

FRIENDSHIP SELECTION  
AND  
FRIENDS' INFLUENCE

Dynamics of networks and actor attributes  
in early adolescence



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Dynamics of networks and actor attributes  
in early adolescence

Vriendschapsselectie en invloed van vrienden  
De dynamiek van netwerken en van eigenschappen van adolescenten  
(met een samenvatting in het Nederlands)

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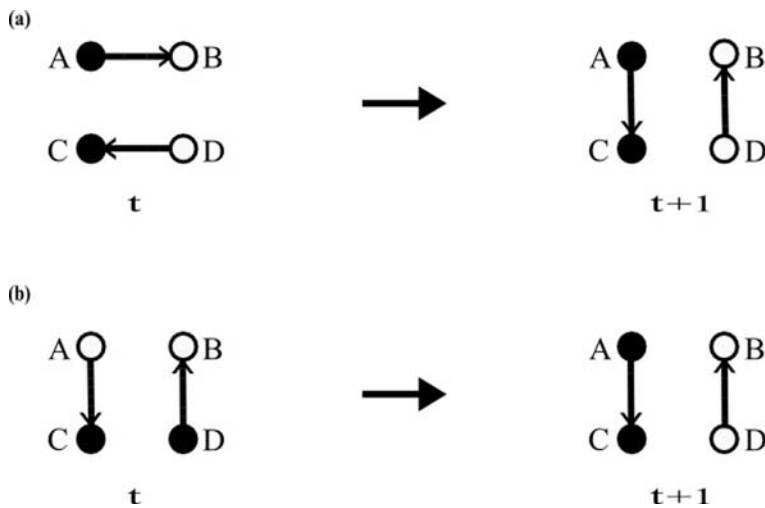
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# 1 Introduction to selection and influence

## 1.1 Research problem

A widespread phenomenon in adolescence is that attributes among friends are similar. This applies to attributes that cannot change such as gender or ethnicity as well as to changeable attributes like behaviors and attitudes. Different processes may cause a positive association of adolescents' and friends' changeable attributes. Consider the friendship ties and the level of alcohol use of four adolescents A, B, C, and D (Figure 1.1). Some of these adolescents are friends and others are not. Arrows between adolescents represent friendship nominations outgoing from one adolescent and incoming for another adolescent who is considered to be a friend; the absence of an arrow indicates that an adolescent does not consider the other as a friend. Black filling of a dot shows that the adolescent consumes alcohol; no filling indicates that the adolescent does not consume alcohol. Note that in our illustration we disregard possible friendship choices connecting B and C as well as possible choices connecting A and D.



**Figure 1.1:** (a) Selection and (b) influence leading to similarity among friends

In panel (a) at time point  $t$ , A considers B to be a friend and D considers C to be a friend. A and C consume alcohol but none of them regards the other as a friend, B and D do not consume alcohol and likewise do not regard each other as a friend. This situation has changed at a later time point  $t + 1$ . Alcohol use or abstinence, respectively, remains the same, but the relationships among the adolescents have changed. A and B differ in their alcohol use, and A no longer considers B as a friend. The same holds for C and D. They differ in their alcohol use and D no longer considers C as a friend. A chose C as a friend; they both consume alcohol. D chose B as a friend and both abstain

from alcohol. A situation has emerged with only friendship nominations to those who are similar.

In panel (b) at time point  $t$ , A considers C to be a friend and D considers C to be a friend. A and B abstain from alcohol and neither regards the other as a friend; C and D consume alcohol and neither regards the other as a friend either. Friendship nominations do not occur among those who are similar. At time point  $t + 1$ , the friendship nominations of A and D have not changed but their alcohol use has. Adolescent A has changed his behavior and is consuming alcohol now, his friend C is still consuming alcohol. D, who used to consume alcohol, has stopped that behavior and abstains from alcohol like his friend B. Again, a situation has emerged with only friendship nominations to those whose alcohol consumption is similar. In (a) and in (b), situations emerge over time with only friendship ties between those whose behavior is similar. As our illustration shows, similarity among friends can be due to different processes.

The main research problem of this dissertation is to explain similarity in actor attributes among friends in early adolescence by looking at the feedback processes between simultaneously evolving friendship networks and individual attributes. “Attribute” refers to changeable variables such as behavior and attitudes. Early adolescence is particularly suitable for the research problem at hand. Being in a period of transition from childhood to adulthood leads to unstable identities. Adolescents cling towards those who are in a similar position — their peers, with whom they establish friendship relationships and develop behaviors and attitudes. This helps them reestablish a stable identity (Sherif & Sherif, 1964).

In panel (a), similarity in an attribute precedes the relationship between two actors. We label this process *selection*. Selection processes can be based on complementarity or similarity of attributes. For friendship ties it has convincingly been argued that similarity is more important (Leenders, 1995). In the literature, association of similar persons is also referred to as *homophily* (Lazarsfeld & Merton, 1954; McPherson, Smith-Lovin, & Cook, 2001). Selection incorporates forming and maintaining a tie. In panel (b), the affiliated actors have adjusted their attribute to another actor and become more similar. We label this process *influence*. In the literature this is also referred to as *contagion*, *socialization*, or *assimilation*. Social influence includes somebody who influences others, intentionally or unintentionally, and somebody who is influenced. We focus on persons changing their attributes, the ones being influenced by others. Selection and influence processes are not mutually exclusive and may operate simultaneously. Actors select their friends and they are influenced by the attributes of these friends. In other words, actors shape the network and the network shapes the actors. Selection processes describe causes of social networks, while influence processes describe consequences of social networks (Leenders, 1995). These processes may vary in their relative strength for different attributes.

A better understanding of the feedback between simultaneously evolving friendships of adolescents and actor attributes calls for answers to two questions:

- 1) **Are adolescents' friendship choices affected by shared attributes?**
- 2) **Are adolescents' attributes affected by their friends' attributes?**

Between the chapters of this dissertation, the attributes investigated vary. We study three different behaviors and attitudes that are relevant for youth and which can affect friendship choice and can be affected by friends: first, delinquency such as stealing, vandalism, graffiti, and fighting; second, attitudes about school-related behaviors such as doing homework, being on time for class, going to each class, getting good grades, and being attentive; and third, alcohol use. These attributes cover different aspects of adolescents' life. Delinquent behavior is a way to explore limits, school attitudes are related to everyday experience of students, and alcohol use is connected to socializing and often seen by adolescents as a sign of maturity. The attributes have in common that they may be part of an adolescents' social identity.

Explanations of friendship formation and (change of) behavior such as balance theory (Festinger, 1957; Heider, 1946), social learning and exchange theory (Blau, 1964; Homans, 1974, Thibaut & Kelley, 1959), and social comparison theory (Erickson, 1988; Festinger, 1954) have in common — though assuming different underlying motivations — that they are compatible with the idea of a purposive actor. Purposive actors are assumed to pursue goals. To this end, they consider costs and benefits of different action alternatives and behave according to the alternative that will most likely help them achieve their goals. One goal is social approval (Kassenberg, 2002; Lindenberg, 1990; Ormel & Lindenberg, 1999), which can be realized by obtaining behavioral confirmation, status, and affection. Individuals cannot attain behavioral confirmation, status, and affection on their own. Other people are essential in attaining social approval. Interaction partners are thus needed. Rewarding friendships and behavior that is accepted by significant others help adolescents attain social approval. The first aim, having rewarding friendship relationships, affects the selection of friends; the second aim, showing approved behavior, is related to social influence.

The more general problem that will be addressed in this book is how to explain similarity of persons belonging to one group. Examples can be found in many different domains, like voluntary organizations (McPherson & Smith-Lovin, 1987), friendship (Lazarsfeld & Merton, 1954), neighborhoods (Loomis, 1946), or work (Ibarra, 1992). In addition to selection and influence processes, there are other processes leading to similarity. First, there are alternative processes leading to the formation and maintenance of ties among similar others. These processes are related to the availability of others and selection based on coinciding attributes. The availability of others

determines with whom one can associate (Blau, 1964; Kalmijn & Flap, 2001). Social activities and interactions are organized around social foci that are often shared by people who have some similar attributes (Feld, 1981). A social focus often constrains the possibilities of developing ties to dissimilar others. Associations to similar others are often formed due to the opportunity structure and less so due to the choices of persons (Feld, 1982; Fischer, Jackson, Stueve, Gerson, & Jones, 1977). Similarity may result from actors selecting their friends due to similarity of other attributes that coincide with the focal attribute or due to network-endogenous processes such as transitivity that inflate similarity (Steglich, Snijders, & Pearson, 2007). For instance, let us assume that adolescents select each other based on similarity in gender and that level of delinquency is associated with gender. If uncontrolled for gender, similarity may be wrongly explained by adolescents selecting each other as friends based on their delinquency levels. Second, there are also alternative processes leading to adjustment of attributes. These processes are often hard to disentangle. Manski's (1993, 1995) well known "reflection problem" refers to this difficulty. In addition to endogenous effects that correspond to influence processes as sketched above, Manski outlined two other effects: contextual effects describing influence processes from background characteristics shared in a network, such as the distribution of gender, ethnicity, or socio-economic status on behaviors and attitudes, and correlated effects are influence processes from the shared institutional environment of a network. An example is a teacher instructing a group of students.

To some extent, we control for alternative processes leading to similarity by focusing on adolescents in first-grade classrooms in Dutch secondary school. The disadvantage of such a design is excluding possible friends from outside class. However, a major advantage is that we can control for the availability of others and coinciding attributes. In a classroom it is assured that all students know each other and are available as friends. By assessing data of complete classes, we have information on attributes about available others. Students of a classroom are similar in age, ability, neighborhood, and related attributes. This controls, to some extent, for selection effects based on similarity of attributes other than the investigated ones that are induced by a homogeneous social focus. In our models we control for similarity of gender and ethnicity and network-endogenous effects such as reciprocity and transitivity, which may be associated with and even inflate similarity of our investigated attributes. Many contextual and correlated effects are similar for all students in one class. The distribution of background variables is the same for each student in a class, and they are exposed to the same institutional environment. We may not be able to completely control for alternative processes leading to similarity among associates. Yet, with our research design we are able to handle selection processes due to a social focus and coinciding attributes as well as influence processes due to contextual and correlated



effects. Hence, we can focus on selection and influence processes leading to similarity that are affected by adolescents' decisions about their friendship relationships and their own attributes.

## 1.2 Earlier research

This thesis integrates advances from two research traditions: studies focusing on selection related to social network research and studies focusing on peer influence related to adolescence research. In the next two sections, we sketch early examples of studies addressing selection or influence processes that are related to these two research traditions. Thereafter, we describe early examples of studies addressing selection and influence processes simultaneously.

### 1.2.1 Selection processes

The study of relationships among similar others goes back to the beginnings of social network analysis. Early social network approaches in educational and developmental psychology are concerned with the interactions of (young) children and the characteristics of their interaction partners. A few examples illustrate studies on selection of similar actors within the social network tradition. As early as 1922, Almack published a paper on the effect of chronological and mental age, and intelligence quotient of children in grades 4 to 7 on their selection of working partners and party guests (Almack, 1922). His results revealed a preference to associate with similar others. Wellman (1926) conducted a similar study of decisive characteristics for the selection of companions among schoolchildren. She investigated whether companions were similar or dissimilar in terms of chronological and mental age, intelligence quotient, scholastic achievement, extroversion, height, and physical achievement. Friendship was determined by observing the contact frequency of 113 students in the seventh, eighth, and ninth grades. It turned out that similarity contributed to friendship formation.

### 1.2.2 Influence processes

Adolescence research is concerned with the social worlds of adolescents, particularly their behavior and attitudes. Within this research tradition, some studies have been conducted in the 1960s on the relevance of adolescents for each other's behaviors and attitudes. In *The Adolescent Society* (1961), Coleman attempted to explain the behavior of adolescents, researching structures and status systems among adolescent students. Coleman's often-cited research showed students responding to formal and informal incentive systems created by their peers. He found influence effects of peers on the behavior of students. Sherif and Sherif (1964) draw similar conclusions. Their study

focuses on reference groups of male adolescents and their effects on personal behavior and attitudes, and investigated adolescent groups with different social backgrounds. Once groups are formed, interpersonal expectations on behaviors and attitudes arise and interaction partners regulate personal behaviors and attitudes. The study shows the importance of relations on individuals' attributes.

### 1.2.3 Investigating selection and influence processes simultaneously

Social network analysis focuses on selection processes among similar actors and adolescence research shows that peers, especially friends, have an influence on adolescents' behavior and attitudes. Two early studies investigating both selection and influence processes are those by Kandel (1978) and Cohen (1977). Their studies built on earlier research by combining the focus of network analysis on selection processes among adolescents and the focus of adolescence research to explain the behavior of adolescents. Kandel investigated substance use. Cohen examined the relative share of different processes leading to peer group homogeneity in various individual characteristics using data of friendship cliques. They both stress the importance of considering selection when studying influence, since otherwise the effect of influence will be exaggerated. Different reasons hampered the systematic study and disentangling of selection and influence processes in these and similar studies, though. These reasons relate to the research designs and the statistical methods. In the upcoming chapters we elaborate on these problems and discuss more recent literature on selection and influence processes. The objective of the present book is therefore twofold. Substantively, we want to gain insight into the dynamics of friendship relationships and adolescents' delinquent behavior, school attitudes, and alcohol use. Methodologically, we aim to overcome problems of earlier studies through an improved research design and by using adequate statistical methods that enable us to separate selection and influence processes.

### 1.3 Description of the studies in this book

In this section we provide a description of the studies that make up the present book. All studies are in the form of research articles and can thus be read independently. There is overlap and there are differences between the studies. They all investigate selection and influence processes among young adolescents simultaneously. The chapters investigate different attributes. Chapters 2, 3, and 4 investigate one attribute at a time, whereas in Chapter 5 we compare the three attributes from the previous chapters and their effect on selection and influence processes. In Chapter 2 we investigate delinquent behavior of adolescents and how it relates to their friendships. Delinquent behavior is operationalized as stealing, vandalism, graffiti, and fighting. Chapter 3 addresses how

attitudes about school-related behavior in early adolescence affect friendship selection and are in turn affected by friends' attitudes. In Chapter 4 we investigate the importance of alcohol use for friendship selection and influence processes among adolescent friends, and examine frequency of alcohol use. The aim of Chapter 5 is to provide insights into friendship selection and friends' influence processes considering the three attributes simultaneously (two behaviors and one attitude) that have been examined in the previous three chapters: delinquency, alcohol consumption, and school attitude. Building on the insights gained in the previous three chapters, we aim at determining the relative importance of selection and influence processes for explaining similarity among adolescents. We analyze the importance of delinquency, alcohol use, and school attitudes for friendship selection, and attempt to discover which of these attributes are the most important for friendship formation and which characteristics are most prone to get influenced by adolescents' friends.

In all chapters we apply an actor-driven approach. Within constraints from the social context, the actors' decisions account for changes of network and attributes. The actor-driven models assume that decisions of actors in a network about their relationship choices and their attributes drive changes of the network structure and actors' attributes in a network. We derive two main hypotheses. One is that adolescents whose attributes are similar tend to become and stay friends. The second main hypothesis is that adolescents tend to adjust their attributes to the attributes of their friends. In Chapter 2 on delinquency, these hypotheses are additionally underpinned by criminological theories. Social control theory has implications for selection processes. Differential association theory has implications for influence processes.

In all chapters we control for other effects related to friendship choices and social influence. Regarding friendship choices, we always control for effects of reciprocity, transitivity, similarity of gender and ethnicity, and having been friends in primary school. The control variables in the influence part of the model specification differ depending on the investigated attribute.

We collected data of 126 first-grade classes in 14 secondary schools in the Netherlands for the purpose of these studies. Students are usually 12 years old when entering secondary school. The data set is longitudinal, with relations and attributes measured at four time points within one school year. The data set consists of multiple networks with the classroom as natural boundary. All data in these studies are based on self-reports: adolescents only report about their own attributes and relationships and not about those of their friends. Friendship relationships are operationalized as directed ties that do not need to be reciprocated. Friendship nominations are not confined to best or three best friends. To our knowledge, our data set is the first combining these characteristics. The number of waves used differs between chapters. The full sample consists of four waves. Information from all waves is used in Chapters 2 and 3.

In Chapters 4 and 5 we use three waves because one of the variables, alcohol use, was not measured at all four time points.

For the analysis of the data we employ stochastic actor-driven models to analyze co-evolving networks and actor attributes in all chapters (Snijders, 2001; Snijders, Steglich, & Schweinberger, 2007). This approach is implemented in the SIENA software, version 3.1 (Snijders, Steglich, Schweinberger, & Huisman, 2007). SIENA is an acronym for *Simulation Investigation for Empirical Network Analysis*. This software enables us to analyze the dynamics in networks and actor attributes simultaneously, and to disentangle selection and influence processes. SIENA includes two estimation methods. In Chapters 2, 3, and 5 we used the Maximum Likelihood (ML) option, which is statistically more efficient. In Chapter 4 we used the Method of Moments (MoM) option, which is less time-consuming. The MoM procedure did not yield good results at the time the analyses for the other chapters were conducted. However, an adapted version of the software was available for the analysis of Chapter 4.

Related to these estimation difficulties, different subsets of classes were selected for the analyses in Chapters 2, 3, and 5. It appeared that due to missing data and too few changes in friendship relationships and attributes, the algorithm occasionally failed to reach convergence and thus results could not be obtained for all classes. In order to have more informative data to prevent this problem, we selected subsamples with few missing data and many changes in relationships and the investigated attribute. The subsamples of these chapters vary because the selection criteria refer to different attributes. The related issue of selectivity is addressed in the upcoming chapters.

Social network methods usually focus on one network at a time. To analyze more networks simultaneously, a full information multilevel approach based on random coefficient models would be required, which is not available yet. We therefore followed a two-stage procedure in all chapters. The first step was to analyze the classes separately with SIENA, the second step to combine the results of many classes. To this end, we used a meta-analytical approach (Snijders & Baerveldt, 2003) that combines each estimated parameter and its standard deviation across classes and tests the variances of the estimated parameters between classes.

The book is structured as follows. Chapter 2 is a study of delinquency; the statistical model is outlined in more detail and this outline serves as a reference for the subsequent chapters. Chapter 3 discusses selection and influence processes related to school attitudes. In Chapter 4 we investigate the relevance of alcohol use for friendship formation and friends' influence on alcohol use. Chapter 5 provides a combined analysis of delinquency, school attitudes and alcohol use. Chapter 6 presents a summary and discussion of the studies with a comparison of the findings between the separate and the combined studies.

## 2 Friendship and delinquency in early adolescence\*

### **Abstract**

Positive association of relevant characteristics is a widespread pattern among adolescent friends. A positive association may be caused by selection of similar others as friends and deselection of dissimilar ones, but also by influence processes where friends adjust their behavior to each other. Social control theory argues that adolescents may select each other as friends based on delinquency. Differential association theory, on the other hand, argues that adolescent friends may influence each other's delinquency levels.

We employ new statistical methods for assessing the empirical evidence for either process, controlling for the other process. These methods are based on "actor-oriented" stochastic simulation models representing combinations of these two processes. Our data are obtained from longitudinal network designs. We analyze data on friendship and delinquency collected in four waves of 544 students in 21 first-grade classrooms of Dutch secondary schools. Results indicate that adolescents with a higher level of delinquency have a greater tendency to select delinquent peers as friends. Estimates of the social influence parameters are not significant. The results are consistent with social control theory but provide no support for differential association theory.

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\* This chapter is co-authored with Tom Snijders, Chris Baerveldt, Christian Steglich and Werner Raub. A slightly different version is currently under review.

## 2.1 Introduction

Parents have been worried about their children's friends since times immemorial. Onlookers may, for similarly long periods, have had their doubts as to whether any supposedly bad behavior of the child was indeed copied from the supposedly bad friends, or had other sources. Similarity between friends is a well-established regularity in many aspects of behavior, including delinquency (e.g., Aseltine, 1995; Baerveldt, Van Rossem, & Vermande, 2003; Baron & Tindall, 1993; Bender & Lösel, 1997; Dishion, Andrews, & Crosby, 1995; Elliot, Huizinga, & Ageton, 1985; Fletcher, Darling, Steinberg, & Dornbusch, 1995; Gilmore, Hawkins, Day, & Catalano, 1992; Haynie, 2001; Jussim & Osgood, 1989; Marcus, 1996; Ploeger, 1997; Poulin, Dishion, & Haas, 1999; Reed & Rose, 1998; Thornberry, Krohn, Lizotte, & Chard Wierschem, 1993; Thornberry, Lizotte, Krohn, Farnworth, & Jang, 1994; Vitaro, Tremblay, Kerr, Pagani, & Bukowski, 1997). The question of whether this is due to peer influence or friendship selection has been much debated, albeit without an unequivocal conclusion. In the criminological literature, social control theory (Hirschi, 1969) has claimed that the association of delinquent behavior between adolescents and their friends is predominantly due to selection processes, while differential association theory (Sutherland & Cressey, 1974) has argued the predominance of influence processes in explaining this association. A comparative assessment of the two mechanisms has been attempted (Baerveldt et al., 2003; Matsueda, 1982), but did not deliver firm conclusions. The fact that selection and influence processes may operate simultaneously (Matsueda & Anderson, 1998) has made the contrast between these positions less stark, but has not made the question easier to solve.

There are three main types of processes that may explain similarity in behavior between peers. These are peer selection, peer influence, and peers being subject to the same contextual influences. A variety of methodological issues have impeded progress on deciding which of these processes is supported by empirical evidence as contributing to the explanation of peer similarity. Basic to these issues is the fact that each individual has the fourfold role of being potentially influenced by and potentially influencing others, and of selecting and potentially being selected by others as friends, so that the convenient assumption of independent subjects, and even the separation between dependent and independent variables, contradicts the processes under study. This requires complex empirical designs because the comparative study of selection and influence processes needs longitudinal network data (for a broad introduction to social network analysis see Wasserman & Faust, 1994) in which a respondent can figure in all four roles — as a chooser of friends, as a potential friend for others, as peer who influences, and as peer who is influenced. Until recently, existing statistical methods did not allow for analyzing selection and influence simultaneously. This paper describes newly developed statistical models for the analysis of social networks co-evolving with

behavioral dimensions of the individuals in the network (Snijders, 2001; Snijders & Baerveldt, 2003; Snijders, Steglich, & Schweinberger, 2007), which can be used to make empirical distinctions between peer selection and influence processes, provided that adequate longitudinal network data are available. Recently, the method has been applied to the study of the importance of delinquency for selection and influence processes among Swedish adolescents (Burk, Steglich, & Snijders, 2007). We illustrate this method with a study of the joint dynamics of friendship relationships and minor delinquent behavior in first-grade classrooms of Dutch secondary schools (ages 12-13). The question of the extent to which peer similarity is the consequence of peers being subject to the same contextual influences outside school (Feld, 1982) is beyond the scope of this paper and will not be addressed. However, it can reasonably be expected that much context-caused similarity will already be reflected in the initial measurement of the network-behavior data. The method used will control for this initial measurement, implying that these effects will not or only weakly contaminate the study of the subsequent dynamics.

Four reasons can be given for choosing Dutch secondary-school first-graders as a study population. First, in early adolescence, peers are very important for the development of behavior (e.g., Giordano, 2003; Steinberg & Sheffield Morris, 2001). The importance of peers fosters influence processes among them. Second, in the Dutch school system most students who enter secondary school lose many of their former primary school relationships. A strong activity in new friendship formation may thus be expected. Third, students spend much time at school and the classroom plays an important role in socialization and identity formation, thus providing a natural social group in which to study selection and influence processes (Kassenberg, 2002). Fourth, although older adolescents may be more prone to show delinquent behavior, initiating and experimenting with (usually minor) delinquent behavior as part of identity formation starts in early adolescence (Moffitt, 1993) and may be triggered by the behavior of peers. It is not yet clear how important minor delinquency is in explaining peer relationships and, vice versa, how important peer relationships are in explaining minor delinquency in this age group. The empirical research questions, which can be regarded as typical for studies of selection and influence, are:

- 1) **Are adolescents' friendship choices affected by shared levels of delinquency?**
- 2) **Are adolescents' delinquency levels affected by their friends' delinquency levels?**

The remainder of this paper is structured as follows. In the next section, theoretical assumptions and methodologically questionable aspects of earlier studies on selection

and influence processes are discussed. Thereafter, we describe the stochastic modeling framework and present our model specification with two parts, one part explaining friendship selection and one part explaining delinquent behavior. This description is deliberately non-technical; for the mathematical elaboration we refer to other papers. After a description of the data and measures, we outline the statistical procedure and present the results. The paper ends with a discussion.

## 2.2 Selection and influence

A considerable body of earlier research addresses selection and influence processes. While adolescence literature (Giordano, 2003) suggests that both delinquency-based selection and peer influence cause the adolescent-peer association of delinquency levels, the classical criminological debate typically favors only one process. Some authors argue that delinquent adolescents have insufficient social skills to maintain strong relationships with their peers, while others argue that delinquent adolescents may have strong mutual bonds through which delinquent behavior is learned. Hansell and Wiatrowski (1981) called these two phenomena, respectively, the “social inability” model and the “social ability” model. Arguments can be found in classical theories for both viewpoints. According to Hirschi’s social control theory, people have a natural disposition to behave delinquently (Gottfredson & Hirschi, 1990; Hirschi, 1969). Strong social bonds, in particular with family and institutions, prevent delinquent behavior, and non-delinquent adolescents are less prone to associate with delinquent peers. Hirschi concludes that the mutual bonds among delinquents can only be explained by selection or, more precisely, by matching processes. Since non-delinquent students prefer non-delinquent friends, delinquent adolescents have to fall back on superficial relationships among themselves. In contrast, differential association theory (Sutherland & Cressey, 1974) suggests that delinquent behavior is acquired through socialization processes where definitions of appropriate behavior are learned. Whether values favoring delinquency are passed on depends on the degree of involvement in delinquent behavior of the friends in a consistent and intimate group. Social relationships with delinquent peers thus precede delinquent behavior, and the intimacy of the relationships of delinquent adolescents does not necessarily differ from that of non-delinquent adolescents.

Empirical research has not yet provided definite evidence to decide between these theories (Marcus, 1996). This is illustrated by the fact that Aseltine (1995) in his review study concluded that the ability model was supported by empirical research, while Baron and Tindall (1993) found support for the inability model. Also, there are some indications for influence and selection processes in school populations (Haynie & Osgood, 2005; Snijders & Baerveldt, 2003). However, the validity of the outcomes



might differ, possibly depending on the research design and method used, and on the population and type of delinquency being studied.

Many of the earlier studies had serious technical problems regarding reliability of measures or research design. First, until recently, most studies relied on peer reporting of delinquency levels, meaning that respondents were asked about the behavior of their friends. This is problematic because respondents overestimate the similarity between their own delinquent behavior and that of their contacts (e.g., Aseltine, 1995; Jussim & Osgood, 1989; Kandel, 1996; Reed & Rose, 1998) — the “false consensus effect” (Ross, Greene, & House, 1977). This problem can be overcome by collecting data in a network design, where peers are also respondents. Second, measures of relationships were often limited to the nomination of up to only three best friends, thus excluding other potentially influential contacts in the peer network and reducing the possibility of controlling for structural effects such as network closure (i.e., the phenomenon that friends of friends tend to be friends). Even in such a sparse design, some studies (e.g., Kandel, 1978) further reduced the data to mutually confirmed first choices. By allowing for more responses, a richer network structure can be assessed and more efficient use of the data can be made. Third, studies on similarity of friends based on ego-centered data do not account for possible similarities among non-friends. Complete network data can show whether similarity is more likely to occur among friends compared to non-friends. Fourth, most network studies were cross-sectional, hampering the analysis of processes over time: cross-sectional analysis can provide evidence for an association between adolescent delinquency and peers' delinquency, but cannot distinguish whether this association is caused by influence or selection. An extension to a longitudinal design solves this problem. Fifth, the few studies that were longitudinal were often case studies of one or two youth groups, and thus lacked statistical power to test influence and selection. Generalization to a population of classrooms is impossible when using such case studies. By analyzing the dynamics of multiple friendship networks in parallel groups, these problems can be addressed. Finally, studies on peer influence need to control for selection effects, and vice versa, otherwise the investigated effect will be overestimated (Cohen, 1977; Kandel, 1978). Studies addressing selection and influence processes were often hampered by the use of inappropriate statistical methods for the dynamic analysis of networks and behavior, where estimation of the selection and influence processes was insufficiently controlled for the other process. By choosing a statistical approach that allows for simultaneous estimation of both effects, such overestimation is avoided. The method proposed in this paper is designed specifically for the analysis of evolving networks and co-evolving behavioral dimensions, and represents selection and influence processes simultaneously, thus controlling the estimation of parameters for each process and controlling each process for the other.

The study design chosen for addressing these issues is as follows. We used a longitudinal approach to detect the determinants of friendship formation and delinquency in a number of networks. We investigated 21 classroom networks in the first grade of secondary school (544 students), measuring delinquency levels and friendship nominations at four time points in one school year to obtain longitudinal information about behavior and network dynamics. The students nominated up to 12 best friends in class and answered questions about their own delinquent behavior. We have complete network data with the class as network boundary. To model and analyze our data, we used recently developed methods for the joint analysis of social network and behavioral dynamics (Snijders, Steglich, & Schweinberger, 2007; Steglich et al., 2007).

### 2.3 Theory and model

This section presents a non-technical account of the model for the co-evolution of network and behavior (in our example, friendship and delinquency) in one group (here, the classroom). For the mathematical details, we refer to Snijders (2001) and Snijders, Steglich, and Schweinberger (2007).

Selection and influence processes occur at the level of the individual adolescent, within the dynamically changing context of the peer group that is composed of similar individuals. The association of delinquency levels between friends is an emergent group-level property resulting from dynamics in the individual adolescent's relational properties (friendships) and behavioral properties (delinquency). For describing and modeling selection and influence processes, it is natural to formulate our theoretical modeling framework as based on individual actors making individual decisions, while being embedded in the social network which is changing as a consequence of what they themselves and the other actors do. Friendships are treated here as the result of unilateral dichotomous (friend / no friend) choices, as reported by the focal individual. Thus, what decisively matters for a friendship relationship to affect changes in friendship or behavior is whether or not this friendship is perceived to exist by the focal actor involved in the change. Confirmation by the partner is not necessary to have a friendship tie, but constitutes an additional property of the relationship that we will control for (*reciprocity*). In terms of data structure, this means that we analyze friendship networks as directed graphs (Wasserman & Faust, 1994). The basic data structure is a panel data set on relationships and behavior, which means that for a number of moments in time (in our case, four), the entire network (friendship) as well as the behavior (delinquency) of all individuals in the group are recorded. This data structure is obtained for a number of groups (school classes) that are regarded as replications of each other, and combined in a meta-analysis (Snijders & Baerveldt, 2003).

The model for a single group is defined as follows. Network ties are denoted by  $Y_{ij}$ , where  $i$  and  $j$  are individual actors, and  $Y_{ij} = 1$  or  $0$ , respectively, according to whether a friendship tie from  $i$  to  $j$  exists or not. This is said to be an outgoing tie for  $i$  and an incoming tie for  $j$ . The behavior of individual  $i$  is denoted  $Z_i$ , and this is assumed to be an ordered discrete variable with values  $1, 2, \dots$ , to  $H$  for some integer  $H \geq 2$ . The total network is the matrix  $Y = (Y_{ij})$ , the behavior is summarized in the vector  $Z = (Z_i)$ . Since these are time-dependent, we may write them as  $Y(t)$  and  $Z(t)$ . States, i.e., actual or potential outcomes of the stochastic processes  $Y(t)$  and  $Z(t)$  are denoted by small letters  $y$  and  $z$ .

The analysis of selection and influence effects is based on a process model for the simultaneous dynamics in the friendship network and the level of delinquent behavior of the actors in the network (Snijders, 2001). This process, which can be simulated on a computer, unfolds between the observation moments of the panel waves. The model is called a stochastic actor-driven model, as it is stochastic in nature and is formulated in terms of changes made by the actors in their outgoing ties and their behavior. The following assumptions are made. The mathematical details are elaborated in Snijders, Steglich, and Schweinberger (2007), where generalizations of this model can also be found.

- (1) The process  $(Y(t), Z(t))$  is a Markov process, with a continuous time parameter  $t$ . This means that changes can and will happen continuously between the observation moments, and the probabilities of changes depend, given all the available covariates, only on the current state  $(y(t), z(t))$  and not on the further past. This is a non-trivial assumption but it is a natural first approximation, and it may be noted that practically all simulation models of individual development have this property.
- (2) The process moves only in small changes, i.e., at any time point  $t$  not more than one of all the variables  $Y_{ij}$  and  $Z_i$  can change. Moreover, at any time point the behavioral variable can be changed no further than to an adjacent category. Thus, at any time point, either nothing changes, or one actor  $i$  changes his or her friendship tie to some other actor  $j$ , or one actor  $i$  changes his or her behavior by  $-1$  or  $+1$  (respecting the boundary values  $1$  and  $H$  of the behavior variable).
- (3) Each actor gets, at random moments, the opportunity to change one outgoing tie: create one new tie, discontinue one existing tie, or leave all ties unchanged. The probabilities of the network changes made by actor  $i$  are determined by a vector of characteristics of this actor, denoted  $s_{Y_i}(y, z)$ , and a vector of parameters  $\beta_Y$  indicating the weight of each of the elements of  $s_{Y_i}(y, z)$  in determining the probability. The characteristics will depend on the network position of actor  $i$  and on the behavior of this actor and of the other actors (in particular those tied to  $i$ ); in particular, they can be dynamically changing over time. Examples of elements of

$s_{Y_i}(y, z)$  are the current number of friendship choices of  $i$ , or the current average delinquent behavior of  $i$ 's friends. Probabilities of moving toward the new state  $(y, z)$  are assumed to be proportional to the exponential function of the linear combination of parameters and positional characteristics,  $\exp(\beta_Y' s_{Y_i}(y, z))$ . Higher values of the  $\beta_Y$  parameter of an element of  $s_{Y_i}(y, z)$  thus imply a stronger tendency for the network to change in such a way that this element of  $s_{Y_i}(y, z)$  becomes higher.

- (4) Similarly, each actor gets, at random moments, the opportunity to change his or her behavior: the options are one unit up, one unit down (as long as this does not lead outside the range of  $Z_i$ ), or no change. The probabilities of the behavior change of actor  $i$  are determined by a vector of characteristics of the actor, denoted  $s_{Z_i}(y, z)$ , and a vector of parameters  $\beta_Z$  indicating the weight of each of the elements of  $s_{Z_i}(y, z)$  in determining the probability. Probabilities of moving toward the new state  $(y, z)$  are assumed to be proportional to the exponential function of the linear combination,  $\exp(\beta_Z' s_{Z_i}(y, z))$ . Examples of components of  $s_{Z_i}(y, z)$  are the value  $z_i$  of  $i$ 's behavior, or the product of  $z_i$  and the average delinquent behavior of  $i$ 's friends. Higher values of the  $\beta_Z$  parameter of these components will imply a stronger tendency for the behavior to move into a direction of higher values of these components.

These assumptions can be loosely summarized by stating that changes in the network and the behavior occur on arbitrary moments between the observations, the probability distribution depends on the current state of the network and the behavior of all group members according to a Markov process, and these probabilities depend on the functions  $\beta_Y' s_{Y_i}(y, z)$  for network changes and  $\beta_Z' s_{Z_i}(y, z)$  for behavioral changes. These functions are called the *objective functions*, as they may be interpreted as seemingly representing the objectives, or resultants of preferences and constraints, of the actors in their relational and behavioral choices, respectively.

These two types of changes distinguish the selection part of the model (assumption 3 above: network changes) from the influence part of the model (assumption 4 above: behavioral changes). The model defines a mutual dependence between the networks and the behavior, because the current behavior will figure in the objective function for friendship dynamics, while the existing network structure will figure in the objective function for behavioral dynamics. Determination of the characteristics  $s_{Y_i}(y, z)$  and  $s_{Z_i}(y, z)$ , which drive the dynamics of networks and behavior, is explicated below in the sections on the selection part and the influence part of the model. The weight vectors  $\beta_Y$  and  $\beta_Z$  are the statistical parameters to be estimated from the data and to be statistically tested. A further set of statistical parameters consists of the rates of change, i.e., the rates at which actors have the opportunity to change one of their network ties, or their

behavior. Generalizations (e.g., non-constant rates of change) are discussed in Snijders, Steglich, and Schweinberger (2007).

In this framework, tendencies toward a positive association between adolescents' and friends' delinquency can be expressed in terms of tendencies in the two types of changes made by the actors, relational or behavioral. On the one hand, such an association can be brought about by a tendency of the actors to form and maintain friendships with those peers who have a similar delinquency level, while abandoning friendships with peers who have a dissimilar delinquency level; this is covered by assumption (3) above. On the other hand, the positive association can result from adjustment to friends, i.e., a behavioral tendency of the actors to adopt behavior that is more similar to the behavior of their network neighbors, as covered by assumption (4) above. Hence, a positive association between adolescents' and friends' delinquency will be explained as a compound outcome of several generative mechanisms, the relative importance of which we will assess by estimating specific parameters for each mechanism and testing these parameters for significance. We will now elaborate on the specification of the two model components.

### 2.3.1 The selection part of the model

The selection part of the model is intended to explain friendship formation and maintenance, and is defined by listing the elements of the vector  $s_{Y_i}(y, z)$ , which forms the basis for the network objective function. The literature provides many arguments why similarity between two actors enhances their chances of becoming friends (McPherson et al., 2001). One of the arguments is that similarity makes it easier to give behavioral confirmation and share activities. We hypothesize that increased likelihood of becoming friends holds for gender (*gender similarity*) and ethnicity (*ethnicity similarity*) because these are basic social identification characteristics for adolescents (Baerveldt, Van Duijn, Vermeij, & Van Hemert, 2004; Clark & Ayers, 1992; Eisenberg, Martin, & Fabes, 1996; Hallinan & Teixeira, 1987; Lubbers, 2003). To test the effect of delinquent behavior on network dynamics, we hypothesize that this also holds for delinquency. The propensity to choose similar others will be expressed by the interaction effect of the delinquency of the focal individual ("ego") with the delinquency of peers (*shared level of delinquency*): more delinquent peers will be relatively more attractive to others who are themselves more delinquent, too. To have a fuller representation of potential effects of delinquent behavior on network change, we also hypothesize that delinquent behavior of an individual affects the propensity to establish (outgoing) friendship ties as well as receive (incoming) friendship ties. These are the *delinquency ego* and *delinquency alter* effects, respectively. All of these delinquency-related effects are in accordance with the social inability model, which posits that more delinquent individuals find it more difficult to make friends (a negative

effect for *delinquency ego*), are less attractive as friends (a negative effect for *delinquency alter*), and have mainly other delinquent individuals to turn to (a positive interaction effect *shared level of delinquency*).

In addition to these effects of individuals' attributes, there are several other known effects on network choice that should be controlled for: so-called endogenous network dynamics, and relationship history. Endogenous (or structural) effects are effects of the network on itself, expressing that the network acts as an opportunity set as well as a constraint on friendship formation (Snijders, 2001). Controlling for such endogenous network dynamic effects is an important way of taking into account the dependency of friendship ties within the school classes. The first element is the selectivity of the friendship relationship, implying that friendship networks will be rather sparse: friendship ties are formed not purely at random, but mainly if there are antecedents for it in the network itself or in the attributes. The sparseness of the network is expressed by including the *outdegree* (number of choices made) in the model. A negative sign is expected, reflecting that creation and maintenance of friendship ties is costly.

Following the literature on adolescence (Giordano, 2003) and on friendship dynamics in general (Van de Bunt, 1999), we further predict two more endogenous network effects. The *reciprocity* effect captures the tendency of an actor to reciprocate friendship choices made by others. We expect a positive effect of reciprocity on friendship formation, as reciprocity reflects mutual affection and trust (Leenders, 1996). Finally, to control for the effect of local clustering, or transitive closure, in friendship networks (Davis & Leinhardt, 1972), we include an effect of *transitivity*, measuring the tendency to call a friend's friend one's own friend. Here also we expect a positive sign.

We also include an effect of tie history in our model. It seems likely that students who have been friends in primary school will stay friends in secondary school (Lubbers, 2003). Their friendship has a history, which will give the relation a stronger continuity than newly formed friendships have. Therefore, having been friends in primary school is expected to be positively related to friendship formation and continuation.

### 2.3.2 The influence part of the model

The influence part of the model captures the determinants of changes in delinquency levels and is defined by listing the elements of the vector  $s_{z_t}(y, z)$ , which forms the basis for the behavior objective function. These elements contain the hypothesized determinants of the probabilities of changes towards other values of the behavior variable. These determinants may include characteristics of the focal actor ("ego"), the current behavior of ego and of ego's friends. Theories about social influence can be expressed by including the latter type of effects, which imply a dependence of the behavior of the focal individual on the behavior of his or her friends. We hypothesize that the average delinquency levels of friends positively affect an adolescent's

delinquency level. In other words, adolescents whose friends have a high average level of delinquency have a higher tendency toward delinquent behavior. We label this effect *average delinquency of friends*.

To model the overall tendency of ego's delinquent behavior on delinquent behavior, we include two basic components in the objective function. One is a linear and the other is a quadratic component, defined by elements  $z_i$  and  $z_i^2$  in the vector  $s_{zi}(y, z)$ . These will be called *tendency delinquency* and *tendency delinquency squared* effects. Together, these can be interpreted as a curvilinear function expressing the result of inclinations and constraints for the possible values of delinquent behavior, for an individual who scores average values on all other variables. When the coefficient of the quadratic term is negative, the function is unimodal, and current values of delinquency lower than the location of the mode predict higher values of delinquency, whereas for values higher than the location of the mode the individual is inclined to decrease his or her delinquent behavior. In other words, delinquency then can be regarded as a self-correcting process. On the other hand, if the coefficient is positive, the function is U-shaped. Low values predict lower levels and high values predict higher values. This represents a self-reinforcing process. We have no expectation regarding the direction of these two basic parameters. In the influence part of the model, we also control for gender (South & Messner, 2000). This effect is labeled *male*. In line with Steffensmeier and Allan (1996), we expect boys to be more delinquent than girls. In this sample, it is not necessary to control for age because everybody within a classroom is of nearly the same age. The elements in the model are listed in Table 2.1. The mathematical expressions for the elements in the objective functions are provided in the Appendix attached to this chapter.

**Table 2.1: Predicted effects**

<i>Selection part</i>	Predicted effect on friendship formation Mechanism and maintenance	
Shared delinquency	+	Inability model.
Delinquency ego	-	Inability model.
Delinquency alter	-	Inability model.
Outdegree	-	Ties to arbitrary others are rare.
Reciprocity	+	Friendship ties tend to be reciprocated.
Transitivity	+	Tendency to become friends with friends of friends.
Gender similarity	+	Similar students tend to be friends.
Ethnicity similarity	+	Similar students tend to be friends.
Friends in primary school	+	Friendships from primary school will be maintained.
<i>Influence part</i>	Predicted effect on delinquency	
Average delinquency of friends	+	Ability model.
Tendency delinquency	?	No prediction.
Tendency delinquency squared	?	No prediction.
Male	+	Boys tend to be more delinquent than girls.

*+*: positive effect; *-*: negative effect; *?*: no prediction

## 2.4 Method

### 2.4.1 Sample

In the Netherlands, students usually enter secondary school at age 12. Secondary school is a new school for the students, where new classes are formed and many classmates meet for the first time. Classmates spend most of their time at school together. The sample comprises medium-sized schools. Every educational track was included. Some schools are private, of different denominations, others are public; there are urban as well as rural schools.

We collected longitudinal (four waves) network data from 3,171 students in 126 first-grade classrooms in 14 secondary schools in the Netherlands (Knecht, 2006). The data collection started in August and September 2003, in the first weeks of the new school year, using a standardized questionnaire. Subsequently, the same students were asked to fill in the questionnaire three more times, at three-month intervals, resulting in four waves in the academic year 2003-04. Six of the 126 classes did not participate in all waves or a high number of students were missing on the day of the survey, leaving us with 120 classes.

### 2.4.2 Measures

The main instrument was a self-completed questionnaire for the students. All data used in this study are self-reported. Relational questions about friendships with classmates and friendships in primary school were tested in earlier research (Baerveldt et al., 2003); all questions, including those regarding delinquency, were also tested in a pilot study. Trained assistants distributed the questionnaire and were available to answer students' questions. The assistants stressed that all information would be treated confidentially. The students usually filled in the questionnaire within 45 minutes (one class period). The percentage of those refusing to fill in the questionnaire at any given time was very low. Some of the students dropped out or were absent on the day of the survey. The students' response rate was quite high — never below 94% at any of the four measurement points. For an overview of the full sample see Table 2.2 in the next section. We now describe the dependent, control, and background variables.

*Friendship.* The students' friendship relationships were assessed by asking about up to 12 best friends in class. The actual question was: "Who are your best friends in class?" In this way we obtained the information about the entire friendship network within a class. To respect the respondent's privacy we used an identification number for each student in a class. The identification number in combination with a code for each class allowed identifying each student in each wave.

*Delinquency.* The students were asked about offences committed in the last three months. Research (Köllisch & Oberwittler, 2004) shows that more realistic prevalence



rates are obtained with paper-and-pencil interviews at school than with face-to-face interviews in households. We asked for frequency of stealing, vandalism, graffiti, and fighting, using five answer categories: “never”, “once”, “two to four times”, “five to ten times” and “more than 10 times” in the last three months. We treated these ordinally recorded frequencies as interval variables, assuming that these categories are roughly equidistant in perceived intensity. A delinquency scale was created by adding the four items, with values ranging from 1 (no delinquency) to 5 (very high level of delinquency). Of the analyzed cases, we could replace 32 missing values by a corrected item mean, meaning that the imputed value is based on an item mean related to the mean value of the items that are known for this person (Huisman, 2000). The scale has sufficient internal cohesion (Cronbach's alpha ranges between .56 and .75) and is sufficiently one-dimensional (the first eigenvalue in a factor analysis is always above 1.8, the other eigenvalues are always below 1.0). Boys are generally more delinquent than girls.

*Control variables.* Almost half of the students were girls. Dutch students were in the majority (83%). Being Dutch is defined as having at least one parent who was born in the Netherlands and speaking Dutch at home. Not all students reported having any classmates with whom they were friends already in primary school.

*Background variables.* The students were on average 12 years and 1 month old at the first data collection. Socioeconomic status is assigned based on the father's and mother's job, educational level needed for this job, and job status. Most of the students have most of their friends and the most important friends in their class.

## 2.5 Statistical procedure

The actor-driven dynamic statistical model of Snijders, Steglich, and Schweinberger (2007), sketched in Section 3, is used to analyze the contributions made jointly by influence and selection processes in the observed dynamics of networks and delinquent behavior. To minimize the possibility of spurious findings due to effects of contextual variables, the data are analyzed per classroom, so that only within-group comparisons are made. Because classrooms are small in size, and changes in delinquency scores are not very frequent, an estimation method is necessary that makes optimal use of the information in the data set. To this end, we employ the recently developed MCMC-based Maximum Likelihood estimation method (Snijders, Koskinen, & Schweinberger, 2007), which is statistically more efficient than the estimation procedure of Snijders, Steglich, and Schweinberger (2007). The currently available computer software for this method yields good results only for classroom data sets that are sufficiently informative: for data sets with too many missing data or too few changes between subsequent waves, the algorithm is likely to run into convergence problems (and therefore likely to yield inconclusive results). We therefore selected a smaller number of classes from the

original sample of 120 classes, based on the following two pragmatic criteria. First, we focused on classes with few missing values for delinquency, to maximize the amount of information and minimize the impact of missing data on the results. The total number of missing values on the delinquency scale per class over all waves does not exceed 12 for any of the included classes. Second, we chose classes where delinquency tends to change much over time, and where, accordingly, the research question can be studied (note that delinquency does not play a major role in this age group; see the descriptive statistics above). The sum of absolute changes of delinquency scores in the observation period is at least 26 for all included classes. By applying the two criteria, we retain 21 classes, for all of which the estimation algorithm yielded converging estimates, used in the results reported below.

This selection is unrelated to delinquency similarity between friends, therefore it will not lead to bias with respect to the hypotheses about delinquency-related selection and influence. However, the selection potentially biases the estimation of the extent of social influence, because in those classes with a small amount of change on delinquent behavior, influence – interpreted here as changes in behavior depending on the behavior of friends – cannot have been large. Interpretation of the results should take into account that the research population has been reduced to the set of classrooms with relatively high changes in delinquency level. Our results can only be generalized to classes where there is change in delinquency.

Table 2.2 shows how the subsample relates to our whole data set on a series of descriptive statistics. The sample matches the data set in background variables. The adolescents in the subsample nominate slightly fewer others as friends, and they are slightly more delinquent than all adolescents in the data set. The first difference is not significant, however. The latter difference could be expected, given the selection criterion and the fact that delinquency is overall rare. Because non-delinquent students can only change their delinquency score by becoming more (not less) delinquent, selection on the total amount of change favors delinquent classes.

**Table 2.2: Overview of data**

Coding	Wave	Full sample 120 classes (3,017 students)			Subsample 21 classes (544 students)			
		Mean or %	SD	Missing in %	Mean or %	SD	Missing in %	
<i>Dependent variables</i>								
Friends of respondent	1 – 12	A	3.56	2.56	4.5	3.78	2.77	4.2
		B	4.19	2.55	9.0	4.31	2.79	7.9
		C	4.31	2.66	7.6	4.51	2.85	7.0
		D	4.06	2.51	7.2	4.24	2.70	6.4
Delinquency	1: none – 5: high	A	1.25	0.47	18.6	1.34	0.57	6.1
		B	1.38	0.57	21.2	1.51	0.62	8.3
		C	1.46	0.65	20.0	1.58	0.74	7.4
		D	1.49	0.71	19.6	1.62	0.82	6.4
<i>Control variables</i>								
Gender	1: female 2: male	1: 49%			1: 45%			0.0
Ethnicity	1: Dutch 2: non-Dutch	1: 83%			1: 78%			7.5
Friends in primary school	1 – 12	1.76	1.84	4.5	1.67	1.89	4.2	
<i>Background variables</i>								
Age	10 – 15 years	A	12.11	0.49	5.6	12.12	0.52	5.5
Socioeconomic status	1: low – 4: high		2.56	0.93	31.2	2.53	0.94	32.4
Respondents with most friends in class		B	52%		12.3	50%		12.1
Respondents with most important friends in class		B	59%		16.0	57%		16.9

For the analyses of our selected classes we follow a strategy of forward model selection (Snijders, Steglich, & Schweinberger, 2007), by first fitting a simple model that does not contain any effects representing friendship selection based on delinquency or influence of friends on delinquent behavior. Such a model corresponds with the overall null hypothesis that friendship and delinquent behavior evolve independently, not connected by selection or influence processes. This model contained effects of *outdegree*, *reciprocity*, *transitivity*, *gender similarity*, *ethnicity similarity*, and *friends in primary school* for the friendship dynamics; and effect of *tendency delinquency*, *tendency delinquency squared*, and *male* for the behavioral dynamics. After estimating this simple model (results not reported), we tested the significance of two alternative operationalizations of the selection paradigm, as well as two alternative operationalizations for the influence paradigm with a score test (Snijders, Steglich, & Schweinberger, 2007). This test assesses the improvement of fit that would be obtained by extending the model through inclusion of the tested effect, without control for the other three tested effects. This allows a choice between the operationalizations according to the best model fit. The first selection operationalization presumes that individuals prefer to be friends with others at the same level of delinquent behavior (*similarity* effect), the second that individuals do not have to be exactly similar but that those with higher levels of delinquent behavior have a stronger preference for friends

who also have higher levels of delinquency (*shared level of delinquency* effect). Of the two influence operationalizations, the first presumes that individuals tend to adjust their delinquency level to the level of delinquency of their friends (again a *similarity* effect), the second that individuals with friends who on average have a higher level of delinquent behavior tend to acquire a higher level of delinquency but not necessarily completely similar to their friends' level (*average delinquency of friends* effect). These alternatives have the same interpretation for practical purposes, but different mathematical expressions for the model specification, so that there are no good prior grounds for choosing between them. Comparing results of the score tests, we chose the effects that showed a higher degree of model fit increase and added these to the model. These were the *shared level of delinquency* effect for selection and the *average delinquency of friends* effect for influence.<sup>1</sup> By including these in the same model, the selection and influence processes are controlled for each other and thus can be distinguished – which was not possible when using earlier models. The choice of the best-fitting representations leads to a chance capitalization, which is accounted for by applying a Bonferroni correction when interpreting the final results.

The model fitting itself follows a two-stage procedure. First, the friendship-delinquency co-evolution process is analyzed by fitting the same model for each class separately. The analyses are carried out using the Maximum Likelihood option in SIENA version 3.1 (Snijders, Steglich, Schweinberger, & Huisman, 2007). Subsequently, the different classes' estimation results are aggregated in a meta-analysis according to Snijders and Baerveldt (2003), employing principles going back to Cochran (1954). In this meta-analysis, it is assumed that parameter values may differ across classrooms; the estimates obtained are the sum of true parameter values and random error. The population means and standard deviations of the true parameter values are tested and estimated for each effect separately. The test of the mean values is based on the *t*-ratio of estimated mean parameter to standard error (approximately in a normal distribution); the test of the variance is carried out by means of a *chi*-squared test, of which only the *p*-value is reported here.

## 2.6 Results for selection and influence processes

Table 2.3 presents the results obtained by the meta-analyses of the SIENA results. We report the estimated mean parameters with their standard errors, the estimated between-classroom standard deviations of the parameters, corrected for the standard errors of the

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<sup>1</sup> It may be noted that in the sections on the selection and influence part of the model, the selection and influence effects were indicated by terms corresponding to these chosen effects, rather than by terms for the non-chosen similarity effects.

estimates per class, and the  $p$ -values of the tests that the parameter variance is 0. Most of the effects in this model are significant, as most parameter estimates are more than 1.96 times their standard errors, indicating significance on the 5%-level.

**Table 2.3: Results of meta-analysis of SIENA analyses (21 classes)**

	Predicted effect	Estimated mean parameter	Standard error	Estimated true standard deviation	p-value of test that variance of parameter is 0
<i>Selection part</i>					
Shared delinquency	+	0.160***	0.037	<0.001	0.402
Delinquency ego	-	-0.002	0.091	0.37	<0.001
Delinquency alter	-	-0.077	0.044	0.15	0.019
Outdegree	-	-1.907***	0.027	<0.001	0.044
Reciprocity	+	0.847***	0.053	0.16	0.011
Transitivity	+	0.194***	0.009	0.03	0.002
Gender similarity	+	0.637***	0.081	0.32	<0.001
Ethnicity similarity	+	0.108	0.056	0.18	0.010
Friends in primary school	+	0.409***	0.072	0.21	0.295
<i>Influence part</i>					
Average delinquency of friends	+	0.032	0.156	<0.001	0.998
Tendency delinquency	?	-0.535***	0.071	0.16	0.045
Tendency delinquency squared	?	-0.000	0.062	0.19	0.092
Male	+	0.387***	0.161	0.53	0.378

*Significance \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$*

The hypothesis tested in the selection part is that students tend to be friends with others who have a similar delinquency level to theirs. Results for the *shared level of delinquency* effect in Table 2.3 show that more delinquent adolescents have a greater tendency to have friends with a higher level of delinquent behavior. The effect has such a high  $t$ -ratio (4.0) that its significance is not affected when a Bonferroni correction is applied to reflect that the best fitting operationalization was chosen out of two operationalizations of selection and influence. The other effects related to delinquency, *delinquency ego* and *delinquency alter*, are not significant. To illustrate the delinquency-related contribution to the network objective function, consider Figure 2.1. A qualitative difference can be observed between non-delinquent adolescents (level 1) for whom attractiveness of potential friends decreases with delinquency level, and strongly delinquent adolescents (levels 3 through 5) where attractiveness increases with delinquency of alter. Taken together, we found weak evidence that higher levels of delinquency decreases attractiveness to be chosen as a friend as indicated by the *delinquency alter* effect.

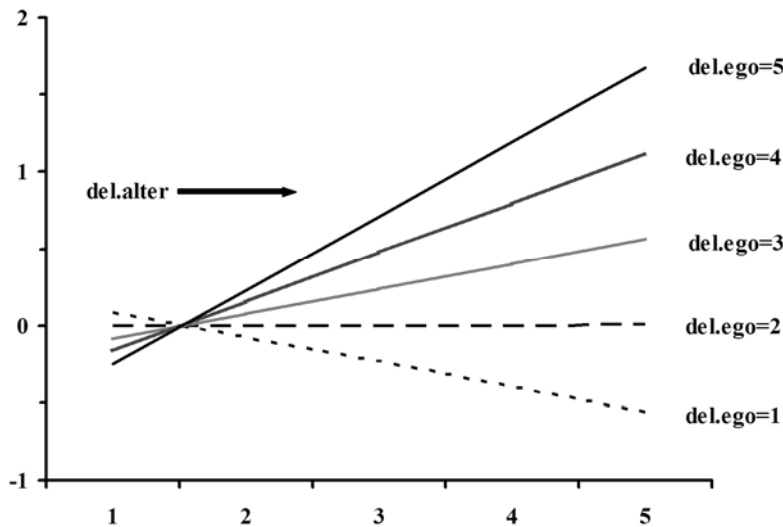


Figure 2.1: Joint contribution of the shared, ego and alter effects of delinquency to the network objective function, for various ego-alter configurations

To get a better understanding of the strength of the *shared level of delinquency* effect, we compare it with the *gender similarity* effect by looking at their effect sizes. A 95% confidence interval is computed by adding plus or minus two times the standard error multiplied with the standard deviation of the delinquency variable to the mean parameter that is also multiplied by the standard deviation. Since the *shared level of delinquency* effect is based on a product, we take the squared standard deviation of delinquency across the observation points. This is used as an approximate effect size. For the *shared level of delinquency* effect we obtain a confidence interval of [0.041; 0.111], for *gender similarity* this is [0.238; 0.400]. The interval for the delinquency interaction is completely below the interval for gender similarity. This indicates that the selection effect based on gender is larger than the one based on delinquency.

There are other results from the model part for friendship dynamics. We find a strong negative *outdegree* effect (-1.907), as expected (see Table 2.1). A tie to an arbitrary other student, without individual or network characteristics adding to his or her attractiveness, has more costs than benefits. For *reciprocity* (average parameter estimate 0.847) and *transitivity* (0.194) we find the expected positive effects. Having the same gender is an important criterion for friendship selection; boys prefer to be friends with boys, and girls with girls. The average *ethnicity similarity* effect is not significant, but this effect does differ between schools (variance  $p=.010$ ). Finally, if available in the new class, friendships from primary school are likely to be maintained in secondary school.

Our second main hypothesis is, that students adjust their own behavior in accordance with the average behavior of their friends. This hypothesis is captured in the influence part of the model. There is no support for the hypothesis that adolescents adjust their delinquent behavior in order to become similar to their friends. The *tendency delinquency* effect is significantly negative, indicating that delinquent behavior is on average unattractive to this population. The *tendency delinquency squared* effect is not significant. Gender has an effect on delinquency level ( $p < 0.001$ ). Given the same conditions, boys tend to develop higher levels of delinquency than girls.

We found significant ( $p < .05$ ) variance between classes for all effects except of the following ones: *shared level of delinquency*, *friends in primary school*, *average delinquency of friends*, *tendency delinquency squared*, and *male*. A significant between-class variation in the parameter for a particular effect points to differences between the classrooms in this aspect of the network-behavior co-evolution process. An approximate 95% confidence interval for the parameter (assuming normality) can be obtained by adding two estimated true standard deviations below and above the estimated average parameter. When this interval is mainly positive or mainly negative, it indicates an effect of a consistent sign but of varying magnitude. This is the case for the *delinquency alter* effect, which is predominantly negative. When it contains important ranges of positive as well as negative values, on the other hand, it suggests the existence of qualitatively different processes in different classrooms. This is the case here for the *delinquency ego* effect and the *tendency delinquency squared* effect. The parameter estimates for the latter effect (estimated mean -0.000, estimated standard deviation 0.19, leading to an interval from -0.38 to +0.38) suggest that in some classrooms the feedback effect may be negative, corresponding to random deviations of delinquency levels around a stable average, whereas in other classrooms it may be positive, corresponding to a polarized classroom where some students have reached, and remain at, a relatively high level of delinquency while the rest (presumably the majority) of the classroom fluctuates around low delinquency levels. This merits further research, but exploration of this issue with the current data set would be mainly speculative, and in the context of this paper we refrain from it.

Correlations of parameter values by class characteristics such as average delinquency level per class, average socio-economic status of parents per class, class size, educational level, proportion of non-Dutch students in the class, and proportion of males in the class were assessed in an exploratory way in order to specify the differences in selection and influence processes between classes. No significant effects were found (parameter values not reported). However, a positive correlation between class size and the value of the *shared level of delinquency* was effect found, suggesting that selection processes based on delinquency are stronger in larger classes. This might

be interpreted by the wider choice of possible friends in larger classes, giving more opportunity to select friends who are similar.

## 2.7 Discussion

The purpose of this study was to investigate the dynamics of delinquent behavior among young adolescents with a new statistical methodology for the investigation of selection and influence processes in networks observed according to a panel design. The statistical model, as defined for a single group, can be regarded as a stochastic simulation model representing the observed differences in networks and behavior at consecutive observation points as the net result of many small changes occurring continuously between the observations. In this model, the probabilities of changes in the network and the behavior depend on the current state of network and behavior combined. Such a model can represent selection processes, influence processes, and combinations of the two. The application of this type of model allows testing and estimation of the parameters representing the weights of behavior of self and peers in selection and deselection of friends, as well as the weights of behavior of friends on the behavior of the focal individual, in such a way that the estimation of selection and influence processes is controlled for the other process and for other effects related to the network (reciprocity, transitivity) and to individual or dyadic attributes. Inclusion of selection and influence processes in one model safeguards against overestimating the effect of either when only one is examined in a model, and gives the possibility to disentangle selection and influence processes.

To combine this model across groups, this paper employed a simple meta-analysis procedure. It would be interesting to combine the groups using a random coefficient model, combining the actor-oriented dynamic network model presented here with the ideas of hierarchical linear and nonlinear modeling. If the requirements of such methods are met, the statistical power is higher than in the simple meta-analysis. Such methods are not yet available, however. The advantage of the meta-analytic approach is that it requires weaker assumptions than a random coefficient model.

We were concerned with examining to what extent, and how, friendship selection is based on the combination of personal and peer delinquency, and to what extent friends have an influence on adolescents' level of delinquency. In this way we wanted to explain the causes for a positive association between adolescents' and friends' delinquency in early adolescence, differentiating between selection and influence processes. Following social control theory (Hirschi, 1969), we hypothesized that students with lower delinquency levels are more likely to become friends with others who have a lower delinquency levels. Thus, a positive association of an adolescent's and a peer's delinquency level fosters friendship formation. Following social learning theories such as differential association theory (Sutherland & Cressey, 1974), we



hypothesized that friends adjust their own delinquent behavior to the average delinquent behavior of their friends, thus becoming more similar to them. We tested these hypotheses with longitudinal multiple network data that gave us information from all adolescents in a friendship network within a classroom about their friendship relationships to classmates and their delinquent behavior at four time points within one school year.

Results indicate that delinquency plays a role as a selection criterion for friendship. We found that adolescents tend to make friends with others who have a similar delinquency level, and we found weak support that delinquent students are less attractive as friends. This part is consistent with the inability model derived from social control theory and in line with Baron and Tindall (1993) who also found support for social control theory when examining the strength of ties in relation to delinquent attitudes. Another part of the inability model, that adolescents are socially less involved, was not supported by our data. Furthermore, we found other aspects such as reciprocity, transitivity, same gender, and tie history contributing to friendship choices, corresponding with earlier research on friendship. The effect size of the interaction effect between own and other's delinquent behavior on friendship choice appeared to be of smaller magnitude compared to the effect of gender similarity on friendship choice.

The illustration of the selection effect in Figure 2.1 suggests a polarization of network members into two groups. The non-delinquent majority of students shows an aversion to delinquent friends. These are the students who score 1 on the scale — 69% of our sample in the first wave, decreasing to 55% in the fourth wave. In contrast, the minority of very delinquent students, scoring 3 through 5 on the scale, shows a preference for delinquent friends. This minority consists of 6% in the first wave, increasing to 15% in the fourth wave. In-between these groups, the students who score 2 on the scale show indifference (or insensitivity) to their friends' delinquency; on average, this middle group consists of 30% of the students.

The second main hypothesis — which relates to the ability model and thus to social learning theories such as differential association theory — on the influence of friends on delinquent behavior, was not supported by the data. We only found delinquency level to be influenced by gender. Boys' delinquency levels are higher on average than girls' delinquency and it also increase more than girls'.

The focus of our study was on young adolescents who are on average 12 to 13 years old. Our results apply to this population where delinquency levels are rather low on average. The importance of delinquency may differ for other age groups. For instance, Burk, Steglich, and Snijders (2007) found selection as well as influence processes related to delinquency in a study that included adolescents up to the age of 18 years.

Here we presented a new statistical method for data with a complex dependence structure; more research is needed to gain a better understanding of its properties. In

particular, the sensitivity of the results for the model assumptions is an important issue. Studying this issue will also throw more light on the question of how to specify the model to obtain robust results. It will also be important to develop effect size measures. Our empirical application of the new method taught us that not more than a small fraction of the data should be missing, and that there should be enough total variation over time in the behavior variable. In our study these requirements led to a relatively large loss of analyzable classrooms. In our network questionnaire, information was requested about within-classroom friends only. For future work it is advisable to do everything possible to limit the extent of missing data and, when feasible, to collect network information for larger units (e.g., in each school being studied, the network between students in all first-grade classrooms). This will increase the amount of information on the network change as well as on the behavioral change, thereby also diminishing the loss (if any) in analyzable networks. It will also diminish problems associated with the problems in determining the network boundary.

This empirical study faces some limitations. First, our focus was on friends within school classes. Although relationships within a classroom form an important social environment for adolescents, they do not represent their entire social world of peers. In addition, it has been pointed out that friends from outside the school should not be disregarded, as they may be more likely to behave delinquently (Dishion et al., 1995). We did test whether delinquent students reported most of their friends and their most important friends to be from outside the class. This was not consistently the case. Second, one assumption of social control theory (Hirschi, 1969) is that relationships among delinquent adolescents are of poor quality. Since we do not have information on the intimacy of the relationship, frequency of contact, or other measures of friendship quality, we are not able to test that part of the theory.

This empirical study also has some strong points. With our statistical methodology and research design we attempted to overcome methodological problems of earlier studies. One strong point of the design is the use of longitudinal network data collected for a relatively large number of classrooms, which seems to be the most accurate way to track down the processes that lead to positive association between adolescents' and their friends' delinquency. Another strength is the use of self-reported data in order to avoid the known problems of overestimating similarity of the friend's behavior to respondent's behavior when using perceived peer data.

The results can be summarized by concluding that, for the dynamics of delinquency between young adolescents in the general population, selection processes and social control theory should be considered as theoretical explanations for the similarities between friends in their level of delinquency. We found support for selection processes in line with social control theory, but no support for influence processes as predicted by differential association theory. We see the SIENA program and its underlying model for

co-evolution of networks and behavior as a promising tool in the study of selection and influence processes. Its future application can hopefully yield further conclusions about the balance between selection and influence, which may well be different in other populations and for other dependent behavior variables.

## Appendix. Formulae for elements of the model

The elements of the vectors  $s_{y_i}(y, z)$  and  $s_{z_i}(y, z)$ , of which weighted sums are used as the objective functions for changes in network ties and in behavior are verbally listed in Table 2.1. The corresponding formulae are listed below. The delinquency variable is supposed to be (for each classroom separately) grand mean centered in these formulae.

*Selection part of the model*

Outdegree	$\sum_j y_{ij}$
Reciprocity	$\sum_j y_{ij} y_{ji}$
Transitivity	$\sum_j k y_{ij} y_{jk} y_{ik}$
Gender or ethnicity similarity	$\sum_j y_{ij} m_{ij}$

where  $m_{ij} = 1$  if  $i$  and  $j$  have the same gender/ethnicity, and 0 otherwise.

Delinquency ego	$\sum_j y_{ij} z_i$
Delinquency alter	$\sum_j y_{ij} z_j$
Shared level of delinquency	$\sum_j y_{ij} z_i z_j$

where  $z_i$  and  $z_j$  indicate the delinquency of individuals  $i$  and  $j$ .

*Influence part of the model*

Tendency delinquency	$z_i$
Tendency delinquency squared	$z_i^2$
Average delinquency of friends	$z_i (\sum_j y_{ij} d_j / \sum_j y_{ij})$ (defining $0/0 = 0$ )
Male	$z_i g_i$

where  $g_i = 1$  if  $i$  is male, and 0 if  $i$  is female.

### 3 Friendship and school attitudes in early adolescence\*

#### **Abstract**

Most adolescents have attitudes towards behaviors that are expected from them by the school such as doing homework, being attentive, getting good grades, being on time, and going to every lesson. Often adolescents' attitudes related to school behavior and their friends' attitudes are positively associated. Different processes are hypothesized to lead to this positive association. One process is that shared school attitudes affect friendship choices. We refer to this as *selection*. Another process is that school attitudes of friends affect adolescents' attributes. We refer to this as *influence*. We hypothesize that (a) students who are more similar in their school attitudes are more likely to form friendship ties, and (b) that adolescents adjust their school attitudes to the average school attitudes held by their friends.

We use relational and behavioral panel data from 793 students in 29 first classes of Dutch secondary schools, measured at four time points. Employing an actor-driven model of the co-evolution of networks and actor attributes as implemented in the SIENA software, we disentangle selection and influence processes. Contrary to our expectations, there is no evidence that school attitudes play a role for friendship selection or in the friends' influence process.

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### 3.1 Introduction

Everybody who has attended school has been confronted with a variety of demands, such as being on time, going to lessons, getting grades, being attentive, and doing homework, whether they liked it or not. Attitudes about these tasks can be in favor of school-related behavior or rejecting of school-related behavior. It is important to study these attitudes towards school-related behavior because they substantially shape adolescents' scholastic experience, their performance and, since young adolescents spend a substantial part of their time at school, their well-being in general. Earlier studies found effects of school attitudes such as school satisfaction on psychological well-being, school engagement, absentee rate, drop-out and behavioral problems (Ainley, 1991). Other studies show the association of school satisfaction with life experiences and academic self-efficacy (Huebner & McCullough, 2000). School satisfaction is one of the most significant predictors for general satisfaction among boys and girls; increasing school satisfaction is associated with increasing positive attitude toward life, lack of depressive mood, joy in life, and self-esteem; low school satisfaction is related to a high frequency of problems with school, parents, and friends among girls and lack of appetite among boys (Katja, Paivi, & Marja-Terttu, 2002).

A correlation between school attitudes and friendship has been found by earlier studies. Results of earlier studies indicate that students are more likely to be friends with students who have similar educational aspirations (Cohen, 1977; Kandel, 1978) and grades (J. L. Epstein, 1983). Three processes explain similarity among friends: context effects, friendship selection, and friends' influence. Context factors that simultaneously affect friends' behavior and attitudes outside school like a sports club will not be addressed in this study. We consider effects of the classroom context by analyzing friendship relations among classmates. In this way, we control for effects of socio-economic status, school, teachers, and the like. While controlling for classroom context, our study focuses on selection and influence processes.

Studies of selection and influence processes of adolescent friends arrive at different conclusions. Kandel (1978) investigated similarity in educational aspiration as a result of assortative pairing and processes of influence in a longitudinal study. Both selection and influence seemed to be approximately of equal importance. Another result of Kandel's study is that dissimilar friends are more likely to break up their relation than friends who are similar regarding educational aspiration. Cohen (1977) identified conformity pressures, disproportionate group-leaving by dissimilar students, and homophilic selection as three sources of homogeneity in student friendship groups. Analyzing forty-nine high school friendship groups for their educational aspiration, he found homophilic selection as the most important factor leading to group homogeneity. Conformity pressures make a small contribution, and group leaving contributed nothing to homogeneity. These studies show that dyadic friendship relations are associated to

school behavior but that the relative importance of selection and influence processes remains an open question. Other research showed the importance of influence processes. In his classical study "The Adolescent Society" (J. S. Coleman, 1961), Coleman pointed out that adolescents' school-related behaviors are affected by the social context of the peer group. Epstein (1981) found that positive peer relationships have an effect on school satisfaction. In addition, it has been argued that friends have an influence on the school adjustment of adolescents (Berndt, 1999; Hartup, 1996).

Influence and selection processes are best studied in a setting where people are establishing new relationships and are faced with uncertainty in situations that may prompt them to change their behaviors and attitudes. For these reasons, a good research setting to study selection and influence processes is young adolescents in first grade of secondary school in the Netherlands. They are in a situation of transition for several reasons. First, in the Dutch school system, students at the beginning of secondary school are 12-13 years old on average and thus at the onset of adolescence. During adolescence, peers are becoming increasingly important in determining interests and influencing attitudes, as the young person spends less time with parents (J. C. Coleman & Hendry, 1990; Larson & Richards, 1991). The importance of peers increases in this period, e.g., for identity formation (Douvan, 1983). The increased importance of friends in adolescence leads to a higher susceptibility to peer influence. Second, students entering secondary school do not necessarily have friends from primary school available. In such a new social setting, it is likely that new friends will be chosen. Third, students of one class have most of their lessons together, and thus spend most of their time at school together. The classroom provides the opportunity to meet. Fourth, after the transition from primary school to secondary school, students find themselves in a new social comparison group, where grades and educational competences are stressed (Harter, Whitesell, & Kowalski, 1992). School behavior is more serious in secondary compared to primary school in the sense that many students new to secondary school have to do homework for the first time and expectations of parents might increase. So, school-related tasks and duties are an issue for secondary school students.

Earlier studies, including those discussed above, suffered from a couple of methodological problems that we wish to overcome with our research design. First, data from respondents about their own attributes are preferable to data from respondents about their friends' attributes (Iannotti & Bush, 1992; Prinstein & Wang, 2005). Adolescents have a tendency to overestimate the similarity between their own and their friends' attributes, which distorts the actual strength of association between friends' attributes. In the literature, this is known as the "false consensus effect" (Ross et al., 1977). Our study uses self-reported instead of peer-reported data. Second, respondents' friendship nominations should not be restricted to a small number. Respondents may have more influential contacts than they are able to nominate given the design of the

questionnaire. In the literature this is known as errors due to a fixed choice design (Holland & Leinhardt, 1979; Wasserman & Faust, 1994). Our questionnaire design allows nominating up to 12 others as friends rather than only up to three best friends. This allows a good control for structural effects such as being friends with a friend of a friend. Third, using complete network data rather than ego-centered data on friendship relations is advantageous. Complete network data give information about similarities and dissimilarities between friends and additionally, information about similarities and dissimilarities between non-friends. Fourth, earlier studies were often based on cross-sectional data. Only a longitudinal design can give insights in the causal connection between friendship and attitudes (Leenders, 1997). In our study, we use panel data on friendship relations and attitudes about school-related behavior, both measured at four time points within one school year rather than cross-sectional data. Fifth, earlier studies were often case studies investigating one or only a few numbers of networks. Studying the co-evolution of social networks and attitudes in many groups provides more statistical power and better confidence in the generalizability of our results. Our sample is composed of 793 students in 29 first classes of 10 Dutch secondary schools. Students were asked about their friendship relations within the class, we have thus the complete friendship network in each classroom. Finally, the results by Cohen (1977) and Kandel (1978) suggest that peer influence on aspirations has been overestimated because it was left unconsidered whether friends' and acquaintances' aspiration levels were alike at the time of friendship choice. In this way, selection processes of similar others were disregarded. Therefore, selection and influence processes need to be studied simultaneously in order not to overestimate the investigated effect (Bauman & Ennett, 1996). The analyses of earlier studies were hampered by inappropriate statistical methods that did not adequately take the dependence of network ties into account, and also did not allow to adequately control influence processes for selection processes, and vice versa. Adequate statistical methods are needed for separating selection and influence processes.

For our analysis, we apply actor-driven modeling as proposed by Snijders, Steglich, and Schweinberger (2007) that is implemented in SIENA (Snijders, Steglich, Schweinberger, & Huisman, 2007), a program that is designed to analyze the dynamics of networks and behavior and which is suitable to investigate selection and influence processes simultaneously.

With our study we attempt to overcome methodological problems and hope to provide answers to the following questions:

- 1) Are adolescents' friendship choices affected by shared school attitudes?**
- 2) Are adolescents' school attitudes affected by their friends' school attitudes?**



This paper is organized as follows. In the next sections, we derive our hypotheses about friendship formation and social influence. We then describe the actor-driven model that is implemented in the SIENA software, which we use for analyzing our data. Then we specify the model with our main hypotheses and control variables. After the description of the data, we report results from the SIENA analyses. We finish with a discussion.

### 3.2 Explaining similarity

#### 3.2.1 Similarity resulting from friendship selection

In this section, we argue why friendship is important for adolescents, why similarity in attributes is expected to be a predictor for friendship formation and maintenance, and why school attitudes affect friendship choices.

Friendships are valued because they provide the individual with a sense of belonging and opportunities for communication and interaction, supply physical and emotional support, and give reassurance of values (McAdams, 1988). Friends help to give orientation in unfamiliar situations, provide guidelines on how to behave, and sociability.

Previous research identified various factors according to which friendship ties are formed with someone from the available pool of others and are maintained. These selection processes can broadly be categorized into *structural* factors and *interpersonal* factors, related to the mutual attraction of two potential friends that is due to their individual attributes. Structural factors are related to the structure of opportunities and constraints that social settings and social networks provide such as effects of reciprocity and transitivity. Interpersonal factors explain individual differences in attractiveness and social activity as well as matching on certain individual characteristics.

Similarity is an interpersonal factor and is considered to be positively related to friendship selection by different theories such as balance theory (Festinger, 1957; Heider, 1946), and social learning exchange theory (Blau, 1964; Homans, 1974; Thibaut & Kelley, 1959). These theories assume that similarity is rewarding and induces liking. Similar others are best able to provide behavioral confirmation and understanding and have similar resources and needs. Similarity is believed to be a good basis for assuming positive outcomes in further interactions as it facilitates communication (Zeggelink, 1993). Friendship selection of students in class is likely to be governed by school attitudes since school is the meeting place of these adolescents and an important part of everyday life. In addition, school attitudes are expressed at various occasions throughout the time spent at school. Students communicate about their school attitudes or they might infer them indirectly by observing what others do, for example whether they always turn in assignments on time, or tend to skip class. Therefore school attitudes qualify as criteria for friendship selection. We hypothesize that adolescents

whose school attitudes are positively associated are more likely to start and maintain a friendship relation than adolescents who differ in their school attitudes.

### 3.2.2 Similarity resulting from friends' influence

In this section, we provide arguments for influence processes and describe processes leading to adjustment of attributes.

It is reasonable to expect influence processes among adolescent friends. Adolescents have the wish to have "appropriate" attitudes. What is defined as appropriate strongly depends on the social context, most likely on intimate relations like friendship relations. Influence among adolescent friends may operate in several ways. In the literature, different mechanisms are identified that can be applied to friends' influence on school attitudes: First, Bronfenbrenner (1967) suggests that friends exert social pressure, and thus change in attitude would be forced by these friends. Second, social reinforcement is considered to be a more subtle form of social pressure (Dishion et al., 1995). Friends provide cues such as laughing in order to express their own attitudes and mark approved attitudes. Or they provide cues to express disapproval of attitudes. Third, modeling (Bandura, 1977, 1986) is another form of social influence based on learning. Adolescents observe role models and subsequently imitate these role models. Role models are assumed to have a stronger influence if they have a positive relationship, like a friendship, with the child or adolescent. Processes of social comparison (Festinger, 1954) work similarly. Adolescents like other persons have a need to evaluate and validate their own attitudes. Since there are no objective standards, they will compare their attitudes with those of their friends. Fourth, information exchange may affect adolescents (Ryan, 2000). Hallinan and Williams (1990) point out that students at school are often in situations where they must obtain information in order to know how to act. This seems quite likely for students in first grade of secondary school who find themselves in a new class in a new school. Adolescents talk about advantages and disadvantages of school-related behavior and in this way shape attitudes of adolescents if arguments are persuasive. Considering these mechanisms, we hypothesize that adolescents will adjust their attitudes about school-related behavior to the average attitudes of their friends without having specific expectations about which of the processes exactly is responsible for this effect.

### 3.3 An actor-driven model

In this section, we describe an actor-driven model for the co-evolution of friendship network and school attitudes in a non-technical way. For mathematical details, we refer to Snijders (2001) and Snijders, Steglich, and Schweinberger (2007). In actor-driven modeling, it is assumed that the network structure and the distribution of attributes are

emerging group level properties resulting from changes on the individual level. Decisions made by individual actors at random moments account for changes in friendship (possibly reflecting selection) and school attitudes (possibly reflecting influence). These decisions shape the network structure and distribution of attitudes among network members, while the same network structure and attitude distribution acts as a constraint on these decisions in a dynamic feedback process. Decisions concern the actor's friendship ties and the actor's school attitudes. Friendship ties are treated as unilateral, i.e., a friendship tie exists when it is perceived by one of the involved actors. The tie does not have to be confirmed by both, but confirmation constitutes an additional property of the relationship (*reciprocity*). Adolescents can decide (a) to form a new friendship tie, (b) to discontinue an existing friendship tie, or (c) to make no tie changes. School attitudes are assumed to be represented as ordinal discrete variables. They can be negative or positive in different variations. Adolescents can decide (a) to adopt more positive school attitudes, (b) to adopt more negative school attitudes about school, or (c) not to change attitudes.

The decision to change a friendship tie and to change one's school attitude can be subject to many factors. Factors affecting the decision to change an outgoing friendship tie and factors affecting the decision to change one's school attitude are specified in the corresponding parts of the model. The selection part and the influence part are mutually interdependent: the dependent variable of one part is the explanatory variable in the other part and vice versa. In other words, friendship choice is explained by school attitudes in the part whereas school attitudes are explained by friends' characteristic in the influence part. Other factors explaining friendship selection and school attitudes are specified in the next section.

### 3.4 Model specification

The selection part of the model aims at explaining friendship dynamics and the influence part of the model aims at explaining the dynamics of school attitudes. Next to the main effects of selection and influence as outlined above, also other factors need to be included in the two model parts. We now proceed to a sketch of the complete model, with all its components.

In the selection part of the model, we control whether school attitudes have effects on network activity, i.e., whether students' more positive or negative attitudes about school-related behavior lead to a variation in the number of friends whom they nominate. This relational activity of students is captured in the *school attitudes ego* parameter. Furthermore, we test whether particular attitudes about school make a student more or less attractive as a friend. This effect is called *school attitudes alter*. Our main hypothesis here is represented by an interaction effect of these previous two effects. We hypothesize that a positive association of own school attitudes and other's

school attitudes facilitates friendship formation and maintenance, and express this by the *shared school attitudes* effect in the model, for which we expect a positive estimate. Arguments and references for this hypothesis have been provided above.

Structural and interpersonal mechanisms are included as control effects in the network objective function. As a basic variable, we incorporate an *outdegree* effect as an intercept for the selection part. This effect describes the preference for having a tie to an arbitrary other, irrespective of the potential further qualities of this relationship (like similarity or reciprocity). We hypothesize a negative effect of *outdegree*, meaning that friendship networks tend to always have a low density (below 50% of all possible ties). We include effects for *reciprocity* and *transitivity* to take into account that friendship choices of friends have an effect on the friendship choices of adolescents. *Reciprocity* is important, especially for friendship relations, since it reflects mutual affection and trust (Leenders, 1996). Reciprocated friendship is more rewarding than an unreciprocated friendship nomination. To control for the effect of network closure, we include the effect of *transitivity*, measuring the increased likelihood to become friends with friends of friends. We expect the parameters associated to these effects to be positive. Effects of reciprocity and transitivity are strongly supported in other studies (e.g., Dahlbäck, 1982). According to our reasoning that friendship choices are governed by similarity, we control for demographic background characteristics, such as gender (*gender similarity*) and ethnicity (*ethnicity similarity*). Similarity in gender has consistently been found among best friends in early adolescence (e.g., Lubbers, 2003). It has also been suggested that friendships are more often found within the same ethnic group (Baerveldt, Van Rossem, Vermande, & Weerman, 2004). Again, we hypothesize that the parameters associated with these effects are positive. To account for effects of tie history, we control for friends from primary school (*friends in primary school*). Tie specific investments, such as commitment, have been made. In addition, trust and familiarity have been built up. Therefore we expect that these friendships will be maintained if the friends are still available in class (again a positive effect).

In the influence part of the model, we include a parameter taking into account whether students adjust their own attitudes to the average attitudes held by their friends and thus are influenced by them. This effect is labeled *average school attitudes of friends*. We expect a positive effect. Two basic parameters are included to model the endogenous effects of school attitudes in the influence part of the model. These are the *tendency school attitudes* effect, a linear component, and the *tendency school attitudes squared* effect, a quadratic component. Together they model the effects of current school attitudes on school attitudes. A positive effect of the quadratic component reflects a reinforcing process, negative school attitudes become even more negative and positive school attitudes become more positive. A negative effect reflects a self-correcting process. Negative school attitudes become more positive and positive school

attitudes become more negative. We do not have expectations regarding the direction of these basic effects. We also include effects measuring the influence of gender (*male*) and *parents' expectation* of their child's school behavior. Girls have been found to hold more positive attitudes towards school than boys (Majoribanks, 1991). Students whose parents consider school behavior to be important, presumably place high value on this behavior and, hence, are expected to have more positive school attitudes. It can be argued that ability may also affect school attitudes. We refrain from including such an effect for reasons of parsimony and because classes are grouped according to educational level.

Still other effects have a bearing on friendship selection and school attitudes. However, due to the limited amount of information in classroom networks consisting on average of 25 students, we are restricted to the relatively parsimonious model sketched above. An overview of the model is provided in Table 3.1.

**Table 3.1: Predicted effects**

<i>Selection part</i>	Predicted effect on friendship formation and maintenance	Mechanism
Shared school attitudes	+	Adolescents with a higher score are more likely to be friends with other adolescents with a higher score.
School attitudes ego	?	No prediction.
School attitudes alter	?	No prediction.
Outdegree	–	Ties to arbitrary others are rare.
Reciprocity	+	Friendship ties tend to be reciprocated.
Transitivity	+	Tendency to become friends with friends of friends.
Gender similarity	+	Similar students tend to be friends.
Ethnicity similarity	+	Similar students tend to be friends.
Friends in primary school	+	Friendships from primary school will be maintained.
<i>Influence part</i>	Predicted effect on school attitudes	
Average school attitudes of friends	+	School attitudes are adjusted toward average school attitudes of friend.
Tendency school attitudes	?	No prediction.
Tendency school attitudes squared	?	No prediction.
Male	+	Boys are more likely to have negative school attitudes than girls.
Parents' expectation	+	Parents influence adolescents' school attitudes positively.

*+*: positive effect; *–*: negative effect; *?*: no prediction

### 3.5 Method

#### 3.5.1 Sample

Our sample includes a mixture of public and private, rural and urban schools and comprises classes of every educational track. In secondary school, students are assigned to tracks according to their abilities. Usually students follow the same track throughout

their time at secondary school. In any given class, students follow the same track or students of two adjacent tracks are grouped together in one class. We collected longitudinal network panel data (four waves) from 3,171 students in 126 first grade classrooms in 14 secondary schools in the Netherlands (Knecht, 2006). Six classes were excluded because they did not participate at all four time points or a high number of students were missing on the day of the survey. The first wave took place immediately after the beginning of the school year 2003-04. The same students participated three more times at three months intervals. We subsequently refer to these as waves A, B, C, and D.

### 3.5.2 Measures

The main instrument for the data gathering is a self-completed questionnaire for the students. All data about students used in this paper are self-reported. Questions about friendship relations to classmates and attitudes about school-related behavior in the last three months are included in all four waves. Trained assistants distributed the questionnaires and were present to answer questions of the students. The students filled in the questionnaire usually within 45 minutes (one lesson). Some of the students dropped out or were absent on the day of the survey. At each of the four waves, more than 93% participated in the survey. We now describe the dependent, control, and background variables. For an overview of the full sample see Table 3.2 in the next section.

*Friendship.* Friendship is measured as perceived friendship, i.e., as a directed relation. It is assessed by asking each student to name a maximum of 12 best friends in class. The actual question is: “Who are your best friends in class?” A definition for “best friend” was not provided in the question. In asking all the members of a school class, we get the information about the entire friendship network within a class. For reasons of confidentiality and ease to track down friends and their friends throughout the four waves, we used an identification number for each student in a class. On average 4 classmates are nominated as friends. Between waves, on average 76% of all possible ties between adolescents of a class are no friendship ties, 12% continue to be friendship ties, 6% have been friendship ties but are not any longer, and another 6% turn into friendship ties.

*School attitudes.* This measure is a scale consisting of five items related to school behavior. The students were asked what they think about the following items: being attentive in class, getting good grades, doing homework, being on time for class, and going to each class. The five answer categories range from “very positive” (1) to “very negative” (5). We formed a scale by computing the mean value of these items for each student. The resulting scale has values from 1 to 5. Thus 1 indicates attitudes in favor of school-related behavior and 5 indicates attitudes rejecting school-related behavior.

Sufficient internal consistency is indicated by Cronbach's alphas ranging from .87 to .90. The mean of school attitudes is increasing, indicating that students' school attitudes are more positive at the beginning than at the end of the academic year. For the analyzed cases over all four waves, we could replace 8 missing values by a corrected item mean (Huisman, 2000). Around 60% of all students do not change their school attitudes in each wave. Approximately 16% change their school attitudes into more favorable ones, and approximately 24% acquire less favorable school attitudes.

*Control variables.* In the sample, half of the respondents were girls. Most of the students (83%) were Dutch, compared to a smaller fraction (17%) of non-Dutch students. Being Dutch was determined by having at least one parent who was born in the Netherlands and speaking predominantly Dutch at home. *Parents' expectation* was measured in the second wave, three months after the start of the academic year. It is composed of three items. Students were asked about the importance of certain school-related behaviors for their parents. The questions were "How important is it for your parents that you: (1) are attentive in class; (2) are doing your best at school; and (3) do your homework?" There were five answer categories from "very important" to "very unimportant". The scale ranged from 1 (child's school-related behavior is very important to parents) to 5 (child's school-related behavior is very unimportant to parents). Cronbach's alpha for this scale is .79. In this way we measured the expectation of parents regarding their child's scholastic behavior as perceived by the student.

*Background variables.* Students were on average 12 years old at the beginning of the data collection. The socio-economic status of the family depends on the educational level, job and working status of the parents. The socio-economic status is not included in our analyses due to the high amount of missing information on this item. Most of the students have most of their friends and their most important friends in class.

### 3.6 Analytical strategy

The actor-driven statistical model as outlined in more detail in Chapter 2 is used for the analysis of selection and influence processes. Analyzing friendship networks within classrooms controls for contextual effects such as a shared institutional environment. A class consists on average of 25 students providing only a limited amount of information. Therefore, we chose SIENA's Maximum Likelihood estimation option (Snijders, Koskinen, & Schweinberger, 2007), which makes efficient use of the available information, rather than the estimation procedure of Snijders, Steglich, and Schweinberger (2007). In order to improve convergence and minimize the impact of missing data on the results of our analyses, we wanted to have classes that provide much information. From the full sample of 120 classes, we selected classes satisfying two criteria. First, change of friendship relations and attitudes should be high. Second, data on friendship relations and attitudes should not be missing. This selection is

unrelated to similarity in school attitudes between friends, therefore it will not lead to bias with respect to the hypotheses about school attitude-related selection and influence. However, the selection potentially biases the estimation of the extent of social influence, because in those classes with a small amount of change on school attitudes, influence cannot have been large. Interpretation of the results should take into account that the research population has been reduced to the set of classrooms with relatively high changes in school attitudes. We retain 36 classes. The selection of the subsample is not related to similarity among friends; therefore, we expect that this selection does not affect our results.

The model fitting follows a two-stage procedure. First, the friendship-school attitude co-evolution process is analyzed by fitting the same SIENA model for each class separately. In this way the selection and influence processes are controlled for each other. Due to occasional convergence problems caused by high levels of collinearity the analyses could only be made successfully for 29 of the 36 class networks. Descriptive statistics of the 29 classes can be compared with the descriptive statistics of the full sample in Table 3.2.

**Table 3.2: Overview of data**

Coding	Wave	Full sample 120 classes (3,017 students)			Subsample 29 classes (793 students)			
		Mean or %	SD	Missing in %	Mean or %	SD	Missing in %	
<i>Dependent variables</i>								
Friends of respondent	1 – 12	A	3.56	2.56	4.5	3.46	2.53	1.9
		B	4.19	2.55	9.0	4.19	2.52	4.9
		C	4.31	2.66	7.6	4.31	2.58	5.2
		D	4.06	2.51	7.2	4.01	2.49	5.6
School attitudes	1: positive – 5: negative	A	1.64	0.57	4.8	1.68	0.56	1.9
		B	1.70	0.61	9.6	1.80	0.64	5.4
		C	1.74	0.64	7.9	1.85	0.65	5.3
		D	1.81	0.69	7.7	1.89	0.70	5.7
<i>Control variables</i>								
Gender	1: female 2: male		1: 49%		0.0	1: 48%		0.0
Ethnicity	1: Dutch 2: non-Dutch		1: 83%		7.7	1: 83%		6.3
Friends in primary school	1 – 12		1.76	1.84	4.5	2.04	1.98	1.9
Parents' expectation	1: high – 5: low	B	1.48	0.50	10.6	1.52	0.48	5.6
<i>Background variables</i>								
Age	10-15 years	A	12.11	0.49	5.6	12.06	0.44	2.8
Socioeconomic status	1: low - 4: high		2.56	0.93	31.2	2.61	0.94	25.9
Respondents with most friends in class		B	52%		12.3	52%		7.7
Respondents with most important friends in class		B	59%		16.0	62%		11.4



Second, the different classes' estimation results are aggregated in a meta-analysis according to Snijders & Baerveldt (2003). The purpose of this meta-analysis is to estimate and test the mean and variance across school classes of the true parameter values. The meta-analysis assumes that parameter estimates obtained per class are the sum of a true value and random deviation, the latter having a known standard deviation given by the standard error reported by SIENA. The analyses were carried out using SIENA version 3.1 (Snijders, Steglich, Schweinberger, & Huisman, 2007).

### 3.7 Results for selection and influence processes

We describe the effects found in the model. We were mainly interested in two processes. One of them is whether friendship choices are affected by a positive association of adolescents' and classmates' school attitudes (*shared school attitudes*) and the other is whether adolescents' school attitudes are affected by the average of their friends' school attitudes (*average school attitudes of friends*). Table 3.3 presents the results obtained by the meta-analysis of the SIENA results of each class. We report the estimated mean parameters with their standard errors, the estimated between-classroom standard deviations of the parameters corrected for the standard errors of the estimates per class, and the *p*-values of the tests that the parameter variance is 0. Most effects in this model are significant because estimates are more than 1.96 times their standard errors, indicating significance on the 5%-level.

**Table 3.3: Results of meta-analysis of SIENA analyses (29 networks)**

	Predicted effect	Estimated mean parameter	Standard error	Estimated true standard deviation	<i>p</i> -value of test that variance of parameter is 0
<i>Selection part</i>					
Shared school attitudes	+	0.064	0.051	0.11	0.107
School attitudes ego	?	-0.082 *	0.041	0.14	<0.001
School attitudes alter	?	0.000	0.033	0.11	0.024
Outdegree	-	-1.907 ***	0.029	0.10	<0.001
Reciprocity	+	0.996 ***	0.052	0.20	<0.001
Transitivity	+	0.185 ***	0.009	0.04	<0.001
Gender similarity	+	0.635 ***	0.056	0.24	<0.001
Ethnicity similarity	+	0.068	0.036	0.02	0.223
Friends in primary school	+	0.557 ***	0.066	0.27	<0.001
<i>Influence part</i>					
Average school attitudes of friends	+	0.109	0.180	<0.001	0.862
Tendency school attitudes	?	-0.007	0.053	<0.001	0.582
Tendency school attitudes squared	?	-0.439 ***	0.059	<0.001	0.737
Male	+	0.247 *	0.100	<0.001	0.770
Parents' expectation	+	0.437 ***	0.089	<0.001	0.761

*Significance* \**p*<0.05; \*\**p*<0.01; \*\*\**p*<0.001

Our hypotheses about the effects of school attitudes on friendship selection are only partly supported by the data. There is no evidence for the hypothesis that a positive association of own and friends' school attitudes fosters friendship selection and that school attitudes affect the popularity of adolescents. There is evidence that adolescents with attitudes rejecting school-related behavior nominate fewer classmates as friends than adolescents with attitudes in favor of school-related behavior (*school attitudes ego*: -0.082). We now present the outcomes for other effects in the selection model. The negative *outdegree* parameter (-1.907) shows us that students prefer not to have friendship relations with arbitrary others, they prefer to have friends to specific others. We find a positive *reciprocity* parameter (0.996) meaning that students prefer reciprocated ties to non-reciprocated ties. There are higher chances to become associated with a friend of a friend than with an unconnected classmate (*transitivity* 0.185). Students in our sample have a tendency for *gender similarity* (0.635). Boys tend to be friends with boys whereas girls prefer to be friends with girls. The data does not support the *ethnicity similarity* effect. Students tend to keep friends they had before. If they were friends with someone at primary school than these friends are likely to be kept (*friends in primary school* 0.557).

In the influence model, we found no support that school attitudes of friends affect adolescents' school attitudes in a significant way. Own school attitudes at an earlier time point have a negative feedback effect on school attitudes at a later time point (*tendency school attitudes squared*: -0.439), indicating that there seems to be an "optimal school attitude" that attracts the students' individual scores. Students scoring above this optimum tend to decrease their score on the school attitudes variable, while students scoring below tend to increase their attitudes. Based on the formulae for the combined influence of the linear and quadratic term of an attribute (Snijders, Steglich, Schweinberger, & Huisman, 2007) and the results reported in the tables, this optimum lies slightly below 2 on the attitudes scale. Other effects equal, boys tend to develop more negative levels of school attitudes than girls (0.247). Parents' expectation affects the school attitudes of their children (0.437). Adolescents whose parents have higher expectations regarding their children's school behavior are inclined to have more positive school attitudes than adolescents whose parents have lower expectations.

Some effects vary significantly ( $p < .05$ ) between classes in the selection model. The  $p$ -value of the test that the variance of a parameter is 0 (see Table 3.3) indicates significance only for effects in the selection model. The effects of *school attitudes ego*, *school attitudes alter*, *outdegree*, *reciprocity*, *transitivity*, *gender similarity* and *friends in primary school* vary between classes. When looking at a rough confidence interval by adding two estimated true standard deviations below and above the estimated average parameter, we obtain more information about the between-class variation. The confidence intervals of the *school attitudes ego* and the *outdegree* effect have only

negative values indicating that in some classes this effect is more negative than in others. The confidence interval of the *school attitudes alter* effect has positive as well as negative values signifying that this effect is positive in some and negative in other classes. The effects of *reciprocity*, *transitivity*, *gender similarity*, and *friends in primary school* only have positive confidence intervals. These effects have varying positive effect magnitudes.

### 3.8 Discussion

In this study, we investigated the effects of attitudes related to school behavior on friendship selection and friends' influence on adolescents' attitudes about school-related behavior. Longitudinal data on relations and school attitudes were collected in a large number of classrooms in Dutch secondary schools for the purpose of this study. Employing actor-driven modeling as implemented in the SIENA software, we were able to disentangle selection and influence processes. The data in our sample did not support the hypothesis that shared school attitudes favor friendship formation and maintenance. Adolescents with positive school attitudes do not have a pronounced tendency to be friends with other students with positive attitudes; and adolescents with negative school attitudes do not necessarily favor others with negative attitudes as friends. The results indicate that students with negative school attitudes tend to select few others as friends. It is not indicated that they have more friends outside class than students with more positive attitudes to compensate for this tendency. We could confirm that friendship choices follow patterns of network closure expressed as reciprocity and transitivity. Students in early adolescence also tend to have ties with others of the same gender and within their ethnic group. Friendships originating in primary school – as far as these friends are still available in secondary school – are maintained. These findings for the control variables are according to our expectation (see Table 3.1) and are in line with previous research on adolescents' friendship selection (Giordano, 2003; Lubbers, 2003).

Regarding the influence model, we found no evidence that friends in class affect how adolescents think about being on time, going to every lesson, being attentive, doing homework, getting good grades, and doing one's best in school. While friends are not influential, there seems to be a normative score around the value 2 on the school attitudes scale on which students tend to score, reducing their scores when they score higher and increase them when they score lower. Also parents are influential in shaping school attitudes. Parents' expectation regarding their child's school behavior as perceived by the child has a positive effect on adolescents' attitudes. If adolescents perceive the expectation by their parents as higher, their attitudes towards school-related behavior are more in favor of these behaviors.

The findings indicate that adolescents choose their friends according to structural and interpersonal effects other than school attitudes. Visible attributes such as gender

and ethnicity are important rather than invisible attributes such as attitudes (Van Duijn, Zeggelink, Huisman, Stokman, & Wasseur, 2003). Friends' school attitudes seem not be important for adolescents' school attitudes. This may be the case because attitudes do not vary much between students. As mentioned before, attitudes are not visible and therefore need not be adjusted. Or they are simply not important for friendships in class but obviously there are important for parents.

In the literature it has been suggested that variation between classes might be explained by class level characteristics. For example, Smith and Glass (1980) found a positive association of small class size and positive (favorable) school-related attitudes. The salience of school attitudes for friendship formation and of friends' influence on school attitudes may also differ between educational tracks (Hallinan & Smith, 1989). We did not find variance for selection based on positively related school attitudes among friends nor for friends' influence on school attitudes. These results show that these processes are independent of class characteristics such as class size or educational track.

Our study faces some limitations. First, the focus of our study was on friends within class. Although we controlled for another important source of influence, namely parents, we disregarded other sources such as the effect of teachers on individual students or friends outside school. Second, the generalization of our results may be restricted. We studied young adolescents at the beginning of high schools. School attitudes may play a different role at later stages of adolescence leading to different results.

With our research design and the use of appropriate statistical methods, we were able to disentangle selection and influence processes. We could not show that school attitudes affect friendship choices of young adolescents or that school attitudes are influenced by friends' school attitudes. Our study underpins the importance of parents for adolescents' school attitudes.

## 4 Friendship and alcohol use in early adolescence \*

### **Abstract**

A common finding in studies on adolescents is that adolescents and their friends have similar levels of alcohol use. Different processes are hypothesized to lead to this positive association. Adolescents with similar levels of alcohol use may be more likely to become and stay friends compared to those with less similar levels (*selection*). Alternatively, adolescents may adjust their level of alcohol use to their friends' level (*influence*).

Our study uses longitudinal relational and behavioral data of 3 waves on complete networks from 2,025 students (aged 12-13) in 78 first-year classes of Dutch secondary schools. We analyze the data by employing actor-driven modeling as implemented in the SIENA software. Our results suggest that shared levels of alcohol use contribute to friendship selection of young adolescents. Weak evidence was found for the effect of friends' alcohol use on adolescents' alcohol use.

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#### 4.1 Introduction

Alcohol use is a widespread phenomenon in adolescence (Hibell, Andersson, Bjarnason, Ahlström, Balakireca, Kokkevi, & Morgan, 2004). Excessive alcohol use in adolescence is considered problematic because of its potential negative long-term effects on health (Brown, Tapert, Granholm, & Delis, 2000) and its association with undesired forms of behavior such as fighting (Swahn & Donovan, 2005), multiple sexual partners (Santelli, Brener, Lowry, Bhatt, & Zabin, 1998), and committing illegal acts (White, Tice, & Loeber, 2002). Alcohol use of young people is assumed to be affected by family-, peer- and school-related factors, and by psychosocial circumstances (McBroom, 1994). Peers' level of alcohol use is hypothesized to be one of the most important factors affecting adolescent drinking behavior (Fergusson, Horwood, & Lynskey, 1995). Researchers typically assume that social influence leads to similar levels of alcohol use among affiliates (e.g., Oetting & Donnermeyer, 1998).

Recent studies confirm that affiliated adolescents tend to have similar levels of alcohol use (Bot, Engels, Knibbe, & Meeus, 2005; Engels & Knibbe, 2000a; Kirke, 2004; Steglich et al., 2007). While similarity among friends seems to be well established, how to explain this association is less clear. Different processes may produce similarity such as selection, influence, and exposure to the same context. Selection here stands for the principle that two adolescents with a similar level of alcohol use may be inclined to form and maintain a friendship relationship, while persons with dissimilar behavior may tend to terminate friendship relationships or not start them in the first place. Alternatively, social influence can lead to similarity when adolescents adjust their level of alcohol use to that of their friends. Finally, exposure to the same context, such as the same recreational club, may let friends adopt the same level of alcohol use. This last process will not be explicitly addressed in the present study. Nevertheless, we account for context effects by studying friendship relationships within classrooms and by including various other determinants of selection and influence processes within school classes as control variables.

Earlier studies do not provide definite answers to the question of whether selection or influence is the main cause of similarity among adolescent friends. A series of studies has identified selection processes causing similarity in alcohol use (Bauman & Ennett, 1996; Engels & Knibbe, 2000a; Fisher & Bauman, 1988; Urberg, Degirmencioglu, & Pilgrim, 1997), while other studies point to peer influence as the process leading to similarity in alcohol use (Bot et al., 2005; Sieving, Perry, & Williams, 2000). Still other studies suggest that similarity is due to both selection and influence processes (Kirke, 2004; Steglich et al., 2007).

Most earlier results are not totally convincing from a methodological point of view, as is outlined in detail by Steglich, Snijders, and Pearson (2007). To answer questions of selection and influence, specific methods are required. In particular, six issues concerning measurement, design, and analysis are of importance. First, it has been argued (Bauman & Fisher, 1986; Engels, Knibbe, De Vries, Drop, & Van Breukelen, 1999) that it makes a difference whether the data on friends' alcohol use is collected from respondents (peer report) or from friends directly (self-report). Peer reporting tends to overestimate the degree of similarity because respondents tend to project their own behavior onto that of their friends (Aseltine, 1995; Kandel, 1996; Prinstein & Wang, 2005; Reed & Rose, 1998). This is also known as the "false consensus effect" (Ross et al., 1977). Engels and colleagues (1999) conclude that information on respondents' drinking behavior from both the respondent and the friend would be desirable. Since this method requires extensive information from respondents, and since it has been found that adolescents' self-reported levels of alcohol use seem to be reliable when confidentiality is assured (Campanelli, Dielman, & Shope, 1987), we chose to only collect self-reported data of our population of Dutch secondary school students.

Second, the number of friends that a respondent can nominate should not be restricted to avoid errors due to a fixed choice design (Holland & Leinhardt, 1979; Wasserman & Faust, 1994). Most studies ask naming one to three best friends (e.g., Fisher & Bauman, 1988; Sieving et al., 2000). Friendship networks assessed in that way are distorted because some influential friends may not be included. Furthermore, triadic or higher-order structures are underrepresented when employing a restricted fixed-choice design. The effects of network characteristics such as reciprocity and transitivity may be underestimated and friendship selection based on similarity may be overrepresented (Steglich et al., 2007). The lower the maximum number of friends that is elicited, the stronger the underrepresentation. Our questionnaire allowed respondents to nominate up to 12 classmates as friends, which is large enough to avoid major restrictions. Less than 1% of the students reported the maximal number of friends.

Third, while ego-centered network friendship data allow the investigation of similarities among friends, complete network data have the additional advantage that information is available on similarity and dissimilarity among adolescents who are not friends. To identify the determinants of friendship selection, this information is indispensable.

Fourth, cross-sectional data can only inform about similarity of friends but are not suitable to determine the causal process leading to similarity. A longitudinal design is needed to provide insights into these processes (Berndt & Murphy, 2002; Fisher & Bauman, 1988). In our study, friendship relationships and alcohol use are measured at three time points within half a year.

Fifth, until recently (Snijders & Baerveldt, 2003), studies on adolescents' networks were case studies in the sense that only one or a very small number of friendship networks were investigated. Possible differences between networks may be disregarded, leading to wrong conclusions. Our sample of 78 classes yields more statistical power to test influence and selection.

Sixth, selection and influence processes need to be investigated simultaneously, otherwise the examined effect may be overestimated (Bauman & Ennett, 1996; Cohen, 1977; Kandel, 1978; Urberg et al., 1997). We employ the method of "actor-driven modeling" to disentangle selection and influence processes (Snijders, Steglich, & Schweinberger, 2007; Steglich et al., 2007). In actor-driven modeling it is assumed that behavioral and network outcomes result from decisions of actors concerning their ties and alcohol use, while changes at the network level are "emergent properties." Actor-driven modeling is implemented in the SIENA program. This is a statistical software for the analysis of longitudinal network and behavior data that implements a modeling framework treating network and behavior as simultaneous dependent variables.

Due to these six methodological problems, the link between friendship and alcohol use in early adolescence is still unresolved. Our research questions address this link:

- 1) Are adolescents' friendship choices affected by shared levels of alcohol use?**
- 2) Are adolescents' levels of alcohol use affected by their friends' level of alcohol use?**

The aim of this study is to improve current research in two ways: substantively, by explaining a positive association in alcohol use among adolescent friends with selection as well as influence processes; and methodologically, by using adequate data and employing statistical methods that enable us to disentangle selection and influence processes. Whether similarity in alcohol use among friends is mainly due to selection or influence processes is not only a scientifically interesting question: identifying the dominant process has practical implications for prevention programs. When influence is found to be dominant, prevention programs that focus on processes among school friends are meaningful. However, when selection is dominant, such programs may have little success, and prevention policy should rather target other factors affecting the onset of alcohol use.

The remainder of this chapter is organized as follows. In the next section, we present our theory and hypotheses. We first aim to explain friendship selection and then explain friends' influence on level of alcohol use. Before the description of the data, we specify the selection part and the influence part of the model, including the main



hypotheses and control variables. Next, we report results from the SIENA analysis. The paper ends with a discussion.

## 4.2 Explaining similarity

### 4.2.1 Similarity resulting from friendship selection

Friends are known to be of profound importance during adolescence (Kassenberg, 2002; Steinberg & Sheffield Morris, 2001) because they yield rewards that one cannot obtain by oneself. Friendships are rewarding when they provide behavioral confirmation and a sense of belonging. Friends give physical and emotional help, as well as reassurance of one's own worth and values (McAdams, 1988). After the transition to secondary school, adolescents are in an unfamiliar situation where they hardly know anybody. Especially under such circumstances, new friends are needed for sociability, guidelines on how to behave, and social approval.

Relationships with similar others are expected to be particularly rewarding. Similarity between two actors increases their chances of becoming friends (McPherson et al., 2001). Different theories such as balance theory (Festinger, 1957; Heider, 1946), social learning and exchange theory (Blau, 1964; Homans, 1974; Thibaut & Kelley, 1959) argue that similarity induces attraction. Similar others are better able to provide relevant behavioral confirmation, as they probably have similar resources and needs. Similarity is a good basis for assuming positive outcomes in further interactions, as it facilitates communication (Zeggelink, 1993).

Similarity in alcohol use is a particular form of similarity relevant to adolescents for forming and maintaining friendship relationships. Alcohol use is a new behavior for adolescents. So here again, adolescents are in an unfamiliar situation, where friends are needed to provide guidelines on how to behave. Since parents may not approve of alcohol use, friends are needed for social approval. Another aspect of alcohol use is its social dimension. It is a shared activity, with alcohol usually being consumed at meeting places with other adolescents.

In conclusion, we hypothesize that adolescents with a higher alcohol use tend to form and maintain friendship ties with others who have a higher alcohol use, and vice versa.

### 4.2.2 Similarity resulting from friends' influence

Adolescents consume alcohol or abstain from it for various reasons. Besides physical goals like getting drunk or staying sober, or developmental goals (Engels & Knibbe, 2000b) such as becoming independent of parental and societal norms (Fisher & Bauman, 1988) and building one's own identity, alcohol use also fulfills social goals. In the process of seeking social approval, some adolescents experiment with alcohol.

Alcohol use or non-use helps to attain status, affection, and behavioral confirmation. These goals cannot be obtained alone, therefore others are needed to attain them (Lindenberg, 1990). This dependence on others enables social influence.

Social influence among young people may operate in several ways. Friends may foster or prevent alcohol consumption. We describe six ways in which influence processes work. First, Bronfenbrenner (1967) suggests that friends exert explicit social pressure on children to cause behavior change. Second, Dishion and colleagues (1995) argue that social reinforcement often works as a more subtle form of social pressure. Friends provide approving cues such as laughing in relation to a certain behavior, and in this way make that behavior seem exciting and enjoyable. They may also provide disapproving cues and make a behavior seem inappropriate. Observational or social learning is a third form of social influence, also known as modeling (Bandura, 1977, 1986). Children and adolescents are assumed to learn more from observing a role model's behavior if they have a positive relationship, like a friendship, with the role model. Friends can serve as positive or negative role models. Fourth, socializing and conformity mechanisms in an actual drinking situation indicate the desire to both be part of the peer group and make new friends by adapting one's own behavior to the standards of the group in order to gain acceptance (Oostveen, Knibbe, & De Vries, 1996). A fifth possibility of how friends influence adolescents' behavior is information exchange (Ryan, 2000). Adolescents talk about advantages and disadvantages of drinking alcohol or abstaining from it. Persuasive arguments lead to behavior change. Sixth, friends also influence the level of alcohol use by providing opportunities for such behavior. In the case of alcohol use, these include creating drinking occasions and making alcohol available (Oetting & Beauvais, 1986).

Considering these processes, we hypothesize that adolescents adjust their level of alcohol use to their friends' average level, but do not derive specific expectations about which of the six processes exactly is responsible for the effect.

#### 4.3 An actor-driven model

We assume an actor-driven model (Snijders, 1996) where the friendship structure and the distribution of level of alcohol use in a class change as a result of individual decisions of students. Students have control of their outgoing friendship nominations (i.e., reciprocation cannot be taken for granted) and their own level of alcohol use. Both types of change are modeled as resulting from comparisons of the alternative courses of action that are possible. Friendship change is modeled as adding or deleting classmates from the current list of friends, all options being compared on a common scale that reflects the adolescent's satisfaction with the resulting situation. Likewise, change of alcohol use is modeled as increasing or decreasing the current level of alcohol use, the resulting situations again being compared with each other on a common scale. These

scales that express an adolescent's satisfaction with the 'network-behavioral neighborhood' (i.e., the set of friends, their interconnectedness and their alcohol use) are the main elements of modeling, called *objective functions*. All factors affecting the adolescents' decisions need to be specified as components of either the network-objective function (when they affect friendship change) or the behavior-objective function (when they affect change of alcohol use). In the next sections we identify several such factors. The total observed change between two observations is then modeled as resulting from an unobserved stochastic process that reflects the simultaneous processes of friendship change and change in alcohol use, as expressed in the objective functions. For more details on the statistical background of the method, we refer the reader to Snijders, Steglich, and Schweinberger (2007).

#### 4.4 Model specification

We now specify the selection part and the influence part of the model. The selection part (modeled by the network-objective function) contains, next to effects related to level of alcohol use, other factors affecting friendship choice. Likewise, the influence part (modeled by the behavior-objective function) contains, next to the effect of the average level of friends' alcohol use, other factors affecting the adolescent's level of alcohol use. We consider the following factors, first giving an outline of the selection part and then of the influence part.

In early adolescence, students who drink are deviant and are less likely to be involved with non-deviant others. Adolescents who use alcohol are still in the minority and therefore will be less socially involved than non-using adolescents. Hence we expect negative effects of high alcohol level on nominating others as friends (*alcohol use ego*) and on being nominated as friend by others (*alcohol use alter*). Our main hypothesis specifies that friendship is easier the more the levels of alcohol use of two students are positively associated. To measure the dependence of friendship choices on the combination of adolescents' own level of alcohol use and the level of the other person, we include an interaction effect (*shared level of alcohol use*).

Next to the effects of alcohol use on friendship selection, we control for other effects that are presumed to have an impact on network choices. These are structural network effects, interpersonal characteristics, and friendship history. Structural network effects reflect opportunities as well as constraints of networks for friendship selection (Snijders, 2001). The tendency to form friendship relationships is indicated by the *outdegree* effect. We expect friendship networks to be sparse, since maintaining relationships takes time and energy, and not everybody will be friends with everybody. We therefore expect a negative sign of the effect. Literature (e.g., Giordano, 2003; Van de Bunt, 1999) suggests the importance of two other structural characteristics related to

network closure, namely *reciprocity* and *transitivity*. *Reciprocity* reflects the inclination to be friends with those nominating the actor as a friend due to mutual affection and trust (Leenders, 1995). Gouldner (1960) proposed the existence of a universal norm that obligates people to reciprocate friendly advances. The *transitivity* effect captures the tendency to nominate friends of friends as one's own friends. In a study of male sixth graders, Dahlbäck (1982) showed that reciprocity and transitivity are important for the development of the friendship structure. Following these theoretical arguments and empirical findings, we anticipate positive signs of the parameters for *reciprocity* and *transitivity*. According to the notion that similarity is rewarding and increases the chances of becoming and staying friends, we control for interpersonal characteristics. Being similar in gender and ethnic background has consistently been found to favor friendship ties in earlier studies (e.g., Baerveldt, Van Duijn et al., 2004; Steglich et al., 2007). We expect the *gender similarity* and *ethnicity similarity* effects to have a positive impact on friendship. An effect of tie history is included as well. It seems reasonable that friendships that have existed in primary school (*friends in primary school*) will be maintained due to familiarity and relationship-specific investments such as time and disclosure. We thus predict that having been *friends in primary school* has a positive effect on friendship choices toward this person.

Our specification of the influence part of the model, explaining tendencies towards alcohol use, includes the next main hypothesis that young adolescents tend to use more alcohol the higher their friends' average level of alcohol use (*average alcohol use of friends*). Next to this, two basic control parameters are included. One effect, a constant, captures the overall tendency to drink vs. not drink alcohol in the long run (*tendency alcohol use*). A zero value reflects that adolescents tend to score on the midpoint of the range for the alcohol use variable. The other effect, a quadratic function, models the effect of the individual adolescent's alcohol use on alcohol use (*tendency alcohol use squared*). A positive estimate indicates an accelerating process; a negative estimate indicates a self-correcting process of earlier alcohol use on latter alcohol use. We have no expectations regarding these basic parameters. We control for the effects of gender (called *male*) and ethnicity (called *non-Dutch*) on level of alcohol use. Studies found that boys tend to acquire a higher level of alcohol use than girls (J. A. Epstein, Botvin, & Diaz, 1998; Green, MacIntyre, West, & Ecob, 1991). Most of the non-Dutch students have a Muslim background. Because the more strict forms of Islam forbid alcohol use, we expect Dutch students to have a higher level of alcohol use than non-Dutch students.

An overview of the model is provided in Table 4.1.

**Table 4.1: Predicted effects**

<i>Selection part</i>	Predicted effect on friendship formation and maintenance	Mechanism
Shared level of alcohol use	+	Adolescents with a higher score are more likely to be friends with other adolescents who have a higher score.
Alcohol use ego	–	Alcohol-using adolescents nominate fewer others as friends.
Alcohol use alter	–	Alcohol-using adolescents are nominated less often as friends by others.
Outdegree	–	Ties to arbitrary others are rare.
Reciprocity	+	Friendship tends to be reciprocated.
Transitivity	+	Tendency to become friends with friends of friends.
Gender similarity	+	Similar students are likely to be friends.
Ethnicity similarity	+	Similar students are likely to be friends.
Friends in primary school	+	Friendships from primary school will be maintained.
<i>Influence part</i>	Predicted effect on alcohol use	
Average alcohol use of friends	+	Alcohol use is adjusted toward average alcohol use of friends.
Tendency alcohol use	?	No prediction.
Tendency alcohol use squared	?	No prediction.
Male	+	Boys are expected to drink more than girls.
Non-Dutch	–	Islam forbids alcohol use.

*+*: positive effect; *–*: negative effect; *?*: no prediction

## 4.5 Methods

### 4.5.1 Sample

In the Netherlands, students usually enter secondary school when they are 12 years old, so most respondents of this study turned 13 during the year of data collection. The secondary school is a new school at a new location. New classes are formed with an average of 25 students, and most classmates are initially new to each other. They are grouped according to age and follow tracks based on ability. Students of one class spend most of their time at school together. Our sample comprises medium-sized schools, and includes all educational tracks. Some schools are private with different kinds of denominations, others are public. There are urban as well as rural schools.

We collected network-behavior panel data on multiple networks from 3,171 students in 126 first-grade classes of 14 secondary schools in the Netherlands (Knecht, 2006). Friendship relationships and level of alcohol use were measured at four time points at three-month intervals within the academic year 2003-04 (waves A, B, C, and D). We do not use the data of wave A and study only data of waves B, C, and D for reasons outlined in the description of the alcohol use item in the next section. Six classes did not participate in all waves or had a high number of missing students on the

day of the data collection. We initially included data of 3,017 students in 120 classes. For reasons provided below, we finally had to settle for 2,025 students in 78 classes.

#### 4.5.2 Measures

The main instrument for the data collection is a questionnaire for the students. All data about students used in this paper are self-reported. Trained assistants distributed the questionnaires and were available to answer questions of students. Questions about friendships with classmates and friendships at primary school were tested in earlier research (Baerveldt et al., 2003), and all questions were tested in a pilot study. The students completed the questionnaire within 45 minutes (one class). They were assured that answers would remain confidential. No one refused to fill in the questionnaire, but some questions were left unanswered. Some of the students dropped out or were absent on the day of the survey. The response rate was above 93% at each of the four waves. The following background, relational, and behavioral measures were used in the analysis. For an overview of the full sample see Table 4.2. Below we describe the dependent, control, and background variables.

*Friendship.* Friendship was measured as a binary self-defined directed friendship tie. The sociometric question was: “Who are your best friends in class?” Students were assured that they could nominate as many others as they wished with a maximum of 12. They were provided with a list of all students for that class. For each student we used a code for reasons of confidentiality and identification. In this way we obtained the information about the entire friendship network within a class. Students reported having on average about four best friends in class.

*Alcohol use.* The information on level of alcohol use was based on the question “How often did you drink alcohol with friends in the last three months?” There were five answer categories: “never”, “once”, “two to four times”, “five to ten times” and “more than 10 times”. High scores represented high frequency of alcohol use. We treated these ordinal recorded frequencies as interval variables, assuming that these categories are roughly equidistant in perceived intensity. The data of three waves were analyzed. In wave A, we asked about alcohol use but not specifically with friends. In waves B, C, and D we asked about alcohol use in the presence of friends. Students who drank on their own were disregarded with this design, using only data of alcohol consumption with friends of waves B, C, and D. This has the advantages that by focusing on the peer context we reduce contamination of the data by exogenous factors we could not measure, such as parental and other non-peer contexts. Data of wave B is treated as the initial state of alcohol consumption, which we study over the period analyzed (between wave B and wave D). The percentage of students who had consumed alcohol at least once in the previous three months increased from one quarter in wave B

to one third in wave D. Mean level of alcohol use increased moderately from 1.46 to 1.64 in the first period and from 1.64 to 1.76 in the second period.

*Control variables.* Half of the respondents were girls, 83% of the respondents were Dutch. Being Dutch was defined as having at least one parent born in the Netherlands and speaking predominantly Dutch at home. Students were asked with which of their current classmates they had been friends at primary school. They could list up to 12 nominations.

*Background variables.* At the beginning of the school year, students were 12 years old on average. We also assessed the students' socio-economic background by asking for parents' job, education needed for the job, and job status. Because of the rather high percentage of missing values, we refrain from using this variable in the analysis. More than half of the respondents had most of their friends (52%) and their most important friends (59%) in class.

#### 4.6 Analytical strategy

The data were analyzed with the SIENA program (Snijders, Steglich, Schweinberger, & Huisman, 2007), which is designed to estimate parameters of models such as the one sketched above. Hypotheses can be tested by calculating *t*-ratios (parameter estimate divided by standard error) and obtaining the corresponding significance levels (*p*-values) from the standard normal distribution (Snijders, 2001). A detailed account of the statistical basis for this type of analysis is given in Snijders, Steglich, and Schweinberger (2007).

The analysis of the data follows a two-stage procedure. In the first step, we fit the same SIENA model (see Table 4.1) for each classroom network separately. For classes that have only a few non-Dutch students or a high number of missing values of the ethnicity variable, the ethnicity effects in the selection and influence parts of the model are not included. This applies to five classes. The analyses are conducted using the Method of Moments option in SIENA version 3.1 (Snijders, Steglich, Schweinberger, & Huisman, 2007). Not all analyses converged; explanations for non-convergence are given in the manual. In general, one can say that non-convergence indicates model misspecification – i.e., some effects could not be identified in the data. From the full sample of 120 classes, we obtained results for 78 classes. Comparing the full sample and the subsample consisting of classes with converging analyses in Table 4.2, we see that they are almost identical in background characteristics. Students in the converging classes have slightly more friends and drink slightly more alcohol, i.e., in these classes there are “more” dependent variables than in the total (and hence particularly in the non-converging) classes. The results for these classes are aggregated according to the meta-analytical method proposed in Snijders & Baerveldt (2003). The purpose of the meta-

analysis is to estimate and test the mean and variance across school classes of the true parameter values.

**Table 4.2: Overview of data (120 classes and 78 classes)**

Coding	Wave	Full sample 120 classes (3,017 students)			Subsample 78 classes (2,025 students)			
		Mean or %	SD	Missing in %	Mean or %	SD	Missing in %	
<i>Dependent variables</i>								
Friends of respondent	1 – 12	B	4.19	2.55	9.0	4.25	2.61	8.5
		C	4.31	2.66	7.6	4.36	2.65	7.2
		D	4.06	2.51	7.2	4.08	2.52	7.2
Alcohol use	1: never	B	1.46	0.95	9.7	1.50	0.97	9.4
	– 5: >10 times	C	1.64	1.13	8.2	1.69	1.17	7.7
		D	1.76	1.23	7.8	1.80	1.25	7.8
<i>Control variables</i>								
Gender	1: female 2: male		1: 49%		0.0	1: 48%		0.0
Ethnicity	1: Dutch 2: non-Dutch		1: 83%		7.7	1: 83%		0.0
Friends in primary school	1 – 12		1.76	1.84	4.5	1.75	1.83	4.2
<i>Background variables</i>								
Age	10 – 15 years	A	12.11	0.49	5.6	12.11	0.48	5.6
Socio-economic status	1: low – 4: high		2.56	0.93	31.2	2.56	0.93	31.3
Respondents with most friends in class		B	52%		12.3	50%		11.9
Respondents with most important friends in class		B	59%		16.0	59%		15.6

#### 4.7 Results for selection and influence processes

We present the results for the selection part of the model, followed by those for the influence part. Estimated mean parameters with their standard error, estimated between-classroom standard deviations of the parameters corrected for the standard errors of the estimates per class, and  $p$ -values of the tests that the parameter variance is 0 are reported. Most of the effects in this model are significant, as most parameter estimates are more than 1.96 times their standard errors, indicating significance at the 5% level.

In the selection part of the model we tested the hypothesis that adolescents with a higher level of alcohol use tend to have friends with a high level of alcohol use and vice versa. The *shared level of alcohol use* parameter that represents this hypothesis has a positive value (0.057). The combination of personal and others' level of alcohol use hardly matters for friendship choices. The effects of *alcohol use ego* and *alcohol use alter* are not significant. Our data do not support the hypothesis that level of alcohol use affects outgoing or incoming friendship choices. The *outdegree* effect is negative (-1.965), reflecting that friendship ties do not evolve at random. Regarding the other effects in the selection model, they are all significant and in the predicted direction. Young adolescents have a tendency to form and maintain reciprocated (0.960) and



transitive (0.156) friendship ties. Similarity in gender and ethnicity facilitate friendship formation and maintenance. Boys have boys and girls have girls as friends; Dutch students tend to choose Dutch students and non-Dutch students tend to choose non-Dutch students as friends. The effect of *gender similarity* (0.759) is stronger than the effect of *ethnicity similarity* (0.148). If available in the new class, friendship ties originating in primary school are likely to be maintained (0.569).

We can classify the effect size of the *shared level of alcohol use* effect better when comparing its confidence interval with that of the *gender similarity* effect. A rough 95% confidence interval is computed by adding plus or minus two times the standard error multiplied by the standard deviation of alcohol use to the mean parameter, which is also multiplied by the standard deviation. Since the *shared level of alcohol use* effect is based on a product, we take the squared standard deviation of delinquency across the observation points. We obtain a confidence interval of [0.042; 0.104] for the *shared level of alcohol use* effect and a confidence interval of [0.321; 0.439] for the *gender similarity* effect. Compared to the gender effect, the *shared level of alcohol use* is rather small.

In the influence part, we tested the hypothesis that adolescents' own level of alcohol use is affected by the level of alcohol use prevailing among their friends. This hypothesis is not confirmed; the coefficient has the predicted, positive direction but falls short of significance ( $p=0.08$ , two-sided). We found a negative *tendency alcohol use* parameter (-0.822). Because this variable is centered, this means that based on the observation period, adolescents are more likely in the long run to score on the low end of the alcohol scale than on the high end of it. A strong significant positive *tendency alcohol use squared* effect (0.270) indicates a positive feedback effect. Those adolescents who scored high on the alcohol use variable tend to score even higher. Alcohol use has an accelerating effect. Adolescents who previously did not use alcohol tend to refrain from it, adolescents who previously used alcohol tend to drink increasingly more. Our hypotheses on the effects of *male* and *non-Dutch* in the influence model are not supported by our sample. Table 4.3 depicts the results obtained by the meta-analyses of the SIENA results.

As shown by the  $p$ -value ( $p<.05$ ) of the test that variance of a parameter is zero, effects vary significantly between classes for *outdegree*, *reciprocity*, *transitivity*, *gender similarity*, *friends in primary school*, and the *tendency alcohol use* parameter. The standard deviations are typically much lower than the mean estimate, so there is no evidence that the direction of the estimate changes between classes. The effects measuring selection (*shared level of alcohol use*) and influence (*average alcohol use of friends*) do not vary between classes. This indicates that the relation between alcohol use and friendship choices is not affected by classroom characteristics such as educational level or neighborhood.

**Table 4.3: Results of meta-analysis of SIENA analyses (78 classes)**

	Predicted effect	Estimated mean parameter	Standard error of mean parameter	Estimated true standard deviation	<i>p</i> -value of test that variance of parameter is 0
<i>Selection part</i>					
Shared level of alcohol use	+	0.057***	0.012	<0.001	0.981
Alcohol use ego	-	-0.019	0.013	<0.001	0.087
Alcohol use alter	-	-0.015	0.013	<0.001	0.372
Outdegree	-	-1.965***	0.035	0.22	<0.001
Reciprocity	+	0.960***	0.043	0.27	<0.001
Transitivity	+	0.156***	0.005	0.02	0.020
Gender similarity	+	0.759***	0.059	0.43	<0.001
Ethnicity similarity	+	0.148***	0.031	0.03	0.567
Friends in primary school	+	0.569***	0.035	<0.001	0.031
<i>Influence part</i>					
Average alcohol use of friends	+	0.135	0.078	<0.001	1.000
Tendency alcohol use	?	-0.822***	0.044	<0.001	<0.001
Tendency alcohol use squared	?	0.270***	0.019	<0.001	0.790
Male	+	0.047	0.069	<0.001	0.999
Non-Dutch	-	-0.049	0.106	<0.001	0.999

**Significance** \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

#### 4.8 Discussion

In this study we investigated the effects of alcohol use on friendship selection and the influence effects of friends' alcohol use on adolescents' alcohol use. Regarding the selection process, we hypothesized that similar students are more likely to become friends. For the influence process we hypothesized that young adolescents' level of alcohol use is positively affected by the average level of their friends' alcohol use. We tested these hypotheses on longitudinal data from students in Dutch secondary schools by applying actor-driven modeling for the dynamics of networks and behavior as implemented in the SIENA software.

Our hypothesis that positively associated levels of adolescents' alcohol use lead to friendship formation and maintenance was confirmed. Adolescents with high levels of alcohol use tend to have friends with high levels, adolescents with low levels tend to have friends with low levels. Further, we found no support that level of alcohol use affects the number of friendship nominations. Likewise, no evidence was found that adolescents' popularity depends on their level of alcohol use. We found that students with higher levels of alcohol use report more often having most of their friends and their most important friends outside class, compared to those with a lower level of alcohol use. We found students who have most friends and most of their important friends outside class to report indeed significantly higher levels of alcohol use compared to those who have most and their most important friends in class (results not reported). Alcohol use might have more meaning for friendship relationships outside the

classroom context. Similarity in alcohol use is not the only factor affecting friendship selection: structural effects such as reciprocity and transitivity, interpersonal effects like similarity in gender and ethnicity, and having been friends in primary school influence friendship choices positively. Regarding the influence hypothesis, we found weak evidence ( $p < 0.10$ ) that adolescents adjust their level of alcohol use to their friends' average level. The positive effect is as expected. Our results show that adolescents have the overall tendency to have low levels of alcohol use and that an adolescent's earlier alcohol use has a reinforcing effect on latter alcohol use. Our data did not support the effect of gender and of ethnicity on level of alcohol use. The meta-analysis revealed that selection and influence processes do not vary between classes. These processes seemingly do not depend on classroom characteristics such as average level of alcohol use, educational track, or neighborhood.

Our study has some limitations. First, we disregarded other sources of influence — friends outside school who might be especially important for alcohol use or parental opinions and drinking behavior. Friends outside class may be important, as our results revealed that adolescents with a higher level of alcohol use tend to have most of their friends and their most important friends outside class. Second, the data on the level of alcohol use is based on frequency of alcohol consumption with friends and not on the amount of alcohol or alcohol consumed without friends. Further research might provide more insight into the different dynamics when considering different types of alcoholic beverages, settings in which alcohol drinking takes place, number of heavy-drinking occasions, or number of intoxications. Third, in our data set respondents are at the onset of adolescence and may be just starting to experiment with alcohol. Our results only apply to this age group. For older adolescents, alcohol use may be more relevant.

Within these limits, we could improve the research design of earlier studies by using self-reported data on complete networks where the number of nominations should not be confined to a small number. Furthermore, our data is longitudinal and on a high number of networks. The SIENA software enabled us to analyze selection and influence simultaneously and thus disentangle dynamics of network and behavior. We conclude that in our data of young adolescents, selection effects based on alcohol use do operate. We found only weak evidence for social influence processes among friends in a classroom. This would confirm results of earlier studies of the age group that we examined in this chapter. These studies indicate that alcohol use affects both selection and influence processes (Kirke, 2004; Steglich et al., 2007). For prevention programs, our findings imply that it is important to consider processes among adolescent friends in class. Such programs should aim at involving friendship pairs or friendship groups within classes as well as outside classes. Future research may provide conclusive evidence about the importance of social influence on adolescents' alcohol use.



## 5 Friendship selection and friends' influence in early adolescence \*

### **Abstract**

A positive association between attributes of adolescent friends can be caused by selection and influence processes. Regarding selection processes, we hypothesize that adolescents whose attributes are positively associated tend to become and stay friends. Regarding influence processes, we hypothesize that adolescents tend to adjust their attributes to their friends' attributes. We studied these processes for delinquency, school attitudes, and alcohol use simultaneously.

We analyzed longitudinal data of 553 students in 20 classes in Dutch secondary schools. The SIENA software enables us to examine the dynamics of the friendship network and the three actor attributes, and to analyze the relative importance of these changing actor attributes for selection and influence processes. Results indicate that friendship selection depends on shared levels of delinquency and alcohol use. There was no evidence that selection is based on school attitudes. No evidence was found that friends influence adolescents' delinquency, school attitudes, or alcohol use. Our results suggest that behavior might be more important for friendship selection than attitudes.

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## 5.1 Introduction

Adolescence is a developmental period during which young people strive for autonomy (Durkin, 1995). Experimenting with behavior at the boundary of what is permitted by dominant social norms is one way to try and achieve autonomy. Showing behaviors and attitudes considered as undesirable by parents and teachers seems typical during adolescence. Examples are violations of legal norms, offenses against school rules, or abuse of illegal substances.

Some attitudes and behaviors seem to be associated with friendship, since adolescent friends are often similar with respect to these attitudes and behaviors. Indeed, adolescents tend to be similar to their friends in their delinquent behavior, school attitudes, and alcohol use (Baron & Tindall, 1993; Bot et al., 2005; Bullers, Cooper, & Russel, 2001; Cohen, 1977; Kandel, 1978; Kirke, 2004; Marcus, 1996; Steglich et al., 2007; Urberg, Luo, Pilgrim, & Degirmencioglu, 2003).

Different processes can explain similarity between friends. One process is that adolescents who are similar become and stay friends. We refer to this as *selection*. A second process is that adolescents adjust their behavior and attitudes to their friends'. We refer to this as *influence*. Exposure to the same contextual influences is a third process that may lead to similarities between friends, but is not investigated in this study. Context factors that simultaneously affect friends' behavior and attitudes outside school, for example membership of two friends from class in a recreational club, will not be addressed. We consider institutional effects of the classroom context by analyzing friendship relationships among classmates. In this way, we control for effects of socio-economic status, school, teachers and the like that are similar for students of one class. While controlling for classroom context, we focus on the simultaneous effects of selection and influence processes among adolescents.

Authors of various studies (Bauman & Ennett, 1996; Cohen, 1977; Kandel, 1978; Kirke, 2004; Steglich et al., 2007) concluded that both selection and influence are of importance for explaining similarity in various characteristics among adolescent friends. Pearson, Steglich, and Snijders (2006) investigated selection and influence processes for substance use among Scottish adolescents. They examined smoking, cannabis use, and alcohol consumption using actor-oriented models (Snijders, 2001; Snijders, Steglich, & Schweinberger, 2007). For alcohol use, they found the strongest selection and the strongest influence effects, indicating that alcohol use and friendship are highly related. A study on adolescents' delinquency (Burk et al., 2007) revealed that both selection and influence processes are relevant. Many earlier studies on selection and influence processes focus on a single attribute or on attributes that are related, such as different forms of substance use. This makes perfect sense when the interest lies on a particular behavior. If there is a general interest in the processes of friendship selection and friends' influence, more than one attribute should be considered to account for different

factors affecting friendship choices and for more attributes that may be affected by friends. Attributes may have varying relevance for selection and influence processes. Some attributes may be of importance mainly for friendship selection, others will be more affected by influence processes, others can be involved in selection as well as in influence processes, while still others may be irrelevant for these processes.

So far it is not clear which attributes are important for friendship selection and which are the attributes most prone to be influenced by friends. Therefore, we investigate three attributes that might be relevant for adolescents in their process toward becoming autonomous, namely delinquency, school attitudes, and alcohol use. All these attributes are ways of expressing one's own identity in early adolescence. Delinquency — stealing, vandalism, graffiti, fighting — is a behavior of societal interest that is counteracted by legal norms. School attitudes are for instance, those towards attentiveness, good grades, attending class, being on time for class, and homework. They reflect everyday behavior and experiences at school. Alcohol use is related to social behavior during spare time that may be seen by peers as an expression of maturity.

The study of dynamic processes between networks and behavior is difficult from the point of view of design, measurement, and analysis. Six issues are of particular importance. First, measurement of behavioral and attitudinal tendencies by using self-reported data from respondents and their friends is more accurate than by using data from respondents about their friends' attributes. The latter type of data gives artificially high correlations between adolescents' characteristics and friends' characteristics (Iannotti & Bush, 1992; Prinstein & Wang, 2005). This problem is also known in the literature as the "false consensus effect" (Ross, Greene, & House, 1977). In our study we only used self-reported data. Second, friendship nominations should not be confined to best friends or three best friends, as has been done in some earlier studies (Fisher & Bauman, 1988; Sieving et al., 2000). This limitation distorts personal friendship networks due to a fixed choice design (Holland & Leinhardt, 1979; Wasserman & Faust, 1994). Such a design may exclude potentially influential others. Furthermore, restriction to a relatively low number of friends hampers adequate control for structural effects such as transitivity. The questionnaire that was used in our data collection allowed nominating up to 12 classmates as friends; this appeared not to restrict the number of nominations. Third, when using ego-centered data on friendships and attributes, only similarity or dissimilarity among friends can be detected but not whether this differs among friends and other peers. This difference can be assessed with complete network data that were used in this study. Fourth, a longitudinal network design is required (Berndt & Murphy, 2002; Fisher & Bauman, 1988). Since continuous registration of changes in friendship and in behavioral tendencies is unfeasible, the type of longitudinal design that can be used for this type of questions is a panel design,

where friendship and behavior are recorded at several discrete moments in time. We collected panel data on students in the first grade of Dutch secondary schools, with friendship relationships, delinquent behavior, school attitudes, and alcohol use measured at three time points. Fifth, earlier studies were often case studies of one network. The ability to generalize to a population of networks is preferable (Snijders & Baerveldt, 2003). Selection and influence processes may differ between classrooms, therefore studying these processes in many groups to try to achieve a better generalizability is a better option. We investigated multiple networks with the class as a natural network boundary. A sixth point concerns the data analysis, in which it is necessary to investigate selection and influence processes simultaneously in order to test each of these processes while controlling for the other. If only one process is investigated without control for the other, the former process will be overestimated. This has been concluded in several studies (Bauman & Ennett, 1996; Duncan, Haller, & Portes, 1968; Kandel, 1978; Urberg et al., 1997). The statistical methods employed in this paper, presented in Snijders, Steglich and Schweinberger (2007), enabled us to model the interdependent dynamics of networks and of actor characteristics, and thereby to disentangle these processes. Because of these problems, earlier studies have left many open questions about the interrelatedness between friendship and attributes in early adolescence. Our research questions deal with this relationship:

- 1) Are adolescents' friendship choices affected by shared levels of delinquency, shared school attitudes, and shared levels of alcohol use?**
- 2) Are adolescents' delinquency, school attitudes, and alcohol use affected by their friends' delinquency, school attitudes, and alcohol use?**
- 3) What is the relative importance of delinquency, school attitudes, and alcohol use for selection and influence processes?**

The aim of this paper is twofold. First, we attempt to improve the understanding of selection and influence processes among adolescents by including attitudes and behaviors in the analysis and by disentangling and assessing their relative importance for selection and influence. Second, we attempt to avoid some methodological flaws of earlier studies with our research design.

The remainder of this paper is organized as follows. In the next sections we present our theoretical assumptions, aiming to explain friendship selection and friends' influence on adolescents' behaviors and attitudes. Thereafter we give an overview of the actor-driven model and our model specification including the selection and influence parts. Next we describe the data we are using before sketching our analytical strategy. The findings are reported and the chapter ends with a discussion.



## 5.2 Explaining similarity

### 5.2.1 Similarity resulting from friendship selection

From developmental psychology (Durkin, 1995; Larson & Richards, 1991), it is known that adolescence is a time when peers and friendship become more important than they were in childhood. Adolescents spend more time outside the parental home with peers than younger children (Engels & Ter Bogt, 2001). Friends become important for the production of social well-being, which is generated by different things such as behavioral confirmation and status (Lindenberg, 1990), a social identity or enjoying activities together.

Many theories on interpersonal behavior (Blau, 1964; Heider, 1958; Homans, 1974; Newcomb, 1961; Thibaut & Kelley, 1959) assume that similarity in attributes induces liking. The similarity-attraction hypothesis is empirically well-confirmed in general (Marsden, 1988; McPherson et al., 2001) and for adolescent friendship (e.g., Kandel, 1978; Kirke, 2004). Similarity facilitates giving and receiving attitudinal and behavioral confirmation, and facilitates communication and participation in shared activities. Discovering similarities is viewed as confirmation for oneself that makes the relationship rewarding (Urberg, Degirmencioglu, & Tolson, 1998).

The importance of similarity for friendship formation and maintenance may vary between attributes according to the degree to which similarity in that attribute is needed for the production of social well-being. The attributes that we investigate differ in the degree to which they provide status, confirmation of behavior and attitudes, social identity, and their importance as a shared activity. Delinquent behavior is objectionable from the viewpoint of most adults. If an adolescent is delinquent, similar friends are of increased importance for behavioral confirmation. Delinquency may be a source of status and social identity, but only by other adolescents who value delinquent behavior. Most likely they are the ones who are delinquent themselves, which gives the additional advantage that delinquency can be committed together. Similar school attitudes are related to confirmation by others. Similar attitudes may help deal with experiences at school. Alcohol use is often a shared activity. Others are needed who also enjoy using alcohol, therefore similarity might be important for the formation and maintenance of friendships. For adolescents, enjoying activities jointly seems to be more salient for friendship selection than agreement and attitudinal confirmation (Urberg et al., 1998; Werner & Parmelee, 1979). Accordingly, we hypothesize that behaviors such as delinquency and alcohol use are relatively more important for friendship choices than school attitudes.

### 5.2.2 Similarity resulting from friends' influence

The assumption that friends influence behavior is derived from balance theory (Festinger, 1957; Heider, 1946) and social comparison theory (Erickson, 1988; Festinger, 1954; Schachter, 1959). These theories conclude that actors adjust their behavior and attitudes to those of others, especially friends.

Different processes of influence can be identified. First, social pressure accounts for behavioral and attitudinal changes and adjustment (Bronfenbrenner, 1967). Oetting and Beauvais (1986) emphasized the importance of peer group norms in the establishment and maintenance of substance use. Second, social reinforcement may lead adolescents to adopt unfavorable attitudes and behavior. Social cues like nodding or smiling communicate and reinforce approved or disapproved attitudes (Dishion et al., 1995). Compared to the first process, this is an implicit process with behavior change not necessarily intended by the sender of social cues. Third, observational and social learning may account for adjustment of attributes among friends. Adolescents look for orientation to their friends and model their behavior accordingly (Bandura, 1977, 1986). Friends can serve as role models for attitudes that are desirable or undesirable attitudes and behavior from the viewpoint of parents, teachers, and society. Fourth, information exchange and persuasive arguments about attitudes and behavior lead to attribute change (Ryan, 2000). Fifth, friends provide opportunities (Oetting & Beauvais, 1986) to express attitudes and to behave in certain ways, for instance, by providing alcohol.

All these processes lead to adjustment of one's own attitudes and behaviors toward those of friends. For some attributes similarity may be more important than for others. The behavior or attitude adolescents prefer to be similar in depends on its reputational salience (Hartup, 1996), defined as the importance of an attribute in determining a child's social reputation. We expect school attitudes to be less exposed to social influences than behaviors. They are less visible than delinquency and alcohol use, and therefore not suitable for observational learning or social pressure because there is hardly any observable evidence that attitudes have changed.

### 5.3 An actor-driven model

In this section we provide a description of an actor-driven model for the co-evolution of networks and behavior, where "behavior" is the term used for changing actor attributes, as proposed by Snijders, Steglich, and Schweinberger (2007). This is an extension of the actor-driven model for network dynamics of Snijders (2001) to the joint dynamics of a network and one or several actor attributes. For mathematical details we refer to the mentioned sources.

Selection and influence processes, while intrinsically linked to the peer group, occur at the level of the individual adolescent. A strong positive association of attributes among friends is an emergent group-level property that can result from dynamics in the individual adolescent's relational properties (friendships) and attribute properties (delinquency, school attitudes, or alcohol use). For describing and modeling selection and influence processes, it is plausible to assume a theoretical modeling framework based on individual actors making changes in their relationships and attributes. Friendship is treated here as possibly one-sided, i.e., what decisively matters for a friendship relationship to affect a given network or behavior change is whether or not this friendship is perceived to exist by the focal actor involved in the change. Confirmation of the partner is not necessary, but constitutes an additional property of the relationship (*reciprocity*). In terms of data structure, this means that we analyze friendship networks as directed graphs (Wasserman & Faust, 1994). The behavior variables are assumed to be represented as ordinal discrete variables with a small number of categories, in our case five. The stochastic model represents how the network and the behavior change over time. For  $n$  actors and  $H$  behavioral variables, the data structure consists of  $n(n-1)$  tie variables and  $Hn$  behavioral variables, all time-dependent. The actor-driven model represents the  $(n-1)$  outgoing tie variables and the  $H$  behavioral variables associated with any given actor as being under the control of this actor, but restricted in such a way that changes over time will be gradual. The network will be represented by  $Y$ , the behavior variables all together by  $Z$ .

The model assumes that actors can change their behavior and friendship ties at arbitrary, randomly determined moments. It is also assumed that at any given moment no more than one actor can change one of the variables under his or her control, and no more than one variable at a time. Data on network and behavior are collected at a few discrete moments in time, and the differences noted between two consecutive observation moments are the cumulative result of all changes that occurred between those moments. When an actor makes a change, this is either a change of an outgoing friendship tie (i.e., forming a new tie or dissolving an existing tie), or a change of one of the attributes of this actor (to a higher or lower attribute level). These two types of decisions define a natural split in the model, one component explaining network changes (selection part), the other explaining behavioral changes (influence part). The probabilities of change depend on weighted sums of explanatory variables, depending on the current state of the network and of the behavior, as regarded from the viewpoint of the focal actor. These weighted sums are called the "network objective function". For the network dynamics, the objective function can be represented as

$$f_{Yi}(y, z) = \sum_k \beta_{Yk} s_{Yik}(y, z)$$

where  $s_{Yik}(y, z)$  is the  $k$ 'th explanatory variable for the network dynamics for actor  $i$ , and  $\beta_{Yk}$  is the associated weight. Subscripts  $Y$  indicate that this refers to network dynamics.

The objective function for the  $h$ 'th behavioral variable is given by

$$f_{Zhi}(y, z) = \sum_k \beta_{Zhk} s_{Zhi}(y, z).$$

When actor  $i$  has the opportunity to make a change in one of his or her outgoing network ties (opportunities which occur at random moments), the allowed changes are either to create one new outgoing tie, to withdraw one existing outgoing tie, or to keep the network unchanged. Denoting the result of this change by  $y'$ , the probabilities of making any of these changes are assumed to be proportional to  $\exp(f_{Yi}(y', z))$ . Similarly, when actor  $i$  can make a change in the  $h$ 'th behavior variable, the allowed changes are to keep the behavior unchanged or to go to an adjacent category, and the probabilities of change are proportional to  $\exp(f_{Zhi}(y, z'))$ , where  $z'$  indicates the result of the change.

The explanatory variables are  $s_{Yik}(y, z)$  and  $s_{Zhi}(y, z)$ . These variables can be endogenously determined, i.e., they are functions of the dependent variables  $y$  and  $z$ . Therefore, the term “explanatory” is more appropriate than “independent” variables. The vectors of weights  $\beta_Y$  and  $\beta_{Zi}$  are statistical parameters, which are to be estimated and tested based on the available data. Some examples of explanatory variables for network dynamics are the number of reciprocated ties of an actor and the number of transitive triplets in which an actor takes part. Actor variables such as gender can explain network dynamics in several ways: applied to the focal actor  $i$  (this is called the ego or activity effect of the variable), or applied to the potential friend (the alter or popularity effect of the variable), or as a similarity effect (calculated dyadically based on the absolute difference between the values for the focal actor and the potential friend). An alternative operationalization for the similarity effect is the product interaction of the ego and alter effects; a positive interaction effect will express that for actors (“egos”) who are high on some variable  $V$ , ties to others (“alters”) are more attractive when those others also are high on  $V$ . These effects indicate that an actor attribute can affect the friendship nominations made (ego effect) and the friendship nominations received (alter effect), and the dyadic combination of an attribute (*shared attribute* effect) affects friendship evolution. Behavior dynamics can be explained by actor variables, by ego's network position, and by the combination of the network structure and actor variables. The average value of a behavioral variable for the actor's friends is an example of the latter. This is a variable that can be used to explain network dynamics as well as behavior dynamics; in the first case it will be part of the explanation of friendship selection processes, in the second case it will be part of the explanation of influence processes.

Note that the current behavior  $z$  figures in the explanatory variables for network dynamics, while the current network structure  $y$  figures in the explanatory variables for behavior dynamics; this leads to a mutual dependence between the network dynamics and the behavior dynamics. Similarly, each of the several behavioral variables can be

part of the explanation of the other behavioral variables, contributing to the mutual dependence between the behaviors.

In this framework, any potential tendency towards an association of attributes between adolescent friends can be expressed in terms of the statistical parameters  $\beta_y$  and  $\beta_{zh}$  that determine the network dynamics and the behavior dynamics. The detailed specification of the statistical model further consists of determining the list of explanatory variables for the network dynamics and for the dynamics of each of the behavioral variables. These lists are provided in Section 4.

#### 5.4 Model specification

We now specify the model consisting of a selection part and an influence part. An overview of the two parts of the model can be found in Table 5.1.

The selection part of the model aims to explain friendship choice. This part incorporates ego effects (how a specific attribute influences the number of friendship choices made) and alter effects (how a specific attribute influences the number of friendship choices received). We assume that a positive association of behaviors and attitudes between two adolescents facilitates friendship formation and maintenance. We include effects related to delinquency, school attitudes, and alcohol use related to friendship selection. High scores on delinquency, on school attitudes, and on alcohol use represent high levels of delinquency, attitudes rejecting school-related behaviors, and high alcohol use respectively. The effects of these attributes are expressed as interaction effects of ego and alters' attributes (how attributes of ego correspond with attributes of alter). We refer to them as *shared attribute* effects. Adolescents who score higher on one attribute are relatively more attractive to others who also score high on that attribute. Next to these hypotheses regarding the effects of delinquency, school attitudes, and alcohol use, we include structural, similarity, and dyadic effects in the selection model. We include an effect referring to the number of friendship ties that an actor has to other actors (*outdegree*). We hypothesize a negative effect since this represents that ties to arbitrary others are costly unless the time and energy for having a friendship tie is compensated by additional factors, like structural properties such as reciprocity. Friendship networks are expected to be sparse. Literature on friendship (Dahlbäck, 1982; Giordano, 2003; Van de Bunt, 1999) provides arguments to control for *reciprocity* and *transitivity*. We expect students to value reciprocated relations positively. Reciprocity reflects mutual affection and trust (Leenders, 1996). We control for local clustering effects, or transitive closure, in friendship networks by including a *transitivity* parameter (Davis & Leinhardt, 1972). For both parameters a positive sign is expected. According to our reasoning that similarity is rewarding and increases the chances of becoming and staying friends, we control for similarity in gender and

ethnicity among adolescent friends (*gender similarity, ethnicity similarity*). Similarity between adolescent friends was consistently found for gender (Steglich et al., 2007) and for ethnicity (e.g., Baerveldt, Van Duijn et al., 2004). An effect of earlier tie history is included as well. It seems reasonable that friendships that have existed during primary school will be kept because relationship-specific investments have been made and familiarity has been built. This has been confirmed empirically as well (Lubbers, 2003). The corresponding effect is called *friends in primary school*.

The influence part of the model is divided into three parts corresponding to the three attributes of delinquency, school attitudes, and alcohol use. In each part we incorporate the hypothesis that the attribute is influenced by friends' average level of the attribute (*average delinquency of friends, average school attitudes of friends, average alcohol use of friends*). In each of the three parts we include two basic parameters. One is the *tendency attribute* parameter modeling the overall tendency to show a behavior, another is the *tendency attribute squared* parameter modeling the feedback effect of an attribute. This feedback effect can be reinforcing or self-correcting, depending on whether the quadratic shape parameter is negative or positive. The *tendency attribute* effect and the *tendency attribute squared* effect can be regarded as effects required to obtain a good fit with the dynamics in the overall distribution of the behavior. We do not have expectations regarding their outcome. For each dependent attribute variable we control for the other two attributes. This is required to fit and evaluate the associations between behaviors and attitudes. According to the notion that problematic behavior and attitudes are positively related (Urberg et al., 1998), we expect positive effects for these parameters. An overview of the model specification is provided in Table 5.1.

**Table 5.1: Predicted effects**

Selection part	Predicted effect on friendship formation and maintenance	Mechanism
Shared delinquency	+	Adolescents with a higher score are more likely to be friends with other adolescents with a higher score.
Delinquency ego	?	No prediction.
Delinquency alter	?	No prediction.
Shared school attitudes	+	Adolescents with a higher score are more likely to be friends with other adolescents with a higher score.
School attitudes ego	?	No prediction.
School attitudes alter	?	No prediction.
Shared level of alcohol use	+	Adolescents with a higher score are more likely to be friends with other adolescents with a higher score.
Alcohol use ego	?	No prediction.
Alcohol use alter	?	No prediction.
Outdegree	-	Ties to arbitrary others are rare.
Reciprocity	+	Friendship ties tend to be reciprocated.
Transitivity	+	Tendency to become friends with friends of friends.
Gender similarity	+	Similar students are likely to be friends.
Ethnicity similarity	+	Similar students are likely to be friends.
Friends in primary school	+	Friendships from primary school will be maintained.
Influence part	Predicted effect on behavior/attitudes	
<i>Dependent variable: Delinquency</i>		
Average delinquency of friends	+	Delinquency level is adjusted toward average delinquency level of friends.
Tendency delinquency	?	No prediction.
Tendency delinquency squared	?	No prediction.
Alcohol use	+	Positive association of attributes.
School attitudes	+	Positive association of attributes.
<i>Dependent variable: School attitudes</i>		
Average school attitudes of friends	+	School attitudes are adjusted toward average school attitudes of friends.
Tendency school attitudes	?	No prediction.
Tendency school attitudes squared	?	No prediction.
Delinquency	+	Positive association of attributes.
Alcohol use	+	Positive association of attributes.
<i>Dependent variable: Alcohol use</i>		
Average alcohol use of friends	+	Level of alcohol use is adjusted toward average alcohol use level of friends.
Tendency alcohol use	?	No prediction.
Tendency alcohol use squared	?	No prediction.
Delinquency	+	Positive association of attributes.
School attitudes	+	Positive association of attributes.

+: positive effect; -: negative effect; ?: no prediction

## 5.5 Method

### 5.5.1 Sample

In the Netherlands, students usually enter secondary school at age 12. It is a new school for the students where new classes are formed and not all classmates are known to each other initially. Students of one class spend most of their time at school together.

We collected longitudinal (four waves) network data from 3,171 students in 126 first-grade classrooms of 14 secondary schools in the Netherlands. The sample comprises a mixture of rural and urban schools. Some schools were private, of different denominations, others were public. All educational levels were included. Six of the 126 classes did not participate in all waves or a high number of students were missing on the day of the survey, leaving us with 3,017 students in 120 classes. The data collection started in August and September 2003, in the first weeks of the new school year, the first wave followed by three waves every three months — a total of four waves in one school year. The data for our study uses three waves of the friendship and attribute information. In the first wave we asked about alcohol use but not specifically with friends. In the following three waves we asked about alcohol use with friends. We excluded the data from the first wave in order to restrict the influence of parents and persons other than friends, so waves B, C, and D were analyzed.

### 5.5.2 Measures

The main instrument for the data collection was a self-completed standardized questionnaire for the students. All data about students used in this paper were self-reported. Relational questions about friendships with classmates and friendships at primary school were tested in earlier research (Baerveldt et al., 2003); all questions were also tested in a pilot study. Trained assistants distributed the questionnaire and were available to answer students' questions. The assistants stressed that all information would be treated confidentially. The students filled in the questionnaire usually within one 45-minute lesson. The percentage of those refusing to fill in the questionnaire at any given time was very low. Some of the students dropped out or were absent on the day of the survey. Still, the response rate was high, and never below 94% at any of the four measurement points. We now describe the dependent, control, and background variables used in the analysis. For an overview of the data, see Table 5.3 in the next section.

*Friendship.* The students' friendship relationships were assessed by asking for up to 12 best friends in class. The actual question was: "Who are your best friends in class?" In this way we obtained the information about the entire friendship network within a class. Students were assured that they could nominate as many or as few fellow students as they considered being their friends. To respect respondents' privacy we used an identification number for each student in a class.



*Delinquency.* Students reported whether they had committed one of the following offenses in the last three months: stealing, vandalism, graffiti, and fighting, using five answer categories for each item (“never”, “once”, “two to four times”, “five to ten times”, and “more than 10 times”). We treated these ordinal categories as an interval variable, assuming that the categories were roughly equidistant in perceived intensity. A delinquency scale was created by adding the four items. The scale has values ranging from 1 (low delinquency level) to 5 (high delinquency level). In the data that we analyze, 12 missing values could be replaced by a corrected item mean where the imputed value is based on an item mean related to the mean value of the items that are known for this person (Huisman, 2000). The scale has sufficient internal cohesion (Cronbach’s alpha ranges between .69 and .73) and is sufficiently one-dimensional (the first eigenvalue in a factor analysis was always above 2.0, the other eigenvalues were always below 1.0). Delinquent behavior increased over time.

*School attitudes.* This measure is a scale consisting of five items related to school behavior. The students were asked what they thought about the following items: being attentive in class, getting good grades, doing homework, being on time for class, and going to each class. The five answer categories ranged from “very favorable” (1) to “very unfavorable” (5). The four items were combined into a five-category measure by computing the mean value of these items for each student. The resulting scale has values from 1 to 5. For the analyzed cases, three missing values could be replaced by a corrected item mean. Sufficient internal cohesion was indicated by Cronbach’s alphas ranging from .88 to .90 and the first eigenvalue in a factor analysis being always above 2.9, the other eigenvalues always below 1.0. The mean overall school attitude scale increased, indicating that students’ school attitudes were more favorable at the beginning of the school year than at the end of the year.

*Alcohol use.* The information on the level of alcohol use was based on the question “How often did you drink alcohol with friends in the last three months?” There were five answer categories, from “never” to “more than ten times”. High scores represent high frequency of alcohol use. The data had been gathered at three time points starting with the second wave; in the first wave we only asked about alcohol use but not specifically with friends. In the following three waves we asked about drinking alcohol with friends. The percentage of students who had consumed alcohol at least once in the last three months increased from one quarter in the second wave to one third in the fourth wave. The level of alcohol use increased moderately.

*Control variables.* Half of the students were girls. Dutch students were in the majority (83%) compared to non-Dutch students (17%). Being Dutch was defined as having at least one parent who was born in the Netherlands and speaking Dutch at home. Students were asked with which of their current classmates they were friends in primary school. They could nominate up to 12 fellow students.

*Background variables.* The students were on average 12 years of age at the beginning of the academic year. Socioeconomic status was assigned based on the job, education for this job and job status of the father and the mother. We did not include this variable in the analysis due to its high number of missing values. The majority of students had most of their friends and their most important friends in class.

How the averages of each attribute per class are correlated is presented in Table 5.2. The correlation coefficients show that attributes are related at the class level. Average delinquency levels are correlated with average delinquency levels per class at different time points. The same is the case for school attitudes and alcohol use. The strength of these correlations is comparable. Furthermore, we found a correlation between the average delinquent behavior and the average alcohol use for all three investigated waves. Apart from a weak association of the average of school attitudes with the average of delinquency for wave D, there is no evidence that school attitudes are related to delinquency or alcohol use at the class level.

**Table 5.2: Correlation of class-level average of attributes (120 classes)**

	Wave	Delinquency			School attitudes			Alcohol use	
		B	C	D	B	C	D	B	C
Delinquency	C	0.793**							
	D	0.657**	0.749**						
School attitudes	B	-0.091	-0.047	0.039					
	C	-0.076	0.067	0.119	0.765**				
	D	-0.121	-0.023	0.194*	0.724**	0.799**			
Alcohol use	B	0.565**	0.545**	0.443**	-0.081	-0.117	-0.128		
	C	0.401**	0.553**	0.468**	-0.016	0.028	0.011	0.726**	
	D	0.356**	0.456**	0.567**	0.073	0.050	0.168	0.595**	0.779**

*Significance* \* $p < .05$ ; \*\* $p < .01$

## 5.6 Analytical strategy

We applied the longitudinal network modeling program SIENA. For the estimation procedure there are two options, estimation based on Method of Moments (Snijders, Steglich, & Schweinberger, 2007) and a MCMC-based Maximum Likelihood estimation (Snijders, Koskinen, & Schweinberger, 2007). We chose the latter, which is statistically more efficient and thus more suitable for small classes with few changes of relationships and attributes. Since this estimation procedure is time-consuming, we selected a small number of classes from the original sample of 120 classes, based on the following two pragmatic criteria. First, we wanted to have classes with a low number of missing values on the changing actor attributes. Second, we wanted classes with a high amount of relational and attribute change. These criteria help minimize the occurrence of occasional convergence problems with the estimation algorithm. Convergence problems may arise mainly for three reasons: the relatively small amount of relational and attribute information in the data of school classes, the complexity of the model for

three changing attribute variables, and the complicated longitudinal model with a dependent network and three dependent behavioral variables. Applying these criteria, we retained 27 classes that are richer in information than the other classes in the full sample.

We first analyzed the selected 27 classes separately with SIENA version 3.1 (Snijders, Steglich, Schweinberger, & Huisman, 2007). The same model is fitted for each class. For an overview of the model, see Table 5.1. For classes with no or only a few non-Dutch students, the ethnicity similarity parameter is meaningless and was excluded from the model. Of these 27 classes, 20 indeed delivered converging estimates. The background variables match well between the subsample of 20 classes and the whole data set. Students in the subsample nominate more friends and the number of friends varies more strongly between students compared to all students in the full data set. This can be expected because of our selection criteria. It does not, however, constitute a selection on the dependent variable, as similarity was no selection criterion. Students in the sample show higher levels of delinquency and alcohol use, and have more unfavorable attitudes towards school-related behavior than the average for all students in the complete data set. Table 5.3 shows how the subsample relates to the full sample on a series of descriptive statistics.

Next, the results of the classes where the parameter estimation procedure converged were aggregated in a meta-analytical approach as proposed by Snijders and Baerveldt (2003). In this approach it is assumed that true parameter values are different between classrooms, so that the observed differences between parameter estimates across classrooms are due partly to estimation inaccuracy, as reflected by standard errors, and due also to true variation between classrooms. For each effect in the model, the mean parameter value and the true between-classroom standard deviation of the parameter are tested and estimated separately. The test of the mean values is based on the *t*-ratio of estimated mean parameter to its standard error; the test of the variance is carried out by means of a *chi*-squared test, of which only the *p*-value is reported here.

**Table 5.3: Overview of data (120 classes and 20 classes)**

Coding	Wave	Full sample 120 classes (3,017 students)			Subsample 20 classes (553 students)			
		Mean or %	SD	Missing in %	Mean or %	SD	Missing in %	
<i>Dependent variables</i>								
Friends of respondent	1 – 12	B	4.19	2.55	9.0	4.46	2.70	5.6
		C	4.31	2.66	7.6	4.41	2.73	6.7
		D	4.06	2.51	7.2	4.15	2.65	5.8
Delinquency	1: none – 5: high	B	1.38	0.57	21.2	1.50	0.65	6.3
		C	1.46	0.65	20.0	1.56	0.72	6.5
		D	1.49	0.71	19.6	1.56	0.73	6.7
School attitudes	1: positive – 5: negative	B	1.70	0.61	9.6	1.79	0.63	6.0
		C	1.74	0.64	7.9	1.82	0.64	6.7
		D	1.81	0.69	7.7	1.85	0.71	6.3
Alcohol use	1: never – 5: > 10 times	B	1.46	0.95	9.7	1.60	1.08	6.7
		C	1.64	1.13	8.2	1.79	1.26	7.1
		D	1.76	1.23	7.8	1.90	1.31	7.1
<i>Control variables</i>								
Gender	1: female 2: male		1: 49%		0.0	1: 47%		0.0
Ethnicity	1: Dutch 2: non-Dutch		1: 83%		7.7	1: 86%		7.1
Friends in primary school	1 – 12		1.76	1.84	4.5	1.97	2.00	4.3
<i>Background variables</i>								
Age	10–15 years		12.11	0.49	5.6	12.08	0.46	5.6
Socioeconomic status	1: low – 4: high		2.56	0.93	31.2	2.54	0.90	28.6
Respondents with most friends in class		B	52%		12.3	51%		8.9
Respondents with most important friends in class		B	59%		16.0	59%		12.5

## 5.7 Results for selection and influence processes

In this section we present the results obtained by the meta-analysis of the SIENA results. Table 5.4 displays the estimated mean parameters with their standard errors, the estimated between-classroom standard deviations corrected for the standard errors of estimation per class, and the  $p$ -values of the tests that the parameter variance is 0. Effects in this model are significant when parameter estimates are more than 1.96 times their standard errors, indicating significance at the 5%-level.

We first present the results for the selection part of the model with friendship as dependent variable, before reporting the results for the influence part of the model with the attributes as dependent variable.

**Table 5.4: Results of meta-analysis of SIENA analyses (20 classes)**

	Predicted effect	Estimated mean parameter	Standard error of mean parameter	Estimated true standard deviation	<i>p</i> -value of test that variance of parameter is 0	
<i>Selection part</i>						
	Shared delinquency	+	0.193 ***	0.056	<0.000	0.661
	Delinquency ego	?	-0.059	0.112	0.35	0.015
	Delinquency alter	?	0.027	0.043	<0.000	0.036
	Shared school attitudes	+	0.061	0.087	0.19	0.377
	School attitudes ego	?	-0.024	0.079	0.21	0.019
	School attitudes alter	?	0.011	0.042	<0.000	0.258
	Shared level of alcohol use	+	0.070 ***	0.020	<0.000	0.071
	Alcohol use ego	?	-0.099	0.052	0.14	0.396
	Alcohol use alter	?	-0.028	0.027	<0.000	0.391
	Outdegree	-	-2.048 ***	0.044	<0.000	0.205
	Reciprocity	+	0.900 ***	0.056	<0.000	0.335
	Transitivity	+	0.202 ***	0.012	0.04	0.024
	Gender similarity	+	0.561 ***	0.072	0.21	0.040
	Ethnicity similarity	+	0.146 **	0.056	<0.000	0.850
	Friends in primary school	+	0.514 ***	0.087	0.22	0.105
<i>Influence parts</i>						
	Average delinquency of friends	+	0.088	0.199	<0.000	0.971
Delinquency	Tendency delinquency	?	-0.784 **	0.295	0.73	0.205
	Tendency delinquency squared	?	-0.091	0.067	<0.000	0.930
	Alcohol use	+	0.115	0.066	<0.000	0.457
	School attitudes	+	0.110	0.133	0.28	0.530
	Average school attitudes of friends	+	-0.011	0.286	<0.000	0.970
School attitudes	Tendency school attitudes	?	-0.080	0.090	<0.000	0.593
	Tendency school attitudes squared	?	-0.353 ***	0.094	<0.000	0.582
	Alcohol use	+	0.162	0.091	<0.000	0.971
	Delinquency	+	-0.011	0.155	<0.000	0.985
	Average alcohol of friends	+	0.132	0.156	<0.000	0.953
Alcohol use	Tendency alcohol use	?	-0.798 ***	0.202	<0.000	0.442
	Tendency alcohol use squared	?	0.202 ***	0.041	<0.000	0.447
	Delinquency	+	0.248 *	0.120	<0.000	0.857
	School attitudes	+	0.052	0.100	<0.000	0.534

*Significance \*p<0.05; \*\*p<0.01; \*\*\*p<0.001*

A positive *shared level of delinquency* effect (0.193) expresses that adolescents with a higher level of delinquency tend to have ties to others with higher levels of delinquency, and vice versa. Consulting the *p*-value of the test that the variance of the parameter is 0, there is no evidence that this effect differs between classes. The mean parameters and their standard errors indicate that there is no support for the delinquency ego and the delinquency alter effects in our sample. They differ between classes. There is no evidence that school attitudes affect the friendship evolution in our sample. The *school attitudes ego* effect differs between classes but has always a negative direction. The effects related to school attitudes are not significant for friendship evolution. The estimated mean parameter of the *shared level of alcohol use* effect is significant, confirming our hypothesis. There is inconclusive evidence for the *alcohol use ego* effect. This effect is negative, indicating that adolescents with high levels of alcohol use tend to nominate fewer classmates as friends than adolescents with low levels of alcohol use.

To get a better understanding of the effect sizes of delinquency and alcohol use on friendship selection, we compare it with the rather strong effect of *gender similarity*. A rough 95% confidence interval is computed by adding plus or minus two times the standard error multiplied with the standard deviation of the explanatory variable to the mean parameter that is also multiplied by the standard deviation. Since the *shared level of delinquency* effect and the *shared level of alcohol use* are based on a product, we take the squared standard deviation of delinquency across the observation points. For the *shared level of delinquency* effect, we obtain a confidence interval of [0.040; 0.150], for *shared level of alcohol use* [0.044; 0.164], and for *gender similarity* [0.209; 0.353]. The effect size of gender is stronger than the effect size of delinquency and alcohol use. Delinquency and alcohol use have a similar effect size.

The negative *outdegree* effect (-2.048) confirms our expectation that friendship ties are not made randomly and that networks of friendships are rather sparse. There is no evidence that the effects differ between classes. The *reciprocity* effect is quite strong, with an estimated average effect of 0.900. Effect sizes appear not to vary between classes. Network closure, represented in the *transitivity* parameter, has a positive effect (0.202) on friendship formation and maintenance. There is evidence that this effect varies between classes. When looking at a rough 95% interval for the parameter by adding two estimated true standard deviations below and above the estimated mean parameter, we see that this interval is wholly positive. In some classes this positive effect is stronger than in others. The *gender similarity* effect has a mean size of 0.561. The effect varies between classes but the same reasoning shows that it is always positive. Similarity in ethnicity makes friendship selection more likely. The *ethnicity similarity* effect is weaker than the *gender similarity* effect. There is no evidence that this effect differs between classes. A positive *friends in primary school* effect indicates

that earlier friends are likely to be kept. This effect does not appear to vary across classes.

In the influence parts of the model, we do not find effects of social influence according to our hypotheses. Our data do not support the hypotheses that attributes of friends affect adolescents' delinquency level, school attitudes, or level of alcohol use. The negative *tendency* parameters indicate that adolescents tend to score low on the attribute variables. In the influence part regarding delinquency, we find weak support for levels of alcohol use having a positive effect on delinquency. For the influence part on school attitudes, the negative *tendency school attitudes squared* effect (-0.353) indicates a negative feedback effect of school attitudes. Those with negative school attitudes tend to develop more positive ones, and vice versa. For alcohol use it works differently, as the positive *tendency alcohol use squared* effect (0.202) shows. Adolescents who abstain from alcohol use continue this behavior, adolescents who used alcohol tend to consume more than before. Furthermore, level of alcohol use is positively affected by delinquency level (0.248).

## 5.8 Discussion

The purpose of this study was to disentangle selection and influence processes for alcohol use, delinquency, and attitude toward school-related behavior among students in early adolescence. We were also interested in the relative strength of these attributes for selection and influence processes and, simultaneously, mutually dependent effects of these three attributes on network dynamics and vice versa.

Delinquency has been found to be influential in friendship choice. As predicted, adolescents form and maintain friendship relationships with others whose delinquency level is positively related to their own. In other words, delinquent adolescents prefer friends with a higher level of delinquency than non-delinquent adolescents do. There is no evidence that delinquency levels of friends in class affect own delinquency levels. Friends outside class might be more influential. This is left to speculation since it is beyond the scope of our study. Delinquent behavior such as stealing, vandalism, graffiti, and fighting may occur among children before the age of 12 and may not be a new behavior for the minority of delinquent adolescents in our sample. They may have experiences with this kind of behavior and not need their friends in class to trigger it. However, it is an important attribute for friendship evolution. We found no support in our data that school attitudes are relevant for selection and influence processes. As hypothesized, delinquency and alcohol use are more important than school attitudes for adolescent friends. School attitudes are less visible and therefore, may not play a role. Like delinquency, the other behavior that we investigated, alcohol use, has an effect on friendship choices. There was weak evidence that friends in class affect alcohol use. It

may be the case that friends outside class are the ones affecting adolescents' alcohol use. This would also explain the (weak) evidence that adolescents with a higher level of alcohol use tend to select fewer others as friends compared to adolescents with a lower level of alcohol use. We found that delinquency affects alcohol use and vice versa.

While improving on methods used in earlier studies on adolescents' friendship and attributes, we could show that not all attributes are important for selection and influence processes. There was no evidence that the selection and influence processes differ between classes. For future research this may mean that studies on a smaller number of networks are sufficient.

Our study has some limitations and offers some groundwork for future research. First, a limitation is that other effects have a bearing on the change in attributes. For instance, parental expectations have a bearing on adolescents' school attitudes. Due to the limited amount of information in small school classes, the estimation algorithm requires a parsimonious model in order to avoid convergence problems of the estimation procedure. Because of this restriction, a number of potentially important effects were left out of the model. We suggest that future studies investigate larger networks with more information in the data, to analyze models with a higher number of effects accounting for the complex selection and influence effects. Second, as mentioned before, our study focuses on friendship relationships within classes. Friends outside class might be relevant for affecting delinquent behavior or alcohol use. In order to fully explore selection and influence processes, friends outside class also need to be considered. Third, generalization of our results may be limited. We studied very young adolescents in Dutch secondary schools. Some of the attributes may only become important at a latter period of adolescence. Comparing young adolescents with older ones may provide new insights. Fourth, we investigated selection and influence effect on a dyadic level embedded in a network. Building on the methods that we used in this study, future research could take into account social entities at the network level stemming from selection and influence processes such as social norms, segmentation, or polarization.



## 6 Summary and discussion

### 6.1 Introduction

In this book we studied the association of friendship relationships and actor attributes of young adolescents. Friends are often found to share attributes. Different processes may explain this association. We have explored selection and influence processes. Selection refers to the formation and maintenance of friendship ties due to certain attributes. Here, attributes are changeable actor characteristics such as behavior or attitudes. Influence refers to change in attributes due to friends' attributes. The selection process describes the consequences of attributes on relationships, while the influence process describes the consequences of relationships on attributes. Accordingly, our research questions address these two processes:

- 1) Are adolescents' friendship choices affected by shared attributes?**
- 2) Are adolescents' attributes affected by their friends' attributes?**

We studied three relevant issues for students in early adolescence that cover different aspects of adolescent life, namely delinquency, school attitudes, and alcohol use. Delinquency is related to exploring limits. School attitudes are related to everyday life at school of all young adolescents. Alcohol use refers to a social behavior that is associated with socializing and is often assumed by adolescents to indicate maturity.

Theories of friendship formation stress the importance of similarity. Similar actors are best able to provide behavioral confirmation and the ties to them are therefore rewarding. Regarding selection processes, we hypothesized that adolescents whose attributes are similar tend to become and stay friends. Theories of social influence suggest that actors change their behavior and attributes to become similar to others they associate with. Regarding influence processes, we hypothesized that adolescents tend to adjust their attributes to the average of their friends' attributes. The two hypotheses lead to the same outcome, that is, similarity among friends.

These hypotheses were tested with relational and behavioral panel data on 3,171 students in 126 classes in the Netherlands. We chose students in the first grade of secondary school because they are in a new social setting where they are likely to reorganize their friendship relations and because the investigated attributes become relevant. Longitudinal data are required in order to determine the causality of relations and attributes. Students' friendship relationships with their classmates and their delinquent behavior, school attitudes, and level of alcohol use were assessed at four waves within the academic year 2003-04.

For the analysis of these data we employed actor-driven modeling for the co-evolution of networks and actor attributes. A basic assumption is that actors in a network have the opportunity to change their ties and their changeable attributes. By

doing so, they shape the structure of the network and the distribution of attributes. The structure and the distribution will in turn affect their individual decisions. Actor-driven modeling is implemented in the SIENA software. This program enables us to disentangle selection and influence processes.

Earlier studies concerned with selection and influence processes for these or related behaviors did not provide conclusive results for either process, and have often been flawed by methodological problems. The objective of the present book was twofold. Substantively, we wanted to gain insight into the dynamics of friendship relationships and adolescents' delinquent behavior, school attitudes, and alcohol use. Methodologically, we aimed to overcome problems of earlier studies through an improved research design and by using adequate statistical methods that enable us to separate selection and influence processes.

We conducted four studies. We first analyzed the three attributes and their co-evolution with friendship relationships separately (Chapters 2 to 4) and then combined these three attributes in one analysis (Chapter 5).

## 6.2 Summary of results

We summarize the results for each chapter. Subsequently, we compare results across chapters and provide answers to our research questions.

### 6.2.1 Results of each chapter

Chapter 2 examines selection and influence processes among adolescents for delinquent behavior such as stealing, vandalism, graffiti, and fighting. For this study we analyzed 544 students in 21 classes. Our outcomes suggest that delinquent behavior is one of the factors contributing to the selection of friends. Adolescents with a higher level of delinquency prefer to have friends with a higher level of such behavior, and vice versa. These findings are in accordance with the prediction of social control theory (Hirschi, 1969) that non-delinquent students associate among themselves and that delinquent students do likewise. We found this effect to be stronger in larger classes, which offer more choices and higher chances of meeting others with similar delinquency levels. The prediction that adolescents with a higher delinquency level have a "social handicap" and are thus less socially involved was partly supported by the data of our sample. We found weak evidence that delinquent students are less attractive as friends than adolescents with a lower delinquency level. Concerning influence processes, there was no evidence that friends' delinquency levels affect delinquency. This does not support the hypothesis drawn from differential association theory (Sutherland & Cressey, 1974). Furthermore, adolescents have a preference for reciprocated, transitive friendship ties with others who are similar in gender and ethnicity. Friendships from primary school

tend to be maintained in secondary school. Delinquent behavior appears to be affected by gender. Other things being equal, boys tend to attain higher levels of delinquency than girls.

In Chapter 3 we investigated the relevance of school attitudes for selection and influence processes among students. School attitudes refer to attitudes about school-related behavior such as being on time, going to every class, being attentive, getting good grades, and doing homework. We investigated 793 students in 29 classes. In contrast to our prediction, there is no evidence that school attitudes are involved in selection or influence processes. Adolescents tend to have reciprocated, transitive friendships with others of the same gender and ethnicity. Earlier friendships that already existed in primary school are likely to be maintained. School attitudes are affected by own school attitudes and by parents. Adolescents with positive school attitudes tend to develop less positive school attitudes, adolescents with negative school attitudes correct these attitudes. Parents' expectations regarding their children's school behavior have a positive effect on their children's school attitudes. Gender affects school attitudes as well. Boys tend to attain less favorable school attitudes than girls.

Chapter 4 deals with the importance of alcohol use for friendship selection and friends' influence on alcohol use. We used data from 2,025 students in 78 classes. Our results suggest that shared levels of alcohol use affect friendship selection. Weak evidence was found that adolescents adjust their level of alcohol use to their friends'. Reciprocity, transitivity, similarity in gender and ethnicity contribute to friendship selection. In addition, friendships from primary school tend to be maintained. Alcohol use is affected by an adolescent's earlier use. Those who had consumed alcohol tend to continue or increase their alcohol use. The effects of gender and ethnicity on alcohol use were in the expected direction, though no statistical evidence was found for these effects.

Chapter 5 combines the study of selection and influence processes for delinquency, school attitudes, and alcohol use. Analyzing 553 students in 20 classes, we found that similarity in delinquent behavior and alcohol use affects friendship choices positively. The effect sizes of delinquency and alcohol use are similar. Contrary to our expectation, no support was found for the effect of shared school attitudes on friendship choices. There was no evidence for friends' influence on adolescents' delinquency level, school attitudes, or alcohol use. Moreover adolescents tend to have reciprocated, transitive friendship ties to others of the same gender and ethnicity, and tend to maintain friendships from primary school. Our analysis revealed that delinquency level is affected by alcohol use and vice versa. Higher values on one predict higher values on the other. Adolescents' previous school attitudes have a self-correcting effect on school attributes whereas adolescents' level of alcohol use has an accelerating effect on alcohol use.

### 6.2.2 Comparison of separate analyses and combined analysis

In this section we compare the results obtained from the separate analyses of a single changing attribute (Chapters 2 to 4) and the results from the analysis of three attributes simultaneously (Chapter 5). It should be noted that we used different subsamples in each chapter. Why and how these subsamples are selected is explained in prior chapters. The results of the separate and combined analyses generally show the same pattern. Table 6.1 summarizes the results from the previous chapters for selection and influence processes. The effect of the interaction of own (“ego”) and other’s (“alter”) attributes on friendship choices represents the selection process (*shared attribute* effects), and the effect of the average attribute held by friends represents the influence process (*average attribute of friends* effects).

**Table 6.1: Overview of results**

Ch.		Estimated mean parameter	SE of mean parameter	CI of mean parameter	Ch.	Estimated mean parameter	SE of mean parameter	CI of mean parameter
2	Shared delinquency	0.160***	0.037	[0.041; 0.111]	5	0.193***	0.056	[0.040; 0.150]
	Average delinquency of friends	0.032	0.156	[-0.016; 0.068]		0.088	0.199	[-0.310; 0.486]
3	Shared school attitudes	0.064	0.051	[-0.038; 0.166]	5	0.061	0.087	[-0.040; 0.164]
	Average school attitudes of friends	0.109	0.180	[-0.251; 0.469]		-0.011	0.286	[-0.583; 0.561]
4	Shared level of alcohol use	0.057***	0.012	[0.042; 0.104]	5	0.070***	0.020	[0.030; 0.110]
	Average alcohol use of friends	0.135	0.078	[-0.021; 0.291]		0.132	0.156	[-0.049; 0.103]

*SE: standard error; CI: confidence interval; significance \*\*\* $p < 0.001$*

For all effects we expected a positive direction. A positive *shared attribute* effect indicates that if adolescents’ own and others’ attributes are positively related, they tend to form or maintain a friendship tie. Positive *average attribute of friends* effects indicate that adolescents tend to adjust their own attribute to their friends’ average attributes. According to our predictions, all estimated mean parameters have a positive sign. One exception is the *average school attitudes of friends* effect in the combined analysis. This effect is not significant and has a rather low value. In Chapter 3 more classes are analyzed than in Chapter 5, therefore results of Chapter 3 have more power. Statistical evidence has been found for the *shared level of delinquency* effect and the *shared level of alcohol use* effect, both in the separate and in the combined analyses. Weak evidence has been found for the *average alcohol use of friends* effect in the single analysis. These results are consistent with studies that found selection processes for delinquency (Baron

& Tindall, 1993) and selection and influence processes for alcohol use (Kirke, 2004; Steglich et al., 2007). There was no evidence for the other effects but they are all in the expected direction.

In order to compare effect sizes, we computed 95% confidence intervals as an approximate standardization. We added plus or minus two times the standard error to the mean parameter. For the selection effects, we considered the standard deviations of the attributes. The confidence intervals of *shared attribute* effects can be compared, as well as the intervals of *average attribute of friends* effects. When comparing the *shared level of delinquency* effect of Chapter 2 with the *shared level of alcohol use* effect of Chapter 4, we see that the effect size of alcohol on friendship selection is comparable to the effect size of delinquency. In the combined analysis of Chapter 5, this has been found as well (see right-hand side of Table 6.1 above). For the other parameters, there is no strong evidence that one of these effects is stronger than the other. There was no support that effects differ between classes.

Comparing the results of the analyses of one attribute with the results of the combined analysis for all three attributes, we conclude that they are quite similar. This provides evidence for the robustness of our findings.

### 6.2.3 Answers to research questions

#### 1) Are adolescents' friendship choices affected by shared attributes?

Our findings suggest that friendship choices in this age group and in the classroom context are not independent of adolescents' attributes. Not all attributes are important, and not all relevant attributes matter to the same extent. We found that the selection of friends is affected by level of delinquency. Adolescents with a high level of delinquency tend to form and maintain friendship ties with others who have a high level of delinquency. Adolescents with a low level of delinquency tend to have friends who have a low level of delinquency. These findings confirm the assumptions drawn from social control theory (Hirschi, 1969) that non-delinquents associate with non-delinquents, leaving delinquent adolescents to form ties among themselves. Alcohol use also affects friendship choices in the classroom. Adolescents with high alcohol use tend to select others with a high alcohol use, and vice versa — after all, alcohol use is a social activity better enjoyed in the company of others. The delinquency effect seems to contribute more than the effect of alcohol use on friendship choices. In Chapter 5 we found that alcohol use and delinquent behavior have a positive effect on each other. Against our prediction, no evidence was found that school attitudes play a role in friendship evolution. Our results indicate that behaviors are more central to selection processes than attitudes. This has also been suggested in other literature on friendship formation (Van Duijn et al., 2003). Different reasons may account for these findings. First, behaviors are more visible than attitudes, and thus are easier to observe. Second,

similar behavior is important for enjoying activities together. This is less the case for shared attitudes.

## **2) Are adolescents' attributes affected by their friends' attributes?**

We did not find statistical support for friends' influence on delinquency, school attitudes, or alcohol use. Most evidence was found for adolescents' adjustment of alcohol use to their friends' average level of alcohol use. Social learning theories applied to these attributes were not strongly confirmed by our data. How can these unexpected results be explained? There might be no need for the minority of delinquent adolescents in our sample to learn this behavior from classmates: delinquent behavior will have probably occurred before secondary school, classmates may not be needed to instigate it. It may very well be that friends influence delinquent behavior but that friends from outside class are more relevant than friends inside class. School attitudes are influenced more by parents than by classmates. Parental influence may be explained by the bigger interest that parents have in school-related issues. School attitudes do not seem to be relevant in the friendship context of students in the first grade of secondary school. This is also suggested by the finding that friendship choices are made independently of the school attitudes of the adolescents involved. The irrelevance of school attitudes may be explained by the limited visibility of this attribute. There was weak evidence that friends in the classroom affect alcohol use. Alcohol use is a social behavior and therefore, may be more prone to influence from others. Generally it seems that adolescents in our sample are more active regarding their friendship choices than their change of attributes. It may be the case that these young adolescents select their friends and only at a later point in time are influenced by them.

### 6.3 Discussion

#### 6.3.1 New contribution

Our aim was to assess friendship selection and friends' influence for different attributes of young adolescents, and to improve the methodological approach. By studying selection and influence processes, we address the problem of identifying processes resulting in similarity of actors within groups, also referred to as the "reflection problem" (Manski, 1993).

We can conclude that not all attributes are of importance for selection and influence processes. Behaviors such as delinquency and alcohol use are more important for selection than attitudes such as those related to school behavior. Hardly any evidence for social influence processes among friends was found. There is only inconclusive evidence that alcohol use is affected by friends' alcohol use. Some behaviors and attitudes are more stable than others and are less influenced by friends in class. There is

no support in our data that friends exert an influence on adolescents' delinquency levels or school attitudes, which may be good news for those who are concerned about negative influences of adolescents' friends. It was also found that parents affect their children's school attitudes. At first glance it may seem that influence processes within school classes are irrelevant and do not need to be considered. However, it is important to note that the inclusion of influence processes in the analysis is necessary in order to analyze selection processes correctly and to not overestimate them.

Major benefits of our studies are related to our research design and the simultaneous analysis of selection and influence. Methodological requirements for the study of selection and influence processes were explicated in the previous chapters. With our research design, we could cater to these requirements. First, we only used self-reported data. All students filled in questionnaires about their own relationships and their own attributes. In this way, we do not run the risk of respondents overestimating the similarity to their friends. Second, adolescents could name up to 12 classmates as friends. This proved to not restrict their answers, ensuring that all friends could be nominated. Third, we assessed friendship networks in school classes, allowing analysis of similarity among friends compared to non-friends. Fourth, we used a panel design with four waves. With this longitudinal design, causes and consequences of friendship networks and attributes among young adolescents could be assessed. Fifth, the data set consisted of a large number of classes. This gives more confidence in the generalizability of our results. Sixth, we investigated selection and influence processes simultaneously. Selection and influence processes could be disentangled by employing an actor-driven model of the co-evolution of networks and actor attributes as implemented in the SIENA software (Snijders, 2001; Snijders, Steglich, & Schweinberger, 2007; Snijders, Steglich, Schweinberger, & Huisman, 2007). To our knowledge, our study is the first using data combining all these requirements and the first applying SIENA to analyze selection and influence processes for multiple networks.

### 6.3.2 Limitations and suggestions for future research

In this section we discuss three main shortcomings of this study and sketch potential directions for future research.

First, we focused on friendships and changing attributes of young adolescents. Our results only apply to this age group and to an observation period of one year. Generalization to older adolescents is not expedient. The evolution of friendship networks and attributes may differ depending on age and developmental stage. Studying friendship selection and friends' influence in a population of young adolescents still has advantages. Friends become more important in adolescence compared to childhood, and increasing amounts of time are spent with them. Students in the first grade of secondary

school are in a phase of transition and may therefore be prone to reorganize their friendship relations and their behaviors and attitudes. In order to generalize our findings, future studies could replicate our research design to investigate dynamics of networks and attributes for older adolescents or for a longer observation period.

Second, only friends in class are considered. Adolescents also form and maintain friendship ties to others than classmates. Our research design does not allow controlling for processes among adolescents who do not belong to one class. Friends outside class may influence attributes of adolescents. This may explain why we found no friends' influence on delinquency and school attitudes, and hardly any evidence for influence on alcohol use. Still, the classroom is an important social environment for adolescents, where they spend much of their time and experience a lot of interaction. Most students in our data set reported having most of their friends and their most important friends in class. Our data suggests that whether studies of relationships within the classroom form a limitation depends on the investigated attribute. For alcohol use, we found a positive association between alcohol use and importance of friends in class. Students with a higher alcohol use tend to have more friends outside class. Such an association could not be found for delinquency or school attitudes.

Third, a related drawback of our studies is that we analyzed friendship relationships within a relatively small network. Classroom networks consist of approximately 25 students. This restricts the number of model parameters. Larger networks may provide more information and would allow more extensive model specifications. On the other hand, research of school classes has the advantage that all adolescents know each other and have the opportunity to become friends. It can also be assessed who is or who is not associated with whom. Since young adolescents spend much of their time in the classroom context, the class forms a natural boundary for friendship networks. A further improvement of the research design would be the investigation of complete grades — then one could still expect all students to have a fair chance of knowing each other and being in sufficient proximity to become friends.

In this book we investigated the importance of friendships and actor attributes such as delinquency, school attitudes, and alcohol use. Other relationships may be of importance for change of attributes, such as reciprocated friendship ties, support and trust relationships, or even negative ties. The list of potentially relevant attributes can also be extended. Additional relevant attributes might be personality traits, taste in music or fashion, or hobbies. Applying a similar approach like the one used in this book also for applications outside the realm of adolescence and for other attributes would improve our knowledge about the dynamics of networks and actor attributes.



## Summary in Dutch (Samenvatting in het Nederlands)

### 1 Introductie

In dit boek bestuderen we de samenhang tussen vriendschapsrelaties en persoonlijke eigenschappen van jonge adolescenten. Het wordt vaak gevonden dat de vrienden van adolescenten overeenkomstige eigenschappen hebben. Verschillende processen kunnen deze associatie verklaren. Wij onderzoeken selectie- en invloedprocessen. “Selectie” verwijst naar de formatie en instandhouding van vriendschapsrelaties *vanwege* bepaalde eigenschappen. Met “eigenschappen” verwijzen we naar persoonlijke eigenschappen die veranderbaar zijn zoals gedrag of attitudes. “Invloed” verwijst naar de verandering in eigenschappen *vanwege* de eigenschappen van vrienden. Het selectieproces beschrijft de gevolgen van persoonlijke eigenschappen op relaties, terwijl het invloedproces de gevolgen van relaties op persoonlijke eigenschappen beschrijft. Onze twee onderzoeksvragen richten zich op deze twee processen:

- 1) **Worden vriendschapskeuzes van adolescenten beïnvloed door gedeelde eigenschappen?**
- 2) **Worden eigenschappen van adolescenten beïnvloed door de eigenschappen van hun vrienden?**

Wij onderzoeken drie relevante onderwerpen voor scholieren in de vroege adolescentie, die verschillende aspecten van het adolescentie leven omvatten, namelijk delinquentie, attitudes ten opzichte van school en alcoholgebruik. Delinquentie is gerelateerd aan het verkennen van grenzen. Attitudes ten opzichte van school zijn gerelateerd aan het dagelijkse leven op school van alle jonge adolescenten. Alcoholgebruik refereert aan een vorm van sociaal gedrag waarvan adolescenten vaak aannemen dat het volwassenheid aanduidt.

Theorieën over vriendschapsrelaties benadrukken het belang van overeenkomstigheid. Actoren die eigenschappen delen zijn het best in staat gedragsbevestiging te verlenen en zijn daarom aantrekkelijke relaties. Wat betreft selectieprocessen veronderstellen we dat adolescenten wiens kenmerken overeenkomstig zijn, de neiging hebben vrienden te worden en te blijven. Theorieën over sociale invloed suggereren dat actoren hun gedrag en attitudes veranderen om meer te lijken op degenen met wie zij omgaan. Wat betreft invloedprocessen veronderstellen we dat adolescenten de neiging hebben hun eigenschappen aan te passen aan het gemiddelde van de eigenschappen van hun vrienden. De twee hypothesen leiden tot dezelfde uitkomst, namelijk, overeenkomstigheid tussen vrienden.

Deze hypothesen worden getoetst met panel data over relaties en eigenschappen van 3.171 leerlingen in 126 klassen in Nederland. We hebben voor scholieren in de eerste klas van de middelbare school gekozen daar zij zich in een nieuwe sociale

omgeving bevinden waarin het waarschijnlijk is dat ze hun vriendschapsrelaties zullen reorganiseren en omdat de onderzochte eigenschappen op die leeftijd relevant worden. Longitudinale data zijn vereist om de causaliteit tussen relaties en eigenschappen te kunnen bepalen. De vriendschappen van scholieren met hun klasgenoten, hun delinquent gedrag, attitudes ten opzichte van school en mate van alcoholgebruik zijn gemeten op vier momenten in het academische jaar 2003-04.

Voor de analyse van deze data maken we gebruik van actor gedreven modellering voor de co-evolutie van netwerken en actor eigenschappen. Een basisassumptie is dat actoren in een netwerk de mogelijkheid hebben om hun relaties en eigenschappen te veranderen. Door dit te doen bepalen ze de structuur van het netwerk en de verdeling van eigenschappen. De structuur van het netwerk en de verdeling van eigenschappen beïnvloeden op hun beurt de individuele beslissingen. Actor gedreven modellering is geïmplementeerd in de SIENA software. Dit programma stelt ons in staat selectie- en invloedprocessen uit elkaar te halen.

Eerdere studies die zich bezighielden met selectie- en invloedprocessen aangaande deze eigenschappen en gerelateerde gedragingen hebben niet afdoende bewijs geleverd voor bovengenoemde processen, en hebben vaak te leiden onder methodologische problemen. Het doel van dit boek is tweeledig. Op inhoudelijk vlak willen we inzicht krijgen in de dynamiek tussen vriendschapsrelaties en delinquent gedrag, attitudes ten opzichte van school en alcoholgebruik van adolescenten. Op methodologisch vlak streven we er naar problemen van eerdere studies te overwinnen met behulp van een verbeterd onderzoeksdesign en door het gebruik van adequate statistische methoden die ons in staat stellen selectie- en invloedprocessen te scheiden.

We voeren vier studies uit. Eerst analyseren we de drie eigenschappen en hun co-evolutie met vriendschapsrelaties afzonderlijk (Hoofdstuk 2 tot en met 4), daarna brengen we deze drie eigenschappen samen in één analyse (Hoofdstuk 5).

## 2 Samenvatting van de resultaten

We vatten de resultaten voor elk hoofdstuk samen. We vergelijken vervolgens de resultaten van de verschillende hoofdstukken en geven we antwoorden op onze onderzoeksvraag.

### 2.1 Resultaten van elk hoofdstuk

Hoofdstuk 2 onderzoekt selectie- en invloedprocessen onder adolescenten met betrekking tot delinquent gedrag zoals stelen, vandalisme, graffiti en vechten. Voor deze studie analyseren we 544 leerlingen in 21 klassen. Onze resultaten suggereren dat delinquent gedrag één van de factoren is die bijdragen aan de selectie van vrienden. Adolescenten die een hoge mate van delinquent gedrag vertonen, prefereren vrienden

die ook een hoge mate van delinquent gedrag vertonen, en vice versa. Deze bevindingen komen overeen met de voorspelling van de sociale controle theorie (Hirschi, 1969) dat niet-delinquente leerlingen met elkaar omgaan en dat delinquente leerlingen hetzelfde doen. Dit effect blijkt sterker in grotere klassen die meer keuzemogelijkheden bieden en waar de kans om anderen met een overeenkomstig niveau van delinquent gedrag tegen te komen groter is. De voorspelling dat adolescenten met een hoger niveau van delinquent gedrag een “sociale handicap“ hebben en dus minder sociaal betrokken zijn wordt gedeeltelijk ondersteund door de data uit onze sample. We vinden enig bewijs dat delinquente leerlingen minder aantrekkelijk zijn dan vrienden dan leerlingen die minder delinquent zijn. Wat betreft invloedprocessen is er geen bewijs dat de mate van delinquentie van vrienden delinquent gedrag beïnvloedt. Dit biedt geen ondersteuning aan de hypothese die uit de differentiële associatie theorie (Sutherland & Cressey, 1974) wordt afgeleid. Verder hebben adolescenten een voorkeur voor wederkerige, transitieve vriendschapsrelaties met anderen die overeenkomen qua sekse en etniciteit. Vriendschappen van de basisschool worden voortgezet op de middelbare school. Delinquent gedrag blijkt te worden beïnvloed door sekse. Controlerend voor alle andere aspecten vertonen jongens in hogere mate delinquent gedrag dan meisjes.

In hoofdstuk 3 onderzoeken we de relevantie van attitudes ten opzichte van school voor selectie- en invloedprocessen onder leerlingen. Attitudes ten opzichte van school verwijzen naar houdingen ten opzichte van schoolgerelateerd gedrag zoals op tijd zijn, naar elke les gaan, oplettend zijn, goede cijfers halen en huiswerk maken. We onderzoeken 793 scholieren in 29 klassen. In tegenstelling tot onze verwachting is er geen bewijs dat attitudes ten opzichte van school betrokken zijn bij selectie- of bij invloedprocessen. Adolescenten neigen wederkerige, transitieve vriendschappen te hebben met anderen van dezelfde sekse en etniciteit. Eerdere vriendschappen die op de basisschool al bestonden worden met grote waarschijnlijkheid in stand gehouden. Attitudes ten opzichte van school worden beïnvloed door eigen attitudes ten opzichte van school en door ouders. Adolescenten met positieve attitudes ten opzichte van school ontwikkelen minder positieve attitudes, adolescenten met negatieve attitudes ten opzichte van school stellen deze bij. De verwachtingen van ouders hebben een positief effect op de attitudes ten opzichte van school van hun kinderen. Sekse heeft eveneens een invloed op attitudes ten opzichte van school. Jongens lijken meer ongunstige attitudes ten opzichte van school te hebben dan meisjes.

Hoofdstuk 4 handelt over het belang van alcoholgebruik voor vriendschapsselectie en de invloed van vrienden op alcoholgebruik. We gebruiken data van 2.025 scholieren uit 78 klassen. Onze resultaten suggereren dat overeenkomstige niveaus van alcoholgebruik vriendschapsselectie beïnvloeden. We vinden enig bewijs dat adolescenten hun niveau van alcoholgebruik aanpassen aan dat van hun vrienden. Wederkerigheid, transitiviteit, gelijkheid in sekse en etniciteit dragen bij aan

vriendschapsselectie. Bovendien neigen scholieren vriendschappen in stand te houden die op de basisschool zijn ontstaan. Alcoholgebruik wordt beïnvloed door eerder gebruik door een adolescent. Zij die alcohol genuttigd hebben neigen hiermee door te gaan of verhogen hun alcoholgebruik. De effecten van sekse en etniciteit op alcoholgebruik liggen in de lijn der verwachting, hoewel geen statistisch significant bewijs voor deze effecten wordt gevonden.

Hoofdstuk 5 combineert de studies van selectie- en invloedprocessen voor delinquentie, attitudes ten opzichte van school en alcoholgebruik. Na het analyseren van 553 studenten in 20 klassen vinden we dat gelijkheid in delinquent gedrag en alcoholgebruik vriendschapskeuzes positief beïnvloeden. De bijdrage van delinquentie is sterker dan die van alcoholgebruik. In tegenstelling tot onze verwachtingen wordt geen bewijs gevonden voor een effect van overeenkomstige attitudes ten opzichte van school op vriendschapskeuzes. Er is geen bewijs voor de invloed van vrienden op het delinquent gedrag, attitudes ten opzichte van school, of alcohol gebruik van scholieren. Bovendien neigen adolescenten wederkerige, transitieve vriendschapsbanden tot anderen van dezelfde sekse te hebben, en vriendschappen van de basisschool in stand te houden. Onze analyse toont aan dat het niveau van delinquentie wordt beïnvloedt door alcoholgebruik en vice versa. Hogere waarden op de één voorspellen hogere waarden op de ander. Eerdere attitudes van adolescenten ten opzichte van school hebben een zelfcorrigerende werking op attitudes van adolescenten ten opzichte van school, terwijl het niveau van alcoholgebruik door adolescenten een bespoedigend effect op alcoholgebruik heeft.

## 2.2 Vergelijking van afzonderlijke analyses en gecombineerde analyse

In deze sectie vergelijken we de resultaten verkregen uit de afzonderlijke analyses van één enkel veranderende eigenschap (Hoofdstukken 2 tot en met 4) en de resultaten van de analyse van de drie eigenschappen gelijktijdig (Hoofdstuk 5). Opgemerkt dient te worden dat we in elk hoofdstuk verschillende subsamples van de data gebruiken. Waarom en hoe deze subsamples geselecteerd zijn is in de betreffende hoofdstukken uiteengezet. De resultaten van de afzonderlijke en gecombineerde analyses tonen over het algemeen hetzelfde patroon. Tabel 1 vat de resultaten van de voorgaande hoofdstukken voor selectie- en invloedprocessen samen. De effecten van de interactie van eigen (“ego”) en andermans (“alter”) eigenschappen op vriendschapskeuzes tonen de selectie effecten (*gedeelde eigenschap* effect). De effecten van de gemiddelde eigenschap van vrienden tonen de invloed effecten (*gemiddelde eigenschap van vrienden* effecten).

**Tabel 1: Overzicht van de resultaten**

H.		Geschatte gemiddelde parameter	SF gemiddelde parameter	BI gemiddelde parameter	H.	Geschatte gemiddelde parameter	SF gemiddelde parameter	BI gemiddelde parameter
2	Gedeelde delinquentie	0.160***	0.037	[0.041; 0.111]	5	0.193***	0.056	[0.040; 0.150]
	Gemiddelde delinquentie van vrienden	0.032	0.156	[-0.016; 0.068]		0.088	0.199	[-0.310; 0.486]
3	Gedeelde attitudes t.o.v. school	0.064	0.051	[-0.038; 0.166]	5	0.061	0.087	[-0.040; 0.164]
	Gemiddelde attitudes t.o.v. school van vrienden	0.109	0.180	[-0.251; 0.469]		-0.011	0.286	[-0.583; 0.561]
4	Gedeeld niveau van alcoholgebruik	0.057***	0.012	[0.042; 0.104]	5	0.070***	0.020	[0.030; 0.110]
	Gemiddeld alcoholgebruik van vrienden	0.135	0.078	[-0.021; 0.291]		0.132	0.156	[-0.049; 0.103]

SF: standaardfout; BI: betrouwbaarheidsinterval; significantie \*\*\* $p < 0.001$

Voor alle effecten verwachtten we een positieve richting. Een positief *gedeeld eigenschap effect* geeft aan dat als eigen en andermans eigenschappen van adolescenten overeenkomen, ze de neiging hebben om een vriendschapsrelatie te vormen of voort te zetten. Positieve *gemiddelde eigenschap van vrienden* effecten geven aan dat adolescenten hun eigen eigenschappen neigen aan te passen aan het gemiddelde in hun vriendenkring. In overeenstemming met onze voorspellingen zijn alle geschatte gemiddelde parameters positief. De enige uitzondering is het *gemiddelde attitudes ten opzichte van school van vrienden* effect in de gecombineerde analyse. Dit effect is niet significant en heeft een tamelijk lage waarde. In Hoofdstuk 3 zijn meer klassen geanalyseerd dan in Hoofdstuk 5, daardoor hebben de resultaten van hoofdstuk 3 meer kracht. Statistisch significant bewijs vinden we alleen voor het *gedeelde delinquentie* effect en het *gedeelde niveau van alcoholgebruik* effect, zowel in de afzonderlijke als in de gecombineerde analyse. Er is geen bewijs voor de andere effecten maar zij zijn allen in de verwachte richting.

Teneinde de effectgroottes te vergelijken berekenen we 95% betrouwbaarheidsintervallen. We voegen plus of min twee keer de standaardfout toe aan de gemiddelde parameter. Voor de selectie effecten gebruiken we de standaarddeviaties van de eigenschappen. De betrouwbaarheidsintervallen van *gedeelde eigenschap* effecten kunnen vergeleken worden, evenals de intervallen van *gemiddelde eigenschappen van vrienden* effecten. Wanneer we het *gedeeld niveau van delinquentie* effect uit Hoofdstuk 2 vergelijken met het *gedeeld niveau van alcoholgebruik* effect uit Hoofdstuk 4, zien we dat de effectgrootte van alcohol op vriendschapsselectie vergelijkbaar is met de effectgrootte van delinquent gedrag. In de gecombineerde analyse van Hoofdstuk 5 kan dit eveneens gevonden worden (zie rechterzijde van Tabel 1 hierboven). Voor de andere parameters is er geen sterk bewijs dat één van deze effecten sterker is dan de andere. Er is ook geen bewijs dat effecten verschillen tussen klassen.

Met betrekking tot de analyse van één eigenschap of meer dan één eigenschap, concluderen we dat de resultaten zeer stabiel zijn. Dit geeft sterk bewijs voor onze resultaten.

### 2.3 Antwoorden op onderzoeksvragen

#### **1) Worden vriendschapskeuzes van adolescenten beïnvloed door gedeelde eigenschappen?**

Onze resultaten suggereren dat vriendschapskeuzes van deze leeftijdsgroep in klaslokalen niet onafhankelijk zijn van eigenschappen van adolescenten. Niet alle eigenschappen zijn belangrijk, en niet alle relevante eigenschappen zijn in dezelfde mate van belang. We vinden dat de selectie van vrienden wordt beïnvloed door het niveau van delinquentie. Adolescenten die een hoge mate van delinquent gedrag vertonen neigen vriendschapsrelaties te vormen en te onderhouden met anderen die ook een hoge mate van delinquent gedrag vertonen. Adolescenten die weinig tot geen delinquent gedrag vertonen neigen vriendschappen te vormen en te onderhouden met anderen die weinig tot geen delinquent gedrag vertonen. Deze bevindingen bevestigen de veronderstellingen die uit de sociale controle theorie (Hirschi, 1969) worden afgeleid, namelijk dat niet-delinquenten met niet-delinquenten kiezen om te gaan, waardoor delinquente adolescenten gedwongen zijn met elkaar relaties aan te gaan. Ook alcoholgebruik beïnvloedt vriendschapskeuzes in het klaslokaal. Adolescenten met een hoog alcoholgebruik neigen vrienden te selecteren die er ook een hoog alcoholgebruik op na houden, en vice versa – alcoholgebruik is per slot van rekening een sociale activiteit die zich beter laat smaken in het gezelschap van anderen. Het effect van een overeenkomstige mate van delinquent gedrag lijkt belangrijker dan het effect van een overeenkomstige mate van alcoholgebruik op vriendschapskeuzes. In hoofdstuk vijf vinden we dat alcohol gebruik en delinquent gedrag elkaar positief beïnvloeden. In

contrast met onze voorspellingen is er geen bewijs dat attitudes ten opzichte van school een rol spelen in de evolutie van het vriendschapsnetwerk. Onze resultaten geven aan dat gedrag belangrijker is in het selectie proces dan attitudes. Dit is ook gesuggereerd in andere literatuur aangaande vriendschapsformatie (Van Duijn et al., 2003). Verschillende redenen kunnen onze bevindingen verklaren. Ten eerste is gedrag beter zichtbaar en daarmee makkelijker te observeren. Ten tweede is gelijk gedrag belangrijk

voor het gezamenlijk genieten van activiteiten. Dit is in het geval van attitudes in mindere mate het geval.

## **2) Worden eigenschappen van adolescenten beïnvloed door de eigenschappen van hun vrienden?**

We vinden geen statistische ondersteuning voor de invloed van vrienden op delinquentie, attitudes ten opzichte van school, of alcoholgebruik. Het meeste bewijs wordt gevonden voor de aanpassingen van alcoholgebruik richting het gemiddelde niveau van alcoholgebruik van vrienden. Voor deze eigenschappen worden sociale invloedstheorieën dus niet sterk ondersteund door de data. Hoe kunnen deze onverwachte resultaten worden verklaard? Voor de minderheid van delinquente adolescenten in onze steekproef is er mogelijk geen noodzaak om dit gedrag te leren van klasgenoten: delinquent gedrag is waarschijnlijk al voorgevallen vóór de middelbare school, waardoor het niet noodzakelijk is dat klasgenoten ertoe aanzetten. Het is daarnaast goed mogelijk dat vrienden elkaar wel beïnvloeden met betrekking tot delinquent gedrag, maar dat vrienden van buiten de klas hier relevanter voor zijn dan vrienden binnen de klas. Attitudes ten opzichte van school worden meer beïnvloed door ouders dan door klasgenoten. Ouderlijke invloed kan worden verklaard door de grote interesse die ouders hebben voor schoolgerelateerde kwesties. Attitudes ten opzichte van school lijken niet relevant te zijn in de vriendschapscontext van scholieren in de eerste klas van de middelbare school. Deze stelling wordt ook ondersteund door de eerdere bevinding dat vriendschapskeuzes onafhankelijk zijn van de attitudes ten opzichte van school van de adolescenten in kwestie. De irrelevantie van attitudes ten opzichte van school kan mogelijk verklaard worden door de beperkte zichtbaarheid van deze eigenschap. Er is enig bewijs dat vrienden uit dezelfde klas elkaars alcoholgebruik beïnvloeden. Alcoholgebruik is een vorm van sociaal gedrag en daardoor is het waarschijnlijk dat dit gedrag gevoeliger is voor invloed van anderen. Over het algemeen lijkt het dat adolescenten in onze steekproef actiever zijn met betrekking tot hun vriendschapskeuzes dan met verandering van eigenschappen. Het zou kunnen zijn dat deze jonge adolescenten hun vrienden selecteren en pas later door hen beïnvloed worden.

### 3 Discussie

#### 3.1 Nieuwe inzichten

Ons doel is om vriendschapsselectie en de invloed van vrienden met betrekking tot verschillende eigenschappen van jonge adolescenten in kaart te brengen, en een verbeterde methodologie te hanteren voor de bestudering van selectie- en invloedprocessen. Door het bestuderen van selectie- en invloedprocessen, adresseren we het probleem van het identificeren van verschillende processen die resulteren in overeenkomstigheid van actoren binnen groepen, ook wel het “reflectie probleem” (Manski, 1993) genoemd.

We kunnen concluderen dat niet alle eigenschappen van belang zijn in selectie- en invloedprocessen. Gedrag, zoals delinquentie en alcoholgebruik zijn van groter belang voor selectie dan attitudes, zoals attitudes ten opzichte van school. Er wordt amper bewijs gevonden voor sociale invloed processen tussen vrienden. Er is slechts onafdoende bewijs dat vrienden elkaar beïnvloeden met betrekking tot alcoholgebruik. Bepaalde gedragingen en attitudes zijn stabiel dan andere, en worden minder beïnvloed door vrienden in de klas. Er is geen steun in onze data voor de invloed van vrienden op delinquent gedrag van adolescenten, wat goed nieuws kan zijn voor diegenen die bezorgd zijn over negatieve invloeden van vrienden van adolescenten. Ook wordt gevonden dat ouders de attitudes ten opzichte van school van hun kinderen beïnvloeden. Op het eerste gezicht lijkt het dat invloedprocessen in schoolklassen irrelevant zijn en niet in beschouwing genomen hoeven te worden. Het is echter belangrijk om op te merken dat het meenemen van invloedprocessen in de analyse noodzakelijk is teneinde selectieprocessen correct te schatten, en niet te overschatten.

Ons onderzoeksdesign en de simultane analyse van selectie en invloedprocessen behoren tot de grote voordelen van onze studies. Methodologische vereisten voor onderzoek naar selectie- en invloedprocessen zijn in voorgaande hoofdstukken uiteengezet. Met ons onderzoeksdesign kunnen wij aan die vereisten voldoen. Ten eerste gebruiken wij enkel zelfrapportages als data. Alle scholieren vulden vragenlijsten in over hun eigen relaties en eigenschappen. Op deze manier lopen we niet het risico dat respondenten hun mate van gelijkheid ten opzichte van hun vrienden overschatten. Ten tweede konden adolescenten maximaal twaalf klasgenoten als vrienden opgeven. Dit heeft hen niet in hun antwoorden beperkt, waardoor alle vrienden genomineerd konden worden. Ten derde bestuderen we vriendschapnetwerken in schoolklassen, wat analyse van gelijkheid onder vrienden in vergelijking tot niet-vrienden toelaat. Ten vierde, maken we gebruik van panelonderzoek met vier observaties. Met dit longitudinale ontwerp kunnen we oorzaken en gevolgen van vriendschapnetwerken en eigenschappen van jonge adolescenten schatten. Ten vijfde, bestaat de dataset uit een groot aantal klassen. Dit geeft meer mogelijkheid tot generaliseren van de resultaten.



Ten zesde, onderzoeken we selectie en invloedsprocessen simultaan. De processen kunnen uit elkaar gehaald worden door gebruik te maken van een actor-gedreven model voor de co-evolutie van netwerken en actor eigenschappen zoals geïmplementeerd in de SIENA software (Snijders, 2001; Snijders, Steglich & Schweinberger, 2007; Snijders, Steglich, Schweinberger, & Huisman, 2007). Naar ons weten is onze studie de eerste die data gebruikt die alle vereisten combineert, en de eerste die SIENA gebruikt om selectie- en invloedsprocessen van meerdere netwerken tegelijkertijd te analyseren.

### 3.2 Beperkingen en suggesties voor toekomstig onderzoek

In deze sectie bespreken we drie belangrijke tekortkomingen van onze studie en schetsen we richtingen voor toekomstig onderzoek.

Ten eerste focussen we ons op vriendschap en veranderende eigenschappen van jonge adolescenten. Onze resultaten zijn enkel van toepassing op deze leeftijdsgroep, en op een observatieperiode van één jaar. Generalisatie naar oudere adolescenten is niet goed mogelijk. De evolutie van vriendschapsnetwerken en eigenschappen is mogelijk afhankelijk van leeftijd en ontwikkelingsfase. Het bestuderen van vriendschapsselectie en invloed van vrienden in een populatie van jonge adolescenten heeft echter ook voordelen. Vrienden worden belangrijker in adolescentie ten opzichte van de kindertijd, en toenemende hoeveelheden tijd worden met hen doorgebracht. Leerlingen in de eerste klas van de middelbare school bevinden zich in een fase van transitie en kunnen daarom vatbaar zijn voor het reorganiseren van hun vriendschapsrelaties en hun gedrag en attitudes. Teneinde onze bevindingen te generaliseren zouden toekomstige studies ons onderzoeksdesign kunnen kopiëren om de dynamiek van netwerken en eigenschappen te analyseren voor oudere adolescenten of over een langere observatieperiode.

Ten tweede is enkel rekening gehouden met vrienden in de klas. Adolescenten vormen en onderhouden ook vriendschapsrelaties met anderen buiten de klas. Ons onderzoeksdesign staat het niet toe te controleren voor processen tussen adolescenten die niet samen in één klas zitten. Vrienden buiten de klas kunnen de eigenschappen van adolescenten beïnvloeden. Dit is een mogelijke verklaring waarom we geen invloed van vrienden op delinquentie en attitudes ten opzichte van school hebben gevonden, en bijna geen bewijs voor invloed met betrekking tot alcoholgebruik. We mogen echter niet vergeten dat het klaslokaal een belangrijke sociale omgeving is voor adolescenten, waar zij veel tijd doorbrengen en veel interactie beleven. De meeste leerlingen in onze dataset geven aan dat de meeste van hun vrienden, en hun meest belangrijke vrienden bij hen in de klas zitten. Onze data lijken aan te tonen dat de mate waarin de beslissing om enkel relaties in het klaslokaal te bestuderen een beperking vormt afhangt van de onderzochte eigenschappen. Voor alcoholgebruik vonden we dat leerlingen met een hoger alcoholgebruik meer vrienden buiten de klas neigen te hebben. Een dergelijke associatie kon niet gevonden worden voor delinquentie.

Ten derde, en gerelateerd aan de bovenstaande tekortkoming, analyseren we vriendschapsrelaties in relatief kleine netwerken. Netwerken binnen een klaslokaal bestaan uit ongeveer vijftwintig leerlingen. Dit legt beperkingen op aan het aantal parameters in het model. Grotere netwerken leveren meer informatie en maken uitgebreidere model specificaties mogelijk. Tegenover deze tekortkoming staat dat onderzoek van schoolklassen het voordeel heeft dat alle adolescenten elkaar kennen en de mogelijkheid hebben vrienden te worden. Tevens kan bepaald worden wie wel en wie niet met elkaar omgaan. Omdat jonge adolescenten veel tijd in het klaslokaal doorbrengen, vormt de klas een natuurlijke begrenzing voor vriendschapsnetwerken. Het bestuderen van complete jaargangen zou een mogelijke oplossing zijn – dan kan men nog steeds verwachten dat alle leerlingen een redelijke kans hebben elkaar te kennen en in een afdoende nabijheid zijn om vrienden te worden.

In dit boek bestuderen we het belang van vriendschappen en actor eigenschappen zoals delinquentie, attitudes ten opzichte van school en alcoholgebruik. Andere relaties zijn mogelijk van belang voor verandering van eigenschappen, zoals wederkerige vriendschapsbanden, steun en vertrouwensrelaties, of zelfs negatieve relaties. De lijst met potentiële relevante eigenschappen kan ook worden uitgebreid. Aanvullende relevante eigenschappen zouden persoonlijkheidskenmerken, muziek- of modesmaak, of hobby's kunnen zijn. Het toepassen van een soortgelijke benadering als in dit boek, ook voor toepassingen buiten het terrein van adolescentie en voor andere eigenschappen, kan onze kennis over de dynamiek van netwerken en actor eigenschappen vergroten.

## Appendix A: Sketch of the Dutch system of secondary education

In this appendix, we outline the system of secondary education in the Netherlands. The text is based on information provided by the European Unit of the European Commission (see: <http://www.eurydice.org>, access date March 27, 2007) and the Dutch Central Bureau of Statistics (Centraal Bureau voor de Statistiek, 2003, Jeugd 2003 cijfers en feiten, <http://www.cbs.nl>, access date March 27, 2007). The next section provides information on public and private schools, followed by a description of the school tracking system.

### Public and private schools

In the Netherlands, there are both public and private schools in secondary education. Private schools are governed by the same legislation as public schools. Both are by law on an equal financial footing. Most of the private schools are denominational in kind, with a majority of Catholic and Protestant schools. Table A1 provides an overview of the number of schools and the number of students per type of school.

**Table A1: Distribution of Dutch schools and students by denomination in 2003**

Type of school	% schools	% students
Public	29	27
Private non-denominational	12	10
Protestant	22	24
Roman-Catholic	26	27
Combination	11	13
total	100% = 667	100% = 891,200

*Source: European Unit of the European Commission*

### Tracking system

After leaving primary school education at the average age of 12 years, students go on to secondary school education. Usually this means changing school. Students are grouped in classes according to their age and schooling track. Basically, there are four different tracks:

- (1) *Pre-university education* (VWO: Voorbereidend Wetenschappelijk Onderwijs): Students follow this track for six years. They can choose between two different types, i.e., athenaeum and gymnasium. Both types of school prepare for university. Approximately 20%<sup>2</sup> of all students in the four main tracks participate in pre-university education.
- (2) *Senior general secondary education* (HAVO: Hoger Algemeen Voortgezet Onderwijs): This track lasts five years and students usually finish it when they are

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<sup>2</sup> All percentages are based on the distribution of students in the four main tracks in the third year of secondary education.

17 years old. It provides general education and prepares students for entry to higher professional education. Approximately 20% of all students follow this track.

- (3) *Pre-vocational secondary education* (VMBO: Voorbereidend Middelbaar Beroeps Onderwijs; until 1999: MAVO and VBO): This track lasts for four years. It provides a basis for further vocational training. At the earliest at the end of the second year, students opt for a particular sector and learning pathway. Each sector (i.e., engineering and technology, care and welfare, business or agriculture) and each learning pathway (theoretical program, combined program, middle-management vocational program, or basic vocational program) has its own curriculum. Approximately 50% of all students follow this track.
- (4) *Pre-vocational secondary education with special needs* (LWOO: Leerweg-Ondersteunend Onderwijs): Students in this track follow the same curriculum as students attending pre-vocational secondary school education, and both groups can be found in one class. The difference between this track and regular pre-vocational secondary education is that students who are thought to be capable of taking a diploma in secondary education but need support with their chosen program are provided with individual coaching. Approximately 10% of all students follow this track.

Besides these four main tracks, students from 12 to 18 years old who are unlikely to obtain a qualification via one of the four learning paths can receive practical training. This only concerns a small percentage of all students in secondary school education. The practical training prepares students for direct entry into the regional labor market. In addition, there is education available for children with learning and behavioral difficulties (LOM: onderwijs voor kinderen met Leer- en Opvoedings-Moeilijkheden). Note that students who follow practical training or who have learning and behavioral difficulties do not form part of our sample.

Whilst the Dutch educational system offers a wide range of possibilities and exceptions, the vast majority of students entering secondary school are assigned to a specific track following the advice of the primary school they attended. This advice is based on the cognitive development of the child as assessed by the primary school staff and typically also on a test taken in the final year of primary school, which measures a child's level of knowledge and understanding ("CITO test"). Most secondary schools offer different tracks. The first grade of secondary school education ("brugklas") is intended as a time of orientation in terms of students' future educational path. First-year students in a class take all subjects at the same level. In the first year of secondary education, two adjacent tracks are often combined; approximately 60% of all students in the first grade are grouped in heterogeneous classes as to educational level. Students of these "combined" classes are assigned to a specific track at a later date. Students usually stay at the same school throughout their secondary education.

## Appendix B: Data collection

### General

Data were collected from students and main teachers of 126 first grade classes at 14 secondary schools in the Netherlands.<sup>3</sup> The data were assessed at four points in time in the academic year 2003-04. A codebook with further information on the data is available (Knecht 2006).

### School and class sampling

Schools were sampled from a database of school card reports of the education inspection (“Kwaliteitskaartgegevens van de Inspectie van het Onderwijs”; [www.onderwijsinspectie.nl](http://www.onderwijsinspectie.nl)) that contains information on all first grade classes of all secondary schools in the Netherlands in September 2001. While most Dutch schools follow certain general rules regarding their educational system and organization (see Appendix A), there are also a number of exceptions. We aimed at composing a sample of average schools in the Netherlands. To this end, we first excluded the largest and smallest schools: the schools had to have a minimum of 450 and a maximum of 3,500 students. We also excluded schools with unusual denominations or serving specific target groups, e.g. schools for athletes, for children of mariners, or for children with special needs. For practical reasons, only schools were considered with classes at two different educational levels. Out of the remaining pool, we randomly contacted 126 schools by phone or mail. We aimed at obtaining a mixture of rural and urban schools. A letter sent to the schools described the background and aim of our study, assured confidentiality of the research, and asked schools to participate. From the 126 schools selected, 67 schools did not respond after the first attempt contact, or there were problems due to changes of address. Thirty-four schools declined to participate in our study. The reasons for refusal to participate varied: the most common reasons were time constraints or participation in another research project. In a lot of cases, the exact reason for refusal has remained unspecified. Ultimately, 25 schools showed interest in participating in our research. From this group, we selected 14 schools in both urban and rural areas with a total of 126 first-grade classes. The 14 schools were selected on the basis of the educational level of their first grades one year prior to the survey (for a description of the different educational levels, see Appendix A). An attempt was made to match the educational level of classes with the distribution of all first-grade classes of secondary schools in the Netherlands. The proportional distribution of educational levels within classes does not correspond with the national distribution of educational levels due to within-school variation in educational levels over time. This may have implications for the extent to which results based on these data can be generalized.

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<sup>3</sup> Information on the Dutch secondary school system can be found in Appendix A.

**Table B1: Class level characteristics**

<i>Educational level</i>	Number of classes
Pre-vocational secondary education with learning support	8
Pre-vocational secondary education with and without learning support	5
Pre-vocational secondary education	19
Pre-vocational secondary education / Senior general secondary education	39
Senior general secondary education	4
Senior general secondary education / Pre-university education	40
Pre-university education	11
<i>Area</i>	
Rural	48
Urban	78
<i>Denomination</i>	
Public	18
Roman-Catholic	53
Protestant	28
Combination (Roman-Catholic & Protestant)	21
<i>School size (2002-03)</i>	Number of Students
Average	1712
Smallest school	801
Largest school	3561

### Timing of the survey

In each school year, four waves were scheduled with three months in between consecutive waves. The first wave took place in August and September 2003, shortly after the start of the academic year 2003-04. Subsequent waves took place in November-December 2003, February-March 2004, and May-June 2004.

### Method

Data have been gathered by means of self-administered questionnaires for students and for teachers. Questionnaires were first tested in a pilot study. The pilot study included three classes in one school and two classes in another school. These classes comprised different educational levels. In the pilot study, we tested the time required for filling in the questionnaire, wording, (mis)interpretation, and content of the complete questionnaire. With most of the main teachers of these five classes, we discussed the items of the mentor questionnaire, which was developed in collaboration with Roel Bosker. The insights obtained in this manner led to adjustments in terms of intelligibility and manageability, of both the questionnaire for students and the one for mentors. Also, some of the network and delinquency items were tested in earlier research (Baerveldt et al., 2003).

Trained assistants visited the schools to distribute questionnaires in the classes. The assistants had a checklist of instructions to ensure that all students received the same information on how to complete the questionnaire, they explained how to answer the different kinds of questions, and stressed confidentiality of the research. The assistants

were present while the students filled in their questionnaires and were available for students' questions. The assistants filled in an evaluation form about the absence or presence of students and teachers, the time required to complete the questionnaires, and problems and frequency of problems experienced with the different items. In addition, they collected the mentor questionnaire from the main teacher of each class in the sample. The students used identification numbers for themselves and their classmates when asked about their relations in class. We provided a list with a unique identification number for each class member.

Of the 126 classes, only 124 participated in all four waves. Two classes were not included at one point in time because of organizational problems or because the class was absent at the day of data collection. Table B2 provides an overview of the number of students and teachers participating per wave.

**Table B2: Response rate of students and teachers**

	Students		Teachers	
	Realized	Not included (%)	Realized	Not included (%)
Wave 1	2996	2.2	126	0.0
Wave 2	2862	7.0	118	6.3
Wave 3	2913	5.9	111	11.9
Wave 4	2932	4.2	84	33.3

#### Student questionnaire

The students' questionnaire aimed at obtaining information on background, behavioral and attitudinal attributes and relations over time.<sup>4</sup> Some questions were included in all four waves; other items were only measured once. In each wave, we asked for the date and the identification codes of the school, the class, and each student so as to allow a full match of the four questionnaires per student.

Most of the background variables were measured only once and split among the four questionnaires. These were the following items (some of which were outlined in previous chapters): school advice on the student's educational level as given by the primary school, gender and age of the respondent, household members of the respondent, living environment (city, village, countryside) and zip code, occupation and occupational status of the parents, education needed for the parents' occupation, religious affiliation of parents and frequency of attending religious gatherings, ethnic background of parents and the language predominantly spoken at the respondent's home, and smoking behavior of the respondent's family members.

<sup>4</sup> The original Dutch version of the items used in this study can be found in Appendix C.

In each wave, we gathered the following information: student's amount of pocket money, importance of friends in and outside class, hobbies, and personality traits. Apart from the information on friendships and friends from primary school, relational questions were included about practical and emotional support received, personal conversation partners, desired friendship partners, disliked classmates, classmates they meet outside class, bullying, similarities in taste in music and clothes, trust, importance of opinion, and with whom they compare grades. Apart from delinquency, attitudes on school-related behavior and alcohol consumption, behavior and attitudes were assessed with regard to smoking, the use of soft drugs, fashion, music, sport, kissing, and trust. For some types of behavior, we asked for intended and expected sanctions of classmates, importance of these behaviors for parents and mentors, and reactions of parents and mentors to some of these behaviors.

#### Mentor questionnaire

The main teacher of each class completed the mentor questionnaire. This teacher usually spends extracurricular time with the class and is the person to address in case of problems or questions. The mentor questionnaire –like the student questionnaire– was filled in at four different points in time in the academic year 2003-04, with approximately three months between consecutive waves.

We asked for background information on the teacher: subjects taught to the class, number of lessons per week given to the class, gender, age, years of experience as a teacher and as a mentor. We also asked about the mentor's opinion and sanctioning of students' school-related behavior, smoking and delinquent behavior of students. Inquiries were made as well into the school's official policy regarding students being late for class. A couple of questions were concerned with the teacher's relation to the students' parents and with the atmosphere in class. In the first wave, we asked information on how attentive individual students were in class. From the second wave on, a question about the social-emotional stability of each student was included. In the second, third, and fourth wave, we asked the teacher to indicate the three best friends of each student in their class. In all waves, teachers were asked to indicate for each student whether they were doing their best, were easily influenced by other students (after the first wave, this question was split into two, one item for students being influenced in a positive way, and one for being influenced negatively), whether student were easily influenced by the teacher, and whether students were opinion leaders or not.



## Appendix C: Original Dutch wording of items

This appendix contains the items with the original Dutch questions and answer categories that have been used in this study. The items are presented with a reference in brackets to the chapters of the study where they are used. In those chapters, the items are translated into English.

### **Friendship nominations of respondent (2, 3, 4, 5)**

Welke klasgenoten zijn jouw beste vrienden?

- Maximum of 12 nominations

### **Friends from primary school (2, 3, 4, 5)**

Met wie van je klas nu was je op je basisschool bevriend?

- Maximum of 12 nominations

### **Most friends in class (2, 3, 4, 5)**

Waar zitten de meeste van je vrienden?

- In deze klas.
- In andere klassen op deze school.
- Buiten deze school.
- Ik heb geen vrienden.

### **Most important friends in class (2, 3, 4, 5)**

Wie zijn het belangrijkste voor je?

- Mijn vrienden in deze klas.
- Mijn vrienden in andere klassen op deze school.
- Mijn vrienden buiten deze school.

### **Delinquency (2, 5)**

Hoe vaak heb jij de volgende dingen in de laatste drie maanden gedaan?

- Iets gestolen.
- Iets expres kapot gemaakt.
- Gevochten.
- Met stiften of met een spuitbus dingen van anderen beklad.

Answer categories for each item:

- Nooit
- 1 keer
- 2 t/m 4 keer
- 5 t/m 10 keer
- meer dan 10 keer

**School attitudes (3,5)**

Geef je mening: vind je het goed of stom als iemand dit doet?

- Opletten tijdens de les.
- Goede cijfers halen.
- Huiswerk leren.
- Op tijd in de les zijn.
- Altijd naar elke les gaan.

Answer categories for each item:

- |                     |                     |
|---------------------|---------------------|
| - Vind ik erg goed. | - Vind ik stom.     |
| - Vind ik goed.     | - Vind ik erg stom. |
| - Maakt niet uit.   |                     |

**Alcohol use (4,5)**

Hoe vaak heb jij de volgende dingen in de laatste drie maanden gedaan?

- |                      |                    |
|----------------------|--------------------|
| - Alcohol gedronken. |                    |
| - Nooit              | - 5 t/m 10 keer    |
| - 1 keer             | - meer dan 10 keer |
| - 2 t/m 4 keer       |                    |

**Gender (2, 3, 4, 5)**

Ben je een jongen of een meisje?

- |          |          |
|----------|----------|
| - Meisje | - Jongen |
|----------|----------|

**Ethnicity (2, 3, 4, 5)**

In welk land is je moeder geboren?

- |                       |                              |
|-----------------------|------------------------------|
| - Nederland           | - België                     |
| - Marokko             | - Turkije                    |
| - Suriname            | - Nederlandse Antillen/Aruba |
| - Anders, namelijk... |                              |

In welk land is je vader geboren?

- |                       |                              |
|-----------------------|------------------------------|
| - Nederland           | - België                     |
| - Marokko             | - Turkije                    |
| - Suriname            | - Nederlandse Antillen/Aruba |
| - Anders, namelijk... |                              |

Welk taal wordt er bij jou thuis vooral gesproken?

- |                  |            |             |
|------------------|------------|-------------|
| - Nederlands     | - Berbers  | - Turks     |
| - Moluks/ maleis | - Arabisch | - Hindi     |
| - Sranan Tongo   | - Javaans  | - Koerdisch |
| - Papiamentu     | - Frans    | - Spaans    |
| - Duits          | - Engels   | - Chinees   |
| - Anders, nl...  |            |             |

**Socio-economic status (2, 3, 4, 5)**

Heeft jouw vader betaald werk?

- Ja, voltijd.
- Ja, deeltijd.
- Nee, hij is huisman.
- Nee, hij is werkloos.
- Nee, hij is met pensioen.
- Ik heb geen vader.

Welk beroep heeft jouw vader?

Welk soort onderwijs heb je tegenwoordig nodig voor dit type beroep?

- Lagere school of VMBO
- HAVO of VWO
- Universiteit
- Weet niet

Heeft jouw moeder betaald werk?

- Ja, voltijd.
- Ja, deeltijd.
- Nee, zij is huisman.
- Nee, zij is werkloos.
- Nee, zij is met pensioen.
- Ik heb geen moeder.

Welk beroep heeft jouw moeder?

Welk soort onderwijs heb je tegenwoordig nodig voor dit type beroep?

- Lagere school of VMBO
- HAVO of VWO
- Universiteit
- Weet niet

**Parents' expectation (3)**

Hoe belangrijk is het voor jouw ouders dat je...

- ...oplet tijdens de les?
- ...je best doet op school?

Answer categories for each item:

- Heel belangrijk
- Belangrijk
- Een beetje belangrijk
- Niet zo belangrijk
- Onbelangrijk



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## Curriculum Vitae

Andrea Knecht was born in Erlenbach am Main, Germany, in 1976. From 1997 to 2002 she studied Sociology and Cultural Sciences at the University of Leipzig. In the course of her studies she spent one term at the University of Groningen, The Netherlands, as an exchange student. Her final thesis was written at the Max Planck Institute for Human Development in Berlin on the topic of educational homogamy. In September 2002, she became a PhD student at the Interuniversity Center for Social Science Theory and Methodology (ICS) in Utrecht, where she completed this dissertation. In 2004 she attended the Essex Summer School in Social Science, Data Analysis and Collection. In the same year she spent a two-month research period at the Institute for Mathematical Behavioral Sciences (IMBS), University of California in Irvine. In 2006, she spent a two-month research period at the Department of Sociology of the National University of Ireland in Maynooth. From January until September 2007, she has worked part-time as researcher at the Netherlands Organisation for Applied Scientific Research (TNO) in Soesterberg. Since October 2007 she is employed as researcher at the Department of Social Sciences at Friedrich-Alexander University Erlangen-Nuremberg, Germany.





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