7	.51–.88

Table 5

Hierarchical linear regression analyses for age at daily smoking for adolescent onset smokers

	B	SE	t	p	Adjusted R^2	ΔR^2	ΔF
Age at daily smoking n=428							
Step 1					0.09	0.09	11.70**
Age	.003	.002	1.89	.06			
Gender	.03	.02	1.69	.09			
Years of education	.02	.004	6.52	<.0001			
Race	−.04	.02	−1.70	.09			
Step 2					0.10	0.01	3.24*
Disinhibition	−.03	.013	−2.35	.02			
Reward Seeking	.0001	.014	−0.02	.99			

* $p < .05$;

** $p < .001$

Table 6

Hierarchical linear regression analyses for tobacco dependence for daily smokers

	B	SE	t	p	Adjusted R^2	ΔR^2	ΔF
FTND n=404/461							
Step 1					0.03	0.03	3.75*
Age	.03	.02	1.29	.20			
Gender	−.42	.25	−1.69	.09			
Years of education	−.16	.05	−3.32	.001			
Race	.14	.29	0.47	.64			
Step 2					0.04	0.01	2.94*
Disinhibition	.36	.16	2.21	.03			
Reward Seeking	.004	.17	0.03	.98			

p <=.05

Note: FTND scores were not available for the full sample of daily smokers