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Being Well-Liked Predicts Increased Use of Alcohol but not Tobacco in Early Adolescence

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Abstract

Although substance use has traditionally been linked to peer deviance, a parallel literature has explored the influence of peer social status (being “well-liked”). This literature hypothesizes that adolescents with higher status will anticipate shifts in social norms and modify their behavior earlier and/or more substantially than lower-status students. As substance use becomes more socially acceptable during early-to-mid-adolescence, higher status youth are hypothesized to reflect this shift in norms by accelerating their use. Although some evidence exists to support this hypothesis, it has never been evaluated in conjunction with the opposing hypothesis (i.e., that substance use contributes to elevated peer status). In this study, we evaluated reciprocal links between peer status and substance use (i.e., alcohol and tobacco) using 3 years of data from a sample of adolescents attending 8 middle schools in the Pacific Northwest. Social network analysis enabled us to model standard network effects along with unique effects for the influence of the network on behavior (i.e., increased substance use as a result of being well-liked) and the influence of behavior on the network (i.e., increased status as a result of substance use). Our results indicated significant bidirectional effects for alcohol use but no significant effects for tobacco use. In other words, being well-liked significantly predicted alcohol use and vice versa, but these processes were not significant for tobacco use. Prevention efforts should consider the dynamics of peer status and peer norms in adolescence with the goal of preventing escalations in problem behavior that can compromise future adjustment.

Keywords

social network analysis; peer status; social norms; alcohol; tobacco; adolescence

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Contributors

T. J. Dishion designed the study. M. J. Van Ryzin conducted the statistical analysis. M. J. Van Ryzin drafted the first version of the manuscript with input from T. J. Dishion and D. DeLay. All authors have reviewed and approved the final version.

Conflict of Interest

All authors declare they have no conflict of interest.

1. Introduction

Adolescence is a developmental period during which many youth begin to experiment with tobacco and alcohol (Johnston et al., 2010); however, escalating use of these substances can have negative long-term impacts on health and well-being (Brook et al., 2002; Chassin et al., 1999; Kandel et al., 1986; Lennings et al., 2003; Soyka, 2000). In particular, early substance use implies an elevated risk for substance abuse and dependence in late adolescence or adulthood (Grant, Stinson, & Harford, 2001; Hingson & Zha, 2009; Pitkänen, Lyyra, & Pulkkinen, 2005; Van Ryzin & Dishion, 2004). For example, alcohol use before age 14 or 15 has been linked to elevated risk for later abuse and dependence (Dawson, Goldstein, Chou, Ruan, & Grant, 2008; Hingson, Heeren, & Winter, 2006), and similar results have been found for tobacco use (Behrendt, Wittchen, Höfler, Lieb, & Beesdo, 2009; Vega & Gil, 2005).

Research exploring peer influences on substance use in adolescence has typically focused on the influence of deviant peers (e.g., Van Ryzin et al., 2012), who provide facilitation, peer pressure, and various types of reinforcement for substance use and other delinquent behavior (Dishion et al., 1995; Van Ryzin and Dishion, 2013), and who, in turn, can promote increased risk of later substance dependence (Van Ryzin and Dishion, 2014). As a result, prevention programs tend to emphasize skills for resisting deviant peer influence, such as peer refusal (e.g., Botvin, 2000).

The concept of peer influence has recently evolved from an interpersonal dynamic (i.e., reinforcement for substance use and other deviant behavior) to include a consideration of more implicit macrodynamics (Dishion, 2014) such as social status, which reflects the extent to which the primary peer group likes and seeks out a specific individual for inclusion in activities. A key strategy for gaining status in peer environments is reading and reflecting the changing social norms of the group; in other words, social norms can exert a socializing effect on group members, and this effect is hypothesized to be more powerful for those who have greater social status (Allen et al., 2005). Thus, as social norms evolve to be favor substance use across adolescence, higher-status youth may exhibit increased use of substances as compared to lower-status youth, including higher levels of tobacco and alcohol use (Allen et al., 2005; Ennett et al., 2006; Mayeux et al., 2008; Tucker et al., 2011; Valente et al., 2005).

Although this literature has established a link between status and substance use, the direction of effects isn't entirely clear. It may be that peer socialization results in higher-status youth being more eager to embrace substance use, but other research has found effects in the opposite direction, in which some forms of antisocial or "adult-like" behavior, such as substance use, can enhance social status (Becker and Luthar, 2007; Killea-Jones et al., 2007). Very little research has evaluated these two hypotheses simultaneously within a single analytic framework; thus, the direction of effects is unclear, as are the implications for substance use prevention and public health.

There are several additional complications that prevent us from drawing strong conclusions from this body of research. One such complication is the different approaches to assessing

social status. For example, some studies assess status using the number of “friendship” nominations (Ennett et al., 2006; Valente et al., 2005). This literature hypothesizes a specific type of socialization that relies on direct social contact; specifically, increased numbers of friends are hypothesized to provide increased opportunities for deviant influence, such as increased access to substances and/or social functions where substances may be available.

Other studies assess social status in terms of student perceptions of who is most popular (Mayeux et al., 2008). These perceptions of popularity are often related to students’ visibility within the social group, which can be a function of both prosocial and antisocial behavior (Gest, Graham-Bermann, & Hartup, 2001; LaFontana & Cillessen, 2002; Parkhurst & Hopmeyer, 1998).

In this study, we assessed social status in terms of the number of “liking” nominations, which is more closely aligned with the theoretical case for peer socialization presented above, where well-liked individuals tend to more strongly reflect the social norms of the group. We take particular care to differentiate between “liking” and other measures of status, such as perceived popularity; as discussed above, perceived popularity has been associated with both prosocial and antisocial behavior, so the existence of links between this form of status and substance use (e.g., Mayeux et al., 2008) should not be surprising. In contrast, being well-liked has generally been associated exclusively with positive outcomes, such as higher levels of prosocial behavior and lower levels of aggression (Gest et al., 2001; Parkhurst and Hopmeyer, 1998). The unique contribution of Allen et al. (2005) was to create an initial link between social status as measured by “liking” and a form of deviant behavior (i.e., elevated substance use). In other words, the findings of Allen et al. (2005) suggested that peer status as measured by “liking” nominations may be a heretofore undiscovered risk factor for escalations in substance use during adolescence. Unfortunately, little research to date has extended these findings.

We aim to evaluate the peer socialization hypothesis presented by Allen et al. (2005) using modern social network analytic techniques, which not only account for interdependence among individuals in a network (which can bias the findings generated by conventional analytic methods), but also simultaneously model change over time in both individual behavior (e.g., substance use) and network processes (e.g., liking, or status; Snijders, 2001; Snijders et al., 2010). Recent research using social network methods has found reciprocal links between substance use and peer status as assessed by the number of friendship nominations (Osgood et al., 2013), which mirrors previous work using more conventional methods that linked number of friends to elevated substance use (Ennett et al., 2006; Valente et al., 2005). Thus far, however, there has been no research using social network methods that has linked substance use to peer status as measured by “liking” nominations. Such a distinction is important, given that research has found that the correlations between number of friends and various other measures of social status decline across early adolescence (Bukowski et al., 1996), suggesting that these concepts are becoming increasingly distinct. In addition, friendship nominations imply a degree of close social contact and shared experiences (and ample opportunity for the microdynamics of social influence, such as facilitation, peer pressure, and reinforcement; Dishion & Tipsord, 2011), whereas “liking” does not have the same developmental implications (Hartup, 1996). Thus, while research has

established that friendships can serve as a context for peer influence on substance use, it is unclear whether a more distal, macrodynamic form of social interaction such as “liking” can impact, or be impacted by, substance use. Our research questions were as follows:

1. Does being well-liked lead to increased use of tobacco and alcohol among middle school students?
2. Does the use of tobacco and alcohol lead to being more well-liked among middle school students?

Our findings will address the question of whether being well-liked can serve as a risk factor for substance use and suggest new avenues for substance use prevention.

2. Material and Methods

2.1 Participants

Our sample included 1,289 students from 8 middle schools in an urban area in the Pacific Northwest who were surveyed annually starting in 2000 in the fall of sixth, seventh, and eighth grades. The sample represents a 74% recruitment rate, and 82% of participants completed all 3 waves of assessment (for recruitment data by school, see Light & Dishion, 2007). The network size per school varied between 129 and 230 students ($M = 165$). The overall sample was 53.2% female, 77.4% European American, and had an average age of 12.14 years at the first wave of measurement; see Table 1 for demographic data by school and Table 2 for substance use data by school. Network data are presented in Table 3 according to the format provided by Veenstra and Steglich (2012).

2.2 Measures

2.2.1 Substance use—Students reports of substance use (tobacco and alcohol) were collected once a year in sixth, seventh, and eighth grades. Students were asked to indicate the number of occasions they had used each substance during the past month. Substance use was coded as follows: 1 (*none*), 2 (*1–3 times*), 3 (*4–6 times*), 4 (*7–9 times*), and 5 (*more than 9 times*). Descriptive data by school are presented in Table 2, and data across schools are presented in Table 3.

2.2.2 Sociometric nominations—Students were asked to name those individuals in their grade with whom they would like to be in a group, and they were allowed to nominate as many other students as they wished. This approach to measuring “liking” is conceptually similar to Allen et al. (2005), who asked students with whom they would want to spend time on a Saturday night.

2.2.3 Demographics—Given findings of sex and ethnic differences in substance use patterns (Jackson et al., 2002; Wallace et al., 2003), we included consideration of these effects in our models. Students indicated their sex (1 = male, 8 = female; this encoding was an artifact of a broader coding system and did not negatively impact model fit) and ethnicity (1 = European American, 0 = non-European American). These predictors were not correlated, $r = -.05$, *ns*.

2.3 Analysis Plan

We conducted our social network analysis using RSiena (Ripley et al., 2012). RSiena implements the Stochastic Actor-Based Model (SABM; Snijders, 2001; Steglich et al., 2010) in which parameters and standard errors are generated using computer simulations within a continuous-time Markov Chain Monte Carlo (MCMC) framework. This process assumes that changes in the network will take place without direct observation and that network change results from both the current state of the network and the probability of further evolution from a given time point (Snijders et al., 2010). The SABM approach models change in the network structure (i.e., nominations) endogenously with changes in individual behavior.

In general, RSiena models are built to control for standard network effects, such as reciprocity and transitivity, which are generally ignored by conventional analytic methods. *Reciprocity* refers to the tendency for individuals to extend more network ties if they are reciprocated, and *transitivity* involves the tendency for network closure among triads; several standard network statistics reflect transitivity, including *3-cycles* and *transitive triplets*. These effects refer to two methods of triadic closure, in which links between individuals suggest an egalitarian (*3-cycles*) or hierarchical (*transitive triplets*) structure in the triad (see Ripley et al., 2012). Since little research to date has used “liking” nominations in social network analysis, it was not clear whether we would find reciprocity and/or transitivity in our networks; thus, we included them in our initial models; since we found them to be significant, they were retained.

In addition to controlling for common network processes such as reciprocity and transitivity, RSiena can independently estimate effects related to network ties and behavior. For example, if the tendency to create a network tie is related to some quality of the individual originating the tie (e.g., his/her sex or tendency to use substances), it is referred to as an *ego* effect (the “ego” is the individual who is the source of the tie). If the tendency to create a network tie is related to some quality of the target of the tie, it is referred to as an *alter* effect (the “alter” is the target of the nomination). If the tendency to create a network tie is related to a quality of both the “ego” and the “alter”, then it is referred to as a *same* or *similarity* effect. Our effect of interest, with regard to network effects, was the tendency for individuals to nominate or “like” those with higher levels of alcohol or tobacco use (i.e., the *alter effect* for substance use); this effect corresponds to the effect of substance use on the tendency for an individual to be liked by others. Our models also included effects representing the tendency for individuals to nominate or “like” others with similar levels of alcohol or tobacco use, and we included effects related to sex and ethnicity (i.e., *ego*, *alter*, and *same* effects). In this context, the *ego* effect represented sex or ethnic differences in the number of outgoing ties (i.e., the tendency to nominate others), the *alter* effect represented differences in the number of incoming ties (i.e., differences in status), and the *same* effect represented the tendency for within-sex or within-ethnic group nominations (i.e., homophily).

With regard to estimating effects for behavioral changes, we initially included *influence* effects on substance use, which represent the tendency for individuals to modify their behavior to match those to whom they are linked. These effects were nonsignificant and

negatively impacted model fit, so they were discarded (we note that influence effects have been found in the literature, but only for friendship networks, not for “liking” networks). We retained effects related to sex and ethnic differences in substance use. We also included effects for behavioral level and tendency, including *linear* and *quadratic* shape. The linear shape represents the overall level of the behavior, whereas the quadratic shape represents the tendency for change (i.e., the effect of the level of the behavior on itself). For example, a positive quadratic shape indicates a U-shaped distribution of behavior in which individuals tend either to have very low or high levels of that behavior (specifically, individuals with lower values tend to further decrease their behavior, while people with higher values tend to increase their behavior). In contrast, a negative quadratic shape indicates a unimodal distribution of the behavior, in which individuals tend to change their behavior in the direction of a mean value (i.e., regression to the mean). Our effect of interest, with regard to behavior, was the tendency for individuals with greater numbers of nominations (i.e., a higher *indegree*) to increase their substance use (i.e., the effect of social status on use).

In sum, our effects of interest included: (a) the effect of being well-liked on substance use (i.e., the *indegree* effect); and, (b) the effect of substance use on the rate of being liked (i.e., the *alter* effect). We estimated separate models for each of the 8 schools and then combined the results across schools using meta-analytic techniques embedded within RSiena. Since all the school models contained an identical set of effects, meta-analysis combined the disparate sets of findings into a single set of results and estimated standard errors that represented the variance in effects across schools.

3. Results

Table 3 provides descriptive statistics for the network structure and individual behavior. Factors such as outdegree, density, reciprocity, and stability/change in ties are within normal ranges (Snijders et al., 2010). In addition, the Jaccard index provides an indication of the stability of the network, and recommended values are between .20 and .60 (Snijders et al., 2010); ours were within this range, albeit at the lower end.

We first evaluated a model for alcohol use; results are presented in Table 4. Network effects are presented first (including the effect of alcohol use on the number of incoming “liking” nominations, known as the *alter* effect), followed by behavioral effects (including the effect of “liking” nominations on alcohol use, known as the *indegree* effect). Our results indicate that alcohol use contributed to being well-liked (the alcohol *alter* effect), and that being well-liked, in turn, contributed to alcohol use (the alcohol *indegree* effect). The results also indicate a tendency toward hierarchical (rather than egalitarian) network closure (i.e., a significant positive effect for *transitive triplets* and a significant negative effect for *three-cycles*), and a significant trend toward reciprocity of ties, suggesting that basic network processes for “liking” are similar to those that have been established for friendship nominations. We also found evidence for homophily by sex (the *same* effect for sex), and sex differences in number of nominations (the *ego* effect for sex) and in the number of incoming nominations (the *alter* effect for sex); the positive *ego* effect indicated that girls provided more “liking” nominations, whereas the negative *alter* effect indicated that boys were more well-liked than girls. The negative *linear* parameter suggested that overall

alcohol use tended to be low, but the positive *quadratic* parameter suggested that there was evidence of dispersion (i.e., a U-shaped distribution of behavior) in which individuals who did consume alcohol tended to consume more over time. We found no sex or ethnic differences in rates of alcohol use (the behavioral effects for sex and ethnicity). Finally, we found a significant tendency for individuals to nominate others with similar levels of alcohol use. Model fit statistics indicated well-fitting models across all schools. All significant effects except for alcohol *indegree* exhibited significant variance across schools (the *alter* effect for ethnicity and sex and ethnic differences in rates of alcohol use also did not exhibit significant variance, but these effects themselves were not significant).

We then fit the model for tobacco use (see Table 5). Our results indicated that both the effect of tobacco use on being well-liked (the tobacco *alter* effect) and the effect of being well-liked on tobacco use (the tobacco *indegree* effect) were nonsignificant. As in the alcohol model, the results indicated a tendency toward hierarchical network closure and a significant trend toward reciprocity, homophily by sex, and sex differences in outgoing nominations and social status. The linear and quadratic trends were not significant, although the marginally negative linear trend suggested an overall low level for tobacco use. Also similar to the alcohol model, we found no sex or ethnic differences in tobacco use. Finally, we found a significant tendency for individuals to nominate others with similar levels of tobacco use. Model fit statistics indicated well-fitting models across all schools. All significant effects varied across the sample, except for the similarity effect for tobacco use.

4. Discussion

In this study, we found evidence for the hypothesis that social status in terms of “liking” nominations can influence substance use, but only with regard to alcohol; the effect for tobacco was not significant. We also found evidence for the hypothesis that alcohol use influenced the rate of “liking” nominations, but again, tobacco did not share this effect. These results provide evidence in support of existing research demonstrating that social status as measured by “liking” can predict increased alcohol consumption in middle school (Allen et al., 2005), while at the same time, alcohol use can provide a boost in social status. We note that these effects emerged even though we simultaneously evaluated bi-directional effects between “liking” and substance use and included effects representing demographic differences (i.e., sex, ethnicity), common social network phenomena (i.e., reciprocity, transitivity), and the tendency for individuals to nominate those who are the same or similar (i.e., homophily). Our modeling framework evaluated these effects simultaneously while accounting for interdependence in the data, addressing a key limitation of conventional analytic methods.

We found no evidence supporting the hypothesis that social status can predict tobacco use or vice versa. The theoretical framework of Allen et al. (2005) is based upon the concept of evolving social norms related to substance use and their influence on individual behavior, so it may be that our results reflect differences in social norms for alcohol as compared to tobacco in the communities studied. Specifically, alcohol may have become more socially acceptable during the course of middle school among the students in our sample, which may be reflected in the higher prevalence of alcohol as compared to tobacco use (see Table 2; a

Wilcoxon Signed Ranks test found that alcohol use was higher than tobacco use at each wave; statistic = -5.75 , -11.17 , and -10.17 , all $p < .001$). If it was indeed becoming more socially acceptable, use of alcohol may have contributed more readily to social status, and youth, especially high status youth, may have been more sensitive to this evolving norm when making decisions about their own behavior. The specific types of problem behavior that appear in groups of youth may be, at least in part, a function of the social ecology of the school (Dishion, 2014). To more completely understand the uptake in substance use in middle school and to develop appropriate prevention and health promotion programs, we must consider the manner in which norms arise in the school social context and how these norms influence the reciprocal link between behavior and peer status (Chang, 2004). Research examining the co-evolution of adolescent behavior, status, and perceived social norms could shed new light on this issue.

4.1 Implications for Theory, Prevention, and Public Health

Our results make a significant contribution to existing social network research that has heretofore linked escalations in alcohol use to an individual's number of friends (Ennett et al., 2006; Osgood et al., 2013). The broader social network literature strongly suggests that friendship serves as a mechanism for peer influence on alcohol use (Burk et al., 2012; Osgood et al., 2013; Steglich et al., 2010); however, a more distal, macrodynamic network process such as "liking" may not present a similar opportunity for peer influence, since "liking" does not have the same developmental implications (and the same degree of direct social contact) as friendship (Bukowski & Hoza, 1989; Hartup, 1996). Indeed, we found no significant results related to influence effects in our "liking" networks, even though such effects have been consistently found in previous research on friendship networks, suggesting that social processes in friendship vs. "liking" networks are at least somewhat different. Thus, we contend that these findings significantly extend theory on peer influence by suggesting that peer socialization processes may confer risk for escalations in alcohol use – and potentially for other risky behaviors that become more widely accepted in adolescence. Further research should explore the mechanisms and processes undergirding peer socialization effects.

From a prevention perspective, program components such as refusal skills, which are designed to target peer influence processes among friends, may not be able to address the apparent risk that is represented by being well-liked. Instead, prevention programming could potentially focus on altering individual response to changing peer norms or encouraging a striving for popularity through other means than substance use. Alternatively, prevention programs could attempt to alter peer norms in favor of abstinence by promoting a substance-free social group that can provide opportunities for peer affiliation without using substances (Gordon, Biglan, & Smolkowski, 2008).

Our results are particularly noteworthy given the age of our sample (i.e., approximately 12 years at baseline) and the rather precipitous drop in the number of youth reporting no use in the previous 30 days across the three years of our study (see Table 2). For example, in School 1, approximately 86% of youth reported no use at Wave 1, but by Wave 3, this percentage drops to approximately 55%. Any alcohol use at this age can confer a

significantly greater risk for later abuse and dependence (Dawson et al., 2008; Hingson et al., 2006; Van Ryzin & Dishion, 2014), so any social influence that can create a significant (i.e., non-zero) increase in alcohol use should be seen as an important public health issue deserving of attention from both a research and a policy perspective.

4.2 Limitations

There are several limitations to this study that must be considered. Most notably, we are limited in terms of the conclusions we can draw regarding the processes involved in peer socialization. Allen et al. (2005) hypothesized that well-liked individuals would be subject to socialization effects derived from evolving group norms, and there is some evidence to support this notion; for example, self-rated popularity has been found to be more predictive of increasing substance use as compared to sociometric measures of popularity (Tucker et al., 2011), suggesting that adolescents who view themselves as popular are more likely to escalate substance use during this period. An alternative hypothesis was offered by Osgood et al. (2013), who suggested that more popular individuals (at least in terms of greater number of friendship nominations) would be more likely to spend time in social situations where alcohol was available, and thus the increase in use may be a function of access to substances rather than peer socialization. Our view is that these processes are entwined, such that increased time in social situations not only provides opportunity for access to substances but also reinforces individual perceptions regarding substance use norms and rates of use among peers. Further research probing more deeply at these mechanisms could attempt to unravel these distinct sources of influence.

We are also limited in terms of the generalizability of our findings, both in terms of the limited ethnic diversity of the sample as well as our focus on alcohol and tobacco use; we cannot necessarily posit that peer socialization processes found for alcohol would generalize to other substances, such as marijuana or hard drugs. Given our results, it may be that links between use of these substances and popularity may depend on their acceptability in the social context. We are also unable to explicitly rule out the possibility that our lack of findings related to tobacco use was a function of the overall low level of use across the sample. There is a lack of methodological research on how variability in behavioral constructs can impact findings in RSiena, so we have no definitive way of addressing this concern. Future research in higher-risk settings may find, for example, that effects for tobacco use do emerge in schools where tobacco use itself is more widespread and more socially acceptable. Finally, although we would like to explicitly model the moderating impact of school-level differences in substance use norms using a multi-level modeling framework, RSiena does not currently provide this capability. We note, however, that effects for sex, ethnicity, and average levels of substance use are included in our models and thus school-level differences in these constructs did not bias our results.

4.3 Conclusion

This study is the first to use social network analysis to examine longitudinal, bidirectional links between adolescent substance use and social status as measured by “liking” nominations. We found that being well-linked significantly predicted alcohol use and vice versa, but these effects were not found for tobacco use. These results confirm that being

well-liked, previously considered a marker of adaptation, may be a significant risk factor for escalations in alcohol use and thus may be worthy of specific prevention programming, particularly given the implications of early alcohol use later abuse and dependence.

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Highlights

- Being well-liked may contribute to escalations in substance use during adolescence.
- Existing research is limited by conventional statistical methods.
- We used social network analysis to examine links between liking and substance use.
- We found bidirectional links between liking and use of alcohol but not tobacco.
- Being well-liked may represent a heretofore unknown risk factor in adolescence.

Table 1

Demographic Data by School

School	Network Size (N)	Age (yrs, Wave 1)	Age (yrs, Wave 2)	Age (yrs, Wave 3)	Percent Female	Percent Euro-Am
1	129	12.19	12.98	14.00	47.75	83.87
2	230	12.10	13.07	13.93	59.61	79.80
3	148	12.02	12.97	13.97	48.80	82.05
4	169	12.19	13.21	13.94	61.54	69.17
5	151	12.22	12.96	13.91	47.54	71.09
6	205	12.18	12.91	13.99	58.39	84.91
7	151	12.09	12.97	13.99	56.21	82.03
8	135	12.18	12.90	13.97	45.45	66.36

Note. The sum of the school social networks is 1,318, which is larger than the overall sample of 1,289 because several students transferred between schools during the project and thus appear in the social networks of more than one school.

Table 2

Substance Use Data by School

School	Alcohol Wave 1			Alcohol Wave 2			Alcohol Wave 3			Tobacco Wave 1			Tobacco Wave 2			Tobacco Wave 3		
	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use	Rate of Use	% No Use
1	1.17	86.02	1.43	67.23	1.65	54.95	1.05	94.62	1.03	96.64	1.17	90.09						
2	1.13	90.69	1.31	75.71	1.58	63.86	1.01	99.51	1.07	96.19	1.19	94.06						
3	1.07	94.02	1.22	85.25	1.39	72.80	1.01	99.15	1.03	96.72	1.15	94.40						
4	1.14	90.23	1.25	80.95	1.43	74.13	1.08	93.98	1.08	96.03	1.22	90.91						
5	1.13	90.63	1.60	67.44	1.93	58.20	1.03	96.88	1.16	92.25	1.43	85.25						
6	1.08	93.71	1.23	82.47	1.50	69.57	1.04	97.48	1.08	96.10	1.23	90.68						
7	1.20	89.06	1.43	77.61	1.48	72.99	1.07	96.09	1.07	95.52	1.17	93.43						
8	1.11	92.52	1.21	85.45	1.35	73.64	1.06	97.20	1.09	95.45	1.14	92.73						

Note. As presented in the Measures section, substance use was coded as follows: 1 (*none*), 2 (*1–3 times*), 3 (*4–6 times*), 4 (*7–9 times*), and 5 (*more than 9 times*). “No Use” are those reporting no use in the previous 30 days.

Table 3

Network Descriptive Data by Wave (Average and range across schools)

	Wave 1	Wave 2	Wave 3
Outdegree (per student)	8.41 (5.12–14.89)	13.44 (7.50–20.44)	14.32 (10.20–20.43)
Number of network ties	1451 (866–3424)	2256 (1267–4368)	2441 (1316–4698)
Reciprocity (percentage)	19.5% (15.2–27.3)	23.7% (18.4–32.2)	26.4% (22.3–29.0)
Density (percentage)	5.1% (3.1–6.5)	8.4% (4.5–13.6)	8.8% (6.9–11.0)
Alcohol use	1.13 (1.07–1.20)	1.35 (1.21–1.60)	1.55 (1.35–1.93)
Tobacco use	1.05 (1.01–1.08)	1.08 (1.03–1.16)	1.24 (1.14–1.43)
		Wave 1 to 2	Wave 2 to 3
Change in network membership			
Number leaving		12.13 (6.0–20.0)	13.88 (10.0–17.0)
Number joining		19.13 (10.0–35.0)	14.13 (3.0–35.0)
Change in network ties			
Distance (<i>n</i> of changed ties)		2366 (1585–4096)	2837 (1553–4618)
Jaccard's index		.20 (.13–.31)	.26 (.21–.33)
Change in behavior			
Stability: alcohol use (percentage)		80.0% (70.5–92.8)	71.2% (61.8–84.6)
Stability: tobacco use (percentage)		94.9% (91.1–97.5)	91.0% (82.7–95.0)

Note. Outdegree reflects the number of outgoing network ties. Reciprocity reflects the percentage of ties that are mutual. Density reflects the number of ties that exist as compared to the total possible number of ties. As presented in the Measures section, substance use was coded as follows: 1 (*none*), 2 (*1–3 times*), 3 (*4–6 times*), 4 (*7–9 times*), and 5 (*more than 9 times*). Change in network membership reflects the number of individuals leaving or joining the network between waves of measurement. With regards to change in network ties, distance reflects the total number of changed ties in the network between waves, and Jaccard Index representing the relative stability of the network, with our networks possessing a somewhat low but adequate level of stability (see Snijders et al., 2010). Change in behavior reflects the percentage of individuals reporting the same level of substance use across waves.

Table 4
Model Coefficients, Standard Errors, and Coefficient Variance Across 8 Schools (Alcohol Model)

Network Parameters	Mean Parameter			Standard Deviation		
	Est.	SE	p	Est.	χ^2	P
Reciprocity (tendency to reciprocate friend nominations)	1.23	.06	< .001	.19	88.26	< .001
Transitive triplets (tendency to nominate friends of friends—hierarchical)	.13	.01	< .001	.04	306.24	< .001
3-cycles (tendency to nominate friends of friends—egalitarian)	-.16	.02	< .001	.05	109.89	< .001
Sex: ego (tendency for outgoing nominations to differ by sex)	.01	.01	.44	.02	92.44	< .001
Sex: alter (tendency for incoming nominations to differ by sex)	-.02	.01	.01	.01	39.65	< .001
Sex: same (tendency to nominate same-sex friends)	.52	.05	< .001	.14	140.03	< .001
Ethnicity: ego (tendency for outgoing nominations to differ by ethnicity)	.05	.03	.16	.08	20.96	.002
Ethnicity: alter (tendency for incoming nominations to differ by ethnicity)	.03	.03	.29	.07	9.15	.17
Ethnicity: same (tendency to nominate same-ethnicity friends)	-.04	.04	.39	.13	62.10	< .001
Alcohol: similarity (tendency to nominate others with similar levels of use)	1.20	.32	.01	.90	29.47	< .001
Alcohol: alter (tendency for incoming nominations to differ as a function of use)	.19	.07	.04	.21	21.77	.003
Behavior Parameters						
Alcohol: linear shape	-1.93		< .001	.81	16.68	.02
Alcohol: quadratic shape	.42	.07	< .001	.19	14.33	.05
Alcohol: effect from sex (change in use as a function of sex)	-.02	.02	.35	.05	10.60	.16
Alcohol: effect from ethnicity (change in use as a function of ethnicity)	.00	.06	.99	.18	3.78	.81
Alcohol: indegree (change in use as a function of nominations)	.02	.01	.02	.02	6.53	.48

Table 5
Model Coefficients, Standard Errors, and Coefficient Variance Across 8 Schools (Tobacco Model)

Network Parameters	Mean Parameter			Standard Deviation		
	Est.	SE	p	Est.	χ^2	p
Reciprocity (tendency to reciprocate friend nominations)	1.21	.07	< .001	.20	85.38	< .001
Transitive triplets (tendency to nominate friends of friends – hierarchical)	.13	.01	< .001	.04	408.63	< .001
3-cycles (tendency to nominate friends of friends – egalitarian)	-.15	.02	< .001	.05	121.15	< .001
Sex: ego (tendency for outgoing nominations to differ by sex)	.01	.01	.22	.02	32.63	< .001
Sex: alter (tendency for incoming nominations to differ by sex)	-.02	.01	.03	.02	37.00	< .001
Sex: same (tendency to nominate same-sex friends)	.52	.05	< .001	.14	67.46	< .001
Ethnicity: ego (tendency for outgoing nominations to differ by ethnicity)	.06	.03	.07	.07	11.62	.07
Ethnicity: alter (tendency for incoming nominations to differ by ethnicity)	.03	.04	.52	.10	27.17	< .001
Ethnicity: same (tendency to nominate same-ethnicity friends)	-.03	.05	.63	.15	68.12	< .001
Tobacco: similarity (tendency to nominate others with similar levels of use)	.09	.04	.05	.11	5.57	.59
Tobacco: alter (tendency for incoming nominations to differ as a function of use)	.34	.30	.30	.73	9.46	.09
Behavior Parameters						
Tobacco: linear shape	-16.69	6.89	.06	16.88	92.89	< .001
Tobacco: quadratic shape	2.74	1.31	.17	2.26	9.00	.01
Tobacco: effect from sex (change in use as a function of sex)	-.01	.07	.90	.14	3.44	.33
Tobacco: effect from ethnicity (change in use as a function of ethnicity)	-.39	.31	.29	.62	1.32	.72
Tobacco: indegree (change in use as a function of nominations)	-.01	.02	.78	.04	1.47	.83