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Proximal and distal social influence on alcohol consumption and marijuana use among middle school adolescents

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Abstract

Objectives—This study assesses the independent and combined effects of (1) perceived peer norms, (2) best friend use, and (3) being in the presence of others who use on middle school adolescents' consumption of marijuana and alcohol, and how the effects of these sources of social influence evolve over time as youth progress through middle school.

Methods—The analytic sample consisted of 11,667 adolescents (50% female; >65% Hispanic) in 6th, 7th or 8th grade from 16 middle schools across three school districts in Southern California. Participants were assessed at 5 time points from 2008 to 2011.

Results—All sources of social influence were predictive of alcohol and marijuana consumption. As youth grew older, spending time with other adolescents who drink increased adolescents' likelihood of drinking alcohol, whereas perceived norms became less influential. Furthermore, as adolescents spent more time around other youths who drink, the predictive value of perceived norms on alcohol consumption decreased. Similarly, as youth grew older, the influence of best friend's use and spending time with other adolescents who use marijuana remain stable, whereas perceived norms became less influential.

Conclusion—Findings suggest that perceived peer norms may be more influential in early adolescence; whereas proximal social determinants (e.g., being in the presence of other peers who consume) become more influential as youth enter middle adolescence. Prevention programs should continue to address misperception of norms with younger adolescents to decrease the

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chances of initiation, but also utilize strategies such as refusal skills and alternate coping mechanisms for older adolescents.

Keywords

social influences; middle school adolescents; alcohol; marijuana

1. Introduction

The middle school years are peak years for substance use initiation and escalation (Johnston et al., 2007; Wittchen et al., 2008; Johnston et al., 2013; SAMHSA, 2013) and early use of substances is often associated with risk for problematic substance use in adulthood (Ellickson et al., 2004; D'Amico et al., 2005a; McCambridge et al., 2011). Recent work has shown that peers play a key role in contributing to both initiation and escalation of substance use during this pivotal developmental period (Simons-Morton and Farhat, 2010; Trucco et al., 2011; Kelly et al., 2012). The assumption that peer influence is central to adolescent alcohol and other drug (AOD) use is reflected in the paradigm underlying programs combating drug and alcohol use. Specifically, these efforts have focused on correcting youths' perceptions of others' consumption as a strategy to reduce AOD use (D'Amico et al., 2005b; Lewis and Neighbors, 2006). These approaches are based on research on perceived norms, which suggests that youth overestimate the drug and alcohol use of their peers (Beck and Treiman, 1996; Thombs et al., 1997; Page et al., 2002; Borsari and Carey, 2003; Neighbors et al., 2007; Pedersen et al., 2013b). Studies with adolescents and college students suggest that these inflated perceptions make alcohol and drug use appear to be common and socially acceptable, which in turn influence youth's subsequent use (Collins et al., 1987; Graham et al., 1991; Hansen and Graham, 1991; Marks et al., 1992; Borsari and Carey, 2001; Olds et al., 2005; Perkins et al., 2005; D'Amico and McCarthy, 2006; Primack et al., 2007). These findings are consistent with those in other areas of risky behavior including smoking (Grube et al., 1986; Biener and Siegel, 2000; Zhang et al., 2000; Etcheverry and Agnew, 2008) and sexual behavior and practices (Baker et al., 1988; Fisher, 2007, 2009).

Although perceived peer norms are important, the way in which they influence youths' consumption may be somewhat removed from everyday experiences. Perceived norms may initially be based on direct observation of individuals' behavior in specific situations; however, these norms are perpetuated and inflated through word of mouth and social conversations (i.e., the influence is more remote). For example, a youth may notice the few outstanding “drunk” people at a party and then share with their friends that “everyone was drunk at the party last night.” These conversations may increase the perception that many other teens are drinking heavily and the norms are perpetuated. However, while highly influential, the influence is more remote and if a youth does not have access to alcohol or any immediate pressures to drink, these perceptions may not be strongly linked to actual drinking behavior. Thus, the effect that these norms may exert is rather distal.

In contrast, *being in the presence of others who use/consume* and *best friends use*, are sources of influence that are directly observable. Youths in close relationships (friends) typically spend time together, observe each other's behavior, engage in behaviors together

(co-engagement/co-consumption), and also share environments and opportunities where behaviors are engaged in (Borsari et al.,, 2001; Bot et al., 2005; Poelen et al., 2007; Simons-Morton and Farhat, 2010; Kelly et al., 2012; Ramirez et al., 2012). These proximal sources of social influence are likely to moderate the influence of peer norms on youths' substance use (Maxwell, 2002). For example, (mis)perceiving that a large proportion of “similar others” drink alcohol may not be sufficient to lead to consumption in the absence of proximal social factors such as spending time in company of others who drink or use drugs. Studies with college students support this contention.

Despite the recognition that both proximal and distal social influences exert a role on AOD consumption in adolescence, very little is known about the relative contribution and dynamic interaction between these social mechanisms. This is especially important given the mixed research on the direct influence of close friends and peers on substance use (Jaccard et al., 2005; Fujimoto and Valente, 2012; de la Haye et al., 2013). This dearth of research jointly examining proximal and distal social influences in early adolescence is surprising given that understanding how these factors operate on AOD use can help determine the type of intervention approaches that may be most successful for this age group. For example, the basic premise underlying norms interventions is that youth feel the need to conform to a drinking norm; thus, they will drink heavily if they believe that the norm is high, but will reduce their drinking if they are provided with accurate information that the norm is lower than they thought. It is important to note that the mere provision of accurate information to change perceived norms may not influence use among adolescents who accurately estimate their peers' substance use. Likewise, presentation of actual norms to correct misperceptions may be irrelevant to youth who do not pay much attention or care about what their non-salient, less familiar peers may or may not be doing. In this case, time spent around friends who drink or use drugs may be a more salient influence on actual behavior. Intervention strategies designed toward refusal skills and alternate coping mechanisms may be more indicated in such a situation.

No research to our knowledge has examined how both distal and proximal influences interact and how these sources of influence may change over time to predict alcohol consumption and drug use among young adolescents. Furthermore, one limitation inherent to previous research examining associations between social influences and AOD is that they cannot determine direct causation between predictors and outcomes. Although longitudinal designs make it possible to examine how putative factors contribute to substance use and how they interact over time, these designs are still subject to omitted variable bias such as unmeasured or uncontrolled variables responsible for the relationship between beliefs and behavior. One approach to control for omitted variable bias is to examine the within-person relationship, rather than the between-person relationship using fixed effects regression modeling. Rather than seeing if students who have (for example) higher norms have greater drug use, we look at the within person relationships. In other words, at the time an individual has higher norms, does this person also have higher substance use? The advantage of this approach is that we control for all person-related covariates, thereby allowing us to draw causal conclusions with greater confidence.

The current study addresses gaps in the literature by examining the effects of proximal and distal influences and young adolescents' subsequent use in a racially and ethnically diverse sample of 11,667 adolescents between grades 6th and 8th. Specifically, this study examines the independent and combined effects of (1) perceived peer norms, (2) best friend use, and (3) being in the presence of others who use on middle school adolescents' marijuana use and alcohol consumption using fixed effects regression modeling. We contend that proximal social determinants moderate the distal influence of peer norms such that best friend use and spending time with others who use decreases the predictive value of peer norms on students' alcohol consumption and marijuana use. We further assess how the effects of these sources of social influences evolve over time as youth progress through middle school, hypothesizing that proximal and distal sources of influences operate differently on younger than on older adolescents. The basis for this contention is that substance use is initially motivated by youths' desire to fit in with others (i.e., engaging in behaviors similar to others will lead these others to like and accept them or to “fit in”). Conceivably, the importance of unfamiliar peers' approval may be greater when students start in a new school and are developing new relationships (6^{th} grade) than when they have already formed stronger relationships with subgroups of students within the school. Furthermore, as students get older, and as they gain more “experience” with alcohol and marijuana, their consumption may become increasingly determined by availability and by direct offers from the peers closest to them rather than by what they believe their non-salient peers are doing.

2. Method

2.1 Participants and Procedure

Participants completed measures as part of a larger research project evaluating CHOICE, a voluntary after-school prevention program implemented within three school districts in southern California for one year in 2008 (D'Amico et al., 2012). None of the sixteen schools initially contacted refused to participate. The research institution's Institutional Review Board approved all materials and procedures used in this study. A Certificate of Confidentiality from the National Institutes of Health protected survey responses.

Active parental permission was required for the study, and individuals could select into or out of the study at any time. At wave 1, a total of 14,979 students across all sixteen schools received parental consent forms to participate in the study with approximately 7,271 students in the 8 control schools and 7,708 students in the 8 intervention schools; 92% of parents returned this form (n = 13,785). Approximately 71% of parents gave permission for their child to participate in the study (n = 9,828). Ninety-four percent of consented students completed the baseline survey (n = 8932), which is higher or comparable to other school-based survey completion rates with this population (Johnson and Hoffmann, 2000; Johnston et al., 2009; Kandel et al., 2004). The current study analyzes data from waves 1 to 5. At the 5^{th} wave, individuals were in 8^{th}, 9^{th}, and 10^{th} grade. Sixty-five percent of youth completed 3 or more surveys across all five waves. The initial sample for this study consisted of 12,940 adolescents. Of these participants, 1237 (9.8%) were eliminated because of only completing one survey giving a total analytic sample of 11667.

2.2 Measures

In addition to reporting demographic information regarding gender, age, grade-level, school, and race/ethnicity, participants completed survey items on their AOD use, perceived norms of general grade-specific peers, how often they spent time with others who use, and best friend use. All measures were administered at each time period.

2.2.1 Substance use—Alcohol and marijuana use were assessed using three single-item measures from previous large-scale studies of youth such as the California Healthy Kids Survey (WestEd, 2008) and Project ALERT (Ellickson et al., 2003). The items asked participants to indicate how many days in the past month (30 days) they had used alcohol/marijuana/cigarettes on a 7 point scale from 0 days to 20-30 days. Due to rare responses at higher levels of use, these items were recoded to reflect a dichotomous variable indicating use or no use in the past 30 days for each substance. Other models failed to converge because of the sparseness of the distributions often encountered in these populations (e.g., D'Amico et al., 2012).

2.2.2. Perceived norms—Participants were asked to think about a group of 100 students (about three classrooms) in their grade and indicate how many students had (1) consumed alcohol at least once a month and (2) ever tried marijuana. Response options ranged from 0 to 10 with multiples of 10 as anchors (WestEd, 2008).

2.2.3. Being in the presence of others who use/consume—Participants reported how often they were with kids who (1) drink alcohol and (2) use marijuana. Response options ranged from 0 = never to 3 = often (Ellickson et al., 2003).

2.2.4. Best friend use—Participants were asked to indicate (yes/no) if their best friend (1) consumed alcohol and (2) used pot (Ellickson et al., 2003).

2.3. Analytic Models

We used fixed effects regression models to estimate the within individual relationship between predictors and substance use outcomes. The form of the model is:

$$y_{it}=X_{it}\beta+\alpha_i+u_{it}$$

Where y_{it} is the logit of the outcome for individual i at time t, X_{it} is the matrix of predictors, α_i is a person effect (created by dummy coding person), and u_{it} is the error term. β is the vector of regression estimates. Importantly, α_i is allowed to be correlated with the X_{it} predictor variable(s). Because α_i is a person effect we control for person, and therefore control for all time invariant variables associated with a person - race, age, gender, socio-economic status, etc. are all controlled for, regardless of whether these variables were measured thereby reducing the risk of omitted variable bias (see, for example, (Allison, 2009)).

For both outcomes (alcohol and marijuana), we estimated a total of 9 models (Table 1). All models included age as a covariate. The three social predictors of interest were: peer norms, being in the presence of other teens using, and best friend use. The first three models contained each social predictor individually, along with its interaction with age.

To aid in interpretation of parameter estimates, age was centered. This means that the effects of other covariates interacting with age are estimates of effects at the mean age. We further graphed the predicted probability of use for individuals at ages 11-16, as a function of levels of norms (high vs. low), being in the presence of others who use/consume, and best friend use. For perceived norms and being in the presence of others who use/consume, we select the upper and lower quartiles (where possible) as the values for ‘high’ and ‘low’ use. The best friend use measure is dichotomous (yes vs. no), and so we use both values for the predicted probabilities.

2.4. Analytic Plan

Fixed effects (conditional) logistic regression models were used to evaluate the association between predictor variables: peer norms, best friend use, and being in the presence of others who use/consume. Fixed effects regression models examine changes within individuals, rather than between individuals. These models make it possible to assess the probability of using as a function of higher/lower values of predictive variables relative to the mean for that individual. Models were estimated using the cslogistic function of the R software package Survival (Therneau, 2013).

The advantage of fixed effects regression models is that all time-invariant characteristics of the person are controlled for, regardless of whether these variables were measured or not (e.g., race, gender, socio-economic status). We therefore have greater faith in the causal conclusions that can be drawn. The disadvantage of fixed effects regression is that there must be intra-individual change (i.e., a person must change their substance use over time) otherwise they cannot be included in the analysis. The underlying reasoning is that we are investigating characteristics of a person, which are associated with their change in substance use, and therefore if a person's use does not change, they are excluded from the analysis. The cost of losing participants in this way is a reduction in power, but our sample size was sufficiently large so adequate power remains.

We examined the extent to which missing data was potentially reducing the generalizability of the results using a multilevel modeling approach, in which surveys were nested within people. We compared responses on the outcomes and the three predictors of interest between those who completed only one survey and those who completed multiple surveys.

3. Results

3.1. Participants' characteristics

For inclusion in each analytic sample, respondents needed to have completed items about their own use and about the three sources of social influence across at least two waves of data collection. If a person completed surveys in wave 1 and wave 3, for example, they were included in the analytic sample. If they only completed a survey at wave 3, they were not

included. In addition, as described above, there must be variance in the answers to the substance use questions because the analysis explores within person change in use. For example, a youth who consistently reported alcohol use would have no variance in his/her answers and would therefore be excluded from that analysis. If this same youth reported no marijuana use at one wave, then reported marijuana use at another wave, he/she would be included in the marijuana analysis.

For marijuana, 751 individuals (50% female), with a mean age of 12.8 (SD 1.12) completed a mean of 3.2 surveys (2415 responses) and reported both use of marijuana and non-use at different waves. The sample was 68% Hispanic, 17% white, 5% Asian, 3% black and 7% mixed/other race.

For alcohol, 1235 individuals (50% female) with a mean age of 12.8 (SD 1.12) responded to a mean of 3.3 surveys (4030 responses) and reported both use of alcohol and non-use at different waves. The sample was 67% Hispanic, 17% white, 7% Asian, 2% black and 7% mixed or other race.

3.2. Missing data analysis

We used a multilevel regression model to explore differences in alcohol and marijuana use and the main predictors between those who completed only one survey (and therefore were not included in the analytic sample) and those who completed more than one survey. Occasions were nested within individuals, and we controlled for school, cohort and grade. These models did not detect statistically significant differences between those who completed only one survey and those who completed more than one survey for the outcome variables (participants' past month consumption of alcohol $p = 0.947$; participants' past month use of marijuana: $p = 0.066$). Statistically significant differences were found for best friend marijuana use, with those who completed only one survey more likely to report that their best friend was consuming alcohol compared with those who completed multiple surveys (participants' past month use of marijuana: $p = 0.447$; participants' past month use of alcohol: $p = 0.225$; being in the presence of others who use marijuana $p = 0.398$; being in the presence of others who consume alcohol: $p = 0.176$; best friend use of alcohol $p = 0.087$; best friend use of marijuana: $p = 0.011$).

In addition, age and grade were predictive of dropout due to the study design. Eighth grade respondents in the first year of the study were in their final year of middle school and surveys were not carried out for this cohort of youth after 8th grade. In addition, at wave 3, a new cohort of students entered the schools at 6th grade and was added to the survey. Follow-up rates also differed across schools. These missing data can be considered a form of planned missingness design of the specific type known as a wave-missing longitudinal design (Little et al., 2013). Given this design, the data are missing at random and therefore the full information estimation approach that we employ provides consistent and unbiased estimates in the presence of this missing data (Allison, 2001).

3.3. Alcohol

Table 2 outlines the partial correlations between the three sources of social influence, age and participant's alcohol consumption controlling for (dummy coded) wave, so as to provide

an estimate of the correlation over time, without being confounded by the trajectories of individuals (these values are very close to the mean correlation). These partial correlations suggest that these variables are related, yet sufficiently independent. These correlations are also in the direction of our hypothesis, namely that students' consumption is more strongly related to proximal influences (being in the presence of others who use and best friend use) than to peer norms.

Table 3 shows the results of the nine conditional logistic regression models. In the first three models, the effects of perceived norms, best friend use and being in the presence of others who consume alcohol were statistically significant, along with the interaction of age × perceived norms in Model 1. When all three predictors were entered into the model (Model 4) they all remained statistically significant. The age × perceived norms interaction indicated that the effect of perceived norms decreased slightly with age, such that the association between perceived norms and respondents' alcohol consumption decreased over time.

In models 5, 6 and 7, best friend use × perceived norms and being in the presence of others who drink alcohol × perceived norms were statistically significant. Models with only lower order effects should not be interpreted in the presence of statistically significant higher order interactions. When all three two-way interaction effects were entered into the model, only perceived norms × being in the presence of others who drink remained statistically significant. The three-way interaction effect (in model 9) was not statistically significant, and so we interpreted model 8.

To assist with interpretation of the parameter estimates, we plot the marginal predicted probabilities. Figure 1 shows the predicted probability of participants' past month use for model 8. We used the regression equation to estimate a representative predicted probability from an individual with each possible set of characteristics. For example, a person who is in the presence of others who use/consume, and who also has high perceived norms, is shown in the top right hand panel of Figure 1. The panel shows two slopes, one for individuals whose best friend drinks (the upper, dashed line) and one for individuals whose best friend does not drink (the lower, solid line). The graph also shows the main effect of age. As age increased the predicted probability of alcohol use increased (positive slopes in Figure 1).

All three social predictors were highly significant and positive, but their effects also varied with age. As age increased, being in the presence of others who drink had a greater effect on the likelihood of alcohol use (steeper slopes on the right hand graphs), whereas the effect of perceived norms was less influential on drinking behavior.

Finally the perceived norms × being in the presence of others who drink was significant and negative. In other words, as adolescents spend more time in the presence of others who consume alcohol, the predictive value of perceived norms decreased.

3.4. Marijuana

Table 4 illustrates the partial correlations between the three sources of social influence, age and participant's consumption controlling for (dummy coded) wave, so as to provide an estimate of the correlation over time, without being confounded by the trajectories of

individuals. These partial correlations suggest that these variables are related, yet sufficiently independent. These correlations are also in the direction of our hypothesis, namely that students' consumption is more strongly related to proximal influences (being in the presence of others and best friend use) than to peer norms.

Table 5 outlines the results of the nine conditional logistic regression models. In the first three models, the effects of perceived norms, best friend use, being in the presence of others who use marijuana and age were statistically significant, along with the interaction of age × perceived norms in Model 1. When all three predictors were entered into the model (Model 4) they all remained statistically significant, along with the age × peer norms interaction. As age increased, the influence of peer norms on marijuana use decreased.

Higher order interactions were not significant, so we base our interpretation on model 4 because it contains all the statistically significant effects. Figure 2 shows the predicted probability of past month marijuana use based on Model 4. The negative age × perceived norms interaction indicated that as age increased, the effect of peer norms was less influential (see Figure 2, where the difference between high and low norms is reduced as age increased).

4. Discussion

This study examined the predictive value of proximal and distal sources of social influence on young adolescents' marijuana use and alcohol consumption: best friend use, being in presence of other adolescents who use and perceived peer norms. We further assessed how these proximal (i.e., best friend use, presence of others who use/consume) and distal (i.e., perceived norms) sources of influence changed over time and how they differentially predicted alcohol and marijuana use over time.

Findings indicated that proximal and distal sources of influence were independently associated with alcohol consumption. However, age qualified these findings such that as youth grew older, proximal factors (i.e., spending time with other adolescents who drink) increased students' likelihood of drinking alcohol whereas perceived norms (distal) became less influential. Given that identity formation takes place during this developmental period, younger adolescents may be more sensitive to the behavior of the larger peer group as they are exploring and trying to figure out where they belong and how they fit in (Luyckx et al., 2006). Peer norms likely become less influential as adolescents commit to different parts of their identity and develop closer ties with specific subgroups of students. In turn, these closer social networks likely become more relevant as social referents. Previous research discusses this relative influence of the social group on substance use. For instance, Polonec and colleagues (2006) found a stronger association between college students' alcohol consumption and their friends' drinking norms than between students' drinking and unfamiliar peer norms. Similarly, Campo et al. (2003a; 2003b) found that norms about a “typical student” were not related to behavior in students whereas norms about “friends” were. These findings are consistent with our results (i.e., perceived norms × presence of other youths who drink) indicating that the predictive value of perceived norms decreased as youths spent more time in the company of other adolescents who drink alcohol.

Furthermore, spending more time in the presence of others who consume alcohol was a more powerful predictor of alcohol consumption as youth aged.

Interestingly, there was no similar interaction between perception of best friend's alcohol use and perceived norms. This is surprising as best friends tend to have the strongest impact on adolescent drinking behavior during this developmental period. However, these findings are consistent with our premise that immediate access to alcohol or presence of others who drink may be more strongly linked to actual drinking behavior than students' *perceptions* of others' (friends or peers) drinking behavior. While highly influential, the impact of best friends' consumption during adolescence may operate through shared opportunities and co-engagement/co-consumption (i.e., direct contact). In this view, being in the presence of others who drink (including being in the presence of best friends who consume), rather than the perception of best friends' consumption, is the immediate predictor of students' actual drinking behavior.

For marijuana, all three sources of social influence were associated with adolescents' marijuana use. As youth aged, perceived norms became less influential, whereas the proximal influence of best friend's use and being in the company of youth who use marijuana remained stable. Given that the age of initiation of marijuana use is two years later than alcohol use, youth may be more likely to be in the commitment stage of their identity; thus, for marijuana use, their consumption may become increasingly determined by direct influences rather than by the perceptions of what the larger peer group does.

During middle school, adolescents' perceptions of AOD use norms among their peers increase dramatically (Pedersen et al., 2013b). These norms may influence their peer group selection as they transition through middle school and high school. For example, youth with higher peer norms and who also want to try alcohol or marijuana may self-select into groups of peers who use heavily to confirm their perception and/or to feel better about themselves (i.e., “My use is not that bad because others around me consume just as much”). Perceived norms may therefore become less important as youth age. Indeed, research among college students has shown that those who heavily use AOD tend to select new friends who also use heavily (Stappenbeck et al., 2010), who in turn may reinforce their perception of others' consumption.

These findings suggest that intervention efforts aimed at correcting overestimates of peers' substance use continue to be warranted in early adolescence. However, once peer groups are established and begin to exert a more direct influence on adolescents' AOD use, it may be more important to focus intervention/prevention efforts on substance use refusal skills, learning alternative strategies to cope with stress beyond use of substances, and providing alternative opportunities to have fun with peers. Targeting groups of friends may further help correct misconceptions about how much close friends use and provide the necessary social contingencies to harness collaborative support from friends. Similar strategies have been used to prevent excessive alcohol consumption among college students (Neighbors et al., 2012); however, further research investigating the effectiveness of close friend networks on prevention and harm reductions efforts among young adolescents is greatly needed.

4.1 Limitations

Students may have underreported their own use or instances in which they were in the presence of others who use due to fear of repercussions – this is a problem inherent in self-report, although possibly exaggerated (see Chan, 2009). Due to these issues, we informed participants that their responses were protected with a Certificate of Confidentiality and researchers involved in the study ensured that teachers and parents were separated from data collection procedures. The comparability of our substance use rates with national norms (SAMHSA, 2013) gives us confidence in the confidentiality procedures utilized. Another limitation is the use of single items to measure the social constructs, although the predictive validity of these measures is well-established (Ellickson et al., 2003; WestEd, 2008; D'Amico et al., 2012; Pedersen et al., 2013a; Tucker et al., 2013). Similarly, we did not measure best friends' actual consumption or use. Without this information, it is not possible to determine whether youth are at greater risk of using *because* of their friends (i.e., social influence), or whether youth select friends who are similar in terms of drug and alcohol consumption (i.e., social selection). Future work should take advantage of recent advancement in statistical network models to tease apart social meisms from effects due to shared environments to have a clearer understanding of how social determinants independently and synergistically operate on substance use. Finally, as with many longitudinal studies, there was missing data across the surveys waves. However, our analytic strategy made it possible to utilize all available data and assumed that data were missing at random. The main implication of this missing data is a slight reduction in power, but since our sample size was large, adequate power remains.

4.2 Conclusions

This study provides an important longitudinal assessment of the distinct and combined effects of social influences on adolescents' alcohol consumption and marijuana use as they transition from middle school to high school. Peer influence is increasingly the focus of prevention and interventions efforts targeting AOD in early and late adolescence. Findings emphasize the importance of continuing to target peer norms among early adolescents. In contrast, resistance skills and alternative activities may be more relevant for older youth.

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Highlights

- Examine social influences on adolescents marijuana and alcohol consumption
- Examine how the effects of these sources of social influence evolve over time
- Perceived peer norms are more influential in early adolescence
- Proximal social determinants become more influential as youth get older

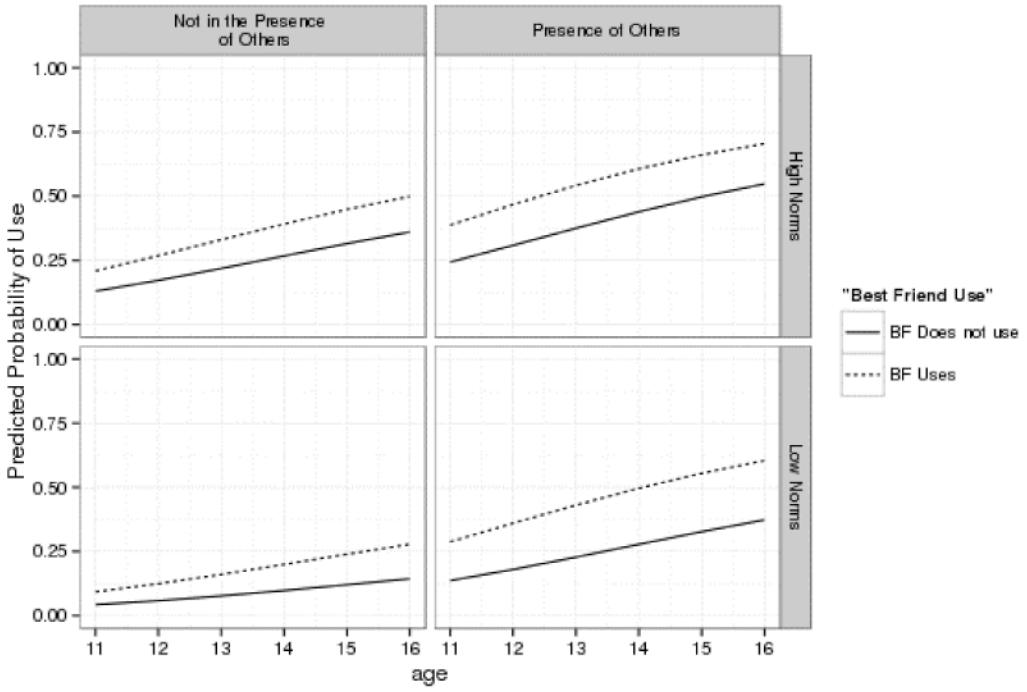

Figure 1.

Predicted probability of alcohol use at each age based parameter estimates from Model 8. A low value for norms is 1 (range is 1-11) and a high value is 6 for time spent with teens who are using a low value is 0 and a high value is 1 (range 0-3) and the item for best friend use is dichotomous, hence we calculate predicted scores for ‘yes’ and ‘no’.

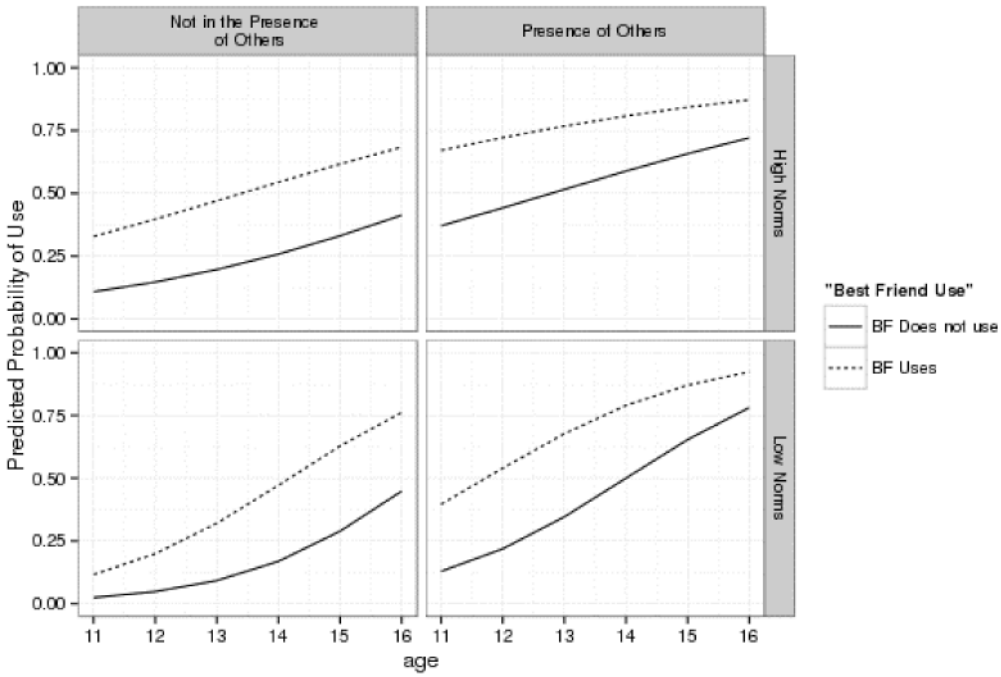

Figure 2.

Predicted probability of marijuana use at each age based on parameter estimates from Model 8. A low value for norms is 1 (range is 1-11) and a high value is 7 for time spent with teens who are using a low value is 0 and a high value is 1 (range 0-3) and the item for best friend use is dichotomous, hence we calculate predicted scores for ‘yes’ and ‘no’.)

Table 1

Fixed effects regression models testing the predictive value of best friend use, peer

Predictors	Models**								
	1	2	3	4	5	6	7	8	9
Norms	x			x	x	x	x	x	x
Best friend use		x		x	x	x	x	x	x
In presence of other teens using			x	x	x	x	x	x	x
Age + age × social predictors	x	x	x	x	x	x	x	x	x
Norms × Best friend use					x			x	x
Norms × In presence of other teens using						x		x	x
Best friend use × In presence of other teens using							x	x	x
Norms × Best friend use × In presence of other teens using									x

norms and being in the presence of other users over time.

** Models 1 through 9 are discussed in the Analytic Plan (Section 2.4).

Table 2

Within-wave correlations between the three sources of social influence, age and participant's alcohol consumption (calculated as the partial correlation between variables controlling for dummy coded wave).

Correlations					
Control Variables	**Self (Previous month)**	**Peer norms**	**Presence of others**	**Best friend use**	**Age**
Self (Previous month)	1.000	.251	.349	.303	.151
Peer norms	.251	1.000	.470	.342	.258
Presence of others	.349	.470	1.000	.478	.221
Best friend use	.303	.342	.478	1.000	.180
Age	.151	.258	.221	.180	1.000

Table 3

Findings of fixed effects regression models for alcohol consumption.

Predictors		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Norms	Est	0.25			0.14	0.19	0.14	0.24	0.26	0.27
	SE	0.02			0.02	0.03	0.02	0.03	0.04	0.04
	OR	1.28			1.15	1.21	1.15	1.27	1.30	1.31
	P	**<0.001**			**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
BF use	Est		1.31		0.78	1.11	0.86	0.76	0.89	0.94
	SE		0.09		0.10	0.16	0.15	0.10	0.19	0.24
	OR		3.70		2.17	3.04	2.36	2.13	2.44	2.57
	P		**<0.001**		**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
With teens who use	Est			0.75	0.51	0.50	0.54	0.74	0.69	0.71
	SE			0.04	0.05	0.05	0.07	0.08	0.09	0.11
	OR			2.12	1.66	1.65	1.72	2.10	1.99	2.03
	P			**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Age × Norms	Est	-0.04			-0.04	-0.03	-0.04	-0.03	-0.03	-0.03
	SE	0.01			0.02	0.02	0.02	0.02	0.02	0.02
	OR	0.96			0.97	0.97	0.97	0.97	0.97	0.97
	P	**0.002**			**0.031**	**0.035**	**0.032**	**0.031**	**0.032**	**0.032**
Age × BF use	Est		-0.03		-0.02	0.04	-0.01	-0.02	0.01	0.01
	SE		0.07		0.09	0.09	0.09	0.09	0.09	0.09
	OR		0.97		0.98	1.04	0.99	0.98	1.01	1.01
	P		0.671		0.794	0.677	0.894	0.824	0.932	0.924
Age × With teens who use	Est			0.02	0.06	0.06	0.06	0.10	0.09	0.09
	SE			0.04	0.04	0.04	0.04	0.04	0.04	0.04
	OR			1.02	1.06	1.06	1.06	1.10	1.10	1.10
	P			0.648	0.202	0.188	0.200	**0.032**	**0.038**	**0.038**
BF use × Norms	Est					-0.09			-0.05	-0.07
	SE					0.03			0.04	0.06
	OR					0.91			0.95	0.93

Predictors		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	P					**0.008**			0.145	0.231
BF use × With teens who use	Est						-0.07		0.06	0.01
	SE						0.09		0.09	0.15
	OR						0.94		1.06	1.01
	P						0.435		0.532	0.927
Norms × With teens who use	Est							-0.06	-0.06	-0.06
	SE							0.02	0.02	0.02
	OR							0.94	0.94	0.94
	P							**<0.001**	**0.001**	**0.010**
BF use × Norms × With teens who use	Est									0.01
	SE									0.03
	OR									1.01
	P									0.726
Age	Est	0.58	0.55	0.39	0.37	0.33	0.36	0.31	0.30	0.30
	SE	0.07	0.05	0.06	0.08	0.08	0.08	0.08	0.08	0.08
	OR	1.78	1.72	1.48	1.44	1.40	1.43	1.36	1.35	1.35
	P	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

Note: Est = regression estimate (B); SE = standard error of regression estimate; OR = odds ratio exp(B); p = probability value.

Table 4

Within-wave correlations between the three sources of social influence, age and participant's marijuana use (calculated as the partial correlation between variables controlling for dummy coded wave).

Correlations					
Control Variables	**Self (Previous month)**	**Peer norms**	**Presence of others**	**Best friend use**	**Age**
Self (Previous month)	1.000	.274	.417	.399	.125
Peer norms	.274	1.000	.499	.335	.303
Presence of others	.417	.499	1.000	.490	.224
Best friend use	.399	.335	.490	1.000	.168
Age	.125	.303	.224	.168	1.000

Drug Alcohol Depend. Author manuscript; available in PMC 2015 November 01.

Table 5

Findings of fixed effects regression models for marijuana use.

Predictors		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Norms	Est	0.28			0.10	0.14	0.10	0.15	0.16	0.14
	SE	0.03			0.03	0.04	0.03	0.05	0.05	0.06
	OR	1.33			1.11	1.15	1.10	1.16	1.17	1.15
	P	**<0.001**			**0.001**	**<0.001**	**0.001**	**0.002**	**0.003**	**0.016**
BF use	Est		2.06		1.31	1.62	1.59	1.29	1.65	1.48
	SE		0.14		0.16	0.26	0.27	0.16	0.31	0.43
	OR		7.81		3.7	5.07	4.91	3.64	5.23	4.41
	P		**<0.001**		**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.001**
With Teens	Est			1.12	0.79	0.77	0.85	0.90	0.89	0.85
	SE			0.07	0.08	0.08	0.09	0.12	0.13	0.15
	OR			3.06	2.2	2.17	2.35	2.47	2.43	2.33
	P			**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Age × Norms	Est	-0.09			-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
	SE	0.02			0.02	0.02	0.02	0.02	0.02	0.02
	OR	0.91			0.95	0.95	0.95	0.95	0.95	0.95
	P	**<0.001**			**0.032**	**0.027**	**0.032**	**0.031**	**0.028**	**0.032**
Age × BF use	Est		-0.23		-0.09	-0.03	-0.06	-0.09	-0.03	-0.03
	SE		0.12		0.14	0.14	0.14	0.14	0.14	0.14
	OR		0.79		0.91	0.97	0.94	0.92	0.97	0.97
	P		**0.047**		0.503	0.828	0.646	0.526	0.809	0.81
Age × With Teens	Est			-0.13	-0.07	-0.06	-0.07	-0.05	-0.05	-0.05
	SE			0.05	0.07	0.07	0.07	0.07	0.07	0.07
	OR			0.88	0.94	0.94	0.94	0.96	0.95	0.95
	P			**0.016**	0.316	0.341	0.317	0.503	0.456	0.446
BF use × Norms	Est					-0.07			-0.05	0.00
	SE					0.05			0.05	0.09
	OR					0.93			0.95	1.00

Predictors		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	P					0.113			0.368	0.991
BF use × With Teens	Est						-0.17		-0.09	0.02
	SE						0.13		0.14	0.23
	OR						0.85		0.91	1.02
	P						0.190		0.524	0.932
Norms × With Teens	Est							-0.03	-0.02	-0.01
	SE							0.02	0.02	0.03
	OR							0.97	0.98	0.99
	P							0.181	0.416	0.787
BF use × Norms × With Teens	Est									-0.02
	SE									0.04
	OR									0.98
	P									0.560
Age	Est	1.05	0.86	0.75	0.80	0.78	0.79	0.76	0.76	0.76
	SE	0.1	0.08	0.11	0.14	0.14	0.14	0.14	0.14	0.14
	OR	2.86	2.37	2.12	2.23	2.18	2.21	2.15	2.13	2.13
	P	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

Note: Est = regression estimate (B); SE = standard error of regression estimate; OR = odds ratio, exp (B); p = probability value.