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Adolescent psychological and social predictors of young adult smoking acquisition and cessation: A ten-year longitudinal study

Roy Otten, PhD¹, Jonathan B. Bricker, PhD^{2,3}, Jingmin Liu, MS², Brian Comstock², and Arthur V. Peterson, PhD²

¹Radboud University Nijmegen, Behavioural Science Institute, Nijmegen, The Netherlands

²Cancer Prevention Research Program, Division of Public Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington, USA ³Department of Psychology, University of Washington, Seattle, Washington, USA

Abstract

Objective—A ten-year follow-up study to test the extent to which theory-based adolescent psychological and social factors directly predict and moderate the prediction of *young adult* smoking acquisition and cessation.

Design—A prospective community-based sample. A total of 2,970 adolescents participated in the large Washington State Hutchinson Smoking Prevention Project (HSPP) longitudinal cohort. As predictors, psychological factors (i.e., parent-noncompliance, friend-compliance, rebelliousness, achievement motivation, and thrill seeking) and social environmental factors (i.e., parent's and friend's smoking) were measured when adolescents were 17–18 years old.

Main outcome measures—As main outcome measures, smoking acquisition and cessation were assessed both at ages 18 and 28.

Results—Psychological and social factors predicted 3% to 7% probability ($p < .05$) of smoking acquisition, and a non-significant to 24% probability ($p < .05$) of smoking continuation (not quitting) in young adulthood. Both friend-compliance and rebelliousness were more powerful predictors of young adult smoking continuation than of smoking acquisition.

Conclusion—First evidence that parent non-compliance, friend compliance, and a lack of achievement motivation predict smoking acquisition and (with the exception of parent non-compliance) smoking continuation in young adulthood. Including these psychological factors in future interventions designed to promote young adult smoking cessation may be useful.

Introduction

Cigarette smoking continues to be the leading cause of preventable morbidity and mortality (Centers for Disease Control and Prevention, 2008; Mackay & Ericksen, 2008). In the US, smoking prevalence rates among young adults are alarmingly high. Although 30-day prevalence rates have decreased over time (Johnston, O'Malley, Bachman, & Schulenberg, 2008), during the past decade declines have been smaller than in previous decades, and the CDC reports that young adults ages 18–24 and 25–44 continue to have the highest prevalence of smoking of all age groups—22.2% and 22.8%, respectively (Centers for

Disease Control and Prevention, 2008). Moreover, during 1993–2007, those aged 18–24 reported a substantial decline in 24-hour quit attempts (59.3% in 1993 and 53.1% in 2007; US Department of Health and Human Services, 2008).

In addition to causing a variety of serious near-term physical symptoms and other negative outcomes (US Department of Health and Human Services, 2008; World Health Organization, 2009), these smoking trends portend an increased likelihood of a lifetime of smoking, thereby contributing to the annual 438,000 premature deaths attributed to smoking and the approximately \$193 billion in annual health-related economic losses in the U.S. alone (Centers for Disease Control and Prevention, 2002). These prevalences and consequences demonstrate that young adult smoking is a serious public health problem. Our own data from the age 28 follow-up of the Hutchinson Smoking Prevention Project (HSPP) longitudinal cohort study show that, among 18-year-old less-than-daily smokers ($N = 2589$), 30% had increased to at-least-daily smoking by age 28. Among 18-year-old at-least-daily smokers ($N = 381$), 29% reported having quit smoking for at least one year by age 28. In sum, there are unacceptably high fractions of acquisition occurring during young adulthood. And while smoking cessation rates are substantial, they have been grossly insufficient to change the fact that the young adult smoking prevalence remains the highest of all age groups (Centers for Disease Control and Prevention, 2008).

To date, we are aware of no theories on the role of adolescent psychosocial factors that predict young adult smoking. To address this important gap, a major contemporary theory pertinent to understanding adolescent smoking may serve a useful theoretical model for understanding the role of adolescent psychosocial factors in young adult smoking. Specifically, the Theory of Triadic Influence (TTI; Petraitis, Flay, & Miller, 1995; Flay, Petraitis, & Hu, 1999), which is based on over 20 years of extant research, posits that there are direct and interactive influences of social and psychological factors on adolescent smoking acquisition. Four unique qualities of the TTI are that (1) it is a comprehensive theory that integrates the constructs from all major theories of adolescent substance abuse (not just one theory), (2) all constructs chosen from prior theories are those for which there was strong empirical support, (3) it integrates these prior constructs into a framework of clearly testable predictions, and (4) it focuses on adolescent psychological and social factors.

Consistent with TTI, the major influences on adolescent smoking are social environments and three types of psychological factors: (1) interpersonal, (2) attitudinal, and (3) intrapersonal (Flay et al., 1999). TTI states that examining these factors at the distal-level helps in understanding the intermediate causes of smoking behavior (Petraitis et al., 1995). Distal-level social environments refer to the behaviors of influential role models (Petraitis et al., 1995). These include having: (a) parents who smoke and (b) close friends who smoke. Both have been found to be of major importance in adolescent smoking (Bricker, Peterson, Leroux, Andersen, Rajan, & Sarason, 2006; Bricker, Otten, Liu, & Peterson, 2009; Oygard, Klepp, Tell, & Vellar, 1995; Bricker, Andersen, Rajan, Sarason, & Peterson, 2007; Otten, Engels, & Van den Eijnden, 2008). One study concentrating on the impact of family and peer role models during the early adolescent years (11–14 years) on smoking among young adults (age 21–24) showed that friends' smoking remained a significant predictor of young adults smoking. Parents' baseline smoking emerged as the strongest long-term predictor of young adult daily smoking (Bricker et al., 2007). Similarly, other studies have shown that both parents' and friends' smoking predict young adult smoking acquisition and cessation (Bricker, Peterson, Andersen, Leroux, Rajan, & Sarason, 2006; Bricker, Peterson, Andersen, Rajan, Leroux, & Sarason, 2006; Otten, Engels, Van de Ven, & Bricker, 2007).

Distal-level interpersonal factors refer to emotional attachments to influential role models (Flay et al., 1999). These include having: (a) a weak desire to comply with parents (i.e.,

parent-noncompliance; Martin, Earlywine, Blackson, Moss, & Tarter, 1994) and (b) a strong desire to comply with friends (i.e., friend-compliance; Santor, Messervey, & Kusumakar, 2000). There is some evidence showing that friend compliance and parent noncompliance are predictive of adolescent smoking transitions (age 14–17; Bricker et al., 2009). However, to date there are no studies examining whether friends compliance and parent noncompliance predict young adult smoking acquisition or cessation.

Distal-level attitudinal factors refer to general values that contribute to attitudes toward tobacco use. These include: (a) a weak desire for achievement (i.e., low achievement motivation; McClelland, Atkinson, Clark, & Lowell, 1953) and (b) rebelliousness, defined as the extent to which adolescents prefer behavior that does not conform to authority in general (Santor et al., 2000). There is no published literature on whether and how achievement motivation predicts young adult smoking acquisition or cessation.

The TTI also posits that certain factors are ultimate-level causes of smoking behavior. Ultimate-level intrapersonal factors are conceptualized as broad dispositional factors of the adolescent that are believed to be important, although less predictive of smoking as compared to distal-level influences (Petraitis et al., 1995). An example of an ultimate-level intrapersonal influence is thrill seeking, a component of sensation seeking, which represents individual differences in the desire to engage in risky behavior (Zuckerman, 1994). There is some evidence that thrill seeking predicts adolescent smoking transitions (Bricker et al., 2009) and young adult smoking acquisition and cessation (Flay, Hu, & Richardson, 1998).

Moderating effects

In addition to the direct predictive role of these TTI-based factors, TTI suggests that the impact of parents' and close friends' smoking is moderated by psychological risk factors. To date, no studies have examined the moderating role of psychological factors in the prediction of *young adult* smoking acquisition or cessation.

Study aims

To date, there are no studies examining whether friends compliance and parent noncompliance predict young adult smoking acquisition or cessation, there is no published literature on whether achievement motivation predicts young adult smoking acquisition or cessation, the role of adolescent thrill seeking in young adult smoking is largely unexplored, there is a paucity of research on the long term longitudinal role of parents' and friends' smoking on young adult smoking cessation, and to date no studies have examined whether psychological factors moderate the role of social factors in the prediction of young adult smoking acquisition or cessation.

The present follow-up study aims to fill these gaps by testing whether TTI-based (Flay et al., 1994, 1999) risk factors predict young adult smoking acquisition and cessation. In sum, using a large representative ten-year longitudinal cohort of young adults, the primary purpose of the present study is to follow-up on our recently-reported findings on adolescent smoking (Bricker et al., 2009). We will examine the extent to which the TTI-consistent (Flay et al., 1994; 1999) risk factors of parent-noncompliance, friend-compliance, rebelliousness, low achievement motivation, thrill seeking, and parents' and close friends' smoking each longitudinally predicted young adult smoking acquisition and cessation. Specifically, this study examines (1) the extent to which TTI-consistent psychological and social factors directly predict the absolute probability of young adult smoking acquisition and cessation (2) whether the psychological factors have a different level of prediction on young adult smoking and cessation as compared to the social factors, (3) to what extent

psychological factors moderate the extent to which social factors predict the absolute probability of young adult smoking.

The value of the results of the present study will be to: (1) provide an important testing of theory-based predictions, (2) add significant new results to the knowledge base on young adult smoking acquisition and cessation, and (3) determine the extent to which these seven psychological and social factors may be promising candidates for inclusion in subsequent young adult smoking prevention and cessation interventions.

Methods

Data for this study were collected as part of a large longitudinal cohort in Washington State: the Hutchinson Smoking Prevention Project (HSPP) (Peterson, Kealey, Mann, Marek, & Sarason, 2000). Of all school districts that were randomly selected, ninety-eight percent (40 out of 41 districts) decided to participate in the trial.

Participants met the following the inclusion criteria. First, the provision of baseline data: (a) at least one parent's and/or guardian's smoking status when the participant was age 17 and (b) participant's baseline smoking status, psychological factors, and close friends' smoking status at age 18. There were 3,249 adolescents who provided these baseline data. Second, the provision of follow-up data: participant's endpoint smoking status at age 28. Of the initial 3,249 adolescents at baseline, 2,970 (88.7%) reported data on their smoking status at age 28. These 2,970 adolescents comprised the total study sample (49% were female and 91% were Caucasian). Ninety-five percent of the female parents were biological mothers of the cohort members. For the male parents, 81% were biological fathers (19% were stepfathers or other guardians).

Procedures

When participants were age 17, their parents self-reported their smoking status via a mailed or telephone survey. At age 18, the participants self-reported their baseline smoking status, psychological factors, and close friends' smoking status via classroom survey or mail/telephone follow-up for those who were absent or no longer enrolled in the school district. At age 28, the participants self-reported their smoking status via mail/telephone follow-up survey. Procedures were approved by the Fred Hutchinson Cancer Research Center's Institutional Review Board.

Measures

TTI-consistent psychological factors—The TTI-consistent psychological factors were measured when a cohort member was age 18. Parent-noncompliance was measured with a two-item scale ($\alpha = .74$, $M = 1.93$). A sample item was: "It is very important for me to do what my parents expect of me" (reverse coded). Friend-compliance was measured with a three-item scale ($\alpha = .62$, $M = 0.74$). A sample item was: "To keep my friends, I'd even do things that aren't good for me." Achievement orientation was measured with a two-item scale ($\alpha = .62$, $M = 2.01$). A sample item was: "I want to work hard to achieve success in life." Rebelliousness was measured with a four-item scale ($\alpha = .54$, $M = 2.05$). A sample item was: "I try to do things I'm not supposed to do." Finally, thrill-seeking was measured with a two-item scale ($\alpha = .60$, $M = 3.44$). A sample item was: "I look for dangerous things to do, just for excitement." The response options for each of the items in these scales were "Not like me" (coded "0"), "A little like me" (coded "1"), "Somewhat like me" (coded "2"), and "Just like me" (coded "3"). The factorial structure of these five measures was tested with an a priori five-factor confirmatory factor analysis (CFA). The absolute fit indices, which show the fit of obtained vs. implied covariance matrices, were the following: chi-

square ($\chi^2 = 3063$; $df = 65$; $p < .001$), Goodness of Fit Index (GFI: .98), and Adjusted Goodness of Fit Index (AGFI: .97). CFA experts provide contrasting interpretations of significant chi-squares (Bentler, 2007; Barrett, 2007; Goffin, 2007; Hayduk, 2007; Markland, 2007; Steiger, 2007). Indeed, some argue that the test is “overemphasized” (Goffin, 2007) and that sole reliance on the test is “regressive” (Steiger, 2007), especially in models with large sample sizes and many degrees of freedom (Bentler, 2007). Therefore, we also provide the reader the following approximate fit indices: Comparative Fit Index (CFI: .91), and Root Mean Squared Error of Approximation (RMSEA: .03). While there are no agreed-upon standard cut-offs for evaluating fit indices, these results generally support a five-factor model (Bentler, 2007, Barrett, 2007; Goffin, 2007; Hayduk, 2007; Markland, 2007; Steiger, 2007). Moreover, the low to moderate correlations among the five factors, ranging from .06 to .46, provided further evidence that they each reflected related yet distinct constructs.

TTI-consistent social factors—Parents’ smoking status when cohort member was age 17. The parent responding to the smoking status survey self-reported his/her smoking status and gave a proxy report of the other parent’s smoking status. The questions asked were: “Do you currently smoke cigarettes?” and “Does your spouse/partner (if any) at this address currently smoke cigarettes?” The response choices were (1) “Yes, at least once a day,” (2) “Yes, but not everyday,” (3) “No, not since (Month/Year),” (4) “No, never smoked regularly,” and (5) “No, never smoked at all.” The question asking if the spouse/partner smokes also included the option of “Not spouse/partner at this address.”

Close friends’ smoking status when cohort member was age 18. Adolescents were asked to report on the number of their close friends who smoke. Close friends’ smoking status was measured using the question: “Of your five closest friends, how many smoke?”

All of these measures (1) have strong evidence of predictive validity in our prior research (see, for example, Bricker et al., 2009), (2) allow for addressing the study’s important scientific questions, and (3) provide a critical early step towards establishing an evidence base for TTI-consistent adolescent psychosocial predictors of young adult smoking and cessation.

Outcome variables

The smoking acquisition outcome was defined as the transition from less-than-daily smoking at 18 to daily smoking (and having smoked at least 100 lifetime cigarettes) by age 28. First, the applicable questions administered at age 18 asked, “Have you ever smoked or tried a cigarette?” and “How often do you currently use cigarettes?” If on the age 18 survey participants reported never having tried a cigarette, or if they did try a cigarette at age 18, but did not smoke one or more cigarettes per day the participant was classified as a less than-daily-smoker at age 18. Second, the applicable questions administered at age 28 were same as those at age 18, and also included the question “About how many cigarettes have you smoked in your entire life?” If the participant reported smoking “one or more cigarettes per day”, and indicated on the survey having smoked at least 100 cigarettes during one’s lifetime, then he or she was classified as having made the transition to smoking daily.

The smoking cessation outcome was defined as the transition from daily smoking at 18 (and having smoked at least 100 lifetime cigarettes) to having quit smoking for at least 1 year by age 28.

Cotinine analysis of a random sample of saliva specimens at age 18 showed very low rates of over-reporting and under-reporting: 1.7% and 1.3%, respectively (Community Intervention Trial for Smoking Cessation, 1995). At age 28, cigarette smoking status was

not validated by biochemical tests. However, research has shown that adults participating in trials of brief tailored smoking cessation counseling self-report their current smoking behavior accurately (Hughes, Keeley, Niaura, Ossip-Klein, Richmond, & Swan, 2003; Botvin & Botvin, 1992; Wills & Cleary, 1997).

Strategy for analyses

To provide probabilities of smoking acquisition and cessation, we extended again, from social to psychological influences, the social transmission probability (STP) model that we have used in multiple previous studies. (see also Bricker, Leroux, Peterson, Kealey, Sarason, Andersen, & Marek, 2003; Bricker et al., 2006; Bricker et al., 2007; Bricker, Peterson, Andersen, Sarason, Rajan, & Leroux, 2007; Bricker, Peterson, Sarason, Andersen, & Rajan, 2007), including our recently reported study in this journal (Bricker et al., 2009). The social transmission probability (STP) model (Becker, 1989) was used in order to model the absolute probabilities that specific psychological and social factors would influence young adult smoking acquisition and quitting. The first model ($N = 2589$) expressed the overall probability of the transition to daily smoking during the period age 18 to 28 as a function of the following independent variables examined simultaneously in the model: (1) scoring above the median on parent non-compliance, friend-compliance, rebelliousness, and thrill-seeking) at age 18 and below the median on achievement motivation at age 17 (scored below the median so that all probabilities can be interpreted in the same direction), (2) number of parent's smoking at age 17, (3) number of close friends' smoking at age 18, the interaction terms of both parent's and friend's smoking by the TTI-related psychological factors. The second model ($N = 381$) expressed the probabilities for smoking continuation for at least 1 year by age 28 as a function of the same variables examined simultaneously in the model. Since probabilities can only be positive, ranging from 0 to 1, they are calculated as the probability of smoking continuation. Each model also included parents' highest level of education as a covariate.

Since it is possible that participants who had attended the same school district might have a correlated smoking status (due to factors such as social mixing and similar SES), we calculated the intraclass correlations (ICCs) for the target outcomes of smoking acquisition and smoking cessation. Both ICCs were close to zero (.004 for acquisition; .002 for cessation), and thus support the analytic method choice.

While the overall rate of missing data was low over the 10-year period assessment, a missing data analysis showed that the following age 18 factors from from the study's model predicted a higher odds of missing smoking status data at age 28: rebelliousness (OR = 1.45; 95% CI = 1.14, 1.86), thrill seeking (OR = 1.49; 95% CI = 1.17, 1.92), achievement motivation (OR = 1.76; 95% CI = 1.37, 2.26), parent's smoking (OR = 1.48; 95% CI = 1.24, 1.76), friend's smoking (OR = 1.20; 95% CI = 1.12, 1.28), and daily smoking (OR = 2.08; 95% CI = 1.55, 2.79). To determine whether missing data impacted the results of the study, the entire analysis was repeated in a supplementary analysis using multiple imputation (Little & Rubin, 1987).

Fitting the models

A logarithmic transformation of the model conveniently puts it in the form of a Generalized Linear Model (GLM) (McCullagh & Nelder, 1989). Thus, statistical inference can use the iterated weighted least squares algorithm, the standard method for GLMs. We implemented this algorithm using the PROC GENMOD procedure in the SAS[®] statistical package, using a log-link function with a binomial distribution (McCullagh & Nelder, 1989). In the supplementary analysis, ten iterations of multiple imputation were calculated using the Imputation by Chained Equations (ICE) command in Stata (v. 10.1; StataCorp, 2007).

Results

Probabilities of transitioning from less-than-daily to daily smoking

The results in Table 1 allow the reader to examine the unique contribution of a predictor in the model. Rows one through four show the probabilities contributed by scoring above the median on the TTI-consistent psychological factors, each parent's smoking, and each close friend's smoking for the prediction of the transition to daily smoking by age 28. For example, for an 18-year old with *two* parents who smoke, the probability of making the transition from less-than-daily to daily smoking by age 28, is the product of the probability of each parent's smoking influence. Expressed algebraically, that would be $[1 - (1 - .05) \cdot (1 - .05)] = .0975$, or a 9.75%. Similarly, for an 18-year old scoring above the median on achievement motivation, the probability of making the transition from less-than-daily to daily smoking by age 28 is $[1 - (1 - .07)] = .07$, or a 7%. Other probabilities contributed by scoring above the median on various psychological factors to the overall prediction were: 3% for parent-noncompliance, 2% for friend-compliance, 5% for rebelliousness, and 4% for thrill-seeking. Furthermore, as shown in row seven, there was a 4% probability contributed by scoring below the median on achievement motivation. All the confidence intervals overlapped, indicating that none of these factors significantly differed from each other.

Probabilities of not transitioning to having quit smoking (i.e., continuation)

Table 1 also shows the probability estimates of the five TTI-consistent psychological factors, each parent's smoking, and each close friend's smoking for the prediction of smoking continuation (i.e., not quitting) by age 28. (Since probabilities can only be positive, ranging from 0 to 1, they are calculated as the probability of smoking continuation) As shown in rows one through four, the probabilities contributed by scoring above the median on various psychological factors to the overall prediction were: 21% for friend-compliance and 24% for rebelliousness. There was a 14% probability contributed by scoring below the median on achievement motivation. In contrast, rows six shows that there was an 8% probability contributed by each parent's smoking status. The probabilities for parent-noncompliance, thrill seeking, and friend's smoking were not significant.

The confidence intervals for the probabilities of the psychological versus social factors show that friend-compliance and rebelliousness each had higher levels of predicting not quitting as compared to friend's smoking. And comparing the confidence intervals for the probabilities of the smoking acquisition versus smoking continuation, it can be seen that friend compliance and rebelliousness had higher probabilities of predicting young adult smoking cessation as compared to continuing smoking. All of the other probabilities' confidence intervals included the zero value.

Interaction between social environments and psychological factors

We found no significant evidence (all $p > .05$) for an interaction between any of the five psychological factors and parent smoking or friend smoking in the prediction of smoking acquisition and smoking continuation.

Finally, the multiple imputation analysis showed that the pattern of results remained unchanged. Thus, there was no evidence from the multiple imputation analysis that missing data impacted the results.

Discussion

Summary and Interpretation of Direct Predictions

Following on our recent study (Bricker et al., 2009), we used a ten-year prospective design to examine the extent to which Theory of Triadic Influence-based psychological and social factors predict smoking acquisition and cessation during young adulthood (i.e., ages 18 to 28). Findings suggest that the psychological and social factors predicted 3% to 7% probability of smoking acquisition, and a non-significant to 24% probability of smoking continuation during young adulthood. These results provide the first evidence that these psychological factors predict smoking acquisition and (with the exception of parent non-compliance) smoking continuation during young adulthood. Of the social environmental factors, only parent's smoking was significant for both smoking acquisition and smoking continuation. Both friend compliance and rebelliousness were more powerful predictors of continuing to smoke than of smoking acquisition.

Building on our prior results on adolescent smoking acquisition (Bricker et al., 2009), the current results demonstrate the substantially-sized, long-term impact of adolescent psychological factors on young adult smoking cessation. The results show that friend-compliance, rebelliousness, and to some extent, lack of achievement motivation during late adolescence (i.e., age 18) are all powerful predictors of the continuation of smoking during the period of young adulthood (i.e., ages 18 to 28). For example, an 18-year old scoring high on the friend-compliance scale has a 21% probability of continuing smoking by age 28. This result suggests that these psychological factors, may be important impediments to the process of quitting smoking during young adulthood.

In contrast, the results suggest that all the psychological and social factors studied here have a significant long-term impact on young adult smoking acquisition. However, the magnitude of their influence is smaller in comparison with our recent results on adolescent acquisition (Bricker et al., 2009).

Summary and Interpretation of Comparisons Between Psychological & Social Factors

The results showed that both friend-compliance and rebelliousness were more powerful predictors of smoking continuation as compared to smoking acquisition. We can speculate why. Specifically, we know that deviant peers are likely to score higher on rebelliousness and there is empirical evidence showing that affiliations with deviant peers can exacerbate the development of deviant behavior (Dishion, Patterson, Stoolmiller, & Skinner, 1991; Van Lier, Vitaro, Wanner, Vuik, & Crijnen, 2005). In a similar vein, adolescents who start smoking may end up in peer group networks where they are more likely to develop an established smoking pattern and where they are less likely to quit and thus continue to smoke. Moreover, friend compliant individuals may affiliate with deviant peers so that continuation of smoking may serve as a common and mutually reinforcing behavior for those who comply with deviant peers (see also Otten, Wanner, Vitaro, & Engels, 2008). Otherwise, smoking may even serve as a social marker of one's internal identity as rebellious. In addition, smoking cessation is known to be more difficult in a context where many people smoke and where there is a high level of exposure to smoking cues. These results further support the interpretation that psychological factors broadly reflecting emotional attachments to peer role models and values that contribute toward one's attitudes toward tobacco are important factors in the young adult cessation process. Future research should continue to conduct these comparisons.

Summary and Interpretation of Interactions

In contrast with our recent report on adolescent smoking (Bricker et al., 2009), we found no evidence that any of the psychological factors studied here moderated either of these social environmental influences. The current study's results suggest the possibility that environmental and psychological factors examined exert their influence on young adult smoking independently.

Public Health Implications

Regarding prevention, the findings suggest that *all* of the psychological and social environmental factors studied here would represent valuable/useful targets for intervention. Targeting these factors could potentially yield significant impact by reaching a broad population of young adults at risk for smoking. Community-based interventions designed to target the role of these psychological and social processes in young adult smoking acquisition could achieve extensive population-level reach, and thereby lead to significant population-level impact. In contrast, the results suggest that the psychological factors of friend-compliance, rebelliousness, and to some extent, lack of achievement motivation may be useful to include in future interventions designed to promote young adult smoking cessation. Interventions could identify adolescents scoring high on these psychological factors and teach them skills for regulating their behavior. For example, friend-compliant adolescents could be taught skills for making decisions more independently of friends.

These results illustrate the utility of a STP statistical model. The model, conceptually and mathematically straightforward, expresses the probability that an individual will make a smoking transition in terms of (1) the number of parents or close friends smoking and (2) one's score (in relation to the median) on the five specific psychological factors examined in this study. To our knowledge, this is the first model of smoking behavior transitions at the level of the individual whose parameters are probabilities of smoking behavior.

Limitations that can be addressed in future research

First, to verify the smoking cessation measure, a biochemical validation would have been valuable. Second, the psychological factors were measured with only a few items per trait, thereby contributing to their modest reliability. However, to survey this large number of participants longitudinally with high retention such brevity was essential. The fact these scales predicted smoking transitions with modest reliability emphasizes the strength of these predictions. Third, although this study's sample was representative of Washington State, only 10% was non-Caucasian. Fourth, while we caution against overinterpretation of the probability estimates, we think the magnitude of *each* of the statistically significant estimates are substantial for the following reasons: (1) each factor was modeled net of all other factors as well as the control and stratification variables, (2) prediction was over a ten year period, (3) measurement error in the predictors may be underestimating their effects, and (4) as argued by Prentice & Miller (1993, pg. 64), even modest statistical predictions from a set of variables may have a substantial impact when said variables are manipulated in an intervention. Future research should expand on the results of this study by examining other predictors included in the TTI theoretical model. Finally, examining other theory-based factors, including other constructs from TTI (Bricker et al., 2009), would be valuable in future research.

Conclusions

In sum, the overall results show that, despite the fact that predictions span a period of ten years of young adult development (i.e., from age 18 to 28) nearly all the TTI-based factors significantly predicted young adult smoking acquisition and cessation. These main results

suggest that TTI, a theory focused on adolescent substance use etiology, does apply to the context of young adult smoking. How TTI applies to young adult smoking may depend on whether the focus is on smoking acquisition or cessation. Specifically, it may be that the TTI-based factors examined here all apply to smoking acquisition whereas only certain TTI-based factors apply to smoking cessation. Most notably, friend-compliance and rebelliousness appear to be powerful predictors of cessation, but considerably more modest predictors of acquisition. A more narrow set of adolescent psychosocial factors from TTI could provide a more parsimonious prediction of young adult cessation. Finally, given the paucity of theory of young adult smoking, combining the current study's results on adolescent psychosocial factors derived from TTI along with young adult predictors derived from theories of young adult development (e.g., Arnett's Theory of Emerging Adulthood; Arnett, 2004) could provide a powerful comprehensive model to predict young adult smoking. Future research should develop and test such models.

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Table 1

Probabilities of (a) transitioning from age 18 less-than-daily to daily smoking by age 28 and (2) *not* transitioning from age 18 daily smoking to having quit smoking for at least 1 year by age 28, given each psychological factor, each parent's smoking, and each close friend's smoking at age 18.

Source of Influence	Prob. of transition to daily smoking (95% CI) N = 2589	P value	Prob. of <i>smoking continuation</i> (95% CI) N = 381	P value
<i>Psychological Factor</i>				
Parent-noncompliance ^a	0.03 (0.01, 0.05)	< .01	0.04 (-0.11, 0.21)	.67
Friend-compliance ^a	0.02 (0.01, 0.04)	< .05	0.21 (0.06, 0.38)	< .01
Rebelliousness ^a	0.05 (0.03, 0.06)	< .0001	0.24 (0.10, 0.39)	< .001
Thrill seeking ^a	0.04 (0.02, 0.06)	< .001	0.09 (-0.02, 0.22)	.11
Achievement motivation ^b	0.07 (0.04, 0.09)	< .0001	0.14 (0.01, 0.26)	< .05
<i>Social Environment</i>				
Parent's smoking ^c	0.05 (0.03, 0.06)	< .0001	0.08 (0.03, 0.14)	< .01
Friend's smoking ^d	0.04 (0.03, 0.04)	< .0001	0.01 (-0.03, 0.02)	.65

^aThe reported probabilities are for scoring *above* the median on the given *psychological factor*.

^bThe reported probabilities are for scoring *below* the median on the given *psychological factor*.

^cThe reported probabilities are for *each* smoking parent.

^dThe reported probabilities are for *each* smoking close friend