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Peer beliefs and smoking in adolescence: A longitudinal social network analysis

Daniel T. Ragan

University of New Mexico, United States

Abstract

Background—Peer smoking is one of the strongest predictors of adolescent cigarette use, but less is known about whether other peer characteristics also contribute to this behavior.

Objectives—This study examines the links between adolescent cigarette use and peer beliefs about smoking. It tests whether peer beliefs about smoking are associated with changes in cigarette use, whether this association is a result of changes in individual beliefs about smoking, and how beliefs inform friendship choices.

Methods—Analyses draw on data collected from 29 school-based networks, each measured at five occasions as students moved from 6th through 9th grade, as part of the study of the PROSPER partnership model. Longitudinal social network models provide estimates of friendship selection and behavior for an average of 6,200 students at each measurement point and more than 9,000 students overall.

Results—Peer beliefs about smoking influence cigarette use both directly and through their impact on individual beliefs. Respondents tend to name friends whose beliefs about smoking are similar to their own, and the likelihood of being named as a friend is higher for those who report more positive beliefs about smoking.

Conclusion—The results from this study suggest that peer beliefs about smoking, in addition to peer cigarette use itself, are associated with adolescent smoking through several mechanisms. Because beliefs favorable to cigarette use are present before adolescents actually smoke, these results underscore the importance of implementing smoking prevention programs in early adolescence.

Keywords

Smoking; Peer influence; Beliefs; Social networks; Adolescence

Name and address: Daniel T. Ragan, Department of Sociology, University of New Mexico, 1915 Roma NE Ste. 1103, MSC05 3080, Albuquerque, NM 87131, dragan@unm.edu, 505-277-6469.

Declarations of interest

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Introduction

While peers are routinely recognized as a potential source of influence on smoking, research generally focuses on the behavior of these peers in influencing others. Other peer characteristics, however, may also contribute to smoking, and identifying these characteristics is important to understanding the etiology of smoking and developing effective prevention programs. This study examines how peer beliefs are connected to smoking in adolescence and argues that the link between peers and smoking extends beyond behavior.

Although cigarette use poses a health risk to all users, smoking among adolescents is an especially important concern. Most adults who smoke began using tobacco at a relatively young age. Among daily smokers, over 85% tried their first cigarette by age 18 and almost 65% began smoking regularly by that age (1). Consequently, considerable attention has been devoted to understanding the causes of adolescent smoking, as reducing it could, over time, have a meaningful impact on rates of smoking in the population.

Among the strongest predictors of adolescent smoking is peer cigarette use (2–5). But while the literature on the influence of peers traditionally focuses on their behavior, what these peers *think* also could contribute to cigarette use. Data from a nationally-representative sample of students in the 8th, 10th, and 12th grades, for instance, reveal that the proportion of those who did not disapprove of smoking was higher than the proportion who smoked cigarettes in the past 30 days (6). Adolescents therefore may face exposure to beliefs favorable to smoking prior to being exposed to cigarette use within their friendship groups, and this may provide an opportunity for these beliefs to influence smoking in early adolescence.

Results from several recent studies suggest that peer beliefs contribute to behaviors such as delinquency and alcohol use (7,8). Megens and Weerman, for example, reported that peer beliefs about whether delinquency is acceptable was a stronger predictor of respondents' delinquent behavior than peer delinquency itself (7). Further, the effect of peer beliefs was mediated by the measure of the respondents' *own* beliefs. Peer beliefs thus influenced behavior because they were associated with changes in individual beliefs, illustrating one reason why peer beliefs may matter.

The friendship selection process is another way beliefs may contribute to smoking, as it determines to whom adolescents are exposed. That is, friendship selection has implications for understanding how adolescents are influenced by their peers because it determines which peers have the opportunity to influence others. In one study, Ragan examined the links between alcohol use and two types of peer beliefs, moral approval of drinking and expectations for drinking, in both the peer influence and selection processes (8). That study found evidence of peer beliefs playing a role in the friendship selection process: adolescents tended to select friends who reported similar beliefs about drinking, and there was a preference for selecting friends who approved of drinking. Selecting friends who held beliefs more favorable to drinking thus increased exposure to alcohol use because those peers drank more. Furthermore, results indicated that peer beliefs influence alcohol use both

directly and indirectly through individual beliefs about drinking. The relationships between peers and deviant behaviors, however, may be different depending on the type of behavior (9), and the links between peer beliefs and smoking remain largely unexamined.

Recent studies have employed social network analysis to simultaneously estimate processes of selection and influence for cigarette use (10–12). These studies, however, have not investigated how peer beliefs shape such use. Additionally, past research indicates perceived peer smoking is associated with individual smoking more so than peer self-reports (13–14), providing an additional reason that the study of cigarette use should examine beliefs in addition to behavior. The current study builds on the work of Ragan by adopting a social network approach to develop a more complete understanding of the ways that peer beliefs contribute to adolescent smoking (8). This study tests several ways that peers beliefs about smoking could be connected to cigarette use. First, a direct effect of peer beliefs on cigarette use, even when controlling for peer smoking, may exist. Second, peer beliefs could influence cigarette use indirectly by altering individual beliefs. That is, if cigarette use is determined in part by adolescents' own beliefs about smoking, then friends' beliefs may influence cigarette use indirectly if they are associated with changes in individual beliefs. Finally, peer beliefs could be related to cigarette use through friendship selection if these beliefs alter the likelihood of being chosen as a friend.

Methods

Data

This study uses data collected from the evaluation of the PROSPER partnership model. PROSPER is a series of community-supported intervention programs designed to reduce risky adolescent behaviors and promote healthy lifestyle choices. Spoth and colleagues provide additional information about the design and implementation of these programs (15,16). Students in twenty-seven school districts in rural and semi-rural Iowa and Pennsylvania communities provided data on five occasions, subsequently referred to as waves of data. The first year of data collection was 2002, and students in two successive cohorts answered questionnaires in the Fall of 6th grade and every Spring thereafter through the 9th grade.

PROSPER featured open enrollment, allowing new students to be added to the sample at any wave, and respondents are included in the analyses for any wave they are present. In the current study, data from an average of 6,200 students at each wave and more than 9,000 students overall are analyzed. Students reported up to seven of their best and closest friends in their grade. This information created “directed” friendship ties indicating whether two students named each other as friends or whether one student named another without that friendship being reciprocated. Research assistants matched friendship nominations to the names on the student rosters with the aid of a computer program and succeeded in matching 83.0% of the provided names. For the 17% unmatched nominations, 1.9% of the names could not be matched due to multiple plausible matches, 0.4% could not be matched due to inappropriate names (e.g. celebrities), and 14.7% of names did not appear on the class roster. These social network data identify which students are friends with each other and provide

direct measures of friends' beliefs and behavior rather than relying on respondents' perceptions of their friends' attributes.

Measures

Past-month cigarette use is measured by an item at each wave that asked respondents, "During the past month, how many times have you smoked any cigarettes?" The original five response categories were recoded to "0" (none), "1" (once), and "2" (a few times or more) because of little variation in cigarette use in the earlier waves of data.

The analyses consider two types of beliefs about smoking. The measure of *expectations for smoking* ($\alpha = 0.85$) was created by combining the responses to three statements about whether respondents associate smoking with positive outcomes: "Teens who smoke have more friends," "Smoking cigarettes makes you look cool," and "Smoking cigarettes lets you have more fun." The response categories to the original statements ranged from "1" (strongly disagree) to "5" (strongly agree). The SIENA software, discussed below, requires ordinal dependent variables. To meet this requirement and to preserve the original distribution of the items, the sum of these responses was recoded as "0" (3), "1" (4–6), "2" (7–9), and "3" (10–15). *Moral approval of smoking* is taken from a question asking how wrong it was for someone the respondent's age to smoke cigarettes. Answers range from "0" (Very wrong) to "3" (Not at all wrong). Higher values correspond to beliefs more favorable to smoking for each belief measure.

Additional covariates control for other factors that may influence cigarette use and beliefs about smoking. The measure of *school adjustment and bonding* ($\alpha = 0.80$) is the mean of eight items that asked students about their attitudes toward school and their teachers, and *risk and sensation seeking* ($\alpha = 0.75$) is the mean of responses to three questions (e.g., how often the respondent does something that feels good regardless of the consequences). The measure of *family relations* ($\alpha = 0.81$) is operationalized as the mean of standardized subscales that corresponded to parental affective quality, joint activities between parents and children, parenting practices, and general family cohesion. For each of these indexes, higher values reflect more positive or affirmative answers to the items. *Sex* ("1" = male), *race* ("1" = White), and living with *both biological parents* ("1" = both parents) are all coded as dummy variables. With the exception of sex and race, each measure is wave-specific. Table 1 presents the means, standard deviations, and ranges of all variables used in the analyses.

Modeling Strategy

This study follows a modeling strategy similar to several other recent publications that examined these data (8,17,18) and used the Simulation Investigation for Empirical Network Analysis (SIENA) software to estimate stochastic actor-based models (SAB) (19–21). Publications by Snijders and by Steglich et al. provide a more thorough explanation of SIENA (19–21), Steglich et al. provide a nontechnical introduction to the program (22), and Osgood et al. explain the application of SIENA to the PROSPER data in more detail (11).

SIENA models longitudinal network data by estimating parameter values that produce simulations comparable to the observed patterns in the data. Estimates from the *network objective function* reflect changes in network structure. A first group of estimates from this

function are labeled selection parameters and indicate the extent to which the attributes of actors correspond to preferences in friendship selection. *Alter* parameters indicate whether the given characteristic is associated with receiving friendship nominations more or less frequently, and reveal, for example, whether adolescents with more positive beliefs about smoking are named as friends more often. *Ego* parameters indicate whether a characteristic is associated with nominating more or fewer friends. *Same/similarity* parameters indicate whether there is a tendency for respondents to name friends who are similar on the characteristic, such as whether adolescents name friends whose beliefs about smoking are similar to their own.

A second group of estimates from the network function are labeled structural parameters and represent patterns in friendship networks that emerge independently of respondent attributes. In addition to a single parameter accounting for the overall rate of friendship choice (*outdegree, density*), all models include structural parameters for tendencies to reciprocate friendships from others (*reciprocity*), choosing the friends of other people the actor named as friends (*transitive triplets*), becoming friends with people who choose the same people the actor did (*balance*), maintaining hierarchical friendship triads (*3-cycles*), and continuity in popularity (*indegree – popularity sqrt*). All models also include parameters to account for the possibility that changes in overall rates of friendship selection occur due to changes in school structure (23), such as multiple elementary schools feeding into the same high school (*merge*) or students transitioning from middle school to high school (*transition*). Although these effects are estimated with ego parameters, they are reported with the structural parameters because they apply to all respondents in the network at a given wave and do not vary between individuals within a network.

Estimates from the *behavior* objective function reflect whether the characteristics of respondents and their friends are associated with changes in a behavioral outcome. *Average similarity* parameters are consistent with the notion of influence and capture the extent that respondents change their beliefs or behaviors to become more similar to those of their friends. *Friendship group mean* parameters are not based on similarity but instead indicate whether respondents have a tendency to report higher values of the outcome when their friends report higher mean values of another covariate. In the current study, these parameters test, for example, whether adolescents change their beliefs to be more similar to their friends while controlling for the amount of smoking within the friendship group. Individual-level behavior parameters control for the effect of respondents' own characteristics on changes in the outcome.

In addition to the parameters discussed above, all models include behavior and friendship rate functions to control for the number of changes in individual behavior and network ties, respectively. Those estimates, however, are not of substantive interest and are omitted from the tables.

The results from this study derive from four models. The first two models estimate changes in both friendships and cigarette use. Taken together, the results from these models indicate whether friends' beliefs about smoking influence individual cigarette use, whether these associations remain when controlling for individual beliefs, and whether beliefs about

smoking play a role in shaping adolescent friendships. Next, there are separate models for each of the two types of beliefs: one model estimates changes in friendships and moral approval of smoking, while the other estimates changes in friendships and expectations for smoking. These models test whether peer beliefs about smoking influence individual beliefs.

SIENA estimated each model for each network (i.e., distinct district-cohort combination) in the sample. Results from 22 of the networks are omitted because results did not achieve satisfactory convergence for at least one model. Convergence difficulties in SIENA are often a consequence of insufficient variation over time to identify all parameters empirically (24), and variation in past-month cigarette use and beliefs about smoking are both limited in the earlier waves of data. Further, other networks are omitted because of data issues that preclude analysis with SIENA: one district did not collect friendship data, one network is missing a wave of data, and a school fire in one district created a chaotic pattern of school transitions. Thus, the final results in the current study are from 29 networks. The estimate for one of the parameters (balance) is fixed to its mean from preliminary results because it interfered with convergence in several networks. All estimates are from models estimated with five phase-2 sub-phases and 4,000 iterations during phase 3. The convergence t values, which represent the extent to which the simulated data vary from the actual data, are less than $\pm .10$ across all networks for all freely-estimated parameters.

Because the four models were estimated separately for each of the networks, each model has network-specific parameter estimates and standard errors. Rather than present 29 separate estimates for each parameter of a model, an aggregate parameter estimate was produced with “variance-known” three-level hierarchical linear models using the HLM 7 software (25). This approach, commonly associated with meta-analysis, essentially weights each set of parameter estimates inversely by its corresponding standard error (26). To account for the nesting inherent in these data (i.e., some districts have two cohorts), school districts within cohorts were the level-two unit of analysis and each district was the level-three unit of analysis. The level-one unit of analysis was the known variance (i.e., the squared standard error) of the estimate.

Results

Table 2 presents results of two models that predict changes in both friendship selections and in past-month cigarette use; the specification of these models is similar except that the first model does not contain parameters corresponding to individuals’ own beliefs about smoking.

Each structural parameter estimate is statistically significant, indicating that friendship choices are not independent of the choices of others in the network. These estimates are consistent across the models predicting changes in beliefs about smoking and are omitted from subsequent tables.

Next, selection parameters reveal preferences in friendship selection based on the characteristics of the respondents. Results from Model 1 indicate that both cigarette use and beliefs about smoking play a role in shaping adolescent friendships. Adolescents who report

more past-month cigarette use ($b = 0.100$, $SE = 0.024$, $p < 0.001$) and who have higher expectations for smoking ($b = 0.015$, $SE = 0.004$, $p < 0.01$) receive friendship nominations at a higher rate relative to their peers. There is also a tendency for those who are more approving of smoking to receive more friendship nominations ($b = 0.015$, $SE = 0.008$, $p < 0.10$).

The results also reveal that adolescents are more likely to name friends whose cigarette use ($b = 0.421$, $SE = 0.047$, $p < 0.001$), approval of smoking ($b = 0.119$, $SE = 0.027$, $p < 0.001$), and expectations for smoking ($b = 0.062$, $SE = 0.014$, $p < 0.001$) are similar to their own. There are no associations, however, between cigarette use or beliefs about smoking and how many friends one names.

Demographic characteristics play a role in the friendship selection process as well. Adolescents name Non-Whites as friends at a higher rate relative to Whites, and females and non-Whites tend to name more friends than males and Whites, respectively. Strong preferences for naming friends of the same sex and race are also observed.

The behavior parameters represent the impact of respondents' and friends' attributes on the behavioral outcome of the model. In Model 1, adolescents tend to change their own cigarette use so it is more similar to their friends' use ($b = 2.144$, $SE = 0.205$, $p < 0.001$). Moreover, increases in friends' expectations for smoking are also associated with increases in cigarette use ($b = 0.236$, $SE = 0.074$, $p < 0.01$). No association between friends' moral approval and past-month smoking is observed.

The individual-level control variables indicate which attributes are associated with changes in cigarette use: decreases are observed when adolescents are male, live with both biological parents, and report higher levels of family relations and school adjustment and bonding, while higher levels of risk and sensation seeking correspond to increases in cigarette use.

Parameters for individuals' own beliefs about smoking are included in Model 2 to assess both the association between individual beliefs and behavior and whether the effect of friends' expectations is mediated by respondents' own beliefs. Not surprisingly, increases in an individual's own approval of smoking ($b = 0.155$, $SE = 0.014$, $p < 0.001$) and positive expectations for smoking ($b = 0.106$, $SE = 0.012$, $p < 0.001$) are both associated with increases in cigarette use. The effect of friends' cigarette use not only remains statistically significant but is also virtually unchanged in magnitude ($b = 2.184$, $SE = 0.173$, $p < 0.001$), while the estimate for peers' expectations for smoking is statistically significant but reduced in magnitude ($b = 0.201$, $SE = 0.073$, $p < 0.05$). Together, these results provide evidence that peers' cigarette use and expectations about smoking shape adolescent cigarette use. Furthermore, adolescents' own beliefs about smoking influence their cigarette use as well. With this finding in mind, the next models predict changes in beliefs about smoking and test whether individuals' own beliefs are influenced by the beliefs and behaviors of their friends.

Table 3 and Table 4 present estimates from models predicting changes in both friendships and in beliefs about smoking. The parameters that predict changes in friendship selection are the same as those in the previous models, and, with several exceptions, the individual-level control variables associated with changes in cigarette use generally predict changes in

beliefs about smoking. Thus, discussion focuses on how friends' attributes are associated with changes in beliefs about smoking.

In Table 3, the estimate for friends' moral approval of smoking mean similarity is positive and statistically significant ($b = 2.233$, $SE = 0.232$, $p < 0.001$), indicating a tendency for adolescents to change their beliefs about whether it is wrong for adolescents to smoke so that these beliefs are more similar to those of friends. There is no evidence that this type of belief changes in response to either friends' cigarette use or friends' expectations for smoking.

Results from a model that predicts changes in both friendships and expectations for smoking are in Table 4. There is again evidence that adolescents change their beliefs about smoking to match those of their friends: individuals' expectations for smoking tend to become more similar to those of friends ($b = 1.774$, $SE = 0.224$, $p < 0.001$). Although friends' cigarette use is not associated with changes in individual expectations for smoking, the estimate for the association between friends' moral approval and individual expectations is positive and statistically significant in this model ($b = 0.128$, $SE = 0.050$, $p < 0.05$). This result suggests that increases in friends' approval of smoking are associated with increases in beliefs about positive expectations for smoking.

Discussion

Rates of smoking rise during adolescence, and identifying the factors that contribute to this increase is a primary goal of researchers across multiple disciplines. This study uses longitudinal social network analysis to test whether peer beliefs about smoking are related to adolescent cigarette use and whether these beliefs play a role in the friendship selection process. While the results from this study support previous empirical research positioning peer behavior as a predictor of smoking, there is also evidence that the influence from peers extends beyond their behavior. Specially, the results support the conclusion that peer beliefs about smoking influence both individual beliefs about smoking and cigarette use itself.

Adolescents tend to change their own beliefs so that they are more similar to those of their friends; thus, those whose friends are more approving of smoking and expect more positive consequences from smoking are more likely to have positive beliefs about smoking. This is consequential because these individual beliefs are themselves associated with changes in cigarette use. Furthermore, changes in friends' positive expectations for smoking are associated with changes in cigarette use. Friends' moral approval of smoking therefore may influence cigarette use through individual beliefs, while friends' expectations for smoking influence cigarette use both directly and through individual beliefs.

These results highlight how different types of beliefs contribute to cigarette use. Both moral approval of and positive expectations for smoking are associated with cigarette use, and the beliefs of peers influence both of these types of individual beliefs. Similarly, the tendency to choose friends with similar beliefs about smoking is observed for both types of beliefs. Consequently, employing only one of these measures would not capture the full importance of peer beliefs to the friendship selection process.

Beliefs about smoking also affect who adolescents name as friends. Adolescents tend to name friends whose beliefs about smoking are similar to their own, and there is a general preference for selecting friends who report more positive expectations of smoking. In addition to explaining how friendships are formed, this also has consequences for explaining the spread of cigarette use. Selecting friends with more favorable beliefs about smoking not only provides an opportunity for one's individual beliefs about smoking to change due to peer influence, but it also increases exposure to behavioral influence since those with favorable beliefs are more likely to smoke.

Limitations

The PROSPER data are not nationally-representative; students in the sample are from small towns with populations that are predominantly White and that contain a substantial proportion of low-income families. Moreover, friendship choices in these data are required to be other students in the same school and grade, effectively limiting inferences from analyses of selection and influence processes to peers that meet these conditions. Future research should address whether the results presented in this study are consistent across other settings and how out-of-school and out-of-grade friends impact the selection and influence processes.

This study explores how peer beliefs about smoking contribute to cigarette use, and one way this may occur is through individuals' own beliefs. But this research design does not model a reciprocal relationship between cigarette use and beliefs about smoking (27), and adolescents may change their beliefs depending on whether their experiences with smoking are favorable or unfavorable. Additional research is needed to explore this possibility.

Conclusions

Limiting the study of peers to their behavior is likely to result in an incomplete understanding of how these peers contribute to the development of cigarette use in adolescence. The results from this study provide evidence that beliefs about smoking, in addition to cigarette use itself, play a role in influencing behavior and in shaping adolescent friendship networks. Because beliefs favorable to cigarette use are present before adolescents actually smoke, these results underscore the importance of implementing smoking prevention programs in early adolescence. Additionally, prevention programs that explicitly address beliefs about smoking may have additional opportunities to reduce cigarette use relative to those limited to advising adolescents to avoid associating with peers who smoke.

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Table 1

Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Cigarette use (past-month)	0.173	0.534	0	2
Moral approval of smoking	0.527	0.854	0	3
Expectations for smoking	0.595	0.774	0	3
Sex	0.492	—	0	1
Race	0.806	—	0	1
Both Biological Parents	0.600	—	0	1
School Adjustment & Bonding	3.784	0.769	1	5
Family Relations	-0.011	0.504	-2.997	1.060
Risk & Sensation Seeking	2.135	1.002	1	5

Values across 29 networks, with a total N of 30,888 person/waves

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Table 2
Selected SIENA Parameter Estimates^a: The Effects of Peer Beliefs on Cigarette Use

	Model 1		Model 2			
	b	SE	SD ^b	b	SE	SD ^b
Network parameters: Changes in Friendships						
Structural parameters						
Outdegree (density)	-3.199 ***	0.072	0.313 <i>cd</i>	-3.185 ***	0.073	0.311 <i>d</i>
Reciprocity	1.967 ***	0.053	0.235 <i>cd</i>	1.967 ***	0.053	0.232 <i>d</i>
Transitive triplets	0.342 ***	0.017	0.074 <i>cd</i>	0.345 ***	0.016	0.072 <i>cd</i>
3-cycles	-0.421 ***	0.020	0.081 <i>d</i>	-0.423 ***	0.020	0.080 <i>d</i>
Balance	0.100	—	—	0.100	—	—
Indegree – popularity (square root)	0.186 ***	0.012	0.046 <i>cd</i>	0.184 ***	0.012	0.047 <i>cd</i>
Merger ego	-0.763 ***	0.117	0.310 <i>cd</i>	-0.766 ***	0.115	0.306 <i>cd</i>
Transition ego	-0.206 ***	0.043	0.164 <i>d</i>	-0.210 ***	0.046	0.182 <i>cd</i>
Selection parameters						
Alter effects: Who is more often named as a friend?						
Cigarette use	0.100 ***	0.024	0.062 <i>d</i>	0.097 **	0.024	0.053
Moral approval of smoking	0.015 $\dot{\ast}$	0.008	0.020 <i>d</i>	0.017 *	0.007	0.015
Expectations for smoking	0.015 **	0.004	0.001	0.015 **	0.004	0.001
Sex	0.007	0.008	0.009	0.010	0.007	0.001
Race	-0.063 ***	0.010	0.034 <i>c</i>	-0.060 ***	0.010	0.029 <i>c</i>
Ego effects: Who names more friends?						
Cigarette use	-0.001	0.039	0.127 <i>d</i>	-0.001	0.043	0.134 <i>d</i>
Moral approval of smoking	-0.016	0.012	0.043 <i>c</i>	-0.011	0.013	0.046 <i>c</i>
Expectations for smoking	-0.010	0.008	0.024	-0.012	0.009	0.020
Sex	-0.166 ***	0.014	0.068 <i>c</i>	-0.169 ***	0.015	0.068 <i>c</i>
Race	-0.038 *	0.016	0.044	-0.034 $\dot{\ast}$	0.017	0.038
Similarity effects: Choosing friends similar to oneself						

	Model 1			Model 2		
	b	SE	SD ^b	b	SE	SD ^b
Cigarette use	0.421 ***	0.047	0.072	0.445 ***	0.051	0.076
Moral approval of smoking	0.119 ***	0.027	0.078 <i>d</i>	0.114 ***	0.026	0.057
Expectations for smoking	0.062 ***	0.014	0.025 <i>c</i>	0.053 **	0.014	0.028 <i>c</i>
Sex	0.713 ***	0.027	0.121 <i>cd</i>	0.705 ***	0.025	0.109 <i>cd</i>
Race	0.180 ***	0.022	0.082 <i>d</i>	0.183 ***	0.022	0.080 <i>d</i>
Behavior parameters: Changes in Cigarette Use						
Friends' attributes						
Cigarette use mean similarity	2.144 ***	0.205	0.033	2.184 ***	0.173	0.032
Mean moral approval of smoking	-0.045	0.076	0.013	-0.044	0.088	0.014
Mean expectations for smoking	0.236 **	0.074	0.011	0.201 *	0.073	0.012
Control variables (individual level)						
Moral approval of smoking	—	—	—	0.155 ***	0.014	0.002
Expectations for smoking	—	—	—	0.106 ***	0.012	0.002
Sex	-0.233 ***	0.031	0.005	-0.224 ***	0.029	0.005
Race	0.008	0.021	0.004	0.014	0.019	0.004
Both Biological Parents	-0.247 ***	0.036	0.046	-0.246 ***	0.033	0.006
School Adjustment & Bonding	-0.221 ***	0.017	0.003	-0.155 ***	0.021	0.003
Family Relations	-0.166 ***	0.031	0.005	-0.097 **	0.026	0.005
Risk & Sensation Seeking	0.145 ***	0.016	0.003	0.119 ***	0.015	0.002

*** $p < .001$.

** $p < .01$.

* $p < .05$.

^c $p < .10$.

All values are means across 29 networks, with a total N of 30,888 person/waves

^aModels also include rate and shape parameters

^bStandard deviation of parameter estimates are the square root of the sum of the level-2 and level-3 HLM variance

^cSignificant variance between cohorts within districts, $p < .05$.

^dSignificant variance across districts, $p < .05$.

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Table 3Selected SIENA Parameter Estimates^a: The Effects of Peers on Moral Approval of Smoking

	b	SE	SD^b
<u>Network parameters: Changes in Friendships</u>			
<u>Selection parameters</u>			
Alter effects: Who is more often named as a friend?			
Cigarette use	0.069 **	0.017	0.041 <i>d</i>
Moral approval of smoking	0.043 **	0.012	0.035
Expectations for smoking	0.012 **	0.004	0.002
Sex	0.009	0.008	0.011
Race	-0.062 ***	0.010	0.035 <i>c</i>
Ego effects: Who names more friends?			
Cigarette use	0.016	0.026	0.083 <i>d</i>
Moral approval of smoking	-0.013	0.018	0.068 <i>c</i>
Expectations for smoking	-0.012	0.008	0.029 <i>c</i>
Sex	-0.165 ***	0.014	0.072 <i>c</i>
Race	-0.040 *	0.016	0.048
Similarity effects: Choosing friends similar to oneself			
Cigarette use	0.268 ***	0.031	0.062
Moral approval of smoking	0.279 ***	0.053	0.159
Expectations for smoking	0.063 ***	0.013	0.028 <i>c</i>
Sex	0.714 ***	0.027	0.121 <i>cd</i>
Race	0.179 ***	0.022	0.086 <i>cd</i>
<u>Behavior parameters: Changes in Moral Approval</u>			
Friends' attributes			
Moral approval of smoking mean similarity	2.233 ***	0.232	0.036
Mean cigarette use	0.136	0.112	0.035
Mean expectations for smoking	-0.044	0.079	0.028
Control variables (individual level)			
Sex	-0.103 ***	0.021	0.013
Race	-0.022	0.038	0.108
Both Biological Parents	-0.137 ***	0.029	0.080 <i>d</i>
School Adjustment & Bonding	-0.179 ***	0.022	0.057 <i>d</i>
Family Relations	-0.259 ***	0.028	0.078 <i>c</i>
Risk & Sensation Seeking	0.100 ***	0.009	0.002

*** < .001.

** p < .01.

* p < .05.

$\dot{p} < .10$.

All values are means across 29 networks, with a total N of 30,888 person/waves

^aModels also include rate, shape, and structural parameters

^bStandard deviation of parameter estimates are the square root of the sum of the level- 2 and level-3 HLM variance

^cSignificant variance between cohorts within districts, $p < .05$.

^dSignificant variance across districts, $p < .05$.

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Table 4Selected SIENA Parameter Estimates^a: The Effects of Peers on Expectations for Smoking

	b	SE	SD ^b
<u>Network parameters: Changes in Friendships</u>			
<u>Selection parameters</u>			
Alter effects: Who is more often named as a friend?			
Cigarette use	0.068 **	0.018	0.041 <i>d</i>
Moral approval of smoking	0.013 †	0.007	0.035
Expectations for smoking	0.034 ***	0.005	0.002
Sex	0.009	0.007	0.011
Race	-0.059 ***	0.010	0.035 <i>c</i>
Ego effects: Who names more friends?			
Cigarette use	0.017	0.024	0.083 <i>d</i>
Moral approval of smoking	-0.016	0.011	0.068 <i>c</i>
Expectations for smoking	-0.015	0.014	0.029 <i>c</i>
Sex	-0.163 ***	0.015	0.072 <i>c</i>
Race	-0.038 *	0.015	0.048
Similarity effects: Choosing friends similar to oneself			
Cigarette use	0.276 ***	0.034	0.062
Moral approval of smoking	0.118 ***	0.026	0.159
Expectations for smoking	0.181 ***	0.034	0.028 <i>c</i>
Sex	0.712 ***	0.027	0.121 <i>cd</i>
Race	0.178 ***	0.022	0.086 <i>cd</i>
<u>Behavior parameters: Changes in Positive Expectations</u>			
Friends' attributes			
Expectations for smoking mean similarity	1.774 ***	0.224	0.036
Mean cigarette use	0.070	0.132	0.035
Mean moral approval of smoking	0.128 *	0.050	0.028
Control variables (individual level)			
Sex	-0.044 †	0.023	0.013
Race	-0.144 ***	0.027	0.108
Both Biological Parents	-0.042	0.027	0.080 <i>d</i>
School Adjustment & Bonding	-0.190 ***	0.015	0.057 <i>d</i>
Family Relations	-0.334 ***	0.029	0.078 <i>c</i>
Risk & Sensation Seeking	0.084 ***	0.013	0.002

*** p < .001.

** p < .01.

* p < .05.

$\dot{p} < .10$.

All values are means across 29 networks, with a total N of 30,888 person/waves

^aModels also include rate, shape, and structural parameters

^bStandard deviation of parameter estimates are the square root of the sum of the level- 2 and level-3 HLM variance

^cSignificant variance between cohorts within districts, $p < .05$.

^dSignificant variance across districts, $p < .05$.

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