



Pressure to drink but not to smoke: Disentangling selection and socialization in adolescent peer networks and peer groups

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A B S T R A C T

Keywords:

Adolescence
Peer networks
Peer groups
Substance use
Alcohol use
Tobacco use
Selection
Socialization

This paper examined the relative influence of selection and socialization on alcohol and tobacco use in adolescent peer networks and peer groups. The sample included 1419 Finnish secondary education students (690 males and 729 females, mean age 16 years at the outset) from nine schools. Participants identified three school friends and described their alcohol and tobacco use on two occasions one year apart. Actor-based models simultaneously examined changes in peer network ties and changes in individual behaviors for all participants within each school. Multi-level analyses examined changes in individual behaviors for adolescents entering new peer groups and adolescents in stable peer groups, both of which were embedded within the school-based peer networks. Similar results emerged from both analytic methods: *Selection* and *socialization* contributed to similarity of alcohol use, but only *selection* was a factor in tobacco use.

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Most adults who smoke cigarettes started smoking as adolescents (Chassin, Presson, Rose, & Sherman, 1996). Adult alcohol abuse can be similarly traced to drinking habits acquired during adolescence (Chapper, Buka, Goldfield, Lipsitt, & Tsuant, 1995). Considerable attention has focused on the socialization of these health risk behaviors out of concern that adolescence is a period of heightened susceptibility to peer pressures (Gardner & Steinberg, 2005). Peer socialization pressures may well be overstated, however, because most studies fail to account for the fact that youth tend to select peers and friends with similar smoking and drinking behaviors (Jaccard, Blanton, & Dodge, 2005; Urberg, 1999). In the present study, we utilize two methods to disentangle effects of peer socialization from antecedent similarity arising from selection. We apply these techniques to the study of peer socialization of adolescent alcohol consumption and cigarette smoking, and we examine whether selection and socialization processes differ for male and female adolescents.

Peer selection and socialization in smoking and drinking

Friends and members of peer groups tend to share similar sociodemographic, behavioral, and interpersonal characteristics (Cairns & Cairns, 1994; Kandel, 1978b; McPherson, Smith-Lovin, & Cook, 2001). At the dyadic level of analysis, this similarity has been referred to as homophily (Kandel, 1978a); at the group level, the tendency of peer group members to resemble each other is known as homogeneity (Cohen, 1977). Homophily and homogeneity are thought to unfold according to a two-step

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process (Urberg, Luo, Pilgrim, & Değirmenciöğlü, 2003). The first step, selection, involves acquiring friends or joining a peer group on the basis of pre-existing similarities. The second step, socialization, describes the tendency of friends and peer group members to grow more similar to one another in response to peer modeling and pressures to conform. These processes function in a complementary manner (Caspi, 2002), but their relative contributions to explaining behavioral similarity differ as a function of the type of deviant behavior under investigation.

There is some agreement on the sources of similarity in cigarette smoking. Most studies indicate that selection plays a significant role in similarity between friends and peer group members (e.g., De Vries, Candel, Engels, & Mercken, 2006; Ennett & Bauman, 1994; Mercken, Snijders, Steglich, & De Vries, 2009b; Simons-Morton, Chen, Abrams, & Haynie, 2004). Socialization effects have also been reported, but these are generally smaller than selection effects (Engels, Knibbe, Drop, & de Haan, 1997; Mercken, Candel, Willems, & de Vries, 2009a). Those studies, mainly carried out among early adolescents, that have reported gender differences usually indicate that females are more susceptible to peer pressure and peer norms for smoking (Chassin, Presson, Sherman, Montello, & McGrew, 1986; Hu, Flay, Hedeker, Siddiqui, & Day, 1995; Sarason, Mankowski, Petersen, & Dinh, 1992), but the evidence is not entirely consistent (Urberg, Cheng, & Shyu, 1991; Urberg, Değirmenciöğlü, & Pilgrim, 1997).

The empirical findings describing selection and socialization in alcohol use are less conclusive. Some studies have reported that peer socialization accounts for most of the similarity (Sieving, Perry, & Williams, 2000; Steglich, Snijders, & Pearson, in press); other research indicates that similarity is primarily a product of peer selection (Farrell, 1994; Fisher & Bauman, 1988; Knecht, Burk, Weesie, & Steglich, in press; Poelen, Engels, Van der Vorst, Scholte, & Vermulst, 2007). One study suggests that selection and socialization both account for a substantial amount of similarity between friends (Popp, Laursen, Burk, Kerr, & Stattin, 2008). Some studies have reported that females (Schulenberg et al., 1999; Simons-Morton, Haynie, Crump, Eitel, & Saylor, 2001) or males (Suls & Green, 2003) are more susceptible to the socialization of alcohol use, while other studies have been unable to find any difference between genders (Urberg et al., 1997).

The primary aim of the present study was to examine the relative importance of peer selection and socialization in adolescent alcohol and tobacco use. Because alcohol use has more of a social component than tobacco use (see Maxwell, 2002; Steglich et al., in press), we expected that selection and socialization would both contribute to similarity of alcohol use, but that selection would account for more similarity in cigarette smoking than would socialization. A secondary aim of this study was to examine potential gender differences in peer selection and socialization. Considering that previous studies have reported somewhat inconsistent results involving gender differences on socialization relating to alcohol and tobacco use, and this study is one of the first to examine gender as a possible moderator of selection processes, we did not make any specific predictions about gender differences on tobacco- and alcohol-related selection and socialization.

Actor-based models of network-behavioral dynamics and multi-level modeling in the investigation of peer selection and socialization

Friendships do not occur in isolation. Rather, relationships among peers occur in an environment consisting of a multitude of interconnected dyadic relationships, commonly referred to as peer networks. Although dyads are an integral part of most groups, each is thought to make distinct contributions to individual adjustment (Laursen, 2005). While an increasing number of studies have utilized peer network analyses to examine selection and socialization processes in children and adolescent peer networks, most previous research examining peer selection and socialization have limited analysis to orthogonal friendship dyads (Kandel, 1978a; Popp et al., 2008; Urberg, 1992; Urberg, Değirmenciöğlü, & Tolson, 1998) and non-overlapping peer groups (Cairns & Cairns, 1994; Ennett & Bauman, 1994; Kiuru, Aunola, Nurmi, Leskinen, & Salmela-Aro, 2008; Urberg et al., 1997). Similarity prior to the formation of a friendship or peer group is interpreted as evidence of selection. After a friendship or peer group has formed, subsequent increases in similarity are interpreted as evidence of socialization. At the dyadic level, selection and socialization are often estimated from correlations or, more recently, from path analyses utilizing the Actor-Partner Interdependence Model (Kashy & Kenny, 2000; Kenny & Cook, 1999, for applications see also Popp et al., 2008, Van Dulmen & Goncy, 2010, from this special issue). At the group level, selection and socialization are typically analyzed with some form of multi-level modeling (Muthén, 1997, Raudenbush & Bryk, 2002; for applications in the peer group context see also Espelage, Holt, & Henkel, 2003; Kiuru et al., 2008; Ryan, 2001). Each approach suffers from two important limitations. First, youth are typically restricted to membership in either a single friendship or a unique (non-overlapping) peer group. Identification of independent dyads or peer groups is a prerequisite for most analytic techniques, which necessarily excludes some relationships and individuals. Second, selection and socialization are typically examined using independent and unique samples. Selection is examined in new friendships or peer groups, whereas socialization is examined in a different sample of youths whose friendships or peer groups already exist. This procedure makes it difficult to directly compare the magnitude of selection and socialization effects.

Longitudinal social network analysis (Snijders, 2001, 2005) and network-behavioral analysis (Burk, Steglich, & Snijders, 2007; Snijders, 2009; Snijders, Steglich, & Schweinberger, 2007) offer an alternative strategy that overcomes both of these limitations. These models are capable of using all peer nominations (both reciprocal and non-reciprocal) within peer networks, while accounting for interdependencies inherent in sociometric data. These methods also simultaneously estimate the effects of selection and socialization within peer networks, which provides more precise estimates of selection and socialization than methods requiring separate analyses. These actor-based models have been successfully used to estimate selection and socialization relating to alcohol use (Knecht et al., in press; Steglich, Snijders, & West, 2006) and tobacco use

(Mercken et al. 2009b; Pearson, Steglich, & Snijders, 2006) within adolescent peer networks. Yet, there has been little consideration of how findings from these methods relate to the results from more conventional analytic methods. The present study applies actor-based models of network-behavioral dynamics to school-based peer networks and uses multi-level modeling to examine changes in individual behaviors for adolescents entering new peer groups and those in stable peer groups that are embedded within these school-based networks. One key aim of the present study was to explore similarities and differences in the results from each analytical approach. Even though contextual effects have been increasingly investigated in adolescent development, still only little is known about the effect of particular data analytic methods on the findings.

Method

Participants and procedure

The participants were 1419 Finnish students (690 females, 729 males) who were asked to complete questionnaires twice during the first and second years of their post-comprehensive education (i.e., one year lag between measurements). At the beginning of the study participants' average age was 16 ($M = 16.36$ years; $SD = 1.49$). Age among 95% of the participants ranged from 15 to 17 years, while 5% of the participants were 18 years or older. Participants were drawn from the broader ongoing FinEdu study, which consists of all students in one medium-sized Finnish town (population 88,000) who entered post-comprehensive education (i.e., senior high schools, vocational schools) six months prior to the initial data collection. Data were collected in January 2005 and in January 2006. We subsequently refer to the initial assessment as "age 16" and the follow-up assessment as "age 17". The present study is limited to participants attending the nine schools (5 senior high schools, 4 vocational schools) with participation rates greater than 65% at both measurement points, a figure consistent with recommendations for minimum participation in peer nomination studies (Cillessen, 2009). Participation rates of these schools ranged from 69% to 98% ($M = 85.44$, $SD = 10.92$) at age 16 and from 67% to 97% ($M = 81.00$, $SD = 9.62$) at age 17. Students in four schools (three vocational schools and 1 senior high school) were excluded because of low participation rates. Questionnaires were administered in groups during regular school hours. The questionnaires were placed into envelopes which were immediately sealed.

Measures

Tobacco use

Youth smoking behaviors were assessed on the basis of self-reported frequency of smoking tobacco using a measure from the Finnish National School Health Survey (Rimpelä, 2003) in the form of the question "Which best describes your smoking?" Response categories ranged from 1 = *I never have smoked* to 5 = *at least once a day*. The 2007 ESPAD report (Substance Use Among Students in 35 European Countries) has shown that the prevalence of cigarette smoking among Finnish adolescents (30% of the adolescents) is at the average European level (Hibell et al., 2009).

Alcohol use

Alcohol use by youths was assessed on the basis of self-reported frequency of alcohol consumption, using a measure from the Finnish National School Health Survey (Rimpelä, 2003) in the form of the question "How often do you drink alcohol?" Response categories ranged from 1 = *never* to 5 = *at least once a week*. The 2007 ESPAD report (Substance Use Among Students in 35 European Countries, Hibell et al., 2009) has shown that the proportion of Finnish students reporting alcohol consumption during the past 12 months (77%) was somewhat lower than European average, but nearly half of the students (45%) had been drunk during the same period. The volumes of alcohol consumed during their most recent occasion of drinking (5.7 cl alc.100%) were also somewhat higher among Finnish adolescents than the European average.

Sociometric nominations

Each year participants were asked to nominate up to three same-grade schoolmates with whom they most liked to spend time. Cross-sex nominations were permitted. The number of nominations made by each participant ranged from 0 to 3 (age 16: $M = 2.50$, $SD = 0.96$; age 17: $M = 2.42$, $SD = 1.09$). The number of nominations received by each participant ranged from 0 to 8 at age 16 ($M = 2.04$, $SD = 1.54$) and from 0 to 11 at age 17 ($M = 1.74$, $SD = 1.53$).

School-based peer networks were delineated using sociometric data from each of the nine participating schools. Peer networks ranged in size from 74 to 470 ($M = 157.67$, $SD = 122.93$) students. Each network is formally represented by two adjacency matrices consisting of dichotomous cells. Each $n \times n$ matrix (with n representing the number of students in a school) represents nomination data collected at one discrete time point. So, in each of the 18 adjacency matrices (9 schools with 2 time points), a peer tie directed from actor i (the nominator) to actor j (the nominee) is either present ($x_{ij} = 1$) or absent ($x_{ij} = 0$). At both points in time, more than half of the peer nominations were reciprocated in each school-based peer network (range from 47% to 69% across); on average nearly one-third of peer nominations involved cohesive relational structures of at least three individuals (range from 19% to 40% across schools).

Cohesive peer groups were also identified using the school-based sociometric data. Peer groups were defined according to the following criteria: (1) at least 50% of a person's reciprocal and unilateral links were within the peer group and (2) there

was a reciprocal, unilateral, or indirect link from each member to every other member of the peer group. Participants were assigned to a group only if both group membership criteria were met. Participants with links to multiple peer groups were assigned to the group in which they had their strongest ties (for details of the strategy of peer group identification and its validity, see Kiuru et al., 2008; Kiuru, Nurmi, Aunola, & Salmela-Aro, 2009; Laursen et al., in press). A total of 319 peer groups (150 groups consisting of females, 136 groups consisting of males, and 33 mixed-sex groups) were identified at age 16, and 288 peer groups (136 groups consisting of females, 114 groups consisting of males, and 38 mixed-sex groups) were identified at age 17. The size of peer groups ranged from 2 to 9 at age 16 ($M = 3.44$, $SD = 1.41$) and at age 17 ($M = 3.30$, $SD = 1.23$).

Analytic strategy

We initially performed repeated measures MANOVAs to examine changes in alcohol and smoking behaviors over time and to test differences in substance use behaviors for males and females. The primary analyses to capture peer context involved actor-based modeling of network-behavioral dynamics and multi-level modeling with individuals nested within peer groups. One key aim of the present study was to explore similarities and differences arising when using each analytical approach.

Actor-based models of network-behavioral dynamics

Selection and socialization effects in adolescent peer networks were assessed using actor-based models of network-behavioral dynamics (Snijders, Steglich, & van de Bunt, 2010), which were specified using the Simulation Investigation for Empirical Network Analyses (SIENA) software program (Snijders, Steglich, Schweinberger, & Huisman, 2007). First, observed network autocorrelations (Moran's I, for formulae and interpretation, see Ripley, 1981, see also Steglich et al., in press) for tobacco and alcohol use were preliminarily investigated to estimate the degree of similarity among peer associates. A network autocorrelation measures the extent to which the value of the variable in question is similar between tied actors. It is close to zero if a variable is independent of the network and close to 1 when actors are almost identical to each other. Then, two models were performed for each of the nine school-based peer networks, one examining the dynamics of tobacco use, and the other examining the dynamics of alcohol use. Parameters estimating peer selection (youth selecting peers with similar substance use) and socialization (youth becoming more similar to the behaviors of peer associates) were tested in each model, which also included parameters estimating several endogenous effects of peer network structure (reciprocity, selectivity, and transitivity), individual behavioral tendencies, and gender differences in friendship and behavioral dynamics.

Changes in relationship ties and changes in individual behaviors were modeled by rate functions, which represent the amount of change in peer networks and individual behaviors observed between the two time points; and objective functions, which represent the types of changes in relationships and individual behaviors. Collectively, these functions stochastically model the total amount of change between observations into the most likely sequence of small changes (micro-steps). Parameters and standard errors are generated using computer simulations within a continuous-time Markov Chain Monte Carlo framework. This method allows missing sociometric and behavioral information, but missing values do not affect the statistical significance of parameter estimates. To simplify the presentation of the results for the nine schools, we employed the meta-analytic procedure developed by Snijders and Baerveldt (2003). This technique provides two statistics for each estimated parameter: the mean parameter represents an unstandardized estimate aggregated across individual school-based peer networks; the standard deviation parameter represents the degree to which estimates vary across school-based networks. The statistical significance of mean parameters was determined by dividing the estimate by its standard error, and was tested using the t -ratio, which follows an approximately normal distribution; the significance of standard deviation parameters was determined with a chi-square difference test with 8 degrees of freedom (number of schools minus one).

Additional actor-based models were also estimated to examine gender differences in selection and socialization effects relating to adolescent smoking and drinking. Specifically, these models included two interaction terms to test whether males or females are more likely to select peer associates with similar smoking and drinking behaviors (moderation of selection) and to test whether males or females are more likely to adopt the smoking and drinking behaviors of their peers (moderation of socialization). The joint and unique contribution of these effects was determined with modified Neyman–Rao score tests (see Snijders et al., 2010). The statistical significance of these interactions was determined by chi-square difference tests, which indicate whether or not each interaction significantly improves the fit of the simulated models to the observed data.

Multi-level models with individuals nested within peer groups

Selection and socialization effects were examined within peer groups using multi-level models with individuals nested within peer groups (Kiuru, Aunola, Vuori, & Nurmi, 2007; Kiuru et al., 2008, 2009; for description of multi-level modeling see also Duncan et al., 1997; Muthén, 1997). These analyses, which were performed with the Mplus statistical package (Muthén & Muthén, 1998–2007), assessed the proportion of the total variance that may be attributed to within-group homogeneity (i.e., degree of peer group similarity). Intraclass correlations (ICC) are calculated by dividing the between-group variance by the total variance (total variance = between-group variance + within-group variance). This differentiation of the variance requires non-overlapping peer groups.

Two types of peer groups were identified to investigate peer selection and socialization within peer groups. *Stable peer groups* remained unchanged from age 16 to age 17 or added less than 50% of new members from age 16 to age 17. A total of 120 peer groups (65 groups consisting of females, 45 groups consisting of males, and 10 mixed-sex groups) met this criterion. *New peer groups* describes peer groups that did not exist at age 16 but that did exist at age 17. A total of 88 peer groups (40 groups

consisting of females, 37 groups consisting of males, and 11 mixed-sex groups) met this criterion. Small samples precluded further analysis of mixed-sex peer groups. Consequently, the peer group sample included 603 adolescents (331 females, 272 males) participating in one of the 110 stable peer groups ($n = 330$) or in one of the 77 new peer groups ($n = 273$).

To assess *selection*, we examined within-group behavioral homogeneity among the members of new peer groups at age 16. Intraclass correlations between the members in new peer groups were calculated separately at age 16 (prior to group formation) and at age 17, (concurrently) using peer group membership at age 17 as the clustering measure. Evidence for selection was demonstrated if members of new peer groups at age 17 were similar in regard to their drinking or smoking behaviors at age 16. To assess *socialization*, we examined the change in behavioral similarity from age 16 to age 17 among adolescents who were members of stable peer groups. This was done by testing the difference between the intraclass correlations at age 16 and 17 among members of stable peer groups. Statistical significance of the difference in ICC estimates from age 16 to age 17 was determined by dividing the estimate of the ICC difference by its standard error (t -values). Evidence for socialization is demonstrated if adolescents in stable peer groups become more similar in behavior over time in regard to their substance use. Gender differences in peer group homogeneity and in selection and socialization effects were examined using a multi-group approach that compares estimates from separate models for male and female peer groups. To control for school differences we added dummy variables as predictors at the peer group level to adjust the ICC estimates for the school effects. The standard MAR approach (*missing at random*) was applied. The parameters of the models were estimated using full-information maximum likelihood estimation with non-normality robust standard errors (*MLR estimator*; Muthén & Muthén, 1998–2007).

Comparison of the peer group subsample and the total peer network sample

The peer group subsample ($n = 603$; members of new and stable peer groups embedded within school-based peer networks) used in multi-level analyses was compared to the total peer network sample ($n = 1419$; all adolescents in school-based peer networks) used in SIENA analyses in terms of mean level smoking and drinking as well as network characteristics by using one-sample t -tests. In these analyses the means of the peer group subsample ($n = 603$) were compared to means of the total network sample ($n = 1419$). The results showed that the mean level smoking (age 16: $M = 2.37$, $SD = 1.67$; age 17: $M = 2.43$, $SD = 1.65$) and drinking (age 16: $M = 2.53$, $SD = 1.24$; age 17: $M = 2.90$, $SD = 1.22$) of the members of the peer group sample did not significantly differ ($p > .05$) from those of the broader peer network sample (smoking at age 16: $M = 2.42$, $SD = 1.68$; smoking at age 17: $M = 2.54$, $SD = 1.70$; drinking at age 16: $M = 2.60$, $SD = 1.25$; drinking at age 17: $M = 2.98$, $SD = 1.23$).

The differences were, however, found in terms of network characteristics. The members of the peer group sample, both at age 16 and 17, were more popular (number of received nominations at age 16: $M = 2.39$, $SD = 1.48$, $t(602) = 5.90$, $p < .001$; number of received nominations at age 17: $M = 2.24$, $SD = 1.40$, $t(602) = 8.78$, $p < .001$). They were also more active (number of given nominations at age 16: $M = 2.65$, $SD = 0.78$, $t(559) = 4.57$, $p < .001$; number of given nominations at age 17: $M = 2.68$, $SD = 0.81$, $t(520) = 7.29$, $p < .001$) and had more reciprocal nominations (number of reciprocal nominations at age 16: $M = 1.49$, $SD = 0.92$, $t(546) = 4.16$, $p < .001$; number of reciprocal nominations at age 17: $M = 1.48$, $SD = 0.92$, $t(520) = 6.88$, $p < .001$) in comparison to the broader peer network sample (popularity at age 16: $M = 2.04$, $SD = 1.54$, popularity at age 17: $M = 1.74$, $SD = 1.53$; activity at age 16: $M = 2.50$, $SD = 0.96$; activity at age 17: $M = 2.42$, $SD = 1.09$; reciprocal nominations at age 16: $M = 1.33$, $SD = 0.97$, reciprocal nominations at age 17: $M = 1.20$, $SD = 1.01$). These results confirm the view that the peer group sample (new and stable peer groups) is a particularly cohesive subsample of the broader peer network.

Results

The results will be presented in the following order. First, we present the results of preliminary analyses (repeated measures MANOVAs). Second, we present results for peer selection and socialization by using actor-based models of network-behavioral dynamics. Finally, the results for peer selection and socialization by using multi-level models within individuals nested within peer groups will be presented.

Preliminary analyses

Repeated measures, 2 (gender) by 2 (age: 16 and 17) MANOVAs, were conducted with drinking and smoking as dependent variables. Adolescent drinking increased from age 16 ($M = 2.52$, $SD = 1.22$) to age 17 ($M = 2.92$, $SD = 1.22$, $F(1,894) = 155.99$, $p < .001$, $partial\eta^2 = 0.15$). Males ($M = 2.79$, $SD = 1.22$) drank slightly more than females ($M = 2.65$, $SD = 1.22$, $F(1,894) = 4.42$, $p < .05$, $partial\eta^2 = 0.01$). Smoking also increased as a function of time, but this effect was moderated by gender ($F(1,891) = 7.77$, $p < .01$, $partial\eta^2 = 0.01$). Follow-up analyses indicated that smoking increased among males from age 16 to age 17 (age 16: $M = 2.29$, $SD = 1.66$; age 17: $M = 2.54$, $SD = 1.71$, $F(1,443) = 21.60$, $p < .001$, $partial\eta^2 = 0.05$), but not among females (age 16: $M = 2.31$, $SD = 1.62$; age 17: $M = 2.36$, $SD = 1.63$, $F(1,448) = 1.57$, $p < .21$, $partial\eta^2 = 0.003$).

Selection and socialization in peer networks: actor-based models of network-behavioral dynamics

The initial investigation of observed autocorrelations (Moran's I) showed that the average network autocorrelation (Moran's I) in school-based peer networks was 0.38 for smoking and 0.30 for drinking, suggesting relatively high similarity in

substance use among peer associates. Table 1 presents the means and standard deviations of parameter estimates for the dynamic modeling of selection and socialization in peer networks regarding the smoking and drinking habits. In both models, the parameters accounting for network structure emerged as statistically significant. Adolescents did not indiscriminately nominate schoolmates as peers (outdegree), peer nominations tend to be reciprocated (reciprocity), dyadic friendships tend to form cohesive triadic relational structures (transitivity), and youth vary in their attractiveness as relationship partners (popularity of alter). The effects of gender on peer network dynamics indicated that males and females did not differ on the number of nominations made (gender ego) or received (gender alter), but males and females did tend to nominate peers of the same gender (gender similarity). The magnitude of these effects did not significantly differ between schools, with the exception of the reciprocity parameter.

Tobacco use

The results for parameters estimating the effects of tobacco use on peer network dynamics (Table 1) showed that youths tended to select peers with similar levels of tobacco use (attribute similarity, *peer selection*). Smoking was associated with receiving more peer nominations (attribute alter), but was unrelated to the number of nominations made (attribute ego). Parameters estimating behavioral dynamics of smoking (Table 1) indicated the average smoking behavior was slightly below the mid-point of the scale (less than once a week, linear tendency), and changes in tobacco use significantly differed as a function of initial levels (quadratic tendency). That is, those who initially reported light smoking were more apt to subsequently report heavier smoking at a later time. Individual smoking behaviors differed for males and females, with males reporting a greater increase in smoking compared to females (effect from gender). Finally, youths did not adopt the smoking behaviors of the peers they had nominated (total behavior similarity, *peer socialization*). That is, the average smoking behaviors of peers did not predict changes in adolescent smoking behaviors over time. These effects did not differ between school-based peer networks, with the exception of initial prevalence in smoking behaviors. Collectively, these results indicate that adolescents selected peers with similar smoking behaviors, but did not change their smoking behaviors to become more similar to their peer associates.

Alcohol use

The results for parameters estimating the effects of alcohol use on network dynamics (Table 1) showed that adolescents tended to select peers with similar levels of drinking (attribute similarity, *peer selection*). Drinking was not significantly associated with the number of nominations received (attribute alter) and made (attribute ego). Parameters estimating the behavioral dynamics of alcohol use (Table 1) indicated a normal distribution ranging from non-drinkers to heavy drinkers, with an average trajectory resulting in scores above the scale mid-point (approximately once a month; linear tendency). Males and females did not differ in change of drinking behaviors (effect of gender). Finally, adolescents tended to adopt the drinking behaviors of their peers (total behavior similarity, *peer socialization*). In other words, both selection and socialization effects involving alcohol use were detected. Standard deviation estimates suggest that these effects did not differ between

Table 1
Dynamic Modeling of Selection and Socialization in Peer Networks: Mean and Standard Deviation Estimates for Smoking and Alcohol Use.

	Smoking				Alcohol use			
	Mean parameter		Standard deviation		Mean parameter		Standard deviation	
	Estimate	SE	Estimate	χ^2	Estimate	SE	Estimate	χ^2
<i>Network dynamics</i>								
Network rate	5.83	0.33	0.56*	20.11	5.70	0.44	0.95***	25.41
Outdegree	-2.54***	0.13	0.00	8.35	-2.18***	0.23	0.47	14.20
Reciprocity	2.01***	0.15	0.36***	29.85	2.00***	0.16	0.38***	31.22
Transitivity	0.54***	0.03	0.00	3.96	0.55***	0.03	0.00	7.50
Popularity of alter (squared)	-0.28***	0.06	0.00	8.16	-0.36***	0.07	0.11	19.17
Gender ego	-0.11	0.08	0.00	6.92	-0.08	0.08	0.00	6.86
Gender alter	0.12	0.08	0.00	6.24	0.13	0.09	0.00	7.96
Gender similarity	0.80***	0.10	0.14	10.57	0.78***	0.11	0.22	13.12
Attribute ego	-0.04	0.03	0.00	9.36	-0.05	0.04	0.00	7.02
Attribute alter	0.08**	0.03	0.00	8.26	0.07	0.04	0.00	4.38
Attribute similarity (selection)	0.53***	0.12	0.00	7.74	0.90*	0.37	0.84	8.83
<i>Behavioral dynamics</i>								
Behavioral rate	1.60	0.17	0.00	21.07	1.44	0.11	0.00	10.38
Linear tendency	-0.26	0.17	0.35***	32.08	0.27***	0.06	0.00	12.57
Quadratic tendency	0.43***	0.03	0.00	3.97	0.03	0.04	0.00	8.01
Effect from gender	0.29*	0.12	0.00	10.84	-0.03	0.11	0.00	5.71
Total similarity (socialization)	0.04	0.28	0.00	8.03	0.78**	0.28	0.00	7.99

Note. Statistical significance of the mean parameter estimates is obtained by an approximate normal distribution applied the *t*-ratio of the estimate divided by its standard error (*SE*). Significance of the standard deviation estimates is based on an approximate chi-square test with eight degrees of freedom (number of schools minus 1). Gender is coded 1 for females and 2 for males. ****p* < .001 ***p* < .01 **p* < .05 (two-tailed test)

Note 2. ¹ 1 = female, 2 = male.

schools. Collectively, these results indicate that adolescents not only selected peers with similar drinking behaviors, but also changed their smoking behaviors to become more similar to their peer associates.

Gender as a moderator of selection and socialization

Additional models of alcohol and tobacco use included interactions testing gender differences in the selection of peers using substances (gender ego by attribute similarity) and in regard to the socialization of substance use (gender ego by total behavior similarity). In all cases, score tests failed to detect joint or unique effects, collectively indicating that gender did not moderate the effects of selection (score test for alcohol use: $\chi^2(9) = 20.47, p = .31$; score test for tobacco use: $\chi^2(9) = 19.42, p = .36$) or socialization (score test for alcohol use: $\chi^2(9) = 15.20, p = .65$; score test for tobacco use: $\chi^2(9) = 16.67, p = .55$) related to either alcohol or tobacco use.

Selection and socialization in cohesive peer groups: multi-level models with individuals nested within peer groups

Tobacco use

Table 2 presents intraclass correlations that describe behavioral similarity within new and stable peer groups. There was evidence of selection regarding tobacco use among new peer groups, but there was no evidence of socialization among stable peer groups. In fact, peer group homogeneity in tobacco decreased from age 16 to age 17 (see Table 2). The results did not change when adjusting for differences between schools.

Alcohol use

New peer groups provided evidence of selection in regard to drinking behaviors (Table 2). The effect for socialization in stable peer groups, in turn, was marginally significant ($p < .10$, two-tailed test). The results did not change when adjusting for differences between schools.

Gender differences in selection and socialization

Additional analyses examined whether selection and socialization effects differed for male and female peer groups. Of the four contrasts conducted, gender differences emerged for one: Females in new peer groups reported more similar drinking behaviors at age 16 than their male counterparts (*Estimate of ICC_{difference}* (females minus males) = 0.26, *S.E.* = 0.12, $p < .05$), suggesting a stronger selection effect for females than males. The addition of school dummy variables did not change this pattern of results.

Discussion

In order to capture the dynamic nature of the peer context, we applied two new statistical techniques to investigate selection and socialization processes related to alcohol and tobacco use. Actor-based models of peer network-behavior dynamics and multi-level modeling of individuals embedded within new and stable peer groups produced similar results. For smoking, there was evidence of peer selection, but not peer socialization. For drinking, evidence of both selection and socialization. Gender did not moderate peer socialization but some indication was found that females were more similar in their drinking behavior to peer group members than males. The results were, for the most part, consistent across analytic techniques, although modest differences emerged.

Smoking behavior

Consistent with previous studies, the results showed that adolescents displayed a strong tendency to choose new peers and peer groups based on similarity in tobacco use (Ennett & Bauman, 1994; Steglich et al., in press; Urberg et al., 1998), but

Table 2
Multi-level Modeling for Peer Selection and Socialization in Peer Groups: Intraclass Correlations (ICC) for Smoking and Alcohol Use.

	Smoking	Alcohol use
<i>New peer groups</i>		
Age 16 (prior to group formation, selection)	0.50***	0.43***
Age 17 (concurrently)	0.49***	0.33***
<i>Stable peer groups</i>		
Age 16	0.55***	0.30***
Age 17	0.37***	0.41***
Δ ICC (age 17 minus age16, socialization ^a)	-0.18*	0.11+

Note. New peer groups: ($N_{\text{between}} = 77, N_{\text{within}} = 273$); Stable Peer Groups: $N_{\text{between}} = 110, N_{\text{within}} = 330$.

*** $p < .001$, ** $p < .01$, * $p < .05$, + $p < .10$ (two-tailed test).

^a Evidence of socialization, when Δ ICC (age 17 minus age 16) is positive and statistically significant (i.e., increased similarity from age 16 to age 17).

adolescents did not adopt the smoking behaviors of peer associates and peer group members (Mercken et al., 2009a, Simons-Morton et al., 2004; Urberg et al., 1997). The actor-based models also indicated that changes in smoking behavior differed as a function of initial levels of smoking. That is, males reported increases in smoking, whereas females did not; adolescents reporting light smoking were more likely to report heavier tobacco use at a later time. Furthermore, these models also accounted for differences between smokers and non-smokers in terms of sociometric popularity. Adolescents with a high level of smoking tended to receive more peer nominations than those who did not smoke.

One possible explanation for these results is that smoking is an addictive activity. Once smokers have started smoking, they may become addicted and thus the social influences on smoking may then become less important for smoking progression (see also Cotterell, 2007). Alternatively, adolescents who smoke may enjoy spending time with other adolescents who also smoke, for example, because they wish to share smoking activities with like-minded peers (see also Zeggelink, 1994). Spending time with other adolescents who smoke may also reinforce their “smoker” identity and a sense of belonging to “cool” peer groups (see also Nichter, Nichter, Vuckovic, Quintero, & Ritenbaugh, 1997). Other adolescents, in turn, who rather value non-smoking and other healthy behaviors may be attracted to one another and avoid smokers. Another likely explanation for the relatively stronger effect of selection compared to socialization, in regard to smoking, is social segregation. For example, it may be that as society separates smokers from non-smokers (i.e., smoking designated areas), smokers may be more likely to establish first contact with other smokers and then affiliate with each other (see also Van de Bunt, Van Duijn, & Snijders, 1999). Finally, it should be noted that high levels of initial similarity, as it was the case in our study, makes it more difficult to detect effects of smoking socialization (see also Cohen, 1983).

Our results suggesting that smoking is driven by selection and not socialization has important implications for school and health authorities in how to deal with the smoking trends of adolescents. For example, researchers and the general public should shift their focus from peer socialization as the most significant contributor to adolescent smoking over to peer selection in order to be able to deal with the issue more effectively. In other words, in addition to promoting abilities to resist peer pressure, interventions should focus on *prevention* efforts on the choice of peers and on reducing the perception that smoking is “cool”.

Drinking behavior

Adolescents selected peer associates based on similar drinking behaviors and were socialized by the drinking behaviors of their peer associates and peer group members. Alcohol use increased from age 16 to age 17, but drinking behaviors did not differ as a function of gender or sociometric popularity. Evidence for socialization of alcohol use, but not of tobacco use, underscores the more social nature of drinking among peers (Maxwell, 2002; Steglich et al., *in press*). For most adolescents drinking is likely to take place in informal social settings, such as discos and private parties with peers (see also Harford & Spiegler, 1983). In Finland, where the legal age of drinking is 18, adolescent drinking most often takes place in private settings and without parental supervision.

Peer pressure to drink can be direct, such as an offer to have a drink, other verbal encouragement, and teasing (Oetting & Beauvais, 1986), or may operate in a more subtle way, such as via internal self-pressure to drink and conform to group norms in order to gain social approval and facilitate social interactions (see also Petraitis, Flay, & Miller, 1995). Even though experimentation with alcohol and tobacco may be considered as normative during adolescence (Hops, Davis, & Lewin, 1999), it is important to keep in mind that peer groups vary widely in terms of their values, norms, and attitudes (Brown, 1990). Peer socialization towards drinking has been found to be highest when drinking is reinforced by normative support from peers (see also Harford & Grant, 1987). In other words, experience with alcohol and attitudes favoring drinking may be related to popularity and high status in the peer group only when peer group norms encourage drinking. Non-drinking peer groups, in turn, may exert considerable pressure on their members to reduce drinking or to not drink at all. Consequently, depending on the peer context, a higher level of alcohol consumption or abstinence from drinking may provide a means of attaining social status, social support, and behavioral confirmation (Knecht et al., *in press*; Lindenberg, 1990).

Our result suggesting that drinking is driven by both selection and socialization, has many implications. From the scientific point of view, even though substance use is likely to co-occur (Jessor & Jessor, 1977; Johnson, Boles, Vaughan, & Kleber, 2000), peer processes seem to operate in a different way when comparing smoking and drinking. Thus, analyzing only a composite score of using *any* substances, that is, smoking and drinking not being differentiated, may hide some important aspects regarding social processes involved in different types of substance abuse. From the practical point of view, the fact that peer socialization in drinking is partly a group phenomenon should be taken seriously when searching for methods of preventing adolescent drinking. Even though promoting the ability of individual adolescents to resist peer pressure to drinking through social skills and stress management (Byrne & Mazanov, 2005) may be important, it may be even more effective to target intervention efforts to the whole peer network to change predominant group norms (see also Salmivalli, Kaukiainen, & Voeten, 2005). Another effective method may be to utilize identified peer group leaders as agents of social change (see also Miller-Johnson & Costanzo, 2004).

Gender as a moderator

Finally, the present study examined whether or not gender moderates the strength of peer selection and socialization processes in smoking and drinking. The results of the actor-based and multi-level models provided no evidence of gender

moderation in *socialization* of either smoking or drinking behaviors. Actor-based models also failed to detect statistically significant differences between the likelihood of males and females to *select peer* associates with similar smoking and drinking behaviors. Multi-level models, on the other hand, indicated that females were more similar to their new peer group members' drinking behaviors prior to group formation. This result suggests that females are particularly motivated to be friends with other females whose drinking behavior is similar to their own. In itself, studying whether gender moderates selection in smoking and drinking is unique to this study. The result showing stronger peer selection in drinking among females compared to males is, however, in accordance with some previous studies showing that females attribute greater importance to peer group membership than is the case with males (Crockett, Losoff, & Petersen, 1984). It is noteworthy, however, that evidence of gender moderation in selection was found only among cohesive *peer groups*, but not in broader *peer networks*. Consequently, there is an evident need for further studies to reveal more detail regarding what kind of role gender plays in the peer processes involved in drinking and other substance use behaviors. Furthermore, more research is needed regarding other potential moderators of selection and socialization, such as group norms, reciprocity, and personality characteristics (see also Bot, Engels, Knibbe, & Meeus, 2005).

Estimating selection and socialization by using actor-based network-behavioral models and multi-level modeling

One major aim of the present study was to explore the extent to which multi-level modeling for non-overlapping peer groups and dynamic methods for entire school-based peer networks yield similar results. Both methods provided identical results for smoking behavior, that is, *peer selection* was found to be an influential factor while *socialization* did not appear to take place. Furthermore, the results of both methods applied to the study of drinking behavior were similar in general, but differed somewhat in the relative importance of selection and socialization. Multi-level modeling for peer groups provided evidence for peer selection but the effect of peer socialization was only marginally significant. Actor-based network-behavioral models, in turn, showed statistically significant effects of both selection and socialization with equal importance.

There are at least three possible explanations for this result. First, it is possible that sensitivity of statistical tests was somewhat lower in multi-level analyses for non-overlapping new and stable peer groups due to lower sample size in comparison to that of dynamic network analyses that encompassed the entire peer network. Second, it is also possible that the magnitude of peer socialization became somewhat underestimated in multi-level analyses for peer groups because the analyses were restricted to the study of adolescents with membership in only a unique and non-overlapping stable peer group. Third, difference in the cohesiveness of two analysis samples may also provide one explanation: only highly cohesive non-overlapping peer groups were analyzed in multi-level models, whereas network-behavioral models analyzed the entire peer network consisting of all reciprocal and non-reciprocal peer ties. If the initial similarity of adolescents in cohesive peer groups is particularly high, it leaves only limited potential for peer socialization. In turn, when analyzing the whole peer network and including the analysis of the different types of peer relationships the initial similarity between peers may have varied more, thus leaving more room for socialization. These potential differences highlight a need to utilize these different methods in a complementary manner. The actor-based models, which simultaneously estimate changes in peer network and individual behavior dynamics, seem to provide estimates that may be more easily generalized to dyadic processes within the entire peer network. Multi-level models, on the other hand, may be more appropriate in situations in which group processes are the focus and when there is little or no overlap between nested structures (groups).

Another difference in the results of multi-level modeling and actor-based peer network analysis was that gender moderated peer selection in drinking when using multi-level modeling for new peer groups, but not when using actor-based network analyses for whole school-based networks. These results may reflect differences in group and network processes in association with females' sensitivity to peer selection. There is, however, a need for future research to replicate this finding. Finally, an important future challenge would be to compare the results of multi-level modeling and dynamic social network analyses for peer processes in regard to a broader array of behaviors and effects.

Limitations

Four limitations should be taken into account in any effort to generalize the results of this study. First, our study included older adolescents (16 years at the beginning of the study), and therefore the results can be generalized only to this age group. Peer socialization may be greater during the early adolescent years when conformity is highest (Berndt, 1979, see also Urberg et al., 1991, see also Aikins, Simon, & Prinstein, 2010, from this special issue). Second, peer relations were studied only among same-grade peers from the same schools. In other words, our study did not investigate peers from other schools and from other grade levels that have also been shown to be important actors in adolescents' peer groups (see also Kerr, Stattin, & Kiesner, 2007). Third, the method used to measure peer groups and networks allowed only three peer nominations. This may have artificially restricted the size of peer groups. Similarly, simulation-based dynamic social network analyses would have benefitted from additional information related to a larger repertoire of peer nominations. By contrast, allowing only three peer nominations emphasizes close peer choices, and therefore captures the most important peers that adolescents have. Fourth, our data were limited to self-reports of individual behaviors. Perceptions are an important component of all relationships and it may well be that concordances based on shared or public perceptions will yield a different pattern of results (Burk & Laursen, 2005, 2010).

Conclusion

In the current study we examined *selection* and *socialization* related to adolescent tobacco and alcohol use in peer networks and in cohesive peer groups using actor-based and multi-level modeling techniques. Both methods generally indicated a similar pattern of findings. Selection played a greater role than socialization for explaining similarity between smoking behaviors of peers, whereas both peer selection and socialization played a significant role in explaining similarity in drinking behaviors. Results did not consistently differ in regard to gender, however additional research is needed to identify individual and relational moderators of socialization processes related to adolescent adjustment. Recent advances in longitudinal social network methods seem to offer a promising alternative to traditional methods for disentangling selection and socialization processes and furthering our understanding of factors placing some youth at increased risk of yielding to peer pressure.

Acknowledgements

This study was part of a larger FinEdu project and was funded by grants from the Academy of Finland (134931, 213486) and the Jacobs Foundation. Support for the preparation of this manuscript was provided to Noona Kiuru by the Academy of Finland (7133146) and to Brett Laursen by the US National Institute of Mental Health (MH58116) and the US National Science Foundation (0923745).

References

- Aikins, J. W., Simon, V. A., & Prinstein, M. J. (2010). Romantic partner selection and socialization of young adolescents' behavior problems and substance use. *Journal of Adolescence*. Special issue: Capturing peer context.
- Berndt, T. J. (1979). Developmental changes in conformity to peers and parents. *Developmental Psychology*, *15*, 608–616.
- Bot, S. M., Engels, R. C. M. E., Knibbe, R. A., & Meeus, W. H. J. (2005). Friend's drinking behaviour and adolescent alcohol consumption: The moderating role of friendship characteristics. *Addictive Behavior*, *30*, 929–947.
- Brown, B. B. (1990). Peer groups and peer cultures. In S. S. Feldman, & G. R. Elliott (Eds.), *At the threshold: The developing adolescent* (pp. 171–196). Cambridge, MA: Harvard University Press.
- Burk, W. J., & Laursen, B. (2005). Adolescent perceptions of friendship and their associations with individual adjustment. *International Journal of Behavioral Development*, *29*, 156–164.
- Burk, W. J., & Laursen, B. (2010). Mother and adolescent reports of associations between child behavior problems and mother-child relationship qualities: Separating shared variance from individual variance. *Journal of Abnormal Child Psychology*, *38*, 657–667.
- Burk, W. J., Steglich, C. E. G., & Snijders, T. A. B. (2007). Beyond dyadic interdependence: Actor-oriented models for co-evolving social networks and individual behaviours. *International Journal of Behavioral Development*, *31*, 397–404.
- Byrne, D. G., & Mazanov, J. (2005). Prevention of adolescent smoking: A prospective test of three models of intervention. *Journal of Substance Use*, *10*, 363–374.
- Cairns, R. B., & Cairns, B. D. (1994). *Lifelines and risks: Pathways of youth in our time*. New York, NY: Cambridge University Press.
- Caspi, V. (2002). Social selection, social causation, and developmental pathways: Empirical strategies for better understanding how individuals and environments are linked across the life-course. In L. Pulkkinen, & A. Caspi (Eds.), *Paths to successful development. Personality in the life course* (pp. 281–301). USA: Cambridge University Press.
- Chaffer, R. L., Buka, S. L., Goldfield, E. C., Lipsitt, L. P., & Tsuang, M. T. (1995). Adolescent problem behaviors as predictors of adult alcohol diagnoses. *International Journal of the Addictions*, *30*, 507–523.
- Chassin, L., Presson, C. C., Rose, J. S., & Sherman, S. J. (1996). The natural history of cigarette smoking from adolescence to adulthood: Demographic predictors of continuity and change. *Health Psychology*, *15*, 478–484.
- Chassin, L., Presson, C. C., Sherman, S. J., Montello, D., & McGrew, J. (1986). Changes in peer and parent influence during adolescence: Longitudinal versus cross-sectional perspectives on smoking initiation. *Developmental Psychology*, *22*, 327–334.
- Cillessen, A. H. N. (2009). Sociometric methods. In K. H. Rubin, W. M. Bukowski, & B. Laursen (Eds.), *Handbook of peer interactions, relationships, and groups* (pp. 82–99). New York: Guilford.
- Cohen, J. (1983). Commentary: The relationship between friendship selection and peer influence. In J. L. Epstein, & N. Karweit (Eds.), *Friends in school* (pp. 163–176). New York: Academic Press.
- Cohen, J. M. (1977). Sources of peer group homogeneity. *Sociology of Education*, *50*, 227–241.
- Cotterell, J. (2007). In H. C. Coleman (Ed.), *Social networks in youth and adolescence* (2nd ed.) *Adolescence and society series* London/New York: Routledge/Taylor and Francis Group.
- Crockett, L., Losoff, M., & Petersen, A. C. (1984). Perceptions of the peer group and friendship in early adolescence. *Journal of Early Adolescence*, *4*, 155–181.
- De Vries, H., Candel, M., Engels, R., & Mercken, I. (2006). Challenges to the peer influence paradigm: Results for 12–13 years olds from six European countries form the European smoking prevention framework approach study. *Tobacco Control*, *15*, 83–89.
- Duncan, T. E., Duncan, S. C., Alpert, A., Hops, H., Stoolmiller, M., & Muthén, B. (1997). Latent variable modeling of longitudinal and multilevel substance use data. *Multivariate Behavioral Research*, *32*, 275–318.
- Engels, R. C., Knibbe, R. A., Drop, M. J., & de Haan, Y. T. (1997). Homogeneity of cigarette smoking within peer groups: Influence or selection? *Health Education & Behavior*, *24*, 801–811.
- Ennett, S. T., & Bauman, K. E. (1994). The contribution of influence and selection to adolescent peer group homogeneity: The case of adolescent cigarette smoking. *Journal of Personality and Social Psychology*, *67*, 653–663.
- Espelage, D. L., Holt, M. K., & Henkel, R. R. (2003). Examination of peer-group contextual effects on aggression during early adolescence. *Child Development*, *74*, 205–220.
- Farrell, A. D. (1994). Structural equation modeling with longitudinal data: Strategies for examining group differences and reciprocal relationships. *Journal of Consulting and Clinical Psychology*, *62*, 477–487.
- Fisher, L. A., & Bauman, K. E. (1988). Influence and selection in the friend-adolescent relationship: Findings from studies of adolescent smoking and drinking. *Journal of Applied Social Psychology*, *18*, 289–314.
- Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology*, *41*, 625–635.
- Harford, T. C., & Grant, B. F. (1987). Psychosocial factors in adolescent drinking contexts. *Journal of Studies on Alcohol*, *48*, 551–557.
- Harford, T. C., & Spiegler, D. L. (1983). Developmental trends of adolescent drinking. *Journal of Studies on Alcohol*, *44*, 181–188.

- Hibell, B., Guttormsson, U., Ahlström, S., Balakireva, O., Bjarnason, T., Kokkevi, A., et al. (2009). *The 2007 ESPAD report – Substance use among students in 35 European countries*. Stockholm: Sweden: The Swedish Council for Information on Alcohol and Other Drugs (CAN). 408 pages, including graphs and tables.
- Hops, H., Davis, D., & Lewin, L. M. (1999). The development of alcohol and other substance use: A gender study of family and peer context. *Journal of Studies on Alcohol*, 13(Suppl.), 22–31.
- Hu, F. B., Flay, B. R., Hedeker, D., Siddiqui, O., & Day, L. E. (1995). The influences of friends' and parental smoking on adolescent smoking behavior: The effects of time and prior smoking. *Journal of Applied Social Psychology*, 25, 2018–2047.
- Jaccard, J., Blanton, H., & Dodge, T. (2005). Peer influences on risk behavior: An analysis of the effects of a close friend. *Developmental Psychology*, 41(1), 135–147.
- Jessor, R., & Jessor, S. (1977). *Problem behavior and psychosocial development: A longitudinal study of youth*. Orlando: Academic Press.
- Johnson, P. B., Boles, S. M., Vaughan, R., & Kleber, H. D. (2000). The co-occurrence of smoking and binge drinking in adolescence. *Addictive Behaviors*, 25, 779–783.
- Kandel, D. B. (1978a). Homophily, selection, and socialization in adolescent friendships. *American Journal of Sociology*, 84, 427–436.
- Kandel, D. B. (1978b). Similarity in real-life adolescent friendship pairs. *Journal of Personality and Social Psychology*, 36, 306–312.
- Kashy, D. A., & Kenny, D. A. (2000). The analysis of data from dyads and groups. In H. T. Reis, & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 451–477). New York: Cambridge University Press.
- Kenny, D. A., & Cook, W. (1999). Partner effects in relationship research: Conceptual issues, analytic difficulties and illustrations. *Personal Relationships*, 6, 433–448.
- Kerr, M., Stattin, H., & Kiesner, J. (2007). Peers and problem behavior: Have we missed something? In R. C. E. Engels, M. Kerr, & H. Stattin (Eds.), *Friends, lovers and groups: Key relationships in adolescence* (pp. 125–153). New York: John Wiley & Sons.
- Kiuru, N., Aunola, K., Nurmi, J.-E., Leskinen, E., & Salmela-Aro, K. (2008). Peer group influence and selection in adolescents' school burnout: A longitudinal study. *Merrill-Palmer Quarterly*, 54, 23–55.
- Kiuru, N., Aunola, K., Vuori, J., & Nurmi, J.-E. (2007). The role of peer groups in adolescents' educational expectations and adjustment. *Journal of Youth and Adolescence*, 36, 995–1009.
- Kiuru, N., Nurmi, J.-E., Aunola, K., & Salmela-Aro, K. (2009). Peer group homogeneity in adolescents' school adjustment varies according to peer group type and gender. *International Journal of Behavioral Development*, 33, 65–76.
- Knecht, A. B., Burk, W. J., Weesie, J., & Steglich, C. Friendship and alcohol use in early adolescence: A multi-level social network approach. *Journal of Research on Adolescence*, in press.
- Laursen, B. (2005). Dyadic and group perspectives on close relationships. *International Journal of Behavioral Development*, 29, 97–100.
- Laursen, B., Bukowski, W. M., Nurmi, J.-E., Marion, D., Salmela-Aro, K., & Kiuru, N. Opposites detract: Middle school peer group antipathies. *Journal of Experimental Child Psychology*, in press.
- Lindenberg, S. (1990). Homo socio-economicus: The emergence of a general model of man in the social sciences. *Journal of Institutional and Theoretical Economics*, 146, 727–748.
- Maxwell, K. A. (2002). Friends: The role of peer influence across adolescent risk behaviors. *Journal of Youth and Adolescence*, 31, 267–277.
- McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 27, 415–444.
- Mercken, L., Candel, M., Willems, P., & de Vries, H. (2009a). Social influence and selection effects in the context of smoking behavior: Changes during early and middle adolescence. *Health Psychology*, 28, 73–82.
- Mercken, L., Snijders, T. A. B., Steglich, C., & De Vries, H. (2009b). Dynamics of adolescent friendship networks and smoking behavior: Social network analyses in six European countries. *Social Science and Medicine*, 69, 1506–1514.
- Miller-Johnson, S., & Costanzo, P. (2004). If you can't beat 'em... induce them to join you: Peer-based interventions during adolescence. In J. B. Kupersmidt, & K. A. Dodge (Eds.), *Children's peer relations: From development to intervention* (pp. 209–222). Washington, DC: American Psychological Association.
- Muthén, B. (1997). Latent variable modeling of longitudinal and multilevel data. In A. Raftery (Ed.), *Sociological methodology* (pp. 453–480). Boston: Blackwell.
- Muthén, L., & Muthén, B. O. (1998–2007). *Mplus version 5*. <http://www.statmodel.com/index2.html>.
- Nichter, M., Nichter, M., Vuckovic, N., Quintero, G., & Ritenbaugh, C. (1997). Smoking experimentation and initiation among adolescent girls: Qualitative and quantitative findings. *Tobacco Control*, 6, 285–295.
- Oetting, E. R., & Beauvais, R. (1986). Peer cluster theory: Drugs and the adolescent. *Journal of Counseling and Development*, 65, 17–22.
- Pearson, M., Steglich, C. E. G., & Snijders, T. A. B. (2006). Homophily and assimilation among sport-active adolescent substance users. *Connections*, 27(1), 47–63.
- Petraitis, J., Flay, B. R., & Miller, T. Q. (1995). Reviewing theories of adolescent substance use: Organizing pieces in the puzzle. *Psychological Bulletin*, 117(1), 67–86.
- Poelen, E. A. P., Engels, R. C. M. E., Van der Vorst, H., Scholte, R. H. J., & Vermulst, A. A. (2007). Best friends and alcohol consumption in adolescence: A within-family analysis. *Drug and Alcohol Dependence*, 88(2–3), 163–173.
- Popp, D., Laursen, B., Burk, W. J., Kerr, M., & Stattin, M. (2008). Modeling homophily over time with an actor-partner interdependence model. *Developmental Psychology*, 44, 1028–1039.
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. USA, California: Sage Publications.
- Rimpelä, M. (2003). *Kouluterveyskysely*. [Questionnaire for school health]. www.stakes.fi/kouluterveys.
- Ripley, B. (1981). *Spatial statistics*. New York: Wiley.
- Ryan, A. M. (2001). The peer group as a context for the development of young adolescent motivation and achievement. *Child Development*, 72, 1135–1150.
- Salmivalli, C., Kaukiainen, A., & Voeten, M. (2005). Anti-bullying intervention: Implementation and outcome. *British Journal of Educational Psychology*, 75, 465–487.
- Sarason, R. G., Mankowski, E. S., Petersen, A. V., & Dinh, K. T. (1992). Adolescents' reasons for smoking. *Journal of School Health*, 62, 185–190.
- Schulenberg, J., Maggs, J. L., Dielman, T. E., Leech, S. L., Kloska, D. D., Shope, J. T., et al. (1999). On peer influences to get drunk: A panel study of young adolescents. *Merrill-Palmer Quarterly*, 45, 108–142.
- Sieving, R. E., Perry, C. L., & Williams, C. L. (2000). Do friendships change behaviors, or do behaviors change friendships? Examining paths of influence in young adolescents' alcohol use. *Journal of Adolescent Health*, 26, 27–35.
- Simons-Morton, B., Chen, R., Abroms, L., & Haynie, D. L. (2004). Latent growth curve analyses of peer and parent influences on smoking progression among early adolescents. *Health Psychology*, 23, 612–621.
- Simons-Morton, B., Haynie, D. L., Crump, A. D., Eitel, P., & Saylor, K. E. (2001). Peer and parent influences on smoking and drinking among early adolescents. *Health Education & Behavior*, 28, 95–107.
- Snijders, T. A. B. (2009). Longitudinal methods of network analysis. In B. Meyers (Ed.), *Encyclopedia of complexity and system science* (pp. 5998–6013). Verlag: Springer, part of the social networks section (section Ed. J. Scott).
- Snijders, T. A. B., & Baerveldt, C. (2003). A multi-level study of the effects of delinquent behavior on friendship evolution. *Journal of Mathematical Sociology*, 27, 123–151.
- Snijders, T. A. B., Steglich, C. E. G., & Schweinberger, M. (2007). Modeling the co-evolution of networks and behavior. In K. van Montfort, H. Oud, & A. Satorra (Eds.), *Longitudinal models in the behavioral and related sciences* (pp. 41–71). Mahwah, NJ: Lawrence Erlbaum.
- Snijders, T. A. B., Steglich, C. E. G., Schweinberger, M., & Huisman, M. (2007). *Manual for SIENA version 3.1*. Netherlands/UK: University of Groningen/University of Oxford.
- Snijders, T. A. B., Steglich, C. E. G., & van de Bunt, G. G. (2010). Introduction to actor-based models for network dynamics. *Social Networks*, 32, 44–60.
- Snijders, T. A. B. (2001). The statistical evaluation of social network dynamics. In M. E. Sobel, & M. P. Becker (Eds.), *Sociological methodology* (pp. 361–395). Boston and London: Basil Blackwell.

- Snijders, T. A. B. (2005). Models for longitudinal network data. In P. Carrington, J. Scott, & S. Wasserman (Eds.), *Models and methods in social network analysis*. New York: Cambridge University Press.
- Steglich, C. E. G., Snijders, T. A. B., & West, P. (2006). Applying SIENA: An illustrative analysis of the co-evolution of adolescents' friendship networks, taste in music, and alcohol consumption. *Methodology*, 2, 48–56.
- Steglich, C., Snijders, T. A. B., & Pearson, M. Dynamic networks and behavior: Separating selection from influence. *Sociological Methodology*, in press.
- Suls, J., & Green, P. (2003). Pluralistic ignorance and college student perceptions of gender-specific alcohol norms. *Health Psychology*, 22, 479–486.
- Urberg, K. A. (1992). Locus of peer influence: Social crowd and best friend. *Journal of Youth and Adolescence*, 21, 439–450.
- Urberg, K. A. (1999). Introduction: Some thoughts about studying the influence of peers on children and adolescents. *Merrill-Palmer Quarterly*, 45, 1–12.
- Urberg, K. A., Cheng, C.-H., & Shyu, S.-J. (1991). Grade changes in peer influence on adolescent cigarette smoking: A comparison of two measures. *Addictive Behaviors*, 16, 21–28.
- Urberg, K. A., Değirmenciöğlü, S. M., & Pilgrim, C. (1997). Close friend and group influence on adolescent cigarette smoking and alcohol use. *Developmental Psychology*, 33, 834–844.
- Urberg, K. A., Değirmenciöğlü, S. M., & Tolson, J. M. (1998). Adolescent friendship selection and termination: The role of similarity. *Journal of Social and Personal Relationships*, 15, 703–710.
- Urberg, K. A., Luo, Q., Pilgrim, C., & Değirmenciöğlü, S. M. (2003). A two-stage model of peer influence in adolescent substance use: Individual and relationship-specific differences in susceptibility to influence. *Addictive Behavior*, 28, 1243–1256.
- Van de Bunt, G. G., Van Duijn, M. A. J., & Snijders, T. A. B. (1999). Friendship networks through time: An actor-oriented statistical network model. *Computational and Mathematical Organization Theory*, 5, 167–192.
- Van Dulmen, M., & Goncy, E. A. (2010). Extending the actor-partner interdependence model to include cross-informant data. *Journal of Adolescence*. Special issue: Capturing peer context.
- Zeggelink, E. P. H. (1994). Dynamics of structure: An individual oriented approach. *Social Networks*, 16, 295–333.