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Peer acceleration: effects of a social network tailored substance abuse prevention program among high-risk adolescents

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ABSTRACT

Objective To test whether a social network tailored substance abuse prevention program can reduce substance use among high-risk adolescents without creating deviancy training (iatrogenic effects). **Methods** A classroom randomized controlled trial comparing control classes with those receiving an evidence-based substance use prevention program [Towards No Drug Abuse (TND)] and TND Network, a peer-led interactive version of TND. Students ($n = 541$, mean age 16.3 years) in 75 classes from 14 alternative high schools completed surveys before and approximately 1 year after curriculum delivery. Past-month use of tobacco, alcohol, marijuana and cocaine were assessed. **Results** Overall, TND Network was effective in reducing substance use. However, the program effect interacted with peer influence and was effective mainly for students who had peer networks that did not use substances. Students with classroom friends who use substances were more likely to increase their use. **Conclusions** A peer-led interactive substance abuse prevention program can accelerate peer influences. For students with a peer environment that supports non-use, the program was effective and reduced substance use. For students with a peer environment that supports substance use, an interactive program may have deleterious effects.

Keywords Adolescents, peer influence, students, social networks, school-based prevention, substance use.

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INTRODUCTION

Substance abuse is a major public health problem in the United States often addressed with school-based prevention programs. Successful programs have been created and implemented, but many have had limited success because they have not incorporated adequately the power and influence of peer social networks. Social networks have been shown repeatedly to be a significant covariate of adolescent substance use. However, most programs incorporate peer influence factors only tangentially, primarily through role modeling and resistance skills training [1–4].

Our prior work showed that using network information to structure a school-based tobacco prevention program increased its effectiveness [4,5]. The statistical analysis revealed a program × network interaction such that the network condition, in which peers were assigned to groups based on their social networks, was more effective in the culturally tailored curriculum than in the traditional social influences condition. Specifically, the culturally tailored program was effective in preventing smoking if students participated in the activities in groups composed of their social network members. However, a traditional social influences program did not appear to be more effective when students participated in groups with their social network members. A significant research and practice question emerging from this prior study was: to what degree is any network tailoring effect dependent on the program within which it is embedded? Consequently, in this study we tailored an existing evidence-based curriculum with network information, keeping program content constant.

A second aim of this study was to understand whether peer aggregation has deleterious effects on substance use outcomes. There has been concern expressed in numerous studies that aggregating adolescents, particularly high-risk adolescents, creates iatrogenic effects in prevention programs resulting in increased deviant behavior [6]. To address these specific aims, this study implemented two substance abuse prevention programs, an existing evidence-based curriculum and a modified version intended to increase peer interaction. The study was designed to test whether peer interaction can improve curriculum outcomes without creating deviancy training.

Background

A variety of approaches have been used to delay illicit substance abuse or reduce it for those who have already started. Early prevention programs were focused primarily on disseminating information about the ill effects of substance use with little success [7]. More recently, programs have taught life skills, resistance skills and re-norming, correcting the misperception that substance use is normative. In addition, curricula have been designed to improve mediators such as self-esteem, self-efficacy, media literacy and resistance skills, among others [8–14].

The social influences approach has become the accepted standard for school-based programs. A recent large-scale, long-term replication of the social influences approach in Washington State, however, found that it was not effective at preventing cigarette use [15]. The Hutchinson Smoking Prevention Project intervened on a cohort from grades 3 to 10 and assessed smoking at 2 years post-intervention. Examination of the curriculum, however, showed that it was implemented by trained teachers without the assistance of peer leaders. Further, group activities such as drama did not allow students to participate with friends, and interactive exercises were not implemented within naturally occurring groups. Thus, while the study was well implemented [16,17], the lack of attention to peer networks or their use in program implementation may have weakened its effectiveness. Further, several researchers have questioned the study's conclusions [18–20], asserting that school-based programs are still valuable in reducing tobacco uptake. Reviews by Bruvold [21], Sussman [7] and Gottfredson & Wilson [22] have indicated that school-based programs can reduce substance use by 25–50%.

Project TND (Towards No Drug Abuse) is a carefully constructed and evaluated program that has been demonstrated in empirical trials to reduce 1-year self-reported use of alcohol, tobacco and hard drugs among a large sample of high-risk youth. Unlike many other purely social influence-based programs, TND focuses on motivation, skills and decision making [3]. Although TND addresses the social environment, it devotes only minimal attention to re-norming and does not instruct refusal skill training, hallmarks of social influence programs. In a series of empirical evaluations of TND, Sussman and colleagues have demonstrated that TND reduces substance use among adolescents both in immediate and long-term (1 year) follow-up. They have also demonstrated that TND is effective among regular high school youth and high-risk youth who attend alternative high schools [23]. TND has shown effects on the prevention of cigarette smoking, alcohol use, marijuana use and hard drug use, over at least a 1-year follow-up, considered across three experimental trials [24]. TND uses a school-based, lesson delivery model consisting of 12 lessons. Each lesson is designed to teach specific cognitive, motivational or behavioral skills that can lead to reductions in substance use [25].

In the present study, the TND curriculum was modified to increase the number of group activities and to create small groups (three to five students) composed of their own social network members. In addition, each group was led by a peer leader chosen by their peers. The traditional form of TND has interactive discussions led by a health educator or a trained classroom teacher conducted at the classroom level whereas the modified version, TND Network, encourages small-group discussions in groups created from naturally occurring friendships and led by a student-chosen leader.

Peer leaders

Peer leaders have been used extensively in tobacco and substance use prevention programs [4,23,26–29]. Botvin and colleagues [30] found that the peer-led plus booster condition was the only intervention condition to affect substance use behavior with the Life Skills curriculum. In a meta-analytical review of substance abuse prevention programs, peer-led programs had a stronger effect size on all outcome measures [3]. According to Tobler [3], peer-led programs have been more effective at reducing substance use than programs lacking a peer component. Peer programs maintained a high effect size for alcohol, tobacco, soft drugs and hard drugs ([3], p. 537). Guidelines for implementing school-based prevention programs acknowledge that peer leaders are an important component of their effectiveness ([31], p. 358).

Programs based on a didactic approach or using a highly structured interaction approach may be less successful than those that build from and make use of naturally occurring affinity groups that arise within schools where adolescents select and reject friends ([32], p. 24).

This recommendation forms the basis for the network condition of this study by aggregating students based on their existing peer friendships. The network condition assigns students to group leaders based on whom they nominate as leaders. There are several reasons why this approach is expected to be more effective. First, peers are credible to the adolescent, so adolescents may be more likely to internalize information conveyed by peers they have nominated. Secondly, peer-delivered programs can create new norms. Norms created within peer groups may be more likely to persist outside the classroom setting. Thirdly, peers can deliver information in a less intimidating manner and use appropriate language. Fourthly, peer-led programs can be easier to implement and teens say that they like peer-led programs more than teacher-led programs ([32], p. 84). The challenges to implementing peer-led programs are variation in the quality of peer leadership capability and concern that high-risk leaders may convey undesirable messages ([33], p. 85). Not only the leaders, but also groups have the potential for reinforcing both positive and negative norms and thus must be put into place with care [33]. Although placing peers into groups might further programmatic objectives, it increases the likelihood of iatrogenic effects, or deviancy training [6].

Deviancy training

Even the most well-intentioned health promotion programs may have negative or unanticipated consequences, referred to as 'boomerang' or 'iatrogenic' effects. Negative effects occur when an intervention's design exacerbates the problem behavior it is supposed to improve. Dishion and colleagues [6] conducted a series of studies among high-risk youth evaluating interventions designed to address their problem behavior. Results showed that participation in peer groups with other high-risk youth resulted in a greater prevalence of the problem behavior. Dishion and colleagues [6] refer to this as deviancy training: '. . . youth with moderate levels of delinquency, and who had deviant friends, were those who escalated to more serious forms of antisocial behavior' ([6], p. 761). The studies by Dishion and colleagues were conducted among high-risk youth, making their results relevant to the current study because students participated with their peer groups, and these peer groups could intensify problem behaviors. For example, students who receive a prevention curriculum in groups of friends who favor drug use may be more likely to subsequently favor drug use and the method of curriculum delivery would have negative effects. Indeed, such an occurrence is plausible, as adolescents may take curriculum content and use it to promote substance abuse by parodying scripts in a pro-use manner. Deviancy training can occur both when problem adolescents are grouped with other problem adolescents and when problem adolescents are grouped with previously 'good' adolescents.

Whether intervention outcomes are positive or negative, both are predicated on the same underlying change mechanism of social influence. The rationale for using peer leaders and assigning them to groups is based upon the expectation that peers influence one another in a positive way. Other prevention program evaluations have not found deviancy-training effects [34], yet programs that encourage social contact logically run some risk of increasing the exposure to negative social influences. Although we expected that highly structured lesson plans and peer leader training would help to preclude deviancy training, this assumption must be tested. Indeed, both positive and negative effects of social influences must be acknowledged and, when possible, evaluated. Thus, the current study tests the theoretical processes underlying the network implementation model by testing for deviancy training in the TND Network condition.

Given the importance of peer influence in this study, we include measures that assess participants' peer environment. We include measures of the number of friends, number of friends in school, popularity, social support and friends' reports of their substance use behavior. The correlation of these constructs with substance use behavior in the context of a program designed to accelerate peer influence may provide clues to the etiology and prevention of substance use among high-risk adolescents. For example, social support has been associated with adolescent substance use, with researchers reporting that peer social support is associated positively with use and parental support associated negatively with use [35]. Peer social support, however, can also have positive effects. Social support was associated positively with intervention adherence among young people living with HIV [36] and has increased the effects of substance use treatment programs [37,38]. Social support, therefore, can provide an amplification of positive program effects as opposed to deviancy training. Social support may provide protection against deviancy training. The theoretical mechanism driving deviancy training is peer influence.

Adolescents with substance using friends are more likely to use substances than those who have non-using friends [39]. Deviancy training occurs when adolescents are placed in settings with peers who engage in more problem behaviors than the adolescent. In this study we recorded adolescent friendships and calculated the degree of substance use by each adolescent's peers. We can test for deviancy training by calculating whether students with peers who use substances are more likely to increase use as a consequence of receiving an interactive program. Deviancy training exists if substance use rates

increase in the network condition for students who have substance-abusing friends.

In sum, this study is designed to determine whether a peer led version of TND can be more effective than the non-peer version and whether deviancy training occurs when interactivity is added to program content. We test for program effects and deviancy training on current substance use 1 year after the program.

METHODS

School selection

We contacted 25 continuation high school districts in southern California to solicit participation. Of these 17 did not participate for various reasons: 10 refused, citing administrative concerns; seven were not used because the classroom populations were too small or some restriction was placed on access. Of the eight districts used for the study, one served as a pilot location and the remaining seven provided classrooms that could be assigned randomly to one of three conditions: control (prevention as usual), TND and TND Network. These seven school districts had 14 continuation high schools located in three counties.

Interventions

TND and TND Network are both 12-session programs delivered over a 3–4-week period, predominantly with classes taught on Tuesday, Wednesday and Thursday. Sixteen health educators were trained by program staff to teach TND and TND Network. The curricula were delivered to 47 classes over a 9-month period to at least 840 students. In many cases the same teachers taught both curricula and they were aware of which one they were teaching. We were careful, however, to stress that there was no preference for which curriculum was expected to be more effective.

TND network

Revisions in structure but not in content to Project TND were made to create more opportunity for group interaction in TND Network. Prior to the start of the project, peer leaders were identified using social network nominations. Students were asked to nominate their classmates who would make good leaders, and those who received the most nominations were selected. Peer leaders were taught how to facilitate group discussion, how to manage group interaction and encouraged to embrace antisubstance use norms. Normative restructuring about drug use was an essential part of the peer leader training. Leadership training took place on the Thursday or Friday before the curriculum began the following week and took approximately 1 hour. A manual was developed for health educators to use in the training.

In Project TND the classroom is divided randomly into two teams and a review game is played at the conclusion of each session. In the network version, the network-based groups were the teams and kept intact throughout the curriculum. Most sessions were revamped to allow for small-group discussion or brainstorming. For example, students role-played assertive communication strategies with their peer leader and group members. There is some expectation that both programs will be effective based on past experience and because they are intensive, meeting for an hour each day over 4 weeks, and the health educator represents a new and different teaching situation. Past studies of TND have shown a 27% prevalence reduction in 30-day cigarette use, 22% prevalence reduction in 30-day marijuana use, 26% prevalence reduction in 30-day hard drug use, 9% prevalence reduction in 30-day alcohol use among baseline drinkers and 25% prevalence reduction in 1-year weapons carrying among males [40], lasting 1–5 years post-program [25].

Measures

Students completed surveys in the classroom before the start of the program. At approximately 1-year follow-up those students still in school completed surveys in their classrooms, whereas students not in school completed the survey via telephone. We measured monthly use of tobacco, alcohol, marijuana and cocaine on 11-point scales with 1 = no use, and 2 = 1–10 times/month, 3 = 11–20 times/month, . . . 11 = 91 + times/month. These outcome measures were the same at baseline and at 1-year follow-up. In addition to use of each substance, we created a composite score by standardizing scores (with a mean of zero and standard deviation of 1) on the four substances and calculating the average across all four items.

For control variables we measured age, grade in school, gender, mother's education level and ethnicity. We included measures of network size by asking students to write the first names or initials of their five closest friends and additionally for each friend whether he/she was also a student at this school. Social support was measured at follow-up with 10 7-point Likert items such as 'I have friends in this school I can turn to for advice'. Social support was not measured at baseline for control group participants and so their immediate post-test social support scores (5 days after the program) were used. Social network data were collected by asking students to write the names of up to five other classmates they considered friends. A roster of the students in the class was provided and students wrote the names and roster numbers of each student they considered a friend. These

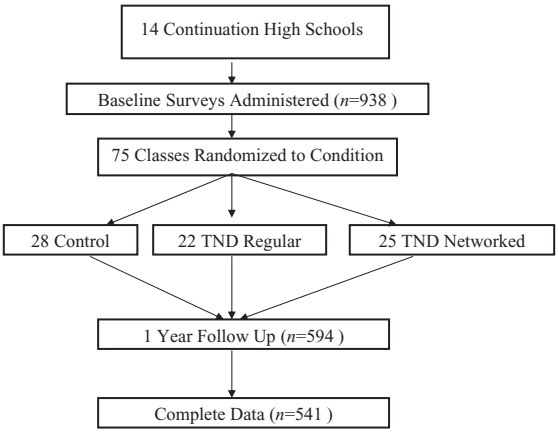

Figure 1 Study design

data provided measures of nominations sent and received. We also used these data and matrix multiplication methods to calculate the substance use of those friends from the friend reports [39,41–43]. Peer use is the average friends' self report for each substance and the average across four substances.

In addition to the friendship network question, we also asked students to indicate five students with whom they would like to be grouped for group projects in class and the five people who make the best leaders for a project in class. The peer leader question provided the basis for the network data used to identify peer leaders as those students who received the most nominations. Groups were created by assigning students to leaders they chose. If none of the leaders they chose were selected as leaders they were assigned to the leader to whom they were sociometrically closest [4,44].

Figure 1 shows the study design with class as the unit of randomization. All students were invited to provide active parental consent and student assent. The procedures were reviewed and approved by the university institutional review board. Some 1493 students were invited to participate with 980 providing valid consent and assent forms (65.6%). Of the 980, 29 students were not interviewed at baseline because they were absent on multiple visits and 13 neglected to report data on their substance use behavior. Of these 938, 344 were lost to follow-up, yielding a 1-year retention rate of 63.3% which is comparable to other studies of continuation high school students [40,45]. Of the 594 students who completed 1-year follow-up surveys, 52 neglected to report data on their substance use behavior and one respondent reported the highest score on the scale for all four substances. (Missing data on substance use outcomes were more likely among students followed-up by telephone than those interviewed in schools.) Omitting these 53 participants leaves a final analytical sample of 541 participants. We also removed these 53 cases from the baseline sample yielding a baseline comparison group of 885.

Statistical analyses

We regressed current use of each substance and the composite score at 1-year follow-up on baseline use and included the demographic and network control variables reported above. This lagged regression model included dummy variables for TND and TND Network to test for intervention effects [46]. In addition to individual substances, we created a composite substance use variable by standardizing the four monthly use variables and calculating the average. All regression analyses controlled for within classroom clustering by specifying school as the clustering variable. This multi-level model helps control for the greater covariation within schools relative to that between schools. Ignoring interdependence among observations due to clustering effects may lead to inflated Type I error and overestimate effects which are not significant [46–50].

RESULTS

Table 1 reports sample characteristics at baseline and follow-up overall and between conditions. Average age at baseline of the students was 16.3 (SD = 1.36) years, which was similar across conditions and for those retained. The average grade was 10.6 (SD = 1.22). Students in alternative high schools are assigned a grade based on the number of units they have completed and work independently to progress between grades. About 62% of the students were male and the average mother's education was 2.92 on a scale of 1 (not completed elementary school) to 6 (graduate degree), with 3 indicating completed high school. Approximately 72% were Hispanic/Latino, 6% African-American, 11% white and 11% other, which included mixed ethnicities, Asian American and other. These characteristics are typical of southern California continuation high schools. On average, students provided the names or initials of 4.16 (SD = 1.32) friends, and about 1.82 (SD = 1.82) of these were friends from the same school.

Factor analysis of the social support scale indicated that two items did not covary with the others and hence were dropped from the scale. The remaining eight items loaded on one factor (eigenvalue = 3.14) with a minimum loading of 0.50. A single scale was constructed with an alpha of 0.88 and the average was 4.53 (SD = 1.37, range, 1–7). Baseline peer substance use was the average for each substance (cigarettes, alcohol, marijuana and cocaine) and the average for all four substances. Baseline composite peer use had a mean of 2.27 (SD = 1.12).

Table 1 Demographic characteristics and substance use rates at baseline for continuation high school sample.

	Baseline (n = 885)				*1-year follow-up (n = 541)*			
	Total	*Control*	*TND*	*Network*	*Total*	*Control*	*TND*	*Network*
n		238	296	351		135	182	224
Demographics								
Age	16.3	16.4	16.4	16.2	16.2	16.4	16.3	16.1
Grade	10.6	10.7	10.7	10.4	10.5	10.8	10.6	10.3
Proportion male	0.62	0.61	0.59	0.65	0.62	0.63	0.56	0.67
Mother's education	2.92	2.92	2.86	2.96	2.90	2.95	2.84	2.92
Ethnicity								
Hispanic/Latino	0.72	0.72	0.72	0.71	0.73	0.74	0.73	0.72
Black	0.06	0.04	0.05	0.08	0.05	0.02	0.05	0.08
White	0.11	0.13	0.09	0.12	0.11	0.12	0.09	0.12
Other	0.11	0.11	0.14	0.09	0.11	0.12	0.13	0.08
Network constructs								
No. friends	4.16	4.35	4.11	4.08	4.28	4.43	4.24	4.22
No. friends in school	1.82	1.79	1.84	1.81	1.86	1.90	1.85	1.86
Social support	4.53	4.41	4.56	4.56	4.53	4.35	4.59	4.60
Nominations sent	3.13	3.42	3.01	3.02	3.21	3.59	3.14	3.04
Nominations received	2.22	2.09	2.23	2.30	2.23	2.18	2.15	2.32
Peer use	2.27	2.42	2.36	2.10	2.31	2.51	2.38	2.13
Monthly use								
Cigarette	2.34	2.14	2.48	2.36	2.41	2.42	2.45	2.38
Alcohol	2.33	2.37	2.51	2.16	2.3	2.43	2.51	2.06
Marijuana	2.59	2.68	2.77	2.37	2.55	2.56	2.88	2.28
Cocaine	1.24	1.20	1.34	1.18	1.29	1.24	1.45	1.20
Total	2.14	2.11	2.3	2.02	1.83	1.72	1.88	1.86
Total (standardized)	–0.01	–0.02	0.06	–0.07	–0.01	–0.06	0.03	0.0

Monthly substance use scores were tobacco, 2.34 (SD = 2.64); alcohol, 2.33 (SD = 2.15); marijuana, 2.59 (SD = 2.78); and cocaine, 1.24 (SD = 1.20). There were no differences on any study variables between conditions, with the following exceptions. Participants in TND Network were at a slightly lower grade, 10.4 compared to 10.7 in the other conditions. Those in TND and TND Network made fewer network nominations than those in the control condition, 3.02 and 3.01, respectively, compared to 3.42. Peer use was also different between study conditions such that it was lowest in TND Network (2.10) compared to TND (2.36) and the control group (2.42). There were no differences on any variables between those retained in the study and those lost to follow-up.

Predictors of change in current use

Table 2 reports the results of the multiple regression analysis to determine whether current monthly use rates changed by condition. For all substances, baseline use rates were associated strongly with follow-up use rates. For example, the regression coefficient for baseline smoking was 0.43 (95% CI: 0.36, 0.50; $P < 0.01$), indicating that an increase of 1 unit on baseline tobacco use was associated with a 0.43 increase in tobacco use at 1-year follow-up. The confidence intervals do not span zero and so indicate a statistically significant association. Age, grade, gender (being male) and mother's education were not associated with changes in current use rates, with the following exceptions. Males were more likely to increase their alcohol use compared to females, students in lower grades were more likely to increase their marijuana use compared to students in higher grades and younger students increased their cocaine use compared to older ones. White students compared to Hispanic/Latinos reported an increase in tobacco use and a decrease in marijuana use; and black students compared to Hispanic/Latinos reported a decrease in marijuana and cocaine use.

Having fewer friends in school was associated with increased use on the composite score (b = –0.03; 95% CI: –0.06, 0.0; $P < 0.05$), but not the individual substances. Social support was associated with increased alcohol use as well as the composite score, but not the other individual substances. Receiving many nominations was associated with increased use of cigarettes, alcohol, marijuana, cocaine and the composite score (e.g. b = 0.05; 95% CI: 0.04, 0.06; $P < 0.01$). Number of friends, nominations sent and peer substance use were not associated with

Table 2 Regression coefficients for monthly substance use on study conditions controlling for baseline use, demographic characteristics and network constructs ($n = 541$).

	Cigarettes	*Alcohol*	*Marijuana*	*Cocaine*	*Total*
Baseline substance use	0.43** (0.36, 0.50)	0.11** (0.07, 0.14)	0.27** (0.17, 0.36)	0.01 (–0.01, 0.01)	0.22** (0.13, 0.31)
Demographics					
Age	–0.03 (–0.15, 0.10)	–0.09 (–0.20, 0.01)	0.03 (–0.14, 0.20)	–0.04* (–0.07, –0.01)	–0.03 (–0.07, 0.01)
Grade	–0.11 (–0.25, 0.05)	–0.01 (–0.09, 0.07)	–0.25* (–0.49, –0.02)	–0.01 (–0.06, 0.03)	–0.05* (–0.09, 0.0)
Male	0.07 (–0.28, 0.46)	0.26* (0.05, 0.47)	0.15 (–0.12, 0.43)	0.02 (–0.04, 0.08)	0.09* (0.02, 0.16)
Mother's education	0.10 (–0.01, 0.25)	0.01 (–0.09, 0.11)	0.02 (–0.12, 0.15)	0.0 (–0.02, 0.02)	0.01 (–0.02, 0.04)
Ethnicity (ref = Hispanic/Latino)					
White	1.22* (0.27, 2.17)	0.26 (–0.06, 0.59)	0.56* (0.04, 1.07)	–0.03 (–0.14, 0.08)	0.24** (0.10, 0.38)
Black	0.13 (–0.70, 0.96)	–0.12 (–0.56, 0.32)	–0.47** (–0.76, –0.18)	–0.07* (–0.14, –0.01)	–0.09 (–0.22, 0.05)
Other	0.11 (–0.50, 0.71)	0.19 (–0.23, 0.60)	0.41 (–0.13, 0.96)	–0.04 (–0.13, 0.06)	0.11 (–0.06, 0.29)
Network constructs					
No. friends	0.11 (–0.04, –0.27)	0.01 (–0.09, 0.11)	0.08 (–0.04, 0.20)	0.0 (–0.02, 0.01)	0.02 (–0.02, 0.06)
No. friends in school	–0.12 (–0.26, 0.02)	–0.03 (–0.09, 0.04)	–0.06 (–0.16, 0.03)	–0.01 (–0.02, 0.01)	–0.03* (–0.06, 0.0)
Social support	0.07 (–0.05, 0.18)	0.11* (0.01, 0.21)	0.10 (–0.02, 0.21)	0.02 (–0.01, 0.05)	0.05* (0.02, 0.07)
Nominations sent	–0.04 (–0.10, 0.02)	–0.05 (–0.10, 0.01)	0.02 (–0.05, 0.09)	0.0 (–0.01, 0.02)	0.0 (–0.02, 0.01)
Nominations received	0.12* (0.03, 0.21)	0.08** (0.05, 0.12)	0.13** (0.07, 0.19)	0.02* (0.01, 0.03)	0.05** (0.04, 0.06)
Peer substance use	0.07 (–0.05, 0.18)	0.03 (–0.04, 0.10)	–0.02 (–0.09, 0.06)	–0.01 (–0.04, 0.03)	0.0 (–0.03, 0.03)
Intervention conditions					
TND	0.07 (–0.47, 0.60)	0.21 (–0.05, 0.47)	0.09 (–0.36, 0.53)	0.03 (–0.06, 0.12)	0.06 (–0.05, 0.18)
Network	–0.40 (–1.19, 0.40)	–0.43 (–1.63, 0.77)	–0.64* (–1.09, –0.19)	–0.37* (–0.63, –0.10)	–0.37** (–0.54, –0.20)
Network × peer use	0.16 (–0.03, 0.35)	0.25 (–0.29, 0.80)	0.34* (0.10, 0.58)	0.28* (0.05, 0.51)	0.19** (0.10, 0.28)
R^2	33%	8%	21%	6%	20%

*$P < 0.05$, **$P < 0.01$.

Table 3 Regression coefficients for change in total monthly substance by study condition ($n = 541$).

	Substance use		
	Control	*TND*	*Network*
n	135	182	224
Baseline substance use	0.10 (–0.05, 0.25)	0.19** (0.08, 0.31)	0.37** (0.18, 0.56)
Demographics			
Age	–0.03 (–0.11, 0.05)	–0.05 (–0.11, 0.02)	–0.04 (–0.08, 0.01)
Grade	0.03 (–0.03, 0.09)	–0.14** (–0.23, –0.06)	0.00 (–0.06, 0.07)
Male	0.09 (–0.04, 0.23)	0.27** (0.11, 0.44)	–0.0 (–0.13, 0.13)
Mother's education	0.02 (–0.05, 0.08)	0.01 (–0.08, 0.10)	–0.01 (–0.05, 0.04)
Ethnicity (ref = Hispanic/Latino)			
White	0.08 (–0.19, 0.35)	0.18 (–0.08, 0.44)	0.29 (–0.01, 0.60)
Black	–0.16 (–0.39, 0.08)	0.34 (–0.17, 0.84)	–0.29** (–0.41, –0.16)
Other	0.04 (–0.21, 0.29)	0.13 (–0.14, 0.40)	–0.06 (–0.18, 0.31)
Network constructs			
No. friends	0.03 (–0.01, 0.07)	0.0 (–0.09, 0.10)	0.04 (0.0, 0.08)
No. friends in school	0.00 (–0.04, 0.04)	–0.07 (–0.11, –0.03)	0.0 (–0.05, 0.04)
Social support	0.04 (–0.07, 0.14)	0.08 (–0.01, 0.18)	0.01 (–0.03, 0.04)
Nominations sent	–0.01 (–0.05, 0.03)	0.0 (–0.04, 0.03)	–0.01 (–0.06, 0.03)
Nominations received	0.05* (0.02, 0.08)	0.09* (0.02, 0.16)	0.02 (–0.02, 0.07)
Peer use	–0.02 (–0.07, 0.04)	0.04 (0.0, 0.08)	0.17** (0.08, 0.26)
R^2	11%	25%	34%

*$P < 0.05$, **$P < 0.01$.

increased use on any substance or the composite score. [Peer use was strongly associated with baseline use (not shown).]

Receiving TND was not associated with changes in any substance use or the composite score relative to control. Receiving TND Network was associated with decreased marijuana (b = –0.64; 95% CI, –1.09, –0.19; $P < 0.05$) and cocaine use (b = –0.37, 95% CI: –0.63, –0.10; $P < 0.05$) relative to control. TND Network was also associated with decreased composite use relative to the control condition (b = –0.37; 95% CI: –0.54, –0.20; $P < 0.01$). The interaction of peer use and being in the network condition was associated with increases in marijuana (b = 0.34; 95% CI, 0.10, 0.58; $P < 0.05$), cocaine (b = 0.28, 95% CI: 0.05, 0.51; $P < 0.05$) and composite substance use (b = 0.19; 95% CI, 0.10, 0.28; $P < 0.01$).

The interaction term of peer use and being in the TND condition was not associated significantly with any substance use outcomes, and its inclusion did not result in a significant effect of TND (results not shown). We also created an interaction term of the TND Network condition and self-reported substance use with the close friends reported in the close friend item. These results were similar to those reported for peer use, namely that substance use decreases for those in the TND Network condition but increases for those in the TND Network condition who have used substances with their close friends.

To gain a sense of the magnitude of these effects we coded the number of students who reported no use at baseline and some use at follow-up (starters, $n = 61$, 11.3%) and those who had any use at baseline and no use at follow-up (quitters, $n = 75$, 13.9%). The quit rate was higher in the intervention conditions (14.3%) than the control (12.6%). The adjusted odds ratio (AOR) for quitting in the network condition was 3.41 (95% CI: 1.68, 6.92; $P < 0.01$), with a decreased AOR of 0.67 (95% CI: 0.47, 0.94; $P < 0.05$) for the quit rate as use among one's peers increases.

Conditional effects

To analyze further the interaction of receiving TND Network and peer use we re-ran the composite use regression model separately by study condition. Table 3 reports the results which show that peer use was associated with increased substance use (total composite) in the network condition (b = 0.17, 95% CI: 0.08, 0.26; $P < 0.01$). Figure 2 illustrates the differential association between substance use and peer use by condition. In the control and TND conditions, as peer use increases change in substance use declines. In contrast, in the TND Network condition, as peer use increases change in substance use increases. Thus, it seems TND Network was effective at reducing substance use but it also may have exacerbated the potential negative influence of peer use.

DISCUSSION

The effectiveness of a network-tailored substance abuse prevention curriculum, TND Network, was tested among

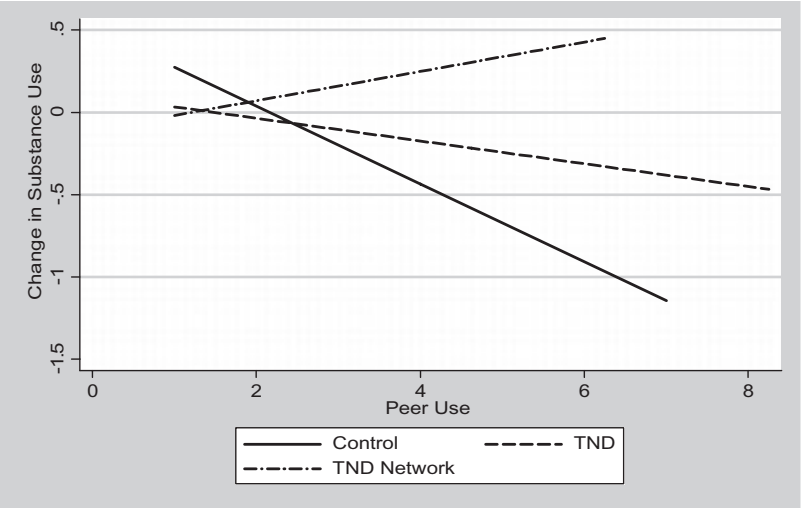

Figure 2 Change in substance use by peer substance use by intervention condition (control, TND, TND Network). The slope of the TND Network condition is significantly different to the control condition based on the results in Table 2

high-risk youth in southern California. Outcomes were change in substance use, cigarettes, alcohol, marijuana, cocaine and a composite score at 1 year after the curriculum. TND Network had greater involvement of peer leaders and group activities with groups and leaders identified via social network characteristics. Because TND relies on a Socratic method of teaching, creating a network version allows us to contrast small-group discussions versus large-group discussions that do not attend to the naturally occurring groups that exist within a classroom. A randomized controlled trial using classroom level assignment was used to determine whether the network version reduced substance use, testing for iatrogenic effects. These iatrogenic effects, or deviancy training, would be evidenced by negative results (increased substance use) among students with drug-using friends in the classrooms in the TND Network condition only.

Results showed that TND Network was associated with monthly reductions in current use of marijuana, cocaine and a composite at 1-year follow-up when an interaction term composed of peer use and being in the TND Network condition was included. Reducing substance use among a high-risk sample such as alternative high school youth is challenging, at best. The TND Network curriculum was able to achieve relatively long-term behavioral effects on marijuana and cocaine use and on a composite use index when all substances were considered together.

The reduced substance use came at the expense of increasing use among some students with existing networks of substance-using peers. Substance use was reduced mainly for those students who nominated as friends other students who reported low levels of substance use. If a student received the network curriculum and had friends in the class who reported using substances, he/she was likely to increase his/her substance-using behaviors over the 1-year interval. Thus, the Network curriculum seemed to achieve its goal of increasing peer influence yet that peer influence, in the context of an alternative high school, was potentially negative for adolescents with drug-using friends.

It is not known why previous effects of TND were not replicated in the current study. Process evaluation results showed no differences in perceived program delivery or perceived effects on student substance use [51]. One may speculate that differences in sample characteristics or context (e.g. mass testing has been introduced which increased academic tension) influenced the results. Alternatively, changes in the larger social climate may account for changes in effects. The findings reported here illustrate the importance of normative beliefs and cultures within the context of substance use. In these data, social support and popularity, measured as the number of friendship nominations received, were associated positively with substance use. This indicates that substance use among these alternative high school students can be an accepted and socially approved behavior. Creating a curriculum that accelerates peer influence within this context can have mixed effects. Our intention was to create a curriculum that ignited positive peer influences within the context of drug abuse education. Evidently this was achieved only for those students who had peer networks that could provide such positive influences.

Throughout the development of TND Network we struggled continually with the challenge of keeping the program content constant while only changing peer interaction. It may be that this approach constrained our efforts to create modules and exercises that capitalized fully on the importance of peer influence. Future curricula may need to be adaptable to the current normative

beliefs of the students, providing positive peer influences when substance use rates are low and combating negative influences when use rates are high.

Further, we feel that future substance abuse prevention and cessation curricula can use social network data more extensively. The present application used a particular network question (who makes the best leader), a particular method for identifying leaders (those who received the most nominations) and a particular method for creating groups (based on nearest neighbors). Future studies may compare variations on any and/or all of these implementation issues. Additional curricula may be developed which link measures and methods to curricula. For example, lessons on resistance skill training might be implemented within friendship dyads, while lessons on normative influences may use popular students. Researchers should not feel constrained to match prior network protocols in the development of new substance abuse prevention programs.

An additional extension would be to combine network data and individual attributes. For example, non-users can be grouped together to discuss ways to continue resisting peer influence on use, while users can be grouped together to discuss ways to support non-use. Other attributes such as gender or ethnicity may be included in network mapping to construct groups that cross gender and/or ethnic boundaries. Future interventions may want to explore novel ways of harnessing the positive effects of social influence. For example, Killeya-Jones and colleagues [52] show that leaders may often engage in 'deviant' behaviors and these leaders may be needed to devise and spread antidrug messages. Students can even use online network programs such as MySpace within classrooms to learn how their behaviors influence one another and reinforce negative stereotypes and behaviors.

These results also underscore that programs emphasizing social interaction may be employed most profitably when social norms favor healthy behaviors. Social interaction can provide inoculation against negative influences that might be generated when deleterious behaviors increase to an unacceptable level. Social interaction is safe when norms favor non-use of an illicit substance, but must be carefully tailored and monitored when norms favor use of such substances.

Finally, this study was innovative in the use of social network analysis methods to emphasize social interaction in the curriculum and to measure peer substance use. Limitations to the study include participant attrition and non-response in the study sample (36.7% lost to follow-up), which is typical in studies of students in alternative high schools, but still of concern. These results may not generalize to students who were lost to follow-up or never participated.

Although there were few significant differences between baseline and follow-up samples there is always concern that the samples differed in unmeasured ways. These limitations aside, the current study provides evidence that deviancy training is context- and individual-specific. Peer interactivity can exacerbate negative and positive influences. Students with few substance-using peers benefited from the interactive program because positive social influences were generated by their peers. Students with substance-using peers, on the other hand, were more likely to be influenced negatively by these peers when social interaction was emphasized. Overall, this study underscores the power of peer influence to accelerate both positive and negative outcomes.

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