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Predicting Adolescent Perceptions of the Risks and Benefits of Cigarette Smoking: A Longitudinal Investigation

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Abstract

Objective—To evaluate developmental changes, personal smoking experiences, and vicarious smoking experiences as predictors of adolescents' perceptions of the risks and benefits of cigarette smoking over time, in order to identify new and effective targets for youth smoking prevention programs.

Design—395 adolescents were surveyed every six months for two school years, from the beginning of 9th grade to the end of 10th grade.

Main Outcome Measures—Time, participant smoking, friend smoking, parental smoking, and sex were evaluated as predictors of smoking-related short-term risk perceptions, long-term risk perceptions, and benefits perceptions using multilevel modeling techniques.

Results—Perceptions of benefits did not change over time. Perceptions of risk decreased with time, but not after sex and parental smoking were included in the model. Adolescents with personal smoking experience reported decreasing perceptions of risk and increasing perceptions of benefits over time. Adolescents with more than 6 friends who smoked also reported increasing perceptions of benefits over time.

Conclusions—Changes in risk perceptions may not purely be the result of developmental processes, but may also be influenced by personal and vicarious experience with smoking. Findings highlight the importance of identifying and targeting modifiable factors that may influence perceptions.

Keywords

Adolescent; Risk Perception; Cigarette Smoking; Decision-Making

Cigarette smoking is the leading preventable cause of death in the United States, and is responsible for more than 440,000 deaths per year (Centers for Disease Control and

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Prevention [CDC], 2002, 2009a, 2009b). Despite a marked decrease in the prevalence rate of smoking in recent decades, approximately 20% of the U.S. population still smokes (CDC, 2008). Studies show that between 60% and 80% of all smokers begin to smoke in adolescence. Of the one million people who progress to daily cigarette smoking every year, 44% are under 18 years of age (Substance Abuse and Mental Health Services Administration [SAMHSA], 2007). Each day, more than 4,000 adolescents between the ages of 12 and 17 try their first cigarette; approximately 1/3rd of these youth eventually become daily smokers (SAMHSA, 2007). Therefore, it is vitally important to identify which factors place adolescents at increased risk for smoking initiation.

Evidence suggests that one of the most proximal influences on adolescent smoking behavior may be their perceptions of the risks and benefits of smoking (Gerrard, Gibbons, Benthin, & Hessling, 1996; Halpern-Felsher, Biehl, Kropp, & Rubenstein, 2004; Halpern-Felsher, Ramos, & Cornell, 2007; Krosnick, Chang, Sherman, Chassin, & Presson, 2006; Rodriguez, Romer, & Audrain-McGovern, 2007; Romer & Jamieson, 2001; Song et al., 2009). This is consistent with theories of health behavior, such as the Theory of Planned Behavior (Ajzen, 1991), the Health Belief Model (Rosenstock, Strecher, & Becker, 1988), and models based in Social Cognitive Theory (Bandura, 1977), which state that beliefs about the consequences of a given behavior will predict whether or not an individual engages in that behavior (Brandon & Baker, 1991; Brandon, Juliano, & Copeland, 1999; Copeland & Carney, 2003; Leventhal & Schmitz, 2006). Several cross-sectional studies have indicated that perceptions of the risks and benefits of smoking are associated with cigarette smoking in adolescents (Halpern-Felsher et al., 2004; Halpern-Felsher et al., 2007; Romer & Jamieson, 2001). Specifically, adolescents who smoke report lower perceptions of risk, including lower estimates of lung cancer, mortality risk, and getting into trouble, as well as higher perceptions of benefits than adolescents who do not smoke. Results from longitudinal studies of adolescent smoking behavior also suggest that smoking-related perceptions predict smoking. These longitudinal studies show that adolescents who report greater perceived risk of short- and long-term health problems, personal harm, and immediate general harm are less likely to smoke or start smoking than adolescents who report less perceived risk (Krosnick et al., 2006; Rodriguez et al., 2007; Song et al., 2009). Similarly, adolescents who perceive greater smoking-related benefits are more likely to start smoking than those who perceive fewer benefits (Song et al., 2009). Given that perceptions of risks and benefits may increase the chance of adolescent smoking initiation by between two to four times (Song et al., 2009), it is important that we understand which factors may influence the development of and changes in these perceptions, with the ultimate goal of identifying factors that may be useful targets for anti-smoking intervention programs.

There are a number of factors that may impact adolescents' perceptions of smoking-related risks and benefits. These factors can be products of developmental processes and those related to adolescents' personal or vicarious experiences with smoking behavior. At a developmental level, adolescents' perceptions are expected to change over time as a result of maturation that influences their decision-making abilities. According to theories of adolescent development, such changes may be the product of neurobiological maturation (Casey, Getz, & Galvan, 2008; Steinberg, 2008), refinements in cognitive processing abilities (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008; Yurgelun-Todd, 2007), improvements in the capacity for abstract reasoning (Piaget, 1972), or increases in "gist-based" or heuristic reasoning (Reyna & Farley, 2006), to name a few. Evidence from existing research on a variety of risky behaviors, including smoking, suggests that perceptions of risk tend to decrease and perceptions of benefits tend to increase as adolescents age (Millstein & Halpern-Felsher, 2002a, 2002b). These studies are cross-sectional, which makes it difficult to separate developmental trajectories from cohort effects, or from the effects of personal and vicarious experience with a given risk behavior. One

study to date has investigated whether perceptions of the risks and benefits of smoking change over time during adolescence (Song et al., 2009). Results indicated that perceptions do not change over time; however, this study only evaluated change across two time points (Song et al., 2009).

In addition to developmental changes, studies have not yet identified experiential factors that may affect adolescents' perceptions of both smoking-related risks and benefits. Such factors, if modifiable, may provide important intervention targets for early smoking prevention programs. Social cognitive models of behavior posit that observational learning, or learning by observing the behavior of others and its consequences, is an important predictor of the development of the positive and negative outcome expectancies (or perceptions) that are associated with a given behavior (Bandura, 1977). Consistent with theories of observational learning, parental and peer smoking are predictors of adolescent smoking behavior: adolescents whose parents and friends smoke are more likely to smoke themselves (Avenevoli & Merikangas, 2003; Institute of Medicine [IOM], 2007; Kobus, 2003; Mayhew, Flay, & Mott, 2000; O'Loughlin, Karp, Koulis, Paradis, & DiFranza, 2009; Otten, Engels, van de Ven, & Bricker, 2007; Wilson, McClish, Heckman, Obando, & Dahman, 2007). Only one study to date has longitudinally tested the influence of peer and parental smoking on adolescents' perceptions of smoking-related risks. Rodriguez et al. (2007) examined beliefs about the personal and general immediate harms of smoking in 11th grade as mediators of the relationship between peer and household smoking in 10th grade, and smoking behavior one year after high school. Exposure to peer and household smoking predicted lower perceptions of personal and immediate general harm in 11th grade. These results lend further support to the hypothesis that vicarious smoking experiences impact smoking-related risk perceptions. However, no study has prospectively examined how adolescents' vicarious smoking experiences may predict changes in the perceived benefits of smoking over time, even though perceptions of benefits are important in predicting later smoking behavior (Song et al., 2009).

Personal behavioral experience with a risk behavior and its associated positive or negative consequences is also hypothesized to affect an adolescent's perceptions of the risks and benefits that are associated with that behavior (Gerrard et al., 1996; Goldberg et al., 2002; Halpern-Felsher et al., 2001). A small number of cross-sectional studies show that people who voluntarily choose to engage in a risky behavior tend to hold lower perceptions of risk than people who do not engage in the behavior, and adolescents who participate in risky behavior report that the benefits associated with the behavior are more likely (Millstein & Halpern-Felsher, 2002b). However, there has been little longitudinal research to determine whether personal experience with smoking may alter adolescents' perceptions of the risks and benefits of smoking. One study showed that youth experience with drinking alcohol predicts lower perceptions of risk and higher perceptions of benefit associated with drinking alcohol and smoking cigarettes six months later (Goldberg, Halpern-Felsher, & Millstein, 2002), but the effects of smoking behavior on subsequent smoking-related risk perceptions were not tested. Findings from another study indicated that smoking in 10th grade is linked to lower perceptions of personal and immediate general harm in 11th grade (Rodriguez et al., 2007), but neither perceptions of benefits nor a comprehensive list of specific smoking-related risks was included in the study. Only one study has longitudinally examined whether personal experience with smoking cigarettes has an impact on perceptions of both risks *and* benefits (Song et al., 2009). Song and colleagues compared the smoking-related perceptions of risks and benefits of adolescents who started smoking during the study to the perceptions of adolescents who did not start smoking during the study, and found that smoking status did not influence perceptions. Unfortunately, it is difficult to explain the possible effects of personal smoking on more long-term changes in perceptions, because the authors tested their hypotheses using only two points in time. It is still unclear whether personal and vicarious

experiences with cigarette smoking predict changes in adolescents' perceptions of the risks and benefits of smoking, and whether these experiences have an impact on perceptions above and beyond the effects of developmental changes.

The current study uses a longitudinal design to assess whether selected developmental and experiential factors may predict perceptions of smoking-related risks and benefits among 395 high school students. We measured adolescents' perceptions of the short-term risks, long-term risks, and benefits of smoking every six months for two school years, for a total of four waves of data. We included sex as an individual-level predictor because there is evidence to suggest that males report fewer health concerns than females, and perceive fewer risks and greater benefits associated with a variety of health-related risky behaviors (see Millstein & Halpern-Felsher, 2002b for a review). We assessed parental smoking at baseline, but measured participant and friend smoking at every time point in the study. We used multilevel modeling to predict changes in perceptions from friend and participant smoking across time (time-varying predictors at Level 1), and from participant sex and parental smoking history at baseline (time-invariant predictors at Level 2). We hypothesized that (1) reflecting developmental processes, perceptions of short- and long-term risks would decrease and perceptions of benefits would increase with time, regardless of the presence of other predictors; (2) compared to adolescents with non-smoking parents, those adolescents with parents who had ever smoked would report lower perceptions of risk and higher perceptions of benefits at baseline, as well as a steeper decrease in perceptions of risk and a steeper increase in perceptions of benefits over time, reflecting observational learning; (3) adolescents who had friends who smoked would exhibit a steeper decrease in perceptions of risk and a steeper increase in perceptions of benefits over time than adolescents with non-smoking friends, reflecting observational learning; (4) adolescents who had tried smoking would show a decrease in risk perceptions and an increase in perceptions of benefits over time, compared to adolescents who had not tried smoking; and (5) male sex would be associated with lower perceptions of risk and higher perceptions of benefits at baseline.

Method

Participants

Participants included 395 adolescents (53.2% female), with a mean age of 14 years at baseline ($SD = 0.4$ years). The sample was 52.0% Caucasian/Non-Hispanic, 24.2% Asian/Pacific Islander, 18.5% Hispanic or Latino, 1.9% African American, and 3.4% Other. At baseline, 25.6% of participants reported having ever tried smoking a cigarette. At baseline, 69.3% of adolescents reported having at least one parent who had ever smoked. Participant smoking was distributed evenly by sex across all survey time points, $\chi^2(1, N = 332 - 393) = 0.1 - 1.6, ps > .20$.

Materials

Demographics—Participants reported their age, sex, ethnicity, and highest level of education completed by their mother.

Smoking behavior—Participants were asked if they had “ever tried smoking a cigarette, even one puff.” Responses were coded dichotomously (0 = no, 1 = yes). Participants also reported whether either of their parents had ever smoked (0 = no, 1 = yes) and how many of their friends currently smoked (1 = none, 2 = 1 friend, 3 = 2 – 5 friends, 4 = 6 – 10 friends, 5 = more than 10 friends). Participants reported their own smoking status and their friends' smoking status at all four survey time points. Parents' smoking behavior was reported at baseline.

Perceptions of smoking-related risks and benefits—Participants estimated the likelihood of 15 smoking-related risks and benefits using conditional risk assessments, in which scenarios were used to explicitly place the outcomes under investigation in the context of a specific behavior. Participants were instructed to imagine two separate smoking scenarios. The first scenario evaluated short-term risks and benefits: “Imagine that you just began smoking. You smoke about 2 or 3 cigarettes each day. Sometimes you smoke alone, and sometimes you smoke with friends. If you smoke about 2 or 3 cigarettes each day, what is the chance that...?” The second scenario evaluated long-term risks: “Imagine that you continued to smoke about 2 or 3 cigarettes each day for the rest of your life. What is the chance that...?” Previous research shows that conditional risk assessments more closely reflect health risk behavior models and are stronger predictors of behavior than unconditional risk assessments, which do not place outcomes in a precise behavioral context (Halpern-Felsher et al, 2001; Ronis, 1992; van der Velde, Hooykaas, & van der Pligt, 1996). After reading the scenarios, participants indicated the likelihood that each outcome would occur, by filling in the blank with any number between 0% and 100%. This percentage chance scale is preferred over other likelihood scales such as log linear scales or lexical scales, as adolescents provide more reliable assessments using this method (Biehl & Halpern-Felsher, 2001).

Principal components analyses have shown that the smoking-related risks and benefits measured here can be divided into three components (Song et al., 2009): short-term risks (get into trouble, smell like an ashtray, get a bad cough, have trouble catching breath, get colds, and have bad breath), long-term risks (lung cancer, cough, trouble catching breath, heart attack, and wrinkles), and benefits (look cool, feel relaxed, be more popular, and look more grown up). These findings are consistent with other research, which shows that perceptions of risks and benefits can be categorized into short-term risks, long-term risks, and benefits (Guilamo-Ramos et al., 2007). Principal components analyses also showed that these three components remained stable across the two school years of the current study. Therefore, we created separate likelihood scores for perceptions of short-term risks, long-term risks, and benefits by averaging the likelihood scores of all the items within each component. We measured perceptions of risks and benefits for every participant at each of the four study time points.

Procedure

Participants were recruited from ninth-grade classrooms in two public high schools (School A and School B) one year apart. Researchers went to each classroom, explained the study, invited students to participate, and provided students with study information and a parental consent form to take home. Those students who signed an adolescent assent form and whose parents signed the parental consent form were eligible to participate in the study. Consent packets were given to 790 students (302 in School A and 488 in School B), of which 418 (53%) returned completed consent forms. Of these 418 students, 395 (94.5%) completed the baseline survey. Out of the 395 students who completed the baseline survey, 363 (91.9%) completed the survey at Time 2, 352 (89.1%) completed the survey at Time 3, and 333 (85.6%) completed the survey at Time 4.

Participants completed surveys every six months from the beginning of ninth grade to the end of tenth grade. Researchers provided instructions and were available to answer questions during every survey administration. The survey consisted of a series of questions about beliefs, attitudes, and behaviors associated with various forms of tobacco use. All procedures were reviewed and approved by the University’s Institutional Review Board (for more details on study procedures, please see <citation omitted to permit blind review>).

Statistical Analyses

Multilevel modeling techniques were used to predict perceptions of smoking-related risks and benefits from the following predictor variables: time, sex, participant smoking, parental smoking, and friend smoking. We evaluated models predicting short-term risks, long-term risks, and benefits as three separate outcome variables. We predicted that the same final model would best fit the data for each dependent variable, but that the strength and direction of the relationships within the model would differ between risk and benefit perceptions. The hypothesized final model was specified as follows: Time, defined as age at each point of assessment, was included as the predictor of interest at Level 1 of the model. Participant and friend smoking were added as time-varying covariates at Level 1. Sex and parental smoking were included as fixed effects at Level 2 of the model. The Level 1/Level 2 equations for the final model are as follows, using Singer and Willett's (2003) notation:

$$\text{Level 1: } Y_{ij} = \Pi_{0i} + \Pi_{1i}\text{Time}_{ij} + \Pi_{2i}\text{ParticipantSmoke}_{ij} + \Pi_{3i}\text{FriendSmoke}_{ij} + \varepsilon_{ij}$$

$$\text{Level 2: } \gamma_{00} + \gamma_{01}\text{Sex} + \gamma_{02}\text{ParentSmoke} + \zeta_{0i}$$

$$\Pi_{1i} = \gamma_{10} + \gamma_{11}\text{Sex} + \gamma_{12}\text{ParentSmoke} + \zeta_{1i}$$

$$\Pi_{2i} = \gamma_{20}$$

$$\Pi_{3i} = \gamma_{30}$$

The hypothesized final model was compared to a series of alternative models using goodness-of-fit indices (e.g., Deviance statistic, AIC, BIC), pseudo- R^2 values (i.e., indicators of effect size), parameter estimates, and theory as guides. As recommended by Singer and Willett (2003), we first fit the Unconditional Means Model (UCMM) to the data, which postulates that a participant's perceptions of risks and benefits consists only of deviations around his or her mean perception and the population's mean perception. Next, we fitted the Unconditional Growth Model (UCGM), which postulates that a participant's perceptions are a function of his or her true change trajectory over time. We then tested a series of alternative models, all nested within the hypothesized final model described above. Finally, we tested the hypothesized final model, which included all time-varying covariates and fixed effects. We examined indicators of linearity, normality, and homoscedasticity for each model to confirm that the data met the assumptions of multilevel models.

Multilevel modeling of longitudinal data using predictors that vary over time often introduces the problem of reciprocal prediction (Singer & Willett, 2003). For example, if A and B are correlated, it can be difficult to determine whether A predicts B or B predicts A. One way to alleviate concerns about reciprocal prediction is to define variables in such a way that the predictor variable precedes the outcome variable in time (Singer & Willett, 2003). This means that, in the present study, participant and friend smoking should temporally precede perceptions of the short-term risk, long-term risk, and benefits of smoking. Therefore, we computed all models using participant and friend smoking at each time point to predict perceptions of risks and benefits at the subsequent time point.

Results

The pattern of study results did not differ between the two schools; therefore, results were collapsed across schools. Time was defined as age in years on the day of each assessment. We calculated age at assessment by subtracting each participant's date of birth from the date of each survey administration. Twelve participants were excluded from data analysis because they did not provide usable date of birth information, resulting in a final sample of 383 adolescents. In every case, the hypothesized final model fit the data better than the UCMM, UCGM, and alternative nested models. We report the results of the final model for each dependent variable here.

Perceptions of Short-term Risk

On average, adolescents believed that they had an 82.41% chance (95% CI: 77.30, 87.51) of experiencing short-term risks associated with smoking (Table 1). Overall, perceptions of short-term risk did not change significantly over time ($\beta = -1.57, p > .50$). However, perceptions of short-term risk declined by an average of 10.41 percentage points every six months among adolescents who had ever tried smoking when compared to adolescents who had never tried smoking ($p < .001$), by an average of 5.54 percentage points every six months among adolescents who had from 6 to 10 friends who smoked ($p < .05$), and by an average of 6.02 percentage points every six months among adolescents who had more than 10 friends who smoked ($p < .05$) when compared to adolescents who did not have any friends who smoked. Neither sex nor parental smoking significantly predicted the rate of change of short-term risk perceptions ($p > .10$ and $p > .60$, respectively). Similarly, sex and parental smoking history did not significantly predict level of risk perception at baseline ($p > .90$ and $p > .70$, respectively). The final model accounted for 16.70% of the within-person variance and 11.09% of the total variance in short-term risk perceptions. (Level 2 effect sizes are not reported for any of our final models because they are no longer meaningful when time-varying predictors are included in the model; Singer & Willett, 2003.)

Perceptions of Long-term Risk

Participants believed that, on average, they had an 85.81% (95% CI: 81.01, 90.62) chance of experiencing long-term risks associated with smoking (Table 1). As with short-term risks, overall perceptions of long-term risk did not change significantly over time ($\beta = -2.87, p > .20$). Neither sex, parental smoking, nor friend smoking predicted rate of change in long-term risk perceptions ($p > .08, p > .70$, and $p > .20$, respectively). However, long-term risk perceptions among adolescents who had ever tried a cigarette decreased by 7.81 percentage points every six months, on average. Neither sex nor parental smoking significantly predicted baseline levels of long-term risk perceptions ($p > .70$ and $p > .50$, respectively). The final model explained 18.26% of the within-person variability and 7.45% of the total variability in long-term risk perceptions.

Perceptions of Benefits

On average, participants believed that they had a 21.12% (95% CI: 15.47, 26.78) chance of experiencing benefits related to cigarette smoking (Table 1). Aggregate level benefits perceptions did not change over time ($\beta = -2.45, p > .10$). Neither sex, parental smoking, nor friend smoking predicted the rate of change in benefits perceptions ($p > .50, p > .60$, and $p > .20$, respectively). Among adolescents who had ever tried a cigarette, perceptions of benefits increased by an average of 6.19 percentage points every six months ($p < .01$). On average, males' perceptions of smoking-related benefits were 6.10 percentage points higher than females at baseline ($p < .05$). Initial perceptions of benefits were not significantly predicted by parental smoking ($p > .80$). The final model accounted for 27.42% of the

within-person variance and 3.53% of the total variance in perceptions of smoking-related benefits.

Model Comparisons

It is important to note that short-term risk perceptions did initially decrease significantly over time as hypothesized, but that this effect disappeared when sex and parental smoking were included in the model. Similarly, perceptions of long-term risk significantly decreased over time until all variables were included in the final model. Perceptions of benefits never changed over time. The fit of the final model was superior to all alternative models for each of the dependent variables, as demonstrated by (1) significant reductions in the Deviance Statistic, AIC, and BIC (Table 2); and (2) improvements in the amount of variance explained by the final model, as shown by increases in pseudo- R^2 values (amount of total and within-person variance explained in Table 1).

Discussion

The current study examined development, vicarious experience, and personal experience with cigarette smoking as potential predictors of adolescents' perceptions of the risks and benefits of smoking. This study improved upon prior research by including perceptions of benefits in addition to perceived risks, using a more comprehensive list of specific types of risks and benefits, and assessing experiences and perceptions more frequently over time than in previous studies. As hypothesized, our results showed that perceptions of short- and long-term risk decreased over time (Hypothesis 1). However, changes in short-term risk perceptions were no longer significant when sex and parental smoking were included as between-subjects fixed effects in the multilevel model, and changes in long-term risk perceptions were no longer significant when all variables were included in the final model. Perceptions of smoking-related benefits remained stable across time. These findings suggest that changes in risk perceptions may not purely be the result of developmental phenomena, but may be accounted for in part by individual and experiential factors.

We examined two primary sources of vicarious smoking experience as predictors of smoking-related perceptions: parental smoking history and number of friends who smoke. Contrary to Hypothesis 2, parental smoking did not predict baseline levels of risk and benefit perceptions, nor was it a significant individual predictor of changes in perceptions over time. The absence of any such effect is contrary to the link between parental smoking and youth smoking seen in the literature (Conrad et al., 1992; Otten et al., 2007; Wilson et al., 2007). One possible explanation is that we focused on predicting perceptions rather than behavior, and perhaps parental smoking is best conceptualized as a direct predictor of adolescent smoking behavior. This explanation is consistent with Social Cognitive Theory in that observational learning predicts behavior, but it ignores the roles of proposed intermediate components of rational decision-making and dual-process models, such as attitudes about smoking and intentions to smoke. Another possible explanation is that our measurement of parental smoking was not adequate. We asked adolescents to report whether or not their biological father or mother had ever smoked. Adolescents may not have recalled this information accurately, which argues for parental report in future studies. It may also be useful to ask adolescents to identify any household members who smoke, because this question format may improve adolescents' ability to report parental smoking, as well as identify other people who may influence their perceptions of smoking. Furthermore, it may be that the effects of parental smoking depend upon the sex of the parent, the extent of parental contact with the child, and single parent status. It is also possible that parent smoking may influence adolescent smoking through its effect on adolescents' perceptions of social norms rather than risks and benefits. Adolescents whose parents smoke may perceive

smoking to be normal, acceptable, and desirable, particularly if they have not witnessed their parents experiencing negative consequences of smoking.

Our hypothesis that friend smoking would predict perceptions of smoking-related risks and benefits was partially supported (Hypothesis 3). When compared to adolescents who had no friends who smoked, adolescents who reported having more than six friends who smoked reported significant decreases in perceptions of short-term risk over time. The negative short-term consequences of smoking that we assessed (getting into trouble, smelling like an ashtray, getting a bad cough, having trouble catching breath, getting colds, and having bad breath) typically have low base rates, especially if adolescents have not started smoking heavily yet. If adolescents do not observe their peers suffering aversive consequences from smoking, then their perceptions of the short-term risks of smoking may decrease (Gerrard et al., 1996; Goldberg et al., 2002; Halpern-Felsher, et al., 2001; Weinstein, 1989). In contrast, friend smoking did not significantly predict the trajectory of long-term risk perceptions over time. Adolescents may have a poor grasp of the cumulative risks of smoking, which are minimal in the short term but become cumulatively large with repeated exposure over a long period of time (Slovic, 2000). As a result, the long-term negative consequences of smoking may appear intangible enough to be unaffected by friends' smoking behavior. Friends' smoking did not significantly predict perceptions of the benefits of smoking either, perhaps because adolescents are not aware of the benefits their friends have experienced. In other words, while adolescents do report that they experience benefits associated with cigarette smoking (Brady, Song, & Halpern-Felsher, 2008), it is unknown whether they clearly communicate these benefits to their friends. Adolescents in the current study may have been reluctant to acknowledge the benefits of smoking to their friends, because they live in California where smoking has become negatively stigmatized.

We also tested the hypothesis that personal experience with smoking would predict smoking-related perceptions (Hypothesis 4; Halpern-Felsher et al., 2001). Consistent with this hypothesis, participants who reported having tried a cigarette showed a significant decrease in short- and long-term risk perceptions, as well as a significant increase in benefit perceptions, over time. This pattern of results suggests that personal smoking experiences during adolescence may predict changes in smoking-related perceptions, and that this effect may remain even after sex and parental smoking are taken into account. The observed changes in perceptions are likely to be conservative estimates, because we included adolescents who had only tried a cigarette once instead of focusing exclusively on adolescents who were heavier smokers. These findings indicate that even trying a cigarette once may lead an adolescent to believe that there are fewer risks and more benefits to smoking than they had previously thought. Participants may change their perceptions to resolve cognitive dissonance between their previous beliefs, which were more negative toward smoking, and the fact their experimentation with smoking is not consistent with these beliefs. When considered in light of the link among attitudes, intentions, and behavior that has been in previous studies (Ajzen, 1991), such findings may explain in part how even minor experimentation can progress to heavier smoking (Choi, Pierce, Gilpin, Farkas, & Berry, 1997; Paul, Blizzard, Patton, Dwyer, & Venn, 2008; Wakefield et al., 2004).

At the individual level, we investigated whether the sex of the adolescent predicts his or her risk perceptions (Hypothesis 5). As hypothesized, male adolescents reported higher levels of benefit perceptions than females at baseline, which corroborates findings from previous studies (Millstein & Halpern-Felsher, 2002b). However, males and females reported the same levels of short- and long-term risk perceptions at baseline and similar trajectories in risk perception over time. These results are inconsistent with research showing that males perceive fewer risks associated with risky behaviors (Millstein & Halpern-Felsher, 2002b). One explanation for this may be that gender differences in risk perception are domain-

specific. In the case of smoking, school prevention programs, messages from health care professionals, and tobacco control media campaigns regularly warn youth of the risks of cigarette smoking, but rarely confront the benefits. Males and females may be equally exposed and equally receptive to these risk messages, thus leading to similar perceptions of risk.

Limitations and Directions for Future Research

The current study has a number of methodological strengths, such as a longitudinal design with multiple points of assessment, an analytic strategy that reduces interpretational problems due to reciprocal prediction, the measurement of both risk and benefit perceptions, the inclusion of a more extensive list of specific risks and benefits, and a large sample size. However, a few limitations must be noted. First, our multilevel models accounted for a relatively small proportion of the within-person variation (16.70% - 24.42%) and total variation (3.53% - 11.09%) in adolescents' perceptions of the risks and benefits of smoking. Specification error, or error due to omitting a potentially important third variable that is related to both the predictor and outcome variables, is a common problem when modeling human behavior and may in part account for our relatively small effect sizes. Future studies should assess the impact of other variables that may influence adolescents' perceptions of the risks and benefits of smoking. Theory and empirical evidence suggest a number of likely candidates, such as ethnicity, personality factors, family structure, cognitive processing styles, marketing and other media exposure, and religious beliefs.

Second, our measures of personal and vicarious smoking experience may have lacked sensitivity and thus reduced our explanatory power by introducing "noise" in the data. It will be important to increase the sensitivity of these measures in the future (e.g., assessing the proportion of an adolescent's friends who smoke). More sensitive measures of smoking experience are also required if we are to determine whether there is a relationship between *amount* of smoking experience and changes in perceptions. Greater levels of exposure to smoking may be more strongly associated with decreases in risk perceptions and increases in benefit perceptions. Third, it should be noted that adolescents in this study reported high perceptions of risk (greater than 80% chance of risk occurring, on average). This level of overestimation is not uncommon among adolescents (Reyna & Farley, 2006). The important issue in the present study is studying factors that may predict these perceptions, rather than the accuracy of the perceptions themselves. Fourth, our results only speak to changes in perceptions in mid-adolescence. They cannot be generalized to the development of smoking-related perceptions in childhood, nor to changes in perceptions as adolescents become young adults. Given that 11% of smokers report that they first tried cigarettes after the age of 19, and that between 11% and 22% of non-smoking college students progress to occasional or daily smoking during the college years (Costa, Jessor, & Turbin, 2007; DeWit, Offord, & Wong, 1997; Everett, et al., 1999; Stockdale, Dawson-Owens, & Sagrestano, 2005; Wetter, et al., 2004), it is critical that we understand how perceptions of the risks and benefits of smoking solidify as young people mature and whether changes in perceptions can predict who is at risk to start smoking after high school.

Conclusions and Implications

The results of the present study suggest that changes in adolescents' perceptions of smoking-related risks and benefits may not be purely the result of developmental processes, but may also be influenced by personal and vicarious experience with smoking. These findings have important implications for theory and practice. At the theoretical level, they suggest that adding experiential components to existing developmental theories may improve our ability to explain and predict adolescents' perceptions of smoking-related risks and benefits, and

ultimately their smoking behavior. It may be possible to extend this theoretical framework to other risk behaviors, such as alcohol use, unsafe driving, and risky sexual activity.

Our findings also have practical relevance. Most youth-directed smoking interventions focus on educating adolescents about the dangers of smoking in an effort to prevent smoking by creating negative attitudes toward the behavior. However, our study suggests that there may be factors in addition to knowledge that predict adolescents' perceptions, both in terms of risks and benefits. Some of these factors may be modifiable, providing us with additional means to prevent adolescent smoking. Our results also show that even limited personal experience with smoking may make adolescents' perceptions more favorable toward smoking, suggesting that it may be beneficial to target prevention programs to children who are not likely to have started smoking yet.

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Table 1
Final multilevel models predicting perceived short-term risks, long-term risks, and benefits of smoking

	Variable	Parameter	Short-term Risks	Long-term Risks	Benefits
Fixed Effects	Initial Status/ Y-intercept (π_{0i})	γ_{00}	82.41*** (2.61)	85.81*** (2.45)	21.12*** (2.89)
	Sex	γ_{01}	- 0.18 (2.67)	- 0.63 (2.47)	6.10* (2.87)
	Parents smoke	γ_{02}	- 0.84 (2.81)	- 1.68 (2.63)	- 0.46 (3.07)
	Rate of Change/ Slope (π_{1i})	γ_{10}	- 1.57 (2.49)	- 2.87 (2.29)	- 2.45 (2.29)
	Sex	γ_{11}	- 4.25 (2.60)	- 3.90 ^m (2.26)	- 1.29 (2.25)
	Parents smoke	γ_{12}	1.21 (2.73)	- 0.63 (2.43)	1.64 (2.43)
	EverSmoke	γ_{20}	- 10.41*** (1.82)	- 7.81*** (1.73)	6.19** (1.82)
	FriendsSmoke (None)	γ_{30}	Ref	Ref	Ref
	FriendsSmoke (1)	γ_{30}	- 1.63 (1.73)	- 1.50 (1.70)	1.99 (1.68)
	FriendsSmoke (2-5)	γ_{30}	- 3.04 ^m (1.58)	- 1.20 (1.54)	- 1.21 (1.55)
	FriendsSmoke (6-10)	γ_{30}	- 5.54* (2.69)	- 0.95 (2.59)	2.76 (2.55)
	FriendsSmoke (> 10)	γ_{30}	- 6.02* (2.72)	- 2.90 (2.70)	- 2.74 (2.61)
	Within-person	σ^2_e	153.40*** (14.19)	183.89*** (14.68)	156.61*** (12.47)
Variance	Level 1				
	Level 2				
	In initial status/ y-intercept	σ^2_0	195.00* (47.46)	123.45* (43.47)	334.51*** (55.39)
	In rate of change/ slope	σ^2_1	56.58 (46.25)	33.27 (36.62)	64.52 (37.31)
	Covariance	σ_{01}	- 27.92 (42.11)	8.95 (36.24)	- 68.35 (41.21)
	Amount of total variance explained		0.1109	0.0745	0.0353
	Amount of within-person variance explained		0.1670	0.1826	0.2742

Note. Ref = the reference category for the FriendsSmoke variable.

Table 2

Differences in goodness-of-fit indices for the Unconditional Means Model (UCMM), Unconditional Growth Model (UCGM), and Final Model predicting short-term risk perceptions, long-term risk perceptions, and benefits perceptions

	Short-Term Risk Perceptions			Long-Term Risk Perceptions			Benefits Perceptions		
	UCMM	UCGM	Final	UCMM	UCGM	Final	UCMM	UCGM	Final
AIC	8037.15	7797.56	6592.00	9082.17	8831.42	7496.62	9311.30	8965.92	7617.50
Difference	--	239.59 ^a	1205.56 ^b	--	250.75	1334.8	--	345.38	1348.42
BIC	8051.64	7826.41	6662.73	9097.02	8860.99	7568.21	9226.19	8995.56	7689.23
Difference	--	225.23	1163.68	--	236.03	1292.78	--	230.63	1306.33
Deviance	8031.15	7785.56	6563.00	9076.17	8819.42	7466.62	9205.30	8953.92	7587.50
Difference	--	245.59	1222.56	--	256.75	1352.8	--	251.38	1366.42

Note. AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, Deviance = Deviance Statistic. All differences are significant. For the difference between the UCMM and the UCGM, χ^2 critical (3) = 9.35 at $\alpha = .05$. For the difference between the UCGM and the Final Model, χ^2 critical (9) = 19.02 at $\alpha = .05$.

^a UCMM - UCGM

^b UCGM - Final Model