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Psychological and Social Risk Factors in Adolescent Smoking Transitions: A Population-Based Longitudinal Study

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Abstract

Objective—This study longitudinally investigated psychological and social risk factors consistent with the Theory of Triadic Influence (TTI) as predictors of adolescent smoking transitions.

Design—Among 4218 adolescents, five psychological risk factors (i.e., parent-noncompliance, friend-compliance, rebelliousness, low achievement motivation, and thrill seeking) were assessed in 9th grade (age 14), two social influence risk factors (i.e., parents' and close friends' smoking) were assessed in grades 3 (age 8) and 9 (age 14), respectively.

Main Outcome Measures—Adolescent smoking transitions occurring between the 9th and 12th (ages 14–17) grade interval.

Results—There was a 22–27% probability contributed by scoring high on each of these psychological risk factors to the overall probability that an adolescent would try smoking. For predicting trying smoking, the probability contributed by these psychological factors was greater than the probability contributed by each parent's and close friend's smoking. Parent-compliance had a higher contribution to the probability of trying smoking when an adolescent's parent smoked ($p < .05$), while friend-compliance had a higher contribution to the probability of trying smoking when an adolescent's friend smoked ($p<.001$).

Conclusion—These psychological and social factors have an important influence on adolescent smoking transitions. Implications for TTI and smoking prevention interventions are discussed.

Keywords

psychological influences; parents; friends; adolescents; smoking

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Introduction

In the United States, 23% of high school seniors smoke at least monthly (Centers for Disease Control and Prevention, 2006), far short of the Healthy People 2010 (US Department of Health and Human Services, 2000) national goal of 16%. For the past four years, the smoking rates for high school seniors have remained flat, a trend that now threatens the historic near 30-year decline in youth smoking (Johnston, O'Malley, Bachman, & Schulenberg, 2008). Youth smoking prevention programs developed to address this serious and timely public health problem unfortunately have "intervention effectiveness [that] is not maintained in the long term (i.e., more than three years post-intervention)" (Dobbins, Decorby, Manske, & Goldblatt, 2008). Basic research on the psychosocial influences on adolescent smoking acquisition is therefore needed to improve youth smoking prevention programs.

Theory of Triadic Influence and adolescent smoking acquisition

A major contemporary theory pertinent to understanding adolescent smoking acquisition is the Theory of Triadic Influence (TTI; Petraitis, Flay, & Miller, 1995; Flay, Petraitis, & Hu, 1999), which is based on over 20 years of extant research. TTI posits that there are direct and interactive influences of social and psychological factors on adolescent smoking acquisition. Based on their extensive review and experience with the research that underlies the TTI, the authors of this theory observe that social environmental influences, such as parents' and friends' smoking, are arguably the most studied and well-supported type of psychosocial influence on adolescent smoking (Flay et al., 1999). In contrast, they say that the following is needed for future research on adolescent smoking acquisition: (1) examine the influence of understudied theory-based psychological factors and (2) use theory to derive and test interactions between psychosocial risk factors. They recommend that this research examine how these theory-based psychosocial factors predict smoking transitions (e.g., from never to trying smoking; Flay et al., 1999). To address these needs, the current study: (1) examines the extent to which TTI-consistent psychological factors directly influence adolescent smoking transitions, (2) illustrates the magnitude of these psychological influences by comparing them with the well-established social influence benchmarks of parents' smoking and friends' smoking, and (3) examines to what extent psychological factors moderate the influence of parents' and close friends' smoking on adolescent smoking transitions.

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. 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 et al., 1994) and (b) a strong desire to comply with friends (i.e., friend-compliance; Santor, Messervey, & Kusumakar, 2000). 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).

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).

Regarding empirical evidence for role of these TTI-based psychological factors in adolescent smoking transitions, there is a small literature suggesting that rebelliousness (Santi, Cargo, Brown, Best, & Cameron, 1994), rejection of adult authority (Santi et al., 1994), and risk-taking (Flay, Hu, & Richardson, 1998) are prospectively associated with adolescent smoking transitions but the other TTI-consistent psychological factors have not been examined as prospective predictors of adolescent smoking transitions. Nor do we know of studies examining the prospective influence of these TTI-consistent psychological factors relative to parents' and close friends' smoking on adolescent smoking transitions.

Psychological factors as moderators of parents' and close friends' smoking

TTI suggests that the impact of various social factors is moderated by an individual's psychological susceptibility to influence by those factors. As based on TTI, we posit that the influence of each parent's and close friend's smoking on each of the smoking transitions would be stronger among adolescents who have psychological risk factors for smoking than among adolescents who do not have these psychological risk factors. For example, parent-noncompliant adolescents would be less likely to model their parents' smoking behavior than parent-compliant adolescents. But we know of no studies of psychological factors that moderate *parents'* smoking influences on adolescent smoking. Since friend-compliant adolescents are inclined to do what their friends are doing (Santor et al., 2000), they may be more likely to model their friends' smoking than friend-noncompliant adolescents. We know of only two studies, both cross-sectional, on psychological factors that moderate the association of *friends'* smoking with adolescent smoking. Specifically, these studies reported that the association between friends' smoking and adolescent smoking was stronger among adolescents who scored high on sensation seeking (Slater, 2003) or rebelliousness (McAlister, Kroskick, & Milburn, 1984) than among adolescents who scored low on these factors.

Study aims

Using a large representative longitudinal cohort of adolescents (N = 4218) residing in Washington State, this paper fills major gaps in needed theory-based empirical research by reporting a longitudinal study of (1) TTI-consistent interpersonal, attitudinal, and intrapersonal psychological factors as predictors of adolescent smoking transitions, (2) the relative influence of these psychological factors versus the well-established social environmental benchmarks of parents' and close friends' smoking in the prediction of adolescent smoking transitions, and (3) the extent to which these psychological factors moderate the influence of parents' and close friends' smoking in the prediction of adolescent smoking transitions. The TTI-consistent psychological factors were (1) parent-noncompliance, (2) friend-compliance, (3) low achievement motivation, and (4) rebelliousness, and (5) thrill-seeking. The three smoking transitions were: never tried to first cigarette (Transition 1), first cigarette to monthly smoking (Transition 2), and monthly to daily smoking (Transition 3). The hypotheses were:

- Hypothesis 1: Adolescents scoring higher on the psychological risk factors would have a higher probability of making each of the smoking transitions.
- Hypothesis 2.1: The *distal*-level psychological risk factors (i.e., parent non-compliance, friend-compliance, low achievement motivation, and rebelliousness) and the *distal*-level social environment factors of each parent's and close friend's smoking would have similar magnitudes of influence on each of the smoking transitions.
- Hypothesis 2.2: The *ultimate*-level psychological risk factor (i.e., thrill seeking) would have a smaller magnitude of influence on smoking transitions than the *distal*-level social environment factors of each parent's and close friend's smoking.
- Hypothesis 3: The psychological risk factors would moderate the influence of the social environment risk factors. Specifically, the influence of each parent's and close

friend's smoking on each of the smoking transitions would be stronger among adolescents scoring higher on the psychological risk factors than among adolescents scoring lower on the risk factors.

Methods

Study sample

The study sample was drawn from the combined control and intervention cohort from a large randomized, Washington State school-based tobacco use prevention trial, the Hutchinson Smoking Prevention Project (HSPP), which is described in detail in Peterson, Kealey, Mann, Marek, and Sarason (2000). Ninety-eight percent (40/41) of all school districts that were randomly selected agreed to participate in the trial.

The eligible study sample was defined as all of the 5,606 adolescents who were targeted for collection of this survey data: (1) at least one parent's and/or guardian's smoking status when the participant was in 3rd grade; (2) participant's psychological factors, smoking status, and close friends' smoking status at 9th grade, and (3) participant's smoking status when s/he was in 12th grade. Of these 5,606 adolescents, 4,877 (87%) had parent-reported smoking status at 3rd grade. Of these 4,877 adolescents, 4,487 (92%) reported on their psychological factors, smoking status, and close friends' smoking status data at 9th grade. Of these 4,487 adolescents, there were 4,218 (94%) who reported data on their smoking status at 12th grade. These 4,218 adolescents comprised the total study sample. The adolescent cohort members were 49% female and 91% Caucasian. Ninety-five percent of the female parents were biological mothers of the cohort members. For the male parents, 81% were biological fathers and 19% were stepfathers or other guardians.

Procedures

Parents reported their smoking status via a mailed or telephone survey when the cohort members were in 3rd grade, with a response rate of 87%.[1] The adolescent cohort members reported their smoking status, psychological factors, and close friends' smoking status using a classroom survey (or by mail and telephone for classroom absentees and those no longer enrolled in the school district) at both the 9th and 12th grade with a response rate of 92% and 94% respectively. All procedures were approved annually by the Fred Hutchinson Cancer Research Center's Institutional Review Board.

Measures

Parents' smoking status when cohort member was in third grade—The parent responding to the smoking status survey self-reported his/her smoking status and then gave a proxy report of the other parent's smoking status. The smoking questions asked were: "Do you use cigarettes?" and "Does your child's other parent use cigarettes?" The response choices were (1) "Yes, occasionally," (2) "Yes, often," (3) "No, not anymore," and (4) "No, never." The number of parents smoking was coded in our analyses as "0" if neither parent gave response (1) or (2); "1" if one parent gave response (1) or (2), but the second parent did not; and "2" if both parents gave response (1) or (2).

Close friends' smoking status when cohort member was in ninth grade— Adolescents in this study were asked to report on the number of their close friends who smoke,

[1]Note that it would have been ideal to measure parents' smoking status at the same time as the other predictors in the study (i.e., 9th grade). However, we felt this data were still valuable for the present study because parents' smoking behavior is stable (Darling & Cumsille, 2003): the number of parents who quit smoking after their child is in 3rd grade is small (Bricker, Rajan, Andersen, & Peterson, 2005) and the number of parents who take up smoking is also low (Johnston, O'Malley, & Bachman, 1999).

a practice which is consistent with prior studies (see, for example, Ellickson, Bird, Orlando, Klein, & McCaffrey, 2003). Close friends' smoking status was measured using the open-ended question: "How many of your close friends smoke cigarettes?" Respondents wrote in the number of close friends who smoked.

Five TTI-consistent psychological factors measured when cohort member was in ninth grade—First, *parent-noncompliance* was measured with a two-item scale (Cronbach alpha = .71). A sample item for this trait was: "I try to do what my parents want me to do" (reverse coded). Second, *friend-compliance* was measured with a three-item scale (Cronbach alpha = .64). A sample item for this trait was: "I do what my friends want me to do, even if I really don't want to." Third, *achievement orientation* was measured with a two-item scale (Cronbach alpha = .74). A sample item for this trait was "Doing the best I can in school is very important to me." Fourth, *rebelliousness* was measured with a four-item scale (Cronbach alpha = .66). A sample item for this trait was: "I don't believe in following the rules." Fifth, *thrill-seeking* was measured with a two-item scale (Cronbach alpha = .70). A sample item for this trait 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 a confirmatory factor analysis. The Goodness of Fit Index (GFI:.96), Adjusted Goodness of Fit Index (AGFI: .95) and Root Mean Squared Error of Approximation (RMSEA: .05) all met standards for a close-fitting model (Bentler, 1990; Joreskog & Sorbom, 1984). The parameter estimates were moderate to high (ranging from .40 to .99), suggesting that the items reflect the constructs they were expected to load on. The moderate correlations among the five factors, ranging from −.19 to . 50, again provided evidence that they each reflected related yet distinct constructs.

Scores for each of the five psychological scales were calculated as the sum of the item raw score multiplied by the item factor score. The means (and ranges) for each of the scales, with higher scores indicating higher levels on the given psychological scale, were the following: parent-noncompliance: 2.61 (0 – 4.47), friend-compliance: .93 (0 – 5.54), low achievement motivation: 3.84 (0 – 4.59), rebelliousness: 2.26 (0 – 6.12), and thrill seeking: 2.11 (0 – 4.24).

Smoking transitions of cohort members occurring between 9th and 12th grade —Following commonly used levels of adolescent smoking (see, for example, Johnson et al., 2002; Norton, Lindrooth, & Ennett, 1998), the three smoking transitions, *occurring only after the 9th grade assessment*, were never smoker to tried first cigarette (Transition 1), tried first cigarette to smoking monthly (Transition 2), and smoking monthly to smoking daily (Transition 3). Data to assess the first smoking transition were based on the question, "Have you ever smoked or tried a cigarette?" If the adolescent responded in the 12^{th} grade survey "one cigarette or more," then s/he was classified as having made the transition from never smoker to tried first cigarette (Transition 1). *Among those who never smoked by 9^{th} grade (eligible n = 2554)*, thirty seven percent of adolescents transitioned to trying smoking by 12^{th} grade. Data on the second and third transitions were based on the question, "How often do you currently use cigarettes?" Among those who ever tried a cigarette by 9^{th} grade, if the adolescent cohort member responded in the 12^{th} grade survey, "once a month or more," then he or she was classified as having made the transition to smoking monthly by 12^{th} grade (Transition 2). *Among those who ever tried a cigarette by 9^{th} grade (eligible n = 2072)*, 40% transitioned to smoking monthly by 12^{th} grade. Among those who had ever smoked monthly, if the adolescent responded in the 12^{th} grade survey, "one or more cigarettes per day," then he or she was classified as having made the transition from smoking monthly to smoking daily (Transition 3). *Among those who ever smoked monthly by 9^{th} grade (eligible n = 1169)*, 55% transitioned to smoking daily by 12^{th} grade. Note that these transitions help account for the

effect of the selection of friends who smoke (Simons-Morton, Chen, Abroms, & Haynie, 2004) because having a close friend who smokes *precedes* the occurrence of each of the three smoking transitions.

Because adolescents may misreport their tobacco use (Murray, O'Connell, Schmid, & Perry, 1987; Pechacek et al., 1984), participants provided a saliva specimen for cotinine analysis as a bogus pipeline to enhance the reliability of self-reported smoking behavior (Murray et al., 1987). In addition, analysis of a 12.6% random sample of the 12th grade saliva specimens provided confidence that the self reports were accurate. Specifically, the fraction of children who said they *did not* smoke but had at least 5ng/mL of cotinine (Feyerabend & Russell, 1990) in their saliva was only 1.2% ($n = 10$). The fraction of children who said they *did* smoke but had less than 5ng/mL of cotinine (Feyerabend & Russell, 1990) in their saliva was only 1.6% ($n = 13$). Similarly, in the 9th grade endpoint, the level of conformity between the cotinine analysis and smoking in the last 3 days was found to be 92.4%.

The social transmission probability model

To provide probabilities of making a smoking transition, we extended, from social to psychological influences, the social transmission probability (STP) model that we have used in six previous studies (Bricker, Andersen, Rajan, Sarason, & Peterson, 2007; Bricker, Peterson, Andersen, et al., 2007; Bricker, Peterson, Sarason, et al., 2007; Bricker, Peterson, Andersen, Leroux, et al., 2006; Bricker, Peterson, Andersen, Rajan, et al., 2006; Bricker, Peterson, Leroux, et al., 2006). This model, an adaptation of the Reed-Frost mathematical model (Becker, 1989), was used in order to model the probabilities contributed by various individual psychological and social factors to the overall probability that an adolescent would make a specific smoking transition. Three separate models were created, one for each of the three smoking transitions. The first model expressed the overall probability that an adolescent makes the first smoking transition as a function of the following independent variables: (1) number of parent's smoking, (2) number of close friend's smoking, (3) scoring above the median on four of the TTI-related psychological factors (i.e., parent non-compliance, friend-compliance, rebelliousness, and thrill-seeking), and below the median on achievement motivation (scored below the median so that all probabilities can be interpreted in the same direction), all the interaction terms of parent's smoking by each of the five psychological factors, and all the interaction terms of friend's smoking by each of the five psychological factors. [We dichotomized the psychological scales at or above (below, for achievement motivation) the median for ease of presentation and for each of comparing results with each parent's and each close friend's smoking. As a supplementary analysis, the psychological scales were also fit as continuous predictors.] The second and third models used the same independent variables for predicting the overall probability of the second transition and overall probability of the third transition, respectively. For control, each model also included parents' highest level of education as a covariate.

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, which was appropriate for our model (McCullagh & Nelder, 1989). Confidence intervals were computed using the robust sandwich variance estimate (Liang & Zeger, 1986) that accounted for the correlation between outcomes for adolescents in the same school district.

Results

Probabilities of the first smoking transition (never to first cigarette)

Reported in the Transition 1 column of Table 1 are the probability estimates for each of the five TTI-consistent psychological factors, each parent's smoking, and each close friend's smoking for the prediction of the *first* smoking transition. As shown in rows one through four, the probabilities contributed by scoring above the median on various psychological factors to the overall prediction that an adolescent would make the first smoking transition were the following: 22% for parent-noncompliance, 26% for friend-compliance, 22% for rebelliousness, and 27% for thrill-seeking. Furthermore, as shown in row five, there was a 27% probability contributed by scoring below the median on achievement motivation. In contrast, rows six and seven show that there was a 7% and 13% probability, respectively, contributed by each parent's and close friend's smoking.

Comparing the magnitude of these probabilities is informative. The probabilities of trying smoking contributed by these psychological factors were greater than the probability contributed by each parent's smoking. Note that all the confidence intervals for the probability estimates of all of the psychological factors were greater than the entire confidence interval for the probability estimate of each parent's smoking. Moreover, with the exception of rebelliousness and parent-noncompliance, the confidence intervals for the probability estimates of all of the psychological factors were greater than the entire confidence interval for *two* parents' smoking. Note that the probability estimate for *two* parents smoking was .14, or, [1– (1–.07) · (1–.07)], with a lower bound confidence interval of .06, or, [1– (1–.03) · (1–.03)], and an upper bound confidence interval of .21, or, [1– (1–.11) · (1–.11)]. Similarly, with the exception of parent-noncompliance, the probabilities of trying smoking contributed by these psychological factors were greater than the probability contributed by each close friend's smoking. Again, all the confidence intervals for the probability estimates of the psychological factors (except parent-noncompliance) were greater than the entire confidence interval for the probability estimate of *each* close friend's smoking. The confidence intervals of the probability estimates for each of the psychological factors overlapped with the confidence interval for *two* close friends' smoking.

Probabilities of the second smoking transition (first cigarette to monthly smoking)

Reported in the Transition 2 column of Table 1 are the results for the second smoking transition. As shown in rows one through four, the probabilities contributed by scoring above the median on various psychological factors to the overall probability that an adolescent would make the second smoking transition were the following: 10% for parent-noncompliance, 12% for friend-compliance, 12% for rebelliousness, and 10% for thrill-seeking. Furthermore, as shown in row five, there was a 13% probability contributed by scoring below the median on achievement motivation. In contrast, rows six and seven show that, there was a nonsignificant (confidence intervals include zero) probability contributed by each parent's and close friend's smoking.

For predicting the second transition, the probabilities contributed by the five psychological factors were *not different than* the probability contributed by *each parent's* smoking, as all the confidence intervals for the five psychological factors overlapped with the confidence interval for each parent's smoking. In contrast, the probabilities contributed by the five psychological factors were *greater* than the probability contributed by *each close friend's* smoking, as the confidence intervals for all of the psychological factors were greater than the entire confidence interval for each close friend's smoking.

Probabilities of the third smoking transition (monthly to daily smoking)

Reported in the Transition 3 column of Table 1 are the probability estimates for the *third* smoking transition. As shown in rows one through four, the probabilities contributed by scoring above the median on the psychological factors to the overall probability that an adolescent would make the third smoking transition were the following: non-significant for parent-noncompliance, 11% for friend-compliance, 14% for rebelliousness, and non-significant for thrill-seeking. Furthermore, as shown in row seven, there was a 16% probability contributed by scoring below the median on achievement motivation to the overall probability that an adolescent would make the third smoking transition. In contrast, there was a 19% and 7% probability, respectively, contributed by each parent's and close friend's smoking. The probabilities contributed by the five psychological factors in predicting the third transition were *not different from* the probability contributed by each parent's and close friend's smoking (confidence intervals overlapped).

We also found no evidence that any of the probabilities reported in Table 1 significantly differed between the control and intervention groups ($p > .05$). Thus, there was no evidence that the HSPP experimental intervention had any influence on the results of this study.

Interaction between parents' smoking and TTI-consistent psychological factors for all three smoking transitions

Among the 15 tests conducted to determine whether each of the five TTI-consistent psychological factors moderated the probability of making a smoking transition as contributed by each parent's smoking, one interaction was significant. Specifically, there was a significant interaction between parents' smoking and parent noncompliance for the first transition ($p < .05$). This interaction is illustrated in Figure 1 as a probability function for the probability that the adolescent would escalate to the first cigarette given the number of parents who smoke broken down by parent-noncompliant (i.e., at or above the median) and parent-compliant (i.e., below the median) adolescents. As can be seen, there was a 45% probability contributed by parent-noncompliance to the overall probability that an adolescent would try smoking, across all levels of parent smoking. In contrast, the probability contributed by parent-compliance increased as the number of smoking parents increased. Specifically, the probability contributed by parent-compliance was 30% if no parents smoked, 37% if one parent smoked, and 43% if two parents smoked.

Interaction between friends' smoking and TTI-consistent psychological factors for all three smoking transitions

One interaction was significant among the 15 tests conducted to determine whether each of the five TTI-consistent psychological factors moderated the probability of making a smoking transition as contributed by each close friend's smoking. Specifically, there was a significant interaction between friend's smoking and friend-compliance for the first transition ($p < .001$). This interaction is illustrated in Figure 2 as a probability function for the overall probability that the adolescent would escalate to the first cigarette given the number of friends who smoke broken down by friend-compliant (i.e., at or above the median on friend-compliance) and friend-noncompliant (i.e., below the median on friend-compliance) adolescents. As Figure 2 illustrates, the probabilities that adolescents would try smoking increased as the number of close friends who smoked increased. But these probabilities were higher for adolescents who were friend-compliant than for adolescents who were friend-noncompliant. Specifically, for predicting trying smoking, the probability contributed by friend-noncompliance was 30% if no friends smoked, 34% if one friend smoked, 38% if two friends smoked, 42% if three friends smoked, and 46% if four or more friends smoked. In contrast, the probability contributed by friend-noncompliance was 44% if no friends smoked, 56% if one friend smoked, 66% if two friends smoked, 73% if three friends smoked, and 79% if four or more friends smoked. When

all of the analyses were rerun with the five psychological factors coded as continuous predictors, the above pattern of results was the same.

Discussion

Summary and interpretation of Hypothesis 1

Hypothesis 1 stated that adolescents scoring higher on the psychological risk factors would have a higher probability of making each of the smoking transitions. The results consistently supported this hypothesis across all three smoking transitions, with a 22–27%, 10–13%, and 11–16%, respectively, contributed by scoring high on these psychological risk factors to the overall probability that an adolescent would try smoking, transition to monthly smoking, and transition to daily smoking. The results for the transition to trying smoking were quite strong. For example, there was a 27% probability contributed by scoring above the median on friend-compliance to the overall probability that an adolescent would try smoking between 9th and 12th grade. These results are consistent with TTI (Flay et al., 1999).

These results extend prior empirical research (Flay et al., 1998; Santi et al., 1994) by (1) providing evidence for the influence of a wider array of psychological factors, (2) reporting specific absolute probabilities of influence, and (3) examining higher-level smoking transitions (i.e., monthly to daily).

Summary and interpretation of Hypothesis 2

Hypothesis 2.1 stated that the distal-level psychological risk factors (i.e., parent non-compliance, friend-compliance, low achievement motivation, and rebelliousness) and the distal-level social environment factors of each parent's and close friend's smoking would have similar magnitudes of influence on each of the smoking transitions. In contrast, Hypothesis 2.2 stated that the ultimate-level psychological risk factor (i.e., thrill seeking) would have a smaller magnitude of influence on smoking transitions than the distal-level social environment factors of each parent's and close friend's smoking. This test was the first known empirical comparison of the influence of these psychological factors versus parents' and close friends' smoking on adolescent smoking transitions. This hypothesis was partially supported. Specifically, the probabilities contributed by the four distal-level psychological factors and the one ultimate-level psychological factor to overall probability of trying smoking were greater than the probabilities contributed by each parent's and each close friend's smoking. Moreover, with the exception of rebelliousness and parent-noncompliance, the probabilities contributed by these psychological factors were also greater than the probability contributed by *two* parents' smoking for the first transition. The probabilities contributed by these psychological factors were also greater than that of each close friend's smoking for the second transition, but there was no evidence they were different than each parent's and close friend's smoking for the third transition (confidence intervals overlapped). Overall, these results suggest that the magnitude of the influence of each of these psychological and social factors may depend on the specific smoking transition being examined.

Summary and interpretation of Hypothesis 3

Hypothesis 3 stated that the influence of each parent's and close friend's smoking on each of the smoking transitions would be stronger among adolescents scoring higher on the psychological risk factors than among adolescents scoring lower on these risk factors. Overall, the results for this hypothesis were consistent with TTI: parent-noncompliance and friend-compliance interact with parents' and friends' smoking behavior in the prediction of adolescent smoking transitions. The results build on TTI by suggesting that the directions of these interactions differ between parent-compliant and friend-compliant adolescents. Specifically, for *parents'* smoking, the only significant interaction was between each parent's smoking and

parent-noncompliance for the first transition ($p < .05$). For trying smoking, the probability contributed by parent-compliance increased as the number of smoking parents increased whereas the probability contributed by parent-noncompliance was 45% across all levels of parent smoking. These results suggest that for the majority of adolescents, parent-compliance is *protective* of trying smoking. But in a household where parents smoke, parent-compliance is a *risk factor* for smoking that increases as the number of parents smoking increases. These findings suggest that parent-compliant adolescents, as compared to parent-noncompliant adolescents, are more likely to model their parents' smoking. In contrast parent-*noncompliance* appears to be a powerful independent influence on trying smoking.

Regarding moderation of *friends'* smoking, the only significant interaction was between each friend's smoking and friend-compliance for the first transition ($p < .001$). The overall probabilities that adolescents would try smoking increased as the number of close friends who smoked increased. But these probabilities were markedly higher for adolescents who were friend-compliant than for adolescents who were friend-noncompliant. Friend-compliant adolescents may be more likely to model their close friends' smoking. The synergistic effect of being friend-compliant and having close friends who smoke is tremendously powerful. Indeed, adolescents had a 79% overall probability of trying smoking if they were friend-compliant and had four or more close friends who smoked. In contrast, noncompliance with one's friends might serve as an important buffer on the influence of close friends' smoking.

Preventive implications

The results for the influence of the five TTI-consistent psychological factors on the transition to trying smoking suggest that preventive interventions could identify adolescents scoring high on these factors and teach them skills for regulating their behavior. The fact that such adolescents could be identified with a small number of psychological survey items is a major practical advantage for preventive interventions. For the interaction of parent smoking with parent-compliance, if the parent-compliant adolescents are modeling parent smoking then perhaps these adolescents would model parent smoking cessation. Since parent smoking cessation may prevent adolescents from smoking (e.g., Bricker et al., 2003), then a parent smoking cessation intervention might especially help prevent parent-compliant adolescents from smoking. In contrast, for parent-noncompliant adolescents, a parenting training intervention might help these adolescents become more parent-compliant. Finally, for the interaction of close friends' smoking with friend-compliance, the results suggest that teaching friend-compliant adolescents skills for making decisions more independently of friends might be valuable.

Limitations that can be addressed in future research

First, although this study represents the general population of Washington residents, it did not include a large percentage of non-Caucasian racial groups. Second, the psychological factors were measured with only a few items per trait, thereby contributing to their modest reliability. (To survey this large number of adolescents 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, data did not allow analysis of the timing of transitions—i.e., whether some predictors were risk factors for more rapid versus more slow smoking transitions. Fourth, since data on the total of close friends were not available it would be valuable in future research to examine the influence of the percentage of friends who smoke. Finally, given that only two among the 30 interactions tested were significant, there could be a multiple comparison Type I error problem. Since this is the first study to ever test these specific interactions, the results need replication in future research.

Conclusions

The key results of the study were that (1) TTI-consistent psychological factors were major predictors of adolescent smoking transitions, with a 22–27% probability contributed by scoring high on each of these psychological risk factors to the overall probability that an adolescent would try smoking; (2) For predicting trying smoking, the probability contributed by these psychological factors was greater than the probability contributed by each parent's and close friend's smoking; (3) Parent-compliance had a higher contribution to the probability of trying smoking when an adolescent's parent smoked ($p < .05$), while friend-compliance had a higher contribution to the probability of trying smoking when an adolescent's friend smoked ($p<.001$).

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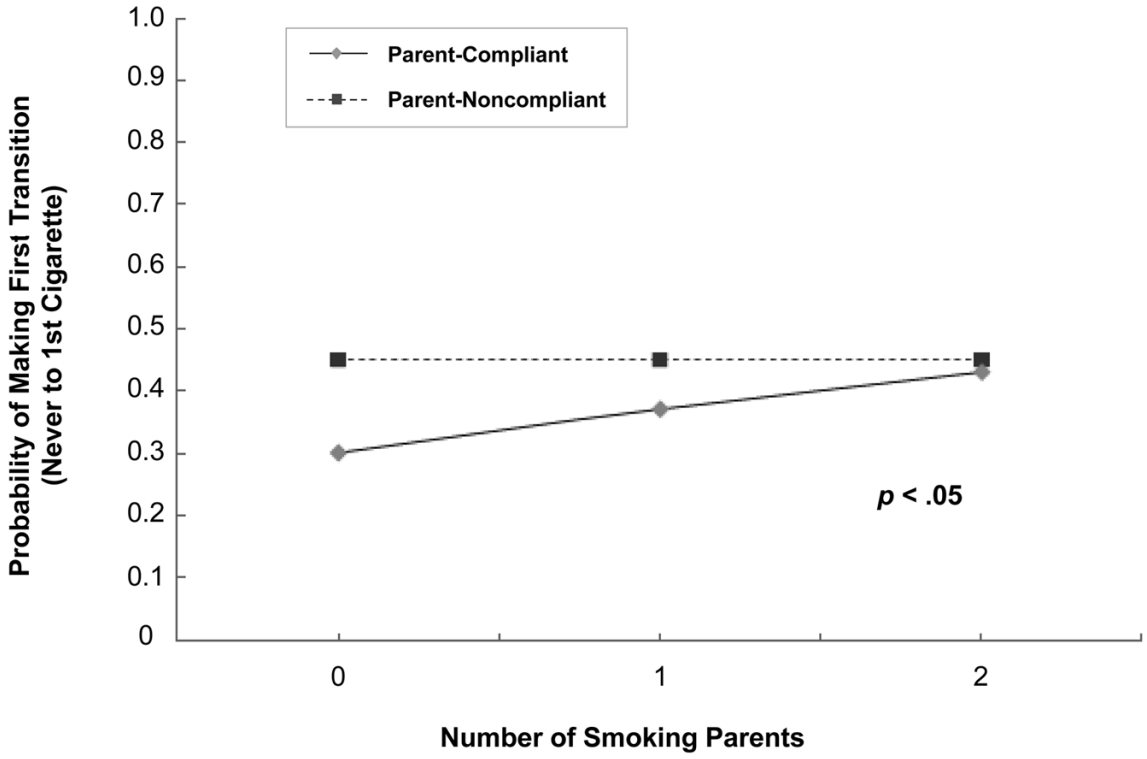

Figure 1.
Probability of making first smoking transition (never to first cigarette) given the number of smoking parents, broken down by whether adolescents were parent-compliant or parent-noncompliant.

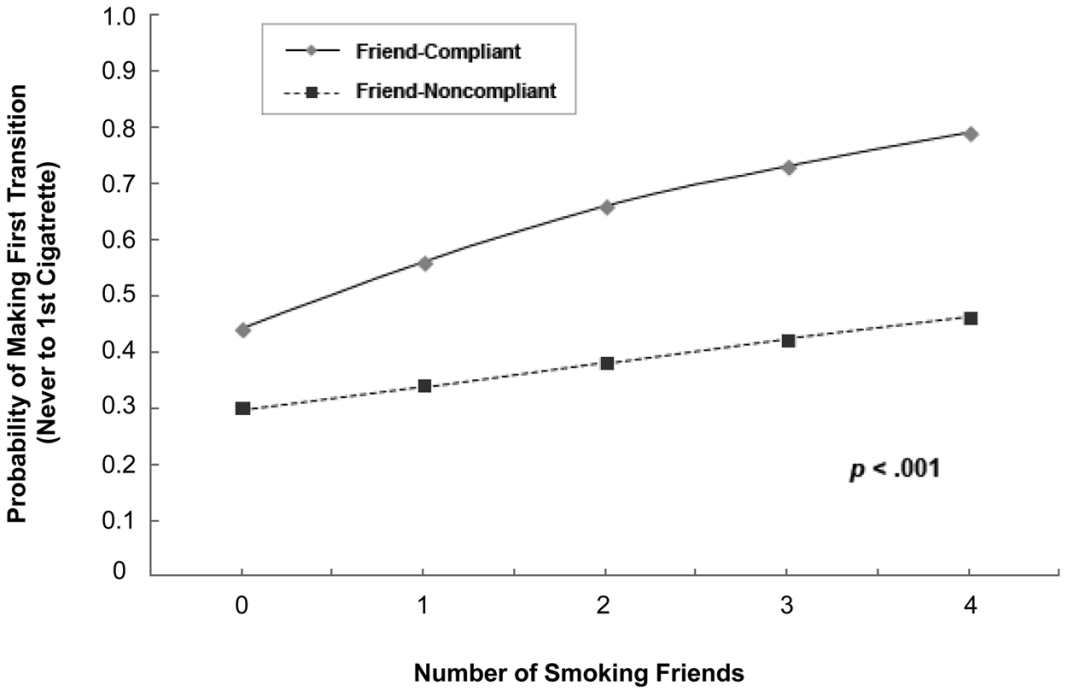

Figure 2.
Probability of making first smoking transition (never to first cigarette) given the number of smoking friends, broken down by whether adolescents were friend-compliant or friend-noncompliant.

Table 1

Probabilities of making smoking transitions given each psychological factor, each parent's smoking, and each close friend's smoking.

Source of Influence	Transition 1 Prob. of Influence (95% CI)	Transition 2 Prob. of Influence (95% CI)	Transition 3 Prob. of Influence (95% CI)
Psychological Factor			
Parent-noncompliance [a]	0.22 (0.14, 0.30)	0.10 (0.03, 0.17)	0.10 (−0.07, 0.22)
Friend-compliance [a]	0.26 (0.22, 0.30)	0.12 (0.06, 0.18)	0.11 (0.00, 0.21)
Rebelliousness [a]	0.22 (0.16, 0.28)	0.12 (0.05, 0.19)	0.14 (0.04, 0.23)
Thrill seeking [a]	0.27 (0.22, 0.32)	0.10 (0.05, 0.14)	0.07 (−0.05, 0.17)
Achievement motivation [b]	0.27 (0.20, 0.35)	0.13 (0.05, 0.22)	0.16 (0.03, 0.31)
Social Environment			
Parent's smoking [c]	0.07 (0.03, 0.11)	0.05 (−0.01, 0.10)	0.19 (0.10, 0.27)
Friend's smoking [d]	0.13 (0.10, 0.16)	0.01 (−0.01, 0.03)	0.07 (0.03, 0.11)

[a] The reported probabilities are for scoring *above* the median on the given *psychological factor*.

[b] The reported probabilities are for scoring *below* the median on the given *psychological factor*.

[c] The reported probabilities are for *each* smoking parent.

[d] The reported probabilities are for *each* smoking close friend.