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### At your own risk

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# CHAPTER 5

## Direct Versus Indirect Peer Influence: The Effect of Actual and Perceived Substance Use by Peers on Adolescents' Own Substance Use\*

\* This chapter is co-authored with Jan Kornelis Dijkstra, Christian Steglich, and René Veenstra and is currently under review by an international peer-reviewed journal. An earlier version of this chapter was presented at the Society for Research in Child Development (SRCD), Philadelphia, PA, United States, March 2015.

### Abstract

The prevalence of substance use, such as smoking tobacco or drinking alcohol, increases gradually during adolescence, and peers have shown to play an important role in the proliferation of these behaviors. Much research has focused on examining peer influence in adolescence. In most studies peer influence is assumed to work through social learning and behavioral modeling. However, adolescents might also be influenced by their perception of peers' substance use. This study therefore tests whether adolescents in peer groups are directly influenced by the tobacco and alcohol use of their peers and indirectly by their perceptions of their peers' behavior. The hypotheses are tested in a large longitudinal sample of early adolescent boys (50.1%) and girls in the Social Network Analyses of Risk behavior in Early adolescence (SNARE) study ( $N = 1,309$ ,  $M$  age = 13.19). Peer influence of actual substance use by peers was found for both tobacco and alcohol use. However, there was no effect of perceived substance use of peers on adolescents' own substance use. Furthermore, respondents underestimated the substance use of their close peers. Early adolescents might be unaware of or unwilling to report their peers' behavior, particularly when it concerns deviancy among close peers, and perceptions of behavior might be harder to measure properly than expected.

Peers play an increasingly significant role during adolescence (Rubin et al., 2006). Particularly peers with whom adolescents spend a lot of time and share more intimate relationships, such as friendships, are important for their development (see also Brown, 2004; Brown & Larson, 2009; Hartup, 1993). Adolescents find social support, acceptance, and a sense of belonging among peers, who also affect their behavioral development. Peer behavior is evidently an important influencing factor on an adolescent's own behavior and studies specifically focusing on peer influence processes in adolescence have steadily increased in the past years (see for example Veenstra et al., 2013). Also with regard to substance use, such as smoking tobacco or drinking alcohol, peer behavior has shown to be related to and influential on the (early) adolescent's own tobacco and alcohol use (e.g., Bot, Engels, Knibbe, & Meeus, 2005; Engels, Knibbe, De Vries, Drop, & Van Breukelen, 1999; Kiuru, Burk, Laursen, Salmela-Aro, & Nurmi, 2010; Mathys, Burk, & Cillessen, 2013; Mercken, Steglich, Knibbe, & De Vries, 2012; Osgood et al., 2013; Sieving, Perry, Williams, 2002; Simons-Morton & Farhat, 2010), though results sometimes differ depending on the type of substance use studied or the timing of the studies.

With regard to tobacco use, results of studies on peer influence have been mixed. Some studies find evidence for influence in for example early adolescence, but not so much in middle or late adolescence (e.g., Haas & Schaefer, 2014; Hall & Valente, 2007; Mathys et al., 2013). This corresponds with the idea that because tobacco use is addictive, peer influence mainly plays a role when the adolescent start smoking. Studies on alcohol use also show mixed evidence throughout adolescence, but mainly indicate that alcohol use by peers has an important influence on adolescents' own drinking behavior (e.g., Mathys et al., 2013; Mercken et al., 2012; Osgood et al., 2013). Although recent social network studies have focused extensively on peer influence processes regarding substance use and a wide variety of related factors, far less is known about the ways in which peer influence tends to work.

Most studies expect peer influence to be a result of behavioral modeling, where adolescents mimic the behavior of peers (Akers, Krohn, Lanza-Kaduce, & Radosevich, 1979; Bandura, 1986; Bandura & McClelland, 1977). However, adolescents not only tend to conform to observed actual peer behavior, but can also conform to expectations they have about behavior (Cialdini et al., 1991). Thus, the idea adolescents have about others' behavior can influence their own behavior. It is likely that, on the one hand, influence is direct and works through mimicking the actual substance use of peers. On the other hand, influence can also be indirect

whereby perceptions of peers' substance use might play a role in how adolescents engage in substance use themselves. This study sets out to examine the direct and indirect influences of peers on adolescents' substance use, specifically tobacco and alcohol use, and tests the effects of actual and perceived substance use of peers on adolescents' own substance use.

### **Influence of Actual and Perceived Substance Use by Peers**

It is generally assumed that the influence of peers' substance use on adolescents' own substance use works mainly through social learning or behavioral modeling of peers' substance use. Through observation, imitation, and modeling, individuals learn which behaviors are appropriate in a certain context and depict what others do given certain circumstances (Bandura & McClelland, 1977). Individuals are inclined to mimic behavior especially when a situation is unclear or ambiguous, and deduce how to behave from the behaviors they observe (Cialdini et al., 1991). Particularly in early adolescence, adolescents find themselves in a new context where it is not always clear how to behave in a desirable way. At this stage of development, adolescents often form new relations with peers and conforming to the behavior of others becomes salient.

Adolescents are likely to conform to the substance use of peers because it increases their chances of being accepted and finding a sense of belonging among peers, which is one of the most important goals in adolescence (e.g., Baumeister & Leary, 1995; Berndt, 1979; Coleman, 1961; Juvonen, 2006; Rubin et al., 2006). Social modeling of deviant behaviors, such as substance use, then occurs when this behavior is considered normative (Burgess & Akers, 1966; Sutherland et al., 1995). By observing and mimicking others' substance use, adolescents learn how to act desirably and increase their chances of becoming accepted by peers. Thus, conforming to the actual substance use of peers is likely, because adolescents want to behave in a way considered desirable to increase peer acceptance. Therefore, we expect peers' substance use to have a direct influence on adolescents' own tobacco and alcohol use (Hypothesis 1).

However, social modeling of actual peer behavior might not be the only way that influences adolescents. Adolescents are also introduced to peer behavior by interacting and communicating with others (Cialdini et al., 1991). This familiarizes adolescents with attitudes and behaviors that are (dis)approved of and can help them decide what is considered desirable. They can form expectations of how to

behave, without necessarily having seen actual behavior. Perceptions of peer behavior can influence adolescents' own behavior as much as actual peer behavior.

Perceived behavior is often subject to a false consensus bias (Marks & Miller, 1987; 1988), when individuals tend to project their own behavior (inaccurately) onto what (they think) others do, especially for behaviors that have a relatively low prevalence. This bias can in turn reinforce how adolescents tend to behave themselves (e.g., Otten, Engels, & Prinstein, 2009; Prinstein & Wang, 2005; Young, Barnes, Meldrum, & Weerman, 2011; Young & Weerman, 2013). Studies show that the relationship between the perception of peer behavior and adolescents' own behavior is common and sometimes even stronger than the relationship between peer-reported behavior and adolescents' own behavior (Boman et al., 2011; Kandel, 1996; Prinstein & Wang, 2005; Weerman & Smeenk, 2005), indicating that it might be important to study perceptions of peer behavior in relation to adolescents' own behavior. Thus, although most studies assume that adolescents are influenced by actual peer behavior, perceived behavior of others might influence adolescents' own behavior as well. We therefore expect that the perceptions adolescents have about the substance use of peers influences their own substance use (Hypothesis 2).

Our hypotheses are tested using stochastic actor-based modeling (RSIENA; Ripley et al., 2014; Snijders et al., 2010) in a large longitudinal sample of adolescent boys and girls. We first examine the discrepancy between adolescents' self-reported substance use and peer-reported substance use to see how accurate adolescents are in their perceptions of the tobacco and alcohol use of peers. Next, we test whether there is direct peer influence on tobacco and alcohol use. We conclude by examining whether the perception of peers' substance use has an indirect influence on adolescents own substance use. For this we use a novel method whereby perceived substance use consists of a network in which adolescents could nominate which of their close peers engage in substance use. This allows us to examine how adolescents perceive each individual in the peer group engaging in substance use, and examine the combined effect of those perceptions on adolescents' own substance use.

## Method

### Participants and Procedure

Data stem from the SNARE (Social Network Analysis of Risk behavior in Early adolescence) project; a longitudinal project on the social development of early

adolescents specifically focused on adolescents' involvement in risk behavior. Two secondary schools participated: one in the middle and one in the north of the Netherlands. All first- and second-year students from these schools were invited to enroll in SNARE (2011-2012). All eligible students received an information letter for themselves and their parents, in which they were asked to participate. If students wished to refrain from participation, or if their parents disagreed with their children's participation, they were requested to send a reply card or email within ten days. In total, 1826 students were approached for this study, of which 40 students (2.2%) refused to participate for several reasons, for example, the parent and/or adolescent had no interest, the adolescent was dyslectic, or it was too time consuming. A total of 1786 students participated in SNARE (83.9% Dutch).

Pre-assessment took place in September 2011, just as students entered the first or second year of secondary school. This was followed by three regular measurement waves in October, December, and April. For the present study we used data from the first three regular waves (October, December, and April) of both first- and second-year students. Of all 1,786 students who participated in the data collection, we focused on the first cohort (students enrolled in SNARE in 2011-2012), resulting in a subsample of 1,309 students (49% boys). The mean age of the sample was 13.19 (ranging from 11 to 15,  $SD = .71$ ). Of the respondents, 39.4% followed pre-vocational education (VMBO) and 60.6% followed pre-university/senior general secondary education (HAVO/VWO). One of the two schools in SNARE runs at four 'locations', each with its own school management, that can be considered as independent schools. We thus had two schools at five school locations and therefore refer to 'school locations' instead of schools when we discuss our sample and data.

During the assessments a teacher and research assistants were present. The research assistant briefly introduced the questionnaire, containing both self-reports as well as peer nominations, which the students filled in on the computer in class. Data were collected with CS socio software ([www.sociometric-study.com](http://www.sociometric-study.com)) developed especially for this study.. The assessment of the questionnaires took place during regular lessons in approximately 45 minutes. Any students absent on the day were assessed within a month, if possible. The anonymity and privacy of the students were guaranteed. The study was approved by the Internal Review Board of one of the participating universities.

## Measures

*Peer (group) networks* were derived from unlimited friendship and group-membership nominations in classes on the items ‘Who are your best friends?’ and ‘Who are part of the group you hang out with the most?’ Nominations for both questions were summed per individual and a total score of 2 was recoded into 1, which was used to construct networks per school location. Using both above-mentioned questions allowed us to construct networks that included individuals who can be considered close peers and belonging to an adolescent’s intimate peer group. For ease of reading, we will refer to the ‘peer group’ when we discuss the peer network (effects).

*Tobacco use.* Self-reports were used to assess tobacco use. We asked respondents how often they had smoked tobacco in the last month. Answer categories were measured on a seven-point scale, ranging from never to more than 20 times (e.g., Monshouwer et al., 2011). Because the onset of smoking tobacco is most important in early adolescence and the prevalence of tobacco use is highly skewed in the data, the answers were dummy-coded, resulting in a variable that measured whether adolescents had (1) or had not (0) smoked in the last month.

*Alcohol use.* Self-reports were also used to assess alcohol use. We asked respondents how often they had drunk alcohol in the last month (Wallace et al., 2002). Answer categories were measured on a 13-point scale, ranging from 0 times to over 40 times or glasses, so that adolescents could indicate how often they had drunk alcohol in that month. Answers on this scale were categorized into never (0), once (1), 2–4 times (2), and 5 times or more (3).

*Perceived tobacco / alcohol use.* Perceptions of substance use (both tobacco use and alcohol use) were based on peer nominations in class on the items ‘Who smokes?’ and ‘Who drinks alcohol?’ respectively. We used only peer nominations of individuals in one’s peer group network (best friends and peers who are part of the group an adolescent hangs out with the most). The nominations were used to construct separate networks per type of substance use and school location, which resulted in networks of perceived substance use. Adolescents indicated which peer group ‘members’ they thought smoked and/or drank alcohol. Nominations between adolescents in different classes were replaced by structural zeroes, which indicated that respondents could not nominate students from other classes.



## Analytical Strategy

Longitudinal social network modeling (RSIENA, version 1.1.286, Steglich, Snijders, & Pearson, 2010) was used to examine peer influence processes in early adolescent substance use and the effect of perceptions of close peers' substance use on adolescents' own behavior. RSIENA models the co-evolution of social networks and behaviors over time (Ripley et al., 2014; Snijders et al., 2010). Among others, changes in individual behavior are modeled as a result of the behavior of peers one has a relationship with (influence effect) and changes in relationships are modeled as the result of pre-existing similarities in behavior (selection effect). The network of relations and the behavior of individuals are dependent variables that can have an effect on each other. In our analyses, RSIENA can then examine influence processes (behavioral dynamics) while controlling for selection processes (network dynamics) in tobacco and alcohol use.

In our models, we added peer network effects to capture the network structure of 'peer groups' and optimize the goodness of fit of the models (Table 5.3). These effects were the following: *outdegree/density* (tendency to create relations with peer group members), *reciprocity* (tendency to reciprocate a group-membership nomination), *transitive triplets* (tendency to nominate a group member of a group member as one's own group member), *transitive reciprocated triplets* (tendency for triads to reciprocate group-membership nominations), *three cycles* (tendency for a (non-)hierarchical structure), *indegree popularity* (tendency for those who receive many group-membership nominations to receive more group-membership nominations), *indegree activity* (activity of popular individuals; nominating others as group member when often nominated oneself), *outdegree activity* (activity of active individuals; nominating many others as group member when one is already often nominating oneself), and *truncated outdegree* (sinks; individuals who nominate no one).

We also controlled for selection effects by examining whether boys nominate (*gender ego*) and were nominated (*gender sender*) more often as group members than girls, and whether respondents of the same gender (gender homophily; measured with the *same-gender effect*) were more likely to select each other as group members. Lastly, we controlled for whether those who smoked tobacco or drank alcohol nominate (*tobacco / alcohol use ego*) and were nominated (*tobacco / alcohol use alter*) more often than those who did not smoke tobacco or drank less alcohol, and whether there was a tendency for respondents to select

each other when they had similar levels of substance use (tobacco / alcohol use homophily; measured with the *ego x alter selection effect*).

In the behavioral part of the models, the *linear shape* effect modeled the overall tendency to substance use (either tobacco or alcohol), while the *quadratic shape* parameter modeled the feedback effect of substance use on itself, resulting in either regression to the mean (negative parameter) or polarization to the extremes of the scale (positive parameter). We controlled for the tendency that boys were more likely than girls to score highly on substance use (*effect from gender*), and that respondents in higher grades were more likely to score highly on substance use than respondents in lower grades (*effect from grade*). Furthermore, we controlled for the tendency that respondents who already drank alcohol at an earlier time point, would smoke tobacco at a later time point (*effect from alcohol use*), and the tendency that respondents who smoked tobacco at an earlier time point, would drink alcohol at a later time point (*effect from tobacco use*).

In Table 5.3, the *average alter effects* in the SIENA analyses reflect whether there was a tendency for adolescents for whom close peers scored higher on substance use to also develop higher levels of substance use themselves over time (or vice versa), thus reflecting the tendency for influence in tobacco and alcohol use (Models 1). In the last step (Models 2), we included an ‘influence’ effect of perceived substance use (*influence of perceptions of tobacco / alcohol use*) to examine if the perception of close peers’ substance use also influenced adolescents’ own substance use.

We conducted the analyses separately for the five school locations, and combined the outcomes in a meta-analysis using the *siena08* function in RSiena (Ripley et al., 2014; Snijders & Baerveldt, 2003). As it turned out, the estimates for tobacco use (behavioral part) of one school location could not converge for model 2. The results regarding tobacco use in the behavioral part in Table 5.3, model 2, are therefore based on the remaining four locations. Examining the goodness of fit of our models (GoF) allowed us to test whether the observed scores at the end of a period were congruent with the simulated values for the end of that period (Lospinoso, 2012; Ripley et al., 2014). This way, we could see whether structures in the peer group network and behaviors are properly captured with the fitted models. We assessed the indegree distribution, outdegree distribution, geodesic distribution, and triad census for the peer group networks. For smoking tobacco and drinking alcohol, we assessed the Moran’s I and behavior distributions. When the GoF of models with a given set of parameters was poorly estimated, we included additional parameters

to obtain a better fit. We also removed parameters that did not significantly add to the model to see how that affected the GoF. By going back and forth, including and excluding parameters, we ended up with a parsimonious model that showed the best possible fit (GoF statistics per school location and fit plots available upon request). The results of the overall GoF estimation across all five school locations showed a good to reasonable fit of the models for the indegree and outdegree distributions of the peer group networks ( $p = .08$  and  $.07$  respectively), but a less good fit for the geodesic distributions ( $p = .01$ ). Triadic structures were especially difficult to fit properly ( $p < .01$ ). The Moran's  $I$  distributions showed very good fit for both tobacco ( $p = .43$ ) and alcohol use ( $p = .14$ ). The behavior distributions for tobacco use across the five school locations also showed a good fit ( $p = .33$ ), but the behavior distributions for alcohol use showed a poorer fit ( $p = .02$ ). Still, the current models offer the best possible fit for the data.

## Results

### Descriptive Statistics

The results from the descriptive analyses showed that about half of the sample consisted of boys, with 52 percent of the respondents residing in the second grade of secondary education (Table 5.1). With regard to the peer group network, respondents nominated on average 6.65 other peers in their class as part of their peer group/as close peers. The average degree of the networks in class was moderate. Between 31% and 32% of respondents in class were nominated as a friend or group member across the three waves. About half of the relations in the network were reciprocal (49%, 50%, and 49%, respectively). The Jaccard index, indicating how relations between peers changed over time, appeared quite stable (Jaccard =  $.58$  and  $.54$ ). This showed that, although there are changes in the relationships of friends and group members, about 58% of the relations did not change between fall (Time 1) and winter (Time 2), and about 54% of the relations did not change between winter (Time 2) and spring (Time 3).

Self-reported substance use showed a prevalence of 7% to 14% for tobacco use and 19% to 24% for alcohol use. The average level of tobacco and alcohol use ranged from  $.02$  to  $.14$  ( $SD$  range from  $.14$  to  $.35$ ), and from  $.17$  to  $.50$  ( $SD$  range from  $.58$  to  $.94$ ) across all school locations. Most adolescents in our sample did not smoke tobacco or drink alcohol at all. The degree to which peers showed similar levels of substance use was positive and moderate for both tobacco use (Moran's  $I = .18, .15,$  and  $.20$  respectively) and alcohol use (Moran's  $I = .14, .18,$  and  $.20$ ). Self-

reported substance use appeared quite stable over time, particularly for smoking tobacco (93% and 89%).

With regard to perceived substance use, respondents nominated few peers as smokers or drinkers. Across all time points, they nominated about one individual (less than 1% of all close peers) who they perceived to use tobacco or alcohol (nominations given). Perceptions of substance use were quite unstable: 30% to 32% of the respondents did not change their perception of peers' tobacco use over time, and 25% to 26% of the respondents did not change their perception of peers' alcohol use. Most adolescents change their perceptions of their peers' substance use, but this is likely related to the low perception of substance use.

Table 5.2 furthermore shows how accurately respondents perceived the substance use of their close peers. The 'correct negative rates' show, when respondents themselves indicated that they did not engage in substance use, what percentage of peers also perceived them as not engaging in substance use. The 'correct positive rates' show that when respondents indicated that they themselves did engage in substance use, what percentage of peers also perceived them as engaging in substance use. Because perceived substance use was operationalized as a network, not nominating anyone would result in not perceiving substance use automatically. This might also explain the high congruence between not reporting to engage in substance use oneself and the perception of not engaging in substance use by peers (the correct negative rates are almost 100 percent). When we focus on the correct positive rate, we see that adolescents correctly perceive their close peers to engage in tobacco use in, 11%, 9%, and 10% of the cases, respectively. For alcohol use, the perception is correct in, 5%, 5%, and 7% of the cases, respectively. In 89% to 95% of the cases respondents indicated that close peers did not engage in substance use, whereas self-reports from respondents indicated that they did, thus indicating that adolescents underestimate or underreport on the substance use of close peers.

### SIENA Results

We found a low density in the peer networks of close peers in classes ( $b = -1.96, p < .001$ ), which indicates that respondents were selective as to who they nominated as being part of their peer group (Table 5.3). Respondents also tended to reciprocate peer nominations ( $b = 2.23, p < .01$ ), nominated peer group members of peer group members as their own peer group members (*transitive triplets*;  $b = .60, p < .001$ ), and tended not to reciprocate nominations in triads (*transitive reciprocated triplets*;  $b = -.31, p < .01$ ). Those often nominated tended not to nominate many others

**Table 5.1.** Descriptive Statistics of the Sample, Peer Network Characteristics, Perceived Tobacco and Alcohol Use Networks, and Self-Reported Tobacco and Alcohol Use

	Time 1 (Fall)	Time 2 (Winter)	Time 3 (Spring)
	Est. (SD)	Est. (SD)	Est. (SD)
<i>Sample</i>			
Boys (proportion)	.49 (.05)	.49 (.05)	.49 (.05)
Age	13.22 (.71)	13.45 (.76)	13.78 (.76)
Grade 2 (proportion)	.52 (.04)	.52 (.04)	.52 (.04)
<i>Peer network</i>			
Nominations given (Mean, SD)	6.53 (0.86)	6.80 (1.23)	6.62 (1.04)
Nominations received (Mean, SD)	6.52 (.86)	6.78 (1.24)	6.60 (1.04)
Average degree (proportion)	.31 (.03)	.32 (.03)	.32 (.04)
Reciprocity (proportion)	.49 (.04)	.50 (.05)	.49 (.06)
Missing (proportion)	.001 (.001)	.003 (.003)	.004 (.002)
<i>Tobacco use</i>			
0	93%	90%	86%
1	7%	10%	14%
Missing	4%	6%	8%
Network autocorrelation			
Moran's <i>I</i>	.18 (.12)	.15 (.05)	.20 (.08)
<i>Alcohol use</i>			
0	79%	81%	77%
1	8%	8%	8%
2	8%	8%	9%
3	5%	3%	7%
Missing	4%	7%	9%
Network autocorrelation			
Moran's <i>I</i>	.14 (.07)	.18 (.06)	.20 (.04)
<i>Perceived tobacco use network</i>			
Nominations given (Mean, SD)	.76 (.70)	.87 (.62)	1.28 (.77)
Nominations received (Mean, SD)	.82 (.64)	.94 (.54)	1.44 (.64)
Average degree (proportion)	.004 (.005)	.004 (.005)	.007 (.006)
Missing (proportion)	.003 (.004)	.014 (.024)	.013 (.021)
<i>Perceived alcohol use network</i>			
Nominations given (Mean, SD)	.76 (.49)	.49 (.30)	.79 (.43)
Nominations received (Mean, SD)	.81 (.43)	.88 (.49)	1.29 (.46)
Average degree (proportion)	.004 (.003)	.004 (.004)	.006 (.005)
Missing (proportion)	.004 (.004)	.013 (.024)	.013 (.021)

**Table 5.1.** Continued

<i>Transitions/Change</i>	Fall – Winter	Winter - Spring
Peer network relations		
Distance	958 (646)	983 (728)
Jaccard	.58 (.05)	.54 (.06)
Perceived tobacco use network relations		
Distance	139 (57)	201 (94)
Jaccard	.32 (.21)	.30 (.14)
Perceived alcohol use network relations		
Distance	176 (54)	224 (98)
Jaccard	.25 (.08)	.26 (.05)
Tobacco use		
Decrease	3%	3%
Increase	5%	8%
Stable	93%	89%
Alcohol use		
Decrease	10%	9%
Increase	10%	14%
Stable	80%	77%

*Note.* \*\*  $p < .01$ .

**Table 5.2.** Crosstabs of Self-Reported and Perceived Tobacco and Alcohol Use in the Peer Group

	Self-reported alcohol use / tobacco use, respectively					
	Time 1		Time 2		Time 3	
Perceived peers'	No	Yes	No	Yes	No	Yes
...tobacco use						
No	27576 (94%)	1475 (4%)	25920 (91%)	2050 (7%)	23969 (87%)	2939 (11%)
Yes	80 (1%)	181 (1%)	128 (1%)	214 (1%)	195 (1%)	322 (1%)
Correct negative rate	99%		99%		96%	
Correct positive rate	11%		9%		10%	
...alcohol use						
No	24286 (83%)	4471 (15%)	23285 (83%)	4396 (15%)	21333 (79%)	5081 (19%)
Yes	163 (1%)	232 (1%)	136 (1%)	223 (1%)	228 (1%)	354 (1%)
Correct negative rate	99%		99%		99%	
Correct positive rate	5%		5%		7%	

**Table 5.3.** RSIENA Meta-Analysis of Peer Network and Alcohol and Tobacco Use Dynamics

	Model 1 <i>b</i> ( <i>SE</i> )	Model 2 <i>b</i> ( <i>SE</i> )
<i>Network dynamics</i>		
Density	-1.96*** (.42)	-1.86*** (.44)
Reciprocity	2.23** (.29)	2.28** (.22)
Transitive triplets	.60*** (.06)	.53*** (.05)
Transitive reciprocated triplets	-.31** (.07)	-.30** (.05)
Three cycles	-.04 (.05)	-.07 (.04)
Indegree popularity (sqrt)	-.14 <sup>+</sup> (.09)	-.15 <sup>+</sup> (.06)
Indegree activity (sqrt)	-1.70** (.34)	-1.49* (.34)
Outdegree activity (sqrt)	.03 (.08)	.01 (.09)
Truncated outdegree	-.08 (.70)	-.19 (.61)
Gender alter (receiver effect)	-.02 (.07)	-.09 (.08)
Gender ego (sender effect)	.17 (.09)	.20 (.10)
Gender homophily	.65* (.18)	.64* (.19)
Tobacco use alter (receiver effect)	-.21 (.20)	-.43 (.48)
Tobacco use ego (sender effect)	-.43 (.26)	-1.04 <sup>+</sup> (.34)
Tobacco use homophily	2.24* (.58)	2.31 <sup>+</sup> (.81)
Alcohol use alter (receiver effect)	-.13 <sup>+</sup> (.06)	-.23 <sup>+</sup> (.09)
Alcohol use ego (sender effect)	.27* (.09)	.30 <sup>+</sup> (.14)
Alcohol use homophily	.01 (.08)	.12 (.14)
<i>Tobacco use dynamics</i>		
Linear shape	-1.50* (.39)	-1.43* (.48)
Effect from gender (boy = 1)	-.38 (.29)	-.17 (.32)
Effect from grade	.11 (.37)	.19 (.56)
Effect from alcohol use	1.26** (.18)	1.37* (.33)
Tobacco use of close peers (influence; average alter)	.92* (.42)	2.00* (.36)
Influence of perception of tobacco use		-.54 (1.16)
<i>Alcohol use dynamics</i>		
Linear shape	-1.69*** (.15)	-1.66*** (.18)
Quadratic shape	.69** (.10)	.70** (.10)
Effect from gender (boy = 1)	.19 (.10)	.18 (.13)
Effect from grade	.29 <sup>+</sup> (.12)	.46 <sup>+</sup> (.20)
Effect from tobacco use	.29 (.25)	.34 (.69)
Alcohol use by close peers (influence; average alter)	1.63* (.70)	2.26* (.95)
Influence of perception of alcohol use		-1.15 (1.09)

*Note.* In the estimates for tobacco use dynamics one school location was excluded due to unsatisfying model convergence. <sup>+</sup>  $p < .10$ ; \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .



(*indegree activity*;  $b = -1.70, p < .01$ ). The gender-homophily effect indicated a tendency for same-gender peers to nominate each other as part of their peer group ( $b = .65, p < .05$ ). With regard to substance use, respondents who smoked tobacco were likely to affiliate with others who also smoked tobacco (*tobacco use homophily*;  $b = 2.24, p < .05$ ). Those who drank alcohol were not more likely to affiliate with each other, but did have a stronger tendency to select more peer group members over time than respondents who did not drink alcohol (*alcohol use ego*;  $b = .27, p < .05$ ). In the behavioral part of the models, the linear shape effect showed a low tendency toward tobacco and alcohol use (*linear shape*;  $b = -1.50, p < .05$ , and  $b = -1.69, p < .001$  respectively) and respondents with a higher score on alcohol use were more likely to have higher scores for alcohol use over time, and vice versa (*quadratic shape*; polarization;  $b = .69, p < .01$ ). Furthermore, there was also an effect of respondents' alcohol use on their tobacco use (*effect from alcohol use*;  $b = 1.26, p < .01$ ), but not of tobacco use on their alcohol use, indicating that adolescents who smoked tobacco did not necessarily tend to score higher on drinking behavior over time, but adolescents who consumed alcohol, tended to score higher on smoking tobacco at a later time point.

To answer our hypotheses, we found in model 1 that there was indeed a direct influence of peers' actual substance use of both tobacco ( $b = .92, p < .05$ ) and alcohol use ( $b = 1.63, p < .05$ ) among close peers but no influence of the perception of peers' substance use on adolescents' own substance use (Model 2), indicating that the perception adolescents had of the behavior of their peers did not affect their own behavior.

## Discussion

Whether peers smoke tobacco or drink alcohol has shown to be an important influence on adolescent's own substance use (e.g., Kiuru et al., 2010; e.g., Mathys et al., 2013; Osgood et al., 2013; Simons-Morton & Farhat, 2010). Adolescents tend to conform and mimic the actual behavior of peers through behavioral modeling, to find a sense of belonging and acceptance (Bandura & McClelland, 1977; Burgess & Akers, 1966; Cialdini et al., 1991). However, besides the direct influence of peers' actual substance use, adolescents can also be influenced by the perception they have of peers' behavior (Cialdini et al., 1991). This study, therefore, set out to examine whether adolescents are directly influenced in smoking tobacco and drinking alcohol by the actual substance use of their peers or also more indirectly through any perceptions they have of peers' substance use.

It was expected that both a direct influence of the substance use of peers (with whom they had a close relationship: best friends and individuals with whom they hang out with most often), and perceptions of close peers' substance use would affect the extent to which adolescents would engage in substance use themselves. The findings of this study showed that adolescents were indeed influenced by the actual substance use of peers in the peer group in both tobacco use and alcohol use. However, perceptions of the substance use of their close peers did not have an effect on adolescent's smoking tobacco or drinking alcohol. From these findings we might conclude that perceptions of peer behavior do not influence adolescents in their own substance use. However, the fact that we did not find an effect of perceived substance use on adolescents' own substance use may be due to how perceptions of the behavior of close peers are formed.

It is likely that the way adolescents think their close peers behave is partly based on their observation of those peers' behaviors. Adolescents spend a lot of time socializing with close peers (Brown, 2004; Gifford-Smith & Brownell, 2003; Rasmussen & Salkind, 2008), and it is unlikely that perceptions of close peers' behavior are independent of observed behavior. Hence, perceptions of substance use by close peers might not play a role, because they overlap with observed substance use of peers. This way, adolescents are mainly influenced directly by peers with whom they have a close relationship.

However, if perceptions of close peer behavior are indeed based on observations of those behaviors, it is strange that we found much disagreement between self-reported and perceived behavior of close peers (see Table 4.2). From previous research, we would expect adolescents to misperceive the behavior of their peers, by overestimating, rather than underestimating, the prevalence of that behavior (Boman et al., 2011; Kandel, 1996; Otten, Engels, & Prinstein, 2009; Prinstein & Wang, 2005; Weerman & Smeenk, 2005). What might occur in peer groups is that adolescents are unwilling to report on the substance use of close peers. Therefore, our measure of perception might not adequately capture the true perceptions of peers' substance use, at least when it comes to close peers. Adolescents might underreport the substance use of close peers because they do not want to 'tell on' peers in the group, which might be the case if they nominated them. It may be fruitful to examine perceptions of behaviors in a sample of adolescents who do not share (close) relationships. There might be a difference in how accurate adolescents are in (their willingness to report) their assessments of behavior of different 'types' of peers. Examining (the discrepancy between self-

reported substance use and) perceived substance use in a sample of unconnected peers, one can rule out behavioral modeling of observed peers behavior and the risk of underreporting on peer group members, thus better testing the effect of perceived substance use on adolescents' own substance use.

Furthermore, particularly adolescents who are not affiliated (yet) might be influenced by the perceptions they have on how others behave, but these perceptions might be based on a more wide-ranged view of peer behavior. Adolescents' perceptions of others' behavior can also be based on more general ideas or social norms of how they are expected to behave (Sherif, 1966; Spears, Oakes, Ellemers, & Haslam, 1997). These general social norms might be formed by what adolescents consider to be stereotypical such that the mere idea of how the stereotypical adolescent would behave could affect their own behavior. Thus, adolescents might be influenced by the perceptions of how others behave, but on a more general level that goes beyond their direct context of peers. It might be worthwhile to examine to what extent adolescents identify themselves with more general characteristics or stereotypes of how adolescents would behave, to see if they are influenced by more overall perceptions of adolescents' behaviors.

Lastly, many datasets that focus on peer influence and network data contain information on relationships between peers. Conversely, they contain information about unconnected adolescents as well. There might be much to gain, if we consider that 'non-relationships' between adolescents are just as interesting to study as relationships between adolescents. Furthermore, the current study focuses on social networks in classes, but (non-)relationships between adolescents can also transcend the classroom. Therefore, future studies might benefit from examining social networks and (perceived) behaviors across classes and/or grades, and not only examine peer influence processes between peers who share a relationship, but also between peers who do not share a relationship could be an interesting and potentially fruitful avenue for future research.

## **Conclusion**

Our study examined the actual and perceived substance use of peers and their influence on adolescents' own substance use. Our findings showed that adolescents are influenced by the behavior of their close peers, but not by what they think those peers do. Furthermore, perceptions of peers' substance use were studied using a novel method – a network of nominations – in which adolescents could nominate whether their close peers engaged in substance use or not. Although this measure of perceptions of behavior might not be the best operationalization of

perceived behavior for adolescents sharing a close relationship, it was informative in demonstrating a discrepancy in what adolescents do and what others think they do. For future studies, it is important to consider how and when adolescents (are willing to) report on their peers' behaviors, particularly when it concerns sensitive subjects or behaviors among close peers. Both actual and perceived peer behavior might have an effect on adolescents' own behavior, but perceptions of behavior might be more difficult to capture and might be based on a more general idea of peer behavior than expected.

