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Considerations of Elder Sibling Closeness in Predicting Younger Sibling Substance Use: Social Learning versus Social Bonding Explanations

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Abstract

Adolescent siblings are often similar in a variety of adjustment outcomes, yet little is known about the processes that explain sibling influences during adolescence. Two alternative explanations were tested, attachment (based in social bonding theory) and anaclitic identification (based in social learning theory). Hypotheses were tested using a sample of 613 adolescent sibling pairs (206 non-adopted, 407 adopted; elder sibling M_{age} = 16.1, younger sibling M_{age} = 13.8) across three sibling contexts (gender composition, age difference, and genetic similarity). Attachment explanations were supported such that the greater the perceived sibling emotional and behavioral closeness, the lower the likelihood of substance use; however, there were considerable moderating effects of sibling gender composition. Anaclitic identification explanations were not supported; closeness and elder sibling substance use did not interact to predict younger sibling substance use. Overall, this research adds to a body of work demonstrating important sibling influences on adolescent substance use.

Keywords

Adolescence; Bonding; Closeness; Sibling Influences; Substance Use

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A review of the literature reveals a clear effect of sibling similarity in a variety of adolescent adjustment outcomes. For example, there is evidence that siblings are similar in risky sexual attitudes and behaviors (McHale, Bissell & Kim, 2009), tobacco use (Slomkowski, Rende, Novak, Lloyd-Richardson & Niaura, 2005), academic achievement and substance use (McGue & Iacono, 2009), externalizing behaviors and delinquency (Rowe, Rodgers & Meseck-Bushey, 1992), as well as self representations (Gamble, Yu & Card, 2010). Following basic social learning principles, evidence is beginning to point to stronger sibling similarity when siblings are the same gender, close in age, and to a lesser extent, when they are genetically similar (McGue & Iacono, 2009; McHale et al., 2009; Rowe & Gulley, 1992).

Still, the theoretical mechanisms that explain sibling similarity are not well understood. We (and others, e.g., McHale et al., 2009) propose that characteristics of sibling relationship quality, including perceived sibling closeness, may be important explanatory variables. In

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this paper, two alternative explanations were tested to predict younger sibling adolescent substance use, an attachment explanation (based in social bonding theory) and an anaclitic identification explanation (based in social learning theory). Central to both explanations are the younger sibling's perceived emotional and behavioral closeness to his or her elder sibling. Finally, hypotheses derived from these explanations were tested across varying sibling contexts, such as gender composition, age difference, and genetic similarity. The goal of this study was to extend knowledge on how perceived sibling closeness and genetic similarity might interact to influence sibling similarity in substance use.

Theoretical Explanations

Social learning theory—Social learning theory is the predominantly cited theory explaining how siblings influence adolescent development. According to social learning theory (Bandura, 1969), people learn from observing and imitating role models around them, including older siblings. One reason children model the behavior of some siblings but not others stems from the *anaclitic identification process* (Bandura, 1969), also known as the *affectionate nurturance* hypothesis (Sears, 1957; see Grusec, 1992 for a review of the overlap between these concepts). These explanations propose that feelings of closeness and warmth towards a sibling, fostered when an elder sibling nurtures their younger sibling, influence the younger sibling to identify and model that elder sibling's behavior.

Indeed, there is increasing support for the concept of anaclitic identification; close and warm relationships with siblings have been associated with greater sibling similarity, and lower warmth with less similarity in adjustment outcomes (Gamble et al., 2010; McHale et al., 2009; Rende, Slomkowski, Lloyd-Richardson & Nieura, 2005; Rowe & Gulley, 1992). For example, Slomkowski et al. (2005) found that when siblings were high in social connection (that is, they spent a lot of time together, had strong affection for each other, and had mutual friends), they were more likely to be similar in their tobacco use. Similar results have been found for substance use and delinquency (Rowe & Gulley, 1992). Altogether, these findings support anaclitic identification as an explanation for sibling similarity.

Social bonding theory—Social bonding theory (Hirschi, 1969) has also been used to explain sibling effects on adolescent adjustment. Specifically, this theory's concept of *attachment* is a useful explanation, proposing that a sense of closeness, with a family member (such as an older sibling) should help to protect children from maladjustment problems According to this theory, children who feel close to their family members are more likely to commit to conventional values and activities, have a greater sense of self-control, and are less likely to engage in dangerous behaviors. Therefore, the sense of closeness to family, in general, leads to a broader sense of closeness to society.

Much like the concept of anaclitic identification, an attachment explanation proposes that when a child is nurtured by an attachment figure, she or he will feel close to that attachment figure. This is known as affectional bonding (Bowlby, 1969). A supported hypothesis derived from an attachment explanation predicts a direct, negative association between younger siblings' reports of sibling closeness and substance use, independent of the elder sibling's substance use (Branje, van Lieshout, van Aken, Haselager, 2004; Brody, 1998; Criss & Shaw, 2005; East & Khoo, 2005; Pike, Coldwell & Dunn, 2002).

Taken together, anaclitic identification and attachment explanations point to the possibility that family members who engage in affectional bonding are likely to encourage feelings of closeness as well as feelings of identification and behavioral modeling amongst those family members. A dilemma occurs when considering the orthogonal combinations of these theoretical hypotheses. Consider a case where a child is nurtured by, and feels close to a sibling who engages in dangerous behaviors, such as heavy substance use. According to anaclitic identification, the child would more likely engage in heavy substance use herself. According to attachment, however, the child would be less likely to engage in substance use because of the independent "buffering effects" of feeling supported and loved (East & Khoo, 2005, p. 578). Considering these separate predictions, there is a need to simultaneously compare the explanatory ability of both theories.

Contextual considerations—Support for the anaclitic identification or attachment explanations appears to be moderated by at least three sibling contexts: sibling gender composition, age difference, and genetic similarity (East & Khoo, 2005; Rowe & Gulley, 1992; Slomkowski et al., 2001). Moreover, support for either theoretical explanation may be dependent on the type of sibling closeness examined, such as behavioral versus emotional closeness (Aron, Aron & Smollan, 1992; Samek & Rueter, in press).

First, the explanatory power of anaclitic identification versus attachment appears to be moderated sibling gender composition. For example, Slomkowski et al. (2001) found that sibling gender composition was a key moderator in the association between sibling relationship quality and sibling similarity in delinquency. In Slomkowski et al.'s study, sibling relationship quality was defined as a sense of perceived emotional closeness (e.g., the degree to which the adolescent perceived the sibling to be loving and affectionate), which is theoretically tied to the sense of closeness described in both the social learning and social bonding frameworks. Slomkowski et al. found that for brother-brother sibling pairs, greater sibling warmth led to greater similarity in high delinquency. However, for sisters, lower warmth led to greater similarity in high delinquency. In other words, greater warmth for an older sister acted as a protective variable in the likelihood of the younger sister's delinquency problems. These results have been replicated by East & Khoo (2005) in terms of substance use as well.

On the other hand, Rowe & Gulley (1992) found that emotional closeness moderated the relationship between sibling similarity in substance use and delinquency for same gender sibling pairs (but not for opposite-gender sibling pairs). These siblings were more likely to be similar if they reported greater warmth and mutual friends, thereby supporting anaclitic identification. Furthermore, social class, parental substance use, or parental rearing styles did not explain the association between sibling similarity in substance use or delinquency. Based on this body of research, it is clear that sibling similarity in externalizing outcomes may depend on the gender composition rather than other familial or parental influences, but, to date, there is a lack of clear replication of the findings on gender effects. Rowe & Gulley also found that having mutual friends did explain more variance in sibling similarity than warmth for brothers. Therefore it might be that the protective effect of sibling warmth may be specific to sisters or sibling pairs with an older sister; however, this relationship is not yet clear.

Second, sibling age difference is also an important contextual consideration. Previous research has found that siblings are altogether more similar in adjustment outcomes when they are close in age (Feinberg & Hetherington, 2000; McGue & Iacono, 2009; McHale, Bissell, & Kim, 2009).

A third important contextual consideration is sibling genetic similarity. The degree of genetic similarity is important in examining associations between sibling substance use and closeness because genetically related siblings tend to report greater closeness (Jankowiak & Diderich, 2000; Pollet, 2007; Samek & Rueter, in press), and are somewhat more likely to be similar in their adjustment outcomes (e.g., McGue & Iacono, 2009; McHale et al., 2009). The research that has included genetically sensitive designs (McHale et al., 2009; Rende et al., 2005; Slomkowski et al., 2005) points to important interaction effects between genetic similarity and social closeness. That is, sibling similarity is better explained by shared environmental effects if siblings are high in social connection and better explained by additive genetic effects when they are low in social connection (Slomkowski et al., 2005). Still, more research is needed to replicate the interaction of closeness and sibling genetic similarity across sibling gender composition in order to verify the generalizability of these findings.

Finally, recent evidence suggests (Samek & Rueter, in press) that while highly correlated, behavioral versus emotional closeness factors are differentially associated with sibling genetic similarity. Whereas sibling behavioral closeness is generally defined as the perceived amount and quality of time spent together, sibling emotional closeness is generally defined as perceived love, trust, and care between siblings. Compared to genetically unrelated siblings, genetically related siblings tended to report greater average behavioral, but not emotional closeness. Moreover, same-gender siblings tended to report more behavioral, but not emotional, closeness. Due to the differential effects of sibling context on closeness types, both dimensions of closeness were included in the present analysis.

Hypotheses

Figure 1 depicts our conceptual model and study hypotheses. Based on previous research supporting *basic social learning* tenets (e.g., McGue & Iacono, 2009; McHale et al., 2009), and the moderate heritability of alcohol and drug use (Kendler, Karkowski, Neale, & Prescott, 2000), we hypothesized that (H1) elder sibling's substance use (SU) would predict younger sibling's SU. Additionally, it was expected this effect would be stronger if (H1a) younger siblings had a same-gender elder sibling; (H1b) the siblings were close in age; and (H1c) the siblings were genetically related.

Based on research supporting an *attachment* hypothesis (e. g., Branje et al., 2004; Criss & Shaw, 2005; East & Khoo, 2005), and again the moderate heritability of alcohol and drug use (Kendler et al., 2000), it was expected that (H2) younger sibling's perceived emotional and behavioral closeness to his or her elder sibling would be significantly, negatively related to younger sibling's SU. Additionally, it was expected this effect would be stronger for (H2a) sister-sister pairs, or pairs with a sister as the elder sibling; (H2b) siblings close in age; and (H2c) genetically unrelated siblings.

Finally, based on research supporting an *anaclitic identification* hypothesis (e.g., Gamble et al., 2010; McHale et al., 2009; Rende et al., 2005) was it was expected that (H3) the interaction of younger sibling's perceived closeness and elder sibling's SU would predict younger sibling's substance use. That is, younger siblings would be more likely to have increased SU if they felt close to his or her elder sibling who had high SU, and decreased substance use if they felt close to his or her elder sibling who had low SU. Additionally, it was expected this effect would be stronger for (H3a) younger siblings had a same-gender elder sibling; (H3b) the siblings were close in age; and (H3c) the siblings were genetically related.

Method

Data Source

The sample consisted of all sibling pairs from the Sibling Interaction and Behavior Study (SIBS) (McGue, Keyes, Sharma, Elkins, Legrand, Johnson & Iacono, 2007), a longitudinal study designed to examine the genetic and environmental effects that predict adolescent substance use (based at the University of Minnesota, Minneapolis). At Wave 1 (data collected in 1998), a total of 617 families participated. In 208 families, both children were the biological offspring of their parents (BIO). In 285 families, both children were adopted and were not genetically related to their parents or each other (ADOPT). Finally, in 124 families, one child was adopted and not genetically related to his/her parents, and one child was the biological offspring of his/her parents (ADOPT-BIO).

Using a list of adoptive parents that was obtained from adoption records, and publicly available directories (e.g., phone directories), 85% of the ADOPT and ADOPT-BIO families were located. Once located, one parent (usually the mother) completed a short interview to determine study eligibility. Adoptive family eligibility included having an adopted child between the ages of 11 and 21 who had been permanently based into the adoptive home prior to age 2 (M_{age}= 4.7 months, SD = 3.4 months), and a second adolescent in the home who was not biologically related to the adopted adolescent, and who was within five years of age from the adopted child. The second child could have been biologically related to either parent, or adopted and placed before age 2. BIO families were identified using publicly available birth certificates selected to match to the adoptive families on child age and gender. All families had to live within driving distance of the lab and had to have siblings within a 5-year age difference to be included in this study. Participation rates between non-adoptive (57%) and adoptive (63%) families were not significantly different. Comparisons of parents' occupation, education, marital status, and DSM IV disorders in children at Wave 1 showed that the study sample is generally representative of the Minneapolis metro region (McGue et al., 2007).

At Wave 2 (3.5 years later), four families were deemed ineligible after determining after W1 that either one of the children in the family (a) had a developmental delay, (b) had died, or (c) was adopted but biologically related to their adopted sibling, leaving a total of 613 eligible families (1,226 adolescents (284 ADOPT families, 206 BIO families, and 123 ADOPT-BIO families). Out of the 613 eligible sibling pairs at Wave 2 (1,226 adolescents), 94% participated, leaving a total N = 1,158 for the present analyses (563 complete sibling pairs, 32 singletons). At Wave 1, each visiting family member was paid $50 for their participation. At Wave 2, each family member was paid $100.

Participants

At Wave 1, younger siblings were on average 13.8 years old (SD = 1.6), and elder siblings 16.1 years (SD = 1.5). Out of the 1,158 adolescents that participated at both W1 and W2, 656 were adopted adolescents and 502 were non-adopted. Among adoptees, 172 were domestic adoptions (female: 42%, Caucasian: 77%), and 484 were internationally adopted (female: 61%, Asian: 89%). The average age difference in sibling pairs was 2.34 years (SD = .89). The majority of sibling pairs were sisters (35.1%), 25.6% were brothers, 23.5% elder brothers-younger sisters, and 15.8% elder sisters-younger brothers. At Wave 2, younger siblings were on average 17.1 years (SD = 1.8), and elder siblings 19.4 years (SD = 1.7). The majority of the sibling's parents were married at Wave 1 (91.1%), and Wave 2 (89.4%). Fisher exact analyses revealed that at Wave 1, participating BIO (13%) families were more significantly more likely to be divorced than ADOPT (6%; $p < .01$), but not ADOPT-BIO families (11%); there were no significant differences across groups at Wave 2. Consistent with the demographics of the state of Minnesota from which this sample was drawn, 97% of parents were Caucasian. On average, 61% adoptive parents and 44% non-adoptive parents attended college.

Procedures

At Wave 1, participating family members (mother, father, elder sibling, younger sibling) came to the research lab for a daylong assessment. They completed informed consent, and were given multiple assessments, including diagnostic interviews and self-report surveys. The same procedure was used at Wave 2; however, only one parent (usually the mother) came to the lab with both children.

Measures

Sibling emotional and behavioral closeness were assessed as latent factors, each with three indicators. The three indicators were single items taken from the *Sibling Relationship Questionnaire* (SRQ) (Furman & Buhrmester, 1985), assessed at Wave 1. The SRQ asks adolescents to rate interactions with their sibling on a scale of 1 (*Hardly at all*) to 5 (*EXTREMELY much*). An example item used to assess sibling emotional closeness included: "How much is there a strong feeling of affection (love) between you and this sibling?" An example item used to assess sibling behavioral closeness included: "How much do you and this sibling go places and do things together?" Tests of measurement model fit, that included both younger sibling emotional and behavior closeness, revealed excellent fit, RMSEA = .05, CFI = .98. Indicator loadings ranged from .79 to .88. Please see the first paragraph of the analysis plan for interpretation of RMSEA, CFI, and indicator loadings, if necessary.

Elder and younger sibling substance use was also assessed as latent factors. Each adolescent completed the *Computerized Substance Use Questionnaire (CSA)* (based on Christiansen & Goldman, 1983; Schafer & Brown, 1991), which assessed tobacco, alcohol, and marijuana use. For the first three substance use indicators, adolescents reported if they had ever used (a) tobacco, (b) alcohol (without parents consent), or (c) marijuana (0 = no, 1 = yes). For the next three indicators, adolescents reported the frequency of (a) tobacco, (b) alcohol, and (c) marijuana use in the past 12 months, coded on a scale of 0 to 9, where 0 indicated "*Never*," 3 indicated "*Once in awhile in the past 12 mon*ths," 6 indicated "*1–2 times a week*," and 9 indicated "*Every day or nearly every day*." Elder sibling substance use variables were used from Wave 1, younger sibling substance use variables were used from Wave 2. These factors also had good fit, RMSEA = .04, CFI = .98, indicator loadings ranged .77 to .97.

Analysis Plan

The goal of this paper was to simultaneously examine associations among multiple latent and observed variables in a series of theoretical models to determine which theory best explained younger sibling substance use. To do this, structural equation modeling (SEM) was used. All analyses were conducted using MPLUS, 6.0 (Muthén & Muthén, 1998–2010), unless otherwise specified.

Latent variable fit—Statistical criteria for determining adequate fit of latent variables include analyzing the standardized factor loadings, the Steiger-Lind root mean square error of approximation (RMSEA, Steiger, 1990), the Bentler comparative index (CFI, Bentler, 1990). A standard interpretation is that the model indicates good fit if the RMSEA ≤ .05 (Kline, 2005), a CFI ≤ .90, and factor loadings of at least .30 (Kline, 2005). Covariates of substance use factors included adolescent age and gender (coded so that 1 = male, 2 = female). Covariates of sibling closeness factors included adolescent age, gender, sibling age difference, and sibling gender composition.

Hypothesis testing—For all hypotheses, SEM results were reported in terms of fit statistics (except for interaction models), path coefficients (β for main effects, b for interaction effects), ratio tests (*t*), statistical significance (α = .05), and effect size (R^2). To test moderator models (H1a-c, H2a-c), Multiple Indicator Multiple Cause (MIMIC) models were utilized. This type of modeling allows for covariates and tests whether the hypothesized associations significantly vary across groups. To determine if the variant model (which allowed associations to vary between groups) fit significantly better than the invariant model (which constrained associations between groups to be equal), we used the DIFFTEST option available in MPLUS, 6.0 (allows for categorical indicators). If there was support for a moderator, (if the DIFFTEST *p*-value < .05), models comparing all possible groups were tested.

For hypotheses using the moderator of sibling gender composition (H1a– H3a), grouping was specified for all possible groups: 1 = male-male (n = 157, 25.6%), 2 = female-female (n = 215, 35.1%), 3 = male elder-female younger (n = 144, 23.5%), and 4 = female elder - male younger (n = 97, 15.8%). Due to small cell size for siblings within 1 year of age, grouping for sibling age difference hypotheses (H1b–H3b) was specified as follows: 1 = siblings pairs that had an age difference of 1.5 years or less (n = 98, 16.0%), 2 = sibling pairs that had an age difference of between 1.5 and 2 years (n = 149, 24.3%), and 3 = sibling pairs with an age difference of more than 2 years (n = 366, 59.7%).

Finally, to test H3, the interaction between sibling closeness and elder sibling substance use as predictors of younger sibling substance, SEM was used and the interaction term was specified using XWITH using MPLUS, 6.0 (Muthén & Muthén, 1998–2010).

Missing Data Analysis

Missing data among variables included in data analysis was due to (1) non-participation at Wave 2 (2.9% elder siblings, 2.5% younger siblings), or (2) failure to complete surveys (7.2% younger siblings sibling closeness at Wave 1; 14.5 – 14.8% younger siblings substance use frequency at Wave 2). Less than 1% of data were missing on all other study variables included in this study's analyses. Chi-Square analyses revealed no statistically significant differences for those who dropped out versus stayed in the study at Wave 2 or between those with missing closeness or substance use data and those with complete data on adoptive status, ethnicity (White versus Non-White), gender, or parental marital status. Missing data were handled using Full Information Maximum Likelihood (FIML), which has proven superior in accurately representing the sample data compared to listwise or pairwise deletion, similar response pattern, and mean imputation in simulation studies (Acock, 2005; Enders & Bandalos, 2001).

Results

Preliminary Analyses

Descriptive statistics—Table 1 outlines descriptive statistics for all study variables. A paired-sample *t*-test showed that younger siblings had higher average sibling emotional closeness (M = .61, SD = .68), than sibling behavioral closeness (M = −1.18, SD = .75), $t(568) = 77.93$, $p < .001$ (tested in SPSS, version 17.0).

Latent variable covariates—Elder sibling substance use was not associated with elder sibling gender, but was associated with elder sibling age (β = .49, t = 6.99, $p < .001$). Younger sibling substance use was significantly associated with younger sibling gender (β = −.10, t = −2.24, $p < .03$), and age (β = .34, t = 4.23, $p < .001$).

Younger sibling's age (β = −.10, t = −1.96, $p < .05$), sibling gender composition (β = −.16, t = −3.44, $p < .001$), and sibling age difference (β = −.12, t = −2.42, $p < .03$) were significantly associated with sibling behavioral closeness; however, younger sibling gender was not. To interpret the effect of sibling gender composition, factor scores were exported and analyzed using SPSS, version 17.0. Post-hoc Tukey LSD tests revealed that younger siblings in female-female or male-male sibling pairs report greater sibling behavioral closeness compared to mixed gender sibling pairs (female-female compared to male-male:

MD = −.03, *SE* = .08, *ns*; female-female compared to male elder-female younger: *MD* = .32, *SE* = .08, $p < .001$; female-female compared to female elder-male younger sibling pairs: *MD* = .28, *SE* = .09, $p < .01$; male-male compared to male elder-female younger *MD* = .29, *SE* = .09, $p < .01$; female elder-male younger *MD* = .26, *SE* = .10, $p < .03$). Finally, younger sibling gender was significantly associated with younger sibling's emotional closeness, (β = .14, $t = 3.03$, $p < .01$). However age, gender composition, and age difference were not. Younger sibling emotional and behavioral closeness were highly correlated (β = .68, $t = 10.59$, $p < .001$), therefore all closeness models were tested separately (emotional versus behavioral) to reduce model multicollinearity.

Hypothesis Testing

Hypothesis 1: Associations between younger and elder sibling substance use—Elder sibling substance use at Wave 1 was significantly associated with younger sibling substance use at Wave 2 (β = .38, $t = 8.82$, $p < .001$, $R^2 = .36$), providing support for hypothesis 1. Model fit indices indicated good fit, RMSEA = .06, CFI = .96, indicator loadings ranged from .75 to .88.

H1a: Sibling gender composition as moderator: Constraining the association between elder and younger sibling substance use to be equal across the sibling gender composition groups did not result in a significantly worse fit of the model (χ^2 (3, *N* = 580) = 3.01, *ns*), therefore H1a was not supported.

H1b: Sibling age difference as moderator: Constraining the association between elder and younger sibling substance use to be equal across the sibling age difference groups did result in a significantly worse fit of the model (χ^2 (2, *N* = 580) = 9.65, $p < .01$), suggesting the association between elder and younger sibling substance use varied across age difference groups. Follow-up DIFFTESTS comparing all possible pair-wise comparisons revealed significant differences for all three groups (siblings ≤ 1.5 years of age compared to the other two groups, χ^2 (1, *N* = 580) = 4.65, $p < .05$; siblings 1.5 to 2 years of age compared to the siblings > 2 years of age, χ^2 (1, *N* = 580) = 7.63, $p < .01$). Siblings ≤ 1.5 years of age ($b = .47$, *SE* = .10, $t = 4.53$, $p < .001$, $R^2 = .37$) had a stronger association, and more variance explained in younger sibling substance use, compared to those 1.5 to 2 years apart and 2 years apart ($b = .29$, *SE* = .08, $t = 3.93$, $p < .001$, $R^2 = .28$). Also, siblings in the 1.5 to 2 years age difference group also had stronger associations than siblings more than 2 years apart in age ($b = .17$, *SE* = .04, $t = 4.08$, $p < .001$, $R^2 = .31$). Therefore H1b was supported, associations were stronger for siblings close in age.

H1c: Sibling genetic similarity as moderator: Constraining the association between elder and younger sibling substance use across sibling genetic similarity groups did not result in a significantly worse fit (χ^2 (1, *N* = 580) = 3.01, *ns*), therefore H1c was not supported. Correlations for genetically related siblings were tended to be greater ($r = .54$, $p < .001$) compared to those not genetically related ($r = .47$, $p < .001$), but again there was no statistically significant difference.

Hypothesis 2: Associations between younger sibling substance use and sibling perceived closeness—Younger sibling's substance use at Wave 2 was significantly associated with sibling behavioral closeness, (β = −.16, $t = -3.55$, $p < .001$, $R^2 = .27$), and with sibling emotional closeness (β = −.11, $t = -2.46$, $p < .03$, $R^2 = .24$), thereby supporting hypothesis 2). Mode fit statistics were excellent for both behavioral closeness (RMSEA = .04, CFI = .98, indicator loadings ranged from .77 to .96) and emotional closeness (RMSEA = .05, CFI = .97, indicator loadings ranged from .78 to .96).

H2a: Sibling gender composition as moderator: This set of hypotheses is first presented in terms of sibling behavioral, and then sibling emotional closeness.

Sibling gender composition and sibling behavioral closeness: Constraining the association between younger sibling perceived behavioral closeness and younger sibling substance use across sibling gender composition groups resulted in a significantly worse fit of the model, (χ^2 (3, N = 577) = 15.16, $p < .01$), supporting H2a for behavioral closeness by suggesting the association between younger sibling perceived behavioral closeness and younger sibling substance use varies across sibling gender composition.

Based on research showing a stronger negative association between closeness and adolescent adjustment problems for sisters (East & Khoo, 2005; Slomkowski et al., 2001), it was expected that the negative association between behavioral closeness and younger sibling substance use would be strongest in sister-sister pairs, or pairs with a sister as the elder sibling . There was some support for this expectation; unstandardized beta weights were the strongest and the proportion of variance explained the greatest for younger brothers with an elder sister ($b = -.45$, $SE = .16$, $t = -2.84$, $p < .01$, $R^2 = .37$), however this was a significantly stronger association than sister-sister pairs, ($b = -.22$, $SE = .10$, $t = -2.20$, $p < .03$, $R^2 = .22$; χ^2 (1, N = 577) = 8.89, p < .01). Moreover, sister-sister sibling pairs did not have a stronger association than brother-brother sibling pairs ($b = .19$, $SE = .12$, $t = 1.52$, *ns*, $R^2 = .39$; χ^2 (1, N = 577) = .75, *ns*). Finally, younger sisters with an elder brother ($b = -.30$, $SE = .10$, $t = -2.92$, $p < .01$, $R^2 = .29$) had a significantly stronger association than sister-sister pairs (χ^2 (1, N = 577) = 11.81, $p < .001$), however, younger brothers with an elder sister had a stronger association than younger sisters with an elder brother (χ^2 (1, N = 577) = 6.53, $p < .03$). No other sibling pair comparisons were significantly different. In total, it appears that sibling behavioral closeness was a stronger predictor of younger sibling substance use for opposite gender sibling pairs.

Sibling gender composition and sibling emotional closeness: Constraining the association between younger sibling perceived emotional closeness and younger sibling substance use across sibling gender composition groups resulted in a significantly worse fit of the model (χ^2 (3, N = 577) =17.62, $p < .001$), supporting H2a for emotional closeness by suggesting the association between younger sibling perceived emotional closeness and younger sibling substance use varies across sibling gender composition.

Based on research showing a stronger negative association between closeness and adolescent adjustment problems for sisters (East & Khoo, 2005; Slomkowski et al., 2001), it was expected that the negative association between emotional closeness and younger sibling substance use would be strongest in sister-sister pairs, or pairs with a sister as the elder sibling. It was found that sibling emotional closeness was not associated with younger sibling substance use for younger siblings that are male, regardless of the gender of the elder sibling and that it was a stronger predictor of younger sibling substance use for younger siblings that are female, regardless of the gender of the elder sibling. Unstandardized beta weights were significantly stronger for sister pairs ($b = -.37$, $SE = .14$, $t = -2.66$, $R^2 = .22$) than brother pairs ($b = .16$, $SE = .14$, $t = 1.14$, *ns*, $R^2 = .39$; χ^2 (1, N = 577) = 7.09, $p < .01$). However, associations were stronger for sisters than for younger brothers with an elder sister ($b = .09$, $SE = .19$, $t = .47$, *ns*, $R^2 = .26$; (1, N = 577) = 13.70, $p < .001$). Moreover, the magnitude in association was just as strong for sister pairs as it was for younger sisters with an elder brother ($b = -.57$, $SE = .15$, $t = -3.87$, $p < .001$, $R^2 = .35$; χ^2 (1, N = 577) =1.08, *ns*). Also, the association for younger sisters with an elder brother was stronger than for brothers (χ^2 (1) =3.39, $p = .05$), and association for brothers was not significantly different from younger brothers with an elder sister (χ^2 (1) =2.11, *ns*). Finally, younger sisters with an elder brother had a significantly stronger association than younger brothers with an elder sister (χ^2 (1) =7.34, $p < .01$). In total, it appears that sibling emotional closeness was particularly important for younger sisters, not sisters all together or siblings with an elder sister.

H2b: Sibling age difference as moderator: Constraining the association between younger sibling perceived behavioral closeness and younger sibling substance use across sibling age difference groups did not result in a significantly worse fit of the model (χ^2 (2, N = 580) = 1.34, *ns*). The same results were found for sibling emotional closeness (χ^2 (2, N = 580) = 2.07, *ns*). Therefore hypothesis 2b, the association will be stronger for siblings close in age, was not supported.

H2c: Sibling genetic similarity as moderator: Constraining the association between younger sibling perceived behavioral closeness and younger sibling substance use across sibling genetic similarity groups did not result in a significantly worse fit (χ^2 (1, N = 580) = .04, *ns*). Again, the same results were found for sibling emotional closeness (χ^2 (1, N = 580) =.23, *ns*). Therefore H2c was not supported.

Hypothesis 3: Interactions between sibling closeness and elder sibling substance use—In the model including both direct effects of sibling closeness and elder sibling substance use (all significant as described in earlier analyses), as well as the interaction between sibling closeness and elder sibling substance use, the interaction was not statistically significant for either behavioral closeness ($b = -.00$, $SE = .02$, $t = -.10$, *ns*) or emotional closeness ($b = -.03$, $SE = .05$, $t = -.51$, *ns*). Since the interaction between closeness and elder sibling SU was not significant, additional 3-way interactions were not tested.

Discussion

This research helps to illuminate sibling influences on adolescent substance use and demonstrates which of the most prominent theories (social learning and social bonding) best explains younger sibling substance use. Two theoretically based hypotheses (anaclitic identification and attachment) were tested under three different contexts of the sibling relationship (age difference, gender composition, genetic similarity). Some contextual differences mattered: sibling age difference was found to moderate basic social learning principles, and sibling gender composition was found to moderate an attachment explanation. However, the same pattern of effects was found for both genetically related and unrelated siblings. There was overall support for attachment but not anaclitic identification as an explanation for younger sibling substance use in our sample of Midwestern adopted and non-adopted youth.

Theoretical Comparisons

As indicated by the strong correlation between elder and younger sibling substance use, siblings were quite similar in their substance use overall, supporting basic social learning expectations (Bandura, 1969). In the family domain of role models, there is increasing evidence for elder sibling influence compared to parental influence as a social learning source contributing to adolescent substance use (McGue & Iacono, 2009). The basic association between elder and younger sibling substance use found in this study also illustrates strong sibling effects on substance use. Specifically, 36% of the variance in younger sibling substance use was explained by the effect of elder sibling substance use alone (without considering other contextual influences).

Social bonding theory (Hirschi, 1969) was also supported. According to the attachment explanation based in this theory, adolescents are less likely to engage in substance use if they feel loved and supported by their family members. Supporting this theory, this study found that adolescents who felt close to their siblings (both behaviorally and emotionally) were less likely to engage in substance use, regardless of whether the elder sibling engaged in substance use. This finding follows other research documenting the protective effect of sibling closeness on substance use (East & Khoo, 2005) and externalizing behavioral problems (Branje et al., 2004; Criss & Shaw, 2005) for the adolescent population.

What was new to this study was simultaneously examining an attachment explanation in conjunction with an anaclitic identification explanation (see Bandura, 1969; Sears, 1957). Anaclitic identification predicts greater sibling similarity in outcomes if younger siblings feel close to his or her elder sibling. It is theorized that if a younger sibling feels nurtured by his or her elder sibling, they are more likely to identify and want to be like that elder sibling. This explanation is in direct competition with a social bonding explanation, which predicts a lower likelihood of adjustment problems if the younger sibling feels close to his or her elder sibling, whether or not the elder sibling has adjustment problems herself. In this study of a Midwestern sample of adopted and non-adopted youth, there was no support for anaclitic identification as a theoretical explanation for younger sibling substance use.

The lack of support for anaclitic identification does not follow prior research that links closeness and sibling similarity to substance use (Rowe & Gulley, 1992; Slomkowski et al., 2001). It is possible that differences in assessment and conceptualization of sibling closeness explain this discrepancy. The current study defined perceptions of sibling closeness in terms of quality of time spent together (behavioral closeness), and affection and love for a sibling (emotional closeness) while earlier research examined whether siblings were a part of the same peer network (Rowe & Gulley, 1992; Slomkowski et al., 2001). It may be that important differences exist in associations of closeness, elder sibling substance use, and younger sibling substance use based on this distinction.

When defining closeness independent of a shared peer network, there is some evidence that closeness and warmth may moderate sibling similarity in outcomes we typically think of as positive, such as global self-worth (Gamble et al., 2010). For example, using a measure similar to the one used in this study, Gamble and colleagues found that the warmer the sibling relationship, the greater sibling similarity in high self-worth, supporting anaclitic identification. Perhaps when conceptualized as belonging in the same peer group, closeness is more likely to moderate sibling similarity in outcomes we typically think of as negative, such as substance use and antisocial behavior through a social contagion framework (Rende et al., 2005).

Sibling Contexts

Support for basic social learning and social bonding expectations were somewhat dependent on sibling context. First, siblings were more similar in their substance use when they were close in age, following basic social learning principles and existing research (Feinberg & Hetherington, 2000; McGue & Iacono, 2009; McHale et al., 2009). However, in this study, the correlation amongst elder and younger siblings was just as strong whether or not they were the same or opposite gender. These findings contradict what social learning theory would predict (Bussey & Bandura, 1984), and previous research has found (e.g., McHale et al., 2009). One reason for this discrepancy is that previous research analyzing gender effects used samples that consisted of mostly twins (e.g., McHale et al., 2009); because twins are the same age, and monozygotic twins are by definition the same gender, they are likely to have the same peer network (Rende et al., 2005). In a population of adolescents with siblings up to 5 years of age apart, as were siblings in this sample, gender effects may be somewhat different due to the lack of potentially sharing the same peer network that twins may because of their same age. This may also tie into the lack of support for anaclitic identification in this paper; even if siblings up to 5 years apart report hanging out and having fun together (behavioral closeness), they may altogether be less likely to share the same peer network compared to monozygotic and same-gender dizygotic twins.

Even though sibling gender composition did not moderate the degree of similarity in sibling substance use, this classification detected strong and differential moderating effects from an attachment explanation. Even though same-gender siblings report greater average sibling behavioral closeness overall (matching previous research, e.g., Furman & Buhrmester, 1985, 1992), the protective effect of sibling behavioral closeness on younger sibling substance use was particularly important for opposite-gender sibling pairs. To date, few studies have explored or documented significant effects for opposite-gender sibling pairs (for an exception, see Bouchey, Shoulberg, Jodl & Eccles, 2010). Future research should continue to investigate the processes that explain why behavioral closeness is particularly protective for opposite-gender sibling pairs. Possibly, feeling close to a sibling of the opposite gender leads to a greater level of comfort with the opposite gender. This level of comfort might then help to increase self-esteem in a developmental period that is strongly influenced by gender socialization (Maccoby, 1986; Slomkowski et al., 2001).

A second important finding supporting an attachment explanation was that the effect of sibling emotional closeness on younger sibling substance use does not appear to be moderated by the gender composition of the sibling pair but rather by the younger sibling's gender. The effect of sibling emotional closeness as a protective effect on younger sibling substance use was the strongest for sibling pairs with a younger sister (regardless of the gender of the elder sibling), and associations were not significant for sibling pairs with a younger brother. An interesting future question might focus on how personality affects the association between closeness and substance use, and whether personality might explain gender effects on closeness and substance use. For example, compared to males, females tend to be higher in trust, nurturance (Feingold, 1994), and emotional intelligence (Schutte, Malouff, Hall, Haggerty, Cooper, Golden & Dornheim, 1998), so it may be that these traits mediate the association between gender and the protective effect of sibling emotional closeness.

In partial support of the broader application of social bonding theory to understanding adolescent substance use, the magnitude of the effect of sibling closeness was not different across siblings that were genetically versus not genetically related, or that were closer in age versus further apart. This finding fits with research demonstrating the importance of social, rather than genetic effects, in explaining sibling similarity in early substance use (Han, McGue & Iacono, 1999; Rende et al., 2005; Slomkowski et al., 2005). As adolescents become older, genetic effects become stronger (e.g., Han et al., 1999), therefore it may be that genetically related siblings will be more similar in their substance use as they progress through adulthood.

Limitations and Potential Alternative Explanations

There were several limitations of this study. First, generalization is limited to a population similar to our sample, which contained a large sub-sample of adopted adolescents that were mostly internationally adopted, female adolescents. Moreover, the parents of siblings in this study were predominately White and married. These demographics match the Midwestern area in which the sample was collected, however, the associations reported may be different for samples with differing demographics. Second, although we included several theoretically identified contextual factors, it is possible that the results we obtained would be different if other control variables had been considered. For example, it may be that anaclitic identification is better supported than attachment when considering family closeness or parent-child closeness, or when controlling for family socio-economic status (SES).

As a preliminary step addressing the potential confound of SES, we conducted several post-hoc analyses using Hollingshead coding of parent's occupation (Hollingshead, 1975) as a control. We found that SES was not a significant control for H1 (elder sibling substance use predicting younger sibling substance use; $t = .58$, $\beta = .01$, $p = .56$) or H2 (younger sibling closeness to elder sibling predicting younger sibling substance use), for either emotional ($t = -1.24$, $\beta = -.07$, $p = .22$) or behavioral closeness ($t = -1.18$, $\beta = -.07$, $p = .24$). However, the lack of significance may be explained by the majority of the sample being classified as high SES (81% classified as having a Hollingshead code of 1, 2, or 3). We encourage future research to continue to explore SES as a potential control or moderator in explanations of younger sibling substance use.

Additional controls to consider in future research include younger sibling's baseline substance and parental substance use. For example, it may be that younger sibling's substance use at an earlier time point leads to a lower level of perceived closeness to an elder sibling and other family members at that time, which better predicts substance use at a later time point as compared to sibling closeness perceptions alone. Indeed, in our study, we found a negative association between younger sibling closeness to elder sibling and elder sibling substance use at Time 1 demonstrating this potential alternative explanation (behavioral closeness: $t = -2.64$; emotional closeness $t = -3.36$, p's < .01).

A third limitation includes the consideration of measurement issues when interpreting the study results. For example, the use of single-items as indicators of sibling closeness may have resulted in low standard errors such that error was less rigorously modeled than if sibling closeness was assessed using additional items. Also, substance use was operationalized as tobacco, marijuana, and alcohol use in one latent construct, reflecting substances used most often amongst youth (Substance Abuse and Mental Heath Services Administration, 2006; U.S. Department of Health and Human Services, 2007). Possibly different patterns of associations exist for each unique drug, and this study's results should not be generalized to all legal and illegal substance use among adolescents.

Conclusion

In conclusion, findings support basic social learning and attachment as explanations for younger sibling substance use, but not anaclitic identification. Altogether, this study adds to the body of research demonstrating the important sibling influences on adolescent substance use (Slomkowski, Conger, Rende, Heylen, Little, Shebloski, Fox, Craine & Conger, 2009). In order to continue to increase understanding of sibling influences, it would be useful to simultaneously determine the correlates and predictors of perceived sibling closeness that are both independent of and dependent on the shared peer network. Second, micro-coding analysis of sibling interaction observations may help to further understand the socializing influences of siblings on substance use (Slomkowski et al., 2009). In this study, few protective effects of sibling closeness were found for adolescent brothers. It may be that observational analysis such as this will help us better understand how brothers might protectively influence one another. After enough knowledge is accumulated on how sibling relationship dynamics develop, assessments and intervention research can be proposed to strengthen close sibling relationships in the service of substance use prevention.

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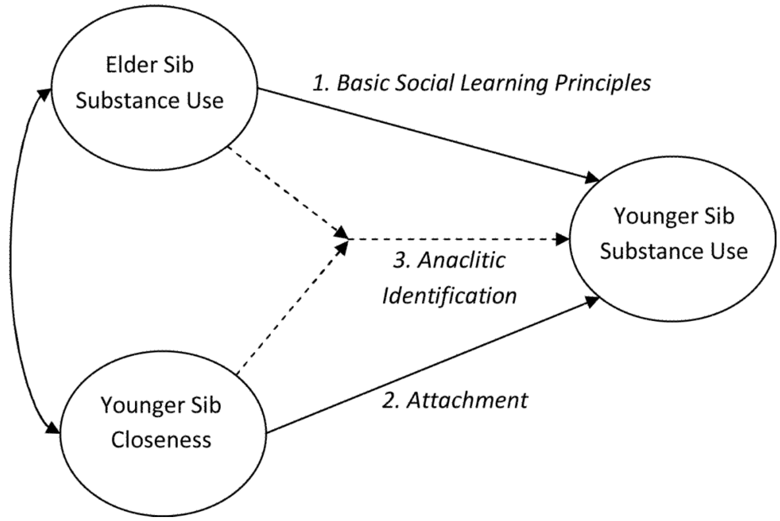

Figure 1.

Conceptual model depicting study hypotheses. Moderating effects of sibling age difference, gender composition, and genetic similarity are not shown for clarity of presenting the theoretical hypotheses. As described in Path 1, basic social learning expectations predict a direct, positive association between elder sibling substance use and younger sibling substance use, particularly for siblings that are close in age, the same gender, and are genetically related. As described in Path 2, an attachment hypothesis (based in social bonding theory) predicts a direct, negative association between younger sibling perceived closeness towards his or her elder sibling and younger sibling substance use. As described in Path 3, an anaclitic identification hypothesis (based in social learning theory) predicts a moderating association between elder and younger substance use based on the younger sibling's perceived closeness towards his or her elder sibling.

Table 1

Descriptive statistics for variables across Wave 1 and Wave 2

	M	SD	Range	n	% Valid
Wave 1					
Elder Sibling					
Ever use tobacco	.34	.48	0 – 1	610	99.5
Tobacco frequency	1.44	2.68	0 – 9	610	99.5
Ever use alcohol	.38	.49	0 – 1	610	99.5
Alcohol frequency	1.16	1.86	0 – 7	610	99.5
Ever use marijuana	.20	.40	0 – 1	610	99.5
Marijuana frequency	.62	1.62	0 – 9	610	99.5
Substance Use Latent Factor	5.94	1.10	4.82 – 9.48	580	94.6
Younger Sibling					
Perceived EMCL	.61	.68	−1.71 — 1.56	569	92.8
Perceived BHCL	−1.18	.75	−3.11 — 0.55	569	92.8
Wave 2					
Younger Sibling					
Ever use tobacco	.43	.50	0 – 1	495	80.8
Tobacco frequency	2.00	3.10	0 – 9	494	80.6
Ever use alcohol	.54	.50	0 – 1	496	80.9
Alcohol frequency	1.89	2.22	0 – 9	496	80.9
Ever use marijuana	.32	.47	0 – 1	495	80.8
Marijuana frequency	1.16	2.29	0 – 9	495	80.8
Substance Use Latent Factor	4.59	1.12	2.44 – 7.81	580	94.6

Note: EMCL = sibling emotional closeness, BHCL = sibling behavioral closeness