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Sibling popularity: A moderator of sibling influence for adolescent substance use

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Abstract

Sibling substance use is a known correlate of adolescent substance use. Yet, not all siblings are equally influential. Sibling influence has been found to vary by age gap, sex, and birth order. Little research, however, has investigated whether siblings' peer context is also a source of variation. The present study tested whether more popular siblings were more influential for adolescent use of cigarettes, alcohol, and marijuana. Data were obtained from sibling pairs in the National Longitudinal Study of Adolescent Health. Findings indicate that older siblings have more influence on younger sibling marijuana use when they have more friends. These findings contribute to prior work examining which siblings are more influential and highlight the need to consider siblings as part of a greater peer context.

Keywords

siblings; popularity; adolescence; substance use initiation; friendship; alcohol use; smoking; marijuana use

INTRODUCTION

On a given day an estimated 3,200 youth under the age of 18 will smoke their first cigarette (Centers for Disease Control, 2014b). The addiction potential of tobacco is high. Of adults who smoke daily, 88% report that they started smoking by the age of 18 (U.S. Department of Health & Human Services, 2012). At the current rate of youth tobacco use more than 5 million of today's youth are expected to die prematurely from a smoking-related illness (Centers for Disease Control, 2014b). Initiation for other substances peaks during adolescence as well. By age 15, half of American youth have had their first drink (Office of the Surgeon General, National Institute on Alcohol Abuse and Alcoholism, & Substance Abuse and Mental Health Services Administration, 2007). These youth are five times more likely to experience alcohol dependence later in life than those who start drinking at legal age (Centers for Disease Control, 2014a). Illicit drug initiation and experimentation is also common in the teen years. In 2011, nearly 40% of high school students reported trying marijuana at some point (Centers for Disease Control, 2012). Roughly 4% of new marijuana users become dependent in the first 2 years of use (Gabbard, 2007). Addiction is more likely when use begins in the teen years (National Institute on Drug Abuse, n.d.).

Both peers and families have been identified as key social influences for use and initiation of each of these substances during adolescence. Delinquency and substance use of one's friends, in particular, is positively and consistently associated with one's own substance use across this period of the life course (Ary, Tildesley, Hops, & Andrews, 1993; Kobus, 2003; Stormshak, Comeau, & Shepard, 2004; Van Ryzin, Fosco, & Dishion, 2012). Siblings also present concordance for substance use (Ary et al., 1993). Research by Trim, Leuthe, and Chassin (2006) as well as Fagan and Najman (2005) found that younger sibling alcohol use was predicted by older sibling use, even after controlling for important confounders such as use at a previous time period, parental use and abuse, shared familial experiences, and mutual peers (Fagan & Najman, 2005; Trim et al., 2006). Fagan and Najman (2005) obtained parallel results for tobacco use while Griffin and colleagues (2002) found that sibling cigarette smoking predicted later marijuana use in adolescents. Parental monitoring and family relationship quality, in contrast, were negatively associated with substance use in adolescence (Van Ryzin et al., 2012).

This paper builds on this line of research by further examining variation in sibling influence for substance use. Existing research has found that sibling influence varies by factors such as sex and birth order. Regarding sex, for instance, Trim and colleagues (2006) found that older sibling substance use was predictive of younger sibling use at a later time period, but only for same-sex sibling pairs. Similarly Rowe and Gulley (1992) found that correlations for substance use were much lower for mixed-sex sibling pairs than for same-sex sibling pairs. For birth order, studies found a line of influence for substance use from older siblings to younger siblings but a much more limited degree of influence of younger siblings on older siblings (Needle et al., 1986; Trim et al., 2006). Adolescents also perceive their older siblings as more influential on their behavior than younger siblings. Whiteman and Christiansen (2008) found that most firstborns (59%) did not view their younger siblings as a source of influence on themselves; only 36% of secondborns felt the same way.

Other previously identified moderators of sibling influence include age gap and warmth/conflict in the sibling relationship. Trim and colleagues (2006), for example, found that older sibling alcohol use positively influenced younger sibling alcohol use, but only among sibling pairs with a low age gap. Samek and Reuter (2011) also found that siblings less than 1.5 years apart in age were more similar in substance use behavior than those with a wider age gap. Similarly, McHale et al (2009) found that the correlations between the risky sexual attitudes of older and younger siblings were stronger when siblings were close in age and stronger when siblings reported closer relationships. The sibling closeness moderator has not been fully supported by the literature. Samek and Reuter (2011) found that sibling closeness and older sibling substance use did not interact to predict younger sibling substance use.

While all of these studies identified characteristics of the sibling or sibling dyad as moderators, other past research has addressed the sibling's own peer context. One study by Craine and colleagues (2009) found that sibling popularity moderated sibling influence for delinquency. Female younger siblings perceiving their older siblings to be popular reported lower levels of delinquency (Craine et al., 2009). Having a popular older brother also led to greater concordance for delinquency within the sibling pair (Craine et al., 2009). While sex was an important point of variation, overall effects demonstrated that sibling popularity

moderated sibling influence (Craine et al., 2009). However, this study did not include substance use as an outcome. Whiteman, Jensen, and Maggs (2013) partially addressed this gap by including a measure of shared peers in their analysis of sibling influence and similarity for alcohol, tobacco, and marijuana use. Substance use similarity on alcohol use was more pronounced when siblings shared a greater proportion of friends (Whiteman et al., 2013). Several questions remain unanswered from these studies. First, it is unclear if younger siblings and their peer context influence older sibling substance use. This direction of influence was not tested by the studies noted above. Second, it is unclear if aspects other than the shared peer group, such as degree of popularity, moderate sibling influence. Lastly, the studies above use measures of perceived friendship. It is unknown how patterns might differ when more objective measures of the social network are used. These questions are addressed by the present paper.

Given the strong peer effects associated with substance use, a sibling's friendship connections may determine whether a particular sibling has a behavioral influence. Existing research has suggested several theoretical possibilities for how this sort of moderation might occur. First, a sibling may serve as a friendship "bridge" between one's own friends and those of the sibling. Substance use behavior and influence may diffuse through this overlap in peer groups (i.e. exposure). Using a very similar argument Kreager and Haynie (2011) found that dating led to changes in adolescent alcohol use partially through the influence of the friends of a dating partner.

Second, the behaviors of a popular sibling may be perceived as a means to attain popularity. Social learning theories propose that individuals learn behaviors through observation, modeling, and the reinforcement or punishment of behavior (Bandura & McClelland, 1977). Modeling of behavior is especially likely when that behavior appears to be rewarded or otherwise acceptable (Bandura & McClelland, 1977). The term vicarious reinforcement refers to the observed reward another person, such as a sibling, receives for his or her behavior (Warr & Stafford, 1991). Even if a sibling is not popular because of substance use, the perceived association may be influential. In the case of older siblings, this can also be termed anticipatory socialization; individuals modify their behavior because they anticipate finding themselves in similar social situations at a later time (Merton & Kitt, 1950). Although they did not examine siblings, Santor, Messervey, and Kusumakar (2000) found that adolescents who scored highly on the tendency to engage in behavior to attain popularity engaged in more illicit substance use. Demant and Järvinen (2010) found that potential social capital both encouraged some drinking behaviors as well as discouraged extreme or non-normative drinking behaviors among adolescents. Both of the arguments above suggest that siblings who have more social connections (i.e. more friends) may be more influential for some behavioral outcomes. This expectation is consistent with the findings of Whiteman et al (2013) and Craine (2009).

Based on predictions from Social Learning theories, this paper also hypothesizes that sibling influence for alcohol, tobacco, and marijuana use will be greater for adolescents whose siblings have more friends or friendship connections than those whose siblings have fewer friends or friendship connections. In other words, adolescents will be more likely to emulate substance use when it appears to be socially rewarding for their siblings. This is consistent

with the concept of vicarious reinforcement (Warr & Stafford, 1991). Unlike many prior studies, this paper tests older sibling influence on younger siblings and vice versa. Patterns of variation by substance (tobacco, alcohol, and marijuana) and measurement of friendship are treated as exploratory questions, as direction and magnitude of variation are not quite clear from the literature.

METHOD

Add Health

This paper uses data from the first two waves of The National Longitudinal Study of Adolescent Health (Add Health), a longitudinal study of a nationally representative sample of individuals who were in grades 7 through 12 in 1994 (Harris, Halpern, Smolen, & Haberstick, 2006). More than 90,000 individuals from 132 schools completed in-school questionnaires in Wave One (Harris et al., 2006). A stratified random subsample was selected to participate in detailed home interviews ($n = 20,745$) (Harris, 2011). Interviews were also conducted with a number of special oversamples, including pairs of siblings (3,139 pairs): 784 twin pairs, 1,251 full sibling pairs, 442 half-sibling pairs, and 662 non-related sibling pairs (Harris et al., 2006). The sample also includes some pairs of cousins who lived together in the same home and were being raised as siblings. Each member of these sibling pairs was administered the same questionnaires and resides in the same home environment (Harris et al., 2006). This sibling pairs subsample is used as the basis for analysis.

Wave Two interviews, based on the same subsample, were conducted one year after the first interview ($n = 2,976$ pairs). To avoid statistical dependence of observations, only one sibling pair per household (randomly selected) is used in analyses (leaving 2,567 pairs). Measures used to assess number of friends and friendship connections (indegree, outdegree, reach) are only available for Add Health schools with a 50% or higher response rate (National Longitudinal Study of Adolescent Health, 2001). Otherwise, these measures would not give an accurate picture of a school's social network. As a result of the response rate requirement, 1,864 individuals in the sibling pairs subsample have missing data on these measures. Analyses are based on 753 non-twin pairs with complete data for all variables in both waves. Twins were omitted from analysis since twins are the same age and will thus likely have more similar, and perhaps more overlapping, social networks than non-twins. In the subsample used for this paper, younger siblings range in age from 11 to 23 with an average age of 15.5. Older siblings range from age 13 to 22 with an average age of 17.5. Approximately 35% of pairs in the sibling pairs sample are missing sample weight information for at least one member of the pair (Chantala, 2001). All analyses in this paper will be unweighted for this reason. As a result of these limitations, results cannot be interpreted as nationally representative (Chantala, 2001).

Measures

Number of friends—Respondents were asked to name up to five of their female friends and up to five of their male friends. These names were then matched to school and class rosters, allowing the primary investigators of the Add Health study to identify friendship

ties, peer groups, and larger social networks. To operationalize number of friends and friendship connections, this paper uses a measure of *indegree* (the number of individuals naming a respondent as a friend), *outdegree* (the number of individuals the respondent lists as friends) and *reach* (the number of individuals within three friendship ties of a respondent) (Snijders, van de Bunt, & Steglich, 2010). Indegree is informative about the degree to which a person is well-liked by peers; a high indegree would indicate that an adolescent has certain attributes that are desirable in a peer network (i.e. is more popular). Outdegree indicates the extent to which an adolescent feels connected to others in the network (self-perceived popularity). Indegree and outdegree are correlated but generally not identical; not all reported friendships are reciprocated. Reach includes the number of ties to friends, friends of friends, and friends of friends' friends. This measure indicates a person's degree of connectedness in a peer network and reflects the number of additional persons who may be influential (or influenced) through their ties to the friends of an individual.

Substance use—Cigarette use and marijuana use were measured by questions asking respondents how often in the past 30 days they used these substances. Since responses were heavily skewed towards never (0), responses were dichotomized as never (0) or once or more (1). For drinking, a question asked respondents how often they used alcohol in the past 12 months. Response categories ranged from every day (1) to never (7). Again, more than half of respondents indicated never drinking the past 12 months. Few reported drinking frequently. As a result, responses were dichotomized as never (0) or once or more in the past month (1).

Controls—Analyses control for the sex, race (black, white, other race) and age of each sibling. A parental education proxy for family socioeconomic status is included as a dyad-level control. This control is the maximum level of education achieved across household resident parents as of Wave One. Levels of education range from 8th grade or less (1) to professional training beyond a college degree (6). Substance-specific controls for peer substance use of each sibling are also included in analyses. These are based on questions that asked respondents to report how many of their three best friends engaged in various forms of substance use (range 0 to 3).

Plan of analysis

Although research has shown that influence typically travels from older to younger siblings (Needle et al., 1986; Trim et al., 2006), some interdependence within a sibling pair is likely. To address this possibility, data are analyzed using Actor-Partner Interdependence Models (Cook & Kenny, 2005) with logistic regression (outcomes are all dichotomous). Using APIM allows for a test of how an individual's values on an independent variable affect his/her own values on the dependent variable ("actor" effects) as well as his/her sibling's values on the dependent variable ("partner" effects). These effects are tested simultaneously in all models. The primary interest in this paper is partner effects, the degree to which a sibling's behavior and friendship ties affect one's own substance use. Actor and partner are distinguished by age (younger vs. older siblings). Multiplicative interaction terms test the interactions between sibling substance use measures and sibling friendship measures. Non-dichotomous predictor variables were centered prior to analysis to assist with interpretation

of interactions and reduce colinearity among predictors. For further details on how data are structured for APIM, the reader is referred to Cook and Kenny (2005).

In its basic form APIM treats the dyad as the highest level of analysis with individuals nested within dyads. Variation in genetic relatedness among sibling pairs is a concern, however. Initial analyses (not shown) were implemented using hierarchical linear modeling with individuals nested within sibling pairs and sibling pairs nested within genetic relatedness types (full siblings, half-siblings, cousins, unrelated pairs). Doing so allowed for an assessment of whether effects varied between these genetic groupings. Null model variance components for the dyad level indicated significant variation across sibling dyads. Null model variance components for the genetic relatedness level were non-significant and virtually zero; thus, there was negligible, if any, genetic-level variation to explain for any of the three outcomes. As a result, all analyses shown in this paper nest individuals within sibling dyads, but do not include nesting by genetic relatedness.

FINDINGS

Sibling pair demographic characteristics are presented in Table I. Approximately half of the pairs are same-sex pairs. Most pairs, about 75%, are full siblings while 11% of the pairs are half-siblings. The average age gap for sibling pairs is approximately two years. Sample means and proportions for all predictors, outcomes, and related variables are presented in Table I as well. As is expected, the proportion of individuals drinking, smoking, and using marijuana increased from one wave to the next, with alcohol use being most common. These estimates are consistent with national statistics (CDC, 2012; Centers for Disease Control, 2014b). In Wave One, number of close peers using substances is consistent with this pattern. On average respondents report more close peers using alcohol than marijuana or cigarettes. Regarding number of friends, both indegree and outdegree indicate that respondents have between 5 and 6 close friends on average. The average for reach is quite high, indicating that respondents have indirect connections to many individuals at school through friends, friends of friends, and friends of those friends. Lastly, this subsample is predominately white and, on average, parents are high school graduates or have attended some college. The age range is consistent with the Add Health sample design.

Drinking

Results from APIM models predicting Wave Two substance use are shown in Tables II, III, and IV. Results for drinking are presented first in Table II. The first set of columns includes a base model without any measures of number of friends. Remaining columns show models testing for an interaction between sibling behavior and siblings' number of friends, as measured by indegree, outdegree, and reach with the measure indicated as column header. Odds ratios are indicated as actor (effect of one's own behavior on one's own outcome) or partner (effect of one sibling's behavior on another sibling's outcome) effects. Models were conducted stepwise with the base model first, followed by a model including self and sibling number of friends, and last a model including the interaction terms. The intermediate model is omitted for brevity but available from the author on request.

Examining the base model in Table II first, one's own drinking in Wave One is a strong, positive and significant predictor of drinking in Wave Two (actor effects). There is a statistically significant, positive effect of an older sibling drinking in Wave One (partner effects). Having an older sibling who drinks in Wave One is associated with a greater likelihood of the younger sibling drinking in Wave Two. The drinking behavior of one's peers in Wave One, is also positively associated with Wave Two drinking. Having an additional close friend drink in Wave One is positively associated with drinking in Wave Two. When number of friends and respective interactions with sibling behavior are added in remaining models (see Table II), these patterns continue to hold. In contrast to expectations, there is no statistically significant interaction between younger sibling behavior and younger siblings' number of friends.

Smoking

A comparable set of models is presented for the smoking outcome in Table III. Examining the base model first, one's own smoking in Wave One is a strong, positive and significant predictor of smoking in Wave Two (actor effects). There is no statistically significant effect of one's sibling smoking in Wave One (partner effects). The smoking behavior of one's peers in Wave One, is positively and significantly associated with smoking in Wave Two, but only for older siblings. Older siblings having an additional friend smoke in Wave One are more likely to smoke in Wave Two. When number of friends and respective interactions with sibling behavior are added in remaining models (see Table III), these patterns continue to hold. However, there is no significant interaction between sibling behavior and sibling number of friends. This is the case regardless of how number of friends is measured.

Marijuana

Lastly, results from APIM models using Wave Two marijuana use as an outcome are presented in Table IV. For the base model, one's own marijuana use in Wave One is a strong, positive and significant predictor of marijuana use in Wave Two (actor effects). There is no statistically significant effect of one's sibling using marijuana in Wave One (partner effects). The marijuana use of one's peers in Wave One, however, is positively and significantly associated with marijuana use in Wave Two.

When number of friends and respective interactions with sibling behavior are added in remaining models (see Table IV), these patterns continue to hold. In addition, there is a statistically significant and positive interaction between older sibling behavior and older siblings' number of friends when number of friends is measured as outdegree. For those whose older siblings use marijuana, every additional friendship tie reported by the older sibling increases the likelihood of the younger sibling using marijuana by 1.4 times. This interaction is graphed in Figure I to demonstrate the difference in predicted probabilities for marijuana use for those whose siblings have a number of friends above the mean and those whose siblings have a below-average number of friends.

In Table IV, there is also a marginally significant, positive interaction between older sibling behavior and older siblings' number of friends when number of friends is measured as reach. For those whose older siblings use marijuana, every additional friendship connection made

to the older sibling increases the likelihood of the younger sibling using marijuana by 1.016 times. This is much less pronounced than the effect for outdegree, but both of these results indicate that older sibling marijuana use is more influential for younger sibling marijuana use when the older sibling has more friends. In other words, older siblings are more influential when they are more popular.

Summary

In sum, peer substance use and one's own substance use in Wave One are consistent, positive predictors of one's likelihood of substance use in Wave Two. This is the case regardless of substance. This finding is in line with existing literature. For smoking and drinking, sibling influence does not appear to be moderated by siblings' number of friends. For marijuana use, however, moderation by siblings' number of friends is apparent. For each outcome siblings with more friends are more influential. Effects vary somewhat by measurement of number of friends. Interactions are statistically significant for outdegree and marginally significant for reach when marijuana use is the outcome. All effects are modest in effect size, particularly for the marginally significant effect.

DISCUSSION & CONCLUSION

Prior research has well-documented the influence of older sibling substance use on younger sibling substance use. Prior research has also determined that influence is moderated by factors including birth order, age gap, sex, and warmth / conflict in the sibling relationship (Samek & Rueter, 2011; Trim et al., 2006; Whiteman et al., 2013). However, few studies have examined how a sibling's popularity in the friendship network affects influence. Social Learning theories would suggest that more popular siblings may be more influential models due to their desirable status. This paper addresses this gap in the literature by (1) examining whether sibling popularity moderates sibling influence for use of alcohol, tobacco, and marijuana; (2) assessing whether moderation patterns vary by type of substance use; (3) determining whether effects are sensitive to measurement of popularity; and (4) evaluating reciprocity in sibling influence for substance use.

Regarding the first aim, only two interaction terms were significantly different from zero. For older sibling marijuana use interacted with older sibling outdegree, the interaction effect has a modest odds ratio of 1.4. The interaction for reach, again with marijuana use, has a smaller odds ratio of 1.016. One possible explanation for these modest effects is the extent to which siblings share peers. Unlike Whiteman, Jensen, and Maggs (2013), the present study did not separate friends shared by siblings from those unique to each sibling in the pair. It is possible that having more shared friends (or more unique friends) may have a greater moderating effect. Future research is needed to explore this possibility, particularly given how frequently siblings share friends.

Drawing on the Arizona Sibling Study, Rowe and colleagues (Hetherington, Reiss, & Plomin, 1994) found that roughly 76% of brothers, 74% of sisters, and 64% of mixed-gender siblings ages 10 to 16 years shared at least one mutual friend. Haynie and McHugh (2003), using Add Health data, found that 36% of siblings shared a mutual friend, although they excluded cousin pairs and half-siblings from their analyses. These sibling types were

included in analyses for the present paper. Time spent with mutual friends is non-trivial. In the Arizona Sibling Study, approximately 47% of brothers, 35% of sisters, and 25% of mixed-gender siblings with mutual friends reported spending time with these friends at least sometimes (Hetherington et al., 1994). If overlap between peer groups is substantial, then there may be little impact stemming from a siblings' peers (since many of these may be one's own peers). Future research exploring this factor is needed.

A second question to consider is why interaction effects were strongest for marijuana. Effects were null for other forms of substance use. Assessing this variation was the second aim of this paper. Although Bailey et al (1992) found that the social context and benefits of marijuana were not related to use after accounting for the drug's perceived physical effects, Osgood et al (Osgood, Feinberg, Wallace, & Moody, 2014) found that alcohol, tobacco, and marijuana use differed greatly by position in the social network. Marijuana users were less likely to be core members of friendship groups (Osgood et al., 2014), suggesting that those marijuana users who manage to hold higher social status are unusual and perhaps especially influential. Those individuals serving as a bridge (liaison) between two social groups were most likely to use marijuana (Osgood et al., 2014), which may explain why the interaction with number of peers measured as reach was marginally significant for that outcome. Reach indicates the degree to which a person is connected to the greater social network through direct and indirect friendship connections. Since liaisons connect social groups, reach has the potential to be higher for these individuals.

Osgood et al (2014) also found that socially integrated adolescents were more likely to drink while isolated adolescents were most likely to smoke cigarettes. This association between smoking and social isolation may explain why siblings' number of friends was not influential for smoking. Social Learning theories would predict that adolescents should repeat behaviors they perceive as being associated with popularity. If smoking is generally more common among the socially isolated, then the smoking-popularity association may be unlikely. In contrast, the drinking-popularity connection may be more apparent. Dumas et al (2014), for example, found that college males who were more central to their peer groups were more likely to drink excessively and engage in aggressive behavior at bars. A connection with sibling popularity was not found in the present paper. However, this paper does not distinguish between any drinking and heavy drinking, which may have different social contexts (Thombs & Beck, 1994).

Building on these popularity-substance differences, a third aim of this paper was to assess differences by measurement of popularity. In this paper, findings indicate a statistically significant interaction for older sibling outdegree, a measure that indicates self-perceived popularity. This effect was actually stronger in magnitude than the interaction effect for reach. As these observations indicate, effects are somewhat sensitive to measurement of popularity. Unlike Craine et al (2009), the present study examined friendship nominations rather than more subjective assessments of perceived popularity. This may account for some of the differences between the two studies. Another possible explanation for differences is range. Outdegree is limited to a maximum of 10, the number of friendship nominations that the study allowed. Range, in contrast, is based on ties to friends, friends of friends, and friends of friends' friends. Thus, the range of the reach measure is much wider. Also, one

could argue that the addition of a direct friendship tie may be more meaningful to an individual than an additional friend of a friend, or friend of a friend's friend. The addition of an indirect friendship may not be visible to younger siblings, thereby limiting the degree of influence that might occur. A one unit increase in reach does not distinguish between direct and indirect links.

It is also interesting that the interaction with indegree for marijuana use did not emerge as statistically significant when reach and outdegree interactions were statistically significant or marginally significant for this outcome. It is unclear why this might be the case. Outdegree is an indicator of self-perceived popularity while indegree is an indicator of desirability; higher indegree would indicate that a particular respondent is more desirable as a friend among peers. These concepts are correlated, but not identical. In a perfectly hierarchical network, more popular individuals tend to have high indegree and low outdegree while unpopular individuals will have low indegree and high outdegree (Snijders et al., 2010). Most individuals will be somewhere in between, with more balance between indegree and outdegree. The imbalances at the extremes of popularity, low and high, may be contributing to differences in effects by measurement of social standing.

The final aim of the present paper was to examine reciprocal influence. Much existing theory, like Social Learning, suggests that older siblings will be influential for younger siblings. The reverse is usually not tested. Results of this paper indicate that, as expected, marijuana use interaction effects are for older siblings influencing younger siblings. It is older sibling popularity that increases older sibling influence for marijuana use. Main effects for other substances also indicate influence of older siblings on younger siblings. Results do not demonstrate influence traveling from younger sibling to older sibling.

Directions for future research

Although this paper examines sibling influence and how this may be moderated by siblings' number of friends, the precise mechanisms through which sibling influence might occur remain to be specified. One factor of interest is the distinct relationship that each child has with his or her parent(s). This is one of three key variables identified by Kumpfer et al (2003) as a protective factor against substance *misuse*. Parent-child relationship characteristics such as warmth, conflict, or time spent together may impact each sibling and the way siblings interact with one another. Some researchers have argued that siblings compete with one another for parental attention and love, leading some siblings to "deidentify" or attempt to distinguish their behavior from that of other siblings (Schachter, Shore, Feldman-Rotman, Marquis, & Campbell, 1976; Whiteman, McHale, & Crouter, 2007). It is also possible that sibling peer context is more salient when siblings have a warm, close relationship than when they do not or that time spent with a sibling may shape the degree of social and observational learning that occurs. These and related factors may be mechanisms through which sibling influence and moderation by sibling peer context occur.

Limitations

Several limitations of this study should be acknowledged. First, although the core Add Health sample is nationally representative, the sibling pairs sample is not, limiting the

generalizability of my results. Restrictions of the sample due to missing data on social network measures further restricts generalizability. Second, sample size, and consequently statistical power, is limited for the complex analyses used in this paper. Third, this paper does not examine the degree of interaction between a respondent and the peers of his or her sibling. Lastly, long-term influences are not examined since waves are only one year apart.

Conclusion

The results of this study have a key practical implication: they help to better identify those most at risk for substance use in adolescence. While parental substance use and sibling substance use are known risk factors (Fagan & Najman, 2005; Li, Pentz, & Chou, 2002; Needle et al., 1986; Trim et al., 2006), this study builds upon prior literature by elaborating on *which* siblings present more risk. Just as some parents present more risk than others (those using substances, in particular), some siblings generate more risk for substance use than others. Results indicate that, at least for marijuana, more popular or socially connected siblings are more influential for adolescent substance use behavior. While siblings and peers are often discussed as separate, competing influences on an individual, this paper emphasizes that these two spheres overlap and that social learning of problem behaviors can occur through their interaction. Unfortunately, a number of existing intervention programs for substance use have addressed a narrow range of risk factors and do not account for this complexity (Gorman, 1996).

The importance of identifying at-risk adolescents cannot be understated. As noted in the introduction, youth who start drinking by age 15 are five times more likely to experience alcohol dependence later in life than those who start drinking at the legal age (Centers for Disease Control, 2014a). Tobacco has high addictive potential as well (U.S. Department of Health & Human Services, 2012). Further, roughly 4% of new marijuana users become dependent in the first two years of use (Gabbard, 2007), with addiction more likely when use begins in the teen years (National Institute on Drug Abuse, n.d.). The context of marijuana use is of particular interest as more states consider legalization of marijuana for recreational purposes. Across all of these substances, however, a clear understanding of risk potential and social context is crucial for effective intervention.

Acknowledgments

DECLARATION OF INTEREST

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Figure I.
Predicted probability of younger sibling marijuana use in wave two by wave one use and older sibling outdegree

Table 1
Sample means and proportions for predictor, outcome, and other selected variables (n=753)

	Wave 1			Wave 2		
	Mean	SD	Range	Mean	SD	Range
Individual characteristics:						
Past month smoking	0.239	(0.427)	0 / 1	0.328	(0.470)	0 / 1
Peers smoking	0.746	(1.010)	0 / 3			
Past month drinking	0.265	(0.442)	0 / 1	0.316	(0.465)	0 / 1
Peers drinking	1.036	(1.142)	0 / 3			
Past month marijuana use	0.103	(0.304)	0 / 1	0.121	(0.327)	0 / 1
Peers using marijuana	0.498	(0.891)	0 / 3			
Indegree	5.195	(4.099)	0 / 24			
Outdegree	4.741	(2.951)	0 / 10			
Reach	63.020	(47.619)	0 / 270			
Black	0.191	(0.393)	0 / 1			
White	0.682	(0.466)	0 / 1			
Other race	0.172	(0.377)	0 / 1			
SES	3.984	(1.256)	1 / 6			
Age	16.095	(1.658)	13 / 21			
Female	0.51	(0.50)	0 / 1			
Sibling pair characteristics (% is percent of sample):						
Cousin pairs	3.09%					
Undetermined genetic tie pairs	3.32%					
Unrelated pairs	7.96%					
Half-siblings	10.36%					
Full siblings	75.27%					
Same-sex siblings	49.60%					
Average age gap in years	2.070	(1.145)	0 / 7.93			

Table II

APIM models for drinking outcome (odds ratios)

Actor	Base Model	Indegree	Outdegree	Reach
Drinking, younger sibling	4.842** (1.400)	4.554** (1.325)	4.690** (1.356)	4.700** (1.365)
Drinking, older sibling	6.824** (1.789)	6.722** (1.775)	6.800** (1.782)	6.832** (1.798)
Peer drinking, younger sibling	1.739** (0.193)	1.753** (0.197)	1.736** (0.193)	1.752** (0.196)
Peer drinking, older sibling	1.546** (0.153)	1.543** (0.154)	1.540** (0.153)	1.548** (0.155)
White, younger sibling	2.014* (0.695)	1.886 ⁺ (0.658)	2.050* (0.622)	1.967* (0.690)
White, older sibling	2.059* (0.621)	2.000* (0.610)	2.052* (0.622)	2.153* (0.664)
Black, younger sibling	1.039 (0.421)	1.015 (0.411)	1.109 (0.454)	1.068 (0.435)
Black, older sibling	1.050 (0.375)	1.061 (0.382)	1.100 (0.396)	1.071 (0.385)
Age, younger sibling	1.196* (0.099)	1.213* (0.101)	1.209* (0.100)	1.196* (0.099)
Age, older sibling	1.388** (0.115)	1.400** (0.118)	1.399** (0.116)	1.396** (0.116)
Female, younger sibling	1.384 (0.310)	1.328 (0.302)	1.326 (0.299)	1.355 (0.306)
Female, older sibling	1.034 (0.219)	1.012 (0.216)	1.008 (0.215)	1.025 (0.219)
Number of friends, younger sibling		1.058* (0.028)	1.018 (0.038)	1.004 (0.003)
Number of friends, older sibling		1.047 (0.032)	0.977 (0.032)	0.999 (0.002)
Partner				
Drinking, younger sibling	1.292 (0.326)	1.312 (0.350)	1.468 (0.392)	1.427 (0.376)
Drinking, older sibling	2.264** (0.525)	2.303** (0.542)	2.206** (0.516)	2.225** (0.523)
Number of friends, younger sibling		0.994 (0.028)	1.009 (0.042)	1.001 (0.003)
Number of friends, older sibling		0.971 (0.041)	0.973 (0.042)	0.977 (0.003)
Interactions				
Younger sibling's number of friends younger sibling drinking		0.996 (0.053)	0.877 (0.076)	0.993 (0.005)
Older sibling's number of friends older sibling drinking		0.989 (0.061)	1.046 (0.080)	1.003 (0.005)
Dyad-Level				
SES	1.016 (0.065)	1.013 (0.065)	1.013 (0.064)	1.017 (0.064)

	Base Model	Indegree	Outdegree	Reach
Intercepts				
Younger sibling	0.295 (0.312)	0.291 (0.311)	0.219 (0.300)	0.312 (0.331)
Older sibling	0.023** (0.024)	0.024** (0.026)	0.023** (0.025)	0.021 (0.023)

** Notes: ^a p< 0.01.
* p< 0.05.
+ p<0.10.
^b Non-dichotomous predictors are centered.
^c Standard errors displayed in parentheses.

Table III

APIM models for smoking outcome (odds ratios)

Actor	Base Model	Indegree	Outdegree	Reach
Smoking, younger sibling	14.173** (4.715)	14.418** (4.837)	14.557** (4.884)	14.411** (4.822)
Smoking, older sibling	8.263** (2.296)	8.412** (2.347)	8.310** (2.318)	8.385** (2.345)
Peer smoking, younger sibling	1.113 (0.136)	1.116 (0.137)	1.124 (0.138)	1.113 (0.137)
Peer smoking, older sibling	1.503** (0.164)	1.523** (0.167)	1.497** (0.165)	1.489** (0.164)
White, younger sibling	2.061* (0.701)	1.892+ (0.650)	1.989* (0.684)	2.015* (0.698)
White, older sibling	2.185* (0.687)	2.070* (0.657)	2.225* (0.706)	2.296** (0.734)
Black, younger sibling	1.137 (0.449)	1.119 (0.441)	1.230 (0.493)	1.147 (0.456)
Black, older sibling	0.997 (0.378)	1.009 (0.384)	0.977 (0.374)	0.990 (0.378)
Age, younger sibling	1.000 (0.078)	1.008 (0.079)	1.005 (0.079)	0.996 (0.078)
Age, older sibling	0.871* (0.066)	0.873+ (0.067)	0.868+ (0.067)	0.871+ (0.067)
Female, younger sibling	1.277 (0.270)	1.248 (0.266)	1.223 (0.262)	1.270 (0.271)
Female, older sibling	1.152 (0.245)	1.139 (0.242)	1.165 (0.251)	1.186 (0.255)
Number of friends, younger sibling		1.047+ (0.028)	1.063 (0.040)	1.002 (0.002)
Number of friends, older sibling		1.051 (0.033)	0.990 (0.037)	0.998 (0.002)
Partner				
Smoking, younger sibling	1.467 (0.364)	1.477 (0.378)	1.459 (0.367)	1.485 (0.373)
Smoking, older sibling	1.431 (0.340)	1.429 (0.340)	1.445 (0.347)	1.455 (0.349)
Number of friends, younger sibling		1.008 (0.029)	0.987 (0.042)	1.000 (0.003)
Number of friends, older sibling		1.027 (0.039)	1.001 (0.045)	1.000 (0.003)
Interactions				
Younger sibling's number of friends* younger sibling smoking		0.976 (0.047)	1.006 (0.079)	0.998 (0.005)
Older sibling's number of friends* older sibling smoking		0.907 (0.056)	1.008 (0.078)	0.997 (0.005)
Dyad-Level				
SES	0.942 (0.058)	0.934 (0.058)	0.942 (0.058)	0.943 (0.058)
Intercepts				

	Base Model	Indegree	Outdegree	Reach
Younger sibling	0.037 ^{***} (0.037)	0.036 ^{***} (0.036)	0.034 ^{***} (0.034)	0.038 ^{***} (0.038)
Older sibling	0.411 (0.404)	0.438 (0.429)	0.437 (0.427)	0.385 (0.377)

^{***} Notes: ^a p< 0.01.
^{*} p< 0.05.
⁺ p<0.10.
^b Non-dichotomous predictors are centered.
^c Standard errors displayed in parentheses.

Table IV

APIM models for marijuana outcome (odds ratios)

	Base Model	Indegree	Outdegree	Reach
Actor				
Marijuana, younger sibling	17.502** (11.599)	19.511** (13.446)	10.457** (5.045)	9.945** (4.696)
Marijuana, older sibling	5.781** (3.173)	5.830** (3.253)	3.659** (1.474)	3.471** (1.395)
Peer marijuana, younger sibling	1.851** (0.359)	1.844** (0.366)	1.722** (0.281)	1.696** (0.271)
Peer marijuana, older sibling	2.495** (0.501)	2.542** (0.527)	2.238** (0.367)	2.214** (0.359)
White, younger sibling	0.498 (0.251)	0.545 (0.279)	0.557 (0.247)	0.556 (0.247)
White, older sibling	1.261 (0.590)	1.239 (0.589)	1.220 (0.493)	1.275 (0.516)
Black, younger sibling	0.785 (0.436)	0.803 (0.449)	0.813 (0.394)	0.916 (0.439)
Black, older sibling	0.995 (0.560)	0.988 (0.560)	0.905 (0.441)	0.884 (0.429)
Age, younger sibling	0.844 (0.110)	0.829 (0.110)	0.843 (0.098)	0.849 (0.098)
Age, older sibling	0.821 (0.101)	0.819 (0.102)	0.849 (0.090)	0.854 (0.090)
Female, younger sibling	0.742 (0.257)	0.763 (0.267)	0.787 (0.244)	0.799 (0.244)
Female, older sibling	0.574 ⁺ (0.192)	0.573 ⁺ (0.193)	0.634 (0.187)	0.639 (0.184)
Number of friends, younger sibling		0.984 (0.046)	0.967 (0.082)	1.001 (0.004)
Number of friends, older sibling		0.997 (0.050)	0.969 (0.048)	0.998 (0.003)
Partner				
Marijuana, younger sibling	1.567 (0.797)	1.595 (0.872)	1.347 (0.586)	1.430 (0.607)
Marijuana, older sibling	1.910 (0.868)	1.964 (0.904)	1.442 (0.590)	1.625 (0.635)
Number of friends, younger sibling		1.015 (0.042)	0.991 (0.051)	0.996 (0.004)
Number of friends, older sibling		0.925 (0.059)	0.911 (0.055)	0.997 (0.010)
Interactions				
Younger sibling's number of friends younger sibling marijuana		0.983 (0.104)	1.123 (0.160)	1.009 (0.010)
Older sibling's number of friends older sibling marijuana		1.044 (0.135)	1.405* (0.188)	1.016 ⁺ (0.009)
Dyad-Level				
SES	0.959 (0.096)	0.972 (0.099)	0.977 (0.082)	0.974 (0.082)
Intercepts				

	Base Model	Indegree	Outdegree	Reach
Younger sibling	0.051 ⁺ (0.081)	0.050 ⁺ (0.081)	0.111 (0.154)	0.109 (0.149)
Older sibling	0.076 ⁺ (0.119)	0.067 ⁺ (0.105)	0.103 ⁺ (0.142)	0.103 ⁺ (0.140)

^{**} *Notes:* ^a $p < 0.01$.

^{*} $p < 0.05$.

⁺ $p < 0.10$.

^b Non-dichotomous predictors are centered.

^c Standard errors displayed in parentheses.