

## **Moderators of Friend Selection and Influence in Relation to Adolescent Alcohol Use**

Evelien M. Hoeben<sup>1</sup>, Kelly L. Rulison<sup>2</sup>, Daniel T. Ragan<sup>3</sup>, Mark E. Feinberg<sup>4</sup>

<sup>1</sup>Corresponding author. Email: [ehoeben@nscr.nl](mailto:ehoeben@nscr.nl), affiliation: Netherlands Institute for the Study of Crime and Law Enforcement (NSCR), Amsterdam, The Netherlands

<sup>2</sup>Email: [klr250@psu.edu](mailto:klr250@psu.edu), affiliation: Department of Human Development and Family Studies, Pennsylvania State University, University Park, USA

<sup>3</sup>Email: [dragan@unm.edu](mailto:dragan@unm.edu), affiliation: Department of Sociology, University of New Mexico, Albuquerque, USA

<sup>4</sup>Email: [mef11@psu.edu](mailto:mef11@psu.edu), affiliation: Prevention Research Center, Department of Human Development and Family Studies, Pennsylvania State University, University Park, USA

Please cite as:

Hoeben, E. M., Rulison, K. L., Ragan, D. T., & Feinberg, M. E.. (2021). Moderators of friend selection and influence in relation to adolescent alcohol use. *Prevention Science*, doi: 10.1007/s11121-021-01208-9.

## **Abstract**

*Friendships form an important context in which adolescents initiate and establish alcohol use patterns, but not all adolescents may be equally affected by this context. Therefore, this study tests whether parenting practices (i.e., parental discipline, parental knowledge, unsupervised time with peers) and individual beliefs (i.e., alcohol descriptive norms, positive social expectations, moral approval of alcohol use) moderate friend selection and influence around alcohol use. Stochastic actor-based models were used to analyze longitudinal social network and survey data from 12,335 adolescents (aged 11 to 17, 51.3% female) who were participating in the PROSPER project. A separate model was estimated for each moderating variable. Adolescents who reported consistent parental discipline, less unsupervised time with peers, higher descriptive alcohol use norms, and less positive social expectations about alcohol use were less likely to select alcohol-using friends. Those who reported consistent parental discipline, better parental knowledge, lower descriptive alcohol use norms, and less positive social expectations were more influenced by their friends' level of alcohol use. Thus, adolescents with these characteristics whose friends frequently use alcohol are at greater risk whereas those whose friends do not use alcohol are at lower risk of using alcohol. The findings show that, although selection and influence processes are connected, they may function in different ways for different groups of adolescents. For some adolescents, it is particularly important to prevent them from selecting alcohol-using friends, because they are more susceptible to influence from such friends. These peer network dynamics might explain how proximal outcomes targeted by many prevention programs (i.e., parenting practices and individual beliefs) translate into changes in alcohol use.*

**Key words:** Adolescent alcohol use; peer selection and influence; social network; parenting

Considerable work has shown that adolescents not only influence each other's alcohol use, but that they also select their friends based on alcohol intake (Light et al. 2013; Osgood et al. 2013). Less research, however, has focused on what characteristics are associated with befriending alcohol-using peers (i.e., moderation of friend selection) and what characteristics are associated with susceptibility to influence from friends (i.e., moderation of friend influence). Note that we focus on selection of alcohol-using friends more generally, which differs from the typical focus in sociometric research on homophilic selection (i.e., selecting friends with similar levels of alcohol use). Selection of alcohol-using friends—regardless of adolescents' own current alcohol use—is important because it creates the immediate peer context that can, in turn, affect future alcohol use (Urberg et al. 2003). In this study, we test two sets of potential moderators that are often targeted as proximal outcomes in alcohol use prevention programs: parenting practices and individual beliefs. Below, we draw on multiple theories and past empirical evidence to argue that these proximal outcomes may affect alcohol use by shaping friend selection and influence processes, which could clarify how interventions reduce or prevent alcohol use.

## Parenting Practices

Parents play an important role in shaping their children's behavior during adolescence (Steinberg and Silk 2002). Parenting practices such as *parental discipline* (e.g., parents' skill in regulating their child's behavior through fair and consistent versus through harsh and erratic discipline), efforts to gain *parental knowledge* (i.e., the extent to which parents know about their children's activities and whereabouts), and managing adolescents' *unsupervised time spent with friends* have all been linked to alcohol use (Warr 2005; Yap et al. 2017). Consequently, substance use prevention programs often target parenting practices as proximal outcomes (Bo et al. 2018; Molgaard et al. 2000; Spoth et al. 2011).

It is not clear, however, how parenting translates into changes in alcohol use. One possibility is that parenting practices may discourage adolescents from befriending alcohol-using peers, reducing their exposure to influence from these peers. These same practices may also limit the influence from any friendships with alcohol-using peers that adolescents do form. For example, adolescents may be more likely to accept and internalize parental rules—including rules regarding alcohol use and friendships with antisocial peers—when these rules are communicated and enforced in a consistent manner (Grusec and Goodnow 1994; Soenens et al. 2009).

Adolescents who tend to confide in their parents also might avoid activities they cannot tell their parents about, such as using alcohol or associating with antisocial peers (Stattin and Kerr 2000).

Further, unsupervised time with friends is likely to provide opportunities for the association with antisocial peers as well as for alcohol use (Hoeben and Weerman 2016; Osgood et al. 1996).

Based on these theoretical arguments, we hypothesize that adolescents who report less consistent discipline, who report less parental knowledge, and who spend more unsupervised time with their friends will be 1) more likely to befriend alcohol-using peers and 2) more susceptible to influence from their friends' alcohol use.

The few empirical studies that test whether parenting moderates peer selection and influence show mixed findings. With respect to selection, parenting styles characterized by consistent discipline and high parental knowledge have been associated with adolescents' having (i.e., selecting) fewer antisocial friends (Trudeau et al. 2012; Warr 2005), although some research suggests that adolescents whose parents are overcontrolling are more likely to have delinquent friends (Keijsers et al. 2012; Tilton-Weaver et al. 2013). Even less studies have tested the role of parenting practices specifically for the selection of *alcohol-using* peers. Warr (2005) found that the amount of unsupervised time with friends—which is to a large extent determined through parenting practices (Janssen et al. 2014)—is associated with adolescents having more alcohol-

using friends. Other studies found no effect of parental monitoring on the likelihood of selecting alcohol-using friends (McCann et al. 2019; Wang et al. 2015). With respect to influence, some studies have shown that parental monitoring and limited unsupervised time spent with peers reduces friend influence on alcohol use (Kiesner et al. 2010; Thorlindsson and Bernburg 2006), but other studies have found no evidence of this moderation (Light et al. 2013; Wang et al. 2015).

## **Individual Beliefs**

Individual beliefs about behavior and potential consequences of behavior—such as *descriptive norms* about alcohol use (i.e., perceptions of how many peers use alcohol), *positive social expectations* associated with alcohol use, and *moral approval* of underage alcohol use (i.e., whether it is “wrong”)—are robust predictors of alcohol use (Neighbors et al. 2007; Ragan 2014). These beliefs are frequently targeted in substance use prevention programs under the premise that these beliefs contribute to adolescents’ decisions on whether to use alcohol (Botvin and Griffin 2004; Lewis and Neighbors 2006; Molgaard et al. 2000).

Despite the strong direct relationship between individual beliefs and alcohol use, we know little about how such beliefs interact with peer dynamics and potentially translate into behavior (Hoeben and Thomas 2019). Adolescents who believe that most of their peers use alcohol and adolescents who expect social rewards from alcohol use (e.g., popularity and peer approval) may view alcohol use as a way to gain social acceptance (Cialdini et al. 1991; Deci and Ryan 2000). Therefore, this group might be more likely to seek alcohol-using friends and might be more susceptible to influence from these friends. Further, adolescents will likely befriend peers who display behavior that is in accordance with their own moral convictions, because they—consciously or unconsciously—try to ease communication and to avoid tension (Huston and Levinger 1978). In other words, adolescents who disapprove of alcohol use will be less likely to

befriend alcohol-using peers. Relatedly, because such adolescents have internal restraints against alcohol use (Tangney et al. 2007), they might be less likely to be influenced by their alcohol-using friends. Based on these theoretical arguments, we hypothesize that adolescents who perceive high descriptive alcohol use norms, who have positive social expectations about alcohol use, and who morally approve of alcohol use will be 1) more likely to befriend alcohol-using peers and 2) more susceptible to influence from their friends' alcohol use.

Few studies have empirically tested individual beliefs as moderators of friend selection or friend influence. With respect to friend selection, there is some indirect support for the moderating role of social expectations. Specifically, Laninga-Wijnen et al. (2017) found that aggression appeared to be a selection criterion for friendships only in contexts where it was associated with popularity, which could be indicative of the presence of positive social expectations about aggression in those contexts. A similar process might apply to alcohol use. With respect to friend influence, research supports the moderating roles of social expectations (Gallupe and Bouchard 2015) and morality (Thomas and McCuddy 2020; Vitaro et al. 2000).

## **Data and Methods**

We used data from the PROSPER project (Spoth et al. 2011), a community prevention trial in 28 rural and semi-rural school districts in Iowa and Pennsylvania. In the original study, researchers recruited districts that enrolled between 1,300 and 5,200 students and had at least 15% of families who qualified for reduced-price lunch. Districts were blocked on size and location and randomly assigned to a control or intervention condition. All adolescents at intervention schools could participate in a universal family-focused program in 6<sup>th</sup> grade and one of three universal school-based programs in 7<sup>th</sup> grade. Starting in 2002, students from two successive 6<sup>th</sup> grade cohorts completed in-school surveys in the fall and spring of 6<sup>th</sup> grade and

every spring thereafter through 12<sup>th</sup> grade (8 waves total). In this study, we excluded the first wave so the time period between waves was consistent and the last wave when participation rates were lower than in earlier waves. Thus, we used the middle six waves of data (i.e., spring 7<sup>th</sup> grade through spring 11<sup>th</sup> grade) including students from both intervention and control schools.

### **Measures**

All variables in our models were measured at each wave and treated as time-varying, with the exception of *gender* and *race/ethnicity*, which were treated as time-stable.

**Friendships.** At each wave, adolescents nominated up to two best friends and five close friends from their school and grade. Researchers successfully matched about 80% of all friendship nominations to the names of other participants; names could not be matched when they were not included on the school roster (18%) or when multiple matches were plausible (2%). These nominations allowed us to match identified friends to their own self-reported attributes and, thus, to obtain direct rather than perceived friend measures. Because friendship nominations were confined to friends within the same school and grade, we consider this set of peers as the pool of potential friends, and refer to these school-grade combinations as “networks”.

**Alcohol use.** We used a one-item measure of past-month alcohol consumption: “During the past month, how many times have you had beer, wine, wine coolers, or other liquor?”, with response options ranging from 0 (not at all) to 5 (more than once a week). We recoded these responses into three categories: none, once, and two or more times, because initial rates of use were too low to support finer distinctions. Table 1 provides descriptive statistics for all variables.

**Moderating variables.** Our first set of potential moderators were different parenting practices: **Parental discipline** ( $\alpha = 0.80$ ) was the mean of five items (e.g., “When I do something wrong, my parents lose their temper and yell at me”), with responses ranging from 1 (always) to 5 (never). Higher values indicated more consistent, less harsh discipline. **Parental**

**knowledge** ( $\alpha = 0.84$ ) was the mean of five items (e.g., “During the day, my parents know where I am”), with responses ranging from 1 (never) to 5 (always). Higher values indicated that adolescents believed their parents knew more about their activities, friends, and whereabouts.

**Unsupervised time spent with friends** was the maximum time adolescents spent with any of their nominated friends “just hanging out outside of school without adults around”. Adolescents answered this item separately for each nominated friend, with response options ranging from 0 (never) to 4 (almost every day), and we used the maximum value across all nominated friends.

Our second set of potential moderators were related to beliefs about alcohol use:

**Descriptive norms** about alcohol use were measured with one item: “In general, how many people your age do you think drink beer, wine or liquor?”, with responses ranging from 1 (none or almost none) to 5 (all or almost all). Positive **social expectations** of alcohol use ( $\alpha = 0.88$ ) was the mean of five items on whether adolescents associated alcohol use with friendship and popularity (e.g., “Drinking alcohol makes you look cool”), with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Finally, **moral approval** of underage alcohol use was measured with one item: “How wrong do you think it is for someone your age to drink beer, wine, or liquor?”, with response options ranging from 1 (very wrong) to 4 (not at all wrong).

**Control variables.** We controlled for variables that have been linked to friendship processes in prior research (Osgood et al. 2015; Ragan 2020): gender (**male** = 1), race/ethnicity (**Non-Hispanic White** = 1), and family structure (**lives with both biological parents** = 1).

### **Statistical Model**

We tested our hypotheses by estimating stochastic actor-based models for each network using the Simulation Investigation for Empirical Network Analysis (SIENA) program (Ripley et al. 2020; Snijders 2001; Steglich et al. 2010). We then combined the parameter estimates from

each network using hierarchical linear modeling (HLM). Below, we provide a brief overview of these methods and types of parameters included in our models.

To model change in panel data, SIENA begins with data observed at one wave and, based on the model and tentative parameter estimates, simulates resulting changes in the data to determine what processes would lead to the data observed at the next wave. Specifically, SIENA uses simulations to jointly estimate two models: One for network change and one for behavior change, using a multinomial logit distribution for both types of change. During the simulations, SIENA randomly selects an actor (i.e., one of the adolescents) who “decides” whether to change their network (i.e., a friendship tie is created, maintained, or dropped) or behavior (i.e., alcohol use increases, remains unchanged, or decreases). The likelihood of a specific change is determined by the current estimates of the model parameters, the actor’s (and other respondents’) characteristics at the current wave, and the currently simulated friendship patterns. For example, if the selected actor has many alcohol-using friends at wave two, a positive parameter estimate for peer influence would indicate a tendency for the actor to increase their own alcohol use at wave three during this step in the simulation. This process is repeated, updating estimates of model parameters to identify the values that are most likely to produce patterns in the simulated data that are comparable to those in the data observed at the next wave. By default, SIENA constrains each model parameter to remain the same over time (e.g., peer influence is assumed to be the same from wave two to three as it is from wave three to four). Thus, the data at each wave inform the simulations that produce the patterns observed at the following wave, and the final estimates correspond to average changes across all waves in the data. Note that the estimates are based on observational data and, therefore, do not prove causation.

Our models included three categories of network parameters that captured how covariates were associated with friendship nominations: (1) *ego* parameters, to capture the association

between the covariate and the tendency to *name* friends, (2) *alter* parameters, to capture the association between the covariate and the tendency to *receive* friendship nominations, and (3) *similarity* parameters, to capture the tendency of friendships to form between adolescents who have similar values on the covariate. Each model included ego, alter, and similarity effects for gender, race/ethnicity, alcohol use, and one of the moderating variables.

We also included network parameters to control for aspects of the network structure that can drive friendship changes: *outdegree (density)*, *reciprocity*, *transitive triplets*, *transitive reciprocated triplets*, *indegree popularity (square root)*, *outdegree truncated at one*, and *indegree assortativity*. We selected these terms based on a combination of past empirical studies of adolescent friendship networks (e.g., Osgood et al. 2013) and a series of model fitting steps to determine which measures provided the best goodness-of-fit statistics across our entire set of networks. We also accounted for changes in overall rates of friendship choice due to the *merging* of multiple schools into a single school or the *transition* from middle school to high school. A description of these structural parameters is included in Online Resource Appendix A and can also be found in other papers that have applied SIENA to the PROSPER data (e.g., Ragan 2020).

Our behavioral parameters captured the association between changes in the covariates and alcohol use. *Friends' alcohol use* measures friend influence and represents the association between the mean of friends' alcohol use and changes in adolescents' own use. *Individual-level behavioral parameters* for gender, race/ethnicity, family structure, and each of the moderators controlled for the association between adolescents' own characteristics and alcohol use.

We included two interaction terms in each model, visualized in Online Resource Appendix B. First, to test whether adolescents differed in their tendency to select friends based on alcohol use, we included an interaction between the *ego* parameter for the moderating variable and the *alter* parameter for alcohol use. Second, to test whether influence differed across

adolescents, we included an interaction between the *individual-level behavioral parameter* for the moderating variable and the parameter for the mean of *friends' alcohol use*. Given the complexity of our modeling approach, we estimated a separate model for each moderating variable. Each model included the alter, ego, and similarity network effects for the moderating variable, the main effect of the moderating variable on alcohol use, and interaction terms for selection and influence. All other parameters were identical across models, including behavior and friendship rate functions to adjust for the number of changes in alcohol use and network ties, respectively, and linear and quadratic shape parameters that assessed a preference toward higher or lower values on alcohol use over time.

We excluded one school district (two networks) that declined to collect social network data, another district (two networks) because a school closing after a fire created a chaotic pattern of school transitions, and one network due to a missing wave of data. Finally, we excluded five networks that did not achieve acceptable convergence in one or more of our models (i.e., the patterns in the simulated data did not match the patterns in the observed data). Thus, our final sample consisted of 12,335 adolescents in the 46 networks that met the convergence criteria (i.e., convergence  $t$  values less than  $+/- 0.10$  for all parameter estimates and overall maximum  $t$  ratios for convergence below 0.25 for each model) across all of our models.

Once we derived estimates of the model parameters from the 46 networks in SIENA, we conducted a meta-analysis using a series of “variance-known” HLM models to obtain the mean and  $p$  value of each parameter across the 46 networks. To account for clustering, the models included random effects for school districts at level three and for networks (i.e., school-grade combinations) at level two. At level one, our estimates of the model parameters from SIENA were used as the outcomes, with the precision of those estimates (i.e., their squared standard errors) serving as known variances. Thus, the estimated coefficient that we present from each

unconditional model is essentially a weighted mean from parameters across 46 networks, where parameter estimates with *small* standard errors contributed *more* to the final estimate.

## Results

### ***Moderators of Selection and Influence — Parenting Practices***

Table 2 provides the mean SIENA estimates for the parenting variables. In the interest of parsimony, the Table presents only the parameter estimates related to alcohol use and the moderating variables; the remaining estimates can be found in Online Resource Appendix A.

The top half of Table 2 shows the results for the friendship network parameters related to alcohol use and parenting. In terms of main effects, we found that across all three models, adolescents who used alcohol named fewer friends than their peers (i.e., negative alcohol use ego effects) and adolescents were more likely to form friendships with peers who had similar levels of alcohol use (i.e., positive alcohol use similarity effects). There were also significant estimates of the parenting variables on the number of friendship nominations received: Adolescents whose parents provided consistent discipline and those who reported higher parental knowledge received significantly *fewer* friendship nominations (i.e., negative parenting alter effects) whereas adolescents who spent more unsupervised time with friends received significantly *more* friendship nominations (i.e., positive parenting alter effect).

Consistent with our hypotheses about moderation of friend selection, we found that adolescents whose parents provided consistent discipline were *less* likely than their peers to select alcohol-using friends ( $\beta = -0.019, p < 0.01$ ) and that adolescents who spent more unsupervised time with friends were *more* likely than their peers to select alcohol-using friends ( $\beta = 0.020, p < 0.01$ ). Contrary to our hypothesis, parental knowledge was not a significant moderator of friend selection. To facilitate interpretation of the significant interactions, we plotted the odds ratios for

selecting high versus non-alcohol using friends in Figs. 1a and 1b (for calculations, see Online Resource Appendix C). Values above 1 indicate a pull toward selecting high alcohol-using friends (i.e., friends who reported using alcohol two or more times in the past month) and values below 1 indicate a pull toward selecting non-alcohol using friends. Figure 1a shows that, compared to adolescents who reported low consistent discipline, adolescents who reported high consistent discipline were less likely to select high alcohol-using friends. Even adolescents who reported high alcohol use—and who were thus drawn to peers with similar levels of alcohol use—were somewhat protected by high consistent discipline, as shown by the lower odds ratio for these adolescents compared to those who reported low consistent discipline (1.320 versus 1.537). Figure 1b shows that, compared to their peers, adolescents who reported spending relatively more unsupervised time with friends were also more likely to select high versus non-alcohol using friends.

The bottom half of Table 2 shows the results for the behavior (i.e., alcohol use) parameters. Contrary to our hypotheses, we found that adolescents who reported consistent discipline were *more* influenced by friends' level of alcohol use ( $\beta = 0.086, p < 0.05$ ) as were adolescents who reported higher parental knowledge ( $\beta = 0.168, p < 0.05$ ). Unsupervised time with friends was not a significant moderator of friend influence. The significant interaction effects are plotted in Figs. 2a and 2b, which display the odds ratios for reporting high versus no alcohol use based on adolescent's characteristics and their friends' average alcohol use (for calculations, see Online Resource Appendix C). Values above 1 indicate a pull toward high alcohol use and values below 1 indicate a pull toward no alcohol use. Given that few adolescents solely had friends whose alcohol use was at the highest level, we also plotted the odds ratios for adolescents whose friends' average alcohol use was moderate (i.e., all of their friends reported using alcohol one time in the past month or they had both high alcohol-using and non-alcohol

using friends). Figure 2a shows that all adolescents were influenced by their friends' alcohol use, but that the influence was greater for those who reported high consistent discipline. That is, compared to adolescents who reported low consistent discipline, those who reported high consistent discipline were *less* likely to use alcohol when they had non-alcohol using friends (0.179 versus 0.586) and when their friends' average alcohol use was moderate (1.191 versus 1.961) and they were *more* likely to use alcohol when their friends' alcohol use was high (7.928 versus 6.559). Figure 2b shows similar results for parental knowledge.

### ***Moderators of Selection and Influence — Individual Beliefs***

Table 3 provides the mean SIENA estimates for the individual belief variables. After controlling for the individual belief ego variables, there were no unique effects of alcohol use on the number of friends named (i.e., alcohol use ego effects) but adolescents were still more likely to form friendships with peers who had similar levels of alcohol use (i.e., alcohol use similarity effects). Additionally, we found that adolescents who reported positive social expectations of alcohol use and those who morally approved of underage alcohol use received significantly *more* friendship nominations than other adolescents (i.e., positive beliefs alter effects).

Contrary to our hypothesis about moderation of friend selection, we found that adolescents who reported *lower* descriptive alcohol use norms were *more* likely to befriend alcohol-using peers ( $\beta = -0.047, p < 0.001$ ). Consistent with our hypothesis, we found that adolescents who had positive social expectations of alcohol use were more likely to befriend alcohol-using peers ( $\beta = 0.019, p < 0.05$ ). We plotted these significant interactions in Figs. 1c and 1d. Figure 1c shows that adolescents with high descriptive alcohol use norms were less likely than those with low descriptive norms to select high alcohol-using friends (i.e., odds ratios are 0.785 versus 1.144 for adolescents who reported no alcohol use; 1.008 versus 1.467 for adolescents who reported high alcohol use). Figure 1d shows that adolescents with high social

expectations of alcohol use were more likely than those with low social expectations to select high alcohol-using friends (i.e., odds ratios are 1.070 versus 0.919 for adolescents who reported no alcohol use; 1.497 versus 1.286 for adolescents who reported high alcohol use).

Contrary to our hypotheses about moderators of friend influence, we found that adolescents who reported higher descriptive alcohol use norms were *less* influenced by their friends' alcohol use ( $\beta = -0.095, p < 0.01$ ) as were adolescents with more positive social expectations of alcohol use ( $\beta = -0.136, p < 0.01$ ). Figure 2c shows that all adolescents were influenced by their peers, but influence was stronger for those with low descriptive norms. Thus, compared to those with high descriptive norms, adolescents with low descriptive norms were *less* likely to use alcohol if they had non-alcohol using friends (0.123 versus 0.555) or when their friends' alcohol use was moderate (0.832 versus 1.758), and they were *more* likely to use alcohol when their friends' alcohol use was high (5.640 versus 5.569). Figure 2d shows similar results for social expectations. Moral approval was not a significant moderator of either friend selection or friend influence.

### ***Supplemental Analyses***

Given that half of the schools had been assigned to the PROSPER intervention program, we tested whether the main results varied systematically by intervention condition. To do so, a binary indicator (i.e., control versus intervention school) was entered as a grand mean-centered level-three (school district) covariate into the HLM analyses. The results are available in Online Resource Appendix D. At conventional levels of statistical significance ( $p < 0.05$ ), we observed differences in only 2 of the 36 parameter estimates (i.e., the behavioral interaction parameter in the model for social expectations and the alcohol use alter parameter in the model for moral approval), suggesting that our main results are largely independent of intervention status.

## **Discussion**

Alcohol use prevention programs often target parenting practices and individual beliefs as proximal outcomes. With good reason, since these factors play an essential role in the etiology of adolescent drinking (Raitasalo et al. 2021; Ragan 2014; Yap et al. 2017). To clarify *how* parenting practices and individual beliefs might translate into reductions in alcohol use, we tested whether they moderate processes of friend selection and friend influence.

With respect to parenting practices, we found support for two of our hypotheses about selection: Adolescents who reported high consistent discipline and those who reported spending less unsupervised time with peers were *less* likely to befriend alcohol-using peers. There was no moderating effect of parental knowledge. By contrast, two of our findings were contradictory to our hypotheses about influence. Specifically, we found that adolescents who reported high consistent discipline and high parental knowledge were *more* likely to be influenced by their friends' level of alcohol use. Importantly, this greater susceptibility to friend influence was protective for adolescents whose friends did not drink or drank moderately: Adolescents who reported high consistent discipline and high parental knowledge were more likely to be pulled toward non-use by their non- or moderately alcohol-using friends. Of course, this effect also meant that the adolescents who *did* have high alcohol-using friends were at higher risk of alcohol use (i.e., high consistent discipline and high parental knowledge can be counterproductive). Notably, however, the protective effect was substantially stronger than the small increased risk for adolescents with high alcohol-using friends (see Figs. 2a and 2b). Rather than a counterproductive effect, the findings might also indicate that adolescents begin receiving more attention from their parents due to their alcohol use, although such a bidirectional association is less likely given the set-up of our models, in which the parenting covariates predict alcohol use at a later time point. Taken together, our results suggest that one way in which parenting practices

shape alcohol use is by shaping peer processes. Intervention content for parents should highlight the critical role they play in limiting their adolescents' exposure to alcohol-using peers. Specifically, parenting practices—such as consistent discipline and ensuring that adolescents spend limited unsupervised time with peers—can reduce adolescents' exposure to risky peer contexts. In turn, these adolescents are then positively influenced by their friends' limited or non-alcohol use. Future research is needed to clarify how these same practices increase risks for the few adolescents who do select high alcohol-using friends.

With respect to individual beliefs, we found support for one hypothesis about friend selection: Adolescents who have positive social expectations of alcohol use are more likely to select alcohol-using friends, which is in line with previous work on peer dynamics and aggression (Laninga-Wijnen et al. 2017). By contrast, our finding that adolescents with high descriptive norms were *less* likely than those with low descriptive norms to befriend alcohol-using peers was opposite to our hypothesis. Further, two of our findings were opposite to our hypotheses about influence. Specifically, we found that adolescents with low descriptive alcohol use norms and those who have negative social expectations of alcohol use were *more* likely to be influenced by their friends' alcohol use. As with the parenting moderating effects, higher susceptibility to friend influence among adolescents who reported low descriptive alcohol use norms and negative social expectations was protective against alcohol use for those adolescents who had non- or moderately alcohol-using friends. As with the parenting factors, this effect also meant that the adolescents who *did* have high alcohol-using friends were at higher risk of alcohol use, although this increased risk was relatively small compared to the protective effect for adolescents with non- or moderately alcohol-using friends (see Figs. 2c and 2d).

This study shows that moderators of friend *selection* and friend *influence* may not have the same ultimate impact on alcohol use: factors may amplify the risk for selecting alcohol-using

friends but mitigate the effects of influence from such friends, or vice versa. Our findings indicate that, while processes of selection and influence are connected, they may function in different ways for different groups of individuals. Future work needs to continue exploring what drives friend selection and influence. Friend selection in particular remains an understudied phenomenon, even though it is crucial in the formation of adolescents' peer context.

These insights help clarify how substance use prevention programs may ultimately reduce alcohol use. For example, many programs aim to enhance parental skills (Molgaard et al. 2000), reduce unsupervised time with peers (Mahoney et al. 2001), "correct" the perceived descriptive norm of alcohol use (Lewis and Neighbors 2006), and reduce positive social expectations about alcohol use (Botvin and Griffin 2004). Our findings suggest that several of these proximal outcomes may impact later alcohol use by shaping who adolescents select as friends—and, thereby, the peer context to which they are exposed. In turn, adolescents who report high consistent discipline, high parental knowledge, or negative social expectations about alcohol use are likely to be influenced toward non-use by their friends' limited or non-use. Notably, we did find that these same factors slightly increased the risk of alcohol use among adolescents who had high alcohol-using friends. Our findings do not shed light on how interventions aimed at "correcting" descriptive norms would reduce alcohol use, as adolescents with low descriptive norms were both more likely to select alcohol-using peers *and* more likely to be influenced by these peers. Future work is needed to clarify the mechanisms underlying the identified counterproductive effects of parenting practices and social expectations, and to explain how perceived descriptive norms translate into alcohol use.

### ***Limitations***

Our findings should be interpreted in context. First, the sample primarily included non-Hispanic White adolescents from non-urban communities, which may limit the generalizability of

the findings. Notably, although peer processes may be different in more urban, ethnically diverse communities, a recent meta-analysis on delinquency suggests that effect sizes for selection and influence processes found in the PROSPER data are comparable to those found in other samples (Gallupe et al. 2019). Second, respondents could only name same-grade, same-school friends, whereas selection and influence processes may operate differently when friends are from different grades (i.e., older or younger) or from other schools (e.g., neighborhood-based friendships). Third, the relative contribution of parenting practices and individual beliefs in friend selection and influence processes could not be determined and, thus, future work should explore to what extent the individual beliefs-peer dynamics association is mediated or moderated by parenting practices (Soenens et al. 2009). Fourth, our SIENA models constrain the parameters to be stable over time. To test for developmental changes, we would have to analyze three-way interactions between model parameters, dummy variables for each time period, and the moderators (i.e., parenting practices and individual beliefs), which is beyond what can be reliably estimated with the current version of SIENA and our data.

In conclusion, we repeat the call of others (Gest et al. 2011; Wang et al. 2015) about the importance of understanding how social networks might shape outcomes within prevention programs. In the current study, we show that parenting practices and individual beliefs affect friend selection and influence. These insights, while shedding light on how substance use prevention programs might shape alcohol use, also point to the lack of universality of peer dynamics: Not everyone is equally likely to befriend alcohol-using peers or is equally susceptible to influence from their friends.

## **Compliance with Ethical Standards**

**Funding.** This work was supported by grants from the W.T. Grant Foundation [8316]; National Institute on Drug Abuse [R01-DA018225]; National Institute of Child Health and Human Development [R24-HD041025], and the Dutch Research Council [VI.Veni.191R.003]. The data are from PROSPER, a project directed by R. L. Spoth, funded by the National Institute on Drug Abuse [R01-DA013709]. The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

**Ethics Approval.** The procedures for the overarching PROSPER study were approved by the IRB committees of Iowa State University and Pennsylvania State University. The PROSPER Peers study was approved separately by the IRB committee at Pennsylvania State. The study was performed in line with the principles of the Declaration of Helsinki.

**Conflicts of Interest.** The authors have no relevant financial or non-financial interests to disclose.

**Consent to Participate.** All participants and their parents provided informed consent, as approved by the IRB.

**Replication.** To inquire about the conditions for access to the data, please contact the first author. The analytical code for this project has been deposited to OSF (<https://osf.io/we3dj/>).

## **Electronic Supplementary Material**

Appendix A: Description and Outcomes of Structural Network Parameters

Appendix B: Visual Depiction of the Theoretical Model

Appendix C: Creating Figs. 1 and 2 to Interpret the Interaction Effects

Appendix D: Supplemental Analyses on Treatment Effects

## References

- Bo, A., Hang Hai, A., & Jaccard, J. (2018). Parent-based interventions on adolescent alcohol use outcomes: A systematic review and meta-analysis. *Drug and Alcohol Dependence*, 191(1), 98-109.
- Botvin, G. J., & Griffin, K. W. (2004). Life skills training: Empirical findings and future directions. *The Journal of Primary Prevention*, 25(2), 211-232.
- Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology*, 24(1), 201-234.
- Deci, E. L., & Ryan, R. M. (2000). The ‘what’ and ‘why’ of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227-268.
- Gallupe, O., & Bouchard, M. (2015). The influence of positional and experienced social benefits on the relationship between peers and alcohol use. *Rationality and Society*, 27(1), 40-69.
- Gallupe, O., McLevey, J., & Brown, S. (2019). Selection and influence: A meta-analysis of the association between peer and personal offending. *Journal of Quantitative Criminology*, 35(2), 313-335.
- Gest, S. D., Osgood, D. W., Feinberg, M. E., Bierman, K. L., & Moody, J. (2011). Strengthening prevention program theories and evaluations: Contributions from social network analysis. *Prevention Science*, 12(1), 349-360.
- Grusec, J. E. & Goodnow, J. J. (1994). Impact of parental discipline methods on the child’s internalization values: A reconceptualization of current points of view. *Developmental Psychology*, 30(1), 4-19.
- Hoeben, E. M. & Thomas, K. J. (2019). Peers and offender decision-making. *Criminology and*

*Public Policy*, 18(4), 759-784.

Hoeben, E. M. & Weerman, F. M. (2016). Why is involvement in unstructured socializing related to adolescent delinquency? *Criminology*, 54(2), 242-281.

Huston, T. L., & Levinger, G. (1978). Interpersonal attraction and relationships. *Annual Review of Psychology*, 29(1), 115-156.

Janssen, H. J., Dekovic, M., & Bruinsma, G. J. N. (2014). Parenting and time adolescents spend in criminogenic settings: A between- and within-person analysis. *British Journal of Criminology*, 54(4), 551-567.

Keijsers, L., Branje, S., Hawk, S. T., Schwartz, S. J., Frijns, T., Koot, H. M., et al. (2012). Forbidden friends as forbidden fruits: Parental supervision of friendships, contact with deviant peers, and adolescent delinquency. *Child Development*, 83(2), 651-666.

Kiesner, J., Poulin, F., & Dishion, T. J. (2010). Adolescent substance use with friends: Moderating and mediating effects of parental monitoring and peer activity contexts. *Merrill Palmer Q*, 56(4), 529-556.

Lanninga-Wijnen, L., Harakeh, Z., Steglich, C., Dijkstra, J. K., & Veenstra, R. (2017). The norms of popular peers moderate friendship dynamics of adolescent aggression. *Child Development*, 88(4), 1265-1283.

Lewis, M. A., & Neighbors, C. (2006). Social norms approaches using descriptive drinking norms education: A review of the research on personalized normative feedback. *Journal of American College Health*, 54(4), 213-218.

Light, J. M., Greenan, C. C., Rusby, J. C., Nies, K. M., & Snijders, T. A. B. (2013). Onset to first alcohol use in early adolescence: A network diffusion model. *Journal of Research on Adolescence*, 23(3), 487-499.

- Mahoney, J. L., Stattin,H., & Magnusson, D. (2001). Youth recreation centre participation and criminal offending: A 20-year longitudinal study of Swedish boys. *International Journal of Behavioral Development*, 25(6), 509-520.
- McCann, M., Jordan, J.-A., Higgins, K., & Moore, L. (2019). Longitudinal social network analysis of peer, family, and school contextual influences on adolescent drinking frequency. *Journal of Adolescent Health*, 65(3), 350-358.
- Molgaard, V. M., Spoth R. L., & Redmond, C. (2000). *Competency training: The Strengthening Families Program for Parents and Youth 10-14*. Juvenile Justice Bulletin. Washington DC: U.S. Department of Justice.
- Neighbors, C., Lee, C. M., Lewis, M. A., Fossos, N., & Larimer, M. E. (2007). Are social norms the best predictor of outcomes among heavy-drinking college students? *Journal of Studies on Alcohol and Drugs*, 68(4), 556-565.
- Osgood, D. W., Feinberg, M. E., & Ragan, D. T. (2015). Social networks and the diffusion of adolescent behavior: Reliable estimates of selection and influence from sixth through ninth grades. *Prevention Science*, 16(6), 832-843.
- Osgood, D. W., Ragan, D. T., Wallace, L., Gest, S. D., Feinberg, M. E., & Moody, J. (2013). Peers and the emergence of alcohol use: Influence and selection processes in adolescent friendship networks. *Journal of Research on Adolescence*, 23(3), 500-512.
- Osgood, D. W., Wilson, J. K., O'Malley, P. M., Bachman, J. G., & Johnston, L. D. (1996). Routine activities and individual deviant behavior. *American Sociological Review*, 61(4), 635-655.
- Ragan, D. T. (2014). Revisiting ‘What they think’: Adolescent drinking and the importance of peer beliefs. *Criminology*, 52(3), 488-513.

- Ragan, D. T. (2020). Similarity between deviant peers: Developmental trends in influence and selection. *Criminology*, 58(2), 336-369.
- Raitasalo, K., Kraus, L., Bye, E. K., Karlsson, P., Tigerstedt, C., Törrönen, J., et al. (2021). Similar countries, similar factors? Studying the decline of heavy episodic drinking in adolescents in Finland, Norway, and Sweden. *Addiction*, 116, 62-71.
- Ripley, R. M., Snijders, T. A. B., Boda, Z., Vörös, A., & Preciado, P. (2020). *Manual for RSiena*. Oxford, England: University of Oxford, Department of Statistics, Nuffield College.
- Snijders, T. A. B. (2001). The statistical evaluation of social network dynamics. *Sociological Methodology*, 31(1), 361-395.
- Soenens, B., Vansteenkiste, M., & Niemiec, C. P. (2009). Should parental prohibition of adolescents' peer relationships be prohibited? *Personal Relationships*, 16(4), 507-530.
- Spoth, R., Redmond, C., Clair, S., Shin, C., Greenberg, M., & Feinberg, M. (2011). Preventing substance misuse through community-university partnerships: Randomized controlled trial outcomes 4 ½ years past baseline. *American Journal of Preventive Medicine*, 40(4), 440-447.
- Stattin, H., & Kerr, M. (2000). Parental monitoring: A reinterpretation. *Child Development*, 71(4), 1072-1085.
- Steglich, C., Snijders, T. A. B., & Pearson, M. (2010). Dynamic networks and behavior: Separating selection from influence. *Sociological Methodology*, 40(1), 329-393.
- Steinberg, L., & Silk, J. S. (2002). Parenting adolescents. In M. H. Bornstein (Ed.), *Handbook of parenting* (pp. 103-134). London: Lawrence Erlbaum Associates, Publishers.
- Tangney, J. P., Stuewig, J., & Mashek, D. J. (2007). Moral emotions and moral behavior. *Annual Review of Psychology*, 58(1), 345-372.
- Thomas, K. J. & McCuddy, T. (2020). Affinity, affiliation, and guilt: Examining between- and

- within-person variability in delinquent peer influence. *Justice Quarterly*, 37(4), 715-738.
- Thorlindsson, T. & Bernburg, J. G. (2006). Peer groups and substance use: Examining the direct and interactive effect of leisure activity. *Adolescence*, 41(162), 321-339.
- Tilton-Weaver, L. C., Burk, W. J., Kerr, M., & Stattin, H. (2013). Can parental monitoring and peer management reduce the selection or influence of delinquent peers? Testing the question using a dynamic social network approach. *Developmental Psychology*, 49(11), 2057-2070.
- Trudeau, L., Mason, W. A., Randall, G. K., Spoth, R., & Ralston, E. (2012). Effects of parenting and deviant peers on early to mid-adolescent conduct problems. *Journal of Abnormal Child Psychology*, 40(1), 1249-1264.
- Urberg, K. A., Luo, Q., Pilgrim, C., & Degirmencioglu, S. M. (2003). A two-stage model of peer influence in adolescent substance use: Individual and relationship-specific differences in susceptibility to peer influence. *Addictive Behaviors*, 28(7), 1243-1256.
- Vitaro, F., Brendgen, M., & Tremblay, R. E. (2000). Influence of deviant friends on delinquency: Searching for moderator variables. *Journal of Abnormal Child Psychology*, 28(4), 313-325.
- Wang, C., Hipp, J. R., Butts, C. T., Jose, R., & Lakon, C. M. (2015). Alcohol use among adolescent youth: The role of friendship networks and family factors in multiple school studies. *PLoS ONE*, 10(3), 1-19.
- Warr, M. (2005). Making delinquent friends: Adult supervision and children's affiliations. *Criminology*, 43(1), 77-106.
- Yap, M. B. H., Cheong, T. W. K., Zaravinos-Tsakos, F., Lubman, D. I., & Jorm, A.F. (2017). Modifiable parenting factors associated with adolescent alcohol misuse: A systematic review and meta-analysis of longitudinal studies. *Addiction*, 112(7), 1142-1162.

Table 1. Descriptive statistics

	Mean	SD	Min.	Max.
Alcohol use	0.457	0.762	0	2
<i>None</i>	0.709	—	—	—
<i>Once</i>	0.124	—	—	—
<i>Two or more times</i>	0.166	—	—	—
Male	0.487	—	0	1
Non-Hispanic White	0.848	—	0	1
Lives with two parents	0.604	—	0	1
Parental discipline	3.526	0.965	1	5
Parental knowledge	4.183	0.807	1	5
Time with friends	3.951	1.195	1	5
Descriptive norms	3.080	1.195	1	5
Social expectations	1.755	0.960	1	5
Moral approval	0.993	1.029	0	3

Values across 46 networks with  $N = 12,335$ .

Table 2. Selected SIENA parameter estimates: Models for parenting variables

	Model 1: Parental Discipline			Model 2: Parental Knowledge			Model 3: Time with Friends		
	OR	b	SE	OR	b	SE	OR	b	SE
<b>Friendship Network Parameters</b>									
<i>Number of friendship nominations received (i.e., covariate selection)</i>									
Parenting alter <sup>a</sup>	0.99	-0.015 **	0.004	0.96	-0.036 ***	0.007	1.01	0.013 **	0.004
Alcohol use alter	1.08	0.074 ***	0.007	1.06	0.063 ***	0.007	1.07	0.069 ***	0.007
<i>Number of friendship nominations made</i>									
Parenting ego <sup>a</sup>	1.02	0.018 ***	0.004	1.05	0.044 ***	0.006	1.02	0.018 **	0.005
Alcohol use ego	0.96	-0.041 ***	0.009	0.97	-0.026 *	0.010	0.94	-0.057 ***	0.010
<i>Choosing similar friends (i.e., homophilic selection)</i>									
Parenting similarity <sup>a</sup>	1.14	0.134 ***	0.020	1.10	0.093 **	0.028	1.12	0.118 ***	0.016
Alcohol use similarity	1.20	0.186 ***	0.027	1.20	0.181 ***	0.022	1.21	0.193 ***	0.027
<i>Moderation of friend selection</i>									
Parenting ego <sup>a</sup> x Alcohol use alter	0.98	-0.019 **	0.006	0.98	-0.023 †	0.012	1.02	0.020 **	0.006
<b>Alcohol Use Parameters</b>									
<i>Friends' attributes (i.e., influence)</i>									
Friends' alcohol use	2.27	0.821 ***	0.048	2.30	0.834 ***	0.051	2.23	0.803 ***	0.052
<i>Individual behavioral parameters (i.e., effect on alcohol use)</i>									
Parenting <sup>a</sup>	0.90	-0.109 ***	0.009	0.82	-0.203 ***	0.015	1.10	0.099 ***	0.009
<i>Moderation of friend influence</i>									
Parenting ego <sup>a</sup> x Friends' alcohol use	1.09	0.086 *	0.037	1.18	0.168 *	0.072	0.95	-0.050	0.044

Models also include parameters for rates, shape, structure, race/ethnicity, gender, and living with two parents. Values across 46 networks with  $N = 12,335$ .

<sup>a</sup>This parameter is specific to the moderator variable in each model (e.g., in Model 1 it refers to parental discipline).

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; † $p < 0.10$

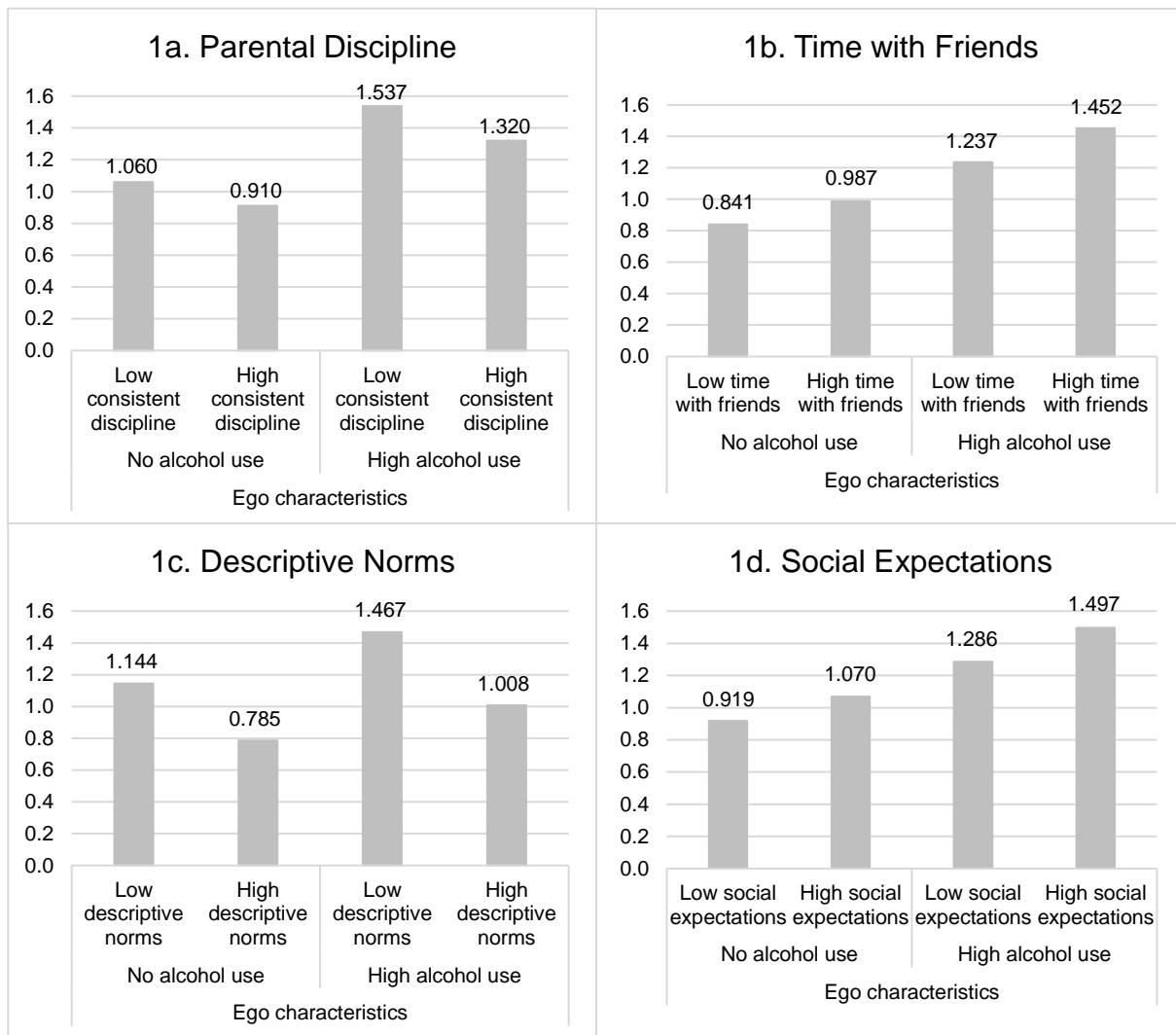
Table 3. Selected SIENA parameter estimates: Models for individual belief variables

	Model 4: Descriptive Norms			Model 5: Social Expectations			Model 6: Moral Approval					
	OR	b	SE	OR	b	SE	OR	b	SE			
<b>Friendship Network Parameters</b>												
<i>Number of friendship nominations received (i.e., covariate selection)</i>												
Beliefs alter <sup>a</sup>	1.01	0.006	†	0.004	1.02	0.022	**	0.006	1.02	0.024	***	0.005
Alcohol use alter	1.10	0.094	***	0.007	1.06	0.056	***	0.007	1.05	0.052	***	0.010
<i>Number of friendship nominations made</i>												
Beliefs ego <sup>a</sup>	0.96	-0.039	***	0.006	0.95	-0.053	***	0.006	0.96	-0.038	***	0.006
Alcohol use ego	1.00	0.000		0.010	1.00	-0.003		0.009	0.99	-0.009		0.009
<i>Choosing similar friends (i.e., homophilic selection)</i>												
Beliefs similarity <sup>a</sup>	1.11	0.109	***	0.016	1.07	0.066	*	0.026	1.07	0.068	***	0.016
Alcohol use similarity	1.28	0.249	***	0.022	1.18	0.168	***	0.025	1.19	0.177	***	0.021
<i>Moderation of friend selection</i>												
Beliefs ego <sup>a</sup> x Alcohol use alter	0.95	-0.047	***	0.007	1.02	0.019	*	0.008	1.00	0.002		0.009
<b>Alcohol Use Parameters</b>												
<i>Friends' attributes (i.e., influence)</i>												
Friends' alcohol use	2.14	0.759	***	0.046	2.13	0.754	***	0.049	2.05	0.719	***	0.047
<i>Individual behavioral parameters (i.e., effect on alcohol use)</i>												
Beliefs <sup>a</sup>	1.16	0.145	***	0.009	1.22	0.199	***	0.012	1.27	0.240	***	0.012
<i>Moderation of friend influence</i>												
Beliefs ego <sup>a</sup> x Friends' alcohol use	0.91	-0.095	**	0.032	0.87	-0.136	**	0.039	0.90	-0.100		0.060

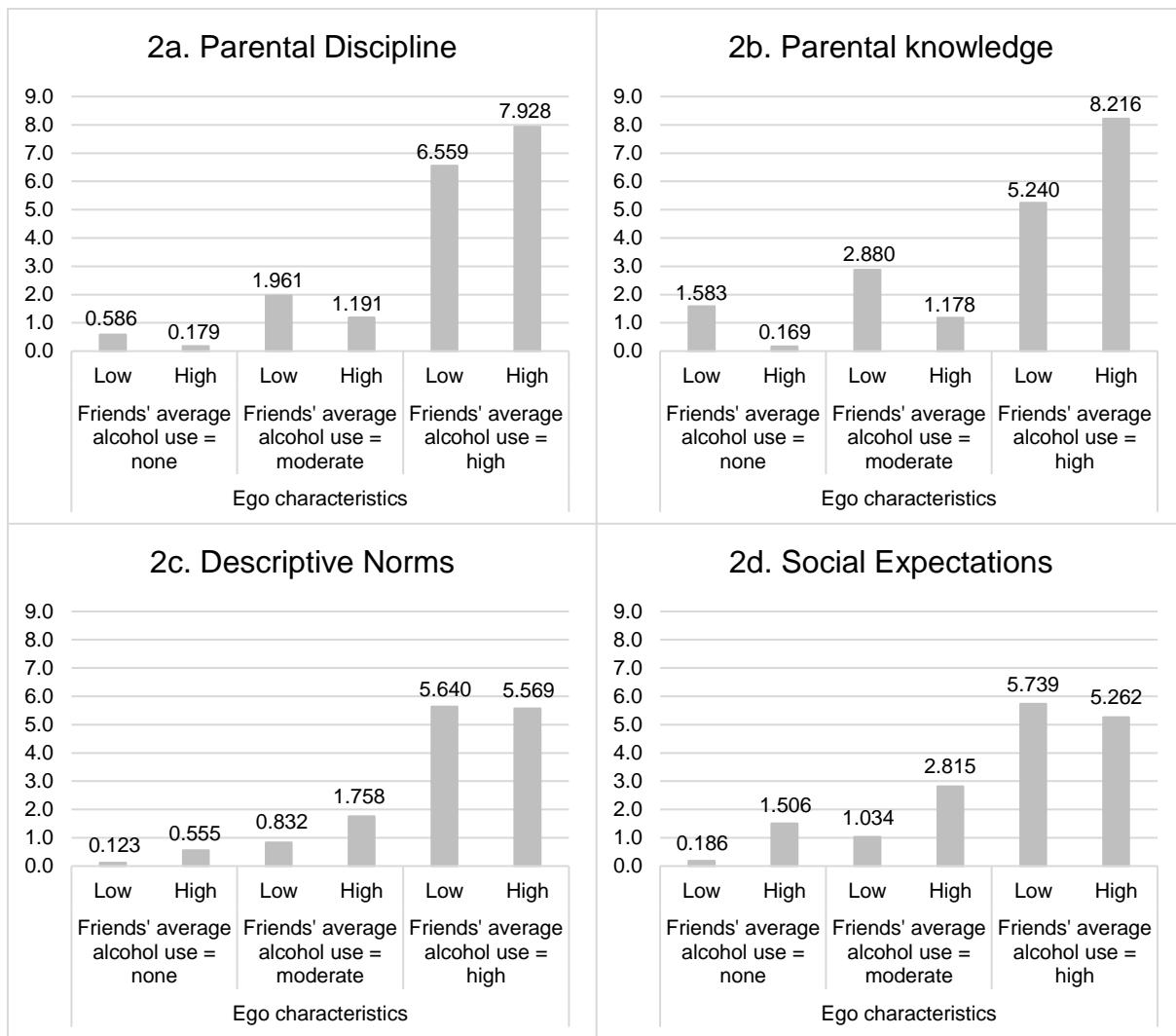
Models also include parameters for rates, shape, structure, race/ethnicity, gender, and living with two parents. Values across 46 networks with  $N = 12,335$ .

<sup>a</sup>This parameter is specific to the moderator variable in each model (e.g., in Model 4 it refers to descriptive norms).

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; † $p < 0.10$



**Fig. 1** Odds ratios for selecting a high-alcohol using versus non-alcohol using peer as friend (i.e., moderation of friend selection)



**Fig. 2** Odds ratios for reporting high versus no alcohol use (i.e., moderation of friend influence)