REGULAR ARTICLE

Sibling influences on adolescent substance use: The role of modeling, collusion, and conflict

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Abstract

The longitudinal associations of older sibling substance use as well as dyadic sibling conflict and collusion to younger sibling substance use were examined in a community-based sample of 244 same-sex sibling pairs. Indirect effects of older siblings on younger sibling substance use were hypothesized via younger sibling deviant peer affiliation and conflict with friends. Adolescents, parents, friends, and teachers completed measures of substance use, conflict, and deviant peer involvement. Observational data were used for both measures of collusion and conflict. Findings suggest that older sibling substance use has a direct effect on younger sibling use, but relationship dynamics and reinforcement played a significant role as well. Specifically, collusion and conflict in the sibling relationship both had indirect effects through younger siblings' deviant peer affiliation. Findings validate the powerful socializing role of both siblings and peers, and elucidate the complex mechanisms through which socialization occurs. Furthermore, data underscore the importance of considering how multiple dimensions of socialization operate in the elaboration of antisocial behavior.

Simply stated, the onset of substance use typically occurs during adolescence. Researchers have consistently found that early involvement with alcohol, tobacco, and drug use increased the risk of drug dependency and abuse later in life (DeBry & Tiffany, 2008; King & Chassin, 2007; Zucker et al., 2006). Adolescent substance use is also considered part of a cluster of problem behaviors (e.g., school failure) that co-occur and support an antisocial developmental trajectory to later delinquency (e.g., Dishion, Nelson, & Bullock, 2004). Much effort has focused on examining social processes involved in adolescent substance use in the family and peer contexts, with an emphasis on how maladaptive parenting practices (e.g., inconsistent discipline) influence other relationships (e.g., peers) that maintain and exacerbate adolescent substance use (e.g., Conger & Rueter, 1996). This study focuses on how social processes in the sibling relationship influence early adolescent substance use through peer processes, an understudied aspect of research and potential target for intervention programs.

Research to date suggests that sibling influences are unique correlates of adolescent substance use. The evidence for resemblance in substance use among siblings is substantial (Duncan, Duncan, & Hops, 2006; Rajan et al., 2003), and perhaps even greater than between children and parents (Ary, Tildesley, Hops, & Andrews, 1993; Fagan & Najman, 2005). Despite the high correlation between siblings' substance use, many have established peer use as an equally powerful predictor (see Needle et al., 1986; Stormshak, Comeau & Shepard, 2004), and research has clearly documented peer relationships as an important context for risk of early substance use. For example, in a sample of high school students, sibling alcohol use had a stronger association with adolescent alcohol use than parental alcohol use, and the association with sibling alcohol use was mediated through peer alcohol use (Windle, 2000). In another study, sibling drinking was found to indirectly influence adolescent alcohol use 4 years later via the adolescents' association with friends who drink (Conger & Rueter, 1996). The majority of these studies, however, have not examined peer influence while simultaneously examining other sibling and peer social dynamics.

Based on the tenets of social learning theory, the guiding theoretical framework for the current study was that social processes in the sibling relationship would influence adolescent substance use via their impact on peer affiliations. More specifically, our framework was predicated on social interaction learning theory (Patterson, 1982; Patterson, Dishion, & Bank, 1984; Reid, Patterson, & Snyder, 2002; Slomkowski,

Rende, Conger, Simons, & Conger, 2001), which proposes three social processes by which siblings contribute to antisocial behavior; namely, modeling, collusion, and conflict (including coercive exchanges). Thus, through direct engagement and exposure to modeling, siblings may normalize and reinforce antisocial behavior, which is believed to generalize to, and become reincarnated in peer interactions (see also Criss & Shaw, 2005; Haynie & McHugh, 2003; and Snyder, Bank, & Burraston, 2005), a more proximal and robust predictor of adolescent involvement with substance abuse (e.g., Dishion & Andrews, 1995). These social processes are modeled in Figure 1 and described in more detail below.

Sibling Conflict and Substance Use

There is growing evidence that conflict in the sibling relationship, in the form of coercive exchanges or more serious victimization, serves as an important context for the development of substance use (Widom, Weiler, & Cottler, 1999). More specifically, Stormshak, Comeau, and Shepard (2004) examined delinquent sibling and peer relationships as predictors of substance use during adolescence. Both sibling conflict and warmth were found to be correlated with sibling delinquency, and both peer and sibling delinquency independently contributed to levels of substance use. Other work, by East and colleagues, found that sibling conflict is predictive of increased substance use among younger siblings, and can be an important mediator between familial risk factors and behavioral outcomes (East & Khoo, 2005; East & Shi, 1997).

The prevailing framework for understanding the link between sibling conflict and elevated substance use has been Patterson's coercion theory (1982), in which coercive

sibling interactions are hypothesized to serve as a training ground for antisocial and delinquent activities, and for interactions with deviant peers who promote further entrenchment in delinquent activities (Bank, Patterson, & Reid, 1996; Criss & Shaw, 2005; Slomkowski et al., 2001; Snyder et al., 2005). According to this model, infrequent or intermittent opportunities to learn and elaborate positive social skills results in the escalation of coercive exchanges in the family that generalize to relationships outside the family (Simons, Whitbeck, Conger, & Wu, 1991). Without adequate social skills, youth are more likely to drift into relationships with peers who resemble their aggressive tactics (Shortt, Capaldi, Dishion, Bank, & Owen, 2003). In support of coercion theory, Bank and colleagues (1996) found that negative sibling interactions involving older brothers resulted in increased risk for aggressive peer relations and for adult antisocial behavior 10 years later. Furthermore, the risk derived from sibling negativity appears to be independent of and augments risk that may arise out of coercive parenting practices or other sibling attributes (Bank, Burraston, & Snyder, 2004; Criss & Shaw, 2005; Stocker, Burwell, & Briggs, 2002). Interaction with hostile and aggressive siblings may also result in heightened dysregulation, which elevates use of poor coping mechanisms such as substance use (East & Khoo, 2005; Windle, 2000). In light of these two perspectives, we posited indirect links between sibling conflict and adolescent substance use via deviant peer affiliation and conflict with friends.

Modeling

Initial research points to modeling in the sibling relationship as an important process in the development of delinquent
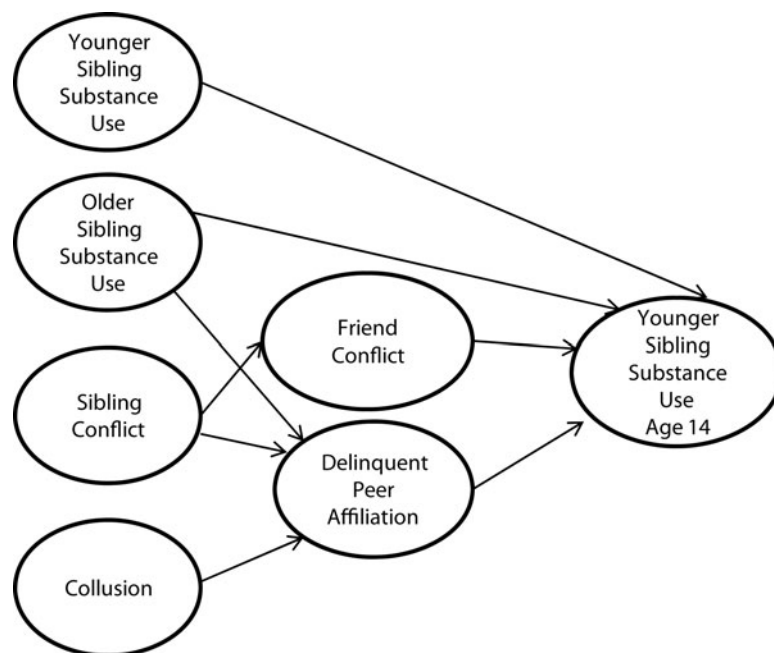

Figure 1. Proposed meditational model. The continuity path from Time 1 (T1) to Time 2 (T2) younger sibling substance use is not shown.

behavior (see Bank et al., 1996; Brody et al., 2003; Fagan & Najman, 2005; Snyder et al., 2005). With regard to modeling, certain characteristics of the sibling relationship may intensify the possibility that younger siblings' behavior is shaped by the behavior of older siblings. First, the inherent power imbalance between older and younger siblings fosters the view of older siblings as "role models," especially when they are of proximal age (Boyle, Sanford, Szatmari, Merikangas, & Offord, 2001; Conger & Rueter, 1996; Whiteman & Christiansen, 2008). In addition, influence is heightened when the siblings are of the same sex, a condition for sibling dyads in the current study (Snyder et al., 2005). Greater identification with siblings in turn, promotes similarity in values and attitudes (Brook, Brook, Richter, & Whiteman, 2006). Because modeling normalizes drinking and drug use, it is probable that younger siblings would gravitate toward peers who resemble and validate older sibling behavior. However, because modeling may occur in the context of other shared risk factors in the family environment, we proposed both a direct, as well as indirect path to adolescent substance use, via deviant peer affiliation.

Collusion

Siblings and peers are thought to provide substantial reinforcement for antisocial activity including substance use. Collusion, or delinquency training, refers to mutual reinforcement of delinquent activities, including aggression, stealing, and substance use. Collusion has been observed during sibling as well as peer interaction (Bullock & Dishion, 2002) and is considered an important vehicle for reinforcing involvement in delinquent activities (Dishion, Capaldi, Spracklen, & Li, 1995; Shortt et al., 2003; Snyder et al., 2005). Although there are few studies of delinquency training with the sibling relationship, some data suggest that siblings' reinforcement is more likely to encourage delinquent behavior in the context of a positive sibling relationship (Dishion, Spracklen, Andrews, & Patterson, 1996). However, using a developmentally sequenced model, Snyder and colleagues (2005) found that sibling conflict precedes greater mutual involvement in deviant activities, which accounted for adjustment problems among younger siblings. Brody, Flor, Hollett-Wright, and McCoy (1998) found that adolescents' alcohol use norms were influenced by older siblings' norms as well as those of parents. Based on these limited studies, we hypothesized that collusion, as evidenced by observed antisocial talk, would elevate involvement in substance use by enhancing participation with deviant peers (see Figure 1).

Summary of Current Study

Concordance rates of sibling substance use are consistently high (Windle, 2000). Research to date supports the validity of social interaction learning theory as a framework for examining sibling social influence processes on adolescent substance use, yet developmental theory indicates the need for a more complete and nuanced understanding of the social mechanisms that account for this influence. The current study extends a growing body of literature in the following ways. First, we consider dyadic sibling influences (i.e., conflict and collusion) in the context of older siblings' use (i.e., modeling). Second, we examine how sibling and peer relationships work together to promote risk for substance use in adolescence. That is, few investigations have modeled the mediating role of nonfamilial processes in the transmission of sibling influence, limiting our understanding of linkages among the multiple social contexts that affect substance use. Third, this study is unique in its use of a multimethod and multireporter measurement strategy, which is often lacking in studies of adolescent substance use (for a review, see Avenevoli & Merikangas, 2003). Multiple reporters including mother and teacher report were used to measure sibling and adolescent substance use and deviant peer affiliation. Observational data were used as indices of the sibling social processes of conflict and antisocial talk, and as one index of conflict with friends.

A mediational model of transmission from older sibling characteristics and sibling interaction, to qualities and characteristics of peer relationships (conflict and deviant peer affiliation) are examined to determine the proximal determinants of adolescent substance use by younger siblings. The following hypotheses were tested as reflected in Figure 1: (a) older sibling substance use at Time 1 (T1) would directly and indirectly (through deviant peer affiliation) affect younger sibling substance use at Time 2 (T2); (b) the relationship between sibling conflict at T1 and younger sibling substance use at T2 would be mediated through conflict in the friendships of younger siblings and through deviant peer affiliation at T1; (c) collusion between siblings at T1 would affect younger sibling substance use at T2 by increasing younger siblings' involvement with deviant peers at T1; and (d) both conflict with friends and deviant peer involvement for the younger sibling at T1 would make unique contributions to younger sibling substance use at T2.

Method

Sample

The target children were the younger siblings (122 younger brothers, 122 younger sisters) from 244 families with same-sex biological siblings. Families identified in the databases of three collaborating school districts located in a medium-sized metropolitan area in the Pacific Northwest as having (a) one child in the seventh grade of a public middle school, (b) a younger same-sex child in the fourth or fifth grade of a public elementary school, and (c) a mother residing in the home, were sent an introduction letter about the study with an option to receive no further contact. The families on the contact list were screened for biological relatedness to confirm eligibility and invited to participate in a home visit to explain the study. Of the 448 families originally identified by the school districts, 364 families were eligible to partici-

pate, and 244 families or 67% completed assessments at T1. At T2, approximately 3 years after the initial assessment, families were recontacted and asked to participate in a follow-up assessment. Of the 244 families that completed T1, 9 families could not be contacted and 215 families (111 younger brothers and 104 younger sisters) completed assessments at T2 for a retention rate of 88%. Reasons for not participating included no time to make it work, too busy, lack of interest, adolescents no longer live in household, and mother illness. Using analyses of variance, there were no significant group differences between families that participated at T2 and families that did not participate at T2 on key baseline demographics (e.g., children's race, mothers' education, financial aid).

Demographics

Mothers reported the children's race as 83% Euro-American, 16% Mixed Race and 1% Native American or Asian American/Pacific Islander. Mothers also reported the children's ethnicity as 7% Hispanic. At T1 and T2, the majority (74%) of the children lived with both biological parents in the same household. In 24% of families, the mothers were divorced or separated from the children's fathers, and in 2%, the children's fathers had died. Regarding the mothers, 21% had a high school education or less, 58% attended college, and 21% pursued graduate professional training or degree. Using the Hollingshead occupational codes, mothers with occupations as skilled, semiskilled, or unskilled manual workers was 37% at T1 and 32% at T2; clerical workers, small business owners, and semi- or minor professionals was 52% at T1 and 54% at T2; and administrators/executives, large business owners, and major professionals was 11% at T1 and 13% at T2. The median household incomes of the families, including child support and assistance before taxes, was $50,000–$59,999 at T1 and T2. The percentage of families that received financial public assistance or aid was 19% at T1 and 15% at T2. Thus, the majority of families were Euro-American, middle income families from intact households.

Procedure

At T1, the younger siblings were on average 10.87 years old (SD = 0.59, range = 9.29–12.62), and participated in laboratory visits with their families (mothers, older siblings) and friends that included videotaped interviews, videotaped dyadic interactions, and questionnaire completion. Older siblings were on average, 13.33 years old (SD = 0.67, range = 12.12–14.93) at T1. Same-sex friends in the same grade or one grade ahead or behind and within 1 year older or younger were selected to participate by the younger siblings. Families and friends were informed that the study was interested in how children make the transition from elementary to middle school and the relationships children have with their siblings and friends during this time. All younger siblings had a friend participate at T1. The 15-min videotaped interactions with

siblings and with friends each comprised a 5-min warm-up task that involved planning something fun to do together and a 10-min problem-solving task on topics the dyads chose to discuss. The top three topics for siblings were arguing or fighting with each other, borrowing each other's things, and chores at home or privileges; the top three topics for friends were figuring out what activity to do, arguing or fighting with each other, and amount of time spent with each other. At T2, when the younger siblings were on average 13.59 years old (SD = 0.79, range = 11.41–15.44) and their older siblings were on average 16.05 years old (SD = 0.65, range = 14.40–17.71), a similar laboratory visit was conducted. Mothers and teachers completed questionnaires about the behavior of younger and older siblings at T1 and T2. Teachers across different subject areas (e.g., history) were selected to participate by the families. Families, friends, and teachers were compensated for their time related to all assessments.

Observational coding of conflict. Observational coding of conflict during dyadic interactions (younger sibling–older sibling; younger sibling–friend) using the microsocial Specific Affect Coding System (SPAFF; Gottman, McCoy, Coan, & Collier, 1996) was conducted on-line in real time. Dyadic interaction was coded continuously in two passes (one pass to code one participant in the dyad and a second pass to code the other participant) using an on-line computerized system that synchronized second by second timing information with the original videotaped conversation. Detection of affect was made by integrating verbal content, voice tone, context, facial expression, gestures, and body movements. The behavior of each dyad member was assigned to 1 of 17 emotions/emotional behavior patterns. Observed conflict was empirically derived by applying a principal components analysis to coded negative emotions and emotional behavior patterns. This analysis resulted in a single six-item negative affect factor and a factor structure that was similar across sibling and friend interaction. Observed conflict scores were computed by first summing the duration of time in seconds that each participant in the dyad was observed displaying contempt, anger, defensiveness, criticism, belligerence, and domineering toward the other during the interaction, and then taking the average of each participant's duration of negative affect to produce an observed conflict score for the dyad. The SPAFF coders were research staff who participated in a 3-month training to learn the code and establish reliability. Two coders independently coded 15% of randomly selected interactions with older siblings and with friends. The overall kappa values ranged from 0.75 to 0.80 across sibling and friend interactions.

Constructs and Instruments

All variables in the current study were used to form latent constructs, with the exception of substance use, in which a composite of variables were used (due to the small number

of items across scales and reporters). To form latent constructs, indicators were identified from the observation and questionnaire data based on face validity and a priori theoretical definitions. All latent constructs were defined by multiple methods and agents. Several criteria were used in construct building in the current study, based on the guidelines provided by Patterson and Bank (1986, 1989). First, individual items that had item-total correlations of less than 0.20 were dropped, as were items with zero variance. Scales were then tested for convergent validity through exploratory factory analysis, in which scales with factor loadings of <0.30 were dropped. Last, confirmatory factor analysis was used (within the measurement model) to examine indicator loadings for each construct, which are presented in Table 1. Details on constructs and measures including scale reliability are provided in Table 1. Although the internal consistency on the Health update, mother report on younger sibling substance use at T1 was low, the items were retained because they met a priori definitions for substance use. Furthermore, because the reliability of this scale increased considerably at T2, it is likely that the alpha at T1 was attenuated due to the low occurrence of substance use.

Older sibling substance use at T1. Older sibling substance use scores were computed by taking the mean of older sibling report, mother report, and teacher report of alcohol, tobacco, and marijuana use during the previous 6–12 months using items from questionnaires (see Table 1). Interreporter correlations ranged from $r = .40$ to .54 ($ps < .01$). The prevalence of older sibling substance use at T1 reported by either older sibling, mother, or teacher was 19%.

Younger sibling substance use at T1. Younger sibling substance use scores were computed by taking the mean of younger sibling report, mother report, and teacher report of alcohol, tobacco, and marijuana use during the previous 6–12 months using items from questionnaires (see Table 1). Interreporter correlations ranged from $r = .16$ to .43 ($ps < .05$), with the lowest correlations between teacher report and mother/younger sibling. Nonetheless, we retained teacher report in the composite because these items are from reliable measures and provide value as a nonredundant source of information. The prevalence of younger sibling substance use at T1 reported by either younger sibling, mother, or teacher was 10%.

Younger sibling substance use at T2. Similar to substance use at T1, younger sibling substance use scores were computed by taking the mean of younger sibling report, mother report, and teacher report of alcohol, tobacco, and marijuana during the previous 6–12 months using items from questionnaires (see Table 1). Note that one additional teacher reported substance use item and two additional mother reported substance use items were added to the Child Behavior Checklist at T2 based on the updated versions of these scales (Achenbach & Rescorla, 2001). Interreporter correlations ranged from $r = .44$ to .66 ($ps < .01$). The prevalence of younger sibling substance use at T2 reported by either younger sibling, mother, or teacher was 19%.

Sibling conflict at T1. The sibling conflict construct comprised three indicators: conflict/antagonism, observed conflict, and aggression (see Table 1). The conflict/antagonism indicator was the mean of older sibling, younger sibling, and mother reports on conflict and antagonism scales. The observed conflict indicator was derived from the SPAFF coding of the sibling interaction and defined as the mean of older sibling's duration of negative affect toward younger sibling and younger sibling's duration of negative affect toward older sibling. The aggression indicator was the mean of older sibling, younger sibling, and mother reports on physical aggression, psychological aggression, relational aggression, and relational aggression involving mother scales.

Friend conflict at T1. Similar to the sibling conflict construct, the friend conflict construct comprised three indicators: conflict/antagonism, observed conflict, and aggression (see Table 1). The conflict/antagonism indicator was the mean of younger sibling and friend reports on conflict and antagonism scales. The observed conflict indicator was derived from the SPAFF coding of the friend interaction and defined as the mean of younger sibling's duration of negative affect toward a friend and the friend's duration of negative affect toward younger sibling. The aggression indicator was the mean of younger sibling and friend reports on physical aggression, psychological aggression, relational aggression, and relational aggression involving mother scales.

Sibling collusion at T1. The sibling collusion construct comprised two indicators: antisocial talk and substance use talk (see Table 1). The antisocial talk indicator was the mean of coder ratings of antisocial talk and staff ratings of antisocial talk during sibling interaction (Capaldi, Dishion, & Crosby, 1991). The substance use talk indicator was defined by coder ratings of substance use talk during sibling interaction. Coder and staff ratings comprised macro global ratings of (a) how much the siblings talked about antisocial topics and activities, rule-breaking and substance use, and swore in expressions for emphasis; and (b) how much the siblings endorsed each other's deviant talk with positive affect, support and encouragement, and acceptance.

Younger sibling deviant peer affiliation at T1. The deviant peer affiliation construct comprised three indicators: younger sibling report, mother report, and teacher report of the degree to which the younger sibling associated with friends who get in trouble, participate in antisocial activities, and use substances (seven items) based on items and scales from interview and questionnaires (see Table 1).

Table 1. *Constructs and measures*

Measure	Items	Scale	Mean (*SD*)	Example Item	Reliability	Indicator Factor Loading
			Older Sibling Substance Use at T1			
Older sibling report						
Sibling report health update[a]	3	0–9	0.25 (0.90)	Typical usage of alcohol		.83
Mother report						
Child Behavior Checklist[b]	1	0–2	0.04 (0.19)	Uses alcohol or drugs		NA
Health update[a]	5	0–9	0.09 (0.31)	How many times has your child drank beer/wine/hard liquor?		.59
Teacher report						
Child Behavior Checklist	1	0–2	0.06 (0.27)	Uses alcohol or drugs		NA
Peer involvement and social skills[c]	1	0–2	0.15 (0.37)	Does this student smoke cigarettes or chew tobacco?		NA
			Younger Sibling Substance Use at T1			
Younger sibling report						
Health update[a]	3	0–9	0.06 (0.30)	Typical usage of cigarettes or chewing tobacco		.65
Mother report						
Child Behavior Checklist[b]	1	0–2	0.00 (0.06)	Uses alcohol or drugs		NA
Health update[a]	5	0–9	0.05 (0.19)	How many times has your child smoked cigarettes or chewed tobacco?		.25
Teacher report						
Child Behavior Checklist[b]	1	0–2	0.06 (0.27)	Uses alcohol or drugs		NA
Peer involvement and social skills[c]	1	0–2	0.15 (0.37)	Does this student smoke cigarettes or chew tobacco?		NA
			Younger Sibling Substance Younger Use at T2			
Younger sibling report						
Health update[a]	3	0–9	0.29 (0.90)	Typical usage of marijuana		.72
Mother report						
Child Behavior Checklist	3	0–2	0.02 (0.13)	Uses drugs for nonmedical purposes		.77
Health update[a]	5	0–9	0.13 (0.60)	How many times has your child used marijuana?		.90
Teacher report						
Child Behavior Checklist[b]	2	0–2	0.02 (0.12)	Smokes/chews/sniffs tobacco		.23
Peer involvement and social skills[c]	1	0–2	0.13 (0.36)	Does this student smoke cigarettes or chew tobacco?		NA
			Sibling Conflict T1			
Conflict/antagonism						.87

Conflict, older sibling/younger sibling/ mother report, network of relationship inventory[d]	3	1–5	3.33 (0.55)	How much do you and your sibling get upset with or mad at each other?	.79–.91	
Antagonism, older sibling/younger sibling/mother report, network of relationship inventory[d]	3	1–5	30.41 (0.59)	How much do you and your sibling get on each other's nerves?	.82–.90	
Aggression						.81
Older and younger sibling physical, older/younger sibling/mother report, Conflict Tactics Scale[e]	5	0–9	20.69 (10.64)	How many times did older sibling push or shove younger sibling?	.84–.91	
Older and younger sibling psychological, older/younger sibling/mother report, Conflict Tactics Scale[e]	8	0–9	30.42 (10.49)	How many times did younger sibling insult or swear at older sibling?	.87–.89	
Older and younger sibling relational, older/younger sibling/mother report[f]	6	0–9	20.02 (10.02)	How many times did older sibling tell friends to stop liking/hanging out with younger sibling?	.68–.79	
Older and younger sibling relational involving mother, older/younger sibling/mother report[f]	3	0–9	20.86 (1.48)	How many times did younger sibling tell mother about something older sibling did?	.68–.78	
Negative affect						.35
Coded negative affect	NA	NA	107 (96)	Duration in (s) of anger, contempt, defensiveness, criticism, belligerence, and domineering during sibling interaction	NA	
SPAFF code[g]						

<table>
<tr><td colspan="7" align="center">Friend Conflict at T1</td></tr>
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Conflict/antagonism						.86
Conflict, younger sibling/friend report, network of relationship inventory[d]	3	1–5	10.98 (0.53)	How much do younger sibling and friend disagree and quarrel?	.77–.81	
Antagonism, younger sibling/friend report, Network of Relationship Inventory[d]	3	1–5	10.88 (0.56)	How much do friend and younger sibling get annoyed at each other?	.78–.81	
Aggression						.68
Younger sibling and friend physical, younger sibling/friend report, Conflict Tactics Scale[e]	5	0–9	0.29 (0.61)	How many times did younger sibling slap or hit friend?	.70–.87	
Younger sibling and friend psychological, younger sibling/friend report, Conflict Tactics Scale[e]	8	0–9	0.35 (0.53)	How many times did friend insult shout or yell at younger sibling?	.73–.84	
Younger sibling and friend relational, younger sibling/friend report[f]	6	0–9	0.29 (0.45)	How many times did younger sibling keep friend from being with group?	.58–.79	
Younger sibling and friend relational involving mother, younger sibling/friend report[6]	3	0–9	0.12 (0.33)	How many times did friend make up things to get younger sibling in trouble with mother?	.55–.78	
Negative affect						.41
Coded negative affect	NA	NA	34 (33)	Duration in seconds of anger, contempt, defensiveness, criticism, belligerence, and domineering during friend interaction	NA	

Table 1 (*cont.*)

Measure	Items	Scale	Mean (*SD*)	Example Item	Reliability	Indicator Factor Loading
SPAFF code[7]						
			Sibling Collusion at T1			
Antisocial talk						.64
Older and younger sibling antisocial talk coder ratings[h]	10	1–5	10.09 (0.35)	How much did older sibling make antisocial and delinquent suggestions?	.91–.93	
Older and younger sibling antisocial talk staff ratings[h]	4	1–5	10.24 (0.57)	Older sibling engaged in antisocial talk e.g., breaking rules, substance use, antisocial activities.	.74 –.83	
Substance use talk						.45
Older and younger sibling substance use talk coder ratings[h]	2	1–5	10.03 (0.18)	How much did older sibling find talk about substance use acceptable?	.69–.75	
Younger sibling deviant peer affiliation at T1						
Younger sibling report						.73
Peer Network Interview[i]	10	0–5	10.19 (0.81)	Number of friends who hang with a tough crowd	.83	
Describing friends[j]	21	1–5	10.21 (0.26)	How many of your friends drink beer/wine/ hard liquor?	.87	
Mother report						.50
Child Behavior Checklist[b]	1	0–2	0.11 (0.32)	Hangs around with kids who get in trouble	NA	
Peer Relations Questionnaire[j]	6	1–5	10.17 (0.26)	Does your child hang out with kids who smoke cigarettes?	.71	
Teacher report						.56
Child Behavior Checklist[b]	1	0–2	0.23 (0.51)	Hangs around with kids who get in trouble	NA	
Peer involvement and social skills[c]	4	1–5	10.56 (0.56)	How often does this student associate with students who smoke cigarettes or chew tobacco?	.81	

Note: Cronbach alphas were computed for measures with three or more items; correlations were computed for measures with two items.
[a] Katz & Gottman (1986).
[b] Achenbach & Rescorla (2001).
[c] Walker & McConnell (1988).
[d] Furman & Buhrmester (1985).
[e] Straus, Hamby, Boney-McCoy, & Sugarman (1996).
[f] Crick, Bigbee, & Howes (1996).
[g] Gottman et al. (1996).
[h] Capaldi et al. (1991).
[i] Dishion, Poulin, & Medici-Skaggs (2000).
[j] Capaldi & Patterson (1989).

Results

Preliminary analyses and plan of analysis

Preliminary analyses were conducted to determine the nature and extent of missing data. Missingness by variable was 0% at T1 and 12% on substance use at T2. Model-based likelihood methods that assume missing at random data are still the current recommended standard (Schafer & Graham, 2002) because the older alternative (complete case analysis or listwise deletion) is based on a more unrealistic assumption of missing completely at random and tends to perform worse in terms of bias and power. Using analysis of variance analyses, there were no demographic differences between families who did/did not participate at T2 (e.g., family structure, household income), nor were there different rates of baseline behavior, including substance use, collusion, or conflict. Therefore, we proceeded under the assumption of missing at random. Thus, in subsequent analyses, missing scores were estimated using full information maximum likelihood estimates in AMOS (Arbuckle, 1999). Unlike pairwise or listwise deletion methods, the full information maximum likelihood procedure does not delete cases missing from one or more waves of data collection, nor does it delete cases that are missing data for one or more variables within a wave of data collection. Therefore, it is more likely to result in unbiased parameters (Wothke, 2000). Second, data were assessed for assumptions of normality. Outliers were adjusted to fall 1.5 times the interquartile range below the 25th percentile or above the 75th percentile (e.g., to the whiskers in Tukey's 1977 boxplot). All variables had acceptable levels of skew and kurtosis (skew < 3 and kurtosis < 10) except younger sibling substance use at T1, which was log transformed to achieve acceptable properties.

Analyses were conducted in three steps. The first step entailed fitting the measurement model while allowing the constructs to correlate freely. In the second step we fit a structural equation model (AMOS 16) to test our hypotheses. In the third step, we conducted formal tests of mediation. Goodness of fit for each model was assessed by examining the comparative fit index (CFI), root mean square error of approximation (RMSEA), and χ^2/df; according to conventional guidelines, a CFI of 0.95 and an RMSEA of 0.08 or less are considered to be a reasonable fit (Browne & Cudeck, 1993; Hu & Bentler, 1999). According to Arbuckle and Wothke (1999), a χ^2/df ratio between 1 and 3 indicates a good fit.

Measurement model and construct intercorrelations

Before testing the structural model, we assessed the measurement model for factor loadings (i.e., confirmatory factor analysis) and intercorrelations among constructs. All factor loadings were significant and are presented in Table 1. The measurement model yielded a good fit to the data, χ^2/df $(60) = 1.34$, $p = .04$, CFI $= 0.98$, RMSEA $= 0.04$. Table 2 describes the positive correlations of the T1 predictors with younger sibling substance use at T2, which were consistent with the hypothesized model. Older sibling substance use was significantly related to sibling collusion and sibling conflict, but sibling conflict and collusion were not significantly related. All three T1 sibling predictors were related to younger sibling substance use at T2, as were the two peer predictors at T1. In addition, older sibling substance use, sibling conflict, and collusion were all related to younger siblings' conflict with friends and deviant peer affiliation, and conflict with siblings was related to conflict with friends.

Structural equation modeling (SEM) model and tests of mediation

Hypothesized SEM models were tested with AMOS 16 software (Figure 2). Mediation models are best estimated in an SEM context because of the greater flexibility SEM programs afford in model specification and estimation options (Preacher & Hayes, 2008). In addition to offering advantages over standard regression methods, SEM has yielded similar results to multilevel modeling approaches when analyzing family data involving sibling pairs (Khoo & Muthén, 2000). Therefore, there is growing sentiment that SEM "provides unbiased estimates of the parameters and standard errors despite the nesting of individuals within families" (Brody, Kim, McBride-Murray, & Brown, 2005, p. 193). The model provided an adequate fit to the data ($\chi^2/df =$

Table 2. *Intercorrelations among constructs*

	1	2	3	4	5	6	7
1. YS substance use (T1)	—						
2. OS substance use (T1)	.58**	—					
3. Sibling collusion (T1)	.19**	.20**	—				
4. Sibling conflict (T1)	.21**	.46**	.03	—			
5. Friend conflict (T1)	.23*	.22*	.28*	.20*	—		
6. Deviant peer affiliation (T1)	.50**	.53**	.33**	.38**	.53**	—	
7. YS substance use (T2)	.39**	.42**	.23**	.17*	27*	.50**	—

Note: YS, younger sibling; T1, Wave 1, T2, Wave 2. OS, older sibling;
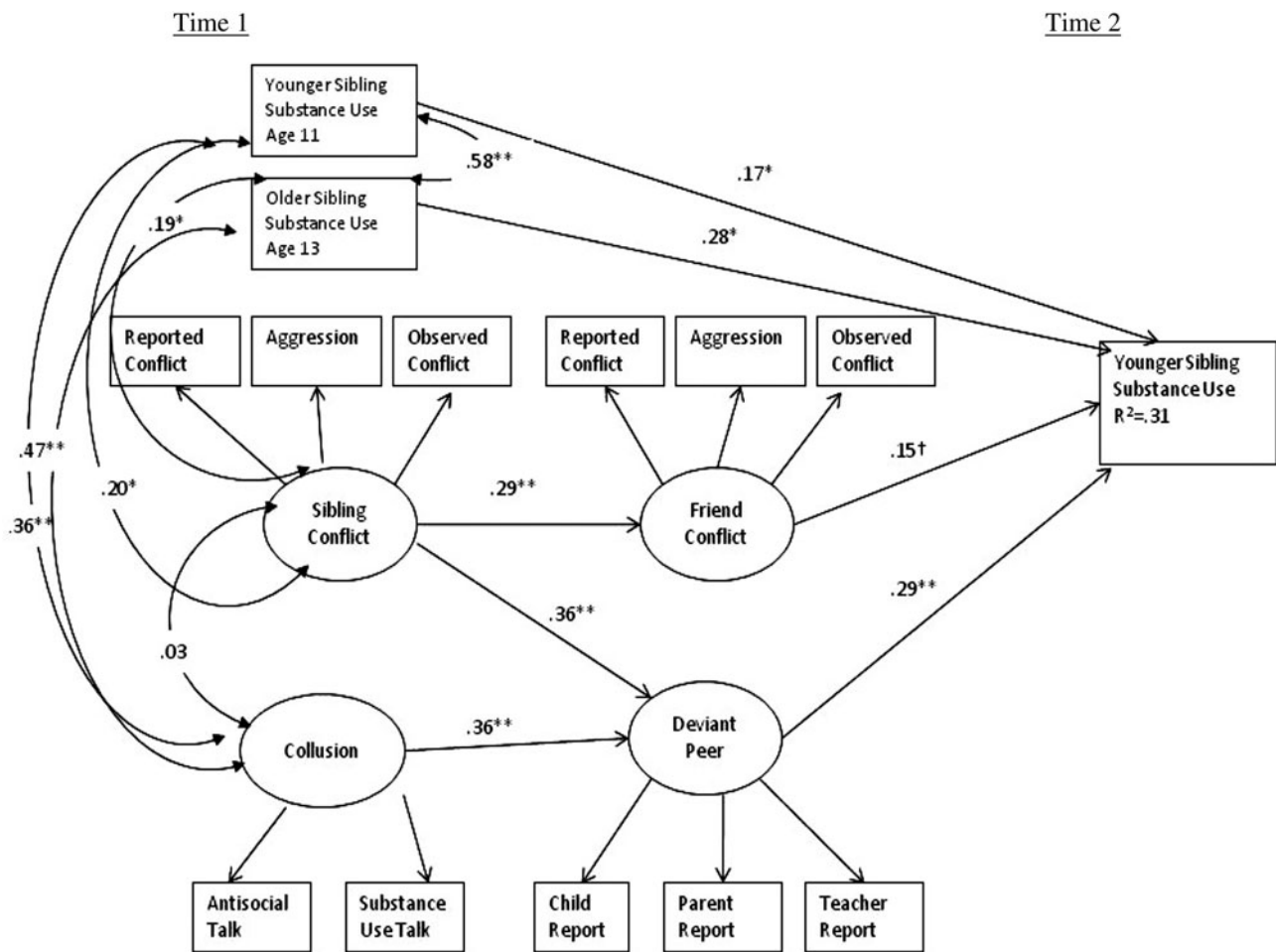*$p < .05$. **$p < .01$.

Figure 2. Structural equation modeling model showing parsimonious model with standardized paths. Reported Conflict, Network of Relationships Inventory; Observed Conflict, microsocial coding of dyadic negative affect.

1.77, CFI = 0.94, RMSEA = 0.05). Specific pathways and tests of mediation are discussed below.

Modeling of substance use. Results indicate that older siblings' substance use at T1 predicted higher levels of use by younger siblings at T2 but not higher levels of deviant peer affiliation, when all variables were assessed simultaneously.

Sibling conflict. Sibling conflict was significantly related to both younger siblings' deviant peer affiliation and conflict with friends at T1; however, conflict with friends was not predictive of younger sibling substance use at T2. Therefore, the only test of mediation was via deviant peer affiliation. With the path between sibling conflict and younger sibling substance use constrained to zero, the model fit did not significantly change, indicating that deviant peer affiliation was sufficient in explaining the link between sibling conflict and younger sibling substance use at T2.

Collusion. Antisocial talk between siblings was significantly linked to higher levels of deviant peer affiliation by younger siblings at T1. The direct effect of collusion on younger

sibling substance use at T2 was not significant, and removal of this path did not result in a significant change in model fit. Therefore, the link between collusion and younger sibling substance use was mediated through deviant peer affiliation.

Alternative models

Although we did not make any predictions regarding gender effects, we nonetheless checked for them. Our sample was too small to allow us to investigate the potential effects of sibling gender on the paths in the conceptual model, and would likely yield unstable estimates. We did, however, use the multigroup comparison procedures from AMOS 16 to determine whether sibling gender conditioned any of the paths. For these analyses, we assessed for the χ^2/df difference of a baseline (noninvariant model) with a two-group gender invariance model in which we imposed equality constraints on all pathways and factor loadings. The differences in χ^2 values were nonsignificant, suggesting gender did not moderate the effects.

Finally, for exploratory purposes, we examined the interactions among the sibling variables to test the degree to which conflict and collusion amplify older sibling substance use, as

well as how conflict may amplify the deleterious effects of antisocial talk. We examined for moderation effects on substance use, as well as the proposed mediators in both regression analyses and in the SEM model, and none were significant. Thus, the more parsimonious model does not include these interaction terms.

Discussion

There is a strongly documented overlap in sibling antisocial behavior, including substance use. To date, the majority of investigations have relied on direct effects models, which have given way to studies examining incremental risk incurred by social experiences with parents, siblings, and peers. The current study builds upon this literature by modeling key peer relationship processes that may mediate the link between older sibling socialization and younger sibling substance use. Research has clearly established that the transition to adolescence is characterized by increasing assertion of independence and autonomy, in part reflected by increases in nonparental social influences (Steinberg, Dahl, Keating, Kupfer, Masten, & Pine, 2006). It is also during this period that most youth initiate substance use as well as other rule-breaking and risky behaviors. Consistent with previous research (Haynie & McHugh, 2003), this paper suggests that siblings and peers may provide complementary influences on how youth navigate this transition and elucidates the social processes by which initiation of substance use may be transmitted in these horizontal sibling and peer relationships.

The model tested in the current study indicates that older siblings' influence on younger sibling substance use may operate through both direct and indirect mechanisms. The model also reveals overlapping and distinct pathways are needed to describe the relationships between older and younger sibling substance use. Older siblings who use substances serve as "role models," as suggested by other direct effects models, exerting influence by normalizing use, or perhaps by providing direct (or indirect) access to substances. In the same vein, younger siblings witness the perceived benefits of substance use by older siblings, which may enhance willingness to use. Contrary to predictions, older siblings' substance use was not significantly tied to increased affiliation with deviant peers by younger siblings when other variables in the model were simultaneously taken into account, including the overlap between older siblings' use, conflict, and collusion.

These findings are consistent with and extend previous work (Conger & Rueter, 1996), suggesting that maladaptive sibling socialization generalizes to problematic peer relations and association with deviant peers, so as to maintain or exacerbate problem behavior. Both sibling conflict and collusion were associated with younger siblings' increased involvement with deviant peers, which in turn predicted younger sibling substance use. In the study by Conger and Rueter (1996), older sibling use and parenting influences indirectly affected younger sibling substance use via friend substance use. Although the current model does not account

for parenting practices, it expands on that of Conger and Reuter by incorporating links to social processes, including sibling relationship quality, conflict with friends, and deviant peer affiliation. Older siblings' substance use no longer had a direct effect on enhanced deviant peer affiliation. This apparent inconsistency with Conger and Reuter may be the result of accounting for other social influence mechanisms. They suggested that older sibling use is important in legitimizing substance use and in fostering affiliation with friends who use, but encouraged future research to elucidate how older sibling substance use influences these sequelae. In the more comprehensive model tested in this report, it appears that collusion provides a vehicle for practicing and normalizing deviant behavior, whereas sibling conflict may prohibit the transfer of skills (e.g., social competence, emotion regulation) needed to successfully engage prosocial peers. Thus, sibling conflict and collusion may have a relatively stronger influence on drift toward deviant peers than modeling.

Contrary to our expectations, conflict with friends did not make a unique contribution to younger sibling substance use in the context of deviant peer affiliation. Despite this, the two peer processes were correlated, and seem to represent different (albeit important) processes: conflict suggests there are underlying skill deficits in areas needed to facilitate and maintain healthy relationships (e.g., emotion regulation, problem solving), whereas deviant peer affiliation highlights the role of reinforcement. Unlike sibling conflict, the ability for teens to select a close friend naturally may limit the amount of relationship conflict, reducing the potency of this construct. Although beyond the scope of this paper, research might usefully examine how friend conflict exacerbates deviant peer affiliation, while taking the sibling relationship into account.

Although we did not have an a priori hypothesis about the association between collusion and sibling conflict, the data suggest that collusion in the form of antisocial talk may be more likely to take place in the context of a warm sibling relationship and that endorsement of substance use and conflict during sibling interaction are somewhat distinct processes. Alternatively, there may be a developmental sequencing in which conflict facilitates later association with older siblings' delinquent friends and collusion by siblings (Snyder et al., 2005). Based on this reasoning, mutual discourse and coparticipation in delinquent behavior are more likely to occur during early to middle adolescence, when younger siblings have had the exposure to and experience with delinquent acts (see Bullock & Dishion, 2002). Without repeated measurements, we cannot ascertain this temporal sequencing, and more work is needed to elucidate the additive and synergistic effects of these developmentally dynamic social processes.

Several methodological strengths of this dataset should be highlighted. Multiple reporters and methods were utilized to define all constructs in the current study, and observational data were used for both conflict and antisocial talk (i.e., delinquency training). Observational data provides a level of objective coding that could otherwise not be captured through self-report data. The current study tested the sibling influence model using

a longitudinal design covering a 3-year time span allowing for a unique developmental perspective; however, additional data points would allow for a more rigorous test of mediation and allow for more flexible analysis of growth in problem behavior.

Limitations

Readers should note that the current sample was comprised of community-based early adolescents, and therefore the range of problem behavior is somewhat attenuated. Given the relatively low level of endorsed substance use in the current sample, there is some caution in the generalizability of the model to higher risk samples and the magnitude of our path coefficients may be underestimated. Some use of substances at this age is normative, and should not be equated with antisocial behavior or problematic use (the latter of which was not measured in the present study). However, the prediction of onset by middle school is critical because timing of use, specifically early use, is strongly associated with higher risk for developing substance abuse disorders (Grant, 1998; Grant & Dawson, 1997; Odgers et al., 2008). Furthermore, youth who use substances during early to middle adolescence are more likely to injure themselves or others (Grunbaum et al., 2004), to engage in risky sexual behavior and experience early pregnancy (Odgers et al., 2008). Thus, any use at this age should be taken seriously, as it is correlated with beliefs, attitudes, and other problem behavior that may heighten one's risk for future dependency.

In addition, several important constructs were not included in the current model, including parenting behavior and emotion regulation capacities. Although sibling influences are thought to be unique, it is possible that the parent characteristics might help explain the association between sibling influences and adolescent substance use. In Patterson's theory (1982), parents are considered the primary agents of coercive exchanges, and homes with sibling conflict and collusion are likely to be characterized by poor parent management and monitoring (especially when one considers parent intervention in sibling conflict). Thus, it is plausible that parent–child conflict and parents' own substance use may contribute to or amplify sibling conflict and adolescent substance use. Although initial work in this area has not supported interaction effects (see Criss & Shaw, 2005), the incorporation of key parenting constructs would allow for a more ecologically valid examination of the complex and multiple social contexts in which behavior problems unfold. Despite the absence of a full ecological model, it should be noted that the current model accounted for a sizeable portion of variance in younger sibling substance use.

The focus of the current study was on younger siblings' alcohol, tobacco, and marijuana use in early adolescence.

Although we used multiple reporters of substance use, we did not capture the complete variability and range of experimentation and use of drugs (e.g., inhalants, hard drug use, prescription drug abuse). Thus, we acknowledge that there may be heterogeneity in pathways to these different substances, and further studies would need to determine whether findings generalize to this broader class of substances.

These characteristics aside, the current findings add to a growing body of literature emphasizing the potent role of siblings in the development of deviant behavior, and point to two important areas of future research not aforementioned. Given that siblings are a powerful influence and it is hard to deselect delinquent siblings (compared to friends), future work should focus on individual factors that mitigate or otherwise diminish the effects of conflict and delinquency training, such as younger siblings' emotion regulation or social skills, which may help facilitate formation of healthy friendships. Parent management skills aimed at managing sibling conflict may also be beneficial. Second, given the powerful socializing role of siblings, relatively fewer investigations have focused on protective factors or positive social processes between siblings that may enhance the development of healthy relationships.

Intervention implications

Aside from traditional family therapy approaches and multisystemic therapy, there are surprisingly few interventions that incorporate siblings. Yet, this study adds to a growing case for the importance of targeting multiple family systems. Sibling social dynamics are processes that are more amenable to intervention than sibling substance use per se (Kim, McHale, Crouter, & Osgood, 2007), and it remains important to identify the specific social processes in the sibling relationship that are associated with problem behavior and substance use. Failure to address siblings, as both a familial and nonfamilial influence (that shares certain characteristics of peers) is likely to hinder efforts to reduce early substance use. In short, interventions targeted at one child in a family could be undermined by sibling experiences, based on the work of Bank and colleagues (2004), who established the efficacy of combined parent and sibling training approaches to treating school-aged children's conduct problems. One other relatively recent and promising example comes from the work of Spoth, Redmond, Shin, and Azevedo (2004), who found preliminary support for reducing growth of substance use using a family focused intervention for adolescents. At a minimum, the findings in this report should encourage practitioners and prevention researchers to incorporate and address the multiple social processes and diverse ecologies both within and outside the family environment that contribute to adolescent problem behavior.

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