Published in final edited form as:
J Youth Adolesc. 2013 November ; 42(11): 1674–1686. doi:10.1007/s10964-012-9869-1.

Online Network Influences on Emerging Adults' Alcohol and Drug Use

Stephanie H. Cook,
Department of Sociomedical Sciences, Mailman School of Public Health, Columbia University, 722 168th Street, Room 556, New York, NY 10032, USA

José A. Bauermeister,
Department of Health Behavior and Health Education, School of Public Health, University of Michigan, 1415 Washington Heights, 3822 SPH 1, Ann Arbor, MI 48109, USA

Deborah Gordon-Messer, and
Department of Health Behavior and Health Education, School of Public Health, University of Michigan, 1415 Washington Heights, 3822 SPH 1, Ann Arbor, MI 48109, USA

Marc A. Zimmerman
M. A. Zimmerman Department of Health Behavior and Health Education, School of Public Health, University of Michigan, 1415 Washington Heights, 3790A SPH 1, Ann Arbor, MI 48109, USA

Abstract

Researchers have reported that network characteristics are associated with substance use behavior. Considering that social interactions within online networks are increasingly common, we examined the relationship between online network characteristics and substance use in a sample of emerging adults (ages 18–24) from across the United States (N = 2,153; *M* = 21 years old; 47 % female; 70 % White). We used regression analyses to examine the relationship between online ego network characteristics (i.e., characteristics of individuals directly related to the focal participant plus the relationships shared among individuals within the online network) and alcohol use and substance use, respectively. Alcohol use was associated with network density (i.e., interconnectedness between individuals in a network), total number of peer ties, and a greater proportion of emotionally close ties. In sex-stratified models, density was related to alcohol use for males but not females. Drug use was associated with an increased number of peer ties, and the increased proportion of network members' discussion and acceptance of drug use, respectively. We also found that online network density and total numbers of ties were associated with more personal drug use for males but not females. Conversely, we noted that social norms were related to increased drug use and this relationship was stronger for females than males. We discuss the implications of our findings for substance use and online network research.

Keywords

Substance use; Networks; Internet; Emerging adulthood

Correspondence to: José A. Bauermeister.

jbauerme@umich.edu.
shc2121@columbia.edu dgordonmesser@gmail.com marcz@umich.edu

Introduction: Peer Relationships and Substance Use

Substance use (e.g., alcohol, illicit drug use) among adults increased from 2008 to 2010, with 18–21 year olds and 21–25 year olds reporting the two highest rates of use (Johnston et al. 2009). Substance use is associated with poor health outcomes during emerging adulthood including psychological distress, risk behaviors, school achievement, and job performance (Bauermeister et al. 2007; Braun et al.2000; Bray et al. 2011; CDC 2010; Cerwonka et al. 2000; Rokach and Orzeck 2003; Stone et al. 2012). Researchers consistently have found that social network characteristics (Pearson and Michell 2000) and social norms about the perceived (injunctive norms) or actual use (descriptive norms) of peer network members are the greatest predictors of personal substance use during emerging adulthood (Donato et al. 1994; Rai et al. 2003; Windle 2000). LaBrie et al. (2010), for example, found that college students' social norms concerning peer use were associated with alcohol use. Given recent interest in delivering substance use interventions online, it is crucial to understand how online networks may influence young adult use. Thus, we contribute to this literature by examining the relationship between online social network characteristics and young adult substance use.

Online Social Networks and Substance Use

Emerging adults increasingly interact with their peers online, but few researchers have examined the relationship between online social networks and substance use. Madden and Zickuhr (2011) reported that 83 % of young adults aged 18–29 had used a social networking site in their lifetime. As a newer way of interacting with peers, emerging adults spend a large amount of time communicating with peers online (Lenhart et al. 2010), and discussing potentially sensitive issues, such as substance use (Moreno et al. 2009). These online exchanges have resulted in the formation of online social networks and norms, with recent evidence suggesting that substance use discussions in online social networks may be related to personal substance use among emerging adults (Stoddard et al. 2012). Given that online social networks have become an important component of emerging adult life, it is necessary to understand how the characteristics of online social networks are related to personal substance use among emerging adults.

Peer Influences, Social Network Analysis, and Emerging Adult Substance Use

Peer relationships play an important role in substance use behaviors during adolescence and emerging adulthood (Borsari and Carey 2001, 2006; Giordano 2003; Stone et al.2012). Researchers have used social network analysis to understand the context of peer relationships and the pathways of peer influence on emerging adult substance use (Bauman and Ennett 1996; Kobus and Henry 2010; Valente et al. 2004). A social network refers to the linkages or ties between people in terms of individual position in the network, similarities between individuals, and the characteristics of the individuals within the network (Israel 1988; Smith and Christakis 2008). Social network theory assumes that the pattern of people's ties and interactions will affect their decision-making and behaviors (Kobus 2003). Network analysis allows researchers to examine a number of characteristics related to interpersonal relationships and determine how these characteristics are associated with health outcomes (Israel 1988). Israel (1988) identified three distinct social network characteristics—structural, interactional, and functional. We describe each of these characteristics below, highlighting prior findings on network characteristics and substance use.

Structural Network Characteristics

Structural characteristic refers to how people are linked in their networks, and are often characterized by size (i.e., the number of direct ties an individual has to other network

members) and density (i.e., the proportion of ties that network members have with one another in the network). The size of one's network may speak to the availability of connections while density may explain how behaviors diffuse across network members (Valente et al. 2004). Researchers have noted mixed findings concerning the relationship between network density and substance use. Some researchers have found that individuals who are not part of a peer social network use substances more than those in more dense networks (Ennett and Bauman 1993; Fang et al. 2003; Pearson and West 2003), whereas others found that individuals in dense networks report more substance use than individuals in less dense networks (Henry and Kobus 2007). Thus, density seems to be a key component to understanding substance use among emerging adults, though the extent to which this relationship exists is unclear. One possible explanation for the divergent findings between density and substance use may be attributable to different network sizes; that is, the size of an individuals' network may influence the likelihood that other ties in the same network know each other. Consequently, it may be important to account for network size when examining the relationship between density and substance use. We examine the association between online network density and substance use among emerging adults, after taking the total number of peer ties into consideration.

Interactional Network Characteristics

Interactional characteristics describe the nature of ties in a network (Israel 1988), including content (i.e., the characteristics of ties in a network), intensity (i.e., the emotional bond between ties), and homophily (i.e., the extent to which network members are similar on certain attributes such as sex, age, and race). When situated in the substance use literature, peer-based relationships are the strongest and most consistent predictors of personal substance use (Valente et al. 2004). These relationships are further influenced by perceptions of emotional closeness with social network members. Closely bonded friends exert a greater influence on substance use behaviors than do friends with whom individuals feel less closeness (Fujimoto and Valente 2012; Hussong 2002). Cox and Bates (2011), for example, found that college students were more likely to drink alcohol when they perceived that close friends drank alcohol. The current study sought to examine how perceptions of closeness with online ties influenced alcohol and drug use.

Homophily theory asserts that individuals tend to interact with other people like themselves (McPherson et al. 2001). Researchers have indicated that having homophilous peers was associated with personal substance use (Ennett and Bauman 1994; Fergusson and Horwood 1997; Urberg et al. 1997). Further, Andrews et al. (2002) found that emerging adult males with more same gender friendships used more substances overall than female emerging adults with same gender friends. In the context of online networks, however, we know little about the role of online homophily in substance use behaviors. This is particularly intriguing given that online interactions enable emerging adults to interact with peers who may not share sociodemographic similarities and/or live in close geographic proximity. In a recent study examining the relationship between online social networking and homophily, for example, Mazur and Richards (2011) found that emerging adults were less likely to report having network members of similar age, race, and geographic location than adolescents. Consistent with our goal of examining how online characteristics influence alcohol and drug use behaviors, we assessed the relationship between the interactional characteristics of online peer networks and substance use.

Functional Network Characteristics

Functional characteristics refer to the social influence of ties in a social network. Descriptive and injunctive norms are one characterization of the influence of ties in a social network. Descriptive norms (or behavioral norms) refer to an individual's perceived prevalence of a

behavior in a given social group, whereas injunctive norms (or perceived norms) refer to an individual's perception of their group's approval of a behavior (Cialdini et al. 1990). These two social norms play a significant role in predicting individual substance use; for example, researchers have noted that college students overestimate the degree to which their peers use marijuana and alcohol (LaBrie et al. 2010; Perkins et al. 1999; Wolfson 2000). This skewed descriptive norm has been noted to be associated with greater use of marijuana and other drugs (Kilmer et al. 2006; Page and Roland 2004; Simons et al. 2006; White et al. 2006). Similarly, (Neighbors et al. 2008) found that injunctive norms relating to close friends' marijuana use were associated with personal substance use. Given the literature, it is important to understand the relationship between substance use and social norms in online networks because repeated exposure to drug use messaging within offline and online peer networks may increase the likelihood of personal substance use (Moreno et al. 2011; Ridout et al.2012; Stoddard et al. 2012). As a contribution to this growing body of work, we examined whether descriptive and injunctive norms were associated with substance use.

Sex Differences: Substance Use and the Composition of Social Networks

Substance use prevalence is unequal in the population by age, race/ethnicity, and gender (Galea et al. 2004). Data from the National Survey on Drug Use and Health indicate that, among emerging adults aged 18–25 years old, 65.3 % of males reported alcohol use compared to 57.1 % of females. Differences in the characteristics of female and male social networks may contribute to observed differences in substance use behavior. The literature on peer influences on substance use suggests that young women may be more sensitive to what others think than young men (Giordano 2003), which may contribute to differences in rates of male and female substance use. Thus, social norms concerning alcohol and drug consumption for emerging adult females may be more salient than for emerging adult males. For instance, Lewis and Neighbors (2004) found that perceived same sex drinking norms were a predictor of personal alcohol use for college females, but not for males. In addition, researchers have shown that emerging adult females are less likely to participate in high-risk behaviors, such as substance use, than emerging adult males (Cubbins and Tanfer 2000; Netting and Burnett 2004; Randolph et al. 2009).

Sex differences also may influence the relationship between social networks and substance use. Researchers using a social network approach have found that females, more often than males, derive psychologically relevant information from their relationships and show increases in substance use due to disturbances in social relationships with peers (Mennis and Mason 2012). In addition, protective networks that prevent use appear to be stronger for females than for males (Mason et al. 2010). Emerging adult males tend to self-disclose less (Franken et al. 1990; Henrich et al. 2000), openly express feelings less, confide in friends within their peer network less (Banks et al.2000; Williams 1985) and place demands on their friends less (Felmlee 1999) than females. Yet, because males tend to bond through activities (Barbee et al. 1990), such as sports and drinking, social drinking with network members may be a way in which young men receive support from friends (Karwacki and Bradley 1996). Therefore, males are more likely than females to develop networks of friends that drink alcohol (Nezlek et al. 1994; Thombs et al. 1993). In contrast, emerging adult females are less likely than males to develop social networks of friends that drink alcohol (Hartzler and Fromme 2003; Wiggins and Wiggins 1992). Given these gender differences, we sought to understand how online social network characteristics might differ by sex and, in turn, moderate the relationship between network characteristics and personal drug use.

The Current Study

Using a social network framework, we sought to understand how online social network characteristics—structural, interactional, and functional—influence personal substance use.

Given the paucity of research specifically examining the relationship between online social network characteristics and emerging adult drug use, we used the offline social network research literature to guide our hypotheses. We focused on two outcomes (alcohol use and illicit drug use) in developing these hypotheses. In terms of alcohol use, we hypothesized that the structural characteristics (i.e., number of network ties and network density) and interactional characteristics (i.e., content—average age of network ties and offline contact with network ties, intensity—emotional closeness, and homophily) would be associated positively with emerging adult alcohol use. We also hypothesized that the relationships between both the structural and interactional online network characteristics and alcohol use would be stronger for males than females.

In terms of drug use, we hypothesized that the structural characteristics (i.e., number of network ties and network density) and interactional characteristics (i.e., content—average age of network ties and offline contact with network ties, intensity—emotional closeness, and homophily) would be associated positively with drug use. We also examined whether drug use was associated with the networks' functional characteristics (i.e., proportion of network ties in which the individual values their opinion on drug use, the proportion of network ties in which the individual discusses drug use, and the proportion of network ties who are accepting of drug use). Given the stigma associated with illicit drug use, we hypothesized that drug use would be greater for participants who discussed drugs with peers and felt that peers were accepting of their use. Furthermore, consistent with prior findings, we hypothesized that network influences on drug use would be more pronounced for males than females.

Methods

Sampling and Sample Characteristics

Data for the current study were collected as part of the Virtual Networks Study (VNS), a cross-sectional observational study examining emerging adults' interpersonal relationships online. To be eligible for participation, youth had to be between the ages of 18 and 24, live in the United States, and have access to the Internet. We used an adapted web-version of Respondent-Driven Sampling (webRDS) to recruit participants (Bauermeister et al. 2012). The first wave of participants (i.e., seeds) were recruited through an online Facebook advertisement, and selected based on race/ethnicity and region of the U.S. to ensure that initial network seeds were diverse and that we would not concentrate recruitment in a single region in the United States. In recognition of varying substance use in the population by race/ethnicity (Galea et al. 2004), we recruited 22 racially diverse seeds from across the U.S. (5 African-American, 8 Latino/Hispanic, 9 White; 7 from the Northeast, 6 from the South, 4 from the West and 5 from the Midwest). The remainder of the sample (N = 3,426) was recruited through referral chains from the original 22 seeds. The full sample (N = 3,447) was 52 % male with a racial composition of 70 % White, 12 % Asian/Pacific Islander, 9 % Hispanic/Latino and 5 % African-American. The average age of participants was 20 years (SD = 1.77) and 96 % had completed high school. Sixty-five percent of the sample used alcohol in the past 30 days and twenty-five percent of the sample reported using one or more substances in the past 30 days. The current study utilized data from individuals who provided peer network data only.

Table 1 provides information on the sample characteristics for the current study. After selecting only cases that provided information for all study variables, the final sample size was 2,153. Fifty-three percent of the sample was male. Ninety-six percent of the sample completed high school; we found slight differences between male and female had completion rates (95 and 97 %, respectively). The racial/ethnic composition of the sample

was majority white (70 %). The sample ranged in age from 18 to 25 (M = 21 years, SD = 1.74). Participants reported an average of four peer ties (M = 3.85, SD = 1.30).

Overall, 75 % of the sample had offline contact with the ties in their networks. Males had a slightly higher proportion of ties that they interacted with offline than females, $t(2,151) = 3.76$, $p < .05$. Females had a slightly higher mean network age than males, $t(2,151) = -3.01$, $p < .05$. Females had a higher proportion of network ties with whom they felt close than males, $t(2,151) = -3.61$, $p < .05$. Males had denser networks than females, $t(2,151) = 2.86$, $p < .05$. In terms of the injunctive norms, female had a higher proportion of drug use opinion importance ties ($t(2,151) = -5.22$, $p < .05$), but had a lower proportion of ties who they felt were accepting of drug use ($t(2,151) = 9.14$, $p < .05$) than males. Overall, alcohol was more prevalent in our sample than were illicit drugs. Males used more alcohol, $t(2,151) = 2.81$, $p < .05$, and drugs in the last 30 days than females, $t(2,151) = 4.22$, $p < .05$.

Missing Data

We had 2,845 participants with peer network data—this included the peer and family network data. The following analysis examines differences in reporting of the network data. Sixteen percent of participants did not provide network data (n = 566). A greater percentage of males (19.4 %) did not provide network data compared to females (13.2 %; $\chi^2(1) = 21.4$, $p < .05$). A greater percentage of those who did not complete high school (26.5 %) were missing network data compared to those who did complete high school (15.4 %; $\chi^2(1) = 11.8$, $p < .05$). Whites were more likely than other races to have provided network data ($\chi^2(4) = 36.7$, $p < .05$). Older participants (ages 21–24) were less likely to provide network data than younger counterparts ($t(3,390) = 2.1$, $p < .05$). We found no differences by substance use (alcohol or illicit drug use), and no differences between participants with peers in their networks and those participants who only listed family members in their networks (n = 36).

Data Collection

Each prospective participant logged into the survey portal using a unique identifying number (UID) and completed a short eligibility screener. Eligible participants consented to the study and completed the survey. On average, the questionnaire took 37 min to complete. Emerging adults received $20 for their participation and were offered an additional $10 each for up to 5 additional participants who were referred and completed the questionnaire. Incentives were paid with a VISA e-gift card. Study data were protected with a 128-bit SSL encryption and kept on a secure firewalled server at the University of Michigan. Data quality checks were conducted to circumvent duplicate and fraudulent entries (Bauermeister et al. 2012). The University of Michigan's Institutional Review Board approved the study.

Measures

Alcohol Use—Frequency of alcohol use was determined by assessing the amount of alcohol consumption in the last 30 days. Response options ranged from 1 = Never/None to 7 = More than once a day. The variable was approximately normally distributed.

Drug Use—Participants were asked about their substance use in the last 30 days. Responses were recorded on a scale with "0" indicating no drug use and "6" indicating substance use more than once a day. Substances included marijuana, cocaine, ecstasy, methamphetamine, ketamine, GHB, poppers, crack, heroin, hallucinogens, non-prescription steroids, and other non-prescription drugs. All of the substances were coded into dichotomous variables (i.e., 0 = no use, 1 = use) and then summed to obtain a variable that assessed the number of drugs used in the past 30 days. The range of the index was 0–6. The resulting variable was skewed; therefore a "1" was added to each value of drug use to

maintain “0” values and then log10 transformed. The resulting variable was approximately normally distribution.

Density—We asked participants to indicate if the people they listed knew each other (i.e., 1 = know each other well, 2 = acquaintances, 3 = no relationship, 4 = I don’t know). Relationships where ties knew each other well or were acquaintances were coded as “connections”; no relationship or I don’t know responses were coded as “no connection”. We calculated density by taking the proportion of connections in the network divided by all possible connections.

Total Peer Ties

We employed egocentric network techniques, which provide information on the relationship of individuals to the participant (Borgatti et al. 2009). The participants (i.e., the ego) were asked to list the 5 people (i.e., the alters) who they interacted with most frequently online. The link between the ‘ego’ and the ‘alter’ is called the ‘tie’ in social network terminology. For each of the 5 people listed data were collected from the participant on demographic characteristics for each of the ties, the participants relationship with each of the ties, the ties’ relationship to one another, and information concerning the ties’ norms surrounding sexual health and drug use. Ties who were family members were excluded from this analysis. In addition, only participants who listed 1 or more peer ties were included in the analysis. We calculated a sum of each participant’s peer ties to create a measure of their total number of ties.

Emotional Closeness—Participants were asked how close they felt to each of the 5 ties. Possible response options were, 1 = very close, 2 = somewhat close, and 3 = not close. We reverse coded these items and calculated the mean closeness score for each participant’s network.

Race Homophily—We calculated race homophily in the same way we calculated sex homophily. We subtracted the ties of similar races and the ties of different races then divide this number by total number of network ties. The scores are on a scale from −1 (indicating network ties similar) to +1 (indicating network times not similar).

Sex Homophily—We calculated sex homophily using the Krackhardt and Stern homophily index (1988). We subtracted the ties of similar sexes and the ties of different sexes then divide this number by total number of network ties. The scores are on a scale from −1 (indicating network ties similar) to +1 (indicating network times not similar).

Age of Network Ties—Participants were asked the age of each tie. Using these entries, we calculated the mean age of the ties in each participant’s network.

Offline Contact with Ties—Participants were asked on average how many times a week they communicated with a tie over the phone, face-to-face, and via text message. If a participant and tie communicated through 1 or more of these modes of communication, the tie was coded as 1 = offline contact and 0 = no offline contact. We calculated the proportion of ties with offline contact for each participant.

Importance of Ties’ Opinion—Participants were asked if each tie’s opinion about drugs was important to them. Respondents were able to answer “yes” or “no” to this question. We then divided the number of “yes” ties by the number of “no” ties for each participant. The resulting variable establishes the proportion of opinion importance across ties for each participant.

Proportion of Discussion Ties—Participants were asked if they ever discussed using drugs with each of the online network ties they listed. Respondents were able to answer "yes" or "no" to this question. We then divided the number of "yes" ties by the number of "no" ties for each participant. The resulting variable establishes the proportion of discussion ties for each participant.

Proportion of Accepting Ties—Participants were asked, "How accepting do you think this person would be if you used drugs." Response options ranged from 1 = completely accepting to 5 = not accepting at all. We computed a dichotomous acceptance variable (Very accepting, accepting and neutral = yes; Not accepting, Not accepting at all = no). We then divided the number of "yes" ties by the number of "no" ties for each participant. The resulting variable establishes the proportion of accepting ties for each participant.

Demographic Information

Participants reported their race/ethnicity, age, sex and highest education level completed. We calculated participant's age by subtracting their month and year of birth from the date of study participation. We identified four racial/ethnic categories (i.e., White, Black, Asian, Latino, Other). Education was collapsed into two categories—"Completed high school" and "Didn't complete high school".

Data Analytic Strategy

We analyzed the data in three steps. We ran descriptive analyses for study variables and attrition analyses for those not included in the peer network data set. After examining the correlations between variables, we found no multicol-linearity in our multivariate analysis. Consequently, we then used multivariate regression to examine the relationship between ego-network characteristics and alcohol and the log-transformed variable for drug use, respectively. Third, we stratified the regression models by sex and tested for sex differences in the regression parameters using independent sample *t* tests. This allowed us to compare the unstandardized beta coefficients (Cohen et al. 2003). We present standardized beta coefficients (β) in the text, and unstandardized beta coefficients and corresponding standard errors in tables. For brevity, only statistically significant ($p < .05$) findings are discussed in text.

Results

Alcohol Use in the Last 30 days

Table 2 reports the results for the multivariate linear regression models predicting the frequency of alcohol use. Females reported less alcohol use than males (β = −.06, $p < .05$). Compared to White participants, Black (β = −.08, $p < .05$), Asian (β = −.15, $p < .05$) and Latino (β = −.07, $p < .05$) participants reported less alcohol use. Age was associated positively with alcohol use (β = .16, $p < .05$). High school completion was also associated positively with alcohol use (β = .08, $p < .05$). In terms of structural characteristics, we found that those emerging adults with denser networks (β = .05, $p < .05$) and more peer ties (β = .09, $p < .05$) had more alcohol use than those with less dense networks and fewer peer ties. Alcohol use was associated positively with the number of reported ties with whom participants interacted offline (β = .08, $p < .05$). In terms of the interactional characteristics, emotional closeness was associated positively with alcohol use (β = .11, $p < .05$). Other interactional network characteristics (i.e., race homophily, sex homophily, average age of ties, or offline contact with ties) were not associated with alcohol use in the full sample.

When we stratified by sex, we found that White males participants reported greater alcohol use frequency than Black (β = <.08, $p < .05$), Asian (β = −.14, $p < .05$), and Latino (β = −.06,

$p < .05$) males. Age (β = .18, $p < .05$) and high school completion (β = .09, $p < .05$) were associated positively with alcohol use for male participants. For the structural characteristics, we found that density (β = .07, $p < .05$) and total peer ties (β = .07, $p < .05$) were associated positively with male alcohol use. Alcohol use was associated positively with the number of reported ties with whom participants interacted offline (β = .07, $p < .05$). We found a positive relationship between emotional closeness and alcohol use for males (β = .12, $p < .05$), but no relationship between other interactional characteristics (i.e., race homophily, sex homophily, average age of ties, and offline contact with ties) and alcohol use for males.

In comparison to White females participants, Black (β = −.08, p < .05) and Asian (β = −.17, $p < .05$) females reported less alcohol use. Age (β = .13, $p < .05$) and high school completion (β = .07, $p < .05$) was associated positively with alcohol use for female participants. For the structural characteristics, we found that total peer ties (β = .10, $p < .05$) was associated with more alcohol use. Alcohol use was associated positively with the number of reported ties with whom participants interacted offline (β = .10, $p < .05$). Females who felt more emotionally close with network ties reported more frequent alcohol use (β = .11, $p < .05$). We found no relationship between other interactional characteristics (i.e., race homophily, sex homophily, average age of ties, and offline contact with ties) and alcohol use for females.

When we compared the female and male regression models, we found that density was a predictor of alcohol use for males but not for females. Sex did not moderate any other relationship in the alcohol model.

Drug Use in the Last 30 Days

Table 3 reports the results of the multivariate linear regression model predicting the number of drugs used in the last 30 days. Females reported less drug use when compared to males (β = −.06, $p < .05$). Compared to White participants, Asian participants (β = −.06, $p < .05$) reported less drug use while participants in the “Other” race/ethnicity category (β = .15, $p < .05$) reported more drug use. We found no relationship between Latino ethnicity, age or education and drug use. In terms of structural characteristics, we found that density was not related to drug use. We found that the total number of peer ties was associated positively with drug use (β = .06, $p < .05$). Drug use was associated positively with the number of reported ties with whom participants interacted offline (β = .06, $p < .05$). None of the interactional network characteristics (i.e., emotional closeness, race homophily, sex homophily, average age of ties, or offline contact with ties) were associated with drug use in the full sample.

We found a positive relationship between reported drug use and the proportion of network ties with whom participants discussed drugs (β = .29, $p < .05$) and perceived to be accepting of drug use (β = .21, $p < .05$), respectively. We did not find a relationship between ties’ opinion importance and personal drug use.

For males, participants who identified racially/ethnically as “Other” (β = .13, $p < .05$) reported more drug use compared to Whites. For the structural characteristics, we found that density (β = .06, $p < .05$) and total peer ties (β = .06, $p < .05$) were associated positively with drug use. We found no relationship between interactional characteristics (i.e., Emotional closeness, Race homophily, Sex homophily, Average age of ties, and Offline contact with ties) and drug use for males. We found that the proportions of ties with whom males had discussed drug use with was positively related to drug use (β = .32, $p < .05$). We also found that the proportion of drug accepting network ties was associated positively with drug use (β

= .25, $p < .05$). We found no relationship between drug use opinion importance and drug use.

Female participants who identified as Asian reported less drug use ($\beta = -.08$, $p < .05$) than White females, while those who identified as "Other" reported more drug use ($\beta = .18$, $p < .05$) than White females. Density and total peer ties were not related to drug use. Race homophily was associated positively with drug use ($\beta = .07$, $p < .05$). We did not find a relationship between any other interactional network characteristics (i.e., emotional closeness, sex homophily, average age of ties, or offline contact with ties) and drug use. Similar to males, we found that discussion of drugs with network ties ($\beta = .25$, $p < .05$) and drug accepting network ties ($\beta = .17$, $p < .05$) was related positively to drug use among female participants. We found no relationship between drug use opinion importance and drug use for female participants.

When we compared the observed associations between the male and female models, we found that the relationship between the proportion of ties discussing drug use and personal drug use was stronger for males than for females ($t(2,146) = 3.54$, $p < .05$). This result also was found for the relationship between accepting drug use ties and drug use ($t(2,146) = 4.24$, $p < .05$). We noted no other differences by sex in the drug use model.

Discussion

Emerging adults spend a large amount of their day communicating with peers online (Lenhart 2010). Prior research has noted that, as part of these conversations, emerging adults may discuss potentially sensitive issues, such as substance use (Moreno et al. 2009). These online exchanges have resulted in the formation of online social networks and norms, with recent evidence suggesting that substance use discussions in online social networks may be related to personal substance use among emerging adults (Stoddard et al. 2012). Given that online social networks have become an important component of emerging adult life, we sought to examine whether emerging adults' online networks were related to personal substance use. Overall, our findings are consistent with the literature on substance use and offline social networks, suggesting that structural, interactional and functional characteristics of online social networks are associated with substance use during emerging adulthood. The influence of emerging adults' online networks on their substance use, however, varied by the type of substance used (alcohol versus illicit drug use) and sex (male/female) of the participant.

Our findings indicate that for alcohol use, dense and emotionally close online networks are associated with more use. Researchers have noted that network density (Haynie 2001), close friend drinking (Larimer et al. 2004) and a drinking buddy culture (Reifman et al. 2006) are associated with alcohol use. In the context of online interactions, researchers have found that emerging adults post pictures and discussions of alcohol on social networking sites indicating that the social experience of alcohol use may extend to online networks (Moreno et al.2010). These online discussions also have been found to encourage permissive norms regarding alcohol use (Stoddard et al. 2012). Extending this work, we find that online networks' structural characteristics may also influence emerging adults' alcohol use. Youth in dense networks were more likely to report greater alcohol use in the past 30 days, even after accounting for network size.

Interestingly, our sex-specific analyses indicated that network density was associated with alcohol use for males but not for females. This finding is consistent with prior evidence reporting that males use social drinking as a way to bond more often than females, and more likely to develop networks of friends who drink alcohol (Barbee et al. 1990; Nezlek et al.

1994; Thombs et al. 1993). Female youth, on the other hand, reported more frequent alcohol use if they nominated a greater number of online ties. One plausible interpretation for this finding is that females with larger social networks may be more likely to be invited to social activities where alcohol is present. This interpretation is further supported by the relationship between alcohol use and participants' in-person contact with online network ties. Though many of the individuals in our sample interact with network members both online and offline, we do not know how often their online *and* offline communication occurs. Thus, the dynamics of who is in an emerging adult online social network and the extent to which they interact with these network members online and offline is important to consider when thinking about the relationship between interactional network characteristics and alcohol use among emerging adults. Future research that examines more closely the compositions and interactions of on- and off line networks may be useful to better understand how social networks influence alcohol use. From an intervention standpoint, our results concerning alcohol use align with the larger body of literature on offline social networks and emerging adult alcohol consumption, and suggest that online networks also may be a suitable venue to implement alcohol abuse prevention programs, particularly given its overlaps with emerging adults' offline networks.

When we examined emerging adults' drug use behaviors, we found that the structure (i.e., total proportion of peer ties) and function of their online network (i.e., drug use discussion ties and accepting ties) were associated with personal drug use. This is consistent with the literature on offline networks and substance use (Bauman and Ennett 1996; Kobus and Henry 2010; Valente et al. 2004). Denser networks are associated with more individual substance use (Ennett and Bauman 1993; Pearson and Michell 2000); however, these results only were supported for males. This result is consistent with prior findings indicating that emerging adult females tend to have less risky peer networks than males (Cubbins and Tanfer 2000). Although these previous findings focus on face-to-face social networks, their applicability to our findings is remarkably similar. Nevertheless, it appears from our results that males' online networks are either more influential on their drug use than females', or they select online network relationships that match their behavior more often than females. Regardless, these results suggest that online interventions for emerging adult substance use prevention may need to be tailored differently for males and females.

Interestingly, when we examined participants' interactional network characteristics, we found no association between drug use and the content (i.e., average age of online network ties and the proportion of online ties with whom participants interact offline), intensity (i.e., emotional closeness) and sex homophily components. In sex-stratified models, we found some evidence that race homophily was associated with drug use for female participants; however, it remains unclear how having a greater racially diverse network may increase female youth's substance use. Future research examining whether this finding is attributable to confounding may be warranted; for example, racial heterogeneity in this context may serve as a proxy for participants' living situation and physical closeness to network ties (e.g., living in an urban area, where both drug prevalence and racial diversity are more common, may influence participants' social network composition and likelihood of being exposed to substances).

Functional characteristics were associated with drug use. These relationships, however, varied by sex, with the influence of ties' discussions and acceptance of drug use on participants' behavior being greater for males than for females. Consistent with prior evidence indicating that females tend to drink less than males and have peer networks that use less alcohol than males (Adams and Nagoshi 1999; Lewis and Neighbors 2004; Nagoshi et al.1994), our results indicate that the influence of norms on drug use may operate in a similar manner. One possible interpretation for these findings may be that females are

criticized and/or stigmatized more heavily than males for using drugs. As a result, they may be more cautious about discussing substance use issues in their social networks (Felmlee 1999). Furthermore, it is also plausible that females engage in fewer conversations regarding personal drug use with peers given that they are less likely than males to use substances in general. Future research that examines the differences between dynamic online networks and bounded social networks for emerging adults may help tease apart factors contributing to emerging adult substance use and tailor prevention programs accordingly.

Although our study provides one of the first national samples using a systematic online sampling strategy and examining online network influences on emerging adult substance use, several study limitations require attention. First, because the design of the study was cross-sectional, causal inference cannot be established. A longitudinal design could help researchers better understand the temporal ordering between social norms and drug use in online social networks. Second, we used ego social networks, which can provide vital information regarding social norms and emerging adult drug use; however, the use of socio-centric networks, which examines all linkages within a bounded area (e.g., school or neighborhood), could provide us with additional information regarding the location of an individual within a social network (e.g., social position, distance, centrality) and how online social norms may effect drug use. Third, missing data was a limitation of this study. We found some differences between respondents with missing data compared to those included in the study, but many of the key study variables did not differ and our attrition was not large. Finally, we did not measure functional characteristics regarding alcohol use (e.g., discussion, acceptance, importance of opinion) in our survey given its prevalence and permissiveness in this population. Considering the noted relationships for substance use, however, it may be useful to test and evaluate explicitly whether online functional network characteristics influence youth alcohol use.

These limitations notwithstanding, this study provides useful insight on the relationship between online networks characteristics and emerging adult drug use. The completely online format of the study allowed us to utilize a national sample of emerging adults from across the country, which has provided a better understanding of substance use behavior more broadly. In addition, due to the increased use of social network sites among emerging adults, the use of this format for data collection and educational interventions may be an effective way to reach the emerging adult population. To this end, future studies may want to examine the features of online networks that may be particularly effective for substance use intervention design.

This study contributes to our understanding of social influences on emerging adult substance use in several critical ways. First, this study is one of the only to study specifically online social network characteristics and substance use among emerging adults. Interestingly, we found that online networks may contribute to individual drug use among emerging adults. Second, our sample included a more representative population of emerging adults than studies of college students. Our sample also included emerging adults working, attending post-secondary education in non-traditional ways, and pursuing alternative educational opportunities. This allowed us to provide valuable information about emerging adult social networks and substance use more broadly. Third, we included information about drug and alcohol use while many studies of emerging adult social networks have focused only on alcohol use using college samples. Finally, we used a completely online format to recruit participants. Due to the increased use of social network sites among emerging adults and the increasing difficulty to conduct mail, telephone, and in-person survey data collection methods, online data collection may become an invaluable tool. Thus, our study not only provides a substantive contribution to the research literature, but also provides an example of an innovative survey methodology for the 21st century. Our findings also suggest that

social networking sites may be a place to consider substance use prevention activities that can both focus on sub-populations and address structural, interactional, and functional characteristics of emerging adult online networks.

Acknowledgments

This research was supported by an award from the National Institute on Drug Abuse to Drs. Zimmerman and Bauermeister (5RC1DA028061-02; 'Virtual Network Influences on Young Adults' Alcohol and Drug Use'). Dr. Bauermeister is supported by a Career Development Award from the National Institute of Mental Health (K01-MH087242). Views expressed in this manuscript do not necessarily represent the views of the funding agencies.

SC participated in the data analysis, interpretation of the data and drafted the manuscript. JB conceived the study, participated in its design and coordination and data analysis, and helped draft the manuscript. DM participated in the data analysis, interpretation of the data, and helped to draft the manuscript. MZ participated in the study design and coordination and helped draft the manuscript. All authors read and approved the final manuscript.

Author Biographies

Stephanie Cook is a doctoral candidate in the Sociomedical Sciences Department at Columbia University's Mailman School of Public Health. She is currently a Ruth Kirschstein Individual National Research Service Award Fellow. Stephanie received her BA in psychology and women's studies from the University of Michigan-Ann Arbor in 2005. She received her MPH from Columbia University in the Department of Sociomedical Sciences-Research Track in 2008. Her substantive foci are young adult sexual health, gender, trauma, and mental health. Her methodological interests are in survey research design, structured diary design and community-based research. Stephanie's dissertation entitled, "Psychological Distress, Sexual Behavior, and Adult Attachment among Young Black Men who Have Sex with Men (YBMSM)," focuses on better understanding the relationship between mental health and sexual behavior with significant attention paid to examining adult attachment as a moderator of this relationship.

Jose Bauermeister is the John G. Searle Assistant Professor in Health Behavior and Health Education and Director of the Sexuality & Health Lab (SexLab) at the University of Michigan's School of Public Health. His primary research interests focus on sexuality and health, and interpersonal prevention and health promotion strategies for high-risk adolescents and young adults. He is Principal Investigator of a NIH K01 grant to examine HIV/AIDS risk among young men who have sex with men (YMSM), and Co-Principal Investigator of the Virtual Network Study. Dr. Bauermeister is member of the Editorial Board of the Journal of Youth & Adolescence, AIDS & Behavior, and Archives of Sexual Behavior.

Deborah Gordon-Messer is the Project Manager and a Research Associate for the Virtual Networks Study at the University of Michigan School of Public Health. She holds a BA in Sociology and Biology from Wesleyan University and completed her MPH at the University of Michigan department of Health Behavior and Health Education. Deborah has worked both internationally and in the U.S. on program coordination, community development and health curriculum design. Her research interests focus on adolescent and young adult health and well-being.

Marc Zimmerman is Chair and Professor in the Department of Health Behavior and Health Education at the University of Michigan School of Public Health. Dr. Zimmerman's research focuses on adolescent health and resiliency and empowerment theory. His work on adolescent health examines how positive factors in adolescent's lives help them overcome risks they face. His research includes analysis of adolescent resiliency for risks associated with alcohol and drug use, violent behavior, precocious sexual behavior, and school failure.

He is also studying developmental transitions and longitudinal models of change. Dr. Zimmerman's work on empowerment theory includes measurement and analysis of psychological and community empowerment. The research includes both longitudinal interview studies and community intervention research. Dr. Zimmerman is the Director of the CDC funded Prevention Research Center of Michigan. He is also the Principal Investigator for the CDC funded Youth Violence Prevention Center. Dr. Zimmerman is the Editor of Youth & Society and is a member of the editorial board for Health Education Research.

References

Adams CE, Nagoshi CT. Changes over one semester in drinking game playing and alcohol use and problems in a college student sample. Substance Abuse. 1999; 20:97–106. [PubMed: 12511824]

Andrews JA, Tildesley E, Hops H, Li F. The influence of peers on young adult substance use. Health Psychology. 2002; 21:349–357. [PubMed: 12090677]

Banks SM, Pandiani JA, Schacht LM, Gauvin LM. Age and mortality among white male problem drinkers. Addiction. 2000; 95:1249–1254. [PubMed: 11092072]

Barbee AP, Gulley MR, Cunningham MR. Support seeking in personal relationships. Journal of Social and Personal Relationships. 1990; 7:531–540.

Bauermeister JA, Zimmerman MA, Barnett TE, Caldwell CH. Working in high school and adaptation in the transition to young adulthood among African American youth. Journal of Youth and Adolescence. 2007; 36:877–890.

Bauermeister JA, Zimmerman MA, Johns MM, Glowacki P, Stoddard S, Volz E. Innovative recruitment using online netowkrs: Lessons learned from an online study of alcohol and other drug use utilizing a web-based Respondent Driven Sampling (webRDS) strategy. Journal of Studies on Alcohol and Drugs. 2012; 73:834–838. [PubMed: 22846248]

Bauman KE, Ennett ST. On the importance of peer influence for adolescent drug use: Commonly neglected considerations. Addiction. 1996; 91:185–198. [PubMed: 8835276]

Borgatti SP, Mehra A, Brass DJ, Labianca G. Network analysis in the social sciences. Science. 2009; 323:892–895. [PubMed: 19213908]

Borsari B, Carey KB. Peer influences on college drinking: A review of the research. Journal of Substance Abuse. 2001; 13:391–424. [PubMed: 11775073]

Borsari B, Carey KB. How the quality of peer relationships influences college alcohol use. Drug and Alcohol Review. 2006; 25:361–370. [PubMed: 16854663]

Braun BL, Hannan P, Wolfson M, Jones-Webb R, Sidney S. Occupational attainment, smoking, alcohol intake, and marijuana use: Ethnic-gender differences in the cardia study. Addictive Behaviors. 2000; 25:399–414. [PubMed: 10890293]

Bray, JW.; Galvin, DM.; Cluff, LA. Young adults in the workplace: A multisite initiative of substance use prevention programs. RTI International; Research Triangle Park, NC: 2011. p. 1-101.

CDC. Youth risk behavior surveillance—United States, 2009. Morbidity and Mortality Weekly Report. 2010; 59:1–142. [PubMed: 20075837]

Cerwonka ER, Isbell TR, Hansen CE. Psychosocial factors as predictors of unsafe sexual practices among young adults. AIDS Education and Prevention. 2000; 12:141–153. [PubMed: 10833039]

Cialdini RB, Reno RR, Kallgren CA. A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. Journal of Personality and Social Psychology. 1990; 58:1015–1026.

Cohen, J.; Cohen, P.; West, SG.; Aiken, L. Applied multiple regression/correlation analysis for the behavioral sciences. Lawrence Erlbaum Associates; Mahwah, NJ: 2003.

Cox JM, Bates SB. Referent group proximity, social norms, and context: Alcohol use in a low-use environment. Journal of American College Health. 2011; 59:252–259. [PubMed: 21308584]

Cubbins LA, Tanfer K. The influence of gender on sex: A study of men's and women's self-reported high-risk sex behavior. Archives of Sexual Behavior. 2000; 29:229–257. [PubMed: 10992980]

Donato F, Monarca S, Chiesa R, Feretti D, Nardi G. Smoking among high school students in 10 Italian towns: Patterns and covariates. Substance Use and Misuse. 1994; 29:1537–1557.

Ennett ST, Bauman KE. Peer group structure and adolescent cigarette smoking: A social network analysis. Journal of Health and Social Behavior. 1993; 34:226–236. [PubMed: 7989667]

Ennett ST, Bauman KE. The contribution of influence and selection to adolescent peer group homogeneity: The case of adolescent cigarette smoking. Journal of Personality and Social Psychology. 1994; 67:653–663. [PubMed: 7965611]

Fang X, Li X, Stanton B, Dong Q. Social network positions and smoking experimentation among Chinese adolescents. American Journal of Health Behavior. 2003; 27:257–267. [PubMed: 12751622]

Felmlee DH. Social norms in same-and cross-gender friendships. Social Psychology Quarterly. 1999; 62:53–67.

Fergusson DM, Horwood L. Early onset cannabis use and psychosocial adjustment in young adults. Addiction. 1997; 92:279–296. [PubMed: 9219390]

Franken RE, Gibson KJ, Mohan P. Sensation seeking and disclosure to close and casual friends. Personality and Individual Differences. 1990; 11:829–832.

Fujimoto K, Valente TW. Decomposing the components of friendship and friends' influence on adolescent drinking and smoking. Journal of Adolescent Health. 2012; 51:136–143. [PubMed: 22824443]

Galea S, Nandi A, Vlahov D. The social epidemiology of substance use. Epidemiologic Reviews. 2004; 26(1):36–52. [PubMed: 15234946]

Giordano PC. Relationships in adolescence. Annual Review of Sociology. 2003; 29:257–281.

Hartzler B, Fromme K. Heavy episodic drinking and college entrance. Journal of Drug Education. 2003; 33:259–274. [PubMed: 15022860]

Haynie DL. Delinquent peers revisited: Does network structure matter? American Journal of Sociology. 2001; 106:1013–1057.

Henrich CC, Kuperminc GP, Sack A, Blatt SJ, Leadbeater BJ. Characteristics and homogeneity of early adolescent friendship groups: A comparison of male and female clique and nonclique members. Applied Developmental Science. 2000; 4:15–26.

Henry DB, Kobus K. Early adolescent social networks and substance use. The Journal of Early Adolescence. 2007; 27:346–362.

Hussong AM. Differentiating peer contexts and risk for adolescent substance use. Journal of Youth and Adolescence. 2002; 31:207–220.

Israel BA. Social networks and health status: Linking theory, research, and practice. Patient Counselling and Health Education. 1988; 4:65–79. [PubMed: 10258419]

Johnston, LD.; O'Malley, PA.; Bachman, JG.; Schulenberg, JE. Monitoring the future: National survey results on drug use, 1975–2008: Volume II, College students and adults ages 19–50. National Institute on Drug Abuse; Bethesda, MD: 2009. (NIH Publication No. 09-7403).

Karwacki SB, Bradley JR. Coping, drinking motives, goal attainment expectancies and family models in relation to alcohol use among college students. Journal of Drug Education. 1996; 26:243–255. [PubMed: 8952209]

Kilmer JR, Walker DD, Lee CM, Palmer RS, Mallett KA, Fabiano P, et al. Misperceptions of college student marijuana use: Implications for prevention. Journal of Studies on Alcohol. 2006; 67:277–281. [PubMed: 16562410]

Kobus K, Henry DB. Interplay of network position and peer substance use in early adolescent cigarette, alcohol, and marijuana use. The Journal of Early Adolescence. 2010; 30:225–245.

Krackhardt D, Stern RN. Informal networks and organizational crises: An experimental simulation. Social Psychology Quarterly. 1988; 51:123–140.

LaBrie JW, Hummer JF, Neighbors C, Larimer ME. Whose opinion matters? The relationship between injunctive norms and alcohol consequences in college students. Addictive Behaviors. 2010; 35:343–349. [PubMed: 20045262]

Larimer ME, Turner AP, Mallett KA, Geisner IM. Predicting drinking behavior and alcohol-related problems among fraternity and sorority members: Examining the role of descriptive and injunctive norms. Psychology of Addictive Behaviors. 2004; 18:203–212. [PubMed: 15482075]

Lenhart, A.; Purcell, K.; Smith, A.; Zickuhr, K. Social media & mobile internet use among teens and young adults. Pew Internet & American Life Project; Washington, DC: 2010.

Lewis MA, Neighbors C. Gender-specific misperceptions of college student drinking norms. Psychology of Addictive Behaviors. 2004; 18:334–339. [PubMed: 15631605]

Madden, M.; Zickuhr, K. 65% of online adults use social networking sites. Pew Internet & American Life; Washington, DC: 2011.

Mason MJ, Valente TW, Coatsworth JD, Mennis J, Lawrence F, Zelenak P. Place-based social network quality and correlates of substance use among urban adolescents. Journal of adolescence. 2010; 33:419–427. [PubMed: 19665785]

Mazur E, Richards L. Adolescents' and emerging adults' social networking online: Homophily or diversity? Journal of Applied Developmental Psychology. 2011; 32:180–188.

McPherson M, Smith-Lovin L, Cook JM. Birds of a feather: Homophily in social networks. Annual Review of Sociology. 2001; 27:415–444.

Mennis J, Mason MJ. Social and geographic contexts of adolescent substance use: The moderating effects of age and gender. Social Networks. 2012; 34:150–157.

Moreno MA, Parks MR, Zimmerman FJ, Brito TE, Christakis DA. Display of health risk behaviors on MySpace by adolescents: Prevalence and associations. Archives of Pediatrics and Adolescent Medicine. 2009; 163:27–34. [PubMed: 19124700]

Moreno MA, Briner LR, Williams A, Brockman L, Walker L, Christakis DA. A content analysis of displayed alcohol references on a social networking web site. Journal of Adolescent Health. 2010; 47(2):168–175. [PubMed: 20638009]

Moreno MA, Christakis DA, Egan KG, Brockman LN, Becker T. Associations between displayed alcohol references on Facebook and problem drinking among college students. Archives of Pediatrics and Adolescent Medicine. 2011; 166(2):157–163. [PubMed: 21969360]

Nagoshi CT, Wood MD, Cote CC, Abbit SM. College drinking game participation within the context of other predictors of alcohol use and problems. Psychology of Addictive Behaviors. 1994; 8:203–213.

Neighbors C, Geisner IM, Lee CM. Perceived marijuana norms and social expectancies among entering college student marijuana users. Psychology of Addictive Behaviors. 2008; 22:433–438. [PubMed: 18778137]

Netting NS, Burnett ML. Twenty years of student sexual behavior: Subcultural adaptations to a changing health environment. Adolescence. 2004; 39:19–38. [PubMed: 15230063]

Nezlek JB, Pilkington CJ, Bilbro KG. Moderation in excess: Binge drinking and social interaction among college students. Journal of Studies on Alcohol and Drug Use. 1994; 54:342–351.

Page RM, Roland M. Misperceptions of the prevalence of marijuana use among college students: Athletes and non-athletes. Journal of Child & Adolescent Substance Abuse. 2004; 14:61–75.

Pearson M, Michell L. Smoke rings: Social network analysis of friendship groups, smoking and drug-taking. Drugs: Education Prevention, and Policy. 2000; 7:21–37.

Pearson M, West P. Drifting smoke rings. Connections. 2003; 25:59–76.

Perkins HW, Meilman PW, Leichliter JS, Cashin JR, Presley CA. Misperceptions of the norms for the frequency of alcohol and other drug use on college campuses. Journal of American College Health. 1999; 47:253–258. [PubMed: 10368559]

Rai AA, Stanton B, Wu Y, Li X, Galbraith J, Cottrell L, et al. Relative influences of perceived parental monitoring and perceived peer involvement on adolescent risk behaviors: an analysis of six cross-sectional data sets. Journal of Adolescent Health. 2003; 33:108–118. [PubMed: 12890602]

Randolph ME, Torres H, Gore-Felton C, Lloyd B, McGarvey EL. Alcohol use and sexual risk behavior among college students: Understanding gender and ethnic differences. The American Journal of Drug and Alcohol Abuse. 2009; 35:80–84. [PubMed: 19253158]

Reifman A, Watson WK, McCourt A. Social networks and college drinking: Probing processes of social influence and selection. Personality and Social Psychology Bulleting. 2006; 32:820–832.

Ridout B, Campbell A, Ellis L. 'Off your Face (book)': Alcohol in online social identity construction and its relation to problem drinking in university students. Drug and Alcohol Review. 2012; 31:20–26. [PubMed: 21355935]

Rokach A, Orzeck T. Coping with loneliness and drug use in young adults. Social Indicators Research. 2003; 61(3):259–283.

Simons JS, Neal DJ, Gaher RM. Risk for marijuana-related problems among college students: An application of zero-inflated negative binomial regression. The American Journal of Drug and Alcohol Abuse. 2006; 32:41–53. [PubMed: 16450642]

Smith KP, Christakis NA. Social networks and health. Annual Review of Sociology. 2008; 34:405–429.

Stoddard S, Bauermeister JA, Gordon-Messer D, Johns MM, Zimmerman MA. Permissive norms and young adults' alcohol and marijuana use: The role of online communities. Journal of Studies on Alcohol. 2012; 73:968–975.

Stone AL, Becker LG, Huber AM, Catalano RF. Review of risk and protective factors of substance use and problem use in emerging adulthood. Addictive Behaviors. 2012; 37:747–775. [PubMed: 22445418]

Thombs DL, Beck KH, Mahoney CA. Effects of social context and gender on drinking patterns of young adults. Journal of Counseling Psychology. 1993; 40:115–119.

Urberg KA, Degirmencioglu SM, Pilgrim C. Close friend and group influence on adolescent cigarette smoking and alcohol use. Developmental Psychology. 1997; 33:834–844. [PubMed: 9300216]

Valente TW, Gallaher P, Mouttapa M. Using social networks to understand and prevent substance use: A transdisciplinary perspective. Substance Use and Misuse. 2004; 39:1685–1712. [PubMed: 15587948]

White HR, McMorris BJ, Catalano RF, Fleming CB, Haggerty KP, Abbott RD. Increases in alcohol and marijuana use during the transition out of high school into emerging adulthood: The effects of leaving home, going to college, and high school protective factors. Journal of Studies on Alcohol. 2006; 67:810–822. [PubMed: 17060997]

Wiggins B, Wiggins JA. Specification of the association between sociability and drinking level among college students. Journal of Studies on Alcohol. 1992; 53:137–141. [PubMed: 1560665]

Williams DG. Gender, masculinity-femininity, and emotional intimacy in same-sex friendship. Sex Roles. 1985; 12:587–600.

Windle M. Parental, sibling, and peer influences on adolescent substance use and alcohol problems. Applied Developmental Science. 2000; 4:98–110.

Wolfson S. Students' estimates of the prevalence of drug use: Evidence for a false consensus effect. Psychology of Addictive Behaviors. 2000; 14:295–298. [PubMed: 10998955]

J Youth Adolesc. Author manuscript; available in PMC 2014 November 01.

Table 1

Descriptive statistics for male and female emerging adults

Variable	Males (N = 1,132) M (SD)/N (%)	Females (N = 1,018) M (SD)/N (%)	Total (N = 2,150) M (SD)/N (%)	t/χ^2
Female	–	–	1,018 (47.3 %)	–
Race				1.54
Black	50 (4.4 %)	54 (5.3 %)	104 (4.8 %)	
White	805 (71.1 %)	712 (69.9 %)	1,517 (70.6 %)	
Asian	129 (11.4 %)	118 (11.6 %)	247 (11.5 %)	
Hispanic/Latino	99 (8.7 %)	84 (8.3 %)	183 (8.5 %)	
Other	49 (4.3 %)	50 (4.9 %)	99 (4.6 %)	
Age	20.69 (1.73)	20.70 (1.76)	20.7 (1.74)	−0.22
Completed high school	1,080 (95.4 %)	990 (97.2 %)	2,070 (96.3 %)	5.08 *
Density	0.84 (0.18)	0.82 (0.18)	0.83 (0.18)	2.86 *
Total peer ties	3.85 (1.30)	3.76 (1.20)	3.81 (1.26)	1.63
Emotional closeness	2.57 (0.39)	2.63 (0.36)	2.60 (0.38)	−3.61 *
Race homophily	−0.53 (0.68)	−0.52 (0.68)	−0.53 (0.68)	−0.20
Sex homophily	−0.32 (0.59)	−0.34 (0.57)	−0.33 (0.58)	1.16
Avg. age of ties	20.45 (2.63)	20.80 (2.73)	20.62 (2.69)	−3.01 *
Offline contact w/ties	0.78 (0.30)	0.74 (0.30)	0.76 (0.30)	3.76 *
Injunctive drug norms				
Opinion ties	0.59 (0.42)	0.69 (0.38)	0.64 (0.41)	−5.22 *
Discuss ties	0.48 (0.44)	0.51 (0.43)	0.50 (0.43)	−1.37
Accept ties	0.65 (0.39)	0.49 (0.40)	0.58 (0.40)	9.14 *
Drug use[a]	0.45 (0.85)	0.31 (0.67)	0.38 (0.77)	4.22 *
Alcohol use	2.88 (1.62)	2.70 (1.40)	2.80 (1.52)	2.81 *

* $p < .05$

[a] Drug use is presented in its raw form in the above table for descriptive purposes. Due to the skewed distribution of this variable, we used the log10 transformation in the multivariate analysis

Table 2

Multivariate regression predicting frequency of alcohol use in the last 30 days

Network characteristics	Variable	Full sample (n = 2,150)		Male (N = 1,132)		Female (N = 1,018)		$T_{\Delta b}$
		b	SE	b	SE	b	SE	
Participant demographics	Female	−0.19*	0.06	–	–	–	–	–
	Black	−0.55*	0.15	−0.60*	0.23	−0.53*	0.20	−0.23
	Asian	−0.74*	0.10	−0.73*	0.15	−0.76*	0.14	0.15
	Latino	−0.38*	0.13	−0.34	0.18	−0.42	0.17	–
	Other	0.15	0.33	0.37	0.47	0.02	0.48	–
	Age	0.14*	0.02	0.17*	0.03	0.11*	0.03	1.41
	Completed high school	0.62*	0.17	0.66*	0.22	0.45*	0.26	0.67
Structural	Density	0.46*	0.20	0.60*	0.29	0.29	0.27	–
	Total peer ties	0.11*	0.03	0.09*	0.04	0.13*	0.04	−0.71
Interactional	Emotional closeness	0.44*	0.09	0.48*	0.13	0.39*	0.13	0.49
	Race homophily	−0.01	0.05	−0.01	0.08	0.11	0.07	–
	Sex homophily	−0.03	0.05	−0.04	0.08	−0.07	0.08	–
	Avg. age of ties	0.03	0.01	0.04	0.02	−0.01	0.02	–
	Offline contact w/ties	0.42*	0.12	0.35*	0.16	0.43*	0.16	−0.35
	R^2	0.10		0.12		0.08		

* $p < .05$

Table 3

Multivariate regression predicting number of drugs used in the last 30 days log transformed

Network characteristics	Variable	Full sample (n = 2,150)		Male (N = 1,132)		Female (N = 1,018)		$T_{\Delta b}$
		b	SE	b	SE	b	SE	
Participant demographics	Female	−0.02*	0.01	–	–	–	–	–
	Black	−0.03	0.02	−0.01	0.02	−0.05	0.02	–
	Asian	−0.03*	0.01	−0.02	0.02	−0.04*	0.01	–
	Latino	0.01	0	0.01	0.02	−0.01	0.02	–
	Other	0.27*	0.04	0.24*	0.05	0.32*	0.05	−1.13
	Age	0.01	0.01	0.01	0.01	−0.01	0	-
	Completed high school	0.01	0.02	0.02	0.02	−0.03	0.03	–
Structural	Density	0.01	0.02	0.07*	0.03	−0.05	0.03	–
	Total peer ties	0.01*	0.01	0.01*	0.01	0.01	0.01	–
Interactional	Emotional closeness	0.01	0.01	0.01	0.01	0.01	0.01	–
	Race homophily	0.01	0.01	0.01	0.01	0.02*	0.02	–
	Sex homophily	0.01	0.01	0.01	0.01	−0.01	.01	–
	Avg. age of ties	0.01	0.01	0.01	0.01	0.01	0.01	–
	Offline contact w/ties	0.02	0.01	0.02	0.02	0.01	0.02	–
Functional	Opinion ties	0.01	0.01	0.01	0.01	0.02	0.01	–
	Discuss ties	0.12*	0.01	0.14*	0.01	0.09*	0.01	3.54*
	Accepting ties	0.09*	0.01	0.12*	0.01	0.06*	0.01	4.24*
	R^2		0.23	0.26		0.18		

* $p < .05$