DISSERTATION

THE COEVOLUTION OF ADOLESCENT FRIENDSHIP NETWORKS AND

SCHOOL OUTCOMES

Submitted by

Sara E. Dieterich

Department of Psychology

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Colorado State University

Fort Collins, Colorado

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Doctoral Committee:

    Advisor: Kimberly Henry

    Randall Swaim
    Daniel Graham
    Lise M. Youngblade

ABSTRACT

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Adolescent underachievement and school disengagement are major problems with far-reaching

consequences for both students and society. Approximately 25% of students in the U.S. do not

graduate from high school (Education Week, 2013), and new and innovative interventions are of

critical importance to raise the graduation rate to an acceptable level. The promotion of positive

friendships may be one avenue for achieving this goal (Kindermann, 2007; Ryan, 2001).

However, a better understanding of the relationship between friendships and school engagement

is needed before we can determine if the promotion of positive friendships is likely to lead to

academic engagement and effective interventions can be developed. Specifically, one key issue

that is not fully understood is the interplay between influence and selection processes. Thus, the

present study examined the extent to which adolescents become increasingly similar to their

friends over time on school outcomes (i.e., influence processes) and the extent to which

adolescents seek out other students to befriend over time that are already similar on these

outcomes (i.e., selection processes) using a new modeling strategy, stochastic actor-based

modeling, among 6th and 7th grade students. A significant selection effect was found for GPA;

however, no other significant selection or influence effects were found for school bonding,

values of education and achievement, or attendance. The results also show that gender did not

moderate the effect of selection or influence for any of the school outcomes. Implications for

prevention are discussed.

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CHAPTER I: INTRODUCTION

Academic underachievement among U.S. students is a serious problem with far-reaching

consequences for both students and society. Among adolescents, only 35% of 8th grade students

are proficient in mathematics while only 34% are proficient in reading (National Center for

Educational Statistics, 2011a; 2011b). Approximately 25% of students do not graduate from

high school (Education Week, 2013). Additionally, the high costs associated with school

dropout are well documented. According to the Alliance for Excellent Education (2009),

students that do not graduate have higher rates of unemployment, lower earning potential and

poorer health outcomes across their life course as well as more adult criminality, incarceration,

and reliance on government assistance than their counterparts who do graduate. Thus,

underachievement is a major concern which warrants much further attention.

Given these consequences, effective interventions focused on raising achievement and

preventing later dropout are critically needed. One viable strategy is to identify students who are

at risk for dropping out; these students often demonstrate behaviors that are indicative of school

disengagement. School *engagement* can reflect behavioral, emotional, and cognitive

engagement (see Fredricks, Blumenfeld, & Paris, 2004) such as participation in school, positive

reactions to the school environment, and investment in academics. On the other hand, school

disengagement is often characterized by a gradual process of disconnection from school, both

physically and psychologically (Finn, 1989), which often culminates in school dropout (Janosz,

Achambault, Morizot, & Pagani, 2008). There are numerous negative outcomes of school

disengagement including dropout, substance use and delinquency (Bachman et al., 2008;

Catalano et al., 2004; Henry, Knight, & Thornberry, 2012). Considering the gradual nature of

disengagement, it follows that students can be identified early in this trajectory and targeted for intervention accordingly. Among 6th graders, Balfanz, Herzog and Mac Iver (2007) were able to identify 60% of the students who would later dropout in high school by using early warning indicators such as low attendance, academic underperformance, and school misbehavior. Despite the promise of early warning systems, there is a dearth of effective interventions that serve to prevent academic underachievement among these younger students; therefore, the development of new and innovative interventions is of critical importance to curb this serious problem.

One potential avenue for intervention concerns the social network or friendships that an adolescents experiences. We do not yet fully understand the role of social networks in the school dropout process; however, it is widely accepted that the social context, including friendship, influences positive as well as negative development (Berndt, 1992, 1999; Bronfenbrenner & Morris, 1998). In addition, Finn (1989) proposed that school engagement stems from a complex interaction of the student with the context (e.g., friendships); therefore, a student's network of social relationships likely presents a promising avenue for efforts aiming to increase student school engagement and prevent later school dropout. However, much remains unknown regarding the impact of social networks on a student's outcomes and a better understanding is the first step in finding a solution to adolescent academic underachievement. In sum, further work such as the present study is greatly needed to address these gaps in our knowledge and inform future prevention efforts.

In this introduction, I will first outline the characterization of school engagement and disengagement among middle school students. Next, the contributing factors in the development of student engagement trajectories will be reviewed, including school-, person-, and

interpersonal-level factors including friendships. Given the potential of a social network approach in preventing underachievement and dropout, evidence of the importance of the social context during adolescence for school outcomes will be emphasized. Then, I will detail the phenomenon of similarity between an adolescent's attitudes and behaviors and those of his friends (Ide et al., 1981; Kindermann, 2007). This is important as two processes are capable of accounting for this similarity: selection and influence (Kandel, 1968; Steglich, Snijders, & Pearson, 2004; Urberg et al., 1997). On one hand, friendships have the power to influence an adolescent and similarity develops as an adolescent assimilates to his friends over time (i.e., influence processes). Alternatively, an adolescent could seek out others to befriend who are already similar to himself to begin with and similarity is maintained among friends over time (i.e., selection processes). While the assessment of the influence and selection processes is prerequisite to the development of effective social network-based interventions, more work is needed to inform a clear picture of the typical progression. Thus, the need for an investigation of these processes to determine the impact of social networks on adolescent school engagement will be highlighted. Finally, I will detail the practical significance of this project for prevention efforts aimed at fostering student engagement, bolstering achievement, and preventing later school dropout among students. Without further examination, a critical gap will remain in our understanding of the far-reaching impact of friendships during adolescence, and our ability to capitalize on the social network for the promotion of academic achievement will remain untapped. The present study seeks to address this gap.

School Engagement and Disengagement during Middle School

An adolescent's experiences at school are of particular importance for positive youth development (Catalano, Haggerty, Oesterle, Fleming, & Hawkins, 2004). Specifically, school

engagement plays a crucial role in an adolescent's academic life (Connell, Spencer, & Aber, 1994; Marks, 2000; Wang & Eccles, 2012). In a review of the literature, Fredricks et al. (2004) concluded that student school engagement positively contributes to desirable academic outcomes among students such as achievement and graduating from high school on time. Conversely, school disengagement is associated with negative outcomes such as later school dropout, substance use, teenage pregnancy, and delinquency (Bachman et al., 2008; Brindis & Philliber, 1998; Catalano et al., 2004; Henry et al., 2012; Janosz et al., 2008). Thus, both school engagement and disengagement are important for student outcomes and a characterization of both is presented next.

School Engagement

Prior work has broadly characterized school engagement as a multifaceted construct consisting of behavioral, cognitive, and emotional engagement in school (Fredricks, Blumenfeld, & Paris, 2004), which can be reflected in a variety of student behaviors and attitudes. Behavioral engagement may be marked by active participation in the classroom (e.g., attendance) and on-task classroom behavior; cognitive engagement may be characterized by student psychological investment in academics; and emotional engagement may be indicated by a student's positive affective reactions to the school environment (see Fredricks et al., 2004; Jimerson, Campos, & Grief, 2003). Bonding to school also is an important component of school engagement. School bonding is often characterized by commitment and attachment to both the academic and social aspects of school (Hawkins & Weis, 1985; Hirschi, 1969; Jimerson, Campos, & Grief, 2003), which can be reflected in the degree of student attachment to teachers, other students, and the larger school environment (Eggert, Thompson, Herting, Nicholas, & Dicker, 1994). This is often measured as student report of feelings towards school in general and social relationships at

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school (Jimerson et al., 2003). It follows that a student who is strongly bonded to school is more likely to exert effort in academic endeavors which would, in turn, positively affect academic outcomes (Finn, 1989) and may protect an adolescent against negative behaviors such as academic difficulties, substance use, and delinquency (Catalano et al., 2004).

Indeed, research has demonstrated the impact of school engagement for student success. Prior work has shown a positive relationship between aspects of school engagement and desirable academic outcomes such as higher grade point average and aspirations for future education (Connell & Wellborn, 1991; Li & Lerner, 2011; Marks, 2000; Wang & Eccles, 2011) and a negative relationship with problem behaviors such as adolescent substance use and delinquency (Catalano et al., 2004; Henry, Thornberry, & Huizinga, 2009; Payne, Gottfredson, & Gottfredson, 2003). To summarize, school engagement may be marked by a variety of dimensions including attendance, academic performance, attitudes towards school and school bonding and research has indicated the importance of this engagement for student outcomes.

School Disengagement

The opposite of school engagement is *disengagement* that can also be characterized by a variety of behaviors such as academic underperformance, truancy, and school misbehavior among middle school students. These behaviors can all predict later school dropout, a potential culmination of a disengagement trajectory (Balfanz et al., 2007; Henry et al., 2012). First, prior work has shown poor academic performance (e.g., failing course grades, low standardized test scores) to be a robust predictor of later school dropout (Alexander et al., 2001; Finn, 1989; Hickman et al., 2008; Mac Iver & Mac Iver, 2009). Finn (1989) posited that students may respond to negative feedback on their performance (e.g., failing grades) by disconnecting from school. Alternatively, poor performance may be a consequence of initial disinterest or

disengagement in school. In either instance, poor academic performance often characterizes school disengagement. Poor school performance can also lead to failing a grade, which is a key predictor for school dropout (Alexander et al., 2001; Hickman et al., 2008). In fact, poor academic performance characterizes school disengagement so robustly that some researchers advocate using academic underperformance to identify at-risk students as early as middle school and to intervene accordingly (Heppen & Bowles Therriault, 2008).

Next, a student's disconnection and disengagement from school may be characterized by a lack of attendance or truancy from school (Hickman et al., 2008; Mac Iver & Mac Iver, 2009). Henry et al. (2012) found truancy during adolescence to be associated with later high school dropout while researchers have also associated high absenteeism in middle school with later school dropout, especially when this absenteeism is coupled with previous grade retention (Gleason & Dynarski, 2002). In fact, Bridgeland et al. (2006) posited attendance to be the best indicator of student school engagement. Furthermore, school misbehavior (e.g., suspensions) can also characterize disengagement; students with a disciplinary record are at a higher risk for eventual school dropout (Hickman et al., 2008*;* Mac Iver & Mac Iver, 2009). For instance, Rumberger and Larson (1998) found that students sent to the school administrator's office for misbehavior during the first semester of 8th grade were more likely to subsequently drop out of high school. Similarly, Finn, Fish, and Scott (2008) found 8th grade school misbehavior such as class disruptiveness and fighting at school to predict later high school dropout. In sum, school disengagement may be characterized by a number of factors including academic underperformance, truancy, and school misbehavior among middle school students, all of which have been shown to be related to poor student outcomes such as later school dropout, substance use, and delinquency (Catalano et al., 2004; Janosz et al., 2008).

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Contributing Factors for Engagement and Disengagement Trajectories

Considering the importance of school engagement for positive youth development, a comprehensive understanding of contributing factors is essential. According to Brofenbrenner (1979), development is influenced by interactions with one's environment (e.g., people, school, culture) (see Figure 1). Specific to school engagement, school-, person-, and interpersonal-level variables are all significant factors that influence whether an adolescent follows a path of engagement or disengagement. To give a general overview, school and personal domains will be briefly highlighted; however, additional attention will be given to interpersonal-level variables, specifically friendships, as this is the focus of the present study.

School- Level Factors in Engagement

Factors specific to the characteristics of the school environment itself may be influential. For instance, school size may affect school disengagement. Smaller schools may provide an environment that is more conducive to participation and engagement (e.g., Fredricks et al., 2004). In fact, large schools in urban areas have a higher dropout rate than smaller schools (Rumberger & Thomas, 2000). Non-secular schools (e.g., Catholic) also report lower dropout rates (Rumberger, 1995). Aspects of the classroom climate may also impact engagement in school. Classroom climates characterized by clear expectations for behavior also appear to support student engagement (Connell & Wellborn, 1991; Christle, Jolivette, & Nelson, 2007; Fredricks, Blumenfeld, Friedel, & Paris, 2005). Finally, characteristics of academic work itself may promote engagement. Student perceptions of challenging and relevant classroom work have been associated with higher engagement among students (e.g., Fredricks et al., 2004; Yair, 2000). In conclusion, school-level factors do appear to contribute substantially to average dropout rates and student disengagement.

Person-Level Factors in Engagement

Factors specific to the individual student may also contribute to disengagement. For example, Alexander et al. (2001) found personal attitudes towards school (i.e., positive sense of self as a student, positive view of the academic environment) protects students from both disengagement and dropout. A student's sense of perceived control of his success in school can also promote engagement, which can lead to higher academic performance (Skinner, Wellborn, & Connell, 1990). Motivational beliefs may also impact a student's engagement with the school context. Achievement motivation encompasses a student's cognitions such as beliefs about his ability to perform, expectancies for performance (i.e., expectations about the results of his performance), and valuation of performance (Ecceles et al., 1998). High achievement motivation has been shown to be related to student engagement dimensions including academic performance and persistence (Durik, Vida, & Eccles, 2006; Pintrich & Schunk, 1996). Last, students with a learning disability are at a greater risk for low school bonding (Murray & Greenberg, 2001), and students with low English language proficiency are less likely to feel as though they belong at school (Morrison, Cosden, O'Farrell, & Campos, 2003). Taken together, these findings suggest person-level factors do indeed contribute to school disengagement.

Interpersonal-Level Factors in Engagement

Factors specific to a student's relationships with parents, teachers, and peers also contribute to a student's engagement in school. Finn (1989) posited the participation-identification model in which a student's social relationships can facilitate (or impede) a student's commitment to and identification with school and, in turn, increase (or reduce) a student's school engagement. For instance, parental attitudes towards school (e.g., expectations for the child's success, beliefs about the child's ability) have been shown to mitigate dropout risk

(Alexander et al., 2001). Further, Marks (2000) found parental involvement in academics (e.g., discussions on academics and future plans for college, attendance at school events) to support school engagement among elementary, middle and high school students as indicated by student-reported effort, attentiveness, and persistence. Retrospective interviews with adults who had dropped out of school revealed that poor parental attitudes toward education were often cited as an important factor in a student's decision to drop out of school (Terry, 2008).

Relationships with teachers are also important for student engagement. Teacher attitudes and behaviors (e.g., high teacher expectations for performance and help from teachers) are associated with increased school engagement (Marks, 2000). Moreover, perceptions of teacher support are associated with increased engagement (Osterman, 2000), a reduced risk of dropout (Croninger & Lee, 2001), and less classroom misbehavior (Ryan & Patrick, 2001). Tucker et al. (2002) also found that students who reported teacher involvement and caring in their lives reported more engagement with school.

Relationships with peers may also play a key role in a student's school engagement. The social context has an important impact on adolescent development (Finn, 1989; Berndt, 1992, 1999; Bronfenbrenner & Morris, 1998); however, we don't have a thorough understanding of the impact of interpersonal relationships on school engagement specifically. Furthermore, Fredricks et al. (2004) posited that school engagement is malleable, with changes to contextual factors (e.g., interpersonal relationships) contributing to changes in individual-level school engagement, indicating the potential impact of these relationships for an adolescent. First, peers (i.e., a student's age mates at school) may impact a student's engagement trajectory. For instance, Coleman et al. (1966) suggested the influence of peers in education in the seminal "Coleman Report"; Coleman and colleagues purported that an individual's achievement could be predicted

by the average level of achievement across all students in the school, although it is possible that third variables accounted for both individual and peer achievement. Additionally, more acceptance by other students at school during 6th grade has been linked to higher student GPA (Wentzel & Caldwell, 1997). Thus, peers do emerge as an important contributing factor for student success.

Relatedly, a student's friendships may also impact school engagement; however, the impact of these relationships may be qualitatively different compared to the impact of peers (see Sage & Kinderman, 1999). Peers represent a contextual-level factor of other students sharing the school environment, while friendships represent a dyadic tie between students who spend time engaged in activities together. Friendships may also be more impactful in adolescent life due to increased closeness and intimacy (Berndt, 1982). Thus, friendships may be a key contributing interpersonal-level factor for a student's engagement or disengagement in school. The role of friendships in school engagement is the focus of this study, and in the next section the impact of friendships during adolescence will be described.

The Critical Impact of Friendships on Adolescent Development

The transition from childhood to adolescence is one marked by numerous developmental changes, tasks, and challenges. Namely, friendships begin to take a more central role as adolescents experience an increase in independence and autonomy (Moffitt, 1993). Adolescents begin to spend increasing amounts of time with friends while decreasing time spent with family (Larson & Verma, 1999). Adolescents rate friendships as more important than other relationships, such as those with parents (Brown, Dolcini, & Leventhal, 1997). Friendships during adolescence are also closer and more intense than friendship during childhood (Berndt, 1982). Similar to adults, adolescents have a strong desire to belong and form interpersonal

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attachments (Baumeister & Leary, 1995; Osterman, 2000); adolescents are then motivated to initiate and maintain friendships, which may be impactful on an adolescent's life. In particular, friendships appear to be especially salient for adolescents in middle school. Sumter, Bokhorst, Steinberg, & Westenberg (2009) examined the susceptibility to influence from friends among youths aged 10 to 18 years old. Resistance to friend influence increased linearly, suggesting the that younger adolescents are most vulnerable to influence from friends than older adolescents. Moreover, the school context may be particularly central for an adolescent when forming and maintaining friendships. When asked to identify friendships, a sample of 1030 9th students in five high schools named 95% within their own school even when not restricted to doing so (Ennett & Bauman, 1994). Adolescents also tend to select friends within their grade (Goodreau et al., 2009). Thus, the school context appears to be of particular importance for adolescent friendships.

Friendships during adolescence are dynamic. Relationships with friends are largely voluntary unlike relationships with family; therefore, change in friendships can be expected. Numerous researchers have demonstrated that adolescent friendship networks change frequently, particularly during school transitions, as friendships are initiated and dissolved over time (Degirmencioglu, Urberg, Tolson, & Richard, 1998; Hardy, Bukowski, & Sippola, 2002; Neckerman, 1996). Compared to childhood when more friendships are initiated than dissolved, early adolescents initiate as many friendships as are dissolved over the school year (Berndt & Hoyle, 1985). Thus, change is frequent, and the dynamic nature of adolescent friendship networks provides opportunities for an adolescent to select new friends who may later influence the adolescent. On the other hand, maintained friendships may also continue to have an impact on an adolescent's development. Some 50% to 75% of adolescent friendships are maintained

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during a school year (Berndt & Hoyle, 1985; Degirmencioglu et al., 1998; Ennett & Bauman, 1996); adolescents maintain long-term friendships while also initiating and dissolving short-term friendships concurrently. Despite these changes, there is no evidence of a difference between long- and short-term friendships in terms of social influence. For instance, Urberg, Degirmencioglu, and Pilgrim (1997) found both types of friendships to be influential for adolescent substance use. Taken together, these findings indicate that friendships are an especially significant aspect of adolescent life. It follows that these relationships may also play a significant role in the development and maintenance of an adolescent's own academic attitudes, behaviors, and outcomes, which will be highlighted in the following section.

Impact of Friendships on School Outcomes

Friendships may be particularity impactful for an adolescent's academic trajectory as adolescents must make decisions regarding their effort and engagement in school and these decisions are made within their social context. The school environment is inherently interpersonal in nature, friendships are formed with peers at school, and the transition to middle school is often marked by changes in the academic environment. For instance, middle school is often characterized by an increased focus on student competition and comparisons of one's own ability to other students (Eccles & Midgley, 1990; Schunk & Pajares, 2002); therefore, friends are a salient reference for an adolescent when making decisions about his own academic performance or behavior. Consequently, the academic performance or school-related behaviors of one's friends many have a substantial impact on an adolescent's own school-related outcomes. In addition, friendships not only determine with whom adolescents spend time but also how adolescents spend their time (Larson and Verma, 1999); therefore, friendships could encourage or discourage school-related behaviors and attitudes. High achieving friend groups may elect to

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spend time in school-related activities, such as doing homework or studying and, as a result, high achievement is maintained by these friendships. Alternatively, low achieving students may choose to spend time together engaged in activities not concerning school (e.g., deviant behavior) and, as a result, underachievement may be maintained by these friendships.

Given the salience of friends, some prior work has begun to explore the impact of friendships on a student' own academic outcomes. Feelings of relatedness or connectedness to one's friends is positively associated with stronger bonding to school among 6th grade students (Furrer & Skinner, 2003), while friendship quality among middle school students is related to academic motivation (Nelson & DeBacker, 2008). Moreover, Ide, Parkerson, Haertel, and Walberg (1981) evaluated the results of ten studies and reported a moderate correlation between an adolescent's own educational outcomes (i.e., standardized achievement tests, grades, educational aspirations, and occupational aspirations) and the same outcomes of his friends. In more recent work, Crosnoe et al. (2003) reported that an adolescent's experiences at school were influenced by his friends; adolescents with friends who were strongly bonded to school had fewer academic problems (e.g., failing grades, suspensions) than those with friends who were less bonded to school. In addition, Kindermann (2007) found friendship group levels of school engagement among 6th grade students to predict changes in a student's own motivation over time. In sum, several researchers have demonstrated the significant impact of friendships on an adolescent's own academic trajectory; however, much of the earlier work examining this impact has suffered from methodological challenges and limitations which present difficulties when exploring the mechanisms behind this impact. I will now turn to these challenges in the next section.

Influence and Selection in Adolescent Friendships

Given the salience of friendships for adolescents, it comes as no surprise that friends are likely to be similar to one another. Initially referred to as the "homogeneity bias" (Fararo & Sunshine, 1964), this observed similarity is also referred to as "network autocorrelation", a term derived from spatial statistics, which refers to the observation of the increased frequency of social ties (i.e., friendships) between similar individuals. Similarity among friends on a number of behavioral and attitudinal dimensions is well documented in the literature (Kandel, 1978; McPherson, Smith-Lovin, & Cook, 2001). Specific to adolescents, evidence suggests network autocorrelation across a wide variety of demographic variables such as race (Hallinan & Williams, 1989; Mouw & Entwisle, 2006) and gender (Dijkstra, Lindenburg, & Veenstra, 2007) as well as attitudinal and behavioral variables such as aggression (Haselager, Hartup, van Lieshout, & Riksen-Walraver, 1998; Rose, Swenson, & Carlson, 2004) and physical activity levels (MacDonald-Wallis, Jago, & Sterne, 2012). Other work has also identified similarity among adolescent friends on risk behaviors such as smoking, substance use, and delinquency (Ennett & Bauman, 1994; Haynie, 2001; Urberg et al., 1997). In an educational context, adolescents are similar to their friends in terms of school bonding, academic performance, and higher education aspirations (Ide et al., 1981; Kindermann, 2007). Adolescents tend to be friends with other similar adolescents. In fact, adolescents often cite similarity when asked about the defining feature of a friendship (McDougall & Hymel, 2007).

Although ample research has documented network autocorrelation, the mechanisms behind this observed similarity are much debated and remain unclear. One commonly cited explanation is the homophily principle (Lazarsfeld & Merton, 1954; McPherson et al., 2001), which reflects the tendency of an individual to associate and form friendships with individuals

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similar to himself. In this sense, an adolescent could seek out others to befriend who are already similar to himself and network autocorrelation is observed over time (i.e., *selection processes*). An alternative explanation of the observed similarity among friends, the assimilation principle, maintains that friendships could socialize an adolescent; consequently, the adolescent may become more similar to his friends over time (i.e., *influence processes*). In either instance, network autocorrelation is the observed end result; however, the operating processes producing the similarity are quite distinct. Previously, it has been assumed that this similarity was the result of influence processes (e.g., socialization, peer pressure); however, selection processes may be operating as well. In her seminal piece, Kandel (1968) was one of the first to note that influence may not be the sole process accounting for similarity among friends; the selection of friends already similar to oneself may also be a robust contributor. Thus, further investigation is necessary to determine the operating processes behind network autocorrelation.

For instance, in an academic context, similarity among friends could occur with highly engaged students reporting friendships with other highly engaged students. A highly engaged student may have highly engaged friends because he modeled school behaviors from his highly engaged friends and thus, became highly engaged himself (i.e., influence processes). On the other hand, it could be the case that he was initially highly engaged and he was more likely to befriend other highly engaged students due to their similarity in engagement in the first place (i.e., selection processes). In both cases, network autocorrelation would be observed; however, differing mechanisms are operating to drive this similarity. Moreover, these two processes may not be mutually exclusive. Indeed, it is quite possible that influence and selection processes are dynamically related; an adolescent could choose to befriend similar adolescents who in turn influence him, which then guides future friendship selection. In fact, this dynamic relationship

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has been observed with alcohol use escalation among adolescents (Light, Greenan, Rusby, Nies, & Snijders, 2013; Osgood et al., 2013). Thus, an acknowledgement of both influence and selection processes is essential for a complete understanding of network autocorrelation among adolescents, which may prove critical for the development of prevention efforts targeting adolescent academic success.

Theoretical Perspectives on Network Autocorrelation

   Influence processes. There is strong support for both an influence and selection process in the social psychological literature**.** In the case of influence processes, friendships precede the adoption of friend's behavior. According to social learning theory (Bandura, 1986), the attitudes, beliefs, and behaviors of an individual's friends are potent influencers of one's own attitudes, beliefs and behaviors; individuals are motivated to assimilate to their friendship group. As a result, friends become increasingly similar over time due to influence processes. Similarly, social control theory (Hirschi, 1969) and primary socialization theory (Oetting & Donnermeyer, 1998) maintain that individuals learn social norms and expectations for behavior by interacting with primary socialization sources (i.e., family, school, and friends). When an adolescent is attached to a positive socialization source (e.g., friends with pro-school attitudes and behaviors), he is more likely to adopt the positive norms and expectations of the source. In this sense, friendships provide the setting to learn norms for behaviors. Thus, similarity among adolescent friends may reflect influence processes.

   From the criminology literature, differential association theorists (Sutherland, 1974) posit that deviance is learned through the interaction and communication with peers. Interactions with peers provide the context for learning values, attitudes, and behaviors of peers. In this sense, associations with friends with certain characteristics (e.g., pro-school attitudes) can result in the

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individual learning attitudes that serve to promote certain behaviors (e.g., pro-school behaviors).

As such, differential association theory argues for influence processes operating among adolescents as attitudes and behaviors are learned from friends.

Furthermore, social influence may occur through processes such as modeling and imitation. For example, an adolescent may observe a friend doing homework and then subsequently imitate this behavior. Adolescents are also more likely to imitate behaviors they have seen rewarded (Bandura, 1986). Pro-school behaviors such as doing homework or studying may be rewarded by praise or good grades in an academic context. An observing adolescent may then model this behavior in order to obtain similar rewards. Conversely, if an adolescent observes behavior such as delinquency rewarded in his friendship group (e.g., increased popularity, praise from friends), then this behavior may be modeled as well. In an examination of high school students, Frank et al. (2008) found that friendships influenced a student's own academic trajectory, specifically math course taking. Frank and colleagues argued that this influence resulted from both the creation of group norms for achievement motives and the sharing of resources (e.g., assistance with schoolwork).

In addition to learning new norms for behaviors, social influence processes may serve to reinforce existing attitudes and behaviors. Friends may provide subtle feedback and reinforcement of an adolescent's behavior through communication processes. Specific to delinquent behaviors, Dishion, McCord, and Poulin (1999) argued that antisocial or disruptive behavior can be reinforced by laughter or positive verbal feedback while prosocial behavior is not reinforced. Over time, this differential reinforcement has been shown to be related to an adolescent's delinquency and substance use (Dishion, Poulin, & Burraston, 2001; Poulin, Dishion, Burraston, 2001). Moreover, Dishion, Spracklen, Andrews, and Patterson, (1996)

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found increases in delinquent behavior over the course of two years when an adolescent's jokes about antisocial behavior were subsequently followed by laughter. On the other hand, there is evidence of positive reinforcement for pro-school behaviors among friends; highly motivated 5th grade students provided reinforcement such as praise, smiling, and laughter for the on–task classroom behavior of friends (Sage & Kindermanm, 1999). Thus, the friendship group can provide a context for the reinforcement of behavior and adolescents are then influenced by their friends.

Influence processes may also operate through the exchange of information. For example, adolescents may express attitudes towards school and also provide a rationale for these attitudes during conversations with friends. Earlier work has supported this information exchange process in terms of school-related outcomes. Berndt, Laychak, & Park, (1990) examined the influence of friends on a student's own achievement motivation. Berndt and colleagues found that when 8th grade students were instructed to discuss making school a priority with a close friend, these friendship pairs aligned their attitudes towards schoolwork more so than friends who were instructed to discuss non-school-related topics. In this case, information exchange among existing friends was posited to influence an adolescent to align with his friends. Moreover, Vygotsky (1978) argued that friends could influence each other as academically competent friends could teach specific learning strategies to less academically competent peers, which is a form of information exchange. In this regard, friends are directly influencing the academic performance of an individual student. In sum, numerous theoretical frameworks can be applied in the understanding of the impact of influence during adolescence.

Selection processes. Alternatively, similarity among adolescents may be the result of selection processes. Similarity may drive friendship choice and similarity would precede the

presence of a friendship. This preferential selection may be due to interpersonal attraction.

Bryne (1971) purported the similarity-attraction hypothesis in which individuals are more likely

to befriend similar others; similarity operates to increase attraction to the other person.

According to a reinforcement-affect explanation (Clore & Byrne, 1974), similarity to another

person may reinforce an individual's initial attitudes and behaviors, which then elicits a positive

affective response to the other person. This affective response would then increase attraction to

the similar person. Further, based on cognitive consistency models, we know that attitudinal

dissimilarity among individuals can foster avoidance, while similarity fosters attraction (Singh &

Ho, 2000). In a longitudinal examination, Selfhout et al. (2010) found similarity on personality

traits (i.e., extraversion, agreeableness, and openness) to predict friendship selection over time

among undergraduate college students. Thus, similarity preceded friendship development and

selection processes drove network autocorrelation.

Similarity among friends may also be understood from a social comparison perspective.

Festinger (1954) proposed that individuals are motivated to compare their attitudes and abilities

to those of other people, and individuals will seek this comparison with similar others in order to

gain an accurate self-evaluation as some domains do not have objective benchmarks by which to

evaluate oneself. Individuals then use other people as a comparison. Therefore, individuals are

motivated to affiliate with similar people and network autocorrelation may result from selection

processes. However, a social comparison perspective would also provide justification for

influence processes occurring among adolescents. When making a social comparison to one's

friends, individuals seek favorable appraisals of one's own identity. If an individual compares

himself to friends on some attribute (e.g., school achievement) and a positive evaluation of

oneself is achieved, the individual is motivated to continue behaviors that reinforce this attribute

(e.g., studying). On the other hand, if social comparison results in a negative appraisal of oneself, individuals may change their behavior (e.g., increase studying) or change self-evaluations (e.g., judge school success as less important for one's identity). In the case of behavior change, influence processes may account for observed network autocorrelation. However, if an individual chooses to change his self-evaluations rather than align his behaviors, then this individual would be motivated to seek out other individuals for comparison who are more similar to him (i.e., selection processes). Taken together, these perspectives suggest that it is both possible and likely that both influence and selection processes are operating to establish network autocorrelation in adolescent school-related outcomes; therefore, an examination of the relative effects of each is needed.

Assessing Influence and Selection

In order to adequately investigate influence and selection processes, a network approach is needed. According to social network theory (Wasserman & Faust, 1994), individuals in a social context interact with other individuals and this interaction can guide decision-making and subsequent behavior. This social context, the social network, is comprised of a set of "actors" (i.e., individuals) and their relationships, often referred to as "ties" (Wasserman & Faust, 1994). Social network analysis (SNA) can be used to study aspects of the network (e.g., whom is friends with whom) as well as the impact of these aspects on individual outcomes (Valente, 2010). According to Wellman and Berkowitz (1988), there are five fundamental principles justifying a network approach. Individual behavior is best predicted by their social network, relationships are best understood when they are the primary unit of analysis, the assumption of independence does not apply to network analysis, the entire network is influential on the individual, and individuals

can have a multitude of relationships. As such, influence and selection processes in adolescence are best understood from a network perspective.

Early work exploring similarity among friends on attributes and behaviors used cross-sectional and correlational methodology, rather than a network approach, and similarity among friends was often attributed to influence processes (e.g., Ide et al., 1981); however, peer selection processes may also be operating. Longitudinal research has found evidence for both influence and selection processes during adolescence, suggesting that the effect of influence may have been overestimated in past research (Steglich, Snijders, & Pearson, 2004; Urberg et al., 1997). Moreover, estimates of peer influence may be inflated if selection processes are ignored (Aral, Muchnik, & Sundararajan, 2009) resulting in erroneous inference about the substantial impact of influence for an adolescent's behavior. Thus, both the effects of influence and selection on network autocorrelation should be examined jointly.

As detailed by Steglich et al. (2010), prior work that has examined both influence and selection has suffered from limitations. First, previous research has used statistical methodology that assumes an independence of observations, which is violated in network data as individuals can report friendships with multiple other individuals. Next, previous examinations failed to account for confounding network effects (i.e., effects by which the network itself promotes certain friendships over other friendships). For example, a natural tendency exists for friendships to be created when individuals share a common friend (i.e., transitivity) which could drive network autocorrelation (Snijders et al., 2007). If these confounding network effects are ignored, estimates of influence and selection effects could be inflated. Lastly, earlier work failed to account for changes in a network or in behavior over time (see Berndt, 1992; Ryan, 2000;

Steglich et al., 2010). As network autocorrelation may be a consequence or an antecedent of a friendship, change over time should be captured and a longitudinal approach is needed.

In addition, previous research relied on adolescents' perceptions of friends' attitudes and behaviors; however, this may result in inflated estimates of similarity among friends due to the false consensus effect (Ross, 1977), which reflects a bias to overestimate the popularity of one's own attitudes, preferences, and beliefs. For instance, adolescents who smoke are more likely to report higher smoking prevalence among their friends than non-smoking adolescents, regardless of the actual prevalence of friend smoking behavior (Urberg, Shyu, & Laing, 1990). Berndt and Keefe (1995) also found that adolescents' reports on peers' classroom involvement and level of classroom disruption were inaccurate. Thus, examinations of influence and selection using networks in which information is gathered from each "actor" may overcome this limitation of past research.

To address these limitations of previous work, a new approach, stochastic actor-based modeling, has been developed to examine the simultaneous evolution of both a social network and individual behavior (this approach is detailed in the "Methods" section) (Snijders, 2001, 2005; Snijders et al., 2007; Steglich et al., 2010). Stochastic actor-based methods address the aforementioned limitations of earlier work and account for the interdependence of both network structure and actor attributes or behaviors. As a result, both selection and influence processes can be examined simultaneously in a longitudinal network framework allowing for the disentanglement of influence and selection processes.

Previous Examinations of Influence and Selection during Adolescence

Numerous lines of research have previously investigated the impact of influence and selection on adolescent network autocorrelation across a variety of outcomes. For instance,

smoking and substance use behaviors among friends have been identified as robust predictors of an adolescent's behavior (Ennett et al., 2008; Kobus, 2003; Urberg et al. 1997; Windle, 2000) and recent longitudinal SNA examinations have found evidence for both influence and selection processes (Cruz, Emery, & Turkheimer, 2012; Go, Tucker, Green, Pollard, & Kennedy, 2012; Hall & Valente, 2007). In fact, alcohol and marijuana use network autocorrelation has been found to be a product of both influence and selection among adolescents based on stochastic actor-based modeling (De la Haye, Green, Kennedy, Pollard, & Tucker, 2013; Knecht, Burk, Weesie, & Steglich, 2011; Mathys et al., 2013). Specific to smoking, Simons-Morton and Farhat (2010) contended in a review that both selection and influence processes operate in adolescent smoking network autocorrelation; however, the effect of selection is somewhat more robust than influence and recent stochastic actor-based examinations have confirmed this assertion (DeLay, Laursen, Kiuru, Nurmi, & Salmela-Aro, 2013; Mercken, Steglich, Sinclair, Holliday, & Moore, 2012; Mathys, Burk, Cillessen; 2013). Several other researchers have further supported the impact of selection processes. For instance, Lewis, Gonzalez, & Kaufman (2012) examined the coevolution of friendship networks on an online social networking website (i.e., Facebook) and taste preferences for music, movies, and books among college students using stochastic actor-based modeling with selection effects emerging as significant. Additionally, similarity among adolescents on weight (de la Haye, 2011) as well as disordered eating and level of body dissatisfaction (Rayner, Schniering, Rappe, Taylor, & Hutchinson, 2013) have been attributed to selection processes rather than influence.

Alternatively, other research suggests the importance of influence for observed network autocorrelations. Simpkins, Schaefer, Price, and Vest (2013) identified influence as primary for adolescent similarity on body mass index and physical activity. In addition, influence has

emerged as the prominent contributing factor for adolescent happiness (Workum, Scholte, Cillessen, Lodder & Giletta, 2013), adolescent delinquency (e.g., weapon-carrying, vandalizing property, theft) (Dijkstra et al., 2010; Weerman, 2011), and aggression among 4th grade students (Molano, Jones, Brown, & Aber, 2013). Moreover, Cheadle and Schwadel (2012) found both influence and selection processes to impact religiosity similarity with the impact of influence estimated to be stronger among adolescents. To summarize, evidence suggests that both selection and influence processes play an important role during adolescence to produce similarity among friends; however, the relative impact of either influence or selection appears to depend on the outcome examined.

Examinations of school outcomes. Many researchers have examined adolescent similarity on school outcomes; however, much of the work focuses on influence as the primary process of interest and neglects selection processes. Also, this prior work largely suffers from the limitations previously discussed and outlined by Steglich et al. (2010) and further work is needed to clarify the relative impact of influence and selection. For instance, Epstein (1983) examined only influence processes longitudinally on an adolescent's academic performance; she found that students with high-achieving friends experienced an increase in achievement over time after controlling for their initial achievement, while students with low-achieving friends experienced a decline in achievement. More recently, Ryan (2001) found friends to be influential for an adolescent's academic achievement and motivation for success among 7th grade students using multilevel modeling and controlling for initial similarity among friends; however, selection was not examined. Similarly, Altermatt and Pomerantz (2003) found evidence of friends' influence on an adolescent's grades over time among 5th and 6th grade students using hierarchical regression but selection processes were not examined. Additional evidence has been

found for influence processes as the academic performance of low-achieving students has been shown to increase after initiating and maintaining friendships with high-achieving friends (Altermatt & Pomerantz, 2005). In another investigation, Kindermann (2007) found levels of school bonding among friends to predict later changes in a student's own bonding to school across the 6th grade school year using structural equation modeling, suggesting influence processes. However, selection processes may have been operating as well. Friendship groups were initially similar in school bonding and compositional changes to these groups over time (i.e., friendship creation or dissolution) resulted in subsequent friendship groups with similar levels of school bonding.

Recently, researchers have begun to overcome methodological challenges and examine network autocorrelation in school outcomes using stochastic actor-based modeling. Lomi, Snijders, Steglich, and Torlo (2011) found that graduate school students both assimilated to the academic performance of friends over time (i.e., influence) and students similar on performance measures were more likely to befriend each other (i.e., selection) over time. Among high school students, Flashman (2012) employed stochastic actor-based modeling and found that similarity in students' level of academic achievement predicted changes in friendships after controlling for influence; high achieving students were more likely to extend ties to other high achieving students and the same held true for low achieving students. This finding lends support to selection processes among high school students. However, Flashman noted that the primary focus on this investigation was selection processes; therefore, common predictors of academic achievement (e.g., gender, race, age) were not included in the influence model and estimates for influence processes were not interpreted due to potential omitted variable bias.

Thus, further examination is needed to examine both selection and influence processes as well as the relative contribution of each process, controlling for the other, on adolescent network autocorrelation for school outcomes. Furthermore, there may be dimensions that moderate the impact of selection and influence processes on school outcomes. A consideration of one potential moderator, gender, is presented next.

Examinations of gender. Gender may also play a role in influence and selection processes on adolescent academic outcomes. Previous research has shown gender similarity in friendships networks among adolescent students (Goodreau et al., 2009; Snijders, van be Bunt, & Steglich, 2010) and older graduate-level students (Lomi et al., 2011); students tend to cluster together by gender. Furthermore, gender does appear to impact selection and influence processes differentially across a variety of adolescent outcomes. Influence processes were found to contribute to network autocorrelation in depressive symptoms only among female adolescents (Giletta et al., 2011) and no gender differences were found in selection processes. Additionally, Mercken (2010) found evidence of selection processes operating for smoking network autocorrelation in both adolescent males and females, but Merken only found evidence of influence processes operating in female networks. On the other hand, influence processes may be stronger in boys than girls for other behaviors. For instance, adolescent boys have been found to conform to their friends' attitudes towards bullying more so than girls over time, suggesting the differential impact of influence processes by gender (Pozzoli & Gini, 2012). Alternatively, Freeman, Hadwin, & Halligan (2011) did not observe gender differences in the impact of influence processes on hostile attributions and aggression among adolescents, suggesting no differential impact for this outcome. Likewise, gender was not found to significantly moderate the effect of influence on adolescent physical aggression (Rulison, Gest, & Loken, 2013).

Finally, Light et al. (2013) did not find gender to moderate selection or influence effects for adolescent alcohol use. Taken together, these findings suggest the impact of gender on influence and selection processes for adolescents; however, this impact appears to vary by the outcome studied. To date, no studies to the author's knowledge have examined the impact of gender on influence and selection processes for adolescent school performance. Among adults, Brashears (2008) found that individuals did indeed cluster together in friendship networks according to their level of education completed; however, Brashears did not examine selection or influence processes among this older sample. Considering the mixed evidence regarding the impact of gender on selection and influence processes on a variety of other behaviors, investigation into the gender differences regarding selection and influence during adolescence on school-related outcomes may prove fruitful.

Implications of the Present Study

As detailed previously, many researchers have theorized about the impact of influence and selection in friendships; however, much remains unknown regarding the relative impact of these processes on adolescent school outcomes. Some behaviors during adolescence appear to be more impacted by influence process (e.g., delinquency) while selection processes have emerged as more prominent for other behaviors (e.g., smoking). As these processes operate differentially across behaviors, an examination of specific school outcomes is critical considering the lasting and far-reaching implications of a student's engagement trajectory. In addition, earlier work investigating the impact of selection and influence suffers from many methodological limitations. Examinations of these processes are critically needed using a new approach, stochastic actor-based modeling, in order to adequately capture the relative impact of each process. Moreover, some work has begun to address network autocorrelation in school

performance among older students; however, an investigation among younger students is warranted given developmental differences between middle school students and older students. Middle school friendships and the impacts of these relationships may be qualitatively different than those later in life. Additionally, a potential exists to identify students who are showing early signs of disengagement and to intervene accordingly during middle school. In sum, further work such as this study is needed to address these gaps in our knowledge of influence and selection processes during adolescence.

Given the importance of social influences on adolescent development, this knowledge is critically important for the development of prevention initiatives to foster positive youth development. In fact, recent work has called for the adoption of a network perspective in prevention science to maximize initiative effectiveness (Gest et al., 2011; Moody, Feinberg, Osgood, & Gest, 2010; Valente et al., 2003). The disentanglement of selection and influence processes has the potential to inform efforts aimed at promoting positive school outcomes, and incorporating the social context could bolster program effectiveness. For instance, influence processes could be targeted if found to contribute to network autocorrelation in school outcomes. Targets of prevention initiatives could include strengthening norms for pro-school attitudes and behaviors in friendship groups, weakening norms for school misbehavior or poor school performance, and building refusal skills for school misbehavior. Gest et al. (2011) proposed utilizing influence processes in prevention program planning by grouping an at-risk student (e.g., low on school bonding, poor academic performer) with prosocial students in activities so the at-risk student may adopt the positive school attitudes and behaviors from these new social influences. Additionally, Valente et al. (2003) used a network informed approach to reduce intentions to smoke; adolescent opinion leaders were identified through peer nominations and

these leaders were used to group students for intervention activities. This "network" condition was associated with decreased intentions to smoke, while no such decrease was seen in groups led by teacher-chosen students or groups led by students chosen at random. In this intervention, network properties (i.e., who is an opinion leader in the classroom) were successfully used to identify who might influence other students and the power of social influence was harnessed to promote positive outcomes in youth. Alternatively, prevention efforts could target selection processes if found to be a dominant contributor to observed adolescent similarity on school outcomes. Programming could be implemented to highlight the importance of both friendship selection for one's own success and of choosing prosocial friends. Neglect of selection processes, provided they are found to be important for adolescent network autocorrelation, may reduce the effectiveness of such programming.

In sum, a more complete understanding of the impact of friendships on school outcomes is needed to inform efforts aimed at promoting positive school outcomes in adolescents and the present study will elucidate the impact of these relationships during adolescence. This study will advance our understanding by using new modeling strategies to examine both influence and selection processes simultaneously to disentangle influence and selection processes among adolescents. Knowledge gained from this study has the potential to inform prevention programing and ultimately help to foster positive adolescent development.

The Present Study

The present study explored both the effect of selection and influence processes on adolescent school outcomes and the effect of gender on these processes. The present study explored the following research questions and tested the following hypotheses:

Research Question 1. To what extent do adolescents *select* friendships based on similarity on school outcomes (i.e., school bonding, grades, value of education and achievement, attendance/truancy, test scores, and school misbehavior indices) over time?

> **Hypothesis 1 (H1):** Similarity on school outcomes at Time 1 will predict the presence of a friendship at Time 2.

Research Question 2. To what extent do adolescents *influence* other adolescents' school outcomes (i.e., school bonding, grades, value of education and achievement, attendance/truancy, test scores, and school misbehavior indices) over time?

> **Hypothesis 2 (H2):** The presence of a friendship at Time 1 will predict similarity on school outcomes at Time 2.

Research Question 3. Is the effect of peer influence or the effect of peer selection more robust on network autocorrelation for school outcomes?

Research Question 4. To what extent does gender moderate the effect of peer influence and selection on network autocorrelation?

CHAPTER II: METHODS

Participants

This study was part of a larger, ongoing study assessing the feasibility of an intervention for middle school students who showed early signs of school disengagement or were isolated from the social network. A control school from the intervention study was chosen for this study. Participants were 6th grade students who attended this middle school in a small town in the Western United States. The total number of students for this school was 360 and the student-teacher ratio was 16:1. The student body was comprised of the following: 52.5% female, 74.2% white, 21.1% Hispanic, 1% Asian American, 1% American Indian, and 2% of students report an "other" ethnicity. The percentage of student eligible for free-or-reduced-priced lunch was 40.3%. This middle school had three elementary "feeder" schools within the school district.

Materials

Social networks. Complete network data were collected at two points in time: Fall of 2012 when the students were in 6th grade and Fall of 2013 when the students were in 7th grade. Network data were collected via an online social network survey ("Network Genie") system during regular school hours. Participants (i.e., egos) were asked to select friends from a list of all potential students (i.e., alters) in the network. Participants were prompted with: "Select people you have talked with (more than saying hello) or done something with in the past 30 days". The network was defined as all students within a grade at the school, and participants could submit unlimited friendship nominations. Then, participants indicated how often they spent time with each student they selected. Participants were asked: "In the past 30 days, how much time have you spent with (name inserted from nominated student list)?" (1 = less than an hour to 5 = more

than 10 hours). The presence of a "friendship tie" was indicated if (1) the participant selected another student as someone they have talked with or spent time with in the past 30 days and (2) the participant indicated that they have spent at least five hours together in the past 30 days. Five hours was chosen as the criterion for friendship to capture the closest relationships. Prior research has shown adolescents to be able to reliably identify and report the members of their social network (Mitchell, 1997).

Value of education and achievement. Students completed a values and interests inventory, derived from earlier work by Rokeach (1973). The extent to which a student values education and achievement was measured with two items ($r = 0.51$, $p < 0.001$). Items included "How important is achievement to you (being all you can be; doing all you can do; accomplishing great things)?" and "How important is education to you (gaining great knowledge and understanding)?" (0 = not important to 3 = most important). Quartile scores were used to classify participants into four groups as the chosen analytic strategy required categorical data.

Bonding to school. Bonding to school was measured with a seven-item measure (α= .73) (Hawkins, Guo, Hill, Battin-Pearson, & Abbott, 2001). Items included: "I feel like I belong at this school", "I have no interest in school" (reverse coded), "The teachers at this school like me", "I wish I went to a different school" (reverse coded), "I like the teachers in the school", "I am often bored at school" (reverse coded), and "This school is a good school to go to" (0 = strongly agree to 10 = strongly disagree). Quartile scores were used to classify participants into four groups.

School records. School record data was collated by a school administrator. Second quarter grade point average (GPA) for each academic year was used as an indicator of grades and academic performance in general. Participants were classified into groups for analysis based on

GPA score (under 1.00, 1.00-1.49, 1.50-1.99, 2.00 – 2.49, 2.50-2.99, 3.00 – 3.49, 3.50 - 4.00). In

addition, attendance records (number of excused and unexcused absences) were collated for the

second quarter of each academic year; participants were classified into four groups based on the

number of unexcused absences across the first and second quarter of each academic year (none,

one, two, three or more). The number of school misbehavior incidents per student was also

collated.

Demographic information. Gender and ethnicity were collated by the school

administrator from official school records.

Procedure

All 6th grade students completed an online survey in late November/early December

2012 (Time 1) assessing friendships nominations, values and interests, and bonding to school as

part of the larger intervention feasibility study. Participants completed the survey again in

December 2013 (Time 2) as 7th grade students during normal school hours. Trained staff

members were responsible for supervising all survey administration and official school records

were collated by staff members. All procedures were approved by the Colorado State University

IRB.

Analytic Strategy

Overview. The present study used longitudinal social network analysis, known as

stochastic actor-based modeling, to examine selection and influence processes. This modeling

strategy incorporates information regarding the presence or absence of friendships among

individuals as well as information about the behaviors of these individuals. Over time, three

outcomes are possible: (1) an individual can make changes to his friendships, (2) change his own

behavior or (3) make no changes. These changes could "co-evolve" as the network can change in

response to prior individual behavior (i.e., student school outcomes drive changes to friendships—selection processes). At the same time, individual behavior can change in response to the prior network structure (i.e., presence or absence of a friendship drives changes to student school outcomes—influence processes). In this sense, there may be coevolution between the network and individual behavior; therefore, the probabilities of these outcomes are estimated simultaneously in stochastic actor-based modeling to avoid misattributing change to only selection or influence. Accordingly, change over time in the network (e.g., who is a friend with whom) and individual behavior (e.g., academic performance) are both treated as dependent variables. The effect of selection processes is controlled for when estimating influence processes while the effect of influence processes is controlled for when examining selection processes. Thus, influence and selection processes can be estimated appropriately and the impact of each process can be disentangled.

Model specification. The coevolution of friendships and school-related variables in a complete network was tested using stochastic actor-based modeling in RSiena, Version 4.0 (Ripley, Snijders, & Preciado, 2011) implemented in the R package, Version 1.1-232 (R Development Core Team, 2011). Using RSiena, a series of models were fit to the data using Snijders et al.'s (2010) recommendations. Parameter estimates were based on 3000 phase 3 iterations and all estimates reported are from models in which convergence was achieved (t-ratios for convergence less than 0.10 is recommended; Ripley, Snijders, Boda, Voros, & Preciado, 2014). Parameter estimates were obtained by Markov chain Monte Carlo methods in RSiena and significance testing was applied as detailed in Snijders et al. (2007). Actor covariates are automatically centered by RSiena and estimates are for centered covariates. Parameter estimates are unstandardized and estimates can be interpreted in terms of conditional

probabilities (similar to parameter interpretation in logistic regression); these will be presented in text as OR (odds ratio).

Separate models were estimated for each school variable of interest (i.e., school bonding, grades, value of education and achievement, attendance/truancy, and school misbehavior indices). Two sets of parameters were estimated for each school variable of interest (see Table 1): (1) "friendship" parameters estimating changes in friendship ties over time, which allows for the examination of selection processes and (2) "behavior" parameters estimating changes in actor behavior over time, which allows for the examination of influence processes. Following the recommendations of Snijders et al. (2010), baseline models for each school variable were specified first in which friendship change and behavior change were examined independent of one another (Model A). Next, co-evolution was considered in models specified in a step-wise forward selection fashion (Model B). As such, selection and influence processes were examined simultaneously. Finally, the potential moderation of gender was considered (Model C).

Hypothesis 1 (H1): Friendship evolution. Changes to friendships networks were examined to address H1. Well-known endogenous network effects are included in most RSiena models (Snijders et al., 2007) and were included in this study (see Table 2). These effects depend only on the network; the structure of the network itself promotes some friendships over others and these effects need to be controlled for in modeling so as not to bias the estimation of selection based on actor attributes. The following endogenous network effects were included by default: (1) *out-degree* (tendency to extend friendships nominations), (2) *reciprocity* (tendency for actors to reciprocate friendships nominations) and (3) *transitive triplets* (tendency for friends of friends to become friends). Demographic control variables were also included representing the effects of gender and ethnicity on friendship nominations extended (*gender ego, ethnicity ego*)

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and on nominations received (*gender alter, ethnicity alter*) as well as the effects of similarity in these variables on friendship nominations (*gender similarity, ethnicity similarity*). A decision was made a priori to retain demographic control parameters regardless of significance testing.

To explore the possibility that actor behavior influences friendships, three effects were included in the model: (1) the extent to which the value on a school variable influences the number of nominations extended (*school variable ego*), (2) the extent to which the value on a school variable influences the number of nominations received (*school variable alter*), and (3) the extent to which actors tend to befriend other actors who are similar on a school variable which addresses H1 (selection processes). Two possible operationalizations of selection processes (*school variable similarity* and *school variable ego * school variable alter*—the interaction of school variable ego and alter effect) were examined for goodness of fit using score-type tests as recommended by Snijders et al. (2010) and a selection effect was chosen for inclusion in each model based on these significance values.

Hypothesis 2 (H2): Behavior evolution. Changes to individual behaviors were examined to address H2. The effects of demographic control variables (*gender, ethnicity*) on behavior change were included. In addition, a *linear shape* and *quadratic shape* effect were included as recommended by Snijders et al. (2010) representing the average score on a school variable across individuals at Time 2 and any possible polarization on a school variable respectively. These shape effects control for the distributional shape of the school variables. The effects of the number of friendships nominations received (*indegree*) an extended (*outdegree*) on school bonding were also tested for inclusion in Model C with score-type tests as recommended by Snijders et al. (2010).

To explore influence processes, the effect of actor behavior change on friendships was examined with the inclusion of one of three possible operationalizations of influence processes (*school variable average similarity, school variable total similarity, school variable average alter),* which were examined for goodness of fit and chosen for inclusion using score-type tests.

Research question 3: Relative contribution. In order to examine whether influence or selection is more robust on network autocorrelation (Research Question 3), procedures suggested by Steglich et al. (2010) were used to quantify the relative contribution of influence and selection processes and comparisons of the strength of influence and selection was made. Using a joint metric for comparison (e.g., Morans I-coefficient, Geary's c-coefficient), network autocorrelation coefficients were calculated. Then, a comparison was made in the proportion of observed autocorrelation accounted for by influence processes, selection processes, control processes (e.g., endogenous network effects such as transitivity) and trend processes. The latter represents alternative processes not examined in the present study but that may have contributed to the evolution of friendships and school variables, which are independent of influence, selection and control processes.

Research question 4: Gender differences. Following the recommendations of Steglich et al. (2010), the effect of gender on friendships and behavior was estimated. First, any segregation in friendships due to gender was examined with the *gender similarity* effect. The moderation of gender on the s*chool variable selection* effect was examined to test whether the effect of school variable similarity on friendship selection differed for males and females. This was represented as the interaction of *gender ego*school variable selection*. In addition, the main effect of gender on school variables was included as the *gender* effect. Gender may also

moderate the s*chool-variable influence* effect and an interaction term *gender*school variable influence* was included to test whether the influence effect differs among males and females.

   Additional model specification. A rate function for both the friendship and the behavior part of the model was estimated. These rate functions represent change in friendships and school variables between Time 1 and Time 2. These rate functions are used for estimation purposes and thus, do not represent the number of observed changes in the network. It is meaningless to test the significance of these parameters as the null hypothesis (i.e., parameter equal to zero) would mean that there is no change at all. Since there are differences between the observed network and individual behavior at Time 1 and Time 2, these rate parameters must be positive and larger than zero.

Missing Data Handling

   In prior examinations of RSiena models, Huisman and Steglich (2008) have estimated that up to 20% missing data will not result in problematic or biased modeling. However, all missing data was handled according to procedures outlined in Huisman and Snijders (2003). Stochastic actor-based modeling can account for "joiners" and "leavers" to the network (e.g., a student starts at the school after time 1 measurement has already occurred, a student leaves the school due to a family move before time 2 measurement). To account for this compositional change to the network, missing time points for an actor were coded using a missing value code. Missing values were then imputed to allow for simulations across all variables; however, these values were not used in the calculations of final parameter estimates. Students leaving or joining the network were then modeled as exogenous events; neither the change to the network nor the timing of these changes are estimated by the model. In this way, the impact of missing data on parameter estimates was minimized. Considering all students who were part of the network at

either time point, 12% of these students were missing at Time 1 (i.e., joiners to the network) and

14% of students were missing at Time 2 (i.e., leavers from the network).

Descriptive Statistics

A summary of network and adolescent characteristics at Time 1 and Time 2 are presented in Table 2. Between Time 1 and Time 2, more friendships ties were created than dissolved and the *average degree* (number of nominations extended) increased. Network *density* (proportion of reported nominations relative to the total number of all possible friendships) also increased over time indicating that the network was in a period of growth. As a measure of network stability, the calculated Jaccard index indicates that the network was sufficiently stable for RSiena modeling (calculated as the proportion of stable friendships to the number of stable and dissolved friendships considering the growth of the network; Snijders et al., 2010).

Average levels of GPA, school bonding, and values of education and achievement were all stable from Time 1 to Time 2 while the average number of absences decreased from Time 1 to Time 2 across students. Considering GPA, 12.34% of students increased by one standard deviation while 22.08% students decreased by one standard deviation. For school bonding, 8.44% of students increased and 8.44% students decreased by one standard deviation. In terms of values of education and achievement, 5.84% of students increased and 7.79% students decreased by one standard deviation. For number of unexcused absences, 9.01% of students increased while 21.43% decreased by one standard deviation. Additionally, table 2 presents the observed network autocorrelation coefficient (Moran's I) for each dependent "behavior" variable, which reflects observed similarity among friends on these variables. Moderate levels of network autocorrelation were observed for GPA at both Time 1 and Time 2, while relatively low levels were observed for the remaining variables. Correlations between dependent "behavior"

variables are presented in Table 3; a significant correlation was observed between school

bonding and values of education and achievement at both Time 1 and Time 2.

RSiena Analysis

      Friendships. A number of parameters concerning friendship dynamics showed

consistent patterns across the school variable models; therefore, they are interpreted once here

for all school variables. Further, the most comprehensive model (Model C) is interpreted. As

expected, *density* was significantly negative indicating that adolescents tended to not nominate

all other students as friends. In other words, networks were sparse and the number of friendship

nominations was low, which is common in friendships networks. Additionally, friendships

tended to be reciprocal (*reciprocity*) and friends tended to be friends with their friends' friends

(*transitive triplets*). Girls tended to receive more nominations than boys (*gender alter*) while

girls and boys extended nominations at an equal rate (*gender ego*). Additionally, adolescents

tended to select friends of the same gender (*gender similarity*). Ethnicity also impacted

friendships as minority adolescents tended to extend more friendship nominations than non-

minority adolescents (*ethnicity ego*); however, minority adolescents were not more likely to

receive nominations (*ethnicity alter*). Similarity on ethnicity did not significantly affect

friendships (*ethnicity similarity*). Adolescents were equally likely to be friends with other

adolescents of their same ethnicity and friends with other adolescents of a different ethnicity than

themselves. Finally, the effects of the number of friendships nominations received (*indegree*) an

extended (*outdegree*) on any of the school variables were not significant, and were not included

in any Model C.

Behavior variables.

School bonding. Adolescents with higher school bonding tended to extend more nominations (*bonding ego*) (OR = 1.34) while school bonding values did not significantly affect the number of nominations received (*bonding alter*) (see Table 4). Also, the main effects of *gender* and *ethnicity* were not significant on school bonding values. To examine selection and influence processes, *bonding similarity* and *total similarity* were chosen for inclusion in Model C as they fit the data best (see Table 8). The parameter representing the selection process (*bonding similarity*) was not significant; similarity on school bonding at Time 1 did not predict the presence of a friendship at Time 2. Thus, H1 was not supported for school bonding. Furthermore, the parameter representing the influence process (*total similarity*) was also not significant; H2 was not supported as the presence of a friendship at Time 1 did not predict similarity on school bonding at Time 2.

GPA. Adolescents' GPA did not significantly affect the tendency to extend or receive friendship nominations (*GPA ego, GPA alter)* (see Table 5)*. The main effect *gender* was also not significant on GPA; however, *ethnicity* was significant indicating that majority adolescents tended to have higher GPA than minority students (OR = 1.58). Further, a significant selection effect was observed for GPA network autocorrelation (*GPA similarity*) (OR = 4.90); similarity on GPA at Time 1 did predict the presence of a friendship at Time 2, which supports H1. On the other hand, the parameter representing influence, *total similarity*, was not significant indicating that a friendship at Time 1 was not predictive of similarity in terms of GPA at Time 2. Thus, H2 was not supported.

Values of education and achievement. Adolescents' reported values of education and achievement did not significantly affect the number of friendship nominations extended or

received (*values ego, values alter*) (see Table 6). Values of education and achievement also did not significantly differ by *gender* or *ethnicity*. Senders of friendship nominations did tend to select other adolescents with higher value of education and achievement scores than themselves (*linear shape*) (OR = 0.80); adolescents nominated up. Considering selection (*values similarity)* and influence (*total similarity)* parameters examining H1 and H2, neither hypothesis was supported for values of education and achievement. Similarity on values at Time 1 did not predict a friendship at Time 2 while a friendship at Time 1 did not predict similarity at Time 2.

    Attendance. The number of unexcused absences did not significantly affect adolescents' tendency to extend or receive friendship nominations (*attendance ego, attendance alter*) (see Table 7)*.* Considering the shape parameters, senders of friendship nominations did tend to select other adolescents with more unexcused absences than themselves (*linear shape*) (OR = 0.06) while there was also a tendency for polarization on the unexcused absence variable (*quadratic shape*) (OR = 6.42) as responses tended to be on the extreme ends of the scale of unexcused absences (either none or three or more). To examine the impact of selection and influence on attendance network autocorrelation, *attendance similarity* (selection) and *total similarity* (influence) were included in Model C; however, neither effect was significant. H1 and H2 were not supported for attendance as similarity at Time 1 did not predict a friendship at Time 2 nor did a friendship at Time 1 predict similarity at Time 1.

    Misbehavior. Preliminary analysis revealed low variation in this dependent variable at both Time 1 (8 misbehavior incidents per 154 students) and Time 2 (3 misbehavior incidents per 154 students); therefore, appropriate modeling could not be conducted considering the low variation and this school variable was not considered in the present analyses.

Research question 3. An examination of whether influence or selection processes were more robust on network autocorrelation was initially proposed; however, only significant selection processes were observed for GPA while evidence for influence was not observed. Thus, the relative contribution of influence could not be compared to the contribution of selection and this research question was not considered in the present analyses.

Research question 4. The impact of gender on selection and influence processes was examined in each school variable Model C to address research question 4. Across all the school variables, gender was not found to be a significant moderator of either selection or influence parameters. The impact of these processes did not differ across male and female adolescents.

CHAPTER IV: DISCUSSION

Considering that 25% of U.S. student do not graduate from high school high and the far-reaching consequences of adolescent underachievement such as lower earning potential, more unemployment, and more criminality across the life span (Alliance for Excellent Education, 2009; Education Week, 2013), investigation into the contributing factors is critically needed to inform the development of prevention and intervention efforts. While it is widely accepted that friendships during adolescence are influential for development (Berndt, 1992, 1999; Bronfenbrenner & Morris, 1998), a gap remains concerning our understanding of the relationship between friendships and adolescent school engagement. Prior work has identified that adolescents cluster together in friendships by school outcomes such as school bonding, academic performance, and higher education aspirations (Ide et al., 1981; Kindermann, 2007); adolescents are similar to their friends on these outcomes. However, the impact of selection and influence processes on this observed similarity among adolescent friends is not fully understood. While these processes have been found to impact school outcomes among older students in high school and graduate school (Flashman, 2012; Lomi et al., 2011), prior work exploring these processes among adolescents has suffered from methodological limitations such as violating the assumption of independence of observations and neglecting confounding network effect. Thus, the present study sought to explore the impact of selection and influence processes on school outcomes among adolescent students as well as the effect of gender on these processes. This exploration was conducted using a new modeling strategy, stochastic actor-based modeling, which allows for the impact of selection and influence to be considered simultaneously, allowing for these processes to be disentangled.

Consistent with previous research (Flashman, 2012; Lomi et al., 2011) and as predicted by the present study's hypotheses, similarity on GPA at Time 1 did significantly predict the presence of a friendship at Time 2. Adolescents tended to befriend other adolescents who were already similar to themselves on GPA. Thus, selection processes were observed to contribute to clustering on GPA; however, significant influence processes were not observed for this school outcome. Adolescents did not become more similar on school outcomes to friends over time. Furthermore, neither selection nor influence processes were observed for the remaining school outcomes of the present study (school bonding, values of education and achievement, and attendance). Potential explanations of these results are discussed in detail below.

Consistent with prior examinations (Dijkstra, Lindenburg, & Veenstra, 2007; Goodreau et al., 2009), adolescents did cluster together in friendships by gender. Girls tended to have friendships with other girls and boys tended to have friendships with other boys. Gender also impacted the tendency to *receive* friendship nominations; girls were identified more often as a friend by other adolescents. On the other hand, results indicate that gender did not moderate the impact of selection or influence processes for the school outcomes explored in the present study. These processes, if present, operated similarly among girls and boys. Other work has found gender to moderate selection and influence processes among adolescents but only for certain outcomes such as smoking and depressive symptoms (Giletta et al., 2011; Mercken, 2010). The contributing processes for school outcomes may be fundamentally different than substance use behaviors or mental health; therefore, gender may not play a contributing role for selection and influence as it does for other dimensions.

Finally and consistent with previous work (Snijders et al., 2007), significant endogenous structural network effects were found in the present study; the structure of the network itself

promoted the presence of some friendships over others regardless of school outcomes. For instance, significant reciprocity and transitivity was observed; adolescents tended to reciprocate friendships as well as become friends with their friends' friends. As such, the structure of the network contributed to friendship formation and maintenance.

Given these results, there are a few potential explanations. While other work has found adolescents to cluster together in friendships by levels of school engagement (Ide et al., 1981; Kindermann, 2007), relatively low network autocorrelation was observed in the present study for the outcomes of school bonding, values of education and achievement, and attendance. Adolescents were not very similar to their friends on these dimensions. As such, this low amount of clustering observed in the present study would make it difficult to detect selection and influence processes if these do indeed operate for these outcomes. Adolescents were only observed to cluster together in friendships by GPA, which is also the only school outcome for which significant selection process were found. Future research is needed to further assess if clustering does indeed exist for subsequent cohorts of students or if the lack of clustering in the current sample represents a shift in adolescent preferences.

Selection processes were found to operate for GPA; however, evidence of influence processes were not found. First, it may be the case that selection operates for GPA as adolescents might be motivated to befriend other adolescents with a strong academic performance in order to benefit from these friendships (e.g., help studying). It then follows that selection was not observed for the other outcomes as these dimensions (school bonding, values, and attendance) would not provide the benefits that another adolescent's academic ability may provide. In addition, the transition to middle school is marked by increased comparisons of one's own academic ability to the ability of others (Eccles & Midgley, 1990; Schunk & Pajares,

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2002) and these comparisons may have implications for adolescent friendships and outcomes. As such, GPA selection could be understood from a social comparison theory perspective (Festinger, 1954). Individuals seek out similar others for comparison when they wish to gain an accurate self-evaluation (Festinger, 1954); therefore, adolescents may be motivated to befriend others who are already similar on GPA in order to accurately assess their own performance through social comparisons with these friends. Furthermore, the significant GPA selection effect may be the result of teacher behavior in the classroom. Adolescents may be seated next to and grouped together for class work based on academic ability and teacher grouping strategies are associated with social network development (Farmer, Lines, & Hamm, 2011; Gest & Rodkin, 2011). Consequently, similar performing adolescents are preferentially grouped together. These adolescents then have more exposure and subsequent opportunity to befriend other adolescents with similar GPA and selection processes may be a product of this grouping.

Next, significant influence was not observed for any of the school outcomes. Previous work has found evidence of influence operating for adolescent school engagement (Altermatt & Pomerantzm 2003; Kindermann, 2007; Ryan, 2001); however, this work suffered from methodological limitations outlined earlier that may have led to the overestimation of influence effects while neglecting selection effects (Aral, Muchnik, & Sundararajan, 2009; Steglich et al., 2010). On the other hand, more recent work using appropriate modeling strategies has identified significant influence processes for outcomes such as adolescent substance use, smoking, aggression, and delinquency (De la Haye et al., 2013; Dijkstra et al., 2010; Knecht, Burk, Weesie, & Steglich, 2011; Mercken et al., 2012; Molano et al., 2013). While school engagement has been purported to be malleable (Fredricks et al., 2004), the results of the present study suggest that influence processes may not be a promising avenue to increase adolescent

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school engagement. Considering GPA specifically, an adolescent's academic performance may be the product of not only motivation but also intrinsic ability; therefore, it may be especially difficult to adjust one's own GPA to match that of his friends and influence processes would not be observed for this outcome. Alternatively, these processes may need more time to unfold. The present study spanned one academic year; however, change to one's own academic performance as a result of influence from friends may take longer than that time frame. For instance, the impact of friend influence may operate through social processes such as modeling or imitation (Bandura, 1986). An adolescent may model the pro-school behavior of friends (e.g., studying); however, this new behavior may not immediately affect GPA as the adolescent works to refine this behavior. A change to one's GPA would reflect consistent improvement to course grades over many semesters. Thus, friends may still influence one another's GPA but it may take time.

Implications

As students who show early signs of disengagement can be identified during middle school, it follows that early intervention is also possible for these students to prevent later school dropout. One avenue involves incorporating the social context, specifically friendship networks, to promote school engagement and positive outcomes for adolescents (Gest et al., 2011; Valente, 2012). The results of the present study highlight the importance of selection processes for adolescents' GPA. As discussed earlier, prevention initiatives could focus on educating adolescents on the importance of choosing high achieving friends for one's own performance. This could involve prevention programming focused on informing adolescents on the consequences of selecting low achieving friends. Poor performing adolescents would be then motivated to seek out friendships with higher performing adolescents. As disengaged adolescents are not being sought out as much as friends, disengagement may be seen as less

desirable, social norms develop that favor engagement, and the base rate of disengagement may decrease across students. For example, All Stars (Hansen & Dusenbury, 2004) is an effective school-based drug abuse prevention program that focuses on establishing norms that support positive behaviors (e.g., non-use of substances, cooperation) so that these behaviors are increased while problem behaviors are decreased. If targeting selection processes results in a shift of norms so that school engagement is favored, this targeting may prove to maximize initiative effectiveness and promote school engagement across students.

Other researchers have focused on targeting influence processes from a network perspective. For instance, Gest and colleagues (2011) encouraged the practice of grouping at-risk adolescents with prosocial adolescents so that at-risk adolescents could be socialized and influenced by the prosocial adolescents to adopt more prosocial behaviors. This strategy aims to accelerate the diffusion of prosocial behaviors by providing opportunities for influence dynamics to unfold. In light of the present study's findings, this approach may not be maximally effective as influence was not observed to play a significant role in school engagement outcomes studied. On the other hand, the power of social influence could be harnessed by leveraging selection processes in the prevention approach. A social network-based intervention, PROSPER, has been successful in reducing problem behaviors among adolescents (e.g., substance use; Osgood et al., 2013) by targeting network structure and subsequently changing influence dynamics. PROSPER focuses on a variety of dimensions including goal setting, peer affiliation, decision-making skills, and social norms for behavior. Osgood and colleagues found that friendship networks changed over time so that prosocial adolescents became more central (i.e., not in the periphery) to the network than antisocial adolescents, which suggests that PROSPER shifted network structure so that prosocial adolescents had more influence potential. Considering school engagement

initiatives, programs could adopt this strategy so that engaged adolescents become more central in the network, their influence potential is increased, and school engagement is diffused. Specific to GPA, programming could aim to strengthen positive perceptions and norms surrounding academic performance, which may result in high achieving adolescents becoming more central in the network. In sum, selection was observed to be impactful for adolescent GPA and prevention initiatives could capitalize on this finding to bolster effectiveness and promote school engagement.

Limitations

First, this present study was conducted with two observation points separated by approximately one year. It is possible that selection and influence processes had a more proximal impact to the transition to middle school; however, any potential impact was not measured until nearly a year later. Other research has found that school engagement declines over adolescence, particularly around school transitions such as the shift from elementary to middle school (Oelsner, Lippold, & Greenberg, 2011; Simons-Morton, Crum, Haynie, & Saylor, 1999), suggesting that the most change to school engagement would occur close to transitions. Perhaps selection and influence processes did operate for the school engagement outcomes closer to the school transition; however, Time 2 was too far removed from this impact. If this is the case, then the impact selection and influence processes on school engagement would have been transient and would not contribute to long-term change to school engagement. It could also be the case that changes to friendships and school engagement outcomes observed at Time 2 were a product of mechanisms not examined in the present study and outside of school outcome selection and influence. Since research into this area is sparse, the ideal time between

observations is not known; however, future research could explore selection and influence processes with multiple assessments closer in time such as once a month assessments.

Another limitation of the present study concerns the assessment of friendships. Friendships were indicated if an adolescent reported that he talked or did something with another adolescent within the last month for more than five hours. However, this conceptualization of a friendship did not account for duration or quality of the relationship. Selection and influence processes may operate differentially across short term and long term friendships as well as low intimacy and high intimacy friendships. Considering adolescent substance use, previous research has shown no difference between long- and short-term friendships in terms of social influence (Urberg et al., 1997); however, this work did not examine selection processes. While duration may not impact influence for substance use, it may be the case that duration and quality of friendships do matter for school engagement outcomes. Substance use can be an easily observable behavior which may allow influence processes to operate in less-intimate relationships. On the other hand, school outcomes such as school bonding and personal values are not readily observed; therefore, high intimacy and long-term relationships may be necessary for friendships to be influential for school outcomes. Furthermore, it may also be difficult for adolescents to use these dimensions when deciding whom to befriend as these outcomes are not easily observable. Thus, future research could explore alternative conceptualizations of friendships. Since the present study did not differentiate between types of friendships, it is impossible to know how these processes may operate considering only long-term, intimate friendships.

Also, friendship networks were bounded by the school; adolescents could only nominate other students currently enrolled in their school. It may be that adolescents' social networks are

much broader and adolescents may both select and be influenced by others who attend other schools. Without capturing these friendships as well, the present examination may have overlooked important friendship and behavioral dynamics. Future research could explore the impact of friendships outside of school. Additionally, online friendships may be particularly important for adolescents considering the current popularity of online social networking sites. High accessibility to social networking websites may allow adolescents to befriend others whom they would not normally interact with in everyday life. On the other hand, recent work has found that adolescents use social networking websites primarily to reinforce existing relationships rather than create new relationships (Subrahmanyam & Greenfield, 2008; Valkenburg & Peter, 2011); adolescents are interacting with existing friends more so than initiating new friendships. Consequently, examinations including online friendships may also not find evidence of selection processes operating for school outcomes. Alternatively, interacting online with existing friends may serve to increase the impact of one's fiends and foster the process of influence. An acquaintance has the potential to become a considerably influential friend if a great deal of time is spent interacting online together and developing the relationship. As online friendships were not considered in the present study, it is impossible to know the extent to which selection and influence processes operate in the context of these relationships. More work is needed to investigate a broader conceptualization of adolescents' total friendship network.

The tendency to cluster together in friendships may also be driven by other structures such as clubs, athletic teams, and honor's classes. For example, it may be the case that adolescents who participate in the same club at school would have more opportunities to both create friendships with other similar adolescents and influence each other, which may produce

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similarity. Thus, future work should control for this potential pre-existing grouping. In addition, adolescents were seen to befriend other adolescents who had similar GPA; however, it is possible that students selected friends based on some other variable which was correlated with GPA but unmeasured in the present study. For example, perhaps students were selecting friends based on similarity on socioeconomic status (SES) and this variable may be correlated with GPA in the current sample. As SES data was not collected, it is unknown if this variable impacted friendships selection. Further investigation is needed to explore this possibility. Moreover, an adolescent's centrality (i.e., level of connectedness) may also have impacted selection and influence processes. For instance, an adolescent with low centrality (i.e., not connected to many other adolescents) may be more influenced by a friend than an adolescent with high centrality (i.e., connected to many others). Thus, differential effects of selection and influence by centrality should be accounted for in future work.

Next, sampled adolescents were predominately Caucasian and attending a middle school in a small town in the Western United States. Selection and influences processes may operate differentially across school contexts, ethnicities, or ages. For example, previous work has identified a higher dropout rate among students attending large urban schools as compared to those attending smaller schools (Rumberger & Thomas, 2000), which suggests the impact of the context on an adolescent's school engagement. Perhaps selection and influences may operate for school engagement in larger, more urban contexts. Similarly, it may be the case that selection and influence processes do operate for minority adolescents and younger students. Additional work is needed to explore the role that ethnicity, age and school context play in these processes with more adolescents across more schools.

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Finally, stochastic actor-based modeling has advantages for examining the coevolution of friendships and behavior, but this modeling strategy is not without limitations. At this time, RSiena modeling requires categorical dependent variables with a limited range (less than ten is ideal). As such, small changes in school outcomes may not have been detected as these variables had to be coded into rather large categories. It is possible that small changes in school engagement outcomes may represent meaningful change in a social context; however, the current modeling strategy cannot detect these small changes.

Future Directions

Considering these limitations as well as the mixed support for the hypotheses of this study, there is a need for further investigation into the contributing processes in school engagement. Frist, the focus in the present study was on selection and influence processes for school engagement among adolescents; however, these processes do not operate in a vacuum of other social dynamics that may impact school engagement as well as friendships. For instance, adolescents may be influenced by peers, rather than just friends. As academic competition increases around the transition to middle school (Eccles & Midgley; Schunk & Pajares, 2002), it follows that an adolescent might be motivated to compete or compare his own performance to peers in the classroom even if they are not friends. An adolescent may also compete or compare himself to popular adolescents in the classroom that also may not be personal friends (Wood, 1989). Thus, peers may exert an influence and contribute to an adolescent's own school engagement. Teachers are also impactful for school engagement. Not only can teachers play a role in the formation of the social network by placing students in groups for classroom work (Farmer et al., 2011; Gest & Rodkin, 2011), teachers can also manage friendship dynamics within the classroom, which can have an impact on subsequent school outcomes. Elementary

school teachers who report being tuned into social dynamics in their classrooms had students with higher levels of school bonding (Gest, Madill, Zadzora, Miller, & Rodkin, 2014). Perceptions that teachers are encouraging of both interpersonal interaction and mutual support are related to increases in motivation and school engagement among adolescents (Ryan & Patrick, 2001). In sum, friendship dynamics unfold amidst other social dynamics; therefore, future work that incorporates this broader perspective would advance our understanding of the specific role of friendships for adolescent school engagement.

Additionally, the current study highlights the role of selection that contributes to similarity among friends in terms of GPA but the question remains –why are adolescents using this dimension rather than other school engagement dimensions in their friendship choices? Is it easier to assess another's academic performance among other adolescents as compared to school bonding, values, or attendance? Is this school engagement dimension perceived as more important than the other dimensions studied in this investigation? As discussed earlier, perhaps GPA is correlated with another dimension (e.g., SES) that went unmeasured in the present study, and selection is really occurring based on this unmeasured dimension rather than GPA. These remaining questions demonstrate a need for future investigation into the motivations behind friendships choices.

Finally, another avenue for future research concerns the possibility for asymmetric influence. For instance, influence from friends who are not engaged in school could be stronger than the influence from engaged friends. As such, differential effects would be observed. The present study operated on the assumption that influence is symmetrical; both high and low performing adolescents could exert influence potential and this assumption should be tested.

Conclusions

      The purpose of this study was to examine the extent to which selection and influence processes operate among adolescents for school engagement outcomes. Contrary to expectations, only selection processes for GPA were observed. While this study is not without its limitations, it is one of the first to use stochastic actor-based modeling to adequately explore the role of selection and influence for adolescent school engagement. Moreover, there are many promising avenues for future research which have the potential to further the current state of the literature on the promotion of adolescent school engagement.
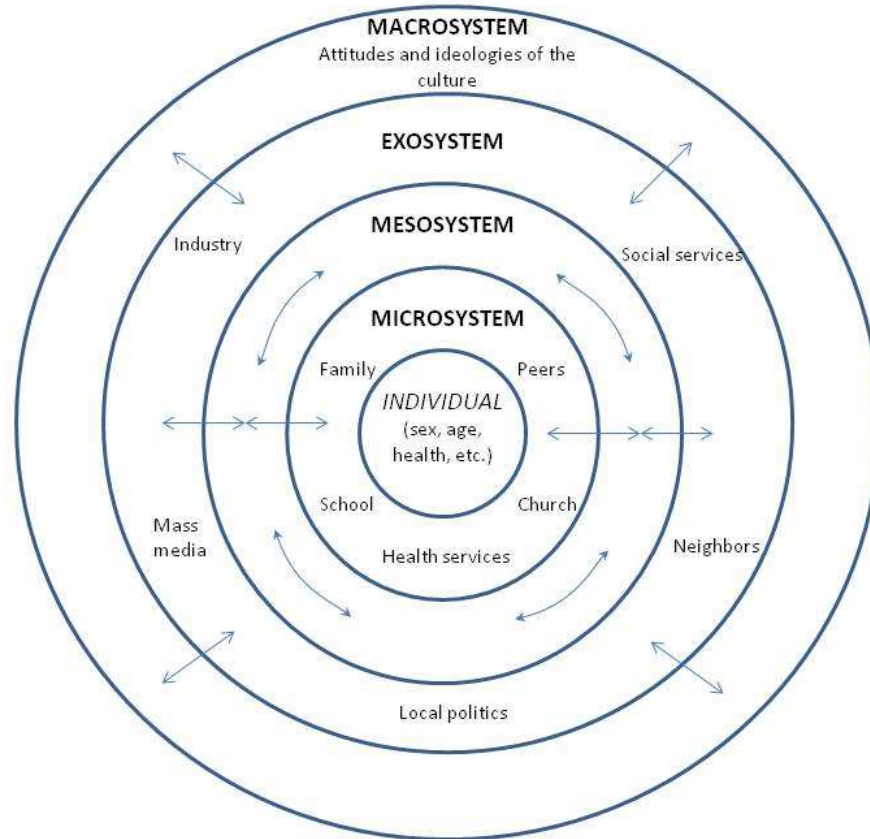
Figure 1. Brofenbrenner's Ecological Systems Model

Table 1

Description of Effects for Modeling the Coevolution of Friendships and School Variables

Effect	Description
Friendship Model	
Rate Function	Frequency of friendship change between Time 1 and Time 2
Structural Network Effects	
Outdegree	Tendency to extend friendships nominations
Reciprocity	Tendency to reciprocate friendships nominations
Transitive Triplets	Tendency for friends of friends to become friends
Gender Effects	
Gender Ego	Tendency for females to select more friends compared to male
Gender Alter	Tendency for females to be selected as friends more often compared to male
Gender Similarity	Tendency to select a friend of the same gender
Ethnicity Effects	
Ethnicity Ego	Tendency for actors in minority group to select more friends compared to actors in majority youth
Ethnicity Alter	Tendency for adolescents in minority group to be selected as friends compared to actors in majority group
Ethnicity Similarity	Tendency to select a friend of the same ethnicity
School Variable Effects	
School Variable Ego	Association between school variables and the number of nominations extended
School Variable Alter	Association between school variables and the number of nominations received
Behavior Model	
Rate Function	Frequency of school variable change between Time 1 and Time 2
Linear Shape	Average score, across actors, on school variables at Time 2
Quadratic Shape	Polarization on school variables
Gender	Effect of actor's gender on actor's own school variables
Ethnicity	Effect of actor's ethnicity on actor's own school variables
Hypotheses	
School Variable Selection (H1)	Tendency to befriend other actors based on similar school variables
School Variable Influence (H2)	Change on school variables to become more similar to friends
Selection X Gender	Interaction of ego gender and school-variable selection effect
Influence X Gender	Interaction of ego gender and school variable influence effect

Note. Candidate operationalizations of school variable influence include: average similarity (effect of average similarity to friends), total similarity (effect of summed similarity to friends), and average alter (effect of friends' average school variable values).

Table 2

Descriptive Statistics for Friendship Networks & Adolescent Characteristics

	T1 (n=136)	T2 (n= 133)
Network Characteristics		
Density	0.03	0.05
Average degree	3.90	6.86
Mutual dyads	160	246
Asymmetric dyads	882	1620
Tie changes		
Absence of tie	---	22,057
Tie creation	---	904
Tie dissolution	---	449
Stable tie	---	152
Jaccard index	---	0.25
Adolescent Characteristics		
School Bonding (range 1-4)		
Mean (SD)	2.27 (1.02)	2.32 (1.13)
Moran's I	0.05	-0.01
GPA (range 1-7)		
Mean (SD)	5.56 (0.95)	5.41 (1.08)
Moran's I	0.22	0.27
Values (range 1-4)		
Mean (SD)	2.30(1.10)	2.30 (1.12)
Moran's I	0.05	0.01
Attendance (range 0-4)		
Mean (SD)	0.53 (0.73)	0.27 (0.63)
Moran's I	0.03	-0.04

Table 3

Correlations among School Variables

Variable	1	2	3	4
1. School Bonding	---	0.10	**0.29**	-0.12
2. GPA	0.01	---	0.07	-0.01
3. Value of Education	**0.31**	0.15	---	0.12
4. Attendance	0.03	-0.06	0.14	---

Note. Correlations at Time 1 are above the diagonal and correlations at Time 2 are below the diagonal). Bolded coefficients indicate significance at the 0.01 level.

Table 4

RSiena Parameter Estimates of Independent Network and Behavior Evolution—School Bonding

	Model A			Model B			Model C		
	Estimate	S.E.	*p*	Estimate	S.E	*p*	Estimate	S.E	*p*
Friendship Model									
Rate function	37.04	2.52		35.67	3.11		35.93	3.26	
Structural network effects									
Outdegree (density)	-2.10	0.04	**< 0.001**	-2.12	0.04	**< 0.001**	-2.11	0.05	**< 0.001**
Reciprocity	0.62	0.13	**< 0.001**	0.62	0.16	**< 0.001**	0.62	0.13	**< 0.001**
Transitive triplets	0.30	0.02	**< 0.001**	0.31	0.03	**< 0.001**	0.30	0.02	**< 0.001**
Gender effects									
Gender ego	0.08	0.06	0.137	0.08	0.06	0.192	0.09	0.06	0.116
Gender alter	-0.25	0.05	**< 0.001**	-0.26	0.05	**< 0.001**	-0.25	0.06	**< 0.001**
Gender similarity	0.33	0.06	**< 0.001**	0.33	0.06	**< 0.001**	0.33	0.06	**< 0.001**
Ethnicity effects									
Ethnicity ego	0.33	0.09	**< 0.001**	0.33	0.10	**< 0.001**	0.32	0.10	**0.002**
Ethnicity alter	0.01	0.09	0.943	0.01	0.09	0.951	0.01	0.10	0.947
Ethnicity similarity	0.11	0.09	0.250	0.11	0.10	0.269	0.11	0.10	0.266
Bonding effects									
Bonding ego				0.13	0.05	**0.008**	0.13	0.05	**0.007**
Bonding alter				0.04	0.04	0.345	0.03	0.05	0.456
Behavior Model									
Rate Function	3.72	0.94		3.66	0.79		3.55	0.74	
Linear shape	-0.16	0.08	0.057	-0.16	0.08	0.065	-0.14	0.09	0.112
Quadratic shape	0.20	0.08	**0.016**	0.23	0.10	**0.030**	0.27	0.16	0.091
Gender	0.05	0.15	0.756	0.05	0.16	0.765	-0.02	0.19	0.909
Ethnicity	-0.15	0.23	0.506	-0.15	0.24	0.520	-0.16	0.25	0.523
Hypotheses									
Selection: Bonding similarity				0.26	0.33	0.420	0.30	0.30	0.317
Influence: Total similarity				0.08	0.17	0.640	0.22	0.42	0.597
Selection X Gender							-0.11	0.63	0.861
Influence X Gender							-0.46	0.63	0.463

Note. p values are based on t-statistics (estimate divided by standard error) which approximate a normal distribution. Significance is denoted by bolded *p* values.

Table 5

RSiena Parameter Estimates of Independent Network and Behavior Evolution—GPA

	Model A			Model B			Model C		
	Estimate	S.E.	*p*	Estimate	S.E	*p*	Estimate	S.E	*p*
Friendship Model									
Rate function	36.62	2.24		35.97	2. 67		36. 61	2.84	
Structural network effects									
Outdegree (density)	-2.11	0.04	**< 0.001**	-2.17	0.06	**< 0.001**	-2.18	0.07	**< 0.001**
Reciprocity	0.62	0.14	**< 0.001**	0.56	0.12	**< 0.001**	0.55	0.15	**< 0.001**
Transitive triplets	0.30	0.03	**< 0.001**	0.30	0.03	**< 0.001**	0.30	0.03	**< 0.001**
Gender effects									
Gender ego	0.08	0.06	0.143	0.03	0.06	0.619	0.09	0.10	0.364
Gender alter	-0.25	0.05	**< 0.001**	-0.26	0.06	**< 0.001**	-0.25	0.06	**< 0.001**
Gender similarity	0.32	0.06	**< 0.001**	0.33	0.06	**< 0.001**	0.34	0.06	**< 0.001**
Ethnicity effects									
Ethnicity ego	0.34	0.10	**< 0.001**	0.46	0.11	**< 0.001**	0.46	0.11	**< 0.001**
Ethnicity alter	0.00	0.09	0.963	0.02	0.11	0.839	0.02	0.10	0.849
Ethnicity similarity	0.11	0.10	0.233	0.03	0.10	0.741	0.03	0.10	0.719
GPA effects									
GPA ego				0.11	0.06	**0.049**	0.11	0.06	0.076
GPA alter				-0.08	0.06	0.133	-0.09	0.06	0.127
Behavior Model									
Rate Function	1.10	0.20		1.17	0.24		1.18	0.21	
Linear shape	-0.17	0.15	0.259	-0.17	0.15	0.265	-0.19	0.16	0.241
Quadratic shape	-0.14	0.10	0.137	-0.07	0.11	0.500	-0.06	0.12	0.639
Gender	0.30	0.27	0.287	0.25	0.28	0.359	0.32	0.33	0.322
Ethnicity	-1.12	0.50	**0.028**	-1.15	0.51	**0.026**	-1.22	0.54	**0.026**
Hypotheses									
Selection: GPA similarity				1.54	0.38	**0.001**	1.59	0.47	**0.001**
Influence: Total similarity				0.35	0.37	0.346	0.54	0.61	0.383
Selection X Gender							-0.48	0.69	0.483
Influence X Gender							-0.67	1.16	0.566

Note. p values are based on t-statistics (estimate divided by standard error) which approximate a normal distribution. Significance is denoted by bolded *p* values.

Table 6

RSiena Parameter Estimates of Independent Network and Behavior Evolution—Values

	Model A			Model B			Model C		
	Estimate	S.E.	*p*	Estimate	S.E	*p*	Estimate	S.E	*p*
Friendship Model									
Rate function	36.85	2.80		36.22	2.78		36.60	2.32	
Structural network effects									
Outdegree (density)	-2.10	0.04	**< 0.001**	-2.12	0.04	**< 0.001**	-2.12	0.05	**< 0.001**
Reciprocity	0.63	0.12	**< 0.001**	0.63	0.14	**< 0.001**	0.63	0.15	**< 0.001**
Transitive triplets	0.31	0.02	**< 0.001**	0.30	0.02	**< 0.001**	0.30	0.03	**< 0.001**
Gender effects									
Gender ego	0.08	0.05	0.129	0.09	0.06	0.128	0.10	0.07	0.153
Gender alter	-0.25	0.05	**< 0.001**	-0.25	0.05	**< 0.001**	-0.26	0.06	**< 0.001**
Gender similarity	0.32	0.06	**< 0.001**	0.32	0.06	**< 0.001**	0.32	0.06	**< 0.001**
Ethnicity effects									
Ethnicity ego	0.33	0.09	**< 0.001**	0.34	0.09	**< 0.001**	0.34	0.10	**< 0.001**
Ethnicity alter	0.01	0.09	0.927	0.00	0.09	0.965	0.00	0.09	0.982
Ethnicity similarity	0.10	0.09	0.272	0.10	0.09	0.275	0.10	0.10	0.292
Values effects									
Values ego				-0.09	0.05	0.101	-0.09	0.06	0.095
Values alter				0.02	0.05	0.716	0.02	0.06	0.738
Behavior Model									
Rate Function	4.62	1.25		4.60	1.09		4.61	1.65	
Linear shape	-0.23	0.08	**0.003**	-0.23	0.08	**0.005**	-0.22	0.08	**0.005**
Quadratic shape	0.21	0.08	**0.007**	0.21	0.11	0.055	0.20	0.13	0.124
Gender	0.07	0.17	0.115	0.27	0.16	0.094	0.26	0.23	0.257
Ethnicity	0.05	0.20	0.792	0.05	0.21	0.818	0.06	0.23	0.808
Hypotheses									
Selection: Values similarity				-0.12	0.42	0.776	-0.10	0.46	0.825
Influence: Total similarity				0.01	0.16	0.974	0.01	0.23	0.961
Selection X Gender							-0.18	0.87	0.858
Influence X Gender							-0.03	0.38	0.937

Note. p values are based on t-statistics (estimate divided by standard error) which approximate a normal distribution. Significance is denoted by bolded *p* values.

Table 7

RSiena Parameter Estimates of Independent Network and Behavior Evolution—Attendance

	Model A			Model B			Model C		
	Estimate	S.E.	*p*	Estimate	S.E	*p*	Estimate	S.E	*p*
Friendship Model									
Rate function	36.83	2.83		36.04	2.58		35.14	3.75	
Structural network effects									
Outdegree (density)	-2.10	0.04	**< 0.001**	-2.18	0.09	**< 0.001**	-2.25	0.24	**< 0.001**
Reciprocity	0.62	0.13	**< 0.001**	0.68	0.17	**< 0.001**	0.65	0.29	**0.026**
Transitive triplets	0.30	0.02	**< 0.001**	0.30	0.03	**< 0.001**	0.31	0.03	**< 0.001**
Gender effects									
Gender ego	0.08	0.06	0.168	0.12	0.06	0.074	0.27	0.48	0.574
Gender alter	-0.24	0.07	**< 0.001**	-0.25	0.07	**< 0.001**	-0.22	0.07	**0.002**
Gender similarity	0.32	0.06	**< 0.001**	0.33	0.06	**< 0.001**	0.30	0.13	**0.023**
Ethnicity effects									
Ethnicity ego	0.33	0.12	**0.006**	0.36	0.11	**0.002**	0.39	0.11	**< 0.001**
Ethnicity alter	0.01	0.12	0.930	0.02	0.11	0.859	0.01	0.15	0.941
Ethnicity similarity	0.10	0.13	0.142	0.10	0.10	0.334	0.10	0.13	0.427
Attendance effects									
Attendance ego				0.47	0.15	**0.002**	0.56	0.39	0.153
Attendance alter				-0.02	0.13	0.859	-0.07	0.27	0.787
Behavior Model									
Rate Function	8.75	6.51		8.86	3.20		7.87	4.96	
Linear shape	-3.10	0.56	**< 0.001**	-3.19	0.43	**< 0.001**	-2.79	1.17	**0.018**
Quadratic shape	2.04	0.52	**< 0.001**	2.05	0.34	**< 0.001**	1.86	0.84	**0.028**
Gender	-0.10	0.23	0.649	-0.13	0.23	0.566	-0.95	0.92	0.299
Ethnicity	0.14	0.28	0.630	0.13	0.30	0.669	0.33	0.41	0.417
Hypotheses									
Selection: Attend similarity				0.64	0.40	0.113	0.96	1.05	0.361
Influence: Total similarity				-0.03	0.06	0.571	0.30	0.78	0.703
Selection X Gender							-1.12	1.61	0.487
Influence X Gender							-0.80	1.60	0.619

Note. p values are based on t-statistics (estimate divided by standard error) which approximate a normal distribution. Significance is denoted by bolded *p* values.

Table 8

Score-Type Testing for Inclusion of Candidate Selection and Influence Effects

	School Bonding	GPA	Values	Attendance
Candidate Effects	*p*	*p*	*p*	*p*
Friendship Dynamics				
Overall test for selection (df = 4)	0.037	< 0.001	0.022	0.002
Variable ego	0.032	0.083	0.680	0.485
Variable alter	0.004	< 0.001	0.082	< 0.001
Variable similarity	**0.447**	**< 0.001**	**0.102**	**0.198**
Variable ego X Variable alter	0.874	< 0.001	0.879	0.353
Bonding Dynamics				
Overall test for influence (df = 3)	0.253	< 0.001	0.239	0.792
Average similarity	0.274	0.259	0.183	0.764
Total similarity	**0.098**	**< 0.001**	**0.070**	**0.484**
Average bonding alter	0.639	0.294	0.993	0.622

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