PEER INFLUENCE AND ADOLESCENT SUBSTANCE USE: A SOCIAL NETWORKS ANALYSIS

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PEER INFLUENCE AND ADOLESCENT SUBSTANCE

USE: A SOCIAL NETWORK ANALYSIS

Abstract

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The relationship between delinquency involvement and association with delinquent peers is well known among theorists and researchers. Although friendship relations are an important aspect of adolescent life, only rarely is the structure of these relations examined systematically. This study uses social network analysis as a tool to examine how association with peers affects adolescent substance use.

Data for the study are from the National Longitudinal Study of Adolescent Health (Add Health). The network characteristics examined include *Centrality*, *Prestige*, *Density*, and *Heterogeneity*. Two types of analyses are presented: a quantitative analysis and a case study. The quantitative study includes a regression analysis of the effects of the social network variables on imminent and later substance use, and an analysis of use trajectory. The case study provides a visual representation of the link between friendship groups and substance use.

The results from the quantitative study suggest that of the four network variables examined only *Prestige* and *Density* have significant short-term effects on substance use. *Prestige* has a positive effect and *Density* has a negative effect. The results regarding *Centrality* and *Heterogeneity* are inconclusive although *Centrality* does appear to have a

negative effect on substance use when the race/ethnicity of the respondents is controlled. *Heterogeneity* has a significant positive effect only for future illegal substance use. The trajectory analyses reveal that trajectories for alcohol use and marijuana use trend in opposite directions. The trajectory for alcohol use shows an increasing number of users and levels of individual use, while that for marijuana use shows a decrease in both numbers of users and levels of use. The case study examines the entire network of a small school. The results are generally consistent with and illustrative of the results from the quantitative study. In addition, the results suggest that individuals who are in structurally similar positions in a friendship group engage in similar levels of substance use.

The research highlights the importance of peer network structures for understanding the relationship between peer association and substance use. Limitations of the study are discussed as are policy implications. Recommendations for future research are also suggested.

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Dedication

This dissertation is dedicated to my mother, father, brother, and maternal relatives who

provided both emotional and financial support.

CHAPTER ONE

INTRODUCTION

For decades, the relationship between peers and delinquency involvement has occupied the attention of theorists and researchers (see Shaw and McKay 1931; Sutherland 1947; Glueck and Glueck 1950; Cohen 1955; Shaw 1966; Hirschi 1969; Jensen 1972; Akers et al. 1979; Krohn et al. 1982; Haynie 2001, 2002; Warr and Stafford 1991; Akers and Lee 1996, 1999; Lee et al. 2004). A wide range of criminological or delinquency theories have been offered to explain various forms of substance use either in general or specific (Akers 1992). It is clear that most youthful offending, including substance use, is group or companion-based (Erickson 1971, 1973; Erickson and Jensen 1977; Reiss 1988; Warr 2002). Not only is there a strong correlation between delinquency involvement and association with delinquent peers, but typically juveniles commit delinquent acts in the company of others (Warr 2002).

In the case of substance use, youthful offenders rely on a social network to access alcohol and/or drugs (Wagenaar et al. 1993; U.S. Department of Health and Human Services 2004; Finn 2006). Therefore, understanding how peer groups are formed and maintained is vital to understanding much youthful substance use. However, although friendship relations are an important aspect of an adolescent's life, only rarely are the structures of these relations examined systematically. In this study, I examine the structures of these associations as they relate to youthful substance use.

Although both substance use and delinquency in general contravene legal and societal standards for adolescents, these behaviors appear to exhibit distinct differences. According to Maggs and Hurrelmann (1998: 370-371), there are five distinctions between substance use and

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delinquency: 1) substance use is statistically normative while delinquent behavior is relatively infrequent for adolescents; 2) substance use is considered a developmental task that may be considered by some to be "healthy exploration" whereas delinquent behavior is not; 3) some substance use such as drinking is a status offense while most delinquent behaviors including the use of other substances such as marijuana are criminal offenses; 4) some substance use such as drinking can be viewed as prosocial behavior whereas most delinquent behavior is considered to be antisocial behavior; and, 5) substance use is categorized as a victimless crime while most delinquent behavior is against other people, property, or environment.

The most recent Monitoring the Future survey in 2006 showed an overall decline in substance use. However, certain drugs such as prescription drugs and tranquilizers continue to have relatively high rates of use (see Johnston et al. 2007). Further, as McCurley and Snyder (2008) note, 35 percent of youth between ages 15 and 17 report using alcohol and 14 percent report marijuana use. These rates suggest that adolescents no doubt consider low levels of alcohol and marijuana use to be relatively acceptable behavior.

Association with one's peers is no doubt an important aspect of an adolescent's life. However, traditional measures of peer influence such as the number of delinquent friends youth may have are often criticized because such measures say little about the quality of these relationships or one's location in a group (see, Zhang and Messner 2000). An alternative measurement of peer influence is based on proximity to others in friendship structures using a social network approach as a tool (see Snijders and Baerveldt 2003). The structures of friendship relations are translated into several network variables that describe how adolescents are enmeshed in different groups. The network variables are then quantified based on one's

relational ties to others. By doing so, the relationship between peer association and substance use can be examined systematically.

In addition, network variables are measured not only in terms of an individual's perceptions of where they may fit in a group, but also how others think the individual is embedded in a particular network. Adolescents do not co-offend with mere acquaintances, but with others who recognize and acknowledge them as members of a group. Therefore, network variables tap into the nature of one's interpersonal relationships and should aid in our understanding of the dynamics of co-offending including the use of illegal substances.

This research addresses a central concern and several related questions. The primary question is: How do social network characteristics affect substance use? That is, does the way friendships form provide greater opportunities for some to learn about and engage in substance use; and, do individuals who share similar or structurally equivalent positions in a group demonstrate similar levels of substance use? A related issue is whether and how early friendship network structures influence later substance use and, if they do, do those early peer networks function as a facilitating or constraining factor over time? That is, is one's structural position in adolescent friendship groups related to substance use in one's early to mid-twenties; and, is the correlation between early alcohol and marijuana use and subsequent more serious substance use attenuated by these early network characteristics? Finally, are the trajectories for different types of substance use over time the same or different?

To answer these research questions, this study includes two separate analyses: a quantitative analysis and a case study. In the quantitative analysis, I examine the relationships between a set of peer network characteristics and adolescent substance use. I subsequently focus on identifiable friendship groups within one school to illustrate the results of the

quantitative study. In the case study, I examine how individuals are connected and determine

the levels of substance use among and within peer groups. I also examine whether individuals

who have structurally similar positions in their peer group exhibit similar levels of substance

use.

Chapter 2 includes a review of past research that examines how friendships influence

delinquency involvement in general and substance use in particular. Theories that can be used

within a network approach to explain substance use are examined as well. This review includes

previous research on co-offending and gang studies, both of which focus on peer group

structures. The hypotheses to be examined in this study are presented in Chapter 3. A

description of data, the measurement of social network and other variables, and the analytical

procedures to be used are discussed in Chapter 4. The analysis and findings are presented in

Chapters 5 and 6. In the final chapter, limitations of this study are discussed as are the policy

implications of the findings.

CHAPTER TWO

THE THEORETICAL CONNECTIONS BETWEEN PEERS AND SUBSTANCE USE

Introduction

In general, research suggests that peer associations strongly influence delinquency involvement, though the nature of that influence remains a matter of debate. For some, delinquent behavior is a result of socialization to peer group norms that support delinquency involvement (Akers 1998). For example, Warr (1993b) reports that exposure to delinquent friends at an early age predicts subsequent delinquency involvement (see also, Akers et al. 1979; Krohn et al. 1984; Akers 1992; Akers and Lee 1999). Thus, the influence of delinquent peers is considered to be a primary factor that leads juveniles to learn values that support delinquent behavior (Akers 1998). On the other hand, some note that delinquent youth do not associate exclusively with delinquent peers. For example, Matza (1964) argues that juveniles "drift" between the conventional and unconventional relationships. In other words, some youth maintain conventional relationships with their parents and non-delinquent peers, while entering into often transitory relationships with delinquent peers. Thus, for some, friendship networks overlap providing a bridge connecting relationships with both delinquent and non-delinquent youth.

Friendships and Delinquency

Although friendship relations are an important, though variable, aspect of adolescent life, only rarely are the structures of these relations examined systematically. Compared to kinship relations (Willmott 1986), friendships are based upon personal choice and mutual agreement to be in a relationship. Further, friendship relations are dynamic over time, that is,

some are maintained while others change or dissolve depending on circumstances (Zeggelink 1993: 7-8). It would seem that people can more easily walk away from friendships by following their emotions or due to disinterest. Nevertheless, it seems likely that friendships play some role both in facilitating and constraining delinquent behavior.

McAdams (1988) characterizes friendship as providing an individual with a sense of belonging and as a source of emotional or physical support and reassurance of self-worth. Although friendships may be prompted by different motives including profit or coercion (Zeggelink 1993: 9), they nevertheless reflect a person's lifestyle, gender, and cognitive state of development (Hays 1988). Depending upon the context, all these factors can be a "drive" to enter into a friendship group. Friendships are also affected by context. For example, for many adolescents, friendships are school-based (see Coleman 1961; Polk and Schafer 1972). Youth tend to form friendships with peers who attend the same school where they spend much of their time interacting with one another in classes and school related activities. These friendships are no doubt influenced at least in part by the various forms of evaluation that occur in the school context, such as grades, as well as common interests that attract youth to specialized school-sponsored interest groups and activities. In addition, since school districts typically determine what school an adolescent will attend, friendship networks are likely to be relatively homogeneous in terms of demographics such as race and social class.

A handful of studies focus specifically on "friendships" and delinquency (see Krohn 1986; Sarnecki 1986; Warr and Stafford 1991; Krohn and Thornberry 1993; Baerveldt and Snijders 1994; Thornberry et al. 1994; Haynie 2002, 2001; Haynie and Osgood 2005). For example, Warr (1993b) reports that peer culture provides an environment that is tolerant of delinquency. Thornberry et al. (1994) examine the relationship between peer association and

delinquency involvement. Consistent with Warr's findings (1993b), they report that social environments in which peer culture encourages delinquency leads to delinquent behavior. Although these studies suggest that juveniles learn from or are influenced by friendship groups, how and what they learn is not always entirely clear.

In one recent study, Haynie (2002) examines the impact of the role of friendship networks on delinquency and reports findings consistent with the central proposition of Sutherland's (1947) theory of differential association. That is, juveniles learn antisocial behavior through direct contact with others in their age group. Baerveldt and Sniders (1994) also find that pupils whose networks include friends who commit offenses are more likely to commit offenses themselves. Similarly, Warr and Stafford (1991) report that the behavior of delinquent friends has a greater effect on juveniles' delinquency than friends' attitudes toward delinquency. Sarnecki (1986) also finds that juveniles who belong to delinquent groups are more actively engaged in delinquency when they associate with other delinquents as members of a group. They show an even greater risk of persistent offending than those who used to, but no longer belong to a delinquent group. In sum, the concept "friendship" refers to something more than a simple association with peers. It refers to structural connections among group members that may be important to our understanding of the statistical association between peer involvement and delinquency, including substance use.

Theoretical Explanations of Peer Influence and Co-offending

Like many criminological theories, Akers' social learning theory (1998) focuses specifically on the role of peers. He notes that typically the primary learning source for youth is their parents or family, but that friends become more influential as youth grow older and gain independence and autonomy from parents. According to Akers (1998), adolescents learn

antisocial behavior through the association with delinquent peers who reinforce definitions favorable to involvement in such behavior. As they are socialized within peer groups, they develop and adhere to group norms that support delinquent behavior.

Following the lead of Sutherland (1947), Akers' key concept is "definitions favorable to the violation of the law," which refers to one's attitudes toward certain behaviors as legal or illegal, right or wrong (Akers 2000: 76). Extending Sutherland's theory of differential association, Akers argues that these "definitions" are acquired through three processes: differential association, differential reinforcement, and imitation. Unlike Sutherland, Akers' position is that youth learn behavior through both direct and indirect interaction with peers.

Differential association refers to "the process whereby one is exposed to normative definitions favorable or unfavorable to" a certain behavior (Akers 2000: 76). Akers argues that differential association refers to direct and indirect "association and interaction with others" (76). Sutherland (1947: 6-7) stated in his seventh proposition in the theory of differential association that the effect of such associations are greater when they are formed early in life ("priority"), when the period of time such associations are maintained is extended ("duration"), and more frequent ("frequency"), and when the other involved are important to them ("intensity"). Consistent with Sutherland's position, but with revisions based on behavioral concepts and propositions, Akers extends the theory of differential association by introducing the concept of "differential reinforcement" (Akers 1998: 45).

Differential reinforcement refers to the balance between the anticipated rewards and costs derived from a behavior. That is, people behave in certain ways depending on the ratio of rewards/costs. When the costs, such as punishment, are greater than the anticipated rewards, juveniles are less likely to engage in delinquent behavior (Akers 1998: 68). Reinforcement that

increases the probability of committing delinquent behavior may be given positively or negatively. This includes positive reinforcement such as praise that encourages delinquent behavior. It may also include negative reinforcement such as negative comments in the form of name calling directed toward youth who initially resist participating in delinquent acts. Reinforcement is provided through the amount of profit that juveniles gain, the frequency of reinforcement, and the probability of alternative options (68).

Similarly, punishment may be given both positively and negatively. Positive punishment refers to the presentation of an unpleasant event such as being arrested, whereas negative punishment refers to reduction or loss of privileges such as restrictions on TV time or a reduction of monthly allowance. Punishment may come from within or from others, and may include feeling sick after using drugs or drinking (see also Akers 1998: 66-75). Punishment, especially that given by others, may make juveniles restrain from delinquent behaviors. However, even when punishment is given, if the amount is too little compared to positive reinforcement, juveniles are likely to engage in delinquent behavior and to do so continuously.

Finally, imitation refers to engaging in certain behaviors after observing similar behaviors by others (Akers 2000: 79). Although most past research has focused on differential association and differential reinforcement, a few scholars note that peer pressure to conform to group norms is often acquired largely through imitation with or without much in the way of reinforcement from others (see, for example, Warr and Stafford 1991). The question is, under what conditions do youth observe and imitate the antisocial behavior of their peers? The answer may be that structural proximity to delinquent friends increases the opportunity to be exposed to delinquent behavior and that close observation results in delinquency involvement. In other words, structurally core members may have more opportunities to witness certain

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behaviors than with fringe members. For example, in his study of delinquent gangs, Fleisher (2002) reports that core members were more likely to engage in antisocial behaviors due to their proximity within the group.

Past research provides strong empirical support for social learning theory when explaining substance use (Akers 2000: 89). For example, in the first of a series of empirical studies, Akers et al. (1979) closely examined the effect of social learning variables. They report that combined, the four key social learning variables, that is, differential association, definition, differential reinforcement, and imitation, explain 55 percent of the variance in alcohol use and 68 percent in marijuana use by adolescents. Further, Akers argues that we learn both conventional and unconventional behavior, and that initiation and desistance of substance use are the products of learning.

Although it is inarguable that there is a strong correlation between involvement with delinquent peers and substance use (see Warr and Stafford 1991), it is questionable whether youth are "transformed" by mere association with delinquent peers. For example, peer influence is an important predictor of substance use, but when it comes to co-offending, that is, the joint participation in illegal activities (Reiss 1988), juveniles do not commit these acts with mere acquaintances (Warr 1996; Weerman 2003). However, "being friends" is not a necessary condition to co-offend. Rather, a common incentive or reward gained from an offense must exist between co-offenders (Weerman 2003). It seems likely that at least part of the correlation between delinquency and association with delinquent peers is a function of social selection. That is, juveniles who have already developed dispositions favorable to delinquent behavior are more likely to choose delinquents as friends and may eventually commit delinquent acts together. Morash (1983) reports that boys who belong to delinquent peer groups have above-

average rates of previous involvement in delinquent activities. When it comes to substance use, Warr (2002: 81) notes that "drug use could be the *raison d'être* that brings a group together." Substance use requires co-dependence on others; thus, what may be referred to as "co-offending" is very common.

"Co-offending," according to Reiss (1988), refers to joint participation in illegal behaviors. Therefore, co-offending is different from simple association with delinquent peers and it is also more common among juveniles than among adults (Warr 1996; Weerman 2003). Without a strong sense of belonging or connection to delinquent others, juveniles are unlikely to commit offenses together. Although Hirschi approached delinquency differently by asking why juveniles do not engage in delinquent behavior, this perspective can be applied to help explain co-offending. Hirschi's (1969) notion of social bonds and social selection is, perhaps, particularly relevant. He explains that social ties to conventional others and/or institutions restrain delinquent behavior, but when these ties are weakened juveniles are more likely to "choose the wrong crowd" and engage in delinquent behavior. However, he questions whether juveniles maintain strong attachments to these unconventional peers (1969: 159).

Hirschi (1969) identifies four elements which he refers to as the "social bond," that is, attachment, commitment, involvement, and belief. He argues that when juveniles have strong attachments to conventional others such as parents or family, the school, and peers, when they have a strong commitment to conventional goals, and when they are engaged in or spend time in conventional activities with non-delinquent others, they are less likely to engage in delinquent behavior. Further, juveniles who have a strong belief in the moral validity of the law are less likely to engage in delinquent behavior.

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According to Hirschi (1969), as long as juveniles maintain strong social bonds to conventional others, they are unlikely to associate with delinquent friends. However, having conventional ties and associating with delinquent peers are not necessarily mutually exclusive; rather, they occur in the course of developing friendships. For example, as Cohen (1955) argued some time ago, youth with similar social and personal problems are attracted to one another and collectively solve their problems in innovative, sometimes delinquent, ways, especially in school. This suggests that with respect to causal order, the processes of selection and socialization cannot be separated from one another. That is, for youth who are predisposed to engage in delinquent behavior, socialization or at least conformity to expectations within peer groups may be, at least in part, a consequence of selecting friends who are similarly predisposed. Thus, association with delinquent peers may at times be a consequence rather than a cause of delinquency involvement (Liska and Messner 1999: 76; Akers 2000: 83; see also, Gottfredson and Hirschi 1990; Sampson and Laub 1993). By the same token, weakened conventional social bonds may not lead juveniles to associate with delinquent peers; rather, their delinquent behavior may weaken conventional social bonds leaving them vulnerable to the influence of delinquent peers (Liska and Messner 1999: 76).

Hirschi's theory is based on a selection model (see Figure 1 below), which suggests that youth with weak ties to conventional others are already predisposed to antisocial behavior. These youth are likely to associate with delinquent friends and then engage in delinquency. Akers' theory, on the other hand, is grounded on a socialization model (see Figure 1), which posits that adolescents develop attitudes favorable to antisocial behavior through the association with other delinquents; then, after acquiring such attitudes they eventually engage in delinquency. However, it appears that selection and socialization effects are interrelated.

Liska (1978: 75) argues that in addition to the socialization effect, which he portrays as an indirect effect, deviant associations also affect delinquency involvement directly as a source of social control (see the third model in Figure 1). However, the social selection process can also incorporated affecting both associations with delinquent friends and as a form of internal control affecting behavior.

Figure 1: Selection vs. Socialization Models

Selection Model

Socialization Model

Selection/Socialization Model
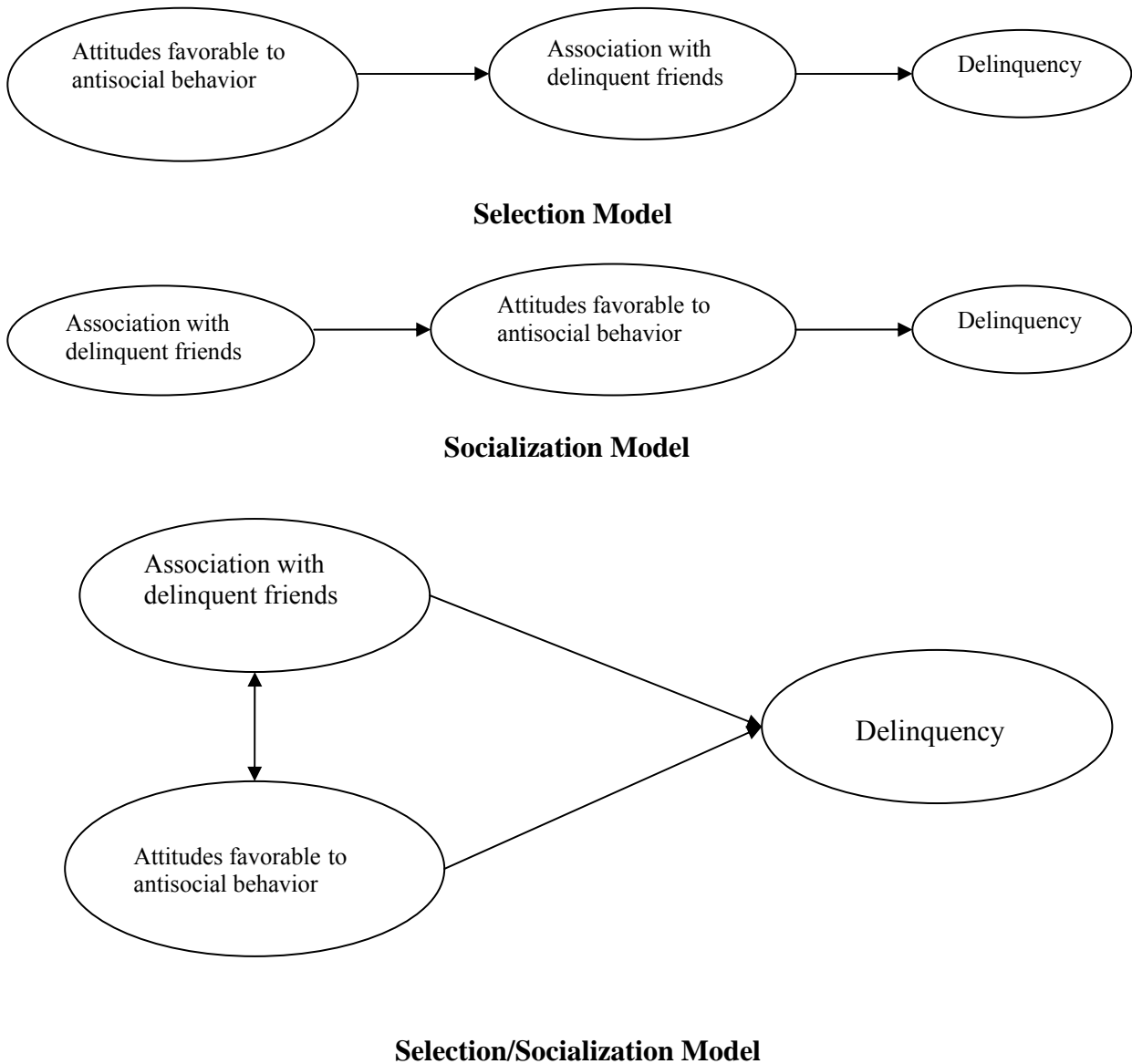
Source: Liska, Allen E. (1978: 76) for the first two diagrams. The Selection/Socialization model combines the first two.

Although Hirschi (1969) focuses on conventional relationships to explain what controls delinquency involvement, some control scholars note the influence of delinquent peers on one's delinquency involvement as well as the constraints of conventional peers. To explain peer influence, these criminologists argue that some aspects of learning theory must be integrated with social control theory (Sarnecki 2001; see also Krohn and Massey 1980; Le Blanc and Caplan 1993). Weak attachments to conventional as well as delinquent others make juveniles feel they have nothing to lose, which in turn contributes to their delinquent behavior.

Although neither of these theories directly addresses the mutual effects of selection and socialization processes, both point to human interaction, which suggests that "human connections" or "social networks" play an important role. Further, although most youth no doubt learn antisocial behavior through interaction with peers, their strong attachments to conventional others presumably mitigate/constrain their delinquency. As a primary control agent, it is inarguable that parents have a significant effect on delinquency involvement (see, for example, Hirschi 1969; Warr 1993a). However, as social learning theorists argue, as adolescents enter puberty they spend more time with and are influenced by their peers (see, for example, Sutherland 1947; Akers 2000). When both effects are examined together, research so far is still inconclusive with regard to the relative importance of each on delinquency involvement (Warr 1993a). In other words, delinquent behavior is to some extent both learned and constrained by an individual's "immediate environment," which includes parents and peers (Scott 1991: 85). Thus, we need to know more about these immediate environments.

Social learning theory assumes that there are conflicting social norms and values in our society, and that one side embraces conventional normative values while the other holds alternative values. Therefore, a violation of normative values is considered deviant. However,

this assumption is problematic because different people belong to different groups. In other words, what is "normative behavior" depends on one's reference group. When people have loyalty to antisocial others, antisocial values are considered "normative" to them and conformity to conventional normative values can be considered deviant (Liska and Messner 1999: 64). It is necessary, then, to observe both the conventional and the antisocial network structures in which youth are enmeshed.

Social bonding theory relies on personal perceptions rather than "facts" or actions (Friday and Hage 1976) as opposed to behaviorists claims that "mental phenomena cannot be part of scientific inquiry" (Liska and Messner 1999: 63). Of the four social bonds, only "involvement" is measured by actual behavior and it refers only to time spent in conventional activities. The quality of one's relationship to certain individuals or groups is measured by attachment. However, an individual's perceived ties are not always the same as what others perceive. That is, two-way or mutual ties between actors[1] do not always exist. Thus, it is important to look at how individuals acknowledge one another.

The social network approach incorporates others' perceptions by using directional ties, that is appointing and nominated ties, and in this way establish the structural connection among participants. When examining existing ties between juveniles and others qualitatively, we need to examine the structure of the peer group to identify directional relationships within a given group. By doing so, we can see how juveniles are positioned within and/or across groups. Directional, or more specifically reciprocal, relationships may help understand substance use which is largely peer-oriented and requires others' resources such as accessibility to substances and knowledge of methods.

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[1] The term "actor" is a commonly used term in social network studies. It refers to an individual who is involved in a specific network.

Although the notion of friendship formation is not specifically addressed by either social learning or control theories, understanding how adolescents are connected to and enmeshed in a peer group may aid our understanding of the dynamics of adolescent substance use. As noted, substance use often takes the form of co-offending. It is likely then, that one's peer group facilitates this behavior. It is also possible that conventional peers can constrain youth from engaging in delinquent behavior even when delinquent peers are present or available. As Reckless (1961) argued in his containment theory, there are push/pull factors to/from delinquency that affect one's behavior. It seems likely that these factors are functional only when there is a substantial connection between juveniles, that is, how they are structurally associated with a particular group.

Social networks can reveal how members are associated with others or where they are located in a group and how susceptible they may be to group norms or values. How efficiently juveniles are socialized undoubtedly depends on how they are incorporated into their friendship network. At the same time, network variables permit examination of the selection process. Looking at one's location in a group over time is one way to understand both processes. In other words, one's choice of belonging to a certain friendship group, as well as susceptibility to peer influence within the group is undoubtedly affected by the structure of peer groups. Thus, by focusing on these structures, we may gain a better understanding of patterns of youthful offending including substance use.

Patterns of Youthful Offending

According to Agnew (2009: 252), adolescents become more peer-centered as they grow older; thus, they are more likely to be influenced by their friends and associates, and commit offenses with friends and associates. Some evidence of this is provided by Burkett (1993) who

reports that the direct effect of perceived parental religiosity on one's choice of friends and

drinking behavior decreases over time (see also Burkett 1977a). Once one chooses delinquent

friends, adolescents are influenced more by these friends than they are by others including

parents (see also, Warr 1993a).

Findings similar to the above are revealed in studies of co-offending. For example,

Weerman (2003) argues that strong attachments or emotional ties to co-offenders are not

necessary; rather, shared motivation to exchange profit may lead juveniles to co-offend. Prior

research suggests that, statistically, most offenses occur in the presence of others. Reiss, for

example, found that about 67 percent of burglary offenders and about 73 percent of robbery

offenders were co-offenders (1988: 121-122). Further, only 16.9 percent of studied juveniles

apprehended for at least one burglary during 7.5-year period were designated as solo-offenders

(1988: 123). Similarly, using official data in Sweden, Sarnecki (2001) reports that almost 60

percent of juveniles committed offenses with someone else. Although the percentage

committed by solo-offenders (41 percent) appears to be high when we focus on incidents, when

we look at offenders, the percentage of solo-offenders remains low (21 percent), consistent

with Reiss' study (1988: 55). More recently, Warr (1996) notes that 73 percent of all

delinquent behaviors he examined were committed in a group. This was particularly true for

alcohol violations (91 percent) and all drug violations (79 percent).

In an early study focusing on group offending, Erickson (1971) found that 78 percent of

all drinking behavior and 77 percent of narcotics use were committed in group situations.

Erickson (1973) also found that over 80 percent of incidents involving drinking were

committed in groups regardless of the juveniles' socioeconomic status. Similarly, Erickson and

Jensen (1977) revealed that about 81 to 91 percent of drinking offenses and 86 to 92 percent of

marijuana use offenses was committed in group situations regardless of living areas. They also report that over 85 percent of both male and female offenders engaging in drinking and marijuana use did so in groups.

Other empirical studies indicate that delinquent behavior is usually committed with delinquent peers, but that in terms of socializing, delinquent youth are much like non-delinquent youth. For example, Sarnecki (1986: 53) reports that the predominant reason for co-offending is what he called "social motive." That is, co-offending is "a way of socialising with peers." Unfortunately, it is not clear how and why these associations are formed, and why some are socialized to group norms while others are not. Thus, whereas the characteristics of co-offenders have been identified, the mechanism of co-offending remains largely unexplained (Reiss 1988; Weerman 2003). This is because, with few exceptions, prior research has ignored how group structures contribute to co-offending.

Although the number of delinquent friends is frequently used as an indicator of an individual's delinquency, Weerman (2003) clearly states that co-offending is different from having delinquent acquaintances or friends. Weerman argues instead that the notion of co-offending is useful for the analysis of social interaction and relationships among co-offenders. He notes that co-offending includes an exchange of any rewards, either material and/or emotional, that cannot be achieved by solo-offending. Further, social exchange is based on needs and desires. That is, according to Weerman (2003: 404), "people base their decisions not only on rewards but also on *costs* and risks…in the social exchange of co-offending. In general, people agree to exchange goods when they expect it to be *profitable enough*. The same is true for co-offending."

Weerman's proposal is relevant to understanding the difference between involvement in networks of co-offending groups and simple association with delinquent peers or accomplice networks as argued by Warr (1996). In other words, knowing or even associating with delinquents is qualitatively different from actually committing delinquent acts together. In the case of co-offending, expected rewards are gained through actual involvement in delinquency. This suggests that juveniles who are already engaged in or are inclined to engage in delinquent behavior select as friends those who will abide by group norms that may include engaging in delinquency together. Thus, as already noted, knowing how an individual is enmeshed into one's peer group would appear, then, to be a key factor in understanding of why an individual co-offends.

Although co-offending groups may not be gangs in the traditional sense of the term (Sarnecki 1986), gang studies are nevertheless very informative given to the nature of interpersonal relationships among gang members. For example, in his early study of delinquent gangs, Thrasher (1927) found that gangs are characterized by relative stability. Youth initially form spontaneous play-groups through their attachment to local territories and when conflicts between groups occur they try to solve problems together. On the other hand, Yablonsky (1973) later questioned the cohesiveness of gangs and focused on the location of members within gangs by distinguishing between core and marginal members. He notes that even among marginal members there are several differentiating characteristics. Because marginal members at the fringe of the gang have no clear identification as a member, Yablonsky argues that they can quit or shift from one gang to another. This suggests that both membership participation and the ability to shift affiliation or drop out altogether may be structurally defined. According to Yablonsky, juveniles who are loosely tied to a delinquent peer group are

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less likely to engage in group activities unless they are motivated to improve their status in group or they have any specific personal reason to commit delinquent behavior. Klein (1995) also found that gangs in general are loosely organized although members of cliques within gangs show high cohesiveness and tend to engage in delinquency together. Clearly, structural connections among members affect delinquency involvement.

While gang studies provide insight into the structure of delinquent groups, Warr (1996) examines both how such groups are structured and the characteristics of the group members.[2] In his study of group structure and delinquency involvement, Warr (1996: 33) reports that "instigators" in a delinquent group tend to be "older, more experienced, and close to other members." Particularly noteworthy is the finding that persons in the center of a group are likely to facilitate the delinquent behavior of others. However, facilitating is not the same as committing delinquent acts by themselves. Further, a very cohesive delinquent group, which in terms of network analysis is defined as a group with high density, apparently maximizes opportunities for members to engage in antisocial behavior.

Until recently, and except for gang research, the structure of peer groups has been relatively ignored because prominent theories take existing networks for granted (Krohn and Thornberry 1993: 102). An individual's association with delinquent peers is not always intentional or for the purpose of delinquency involvement. If an association with delinquent peers is the result of external factors such as coercion, being a groupie, or a steady romantic partner, an actor's unwillingness to engage in delinquent behavior will, in turn, affect whether and how that individual is enmeshed in and socialized within the group. On the other hand, juveniles who chose to join a group are perhaps more likely to be connected to others and, in

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[2] Warr explores the character of delinquent groups excluding gangs because, he argues, they are conceptually different.

turn, to be socialized to the values in the group. This may be especially true for substance use. Given the matter of access, substance use is heavily peer oriented. By focusing on friendship network structures, we can examine the proximity between actors, which appears to be one of the factors that affect socialization (Sutherland, 1947).

Career Offending

Career offending in general refers to lifelong criminal behavior that becomes one's livelihood. According to the age-crime curve, most offenders desist from antisocial activities by the age of 30 with the peaks in the mid to late teens and early twenties (FBI 2008: Table 38). The arrest data in the 2008 Uniform Crime Reports also show that liquor law violations as well as drug violations peak in the 19 and 18 year old age groups respectively (2008: Table 38). Explanations of substance use should include consideration of behavioral changes such as entrance into, changes in the involvement level, and desistance from this behavior.

Moffitt (1993) identifies two types of offenders: Life-course-persistent (LCP) offenders and adolescent-limited (AL) offenders, the latter of which is consistent with the age-crime curve. LCP refers to individuals who "exhibit changing manifestations of antisocial behavior" throughout their life course (Moffitt 1993: 679). AL refers to individuals who engage in antisocial behavior during early adolescence, but desist sometime in their late adolescence. Moffitt's taxonomy for the age-crime curve suggests the need for further research over the life course.

It is often assumed that the relationship between age and substance use over time will exhibit a single predictable direction or trajectory. However, the behavioral trajectories of youth typically are not singular. Following Moffitt's lead, researchers have found more complicated behavioral trajectories. For example, using data from a longitudinal study of

Pittsburgh youth, Loeber et al. (1993) identified three distinctive trajectory patterns in offending careers: the authority conflict pathway, the covert pathway, and the overt pathway. The authority conflict pathway is the most common and is consistent with the age-crime curve. This pathway shows that the onset of delinquency begins at early age with stubborn behavior, which leads to disobedience. Eventually, these adolescents tend to avoid authority figures by staying out late, skipping school, or running away. The second two pathways show progressive patterns. The covert pathway refers to a trajectory beginning with minor delinquent behaviors such as shoplifting but then progress to property damage and ultimately to more serious forms of theft. The overt pathway refers to a trajectory that begins with aggressive behaviors such as bullying, which then escalates to more serious violent behavior. Although these three pathways were found in their study, other evidence suggests that possible behavioral trajectories are likely to be more complicated (see also D'Unger et al. 1998; Nagin et al. 1995). This may be particularly true for substance use.

Using the four waves of national panel data from the Monitoring the Future survey, Schulenberg et al. (2005) found six trajectory groups for marijuana use among adolescents ranging from abstain (no use in the past 12 months at all four waves) to rare (infrequent marijuana use at one or more waves), fling (no or infrequent marijuana use at waves 1and 4, and frequent use at waves 2 and/or 3), as well as those who increased use, those who decreased use, and some who were chronic users over time. The most common pathway is being abstainer at all times (47 percent) followed by rare users (28 percent). Later reports using the same data source substantiate these findings (see Johnston et al. 2007).

According to Sampson and Laub (1993: 2003; see also Laub and Sampson 1993) behavioral change from unconventional to conventional is often the product of institutional

change such as joining the military or getting married. However, as Warr points out (1998), such institutional changes do not change one's behavior directly or do not necessarily come first. Rather, one's already altered behavior may bring institutional changes through relational changes. For example, according to Sampson and Laub (1993: 2003) marriage can be a reason for desistance from antisocial behavior. On the other hand, Warr (1998) argues that we should consider marriage as a process in one's life course rather than one single positive transition point. He found that the effect of getting married on criminal behavior is largely diminished when peer influence is held constant (202). Instead, he argues, changes in friendships before marriage seem to explain the effect of marriage on desistance (204). Warr suggests alternative arguments that challenge the general effect of marriage on desistence: delinquents who cease their antisocial behaviors become more attractive as potential mates (210).

Friendship networks may contribute to these changes in behavior over time. Prior research suggests that over time substance use often progresses through different developmental stages. For example, Maggs and Hurrelmann (1998) examine adolescent substance use focusing on peer relations. They include measures of the respondents' perceived peer group closeness and perceived position in the peer group as relational variables. Perceived peer group closeness is positively correlated with substance use only among students who are in higher grades (ninth and tenth), whereas perceived central position is positively correlated with substance use among adolescents who are in middle grades (eighth and ninth). In addition, their findings reveal that among eighth to tenth graders substance use is associated with an increase in frequency of peer involvement whereas among tenth graders substance use is associated with an increase in perceived peer group closeness. This suggests that adolescents' willingness to be a part of groups, affects substance use.

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Later, in their four-wave panel study of adolescent problem behaviors such as substance use, Wiesner and Windle (2004) reveal that individuals show that adolescents can be classified into distinct offending patterns resulting from changes in interaction with different types of reference groups. Although it is almost impossible to follow the life histories of large numbers of subjects, we can focus on certain life stage periods and conduct qualitative research to understand whether friendships or changes in friendships affect substance use, or whether one's tendency to choose certain groups or one's position in a group affects substance use.

Another example is found in the landmark study of the careers of drug smugglers by Adler and Adler (1983). They provide an understanding of the possible role of peer networks in their explaining of why dealers do not desist from their business. Although there are surface factors such as resistance to giving up a hedonistic life style, they found that the social network of underworld dealers is the strongest reason for their persistent drug dealing. Clearly, old social networks keep pulling dealers back. Although Adler and Adler are not entirely clear on how this social network is organized and how it affects the criminal behavior of dealers, they do note that dealers who are already deep into the business are no longer capable of withdrawing from the drug world. In other words, the social networks of drug smugglers are too strong and supersede any conventional networks they may have. This study informs us that social networks can affect one's behavior over time and suggests the need to incorporate network variables into the analyses.

Past studies have identified how friendship networks influence the development of substance use. Using a three-wave panel of Ohio youth in a state-level correctional facility, Schroeder et al. (2007) classify subjects into three groups: "desisters" who were free from serious and/or frequent offenses and were not incarcerated during the two follow-up periods;

"persisters" who exhibited serious and/or frequent offending patterns and/or were incarcerated during both follow-up periods; and, those in an "unstable" group categorized as "desisters" at the first follow-up period but "persisters" at the second follow-up period. They report a strong relationship between substance use and peer's engagement in criminal activity. They also note that when "persisters" are compared to "desisters," friends' criminal acts significantly lowered the odds of desistance from use over time. This suggests that continued association with deviant friends reduces exposure to conventional others and values that might alter their behavior.

Clearly, individuals may not behave in the same manner throughout life. That is, they can adopt or abolish certain values in their life and change their behavior in a manner consistent with their "new" value system as it develops through peer association. Some are involved in delinquency at an early age, quit offending for a period of time and then go back to offending while others exhibit different patterns such as progressive involvement in illicit activities (see Hawkins and Weis 1985; Loeber and LeBlanc 1990; Laub and Sampson 1993; Sampson and Laub 1993; Catalano and Hawkins 1996; Loeber 1996; Loeber et al. 1998; etc).

Past research such as that by Garnier and Stein (2002) supports the notion that peers exert a signification influence on initial substance use. If, as Akers claims (for example, 1998, 2000), human beings can learn and adapt conventional behavior, it seems reasonable to apply this notion to the desistance process as well. Mere acquaintances are unlikely to affect one's attitude toward substance use, provide an opportunity to imitate others' behavior, or receive differential reinforcement. In other words, mere acquaintances are less likely to either facilitate or constrain one's behavior. As noted by Sutherland (1947), how we learn is weighted by priority, duration, frequency, and intensity of one's associations. This again suggests that we

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should pay attention to how individuals are enmeshed into a social group. This leads us to develop the core notion that network characteristics such as structural proximity may affect antisocial behavior over the life course.

Empirical Studies using Social Network Analysis

Some recent research suggests that social networks provide a useful organizing concept to bridge the theoretical concerns addressed above by focusing on identifiable relational ties or relationships among actors within certain groups (Fischer 1977: 24). The social network approach views actors as active subjects with choices rather than as passive objects (28-29). Fleisher (2002: 200) argues that the social network analysis is a method of "describing and analyzing webs of social relations." The focus is on dynamic human interaction. Unlike traditional delinquency studies, with the possible exception of gang studies, the social network approach focuses on individuals as members of specific groups and how those groups are structured.

A social network is often represented by a sociogram in which actors are dots and the ties between them are expressed by lines. Since researchers deal with relational ties, the data must be collected within small groups of people on a non-random basis. Graphic descriptions, from simple sociograms to more complicated descriptions, may be useful to our understanding of interpersonal connections within groups by measuring links (ties) among actors. In this way they illustrate how groups are formed and how the individuals within them are connected. The social network approach can be used in both quantitative/statistical and qualitative/descriptive analyses.

According to Krohn (1986: S82-S83), a primary assumption underlying this approach is that "a social network constrains individual behavior...and the probability of behavior

consistent with the continuance of their network relationships will increase." That is, what facilitates or restrains one's behavior is not just whom one knows, but how one is related to others in the network. Social network variables consistent with social learning and control theories allow us to examine the effect peer relationships have on substance use.

In a subsequent study, Krohn et al. (1988) examine the relationship between specific characteristics in adolescent social network structures and cigarette smoking to test Friday and Hage's (1976) notion that "role overlap" accounts for much delinquent behavior. Friday and Hage (1976: 355) argue that the number of opportunities to be socialized to conform to social norms will depend on the types of relationships an actor has. Krohn et al. (1988) hypothesize that greater multiplexity, that is involvement in multiple groups with different social roles between any two actors in different social contexts, constrains a member's behavior within given groups because his/her antisocial behavior is more likely to be detected. Krohn et al. report that joint participation in conventional activities with peers or parents reduces the risk of cigarette smoking. Their findings support the notion that network multiplexity may constrain an actor's antisocial behavior. Similarly, Burkett (1977a, b; see also Burkett and Jensen 1975) reports that isolation from conventional activities may lead to heavy involvement in alcohol and drug use. However, it is highly unlikely that individuals belong to only one institution, organization, or group. As a counter argument, simply joining multiple groups will not in itself exert much control over one's behavior. Rather, how well individuals are recognized by other members within those groups is likely to be more important. Nonetheless, Thornberry et al. (2003: 15) later declare that a network perspective assumes that "all social networks constrain the behavior of their participants to some extent depending on the structure of the social network."

Although Krohn et al. (1988) provide some supportive evidence for multiplexity; their study is not limitation-free. First, certainly one's association with groups may change over time. However, whether such changes in association affects antisocial behavior or the tendency of an individual to take a similar position in a new group regardless of changes in friendship is not known, which suggests the need for longitudinal data. Second, the quality of relationships, that is, mutual acknowledgements within groups, is often overlooked. In other words, joining multiple groups does not determine the quality of relationship. Thus, the nature of each association within and/or across groups should be examined as well as how joint participation in conventional activity impacts one's behavior.

While there is evidence that multiplexity within friendship networks plays an important role in substance use, another network characteristic, that is, the cohesiveness of groups, must be examined (see also, Baeveldt and Snijders 1994 and Haynie 2001). For example, using data from the Rochester Youth Development Study, Krohn and Thornberry (1993) examine the effects of network characteristics on the stability in alcohol and marijuana use. Although they find that cohesiveness does not show any significant difference between drug users and non-users, different levels of cohesiveness appear to be related to race/ethnicity. They find that both African American and Hispanic alcohol and marijuana users are likely to be in more intimate relationships than are non-users. This suggests that within certain racial/ethnic groups substance user groups are relatively cohesive, and therefore provide greater opportunities for involvement in substance use. Determining levels of cohesiveness may be a key to understanding substance use that often takes the form of co-offending.

Fleisher's (2000) ethnographic research in Kansas City is based on a social network approach. This study documents how gang members get involved in delinquency. His findings

suggest that youth engaged in serious delinquency are more likely to be located in the center of the gangs. The closer and stronger the ties between members, especially among core members, the more troubles in any way they have in life. This is consistent with Warr's (1996) findings that with the exception of assault the instigators of offenses are more likely to have committed prior offenses than are joiners.

Haynie (2001) reports that among popular youth, peer's delinquency involvement is strongly associated with one's own delinquency. While instigators tend to be in the center of a group and more actively engage in delinquency, the questions remain about who initiates crime/delinquency. Haynie's findings suggest that the more popular an individual is, the more opportunities for antisocial behavior they have and the more likely they are to be influenced by their peers. Although there is a measurement flaw in her research[3] popularity is an important network characteristic that needs further examination.

Using National Youth Survey data, Wright and Cullen (2004: 186) report that respondents who obtained "new sets of peers" at one's workplace are more likely to disrupt old delinquent relationships and to alter their past antisocial behavior through newly formed associations. The change in social network alters one's delinquent behavior and prevents future offending because offending would risk losing the new relationships. Unfortunately, the quality of relationships between subjects and their prosocial coworkers is not taken into account. In other words, a mere change in association may not be enough to convince the actor to quit antisocial behavior. How they are connected, that is, the quality of their relationships should be considered.

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[3] The number of appointments from others as a friend is not standardized by the number of group members. Because the maximum appointment is conditioned by the group size, we have to adjust the number of appointments by the group size.

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As noted, Weerman (2003) and Warr (1996) claim that mere association with delinquent peers is not adequate to explain co-offending. Rather, how juveniles are tied together in a friendship group and how they are enmeshed into the group may explain co-offending. Also, Fleisher (2000) reports that gang members who are located in the center of the group are more likely to commit offenses. In addition, a leader, who tends to be in the center of a group, commits more offenses and those who commit recognizable amount of offenses would gain a position near center. As already noted above, a popular person may have opportunities for delinquent activities brought to their attention by other members.

As already alluded to, another factor that may affect offending is group cohesion. As Klein (1971) observes, less cohesive gangs are more likely to engage in a greater variety of delinquent behaviors, whereas more specialized gangs are more likely to be characterized by group solidarity as Thrasher (1927) described. Also, Warr (1996: 33) reports that juveniles commonly "belong to multiple delinquent groups over their careers and they change their accomplices frequently," which would suggest that such groups tend not to be terribly cohesive. Given this, the evidence that group cohesiveness is a major factor regarding engagement in delinquent activities is inconclusive. If juveniles constantly "drift" (Matza 1964) between the conventional and unconventional, identifying how they become enmeshed in a certain group at the point of offending may help us understand the nature and role of these groups.

The above empirical research suggests three issues regarding social networks: 1) mere association with delinquent peers is not enough to explain either individual behavior or co-offending; 2) core members who are located close to the center of a delinquent group appear to be more likely to commit delinquent behavior; and 3) although there is conflicting support for the notion, it appears that individuals in cohesive groups are less likely to engage in delinquent

behavior. With regard to the latter, social control theory seems to suggest that groups in which members are strongly attached to one another are likely to support conventional norms. Less cohesive groups may facilitate delinquency or substance use given weak conventional controls that are likely to exist.

In addition to the above, it appears from the review of the literature that some attention should be paid to diversity within groups. Early on, adolescents tend to develop their friendship networks in school and are likely to choose same-sex friends. Depending upon the composition of the school or neighborhood, they may also choose friends in terms of racial/ethnic similarities and differences (see, for example, Cairns and Cairns 1994). If we assume that groups that are heterogeneous in terms of race/ethnicity are likely to be less cohesive and therefore exert weak conventional controls, then members of such groups are more likely to engage in substance use. In other words, members of such groups may enjoy more freedom in their behavior, which may increase the likelihood of substance involvement. As control theory suggests, members of less cohesive groups may not be subject to conventional controls that would prohibit substance use.

I should also note that Cairns and Cairns (1994: 109) report that during mid-adolescence, social groups tend to be homogeneous with regard to age, gender, and race. A major property of school systems is segregation by age. Thus, as long as individuals participate in traditional school systems, age similarities in one's peer group are likely to exist over time all other things being equal. Regarding gender, such homogeneity diminishes to some extent as youth grow older, but it is likely to remain a strong factor in terms of choice of friends during adolescence. However, compared to gender, racial homogeneity appears to increase as youth advance through the adolescent years. Cairns and Cairns (109) argue that adolescents

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compared to young children are aware of differences, are under strong pressure to choose friends who are similar to themselves, and are more likely to have opportunities to achieve similarities as a function of development, and this may extend to race/ethnicity. Although they report lower incidence of substance use among African Americans, how this affects substance use in the context of diversity in groups remains to be seen.

Finally, past theories and research suggest that how an individual is associated with a group may affect delinquency involvement, and a change in relationships over time may alter one's behavioral trajectory. The notion of social networks appears to be important to understanding substance use at any stage of one's life. In the following chapter, several hypotheses derived from social learning and control theories and past research are presented.

CHAPTER THREE

HYPOTHESES

As noted in the previous chapter, the majority of youth engaged in delinquent behaviors including substance uses are involved with other youth engaged in similar behaviors. Social learning theory suggests that youth involved in friendship groups that include "delinquent" peers are socialized by those peers, and as a result, come to share definitions favorable to illegal behavior including substance use and to engage in behaviors consistent with those attitudes (Akers, 1998: 2000). Some extend this idea to include consideration of co-offending, which according to Sarnecki (1986:53) represents "a way of socialising with peers."

On the other hand, social control or bonding theory (Hirschi 1969) suggests that youth with weak bonds to conventional others and who do not maintain strong beliefs in the moral validity of the law are likely to select as friends those who drink or use drugs. However, choosing the "wrong crowd" does not necessarily mean that juveniles will actually engage in substance use. Whether they do or not engage in these behaviors is likely to depend on how they are enmeshed in or connected to a group of substance users. In other words, the strength of peer group socialization effects and the likelihood that youth will engage in these behaviors will depend upon where an individual is located within a group, that is, how the actor is recognized by his/her peers and where they locate themselves.

Although social learning and control theories tend to ignore these structural and organizational aspects of peer groups, it has been suggested by some that criminologists should direct their attention to the relationship between the structure of social networks and the processes of social selection and socialization. Cairns and Cairns (1994), for example, aptly

describe how social networks function, and emphasize the importance of examining selection and socialization effects together:

> Within the clusters of adolescence, strong **reciprocal** forces operate on all members toward conformity...A systematic account of social clusters and friendship must take into account the powerful effects of **reciprocal** influence demonstrated in experimental studies and observational analyses. The message from these investigations is that **reciprocal** interactions lead to high levels of behavioral and attitudinal similarity, regardless of the initial status of the people involved. The evidence on adolescent group dynamics strongly points to the operation of both differential selection factors and **reciprocal** influences (1994: 128-9) [Emphasis added].

Here substance use will be examined using social network variables that incorporate both selection and socialization effects. By doing so, I hope to determine whether certain characteristics of friendship groups render juveniles more or less susceptible to substance use.

Coleman (1961) argues that over several decades the school has become a major institution affecting adolescent behavior. Because most youth spend considerable time in school with people their own age, it makes sense to examine school-based friendship groups. Polk and Schafer (1972), like Coleman note that a major characteristic of school is "the age segregation and cloistering" that occurs in that context, and that the "high school has come to dominate the life of the adolescents and many of the free-time activities of the student are also school-based." (13) As Sutherland (1947) proposed several decades ago, how juveniles learn certain values is weighted by four factors: frequency, duration, priority, and intensity. With regard to their peers, these four factors are likely to be affected by their involvement in the school system. Given the nature of schools, youth spend considerable time in structural proximity to each other through both formal and informal activities. The school is the source of various social evaluations that often affect their choice of friends. Thus, youth tend to become involved with friendship groups that develop within the school they attend. An

individual's susceptibility to peer influence is likely to depend on one's position in one or more of the many groups that exist within the school context.

Whether one is centrally or marginally connected to a friendship group or how close one is to other members is also likely to impact one's involvement in both conventional and "illegal" behavior. In other words, one's position in a social network is expected to affect one's use or non-use of alcohol and/or other drugs and if the former the level of one's use. However, one's involvement in friendship groups is also influenced by other factors. For example, a key institution affecting one's friendships and behavior is the family. Parents in particular exert considerable and typically conventional control over adolescent behavior. Attachment to parents helps shape adolescent friendship networks by influencing the selection of friends who, in turn, influence substance use. If true, the effects of the network characteristics should become stronger when the effect of attachment to parents is held constant. Furthermore, given the increased frequency of involvement, the importance attached to various activities and individuals as well as the intensity of school-based networks, it is expected that this influence will endure over time as other sources of control such as attachment to parents diminish over time relative to the influence of peers with whom they become increasingly involved.

Warr (2002: 130) notes that most delinquency theories focus primarily on individual differences rather than group differences. Group characteristics are rarely paid attention to when we try to understand individual differences for antisocial behavior (see also Krohn and Thornberry, 1993; Fleisher, 2000; Haynie, 2001). It seems likely that social network variables such as *Centrality*, *Prestige*, *Density*, and *Heterogeneity* can be used to explain the level of substance use. From a structural viewpoint, *Centrality*, that is, an actor's perception of his/her position in a group and his/her *Prestige* or popularity within a friendship group are argued to be

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predictors of substance use to the extent that they provide increased opportunities to engage in such behaviors. According to Warr (1996), location in the center of a group may facilitate engagement in substance use.

On the other hand, *Density* or cohesiveness may be expected as a constraining factor. That is, from control perspective, cohesiveness may produce conformity to normative behavior. In other words, in cohesive groups, members are likely to monitor others' behavior not to deviate. However, some may argue that cohesion in groups facilitate antisocial behavior because cohesiveness must be present for secrecy when adolescents engage in illegal behavior. Thus, when a peer group is cohesive enough to show loyalty to group norms, substance use is likely to occur. Although past gang research at least suggests the opposite consequences of *Density* (see Thrasher 1927; Klein 1995), I argue that substance use is less likely to occur in cohesive groups.

Two types of directional ties are used to quantify an actor's location in a group: out-degree and in-degree. Out-degree refers to an actor nomination of others as friends, while in-degree refers to actor being appointed as a friend by another actor. *Centrality* is defined in terms of out-degree, that is, the number times an actor nominates others as friends. *Centrality* refers to an actor's "activeness" or willingness to be a part of one friendship group rather than another.

Prestige measures one's popularity. Using network terminology, popularity is called *Prestige*, which refers to appointed ties from others, that is, in-degree. An offending event within a group context suggests that availability of opportunity to engage in substance use is a key variable. In other words, a popular actor in a given group is likely to be informed and invited to participate in offending opportunities if they occur.

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Density refers to the cohesiveness of a group. Within the context of gang studies, Thrasher (1927) suggests that when gangs encounter external conflicts, they exhibit high cohesiveness or solidarity in order to resolve the conflicts. Therefore group members are likely to expect similar behaviors from one another in the future. On the other hand, there is at least some evidence which suggests that gang members are loosely connected to one another (Klein 1995). Thus, in some cases a lack of group cohesion may increase the likelihood that group members will engage in antisocial behavior including substance use.

Apart from gang studies, Krohn (1986: S82-83) found that social networks typically constrain one's behavior. In a subsequent study, Krohn et al. (1988) examined how multiplexity may produce conformity. Their findings suggest that one's antisocial behavior is easily detected if an individual is a member of multiple groups that constrain one's behavior. They also note that as constraints decrease, the probability that people will engage in unacceptable behaviors increases. However, although it is common that individuals belong to multiple groups, institutions, or organizations, simply joining multiple groups is unlikely to produce conformity. If no one recognizes an individual or cares about his/her behavior, one might question whether group participation serves as a constraining factor. Multiplexity as identified by Kohn et al. (1988) may constrain individuals' antisocial behavior only when members recognize each other within such groups.

If this is the case, recognition by other group members or *Density* is expected to produce conformity to normative behaviors of the group. Consistent with findings by Krohn (1986) and Krohn et al. (1988), Haynie (2001) reports that high cohesiveness in a group will reduce the level of delinquency involvement. However, Krohn and Thornberry (1993) report that cohesiveness among African American and Hispanic alcohol and marijuana users is higher

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than what is found for other racial/ethnic user groups. Since substance use is a prohibited behavior, loyalty to a membership group or secrecy may be essential for these youth. Although cohesiveness may serve as a monitoring function within some groups thus controlling members' antisocial behavior, it may allow higher levels of substance use in groups in which it is acceptable behavior. Although findings from past research are mixed, it is expected that greater *Density* will be negatively associated with substance use.

Given the above, it seems clear that *Heterogeneity* or diversity in a group, may affect one's substance use though perhaps indirectly. As mentioned in the previous chapter, adolescents may choose friends in terms of racial/ethnic similarities and differences depending upon the composition of the school or neighborhood (see, for example, Cairns and Cairns 1994). Control theory suggests that members of less cohesive groups may not be exposed to consistent conventional controls that would prohibit substance use. Therefore, in general, it is expected that racially/ethnically heterogeneous groups will be less cohesive and therefore less constraining in terms of substance use.

In addition to the network variables I also examine whether the effect of attachment to parents plays a significant role on adolescent substance use. Haynie and Osgood (2005) report that while youth are more likely to engage in delinquent behaviors if their friends are highly delinquent, youth who spend considerable unsupervised time with friends are more likely to engage in delinquent behaviors even after controlling for peer delinquency. Further, as Warr's (1993a) finding that parental attachment has little effect on delinquency involvement once adolescents are already exposed to delinquent peers, suggests that for some youth parental control is often limited to the time period before adolescents start to associate with their peers. Past research suggests that parents may be a strong contender to the influence of peers, but that

this effect appears to be conditional. I argue that peer influence is determined by where an individual is located in a peer group. Here, I examine whether one's structural position in a friendship group remains when controlling for the effect of attachment to parents. Thus, when attachment to parents is held constant, the more likely it is that one will be influenced by peers in terms of peer group *Centrality*, *Prestige*, and *Density* and that these youth are more likely to be involved in substance use.

The first set of hypotheses focuses on immediate or short-term network effects. The second set focuses on long-term effect of early network variables.

H1-a: The greater the *Centrality* of an actor's location in his/her peer group, the greater the likelihood the actor will engage in substance use.

H1-b: The greater an actor's *Prestige* in his/her peer group, the greater the likelihood the actor will engage in substance use.

H1-c: The greater the group *Density* of an actor's peer group, the less the likelihood that the actor will engage in substance use.

H1-d: The greater the racial/ethnic *Heterogeneity* of a group, the greater the likelihood of substance use.

H1-e: The effects of *Centrality*, *Prestige*, *Density*, and *Heterogeneity* on substance use will be stronger when the attachment to parents is held constant.

Although the strong correlation between early substance use and later use is often noted, the long-term effects of friendship networks on substance use have not been systematically examined. As noted earlier, Sutherland (1947: 7) argued associations leading to the learning of definitions favorable to the violation of the law would vary in terms of frequency, priority, duration, and intensity. It was also noted, particularly in reference to Coleman (1961) that

school-oriented peer relationships occupy a significant part of the life of adolescents (see also Polk and Schafer 1972). Furthermore, this comes with the added element of increased separation from adults, and perhaps most notably parents, who traditionally have been the primary source of conventional social control with respect to youthful behavior.

Given the role of schools in the lives of adolescents, it may be argued that social network relationships that develop from middle school through high school are likely to play a significant role in the development of social and behavioral patterns that will impact extend at least into early adulthood. If true, then early network relationships may help explain the strong correlation between early and later substance use. Thus, we can expect that the social network variables will help explain the apparent causal effect of early substance use on later use. This is the focus of the second set of hypothesis.

> H2: The effect of early alcohol and marijuana use on future alcohol, marijuana, and
> other illicit/unauthorized drug use in early adulthood is attenuated by early network
> variables, *Centrality*, *Prestige*, *Density*, and *Heterogeneity*.

If H2 is true, we can expect that when we control for effects of the early social network variables the statistical relationship between early and later use will be mitigated. That is, the early social network variables also account for later substance use.

Finally, it is often assumed that the relationship between age and the level of substance use over time will follow a single predictable direction or trajectory. However, the behavioral trajectories of youth typically are not singular. For example, as already noted, some past research (see D'Unger et al. 1998; Nagin et al. 1995; Loeber et al. 1993) has identified multiple trajectory patterns in career offending. Whether multiple and meaningful pathways exist in terms of changes in the level of substance use among youth in this study is at this point an open

question. However, since alcohol is a legal for adults we can expect that with age many will

begin use and some will increase the level of use. On the other hand, because marijuana use is

illegal for both youth and adults it is expected that the number of users will decrease as youth

move into adulthood and have more to lose by getting caught. Thus, different trajectory

patterns between alcohol and marijuana use are expected.

 H3: Over time the trajectory for alcohol use will show an increase in drinking behavior,

   while that for marijuana use will show a decrease.

 In summary, the focus of this study is on how the network variables, *Centrality*,

Prestige, *Density*, and *Heterogeneity*, which incorporate both selection and socialization effects,

influence substance use. Because most youth attend school, friendships developed there are

perhaps particularly important because they spend considerable time in structural proximity to

one another in formal or informal activities. Therefore, these hypotheses will be tested using

data from a study of in-school youth. In the following chapter, the data will be described along

with the measurement of the variables and the analytical strategy to be used.

CHAPTER FOUR

METHODS

Introduction

The central question for this research is: How do peer network characteristics affect substance use among adolescents? The selection of friendship groups and an actor's structural position in a group are used to explain the relationship between peer involvement and substance use. This study includes two separate analyses: a quantitative analysis and a case study. In the quantitative analysis, I examine the relationships between a set of peer network characteristics and adolescent substance use. I then focus on identifiable friendship groups within one school to illustrate the results of the quantitative study. In the case study, I examine how individuals are connected and determine the level of substance use among and within peer groups. The case study is performed to visualize the interrelationships among peers and the level of substance use and to observe structural equivalence among them that is not accomplished by the quantitative study. The visual results revealed in sociometric diagrams allow us to understand of the association between one's structural position and substance use. The data, methods, and measurement are described below.

Study Design and Sample

This study uses data from the National Longitudinal Study of Adolescent Health (Add Health),[4] which focuses on adolescent health and risk-taking behaviors in the context of social networks such as families, friends and other peers, schools, neighborhoods, and communities. The Add Health study was initiated in 1994 "under a grant from the National institute of Child

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[4] The Add Health study was designed by J. Richard Udry (Carolina Population Center, UNC-Chapel Hill), Peter S. Bearman (Department of Sociology, Columbia University) and Kathleen Mullan Harris (Department of Sociology, and Carolina Population Center Faculty Fellow, UNC-Chapel Hill).

Health and Human Development (NICHD) with co-funding from 17 other federal agencies (see Harris et al. 2009)." The study initially involved youth enrolled in grades 7-12 in a nationally representative sample of 145 schools. Waves I and II were conducted in 1994-1995 and 1996 respectively and explored factors that influence adolescent behavior. These factors included personal characteristics, comprehensive information about families and friends, romantic relationships, peer group involvement, and school, neighborhood, and community characteristics. Wave III consisted of interviews conducted in 2001-2002 when the original respondents were between ages 18 and 26.

The Wave I data consist of responses to a self-administered in-school survey completed by approximately 90,000 students enrolled in grades 7 through 12 with a high school participation response rate of more than 70 percent. Slightly over 20,000 students were then selected from the rosters of the participating schools for a second phase of Wave I. This involved an in-home interview with the respondents and their parents. In the home-interviews, students were asked questions about sensitive issues such as sexual orientation and criminal activities that were not included on the in-school questionnaire. Friendship network data were collected as a part of the in-school survey. Respondents were asked to nominate up to five male and female friends. Valid nominations are friends whose name appeared on the respondent's school roster. The Wave II data consist of an in-home interview with 14,738 students who participated in Wave I.[5] Follow up data were gathered in 2001-2002 with 15,170 respondents[6] participating in the Wave III in-home interview.

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[5] For details, consult with UNC Carolina Population Center: Add Health website—study design.
[6] A fourth in-home interview (Wave IV) was conducted using a nationally representative sample of over 20,000 adolescents who were first interviewed in Wave I. However, as of September 2009 the Wave IV data had not been released.

Embedded within these cross-sectional surveys is a three-wave panel study design that included students who participated in both the in-school survey and the in-home interviews at all three time periods (N=8,503). From this number, 334 respondents whose ages[7] were not reported or were younger than 13 and older than 18 at Wave I, were excluded to include the common age range at junior high and high school. In addition, 84 respondents who did not identify their race/ethnicity were dropped. The resulting sample includes 8,085 respondents from 132 schools.[8]

Identification of a school to be selected for the case study was limited to schools in which the entire student body participated in the in-home interview. The questionnaire completed by school administrators was used to identify a "saturated sample."[9] This saturated sample allows us to identify friendship groups within a given school. Sixteen schools met the criteria for a "saturated school." Although all students from these schools were interviewed at home, not all students participated in the in-school survey in which the network questions were asked, and some did not participate in the Wave II in-home interview. In addition, ten schools in which less than 70 percent of the students participated in the in-school survey during Wave I and/or Wave II interview were eventually dropped because most of the network and/or substance use information was not available. The number of respondents in the five schools in which more than 70% of students participated in all of the in-school surveys and Wave I and Wave II in-home interviews, were 20, 43, 53, 55, 61, and 161, respectively.

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[7] Age is calculated based on the date the students were interviewed. Some discrepancies in self-reported sex are corrected.

[8] In addition to the above, a picture vocabulary test was also given to the respondents, and spatial data that identify the respondents' household in a community were included in the Wave I data. The picture vocabulary test, the interviews with the parents, and the spatial data are not used in the current study.

[9] School information was collected from school administrators. One question asked whether "all students at this school were selected for the In-Home Interview" (Add Health School Information Codebook). Responses to this question were used to identify saturated schools.

Because the purpose of case study is to provide a visual understanding of the relationship between friendship connections and substance use, a school with sufficient data in terms of friendship networks and substance use but small enough to diagram was selected. The sample school consists of 61 respondents. Consistent with the quantitative sample, the age range is limited to the initial 13 to 18 year old group. Although the quantitative and case study samples are similar in terms of age and sex distributions there is, unfortunately, almost no racial variation in the case study sample (see Tables 3 and 4).

Dependent Variables

Three types of substance use and two types of alcohol related problems are examined: Frequency of alcohol and marijuana use reported at Waves II and III; other drug use at Wave III; and binge drinking and problems caused by drinking reported at Wave III (see Appendix A).

Frequency of alcohol use is measured by the following question: "During the past 12 months, on how many days did you drink alcohol?"[10] Drinking under parental supervision or having just a sip is not counted as experience. Responses are collapsed into seven categories ranging from "Never" (0) to "Every day or almost every day" (6).

During Wave II, marijuana use is measured by the following question: "Since the last interview, how many times have you used marijuana?" Frequency of marijuana use is converted into three categories: "Never" (0), "1-10 times" (1), and "More than 11 times" (2). At Wave III, marijuana use is measured by the question: "In the past year, have you used marijuana?" The response alternatives were: Yes (1) or No (0). Unfortunately, given this change in wording, the variation in the level of marijuana use at Wave III is different from that at Wave II.

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[10] All questions presented in the text are directly cited from the codebooks.

Alcohol related problems including binge drinking and problems caused by drinking were measured at Wave III. Binge drinking is measured by the question: "During the past 12 months, on how many days did you drink five or more drinks in a row?" The responses were collapsed into seven categories ranging from "Never" (0) to "Every day or almost every day" (6).

Problems caused by drinking are measured by nine questions about negative experiences as a result of drinking. These questions took the following form: "Over the past 12 months, how many times were you hung over?" (see Appendix B). Responses to the nine questions are summed to create an initial scale ranging from 0 to 32. Scale scores were then collapsed into three categories: Never (0), 1-10 (1), and 11-32 (2). The Cronbach's alpha reliability coefficient for this scale is 0.88.

In addition to the measures of substance use described above, other drug use is measured only at Wave III. Participants were asked the following questions about their use of eight illegal/unauthorized drugs since the Wave I interview: "Since June 1995, have you taken any of the following drugs [sedatives or downers, tranquilizers, stimulants or uppers, pain killers, steroids or anabolic steroids, cocaine, crystal meth, and other types of illegal drugs] without a doctor's permission?" "Yes" or "No" responses to each of the eight items were combined to create a scale of "Other drug use" ranging from 0 to 8 (see Appendix A and C). The Cronbach's alpha reliability coefficient for this scale is 0.80.

The purpose of the case study is to visualize the respondents' existing interpersonal relationships and the level of substance use while the students are in school. Thus, the dependent variables used for the case study are alcohol and marijuana use at Wave II.

Independent Variables

The independent variables include the network characteristics, which refer to how individuals are enmeshed into friendship groups. In addition, the respondents' attachment to parents is also included as an independent variable. Because I am examining future substance use, the independent variables must be measured prior to the dependent variables (see Elliott and Voss, 1974; Farrington, 1986; Liska and Messner, 1999). Therefore, all independent variables are measured at Wave I.

Four key network variables are used to explain substance use. These include: C*entrality*, *Density*, *Prestige*, and *Heterogeneity*. Unfortunately, there is little agreement on terminology and definition among network scholars. Therefore, Wasserman and Faust's (1994) terminology and analytical orientation are used here.

The key network element, *Degree* indicates the extent to which an actor is related to others in his/her social network and is measured by the number of non-directional ties an actor possesses. *Degree* can be differentiated into two types of directional ties: 1) *In-degree*, which refers to the number of nominations as a friend received from others; and, 2) *Out-degree*, which refers to the number of nominations as a friend that the actor directs to others. As noted, *Degree* itself is non-directional, which means that mutual nominations between two actors are not necessary. However, because directional ties suggest a stronger link between two actors than does a one-way connection, directional ties are used to measure the four network variables.

Centrality assumes that an actor who is in the center of the network is active, independent, and has options from which to choose in terms of behavior. Therefore, *Centrality* is measured using the actor's nomination of others, that is, *Out-degree* standardized by all possible nominations within a group. *Centrality* is quantified by the following formula:

$$CENTRALITY = \frac{\text{Out-degree}}{g\text{-}1}$$

Where g = The number of group members or group size[11]

Prestige refers to how popular and/or important an actor is within a given network. This is measured by the proportion of appointed ties or *In-degree* to the maximum number of possible appointed ties. For example, the maximum number of possible appointed ties in a group of ten is nine. Thus, an individual who is appointed as a friend from nine members the actor is considered very popular in the group. *Prestige* is calculated by the following formula:

$$PRESTIGE = \frac{\text{In-degree}}{g\text{-}1}$$

Where g = The number of group members or group size

Density refers to the cohesiveness of a group and is defined as the proportion of the number of existing ties in a group to all possible ties in that group. *Density* is calculated by the following formula:

$$DENSITY = \frac{\text{The sum of total send- and receive-network}^{12}}{g * (g\text{ -}1)}$$

Where g = The number of group members or group size
Where $g * (g\text{ -}1)$ = The number of possible ties

Lastly, *Heterogeneity* refers to how diverse a group is. Here *Heterogeneity* in a group is based on the racial/ethnic attributes of the group members. *Heterogeneity* is a group-based variable quantified by the following formula:

$$HETEROGENEITY_{u} = 1 - \left[\sum_{1}^{n} \left(\frac{A_k}{en} \right)^2 \right]$$

Where A = the categorical attribute: race
Ak = the number of nodes with trait k in the ego network
en = the number of nodes in the ego network with valid data on A
n = the total number of traits of A represented in the ego network

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[11] Group size can be measured by several ways: based on nominating ties, appointed ties, and nominating-appointed (non-directional) ties. Since a group usually consists of both nominating ties and appointed ties, group size in this study is determined by both nominating and appointed ties.
[12] This refers to directional ties.

Cairns and Cairns (1994) report that "groups tend to form along any salient characteristic where similarity can be defined (114)" including age, sex, race, etc. On the other hand, they also found that there are significant racial differences in substance use. This suggests that substance use may be more acceptable among some racial/ethnic groups than others. The value 0 refers to complete homogeneity in a group and the higher score indicates greater heterogeneity in a group.

As noted, the network variables focus on peer relationships. Although adolescents spend more time with friends as they grow older, attachment to parents may continue to serve as a major constraining factor regarding substance use. *Attachment to Parents* is measured by five items each in reference to the respondent's mother and father.[13] These are: 1) "How close do you feel to your mother/father?" 2) "How much do you think she/he cares about you?" 3) "Most of the time, your mother/father is warm and loving toward you," 4) "You are satisfied with the way your mother/father and you communicate with each other," and 5) "Overall, you are satisfied with your relationship with your mother/father." The five response categories range from "Not at all/strongly disagree" (1) to "Very much/strongly agree" (5). These ten items (five for each parent) were first summed and then recoded into three categories: Low (1=5-20), Medium (2=21-40), and High (3=41-50). The range of the summed values varied from five to fifty and the frequency were unevenly distributed. Thus, instead of using an ordinal variable and to be consistent with other variables, I categorized the responses into three levels of attachment to parents. The Cronbach's alpha reliability for this scale is 0.88.

Because multicollinearity makes estimation less precise (Hamilton 1992: 82) the relationships between the independent and control variables were examined to determine

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[13] Parents include biological parents, adoptive parents, stepparents, foster parents, etc. (Section 16 in the Wave I Codebook)

whether or not they are highly intercorrelated. Multicollinearity is detected using the Variance

Inflation Factor (VIF) command in STATA to determine "what fraction of the first independent

variable's variance is independent of the other independent variables (Hamilton 2003: 166)."

According to Hamilton (1992: 133-134), perfect multicollinearity occurs when the R^2 equals to

1 with the range from 0 to 1. Tolerance is calculated by $1-R^2$ and perfect multicollinearity

occurs when tolerance equals to zero with the range from 0 to 1. Hamilton (2003: 167) notes

that tolerance tells us "what proportion of each independent/control variable's variance is

independent of all other such variables and a low proportion of tolerance indicates potential

problems." Hamilton also notes that VIF provides guidance of the increase in coefficient

variances suggesting "the degree to which other coefficients' variances are increased due to the

inclusion of that predictor." In general, a VIF value greater than 10 is a cause of concern. The

test did not detect severe multicollinearity (see Table 1).

Table 1. Multicollinearity Diagnostic

Variable	VIF	R-Squared	Tolerance
Age	1.05	0.0512	0.9488
Sex	1.05	0.0478	0.9522
African American	1.19	0.1627	0.8373
Hispanic	1.29	0.2247	0.7753
Asian	1.11	0.0987	0.9013
Native American/American Indian	1.02	0.0178	0.9822
Centrality	2.73	0.6333	0.3667
Prestige	2.87	0.6511	0.3489
Density	1.29	0.2269	0.7731
Heterogeneity	1.22	0.1807	0.8193
Attachment	1.05	0.0517	0.9483
Mean VIF	1.44		

Specification errors were also examined to determine whether relevant variables are

included for analyses. The command under the STATA (SE version 10) operation "performs a

link test for model specification after any single-equation estimation command, such as logistic

regression and regression." It provides an initial diagnosis that indicates whether a model is

properly specified by the predictor variables (see Table 2). This test is run after the logit or

logistic regression is estimated. To determine whether the model in which necessary variables

are included is properly specified, the "linktest" creates two variables: the linear predicted

value (_hat) and linear predicted value squared (_hatsq). The first coefficient (_hat) must be

significant because this value reflects the significance of the model itself. The second

coefficient (_hatsq) suggests that we might omit relevant variable(s), usually interaction terms,

if the value is significant. The linear predicted value (_hatsq) indicates that the linktest failed

to reject the assumption that the model is properly specified without removing any variables.

Thus, specification error is not a concern (UCLA Academic Technology Services,

http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm). The test confirmed

that independent and control variables indicated in Table 1 can be meaningfully selected for

this study (see Table 2).

Table 2. Logistic Regression Diagnostics for Specification Error

Variable	Coefficient	P>|z|
_hat	1.07	0.007
_hatsq	-0.0112	0.863

Control Variables

Control variables include: Age, sex, and race/ethnicity. Age and sex were determined

from the Wave I interview. The sample for the quantitative study consists of 49% males and

51% females. The mean age is 15.3 years old. The sample school in the case study consists of

47.5% males, 52.5% females, and the mean age is 15.1 years old.

Race/ethnicity includes: Non-Hispanic Whites, African Americans, Hispanics, Asians or Pacific Islanders, and American Indians or Native Americans.[14] The descriptive statistics for the two samples including the racial/ethnic distributions are presented in Tables 3 and 4 (see Appendix A for a detailed variable description).

Table 3. Descriptive Statistics for the Quantitative Study (N=8,085)

Variables		Mean	Std. Dev.	Min	Max
Independent Variables					
Centrality		0.61	0.31	0	1
Prestige		0.63	0.29	0	1
Density		0.30	0.15	0.06	1
Heterogeneity		0.28	0.22	0	0.80
Attachment to Parents		2.46	0.63	1	3
Control Variables					
Age		15.33	1.46	13	18
Male (=1)				0	1
Male	46.10%				
Female	53.90%				
Race					
Non-Hispanic White	52.99%				
African American	22.20%				
Hispanic	15.34%				
Asian	7.74%				
American Indian or					
Native Americans	1.73%				
Dependent Variables					
Drinking level at Wave II in the past 12 months		1.88	1.41	0	6
Marijuana use at Wave II in the past 12 months		0.33	0.64	0	2
Drinking level at Wave III in the past 12 months		2.19	1.74	0	6
Marijuana use at Wave III in the past 12 months		0.31	0.46	0	1
Binge drinking at Wave III in the past 12 months		1.24	1.57	0	6
Problem drinking at Wave III in the past 12 months		0.69	0.64	0	2
Drug use at Wave III in the past 12 months		0.73	1.47	0	8

Analytical Strategy

Because the dependent variables are ordered categories, the hypotheses are examined using ordered logistic regression. The statistical software STATA is used in the quantitative analysis. For the analyses, weight variables are incorporated to correct for design effects. For

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[14] Hereafter, these racial/ethnic groups are referred as to Whites, Asians, and Native Americans.

example, in the Add Health study, some minority groups such as African Americans from well educated families and Cubans were oversampled to make the sample representative of school enrollments in the United States. Thus, the data are adjusted equivalent to an unbiased nationally representative sample. In addition, survey data commonly reflect a complex sampling design based on oversampling, clustering, and stratification, which requires specialized analytical tools that provide appropriate adjustment to the stratified sample (Hamilton 2003, 50-51).

Table 4. Descriptive Statistics for the Case Study (N=61)

Variables		Mean	Std. Dev.	Min	Max
Independent Variables					
Centrality		0.66	0.27	0	1
Prestige		0.72	0.25	0	1
Density		0.46	0.16	0.22	0.83
Heterogeneity		0.17	0.15	0	0.48
Attachment to parents		2.89	0.37	1	3
Control Variables					
Age		15.07	1.79	12	20
Male (=1)				0	1
Male	47.54%				
Female	52.46%				
Race					
Non-Hispanic White	95.08%				
Hispanic	4.92%				
Dependent Variables					
Drinking level in the past 12 months		0.25	0.62	0	2
Marijuana use in Wave II in the past 12 months		0.15	0.40	0	2

In addition to two-wave logistic regression, changes in alcohol and marijuana use throughout the three waves are examined to determine whether individuals exhibit different patterns in substance use over time. The software package M-Plus (Muthen and Muthen, 2001) is used to draw trajectories for substance use. M-Plus is "a statistical modeling program" that allows researchers to employ various level of analysis or estimates both cross-sectional and

longitudinal data (see Muthen and Muthen, M-Plus homepage, retrieved on February 15, 2010: http://www.statmodel.com/features.shtml).

In terms of changes in the level of substance use, a Latent Growth Mixture Model (LGMM) is used to draw meaningful trajectories of substance use from late teens to mid-twenties among the entire sample. Selecting models that exhibit significant difference in behavioral patterns is sought within a Bayesian context (Bayes 1763).[15] Here Schwartz's Bayesian information Criterion (BIC)[16] is used because it maximizes the function of models to choose from others that include different numbers of models.

A conventional growth model estimates a developmental trajectory for the population based on individual differences. In contrast, the LGMM (see Wiesner and Windle 2004: 435) assumes that "the population is composed of a mixture of distinct subgroups, each defined by a prototypical growth curve." Since each individual is supposed to have a different level of substance involvement and trajectory pattern, I attempt to identify a number of distinct pathways in substance use based on the characteristics of one's friendship network. The LGMM is better suited to the task than Hierarchical Linear Model (HLM). Although HLM captures within- and between-person differences such as gender and race (Horney et al. 1995) LGMM identifies the full variation of the data, that is, multiple unobserved trajectories. Because individual differences beyond the traditional demographic differences listed above are of interest here, the LGMM is most appropriate.

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[15] Responding to Schwartz's criticism that "the maximum likelihood (ML) principle invariably leads to choosing the highest possible dimension (1978, 461)" to fit observations, Akaike (1974) expanded the ML principle to choose a best-fit model among different parameters by running ML separately for different models. However, Akaike's expansion, which is referred to as the Akaike Information Criterion (AIC), has been criticized for its inconsistency (see Kashyap, 1980).

[16] BIC=-2logL+r ln n where L=the maximized value of the likelihood function for an estimated model: r=the number of free parameters to be estimated; and n=the number of observations.

For the case study, UCINET (by Roberta Chase and Steve Borgatti) is used to create a sociomatrix and sociogram to describe interpersonal and structural connections within a given group. UCINET, which allows us to grasp the individuals' positions within their networks, is an excellent tool to provide detailed network connections graphically. Further, according to Scott (1991: 117), it also offers us an instrument to divide the sample into subgroups such as cliques that consist of a subset of nodes of three of more in which "every possible pair of nodes is directly connected by a line and the clique is not contained in any other clique."

CHAPTER FIVE

QUANTITATIVE STUDY: FINDINGS AND DISCUSSION

Introduction

In this chapter I examine the relationship between network characteristics and substance use. The focus of the regression analyses relating to Hypothesis 1 is on how structural proximity to one's friends at Wave I affects the use of alcohol and marijuana at Wave II. This hypothesis is tested using different models to determine the effects of the network variables *Centrality, Prestige, Density,* and *Heterogeneity*. I also examine whether the effects of the network variables on substance use increase when the level of attachment to parents is held constant.

Although a positive relationship between early and later substance use has been well-documented by criminologists (for discussions, see Cairns and Cairns 1994; Barnes et al. 1992), the potential long-term effects of early friendships on later substance use has not been examined systematically. The analyses testing Hypothesis 2 examine the relationship between the respondents' positions in early friendship networks and substance use at Wave III as respondents move into adulthood. Finally, I examine Hypothesis 3, which deals with long-term behavioral trajectories for alcohol and marijuana use.

Hypothesis 1

Four initial models are used to address Hypothesis 1, which states that the greater the *Centrality*, *Prestige*, *and Heterogeneity* of an individual's location in a social network, the greater the likelihood the individual will engage in substance use; and, the greater the *Density*

of an individual's social network, the less likely it is that the individual will engage in substance use.

Model 1 addresses the role of *Centrality*, which refers to an actor's activeness in nominating others as friends. Greater *Centrality* is expected to be associated with higher levels of substance use because these individuals are assumed to have greater opportunities to engage in substance use. Model 2 examines *Prestige*, which refers to the popularity of an actor. If we assume that alcohol or drug use is acceptable behavior among adolescents, then the more often an actor is nominated as a friend by others, or is popular in one's peer group, the more likely it is that the actor will be a substance user. Model 3 addresses the *Density* or cohesiveness of an actor's friendship groups. If we assume that cohesiveness in groups reflects strong attachment to conventional peers, then youth in less cohesive groups should have greater freedom to engage in prohibited behaviors and therefore have higher levels of substance use. Model 4 examines the effect of the degree of racial/ethnic *Heterogeneity* within groups. Here it is assumed that heterogeneous groups will be characterized by a diversity of values or attitudes toward substance use. As such, these groups are less likely than homogeneous groups to be cohesive and less consistent in the enforcement of conventional controls. Actors in such groups are expected to have higher levels of substance use.

Finally, Models 5 through 7 explore whether the effects of the network variables are increased when attachment to parents is controlled. Because attachment to parents is assumed to be a source of conventional social control, it is expected that strong attachment to parents will serve as a constraining factor with respect to substance use. If true, and assuming that everyone equally attached to their parents, the effects of the network variables should be strengthened.

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As the intercorrelations among the variables reported in Table 5 reveal, all of the independent variables are correlated with both alcohol and marijuana use. In addition, age is positively correlated with substance use while sex is positively correlated with these behaviors indicating that substance users are most likely to be older and male. It should be noted that although the correlation coefficients are statistically significant most are small. This is no doubt due in part to the skewed distributions of the substance use measures, which is typical in this type of study. Nevertheless, these findings suggest some initial support for Hypothesis 1. For example, *Prestige* is positively associated with both alcohol and marijuana use and *Density* is negatively associated with both substances. On the other hand, the correlation between *Centrality* and substance use is just the opposite from the hypothesized direction, and *Heterogeneity* varies by substance type. A somewhat different picture emerges when I turn to the regression analysis.

Alcohol Use

The results for Model 1 are reported in Table 6 and indicate that *Centrality* does not have the expected positive effect on alcohol use. Greater *Centrality* of an actor in a group, at least as measured here, has no apparent effect on alcohol use.

Similarly, Model 2 reveals that like *Centrality*, *Prestige* has no effect on alcohol use. *Prestige*, or popularity, was expected to be associated with a greater likelihood of underage drinking. It may be that because alcohol is an easily accessible substance, one's position in a network makes little difference. An alternative explanation is that popular individuals are more likely to be law-abiding and thus nominated by non-delinquent friends who represent the majority of respondents. Some suggestive evidence of this can be seen given the findings regarding *Density*.

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Table 5. Correlation Matrix for All Variables

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)
(1) Age	1.000																
(2) Male	0.063	***	1.000														
(3) Centrality	-0.061	***	-0.076	***	1.000												
(4) Prestige	0.067	***	-0.030	**	-0.742	***	1.000										
(5) Density	0.014		-0.011		0.060	***	0.252	***	1.000								
(6) Heterogeneity	-0.096	***	-0.006		-0.003		-0.048	***	-0.128	***	1.000						
(7) Attachment to Parents	-0.083	***	0.105	***	0.032	**	-0.017		-0.005		-0.052	***	1.000				
(8) Alcohol Use	0.174	***	0.046	***	-0.027	*	0.041	***	-0.033	**	-0.055	***	-0.076	***	1.000		
(9) Marijuana Use	0.094	***	0.031	**	-0.045	***	0.054	***	-0.012		0.043	***	-0.138	***	0.429	***	1.000

*p<0.05, **p<0.01, ***p<0.001

Table 6. Network Characteristics on Alcohol Use at Wave II (N=7,106)

Variable	Model 1		Model 2		Model 3		Model 4	
Age	0.26	***	0.26	***	0.27	***	0.26	***
	(0.02)		(0.02)		(0.02)		(0.02)	
Male	-0.09		-0.07		-0.08		-0.08	
	(0.07)		(0.07)		(0.07)		(0.07)	
African American	-0.83	***	-0.82	***	-0.83	***	-0.81	***
	(0.12)		(0.12)		(0.13)		(0.12)	
Hispanic	-0.09		-0.08		-0.07		-0.06	
	(0.11)		(0.11)		(0.12)		(0.12)	
Asian	-0.82	***	-0.83	***	-0.78	***	-0.81	***
	(0.19)		(0.19)		(0.19)		(0.19)	
Native American	-0.28		-0.27		-0.29		0.27	
	(0.28)		(0.28)		(0.28)		(0.28)	
Centrality	-0.16							
	(0.11)							
Prestige			0.25					
			(0.13)					
Density					-0.77	*		
					(0.33)			
Heterogeneity							-0.09	
							(0.22)	
F	0.00	***	0.00	***	0.00	***	0.00	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

Consistent with my hypothesis, Model 3 shows that group *Density* or cohesiveness has a significant negative effect on alcohol use. Individuals who belong to cohesive groups are less likely to drink. Cohesive groups appear to serve as a source of conventional social control and thus constrain rather than facilitate adolescent drinking. This is consistent with the findings reported by Burkett (1977b) that isolation from conventional social activities may lead to heavy involvement of alcohol and drug use. The finding is also consistent with Haynie's (2001) study, which suggests that *Density* is negatively associated with delinquency involvement when all other variables are controlled.

Groups characterized by racial/ethnic heterogeneity were hypothesized to be less constraining with regard to adolescent drinking than more homogeneous groups. That is,

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racial/ethnic heterogeneous groups are expected to lack solidarity with respect to the enforcement of conventional social controls relating to substance use. In the absence of such controls substance use is more likely to occur. As noted in Table 5, *Heterogeneity* is negatively correlated with *Density*, which suggests that heterogeneous groups are less cohesive. However, the findings do not support the hypothesis that *Heterogeneity* increases the likelihood of drinking. Model 4 shows that *Heterogeneity* has no apparent effect on underage drinking.

 Interestingly, when the network characteristics are examined together (see Model 5 in Table 7) still another picture emerges. In addition to *Density, Prestige* now shows a significant effect on drinking. It appears that popular individuals are more likely to engage in underage drinking, but that those in cohesive groups are less likely to drink. In other words, someone who is popular, but belongs to a loosely organized group is most likely to engage in underage drinking. Furthermore, although individuals are recognized and nominated by others, they rarely reciprocate by nominating others as friends. This may contribute to the appearance of a lack of cohesiveness in the groups to which they belong. This appears to be similar to what Yablonsky (1959) refers to as a "near-group," which is loosely organized around a sometimes charismatic "leader."

Consistent with past research, these findings show that youth who drink tend to be somewhat older than those who do not. However, in these models differences by sex appear to be negated. This discrepancy between the correlations and the regression analysis is explained by the effects of other independent variables.

Among the network variables, attachment to parents is positively correlated with *Centrality* and negatively correlated with *Heterogeneity* (see Table 5). Social control theory suggests that youth who are strongly attached to their parents are unlikely to choose friends

who are substance users, whereas those who do not have such ties are more likely to do so.

The network variables, which are generally consistent with social learning theory, suggest that

those who are involved with substance users are likely to be subject to socialization to within

friendship group expectations. Therefore, it is necessary to examine how the effects of the

network variables change when attachment to parents is controlled.

Table 7. The Effects of the Network Variables on Alcohol Use When Attachment to Parents is Held Constant (N=7,040)

Variable	Model 5		Model 6		Model 7	
Age	0.26	***	0.25	***	0.24	***
	(0.02)		(0.02)		(0.02)	
Sex	-0.05		-0.04		0.00	
	(0.07)		(0.07)		(0.07)	
African American	-0.78	***	-0.91	***	-0.88	***
	(0.12)		(0.12)		(0.12)	
Hispanic	0.00		-0.10		-0.01	
	(0.12)		(0.11)		(0.11)	
Asian	-0.70	***	-0.81	***	-0.70	***
	(0.19)		(0.19)		(0.19)	
Native American	-0.27		-0.31		-0.31	
	(0.28)		(0.27)		(0.28)	
Centrality	0.36				0.39	*
	(0.18)				(0.19)	
Prestige	0.65	**			0.69	***
	(0.21)				(0.21)	
Density	-1.16	**			-1.22	**
	(0.37)				(0.38)	
Heterogeneity	-0.22				-0.27	
	(0.23)				(0.23)	
Attachment to Parents			-0.32	***	-0.34	***
			(0.06)		(0.06)	
F	0.00	***	0.00	***	0.00	***

* $p<0.05$, **$p<0.01$, ***$p<0.001$
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

Attachment to parents has, as expected, a strong negative effect on alcohol use (see

Model 6 in Table 7). As control theory suggests, attachment to parents serves as a constraining

factor. When the effect of attachment to parents is included in Model 7 (Table 7), *Centrality*

shows a significant positive effect on alcohol use. In addition, the positive effect of *Prestige*

and the negative effect of *Density* are stronger. Clearly attachment to parents has a significant

impact on adolescent alcohol use, but when attachment to parents is controlled the effects of the

network variables on alcohol use are stronger. For example, the significance level of *Density*

increased, and *Centrality* became significant. Although the coefficient of attachment to parents

is marginally increased by controlling for the network variables, the change is not statistically

significant.[17] Overall, Hypothesis 1 for alcohol use is partially supported.

Although not addressed to this point, it is apparent from the models examined that with

the possible exception of Native Americans, there are significant differences in levels of

alcohol use by race/ethnic groups. For example, the mean drinking level of Whites is

significantly greater than for African Americans and Asians (Table 8). The findings also reveal

that as a group, Hispanic youth drink significantly more than either African American or Asian

youth. These differences are borne out when I examine racial/ethnic differences in alcohol use

using One-Way Analysis of Variance or ANOVA. Because there are five racial/ethnic

categories in the sample, the Scheffé multiple-comparison test is used to determine the

differences between each pair of means (Hamilton, 1998: 117). As noted, the results reveal

significant racial/ethnic differences in the levels of alcohol use. To understand to role of

racial/ethnic differences, interaction terms are examined for each of the previous models (see

Table 9, Models 1a-4a).

When the interaction terms are examined, *Centrality* becomes significant and serves as

constraining factor for some youth. For example, *Centrality* has a significant positive effect on

drinking among African Americans. Thus, the initial hypothesis regarding *Centrality* is

supported, but only among African Americans. For these youth, the general effect of

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[17] Although it is not within the scope of this study, when the effects of the network variables are examined by the
levels of attachment to parents, the results are inconsistent or non-significant.

Centrality may mean that those who are actively involved in their friendship groups are unlikely to disapprove of others' drinking even if they do not drink themselves. This is different from Warr's (1996) finding which suggests that instigators will exhibit higher levels of delinquency involvement. For all other race/ethnic groups locating in the center of the group by nominating others as friends is unrelated to underage drinking.

Table 8. ANOVA for Difference in Alcohol Use at Wave II (N=8,036)

Difference	Hispanic		African American		Asian		Native American
African American	-0.35	***					
Asian	-0.31	***	0.04				
Native American	-0.09		0.26		0.22		
White	0.13		0.48	***	0.44	***	0.22

*p<0.05, **p<0.01, ***p<0.001

Although *Prestige* becomes significant when interaction terms are considered, none of the interaction terms are significant. Thus, this model does not offer clear evidence that minorities in general are more or less influenced by *Prestige* than are Whites. In other words, it appears that *Prestige* or popularity is related to drinking behavior regardless of race. Contrary to the findings for the sample as a whole, *Density* has a significant positive effect on underage drinking among African Americans and Asians. This is, in part, consistent with findings reported by Krohn and Thornberry (1993) that showed cohesiveness among African American substance users to be strong. However, the findings are not consistent with the additional finding that cohesiveness is strong among Hispanic user groups. Furthermore, and contrary to Krohn and Thornberry's findings (1993), cohesiveness among Asians is also strong and significant. In any event, these findings suggest that *Density* functions differently based on one's racial/ethnic background.

Table 9. Interaction Effects with Network Characteristics on Alcohol Use at Wave II (N=7,040)

Variable	Centrality Model 1-a		Prestige Model 2-a		Density Model 3-a		Heterogeneity Model 4-a	
Age	0.27	***	0.26	***	0.27	***	0.26	***
	(0.02)		(0.02)		(0.02)		(0.02)	
Male	-0.09		-0.07		-0.08		-0.08	
	(0.07)		(0.07)		(0.07)		(0.07)	
African American	-1.30	***	-0.47		-1.34	***	-0.78	***
	(0.24)		(0.25)		(0.30)		(0.18)	
Hispanic	-0.25		0.19		-0.37		0.16	
	(0.20)		(0.26)		(0.26)		(0.25)	
Asian	-1.35	**	-0.10		-1.52	***	-1.18	***
	(0.42)		(0.47)		(0.36)		(0.21)	
Native American	-0.60		-0.03		-0.78		-1.37	*
	(0.59)		(0.75)		(0.54)		(0.63)	
Network variable	-0.35	*	0.41	*	-1.26	**	-0.19	
	(0.15)		(0.17)		(0.41)		(0.26)	
Network variable x African American	0.81	*	-0.56		1.84	*	-0.09	
	(0.33)		(0.34)		(0.85)		(0.42)	
Network variable x Hispanic	0.26		-0.28		1.02		-0.41	
	(0.33)		(0.35)		(0.69)		(0.57)	
Network variable x Asian	0.86		-1.13		2.24	*	1.02	
	(0.51)		(0.70)		(0.78)		(0.68)	
Network variable x Native American	0.52		-0.39		1.82		3.71	
	(0.98)		(1.12)		(2.01)		(1.93)	
F	0.00	***	0.00	***	0.00	***	0.00	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

When the variable *Heterogeneity* is examined, I find virtually no interaction effects on drinking. However, drinking among Native Americans does appear to be significantly different from Whites. When all other variables including the interaction terms are controlled (see Model 4-a) the drinking level among Native Americans is significantly lower than Whites. This is, perhaps somewhat surprising given the fact that according to the 2008 population statistics (see U.S. Census Bureau 2000: Table 3), Native Americans comprise only 1.01 percent of total population in the United States. However, given the even smaller number who

attend school outside of reservations, they are perhaps more likely than others to belong to a

racially/ethnically diverse groups. This suggests that Native American youth may be more

tolerant of diverse social settings and thus at least some are better able to cope with such

settings by drinking compared to White youth.

Further examination of race/ethnicity reveals which network variables have an effect on

substance use (see Table 10). Consistent with the interaction model (see Model 1-a in Table 9),

Centrality has a significant effect on underage drinking only among African Americans. On

the other hand, *Prestige* is positively associated with underage drinking only among Whites.

Density also seems to function uniquely depending on race/ethnicity. For example, it has a

significant positive effect on underage drinking among Asians, but a significant negative effect

among Whites. One plausible explanation for this difference is that Asians may believe that

illegal activity should be kept secret; thus they commit such behavior only when group

members are closely connected.

Table 10. Network Effects on Alcohol Use at Wave II by Race/Ethnicity

	White		African American		Hispanic		Asian		Native American	
Age	0.29	***	0.27	***	0.18	**	0.23	*	-0.34	
	(0.03)		(0.06)		(0.07)		(0.10)		(0.18)	
Male	-0.02		-0.03		-0.05		0.08		-0.37	
	(0.09)		(0.20)		(0.21)		(0.33)		(0.42)	
Centrality	0.36		0.84	*	0.16		-0.95		-0.59	
	(0.24)		(0.41)		(0.58)		(0.64)		(1.56)	
Prestige	0.83	**	0.61		0.36		-1.97		0.41	
	(0.26)		(0.44)		(0.64)		(0.99)		(1.66)	
Density	-1.74	***	0.10		-0.69		2.41	*	0.98	
	(0.46)		(0.78)		(0.80)		(1.11)		(2.44)	
Heterogeneity	-0.22		-0.24		-0.78		1.02		3.48	*
	(0.27)		(0.40)		(0.59)		(0.68)		(1.51)	
F	0.000	***	0.000	***	0.141		0.055		0.087	
N	3,835		1,534		1,054		560		123	

*p<.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Finally, when I examine alcohol use within race/ethnicity, *Heterogeneity* has a significant positive effect on underage drinking only among Native Americans. Furthermore, when the social network variables are examined together, the effect of *Heterogeneity* continues to show a significant positive association with underage drinking among Native Americans. There are at least two plausible explanations for this finding. First, based on socialization model, members of heterogeneous groups are more likely to be exposed to and possibly accept different values and therefore behave accordingly. For Native Americans, *Heterogeneity* in groups may create different opportunities to engage in alcohol use, which in turn, may increase the likelihood of drinking when other social network factors are taken into account. Second, it is also possible that Native Americans are likely to experience social isolation and when possible, selectively choose other Native Americans as friends. However, failing that due to the small number of choices, such negative experiences may result in more drinking as a means of coping with social isolation and a lack of conventional social controls even though they may still drink less than Whites.

As noted earlier, when drinking by Native Americans is compared to Whites and *Heterogeneity* is examined alone, Native Americans drink less than Whites (Table 9). However, when *Heterogeneity* is examined within race/ethnicity it appears to have no significant effect among White youth (Table 10). This may be due to the fact that given their large numbers, White youth are less likely to be in racially/ethnically diverse friendship groups. My interpretation with the findings in these two Tables is that *Heterogeneity* in general does not have an effect on underage drinking among White youth, but when they happen to be in a racially/ethnically diverse group Whites are more likely to drink. On the other hand, because Native Americans are more likely to be in racially/ethnically diverse groups when attending

schools outside of reservations and they are used to being in such social setting, *Heterogeneity*

has less impact on drinking among them compared to Whites. However, when *Heterogeneity* is

examined within race/ethnicity, it greatly affects the level of drinking among Native American

youth because unlike Whites youth they are unable to avoid heterogeneous social settings. As

already noted, the small number of Native Americans in the total sample renders these findings,

and my interpretation of them, tentative at best.

In sum, with the exception of *Density* each network variable, by itself, does not appear

to have a significant effect on drinking. However, a different picture emerges when all of the

variables are controlled. *Prestige* appears to be significant as a facilitating factor whereas

Density appears to be a significant constraining factor. In addition, the effects vary by

race/ethnicity.

Marijuana Use

Actively nominating others as friends is expected to be associated higher levels of

marijuana use because individuals seek opportunities to engage in marijuana use. However, the

findings reported in Model 1 in Table 11 suggest that *Centrality* is strongly and negatively

related to marijuana use. This is contrary to Warr's (1996) findings that instigators, who are

likely to occupy a central location in a group, are more likely to engage in delinquent behavior

than followers. These findings suggest that individuals with high *Centrality* are less likely to

engage in illegal activities. The discrepancy between Warr's (1996) and these findings may be

due to how I have measured *Centrality*. He identified instigators as those who initiate the

commission of certain offenses rather than one's location within a group. The number of

nominations of others as friends that an individual makes, which is the measure used here, may

be indicative of one's self-perceived location in a group rather than one's location in the group

as defined by others. Those that an individual selects as friends may not provide greater

opportunities to engage in marijuana use.

Table 11. Network Characteristics on Marijuana Use at Wave II (N=6,943)

Variable	Model 1		Model 2		Model 3		Model 4	
Age	0.17	***	0.17	***	0.18	***	0.20	***
	(0.03)		(0.03)		(0.03)		(0.03)	
Male	-0.08		-0.05		-0.05		-0.05	
	(0.11)		(0.10)		(0.11)		(0.11)	
African American	-0.14		-0.10		-0.11		-0.17	
	(0.14)		(0.14)		(0.14)		(0.14)	
Hispanic	0.13		0.16		0.18		-0.03	
	(0.14)		(0.14)		(0.14)		(0.15)	
Asian	-0.77	**	-0.77	**	-0.74	**	-0.91	***
	(0.25)		(0.25)		(0.25)		(0.25)	
Native American	0.70	**	0.72	**	0.71	**	0.68	*
	(0.26)		(0.25)		(0.26)		(0.26)	
Centrality	-0.45	***						
	(0.13)							
Prestige			0.51	***				
			(0.12)					
Density					-0.50			
					(0.30)			
Heterogeneity							0.75	***
							(0.22)	
F	0.00	***	0.00	***	0.00	***	0.00	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

As expected, *Prestige* does have a significant positive effect on marijuana use (Model

2). One's popularity in a friendship network is perhaps more likely to play a crucial role for

marijuana use because compared to alcohol, marijuana is not as readily accessible. Therefore,

juveniles who are the center of attention may have greater opportunities to experience

marijuana with their friends. It may also be the case that those who already use marijuana are

perceived as "cool" and are selected as friends for this reason.

Unlike alcohol use, *Density* does not have a significant effect on marijuana use (Table

11, Model 3). Within group cohesiveness is apparently unrelated to the use of marijuana.

Although network connections may be necessary for an initial experience, once involved in marijuana use, adolescents do not appear to be bound to a cohesive group.

Finally, the findings regarding *Heterogeneity* are consistent with my expectation that members of heterogeneous groups are more likely to use marijuana. This is indicated by the significant positive effect on marijuana use (see Model 4 in Table 11). Racial/ethnic heterogeneity in friendship groups may weaken the level of cohesiveness in group, which in turn, facilitates marijuana use due to the lack of conventional control from others (r between *Density* and *Heterogeneity*=-0.128). Racial/ethnic heterogeneity may also be indicative of diverse and possibly competing value/belief systems within such groups. If true, this finding is consistent with the notion that adolescents in heterogeneous groups are more likely to be exposed to values supportive of marijuana use.

The above makes a little more sense when I examine what happens when all of the independent variables are included. When all the network variables are included the effect of *Centrality* is canceled out. Consistent with Models 1 through 4, *Prestige* and *Heterogeneity* have significant positive effects on marijuana use. The entire model is consistent with the notion that friendship networks are necessary for individuals to develop attitudes favorable to marijuana use and to engage in the behavior. For example, in heterogeneous groups where diverse values or definitions favorable toward marijuana use are potentially more likely, individuals are also more likely to be users. Given exposure to normative values different from their own, marijuana use may very well be based on newly developed attitudes as a product of socialization. At the same time, it may be that some may choose to belong to heterogeneous groups that appear to have normative values and standards similar to their own. Furthermore,

popular individuals are more likely to engage in marijuana use or alternatively, marijuana users tend to be popular among non-users who aspire to be like them.

As was true for alcohol use, Model 6 in Table 12 shows that attachment to parents has a significant negative effect on marijuana use. Consistent with alcohol use, when all independent variables are incorporated in Model 7, *Centrality* remains non-significant. However, *Density* is significantly and negatively related to marijuana use. *Prestige* has a significant positive effect on marijuana use and its effect is stronger. The differences from the findings for alcohol use are that *Heterogeneity* has a significant positive effect on marijuana use while *Centrality* has no effect. This seems to be consistent with Orcutt's study (1978) of alcohol and marijuana use in which he found that marijuana use is more acceptable than alcohol when the subject's motivation is "personal" rather than "social." That is, smoking marijuana is acceptable in a small though not necessarily cohesive group of friends as a means of coping with the stresses of school or not "fitting in" compared to drinking alcohol to withdraw from a boring party.

The entire model shows that attachment to parents still has a significant negative effect on marijuana use, but the effect is virtually the same when the network variables are included. That is, among adolescents, attachment to parents is not affected by the network variables whereas the network variables are influenced when attachment to parents is controlled. Among adolescents, friendship networks are undoubtedly a major socialization agency, and when the impact of parents is controlled youth are more likely to be affected by the friendship network position with regard to marijuana use.

As with alcohol use, age is clearly related to individual use of marijuana, that is, youth who engage in marijuana use tend to be older than non-users. When age is controlled, all of the network variables except for *Centrality* show a significant influence on marijuana use.

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Consistent with alcohol use, sex appears to be unrelated to marijuana use even though there is a modest correlation between the two. In general, Hypothesis 1 for marijuana use is generally well supported.

Table 12. The Effects of the Network Variables on Marijuana Use When Attachment to Parents is Held Constant (N=6,943)

Variable	Model 5		Model 6		Model 7	
Age	0.19	***	0.16	***	0.16	***
	(0.03)		(0.03)		(0.03)	
Male	-0.04		0.04		0.06	
	(0.11)		(0.11)		(0.11)	
African American	-0.17		-0.31	*	-0.36	*
	(0.14)		(0.14)		(0.14)	
Hispanic	-0.02		0.12		-0.04	
	(0.15)		(0.14)		(0.15)	
Asian	-0.88	***	-0.81	**	-0.90	***
	(0.25)		(0.23)		(0.23)	
Native American	0.67	*	0.66	*	0.61	*
	(0.26)		(0.25)		(0.26)	
Centrality	-0.02				0.05	
	(0.24)				(0.25)	
Prestige	0.59	*			0.68	**
	(0.25)				(0.26)	
Density	-0.63	*			-0.77	*
	(0.34)				(0.35)	
Heterogeneity	0.73	**			0.64	**
	(0.23)				(0.24)	
Attachment to Parents			-0.69	***	-0.69	***
			(0.08)		(0.08)	
F	0.00	***	0.00	***	0.00	***

* $p<0.05$, **$p<0.01$, ***$p<0.001$
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

Considering all the models above, it is apparent that there are racial/ethnic differences in marijuana use just as there are for alcohol use. The ANOVA results reported in Table 13 are generally consistent although there are some differences. For example, the ANOVA analysis shows that both African American and Asian youth are less likely than White youth to use

marijuana. The fact that there are differences between groups suggests that the interaction effects of the network variables with race/ethnicity need to be examined.

Table 13. ANOVA for Difference in Marijuana Use at Wave II (N=7,942)

Difference	Hispanic		African American		Asian		Native American
African American	-0.08	*					
Asian	-0.13	**	-0.05				
Native American	0.10		0.18	*	0.23	**	
White	-0.01		0.07	**	0.12	***	-0.11

*p<0.05, **p<0.01, ***p<0.001

When the interaction terms are included in each model, all of the network variables are significantly related to marijuana use though the direction varies. *Centrality* continues to have a significant negative effect on marijuana use (Table 14, Model 1-a). Unlike alcohol use, *Centrality* does not have any effect for marijuana use among African Americans. On the other hand, *Prestige* has a significant positive effect on marijuana use regardless of race/ethnicity (Model 2-a) and popular individuals are more likely to use marijuana.

In general, *Density* (see Model 3-a) appears to be a constraining factor for the sample as a whole. Since the sample is predominantly White, the overall effect may be due to their large numbers. However, whereas the general effect of *Density* is negative, it is positively associated with marijuana use among African American and Hispanic youth. This is consistent with the findings reported by Krohn and Thornberry (1993) that both African American and Hispanic alcohol and marijuana users are more intimately related to one another than are non-users. For these racial/ethnic groups, adolescents that use marijuana are likely to be members of relatively cohesive groups. Why and how these differences occur is beyond the scope of this investigation, but a plausible explanation is that certain racial/ethnic groups are more likely to hide their illegal behavior from those outside their group and to demand loyalty to the group.

Table 14. Interaction Effects with Network Characteristics on Marijuana Use at Wave II (N=6,943)

Variable	Centrality Model 1-a		Prestige Model 2-a		Density Model 3-a		Heterogeneity Model 4-a	
Age	0.17	***	0.17	***	0.18	***	0.20	***
	(0.03)		(0.03)		(0.03)		(0.03)	
Male	-0.08		-0.05		-0.05		-0.05	
	(0.11)		(0.11)		(0.11)		(0.11)	
African American	-0.40		0.04		-0.76	***	-0.05	
	(0.24)		(0.25)		(0.21)		(0.23)	
Hispanic	-0.05		0.30		-0.27		0.57	
	(0.26)		(0.30)		(0.23)		(0.38)	
Asian	-0.81		-0.58		-0.69		-1.09	
	(0.41)		(0.54)		(0.61)		(0.55)	
Native American	-0.06		1.15		-0.29		0.98	*
	(0.53)		(0.61)		(0.56)		(0.46)	
Network variable	-0.61	***	0.60	***	-1.10	**	0.96	***
	(0.17)		(0.16)		(0.38)		(0.26)	
Network variable x African American	0.45		-0.22		2.30	***	-0.42	
	(0.31)		(0.37)		(0.63)		(0.55)	
Network variable x Hispanic	0.31		-0.23		1.50	*	-1.36	
	(0.37)		(0.41)		(0.63)		(0.73)	
Network variable x Asian	-0.06		-0.30		-0.04		0.31	
	(0.57)		(0.81)		(2.01)		(1.21)	
Network variable x Native American	1.25		-0.70		1.52		-1.11	
	(0.81)		(0.91)		(1.99)		(1.39)	
F	0.00	***	0.00	***	0.00	***	0.00	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

Whereas *Density* has a negative effect on marijuana use, *Heterogeneity* has a significant positive effect on marijuana use regardless of racial/ethnic group (Model 4-a). That is, an actor in a heterogeneous group is more likely to use marijuana due at least in part to the lack of cohesiveness characteristic of such groups. In addition, due to the different cultural backgrounds of the group members, different value systems regarding certain behaviors are perhaps more likely to co-exist in racially/ethnically heterogeneous groups. In such settings, we can assume that individuals are more likely to accept rather than reject different values.

This appears inconsistent with the earlier findings, which suggested that African American and Hispanic youth are more likely to engage in marijuana use in cohesive groups.

When interaction effects are considered, the network variables appear to have stronger effects on marijuana use than was the case for alcohol use. The major difference between alcohol and marijuana use is that only *Heterogeneity* has a significant positive effect on marijuana use regardless of race/ethnicity. The reason for this difference is beyond the scope of this study, but we can assume that because alcohol is a legal substance and underage drinking is a status offense, competing normative values related to alcohol use are less likely to exist.

Although we know how network variables function when the interaction terms are embedded in these models, the independent effects of the network variables across racial/ethnic groups are not entirely clear. For example, African American and Hispanic youth engage in marijuana use in cohesive groups while the sample as a whole suggests that *Heterogeneity* increases the likelihood for marijuana use. Thus, the effects of network variables by race/ethnicity need to be examined more closely (see Table 15).

Among Whites, *Prestige* and *Heterogeneity* have significant positive effects on marijuana use whereas *Density* has a significant negative effect. As already noted, Whites typically belong to homogeneous groups in terms of race/ethnicity. Once the level of *Heterogeneity* is controlled, they are likely to be susceptible to any diversity of values to which they may be exposed and thus more likely to engage in marijuana use. None of the network variables is significant among any of the other racial/ethnic groups.

In sum, Hypothesis 1 is relatively well supported for marijuana use. The findings suggest that the network variables examined here have significant effects on substance use

although these effects vary by substance. That is, *Centrality*, *Prestige*, and *Heterogeneity* have

significant effects on marijuana use. Only *Density* has a significant effect on alcohol use. It is

also notable that for the sample as a whole the effects of *Density* and racial *Heterogeneity* are in

opposite directions.   As the simple correlations suggest, these two variables are strongly and

negatively correlated. It appears then, that heterogeneous groups are less cohesive than are

homogeneous groups. Given within-group diversity, members are likely to be exposed to

different normative expectations or standards. At the same time, and perhaps due to competing

values, members are less likely to be constrained by conventional expectations. In the absence

of such controls, they are more likely to engage in marijuana use.

Table 15. Network Effects on Marijuana Use at Wave II by Race/Ethnicity

	White		African American		Hispanic	Asian	Native American	
Age	0.24	***	0.15	*	0.09	0.03	-0.46	*
	(0.03)		(0.06)		(0.08)	(0.14)	(0.17)	
Male	-0.12		0.69	***	-0.43	-0.18	-0.27	
	(0.14)		(0.21)		(0.22)	(0.39)	(0.44)	
Centrality	-0.09		0.62		-0.29	-0.58	0.65	
	(0.32)		(0.45)		(0.51)	(1.01)	(1.02)	
Prestige	0.65	*	0.79		0.08	0.41	0.74	
	(0.32)		(0.52)		(0.65)	(1.23)	(1.42)	
Density	-1.19	**	0.93		0.18	-1.26	-0.74	
	(0.43)		(0.54)		(0.87)	(2.41)	(2.20)	
Heterogeneity	0.10	***	0.53		-0.27	0.38	-0.37	
	(0.28)		(0.45)		(0.80)	(1.50)	(1.21)	
F	0.000	***	0.001	***	0.270	0.546	0.333	
N	3,791		1,528		1,037	555	121	

*p<.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Finally, it should be noted again that among the four network variables, only *Centrality*

is based solely on an actor's active nominations or wish to be a part of a group. In other words,

the negative effect of *Centrality* on marijuana use may reflect an actor's one-way connection to

others. However, when dealing with an illegal substance, *Prestige* may be the most important

factor that affects marijuana use because recognition from others provides a wider range of opportunities to engage in this behavior.

Hypothesis 2

Here I examine the extent to which one's position in high school social networks impacts the relationship between early and later substance use. Substance use in this case includes alcohol and marijuana use, problem drinking, and the use of other illicit/unauthorized drugs during the subjects' mid-twenties as measured at Wave III.

Alcohol Use

It is common knowledge among criminologists and sociologists that underage drinking is positively associated with later drinking behavior. The Add Health data are consistent with this long-standing observation. The correlations between early and later alcohol use, and early use and binge drinking and problems related to drinking are all significant (see Table 16). Further, as noted in Model 1 in Table 17, the regression analysis reveals that early alcohol use is positively associated with later alcohol use and related problems.

When Model 1 is expanded to include the network variables (see Model 2), the effect of early drinking does not change. Furthermore, all of the network variables except *Heterogeneity* are significant. *Centrality* and *Prestige* appear to predict later drinking whereas *Density* is negatively associated with later drinking behavior. There is, however, some initial evidence that there may be some differences by race/ethnicity. For example, by their mid- twenties, all

Table 16. Correlation Matrix among Dependent Variables at Waves II and III

	(1)		(2)		(3)		(4)		(5)		(6)		(7)
(1) Alcohol Use at Wave II	1.000												
(2) Marijuana Use at Wave II	0.429	***	1.000										
(3) Alcohol Use at Wave III	0.283	***	0.176	***	1.000								
(4) Marijuana Use at Wave III	0.203	***	0.278	***	0.408	***	1.000						
(5) Binge Drinking at Wave III	0.257	***	0.184	***	0.731	***	0.389	***	1.000				
(6) Problem Drinking at Wave III	0.240	***	0.193	***	0.667	***	0.422	***	0.723	***	1.000		
(7) Illicit/Unauthorized Drug Use at Wave III	0.218	***	0.284	***	0.292	***	0.435	***	0.335	***	0.389	***	1.000

*p<0.05, **p<0.01, ***p<0.001

Table 17. Network Effects on Alcohol Use at Wave III (N=6,845)

Variable	Model 1		Model 2	
Age	0.00		0.01	
	(0.03)		(0.03)	
Male	0.69	***	0.74	***
	(0.06)		(0.06)	
African American	-1.04	***	-1.02	***
	(0.12)		(0.12)	
Hispanic	-0.52	***	-0.55	***
	(0.11)		(0.11)	
Asian	-0.65	***	-0.67	***
	(0.15)		(0.15)	
Native American	-0.43	***	-0.44	*
	(0.20)		(0.20)	
Centrality			0.81	***
			(0.18)	
Prestige			0.84	***
			(0.18)	
Density			-0.89	**
			(0.29)	
Heterogeneity			0.28	
			(0.17)	
Drinking level in Wave II	0.33	***	0.33	***
	(0.03)		(0.03)	
F	0.000	***	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

racial/ethnic groups drink significantly less than Whites. In addition, and not surprisingly, age

is no longer a significant factor once a majority of the sample reaches the legal drinking age.

On the other hand, some differences do emerge in the drinking behavior of males and females.

By the early to mid-twenties males are more likely to drink and to drink at higher levels than

are females.

Taken together, these findings suggest that an individual's social location in friendship

groups during early adolescence continue to influence drinking behavior into the post-

adolescent years. In addition, the effect of early drinking on later drinking is significant

regardless of network characteristics. This is consistent with the notion that once individuals

start drinking, the behavior carries over into their mid-twenties regardless of earlier location in their networks. Overall, the findings for alcohol use do not support Hypothesis 2.

Marijuana Use

When I examine the relationship between early and later marijuana use, a somewhat different pattern emerges, although it remains the case that the two are highly correlated (see Table 16). This is revealed in the regression analysis (see Model 1 in Table 18). As with alcohol use, when the network variables are incorporated in the model, the effect of past marijuana use is slightly weakened. Unlike the findings for alcohol use, amongst the network variables only *Heterogeneity* becomes a significant factor (Table 18) while *Density*, which was significant for alcohol use, appears to be unrelated to later marijuana use. Thus, Hypothesis 2, which states that the effect of early marijuana use on later marijuana use is attenuated when the network variables are controlled, receives some support.

Orcutt's (1978) observation that marijuana is more acceptable when the motivation is personal, not social may be relevant here. When it comes to an illegal substance, culturally oriented but competing values are likely to affect individual substance use. At the same time, racially/ethnically heterogeneous groups are perhaps less likely to be cohesive and thus lacking in conventional social controls. Therefore, those individuals who were in heterogeneous groups early on may be more likely to engage in marijuana use and continue that use into their mid twenties.

When I turn to racial/ethnic differences I find that African Americans, Hispanics, and Asians use marijuana significantly less than do Whites. Use by Native Americans, on the other hand, is not significantly different from Whites. This is true quite apart from the network

variables. In general, the findings suggest that Whites are more likely to engage in marijuana use in early adulthood.

Table 18. Network Effects on Marijuana Use at Wave III (N=6,526)

Variable	Model 1		Model 2	
Age	-0.16	***	-0.15	***
	(0.03)		(0.03)	
Male	0.51	***	0.55	***
	(0.08)		(0.08)	
African American	-0.47	***	-0.48	***
	(0.12)		(0.13)	
Hispanic	-0.42	*	-0.52	**
	(0.16)		(0.17)	
Asian	-0.57	**	-0.66	***
	(0.18)		(0.19)	
Native American	-0.39		-0.40	
	(0.23)		(0.23)	
Centrality			0.53	*
			(0.22)	
Prestige			0.51	*
			(0.23)	
Density			-0.58	
			(0.31)	
Heterogeneity			0.52	*
			(0.21)	
Marijuana Use at Wave II	0.88	***	0.87	***
	(0.06)		(0.06)	
F	0.000	***	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

Unlike drinking behavior, age is strongly related to marijuana use. Although the correlation between age and marijuana use at Wave III is -0.07, which suggests only a marginal association, the regression analysis suggests otherwise. As noted in Table 18 age is negatively associated with marijuana use at Wave III. This finding suggests that juveniles in the sample use marijuana experimentally early on, but are likely to quit as they get older. This is consistent with official data which indicates that the number of arrests for drug abuse violations is the highest at age 18 and gradually decreases (see Uniform Crime Reports 2008: Table 38).

As with drinking, differences by sex emerge in terms of marijuana use with males being more likely than females to be users.

Drinking Related Problems

Hypothesis 2 also states that the effect of early alcohol use is diminished when the network variables are controlled. Two measures of problem drinking are examined: binge drinking and negative experiences caused by drinking. As reported in Table 19, early alcohol use has a significant positive effect on later binge drinking. However, the findings in Table 20 suggest that this relationship does not hold for Native Americans.[18] As already noted, one possible explanation for this is that Native Americans are able to cope with adverse situations as they grow older.

Table 19. The Effect of Early Alcohol Use on Binge Drinking at Wave III

Variable	Coefficient	
Age	-0.11	***
	0.03	
Male	0.88	***
	0.06	
Drinking at Wave II	0.34	***
	0.02	
F	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Consistent with expectations, the results show those individuals who engaged in underage drinking during their teens are more likely to develop binge drinking later on and that this can be predicted by one's location in early friendship networks. When network variables are incorporated into the analysis (see Table 21), the effect of early alcohol use becomes weaker although it is still significant. That is, the network variables appear to attenuate the

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[18] The low level of significance is no doubt due to the small sample size. A coefficient of this magnitude would be statistically significant with a larger N.

effect of early alcohol use, but only slightly. Interestingly, all network variables except for

Heterogeneity are significant and in the expected direction.

Table 20. The Effect of Early Alcohol Use on Binge Drinking at Wave III by Race/Ethnicity

	White		African American		Hispanic		Asian		Native American
Age	-0.12	***	0.00		-0.02		-0.24	**	-0.04
	(0.03)		(0.06)		(0.07)		(0.08)		(0.16)
Male	0.89	***	0.88	***	1.09	***	1.10	**	0.44
	(0.06)		(0.16)		(0.17)		(0.36)		(0.37)
Drinking at Wave II	0.31	***	0.33	***	0.25	***	0.57	***	0.37
	(0.02)		(0.05		(0.07)		(0.12)		(0.20)
F	0.000	***	0.000	***	0.000	***	0.000	***	0.098
N	3,956		1,595		1,130		572		127

*p<0.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Table 21. Network Effects on Binge Drinking at Wave III (N=6,436)

	Model 1		Model 2	
Age	-0.09	***	-0.09	***
	(0.02)		(0.03)	
Male	0.92	***	0.96	***
	(0.06)		(0.06)	
African American	-1.44	***	-1.43	***
	(0.13)		(0.13)	
Hispanic	-0.47	***	-0.47	***
	(0.10)		(0.11)	
Asian	-0.96	***	-0.95	***
	(0.18)		(0.18)	
Native American	-0.06		-0.06	
	(0.20)		(0.19)	
Centrality			0.45	*
			(0.19)	
Prestige			0.71	***
			(0.19)	
Density			-0.95	***
			(0.26)	
Heterogeneity			0.14	
			(0.18)	
Drinking level in Wave II	0.31	***	0.30	***
	(0.02)		(0.02)	
F	0.000	***	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

As already noted the earlier results suggest that *Centrality* and *Prestige* are facilitating factors while *Density* is a constraining factor. Individuals who actively nominated others as friends and were popular while in high school are more likely to drink heavily later on. Adolescents who were in cohesive groups are less likely to engage in binge drinking later apparently due to relatively strong conventional social controls. This can no doubt be explained by their attachment to conventional peers. Cohesiveness represents a collective effort to produce conformity to conventional expectations.

With regard to race/ethnicity, when all other variables are controlled Whites are more likely to engage in binge drinking at Wave III (see Table 21). The levels of binge drinking among all other race/ethnicity groups are significantly lower than the levels for Whites. Whites are also more likely to be members of racially/ethnically homogeneous groups. However, once the level of *Heterogeneity* is controlled, Whites in heterogeneous groups are more likely to drink.

It is also apparent that males are more likely to engage in binge drinking. The mean values of binge drinking for males and females, which are related to network variables, are 1.64 and 0.89 respectively. The t-value is 21.19, which is statistically significant ($p < 0.001$, output not presented).

The findings in Table 22 reveal that underage drinking is positively associated with alcohol-related problems in early adulthood. Consistent with expectations, youth who engaged in underage drinking during adolescence are more likely to experience problems caused by drinking in their mid-twenties. However, unlike binge drinking, all racial/ethnic groups show a significant positive relationship between early alcohol use and later alcohol-related problems (see Table 23). The findings in Table 24 suggest that when the network variables are

incorporated, the effect of early drinking behavior on problems caused by drinking is weakened, but again only slightly. Not surprisingly, as with binge drinking, the effects of all of the network variables other than *Heterogeneity* are significant.

Table 22. The Effect of Early Alcohol Use on Alcohol-Related Problems at Wave III (N=7,404)

Variable	Coefficient	
Age	-0.10	**
	0.03	
Male	0.58	***
	0.07	
Drinking at Wave II	0.37	***
	0.03	
F	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Table 23. The Effect of Early Alcohol Use on Alcohol-Related Problems at Wave III by Race/Ethnicity

	White		African American		Hispanic		Asian		Native American	
Age	-0.11	**	-0.03		0.02		-0.16	*	-0.06	
	(0.04)		(0.05)		(0.07)		(0.08)		(0.15)	
Male	0.50	***	0.58	***	0.92	***	0.99	**	0.57	
	(0.08)		(0.15)		(0.16)		(0.34)		(0.41)	
Drinking at Wave II	0.35	***	0.30	***	0.22	*	0.71	***	0.76	***
	(0.03)		(0.07)		(0.08)		(0.11)		(0.19)	
F	0.000	***	0.000	***	0.000	***	0.000	***	0.000	***
N	3,966		1,597		1,141		574		121	

*p<0.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Centrality and *Prestige* serve as facilitating factors whereas *Density* functions as a constraining factor. Males are more likely to experience problems associated with drinking than females, and age is negatively associated with problems associated with by drinking at Wave III. Although age is not a significant factor for drinking in general, perhaps because drinking after age 21 is no longer prohibited, it is negatively associated with problem drinking.

This suggests that as people mature they are less likely to experience problems related to drinking. These results are quite similar to those for binge drinking. This is not surprising given the relatively correlation between binge drinking and drinking related problems at Wave III (r=0.68).

Table 24. The Effect of Early Alcohol Use on Alcohol-Related Problems at Wave III Attenuated by Network Variables (N=6,436)

	Model 1		Model 2	
Age	-0.07	*	-0.07	*
	(0.03)		(0.03)	
Male	0.62	***	0.68	***
	(0.07)		(0.07)	
African American	-1.11	***	-1.10	***
	(0.12)		(0.12)	
Hispanic	-0.54	***	-0.58	***
	(0.12)		(0.13)	
Asian	-0.60	***	-0.62	***
	(0.18)		(0.19)	
Native American	-0.32		-0.33	
	(0.22)		(0.22)	
Centrality			0.79	***
			(0.19)	
Prestige			0.95	***
			(0.20)	
Density			-1.18	***
			(0.26)	
Heterogeneity			0.38	
			(0.20)	
Drinking level in Wave II	0.35	***	0.34	***
	(0.03)		(0.03)	
F	0.000	***	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

Drug Use

Not surprisingly, early marijuana use is highly associated with later use of other illicit/unauthorized drugs (Table 25). However, the findings in Table 26 show that there are significant differences between racial/ethnic groups in the use of other drugs. Except for African Americans and Native Americans, marijuana use reported in Wave II is positively and

significantly associated with illicit/unauthorized drug use in Wave III. How the effect of early marijuana use on other illegal/unauthorized drug use is attenuated by the network variables is examined in Table 27.

Table 25. The Effect of Early Marijuana Use on Other Drug Use at Wave III (N=7,659)

Variable	Coefficient	
Age	-0.13	***
	(0.03)	
Male	0.39	***
	(0.07)	
Level of marijuana use at Wave II	0.89	***
	(0.06)	
F	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

Table 26. The Effect of Early Marijuana Use on Other Drug Use at Wave III by Race/Ethnicity

	White		African American	Hispanic		Asian		Native American	
Age	-0.15	***	-0.03	0.05		-0.29	**	-0.33	*
	(0.04)		(0.05)	(0.07)		(0.09)		(0.17)	
Male	0.46	***	0.12	0.26		0.40		0.57	
	(0.09)		(0.20)	(0.20)		(0.28)		(0.54)	
Marijuana Use at Wave II	0.97	***	0.15	1.04	***	0.97	***	0.53	
	(0.06)		(0.14)	(0.14)		(0.26)		(0.39)	
F	0.000	***	0.5123	0.000	***	0.000	***	0.1285	
N	4,075		1,680	1,173		600		121	

*p<0.05, **p<0.01, ***p<0.001
Values in parentheses are linearized standard errors.

As expected, it appears that the network variables tend to attenuate the effect of early marijuana use on illicit/unauthorized drug use in one's mid-twenties. When I focus on the effect of early marijuana use in Model 1, males are more likely to engage in illicit/unauthorized drug use. With regard to racial/ethnic differences, African Americans and Hispanics experience illicit/unauthorized drug use significantly less than Whites, but Asians and Native Americans are not significantly different from Whites.

Table 27. Network Effects on Other Drug Use at Wave III (N=6,436)

	Model 1		Model 2	
Age	-0.12	***	-0.12	***
	(0.03)		(0.03)	
Male	0.39	***	0.37	***
	(0.08)		(0.08)	
African American	-0.93	***	-0.98	***
	(0.10)		(0.10)	
Hispanic	-0.36	**	-0.50	***
	(0.12)		(0.14)	
Asian	-0.39	*	-0.49	**
	(0.18)		(0.19)	
Native American	0.1		-0.01	
	(0.25)		(0.25)	
Centrality			-0.05	
			(0.23)	
Prestige			0.15	
			(0.21)	
Density			-0.11	
			(0.31)	
Heterogeneity			0.52	*
			(0.21)	
Marijuana Use at Wave II	0.87	***	0.86	***
	(0.06)		(0.06)	
F	0.000	***	0.000	***

*p<0.05, **p<0.01, ***p<0.001
Race/ethnicity is in reference to Whites.
Values in parentheses are linearized standard errors.

When the network variables are incorporated into the general model, not only do they attenuate the effect of early marijuana use, but unlike alcohol related problems only *Heterogeneity* appears to be a significantly related to the use of illegal drugs. The tendency for adolescents in racially heterogeneous groups to accept different opinions from their own may result in engaging in drug use rather than rejecting use in the future. A lack of cohesiveness in racially/ethnically heterogeneous groups suggests an absence of conventional social control, which may in turn facilitate drug use if the actors adopt new value systems to which they have been exposed.

When *Heterogeneity* is controlled, Asians exhibit significantly lower illicit/unauthorized drug involvement than Whites. For Asians, *Heterogeneity* may weaken

group cohesiveness or control resulting in a greater likelihood of illicit/unauthorized drug use. Since Asians consist of only 4.35 percent of total population in the United States according to population estimates by the U.S. Census Bureau in 2008, it might be a rare for them to belong to homogeneous groups in natural social settings except for certain cities where the population of Asians is high. Thus, any kind of socialization for them is likely to be in heterogeneous setting. This explanation is based on the racial/ethnic composition in the United States and similar to the one given for Native Americans given for alcohol use. Due to racial/ethnic composition in the United States, Asians exhibit significantly lower drug use experience than Whites when *Heterogeneity* is set equal. This may be because Asians are less susceptible to diverse situations and conformity to conventional social norms that may be weakened in a heterogeneous setting.

In general, Hypothesis 2 is supported by the data. As expected, early network characteristics appear to attenuate the relationship between early substance use and later substance use. In fact, how individuals are enmeshed into a group in their adolescent years seems to have greater long-term compared to short-term effect. In other words, there is some evidence that network characteristics that develop during the adolescent years carry over into the respondents' early adult years. However, there are some differences by substance type.

With regard to alcohol use, *Centrality* and *Prestige* have positive long-term effects while *Density* tends to have a long-term negative effect. *Heterogeneity* on the other hand appears to be unrelated to alcohol use. However, *Heterogeneity* does show a positive effect for marijuana and other drug use. In one's mid-twenties, alcohol use appears to be associated with popularity while marijuana/other drugs are used among those who are in heterogeneous groups

that are assumed to be less cohesive. This suggests that marijuana/other drug users are likely to engage in such behaviors independently regardless of early friendship networks.

Hypothesis 3

Here I examine whether multiple and meaningful pathways exist in terms of changes in the level of substance use among youth. Hypothesis 3 states that due to different legal definitions for alcohol and marijuana use, many will begin to use alcohol and some will increase their levels of use while the number of marijuana users is likely to decrease as youth move into adulthood and have more to lose by getting caught.

As already noted, early substance use is associated with later substance use. When the relationship between early and later substance use is examined by race/ethnicity, the findings in Tables 28 and 29 reveal that early alcohol use is positively associated with later use across all race/ethnic groups. Since alcohol is a legal substance and by Wave III the majority of respondents are no longer minors, this progression is to be expected. On the other hand, marijuana is an illegal substance regardless of age. Nevertheless, early marijuana use is also positively associated with later use over the five to six year span between Waves II and III. In general, the regression analysis shows a positive association between early and later alcohol and marijuana use. However, I cannot address levels of use or behavioral change until examining trajectories over time.

Below a one-trajectory growth curve is shown using an unconditional analysis that specifies the model without a predictor variable (see Figure 2). Because the interval of three waves is not equidistant, specific commands are given to adjust such differences when the M-Plus software is used. The same analysis is processed from two- to five-trajectories models to

determine the number of trajectories that provides the best fit with the data. The model fitting

statistics for each trajectory-model are presented in Table 30.

Table 28. The Effect of Alcohol Use at Wave II on Alcohol Use at Wave III by Race/Ethnicity

Variable	White		African American		Hispanic		Asian		Native American	
Age	0.00		0.03		-0.01		-0.11		0.00	
	(0.03)		(0.05)		(0.06)		(0.07)		(0.15)	
Sex	0.66	***	0.44	***	0.87	***	0.91	**	0.00	
	(0.07)		(0.13)		(0.15)		(0.29)		(0.34)	
Alcohol Use at Wave II	0.34	***	0.35	***	0.29	***	0.51	***	0.35	*
	(0.03)		(0.05)		(0.06)		(0.13)		(0.18)	
F	0.000	***	0.000	***	0.000	***	0.000	***	0.264	

*p<0.05, **p<0.01, ***p<0.001
The values are regression coefficients of alcohol use at Wave II on alcohol use at Wave III for each variable.
Values in parentheses are linearized standard errors.

Table 29. The Effect of Marijuana Use at Wave II on Marijuana Use at Wave III by Race/Ethnicity

| Variable	White		African American		Hispanic		Asian		Native American	
Age	-0.16	***	-0.13	*	-0.09		-0.30	*	-0.44	*
	(0.03)		(0.06)		(0.09)		(0.12)		(0.19)	
Sex	0.49	***	0.65	***	0.27		0.74		0.20	
	(0.10)		(0.18)		(0.22)		(0.40)		(0.54)	
Marijuana use at Wave II	0.85	***	1.09	***	0.94	***	1.45	***	1.06	**
	(0.07)		(0.14)		(0.15)		(0.28)		(0.35)	
F	0.000	***	0.000	***	0.000	***	0.000	***	0.001	***

*p<0.05, **p<0.01, ***p<0.001
The values are regression coefficients of marijuana use at Wave II on marijuana use at Wave III for each variable.
Values in parentheses are linearized standard errors.

**Figure 2. The Growth Trajectory for Alcohol Use for the One-trajectory Latent Variable
Growth Mixture Model**
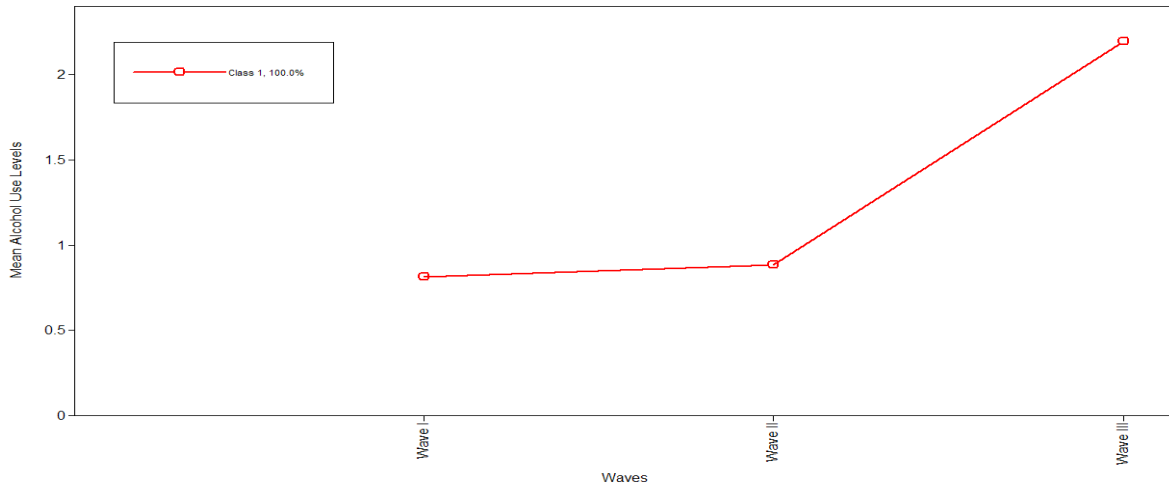
Although the sample as a whole exhibits an upward trajectory for alcohol use, my

analysis suggests that more than one trajectory can be identified. Figure 3 shows the potential

trajectories for this sample. The number of trajectories that meet the best-fit model criterion is

determined by H_0 log likelihood, Akaike's Information Criterion (AIC), Bayes Information

Criterion (BIC), Sample-size-adjusted BIC (ABIC), entropy, and the Vuong-Lo-Mendell-Rubin

(VLMR) likelihood ratio test with t-value. These measures are used for model comparisons to

determine the best-fit model. Decreased values in H_0 log likelihood, AIC, BIC, and ABIC

indicate model improvement from the previous model being tested. The value of entropy

ranges from 0 to 1, with a higher value indicating greater clarity in the model being tested.

Ascertaining of the VLMR likelihood ratio test is determined by p-values. A p-value less than

0.05 indicates that the estimated model is a better fit than the model with one fewer trajectory

(Duncan et al. 2006:14, 131-132).

Figure 3. Observed Levels of Alcohol Use
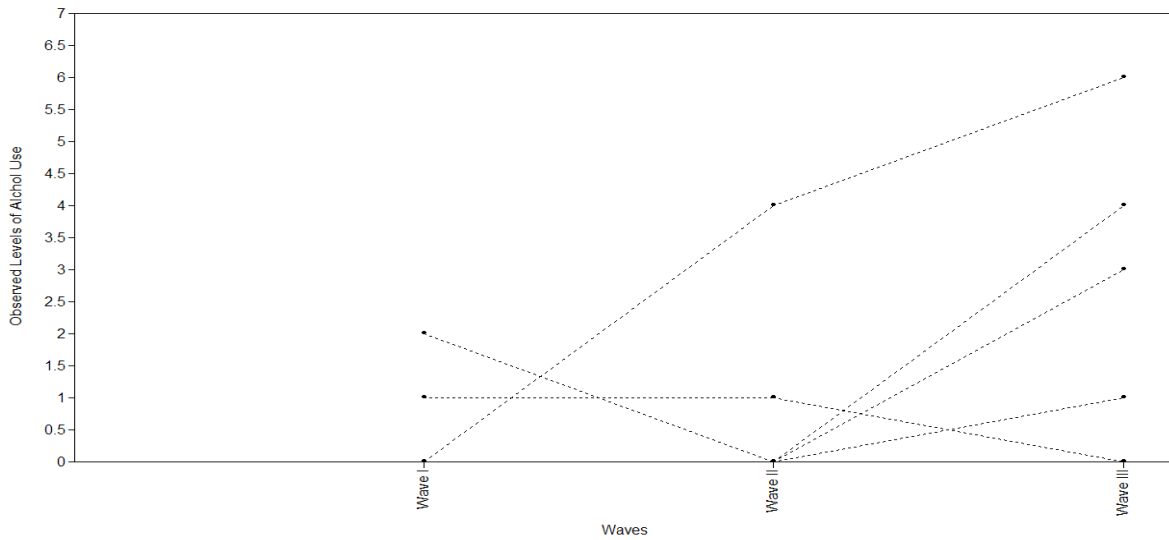
To determine the number of trajectories in a model, I must first compare a single-trajectory model with a two-trajectory model. A better model will show smaller values for H_0, AIC, BIC, and ABIC, and entropy must converge indicating "greater clarity in classification" (Duncan et al. 2006: 131) with a larger value close to 1. As presented in Table 28, decreased values in all H_0 log likelihood, AIC, BIC, and ABIC indicate improvement from the single-trajectory model to the two-trajectory model. Moreover, the VLMR likelihood ratio test (3803.371, p=0.000) suggests that the two-trajectory model provides a better fit with the data than the single-trajectory model. Also, high entropy convergence confirms that the two-trajectory model is better than the single-trajectory model.

Comparing the two-trajectory model to a three-trajectory model, the values of H_0 log likelihood, AIC, BIC, and ABIC decrease, but the entropy value increases. This suggests that the three-trajectory model is superior to the two-trajectory model. The VLMR likelihood ratio test (3838.491, p=0.000) confirms that the three-trajectory model provides a better fit with the data.

Table 30. Fit Indices from One-trajectory to Five-trajectory Mixture Models for Alcohol Use

	Trajectory	of the Model			
	1	2	3	4	5
H_0[19]	-42274.3	-40372.6	-39469.1	-33376.6	-37713.5
AIC	84564.62	80767.24	78966.22	66787.21	75466.97
BIC	84620.6	80844.22	79064.19	66906.11	75606.93
ABIC[20]	84595.18	80809.26	79019.7	66852.09	75543.37
ENT[21]		0.914	0.991	0.969	0.995
VLMRLRT[22]		3803.371	3838.491	4.327	1057.186
P-value		0.0000	0.000	0.1445	0.0002

When I compare the three-trajectory model to a four-trajectory model, all values for H_0 log likelihood, AIC, BIC, and ABIC decrease showing model improvement. However, entropy value does not increase. The insignificant p-value also indicates that the three-trajectory model is better than the four-trajectory model. The level of significance decreases with an increase in the number of trajectories tested once the best-fit model is determined. Surprisingly, the five-class model is statistically significant and shows improved entropy level. However, although the statistics show significance in the five-trajectory model, the trajectory that indicates complete desisters from Wave I to Waves II and III[23] includes only three individuals of the 8,085 respondents. This renders it a less than meaningful trajectory. Taking every factor into consideration, the three-trajectory model provides the best fit (Figure 4).

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[19] H0 log likelihood
[20] ABIC=sample size adjusted BIC
[21] Entropy ranges from 0 to 1 and higher value indicates "greater clarity in classification (Duncan et al. 2006: 131)."
[22] The Vuong-Lo-Mendell-Rubin (VLMR) likelihood ratio test provides "a standard of comparison for ascertaining the preferred number of classes in a model (Duncan et al. 2006: 132)."
[23] The figure is not presented.

Figure 4. The Three-trajectory Latent Variable Growth Mixture Model for Alcohol Use
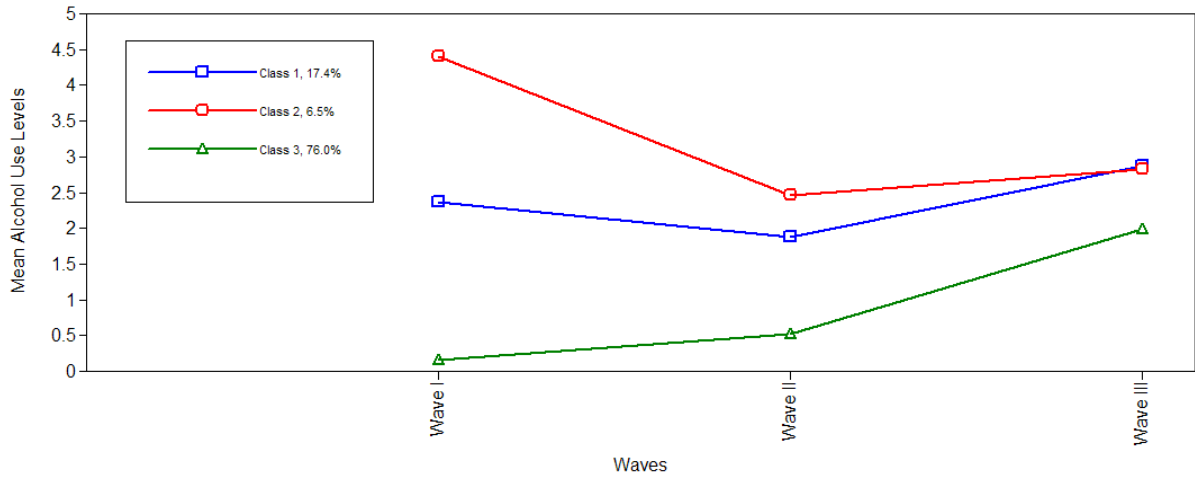
In this sample, the group that shows a pattern of increasing levels of drinking at each time period is most common (76% of the sample: the green line with a triangle) followed by those individuals who maintain an attenuated level of drinking over the eight-year span (17.4%: the blue line with a square). The least common group may be referred to as "relapsers." This group includes those who were heavy drinkers at Wave I, then decreased their level of use at Wave II, but increased again at Wave III (6.5%: the red line with a circle). In general then, the findings for alcohol use support Hypothesis 3.

As already noted the results of the earlier analyses revealed racial/ethnic differences in the levels of alcohol and marijuana use. As such, it is necessary to examine trajectories by race/ethnicity.

As expected, when drawn by race/ethnicity, I find different behavioral trajectories for each race/ethnic group. First, as Figure 5 shows, Whites exhibit very similar trajectories to the sample as a whole. This is not surprising because Whites are by far the most dominant group in the sample in terms of sheer numbers. However, African Americans[24] and Asians also

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[24] The four-trajectory model is also significant, but the fourth trajectory represents only a small number of adolescents; therefore, only the three-trajectory model is meaningful.

exhibit very similar trajectory patterns compared to the sample as a whole (see Figure 6 and 7). As a distinct trajectory, desisters are found only among Hispanics and Native Americans (see Figures 8 and 9).

Figure 5. Trajectories of Alcohol Use among White Youth
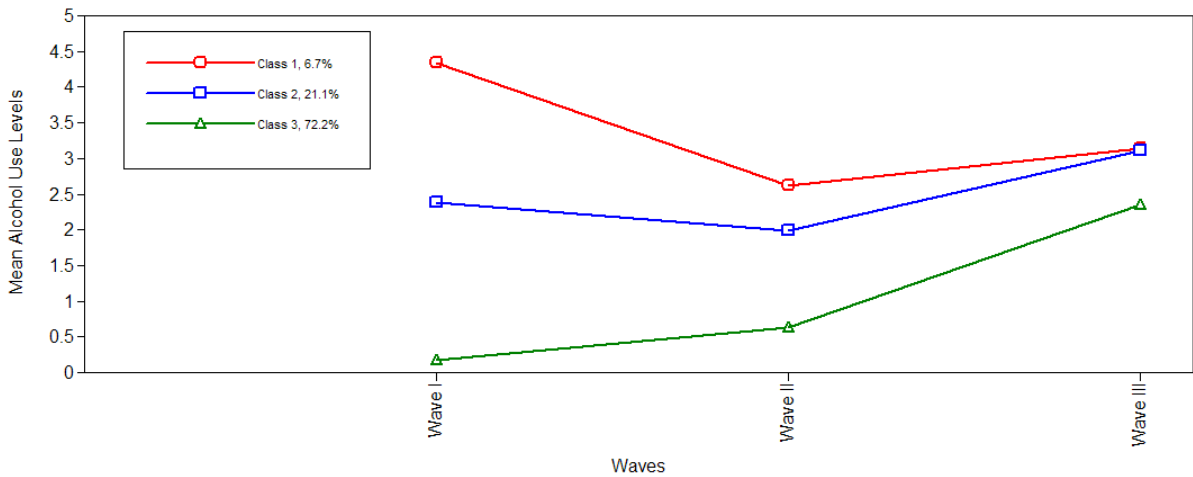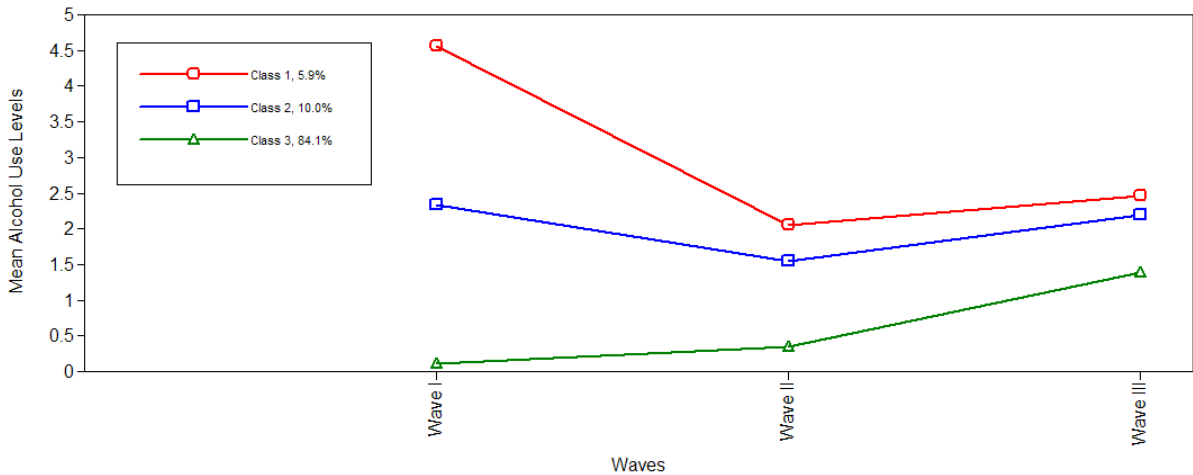

**Figure 6. Trajectories of Alcohol Use among African American Youth**

Native Americans show a particularly interesting picture. The range of mean drinking levels among the three groups become smaller from about 4.5, which is the difference between the highest and lowest means at Wave I, to 0.5, which is the difference between the highest and

lowest means at Wave III. That is, their drinking behavior became extremely similar at Wave III. In the three-trajectory model, Native American youth who exhibit the lowest levels of drinking at Wave I pass over the levels of the other two trajectories by Wave III (Figure 9). The existence of desisters may contribute to the convergence in the drinking level at Wave III.

The levels of marijuana use in the past 30 days at Waves I through III are used to draw trajectories for marijuana use. The findings reveal that a three-trajectory model provides the best fit for marijuana use (Table 31 and Figure 10).[25] The majority of users (76.6%: the blue line with a triangle) appear to be experimental users at Wave II and non-users by Wave III. About one-fourth of the sample (23.1%: the green line with a triangle) show an increase in marijuana use over time and only a small group of individuals (0.3%: the red line with a circle) desist from marijuana use over time. As with alcohol use, the findings for marijuana use provide support for Hypothesis 3.

**Figure 7. Trajectories of Alcohol Use among Asian Youth**
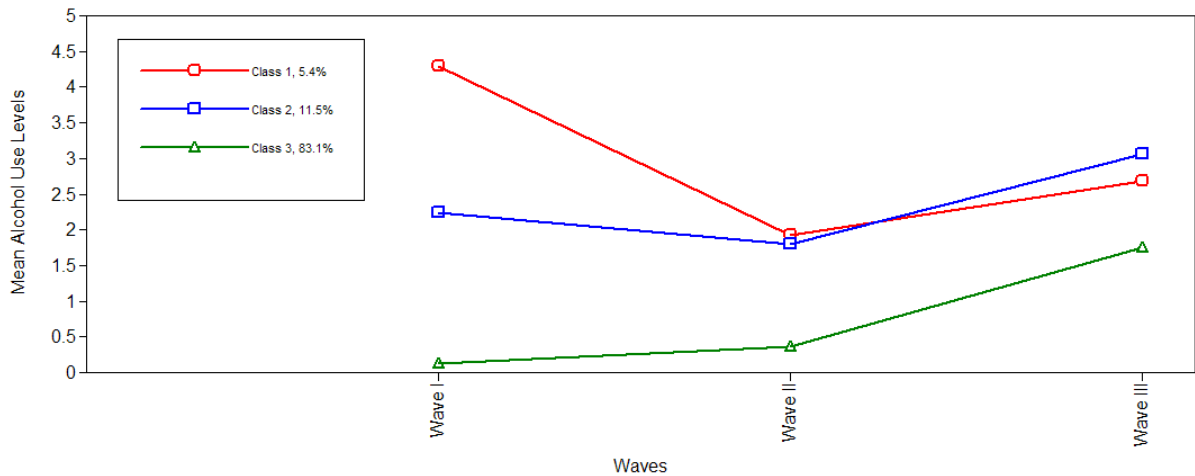
When examining marijuana use by race/ethnicity, three trajectories were observed only among Whites (Figure 11). These trajectories appear to account for the three different

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[25] The model did not converge into four trajectories, but started to do again into five-class trajectories. Although entropy value increased, trajectory 1 and 5 contained only a small number of individuals which resulted in 0.01percenr (6 individuals) and 0.02 percent (16 individuals) of this model.

trajectories for the sample as a whole. One group (77.9%: the blue line with a square)

gradually increased their marijuana use while the other (12.8%: the red line with a circle)

slowly decreased the level of marijuana use over time. The final group (9.3%: the green line

with a triangle) exhibits sharp increase in marijuana use over time. This group includes youth

who were non-users at Wave I, then, rapidly increased their use over time. The findings related

to Hypothesis 2 suggested that *Heterogeneity* in groups is related to an increase in the level of

marijuana use; thus, White individuals who exhibit a decrease in the level of marijuana use are

assumed to be in homogeneous and therefore cohesive groups as they get older.

Figure 8. Trajectories of Alcohol Use among Hispanic Youth
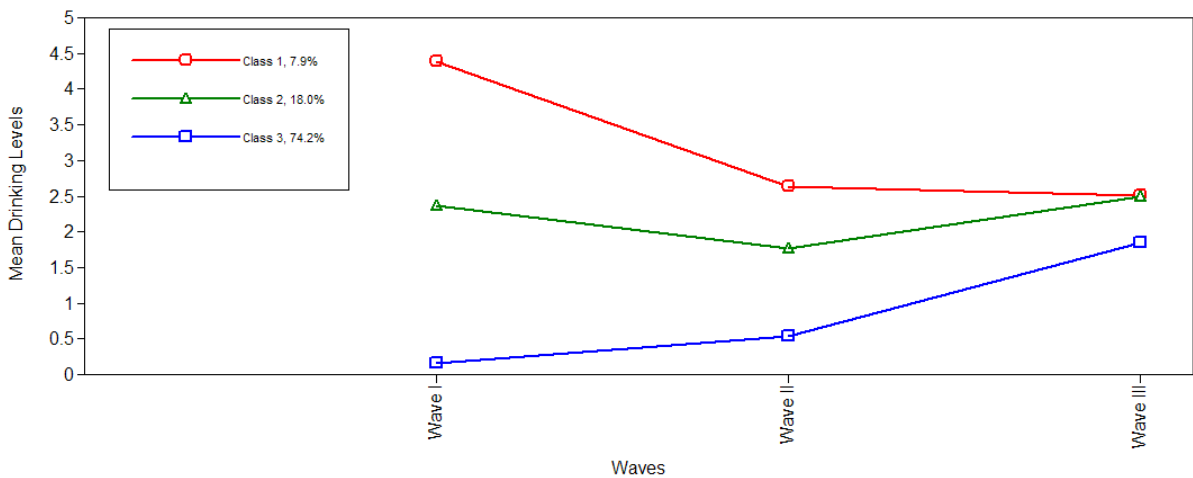
African American and Asian Youth exhibit trajectories consistent with my expectation

(see Figures 12 and 13). Less than 15 percent of each racial group shows progression into

marijuana use. The only difference between African American and Asian Youth is that the

majority of African American youth appear to continue marijuana use at the very low level

over three waves whereas the majority of Asian youth actually desist from marijuana use at

Wave III.

Figure 9. Trajectories of Alcohol Use among Native American Youth
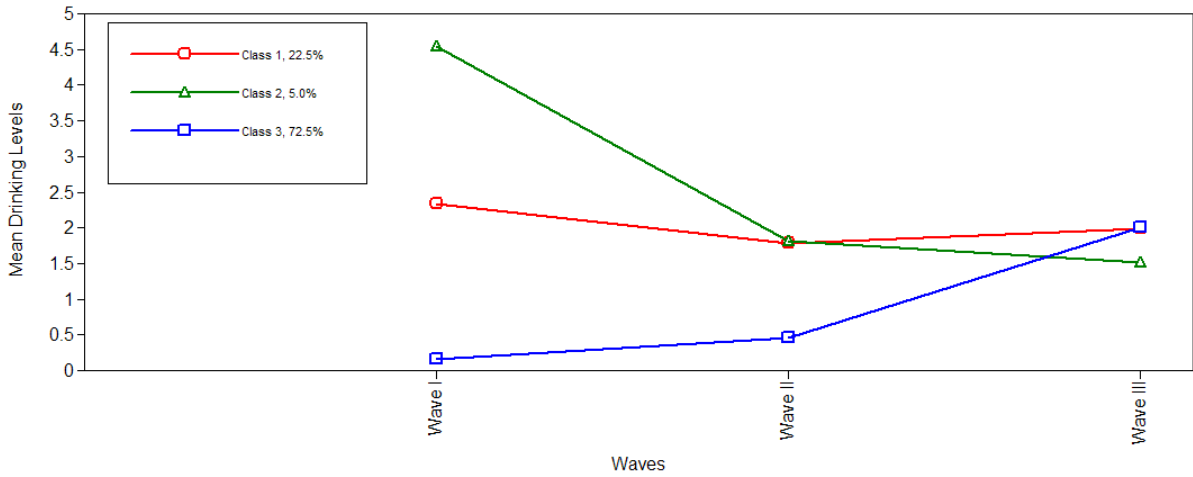

Table 31. Fit Indices from One-trajectory to Five-trajectory Mixture Models for Marijuana Use

	Trajectory	of the Model			
	1	2	3	4	5
H0	-15037.950	-12492.714	-11773.843	N/A	-9963.301
AIC	30091.901	25007.429	23575.687	--	19966.603
BIC	30147.882	25084.403	23673.654	--	20106.56
ABIC	30122.460	25049.447	23629.165	--	20042.999
ENT		0.922	0.954	--	0.965
VLMRLRT		5090.472	133.858	--	-3250.034
p-value		0.000	0.0225	--	0.9998

Hispanic youth exhibit only two distinct trajectories with respect to marijuana use. For the sample as a whole, the percentage of adolescents who reported an increase in the level of marijuana use over time is relatively small. However, Hispanic youth who exhibit the increase in the levels of marijuana use were 86.2 % (Figure 14). On the other hand, the level of use for this group remains quite low.

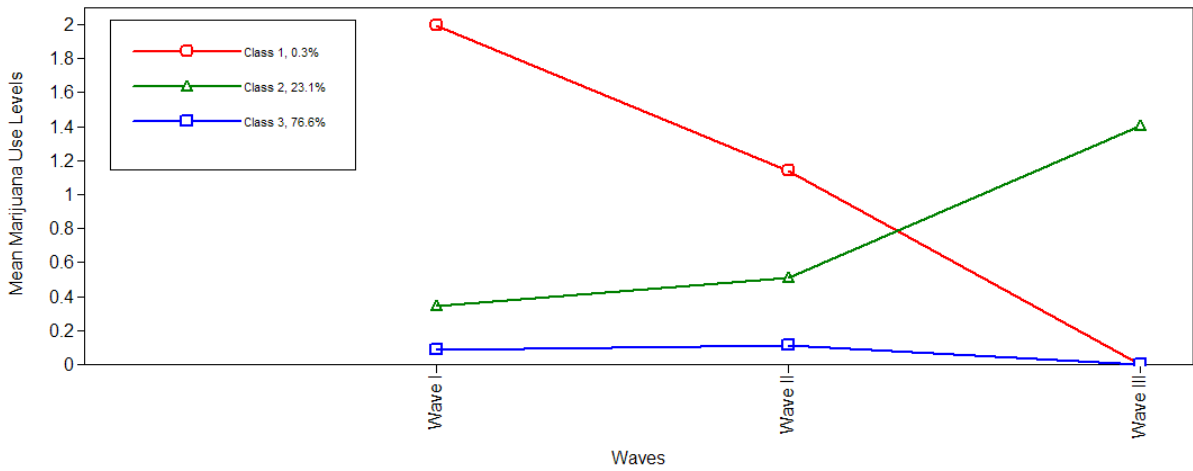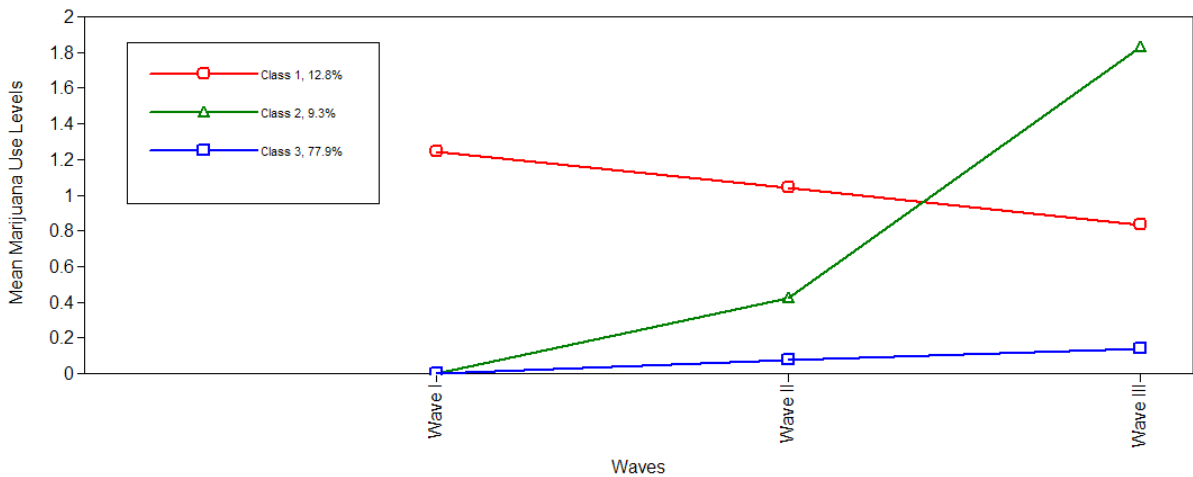**Figure 10. The Three-trajectory Latent Variable Growth Mixture Model for Marijuana Use**

Figure 11. Trajectories of Marijuana Use among White Youth

It is also noteworthy that among Native American youth there are two distinct trajectories (Figure 15). Although these groups show very similar marijuana use level at Wave I, they eventually take very divergent trajectories: Some become non-users while others become heavy users by Wave III. As the results relating to Hypotheses 2 revealed, *Heterogeneity* in one's early friendship has a significant positive effect on later marijuana use. As already noted, Native American youth in this study tend to be in heterogeneous groups. Thus, although it is not surprising that the Native Americans show an increase in use over time

the fact that it is so substantial is. Further research is necessary to understand or explain both

this increase, but also why a large number decrease their use over time.

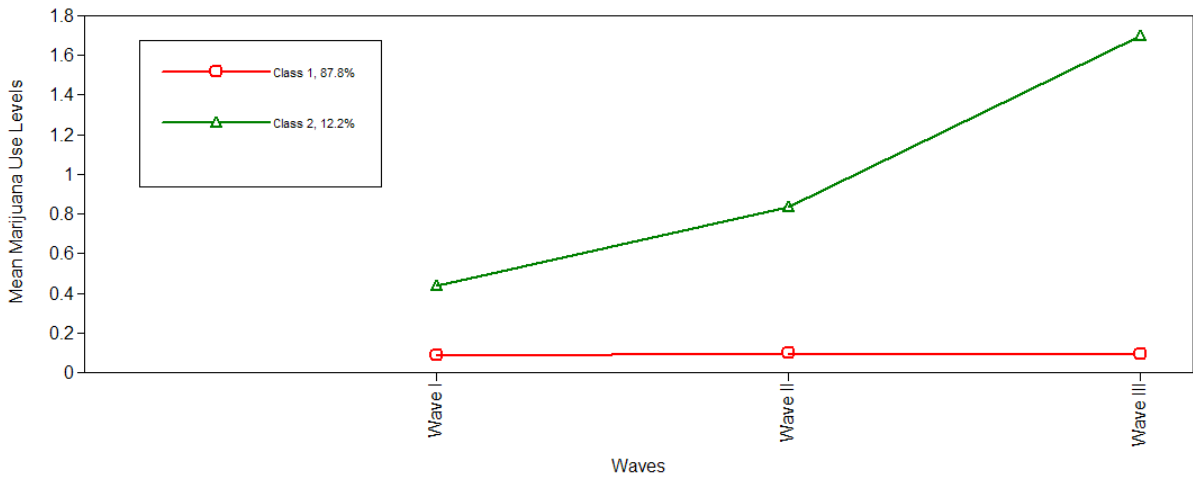**Figure 12. Trajectories of Marijuana Use among African American Youth**

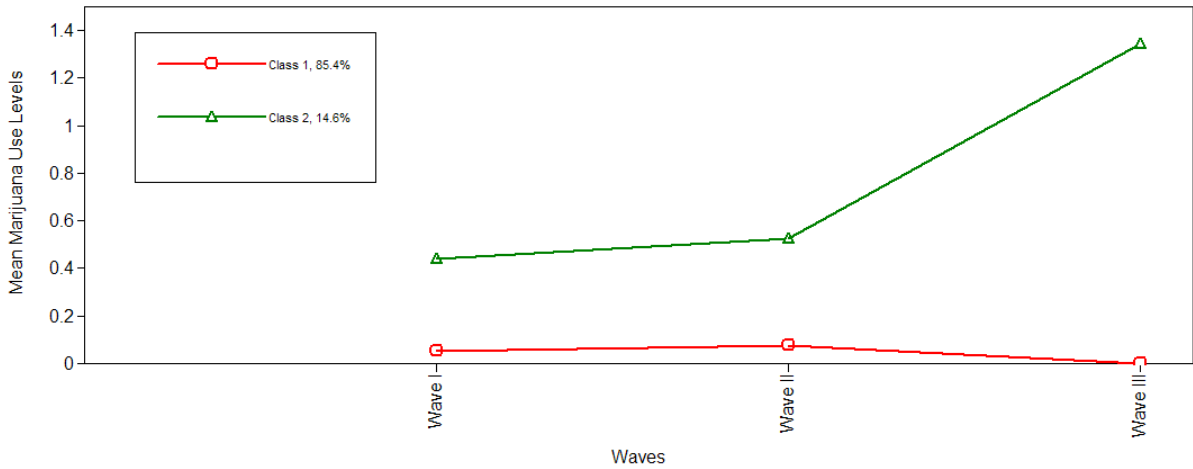**Figure 13. Trajectories of Marijuana Use among Asian Youth**

Figure 14. Trajectories of Marijuana Use among Hispanic Youth
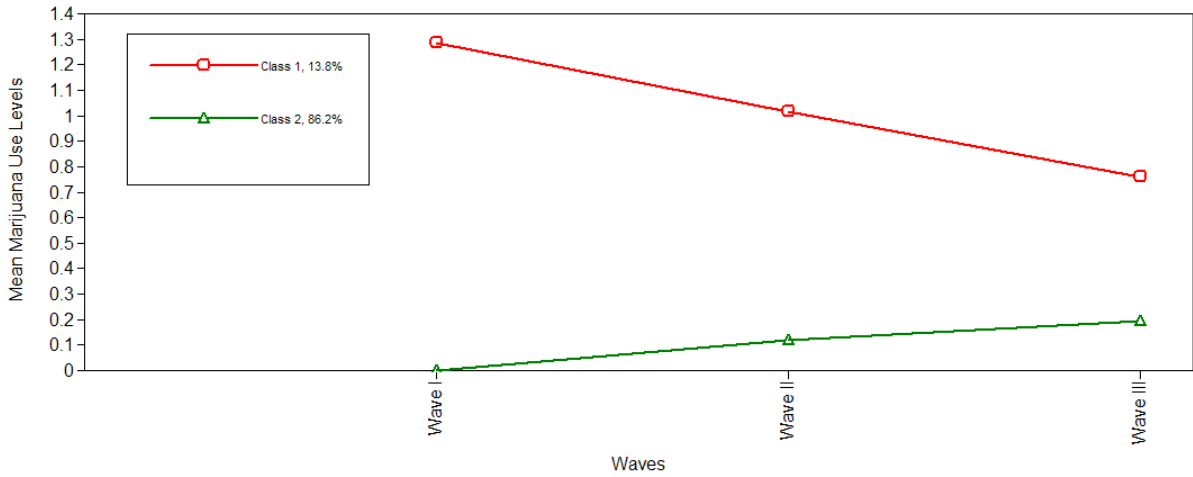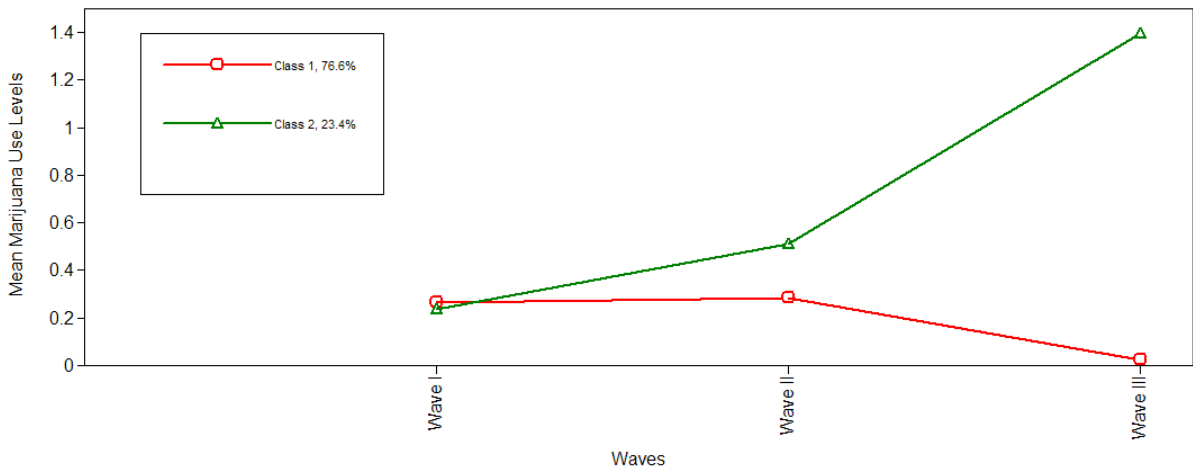

Figure 15. Trajectories of Marijuana Use among Native American Youth

Summary

In this chapter, three hypotheses were examined relating to the short-term effects of friendship networks on alcohol and marijuana use, the long-term effects of those networks on alcohol, marijuana, other illicit/unauthorized drug use, and expected behavioral trajectories for alcohol and marijuana use over time. The findings suggest some support for the initial hypothesis, but the effects of social network variables were different depending upon the

substance use in question. That is, only *Density* showed a significant negative effect on alcohol use whereas *Centrality*, *Prestige*, and *Heterogeneity* showed significant positive effects on marijuana use. In addition, when attachment to parents is controlled, the effects of network variables are increased for both alcohol and marijuana use.

Consistent with the expectations stated in Hypothesis 2, early network characteristics appear to attenuate the relationship between early and later substance use. That is, network characteristics that develop during the adolescent years appear to carry over into the respondents' early adult years. Again, however, there is some variation with respect to substance type. For alcohol use, *Centrality* and *Prestige* showed positive long-term effects while *Density* was found to have a long-term negative effect. *Heterogeneity* on the other hand appears to be unrelated to alcohol use but does show a significant positive effect for marijuana and other drug use.

The results relating to Hypothesis 3 suggest that as expected the majority of youth exhibit an upward trajectory for alcohol use but a downward trajectory for marijuana use. In addition, when the trajectory analyses were conducted by race/ethnicity, some racial/ethnic groups exhibit distinct trajectories. The trajectory analysis suggests then, that patterns of behavioral change are not monotonous; rather, there are discernable differences in patterns of behavioral trajectories both within and between racial/ethnic groups. Whether early network predispositions or relational changes contribute to these trajectories remains to be addressed by future research. However, the findings relating to the long-term effects of early friendship networks suggest that they probably do.

CHAPTER SIX

# CASE STUDY: FINDINGS AND DISCUSSION

Introduction

The purpose of the case study is to visually demonstrate the relationship between friendship networks and the level of substance use. The case study is processed by UCINET, which was developed specifically for the study of social networks. This software is used to provide a representation of interpersonal relationships, detect cohesive subgroups, and identify actors who are in structurally equivalent positions.

UCINET deals with both non-directional and directional connections. Mutual nominations are not required. In the case of non-directional ties, that is, if actor A nominates actor B, the tie between them exists even if B has not nominated A, UCINET treats this as a connection between the two. This can be demonstrated using a simple example of a group with five actors. In the case of non-directional relationships, the matrix must be symmetric (see Table 32). The matrix is then transformed into a sociogram (see Figure 16). The shape of any sociogram is determined by moving nodes, which in Figure 16 are actors represented by blue squares. These symbols locate an actor with many ties in the center of the diagram. In this example there are two such actors, A and B, both of whom have three ties to others.

Table 32. Hypothetical Non-Directional Network Matrix

| Actors	A	B	C	D	E
A	0	1	1	1	0
B	1	0	1	0	1
C	1	1	0	0	0
D	1	0	0	0	1
E	0	1	0	1	0

Figure 16. A Non-Directional Sociogram
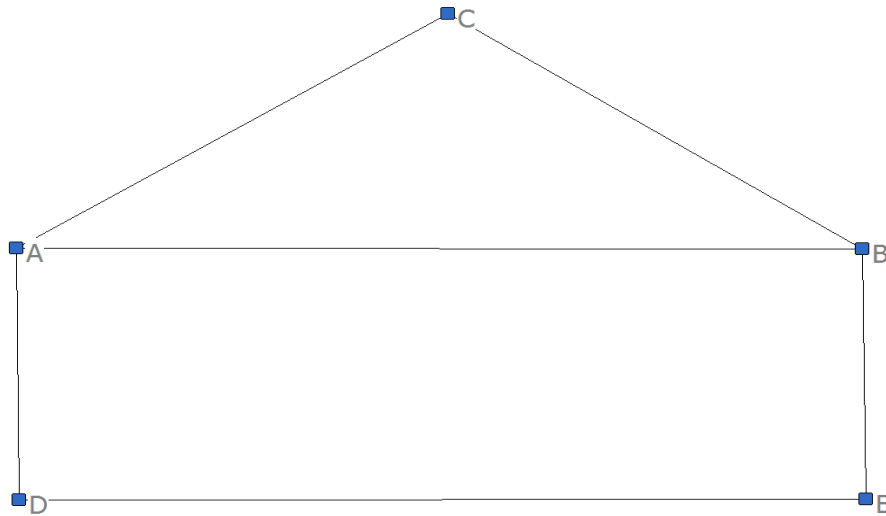
Typically, relationships are assumed to be directional. Within friendship networks, how friends are likely to be influenced is determined by nomination vectors, that is, the direction of the ties. When a friend's vector is directed toward another actor, it is assumed that the nominated actor will be influenced by the person doing the choosing. For example, as indicated in Table 33, B nominates E but not other way around. Therefore, although non-directional and directional sociograms will be the same in terms of shape, the arrows indicating who is likely to be influencing whom provides a more meaningful understanding of existing relationships (see Figure 17).

Table 33. Hypothetical Directional Network Matrix

Actors	A	B	C	D	E
A	0	1	0	1	0
B	0	0	1	0	1
C	1	1	0	0	0
D	1	0	0	0	1
E	0	0	0	1	0

Figure 17. A Directional Sociogram
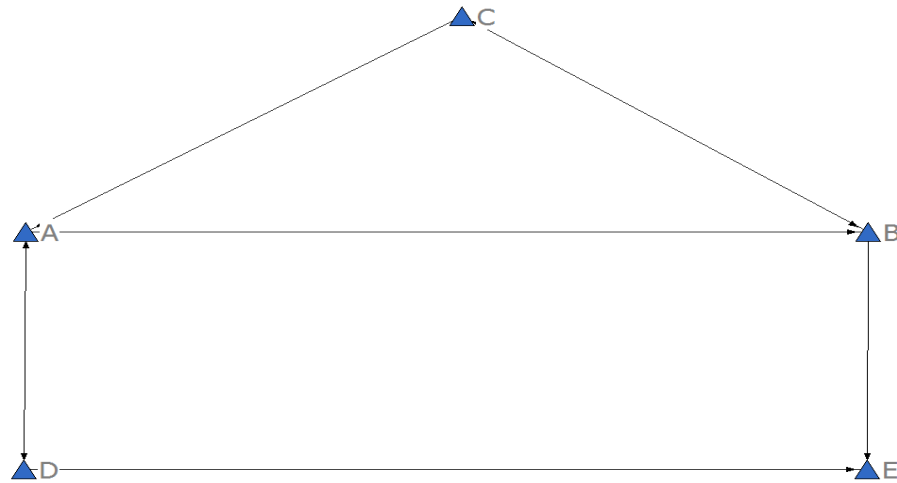
Findings

In this study, I focus on school-based friendship nominations. As described in Chapter 3, one small school with 61 students was selected for the case study. It is recognized that friendships may extend beyond school boundaries. However, given the nature of the Add Health study design, friends are limited to those who attend the same school.

Description of Sociograms for Alcohol Use and Marijuana Use

Friendship nomination matrices are generated using data on the levels of drinking (Figure 18) and marijuana use (Figure 19). By using this tool, we can see how substance users are enmeshed in friendship groups. Each letter in Figures 18 and 19 represents an actor. The levels of alcohol and marijuana use at Wave II are indicated by different shapes.

For drinking:

    ($\bigcirc$) represents never drinks
    ($\square$) represents once or twice in the past 12 months
    ($\triangle$) represents once a month or less
    ($\diamondsuit$) represents 2 or 3 times a month
    ($\odot$) indicates a missing value

For marijuana use:

    (○) represents never used marijuana

    (□) represents low level of use

    (△) represents high level of marijuana use

    (◉) represents missing values

As can be seen in Figures 18 and 19, all students are tied to others except for three who may be described as social isolates. These three are located in the top left corners of the two Figures. In general, there are two major groups in this school as illustrated in both diagrams, and these groups are bridged by one actor U. This person is in a convenient location to maintain contact with any other student in either of the two groups. In other words, without this person, the two groups would be separate.

In terms of alcohol use, we can identify one user subgroup on the far left of the diagram in Figure 18. This group includes actors D, AB, AP, and BA. The sociogram suggests that alcohol users are likely to be directly linked to other users. The one apparent exception is the relationship between actors D and AP. These two are indirectly linked through actor AB who happens to be a non-drinker.

In addition to the above, it should be noted that the mean age of the alcohol users is 16.7 and that two of the three drinkers are female. Because the number of alcohol users is very small the fact that the larger proportion of female drinkers compared to the quantitative results is not particularly meaningful. However, the age factor is generally consistent with the quantitative results, which suggested that older youth may socialize younger youth with regard to substance use.

For marijuana use, all of the users again appear to be connected to one another. It is also interesting to note that, as expected there is overlap between the alcohol and marijuana

users (Figure 19). This is perhaps understandable because alcohol use is a status offense and marijuana is illegal for adults. Therefore, marijuana users are more likely to use alcohol than the other way around. However, it seems clear that in this school substance use is limited to a small group. It is also noteworthy that there are no extreme users. Rather, all users maintain similar levels of substance use. This may reflect the small school size, which serves as a source of conventional control.

The Effects of Network Variables on Alcohol and Marijuana Use

Since the three substance users identified above, that is D, AP, and BA, are in the same group, the number of directional ties is used to examine *Centrality* and *Prestige* without standardizing by the users' network size. Among attenuate level alcohol users, that is, actors D, AP, and BA, neither D nor AP nominated anyone as a friend, but each is appointed as a friend by other classmates (see Figures 18 or 19). Actor D has four appointed ties and actor AP has two. Actor BA, who is in close proximity to actors D and AP, nominated four classmates and received five nominations. Except for actor BA, the proportion of appointing ties over nominating ties is very high. This consistent with the earlier finding that *Centrality*, at least as measured here, is not associated with alcohol use. Also, consistent with the earlier findings, is the fact that alcohol users tend to be popular as indicated by their high *Prestige* standing. The fourth student AB is a non-drinker, but is in a group of alcohol users D, AP, and BA and nominated all three as friends. Interestingly, none of the alcohol users nominated AB as a friend.

This group, including AB, seems similar to what Yablonsky (1959: 109) referred to as a "near group" which is characterized as one in which there is "diffuse role definition, limited cohesion, shifting membership, or limited definition of membership expectations." In the near

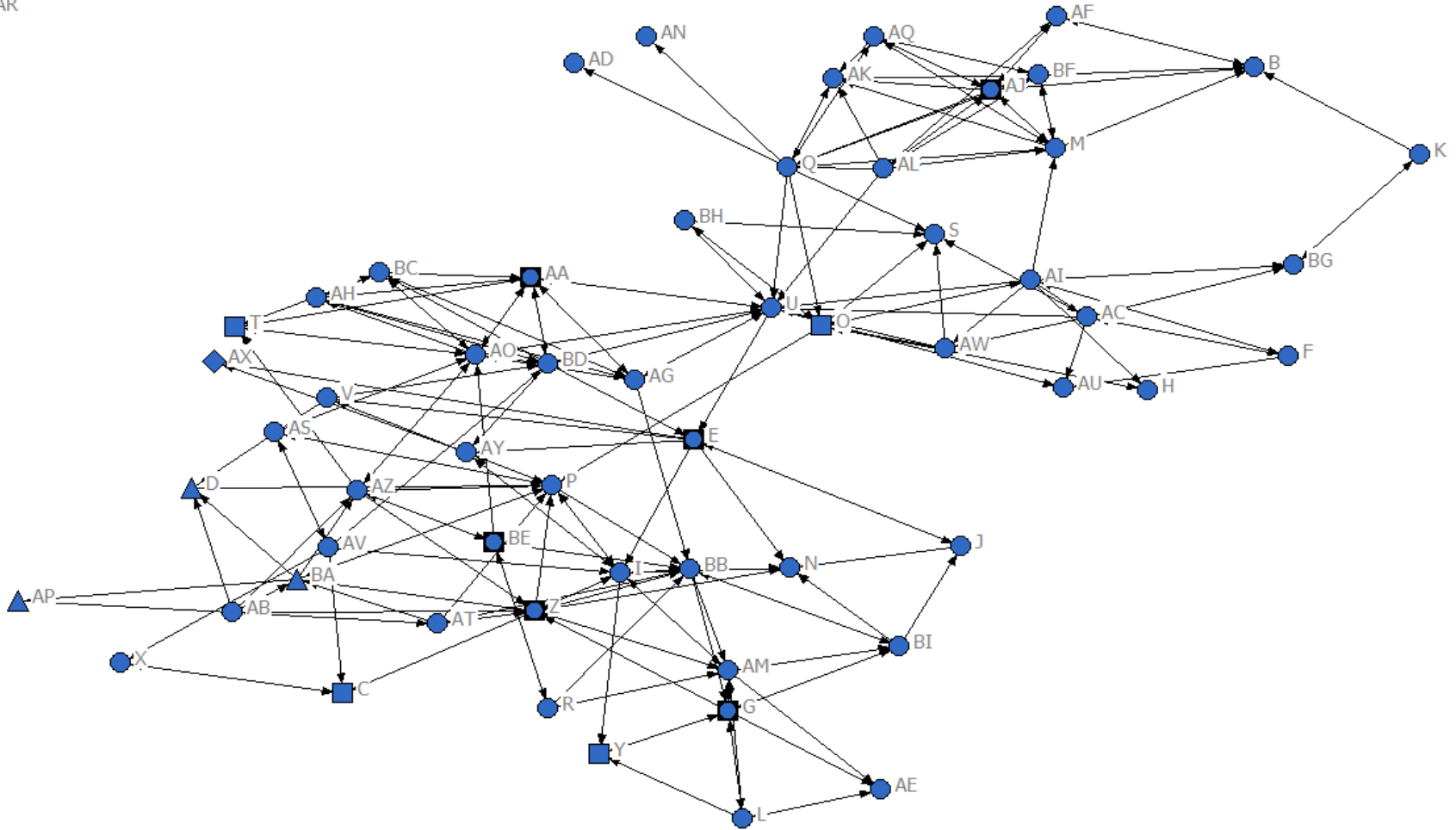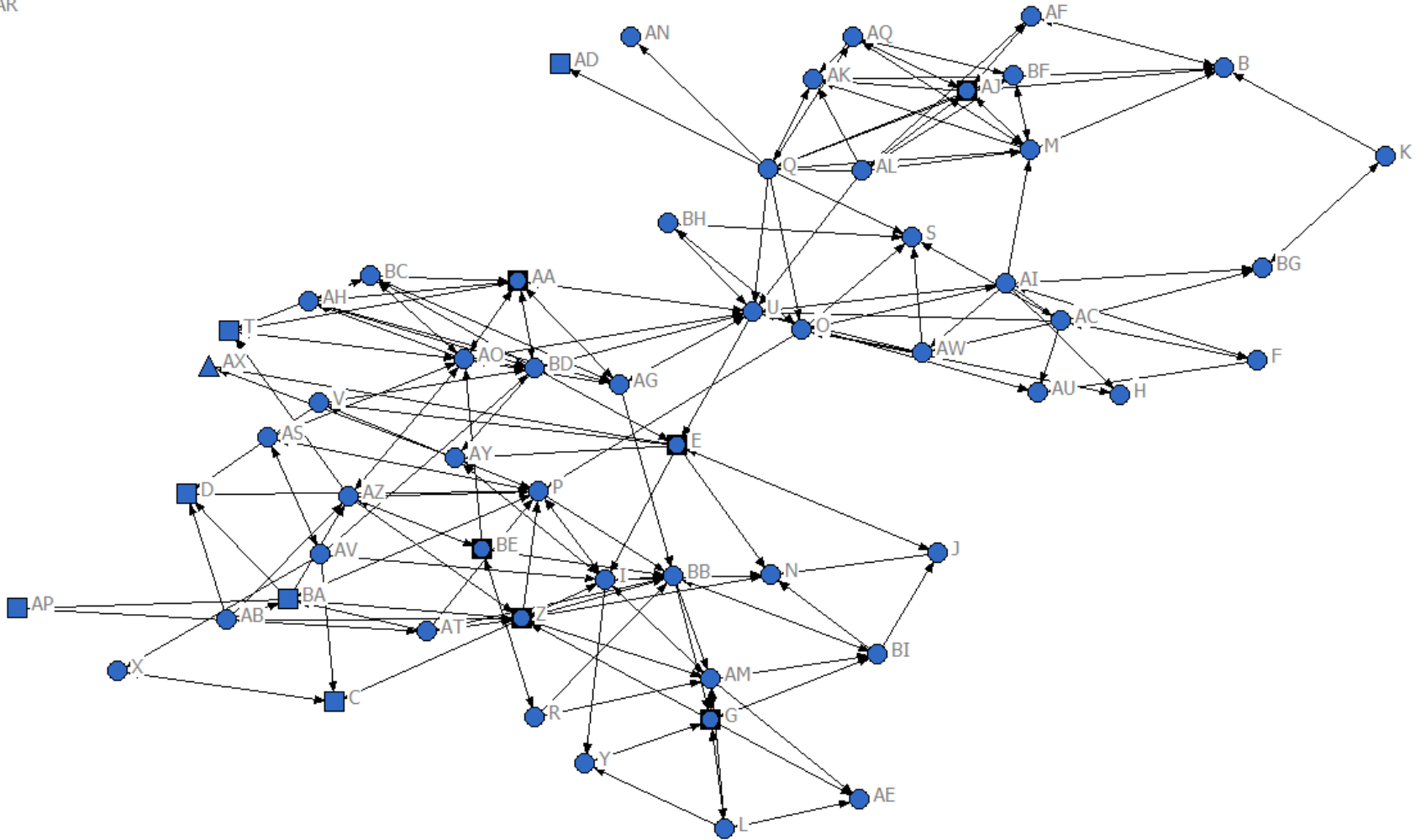**Figure 18. School-based Friendships and Alcohol Use**

Figure 19. School-based Friendships and Marijuana Use

group, marginal members are those who "claim affiliation in the gang but only participate in it according to their emotional needs at given times" or are "never defined by themselves or others as a gang member." (113) Actor AB appears to take on this role in this group.

When examining *Density*, or cohesiveness, using the density measure from the quantitative study (see Table 34),[26] it appears that students who have ever used alcohol or marijuana show approximately the same density levels as the average for all students in this school (Mean *Density* level=0.46).[27] For example, the *Density* level of actor D is 0.5 and for actor BA it is 0.45. This appears to reflect the results for alcohol use in the quantitative study although some qualifications are necessary. In the user group, the average level of *Density* for actors D, AB, AP, and BA is 0.42 (5/4*(4-1)), which is lower than the average individual *Density* levels for all youth attending this school.[28] This is again consistent with the results in the quantitative study, which showed that users are likely to be members of groups that are less cohesive than most.

Table 34. Network Characteristics Held by Actors

Actors	Indegree	Outdegree	Centrality	Prestige	Density
D	4	0	0	1	0.5
AB	0	6	1	0	0.43
AP	(2)				
BA	5	4	0.57	0.71	0.45

* Blank refers to missing values due to non-participation in the network survey.
* The value in parentheses is based on manual counting.

[26] The full table, which includes all respondents in the Case Study school, is too large to reproduce here. It is available from the author upon request.
[27] Average *Density* is calculated based on the *Density* values for each individual. This was calculated as follows: The sum of *Density* is divided by the number of students. Those who did not participate in the school survey were not included.
[28] Because actor AP did not participate in school survey, all four network variables for AP are recorded as missing. However, because the actor AP is appointed as a friend from others, we can count the incoming ties manually as indicated in the parentheses in Table 34.

As noted above, there are no extreme substance users in the substance user group. There are at least two plausible explanations for this. One explanation is that the substance user group effectively controls the upper limits of use. This involves the notion of socialization to group norms that place limits on the level of substance use the members will tolerate. An alternative explanation is that substance users choose as friends others who exhibit similar levels of substance use. This involves the notion of social selection and suggests that users are more likely to choose others whose substance use levels are similar to their own. Thus, either or both selection and socialization effects may account for the absence of extreme users.

As noted in Chapter 3 the Case Study sample includes very few minority students (three out of 61 students). Therefore, the network variable *Heterogeneity* cannot be examined. However, among the substance group members identified above, actor D is Hispanic. Thus, this user group can be considered to be a heterogeneous group and is consistent with the findings in the quantitative study although this holds only for marijuana use.

When I turn to the level of attachment to parents, actors D, AB, and BA express attenuate attachment to their parents, and actor AP reports low attachment (Table 35). The fact that none of the alcohol and marijuana users express high attachment to parents suggests that they are less constrained in choosing other substance users as friends. This is also consistent with Warr's (1993a) findings that the strength of one's attachment to parents influences friend selection. These findings are also consistent with the results from the quantitative study where I found that high attachment to parents was negatively associated with both alcohol and marijuana use.

Table 35. Levels of Attachment to Parents

Actor	Attachment Level
D	Medium (2)
AB	Medium (2)
AP	Low (1)
BA	Medium (2)

Structural Equivalence

Structural Equivalence is useful tool to determine whether actors have similar positions within a group and what difference that may make in terms of their behavior. It is expected that actors who occupy similar positions will engage in similar levels of substance use given roughly equivalent opportunities to obtain and use illegal substances. Further, the possibility of co-offending may also be identified. Structurally equivalent substance users who are connected are expected to not only have similar levels of substance use but to collectively share the experience.

Structural Equivalence was first addressed by Lorrain and White (1971) and refers to absolutely "substitutable" positions in a structure (63). That is, if some members have an identical role or position they can be considered to be interchangeable (Scott 1991; Wasserman and Faust 1994). Technically, actors who have identical rows and columns in a sociomatrix occupy a structurally equivalent position in their network (Scott 1991; Wasserman and Faust 1994). For example, if two gang members, A and B, have the same leader and/or instigator C, and the same followers X, Y, and Z under them, the two are in substitutable positions within the gang. As illustrated in the example in Figure 20, the structural positions of A and B in the gang organization are identical. However, because it is unlikely that actors share exactly the same position or location in a group, I may have to use approximations.

Figure 20. Example of Structural Equivalence
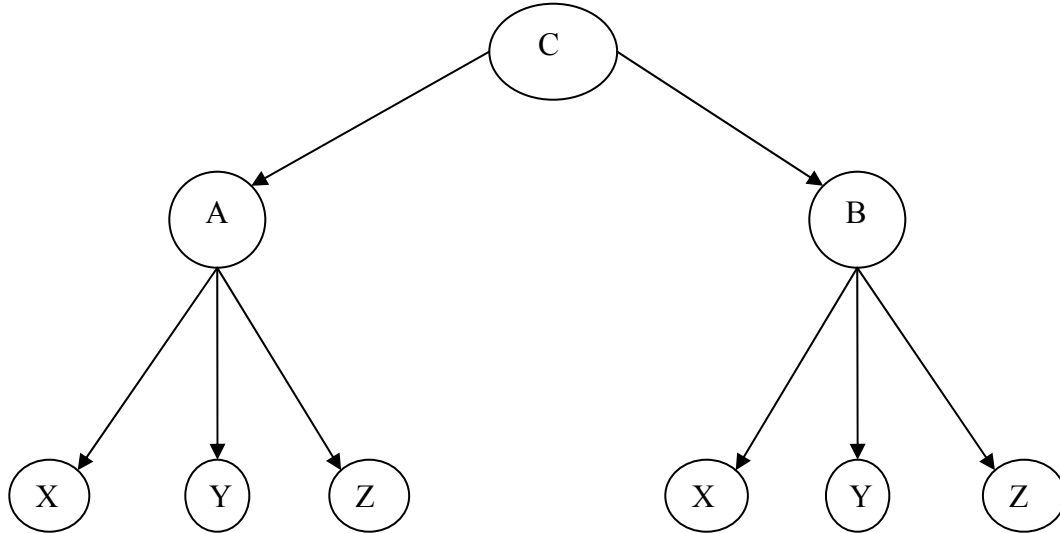
There are several alternative measures of *Structural Equivalence*, but the most widely used are Euclidean distance and Pearson correlation. Euclidean distance was developed by Burt (1976; 1978) and structural equivalence between actors is determined using geodesic distance, which refers to the shortest path between actors (Wasserman and Faust 1994: 367). The Euclidean distance is computed for all pairs in the networks. The second measure uses the "Pearson product-moment" (368) correlation coefficient to determine the degree of similarity or dissimilarity between every pair of actors. When two actors are structurally equivalent, the correlation between pairs of actors is +1; when two actors are completely dissimilar the correlation is -1. When a network is large as is the case here, it is likely that two actors are located some distance from each other. Therefore, Euclidean distance is not the best measure. Thus, I have used Pearson correlation.

Since the majority of students in this school are not substance users, I can focus on similarities in the positions of actors D, AP, and BA, the few substance users identified in the analysis. The correlations between actors D and AP, D and BA, and AP and BA are 0.7, 0.42,

and 0.37 respectively (see Table 36).[29] These correlations are strong enough to suggest

similarity rather than dissimilarity. This is especially true for actors D and AP. The other

substance user pairs D and BA, and AP and BA exhibit similarity, but at somewhat lower level.

Figure 21 illustrates the direct ties among six substance users who engage in both

alcohol and marijuana use and allows us to examine their structural equivalence. For example,

when I compare D to AP I find that both actors are connected through AB and BA. This is one

aspect of the similarity between D and AP. Second, these connections are made based on

nominations from AB and BA. Third, both D and AP do not nominate anyone else. In addition,

and as already noted, the Pearson correlations indicate strong similarity between D and AP

(r=0.70, Table 36). A second example showing similarity involves actors AP and BA. Both are

nominated by AB and the appointed ties overweigh nominating ties. Actors AP and BA hold

relatively similar positions (r=0.37). Finally, with regard to dissimilarity, I can compare the

relationship between AX and BA. They are completely detached from each other and there are

no overlapped actors. In this case, the Pearson correlation is only -0.04, which indicates that

AX and BA are not structurally similar.

Table 36. Structural Equivalence Matrix (Pearson Correlation)

	C	D	T	AP	AX	BA
C	1.00					
D	-0.04	1.00				
T	-0.04	-0.04	1.00			
AP	-0.02	0.70	-0.03	1.00		
AX	-0.02	-0.02	-0.03	-0.02	1.00	
BA	0.14	0.42	-0.06	0.37	-0.04	1.00

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[29] The full matrix is too large to reproduce here. It is available from the author upon request.

Figure 21. Structural Equivalence among Substance Users
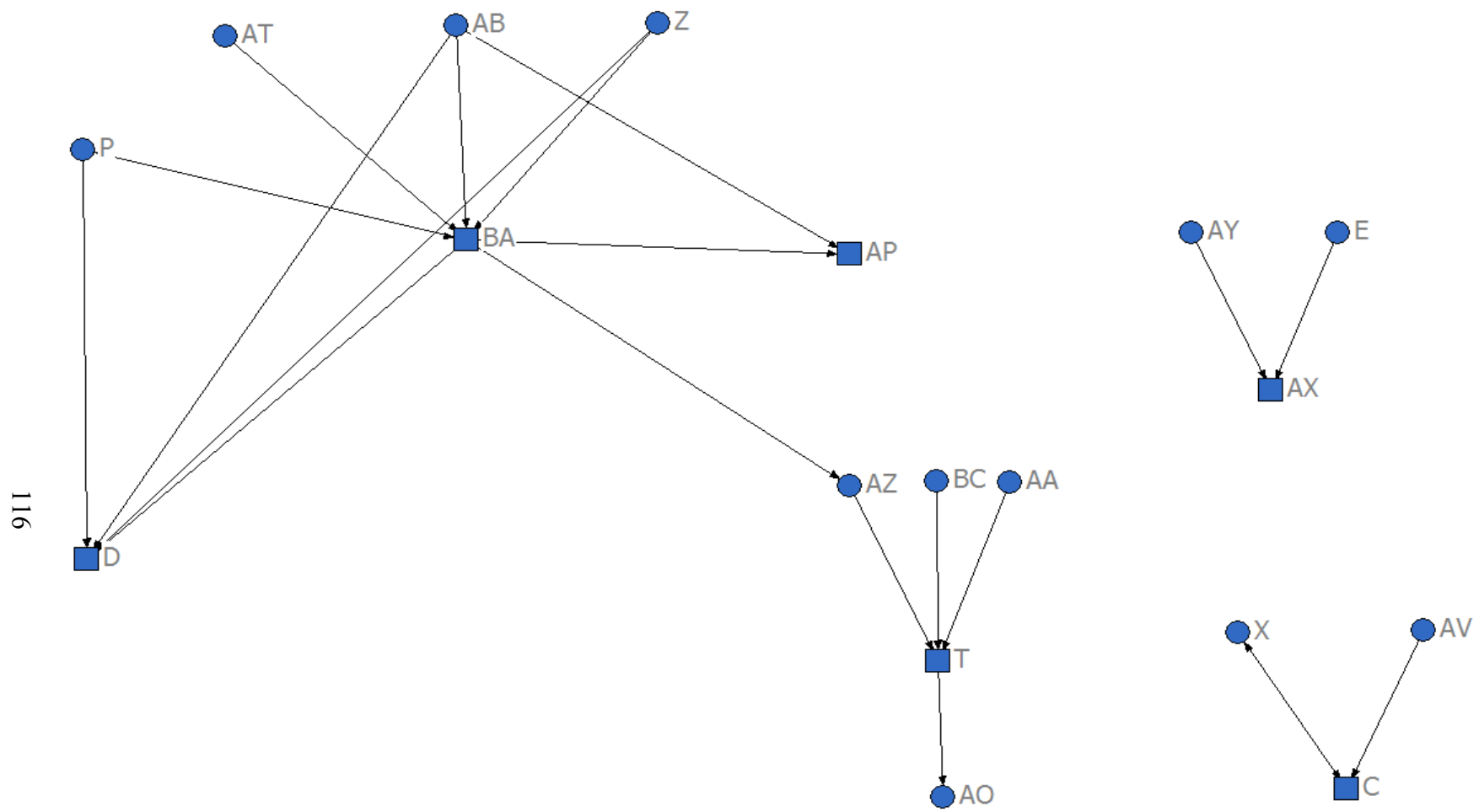
Square: Users; Circle: Non-Users

Whereas actors D and AP who occupy structurally similar positions show similar levels of substance use for both alcohol and marijuana, actors AX and BA occupy structurally dissimilar positions and engage in very different levels of substance use. Taken together, these findings provide evidence that allows us to conclude, at least tentatively, that substance users with structurally similar, if not equivalent, positions are more likely to exhibit the similar levels of substance use than will those who do not. Further, there may be more variation with regard to the level of substance use among those who are in the less structurally equivalent positions.

Not only do actors who have structurally equivalent or similar positions exhibit similar levels of substance use, but these structurally equivalent actors are also likely to be directly connected to each other. This is similar to what Akers (2000: 83) refers to as "a bird joining a flock and changing its feathers." That is, one actor who associates with a substance user begins use and then maintains a level of use similar to the other. However, as Akers admits (83) differential association with substance users is often more likely to a consequence rather than a cause. Thus, some might argue, as Hirschi (1969) no doubt would, that the findings here are more an outcome of the process of social selection. That is, "birds of a feather flock together." Although this does not go beyond speculation due to the absence of friendship information in Waves II and III, the results offer evidence of a selection effect.

Considering the presence of ties between substance users, co-offending is no doubt likely to occur. However, although having similar positions may be necessary for co-offending, it is not sufficient to explain it. Similarly, having ties between actors is essential to co-offend, but again is not sufficient to explain it. Both conditions must exist simultaneously for co-offending to occur. In this example, actors D and AP are in the roughly equivalent positions, but the two not connected. Without a direct tie between D and AP, they are less likely to co-

offend. On the other hand, actors D and BA and AP and BA have relatively similar positions and each pair is connected. In this case, each pair of actors has greater likelihood of co-offending.

Examining *Structural Equivalence* allows us to understand that most of the group members engage in substance use at similar level. Moreover, the connections among actors imply the possibility of co-offending. Here I can only conclude that individuals who share similar positions within a group tend to engage in similar levels of substance use.

Summary and Conclusion

The purpose of the case study is to enhance our understanding of substance use by providing a visual representation of the findings in the quantitative study. In general, this case study reflects the findings from the quantitative study. The correlation between network characteristics and substance use puts substance users in center of relatively well defined subgroups. Although there is no way to determine definitively whether these users co-offend or offend individually, substance use and in particular marijuana use tends to take the form of co-offending. In this sense, the results are at least consistent with the notion of co-offending among substance users.

As discussed in the quantitative study, higher *Centrality* may reflect the tendency of some youthful actors to "show-off" or engage in "groupie" type behavior. Without recognition from others, it is perhaps questionable whether opportunities for substance use exist for fringe members. On the other hand, *Prestige* directly reflects opportunities for substance use given the nature of their connections to others. It is also possible that their experience with substance use is the reason for their popularity, which in turn may provide additional opportunities for substance use. Finally, not only do actors who have structurally equivalent or at least similar

positions exhibit similar levels of substance use, but also these actors are likely to be directly connected to each other. This again suggests that the possibility of co-offending.

It is important to note that there are only a few substance users in the school chosen for the case study. There are a few plausible reasons for this. First, given the nature of the "saturated sample," students who responded may be very conventional and thus willing to participate in the lengthy in-home interview with less concern about the confidentiality of their responses than would frequent users. In addition, as with any study using self-reported behavior and attitudes, it is possible that their responses reflect expected rather than actual behavior and attitudes. Second, this school includes students in grades 7 through 12 grades and this may have limited the distribution of substance use given the inclusion of a large proportion of younger students. This may also reflect a potential school size effect. For example, the function of density can be applied to the school as a whole. In a small school, students are more likely to know each other which may result in fewer substance users than in the general adolescent population. Further, the racial/ethnic homogeneity of the school may contribute to a small number of substance users and the relatively low level of substance use even among users. Despite these caveats, it appears that overall the findings from the case study are generally consistent with the results in the quantitative study.

CHAPTER SEVEN

SUMMARY AND CONCLUSION

Discussion

This study has focused on the structure of adolescent friendship networks and examined how one's position in these structures affects substance use. Using data from a national panel study of in-school youth, I examined the effects of four network variables, *Centrality, Prestige, Density,* and *Heterogeneity* on substance use during high school and then again when the respondents were in their mid-twenties. It is clear from the findings that although the structure of friendship networks impact substance use the effects vary by race/ethnicity, and substance type, and time.

Contrary to expectations, my initial analysis revealed that the network variables showed little overall effect on underage drinking. However, when interactions with race/ethnicity were taken into account the effects of *Centrality*, *Prestige*, and *Density* were found to be statistically significant although direction of the effects varied somewhat by group. For example, whereas the overall effect of *Density* on alcohol use was negative, it had a significant positive effect on alcohol use among both African American and Asian youth. *Centrality* showed a significant positive effect only among African Americans. On the other hand, *Prestige* or popularity had a significant positive effect regardless of racial/ethnic group while *Heterogeneity* was found to be not significant even after race/ethnicity was taken into account. However, it is possible that the small sample size may account lack of statistical significance for Native Americans.

The findings for marijuana use were somewhat different. Contrary to expectations, *Centrality* was negatively associated with marijuana use. However, and consistent with the

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findings for alcohol use, *Prestige* was positively associated with use. These results suggest that within their friendship groups, marijuana users tended to be popular individuals who rarely nominated others as friends. This combined with the finding that *Heterogeneity* was also positively associated with marijuana would seem to suggest that these groups tend not to be very cohesive. In fact, *Density* had no significant effect on marijuana use. The picture that emerges is one in which marijuana users tend to be in the center of loosely organized groups. This seems consistent with Orcutt's (1978) observation that individuals engage in marijuana use for personal rather than social reasons.

As with alcohol use when interactions with race/ethnicity were taken into account, all network variables were significant and again the direction of these effects on marijuana use again varied somewhat across groups. *Density* appeared to serve as a facilitating factor only among African Americans and Hispanics. Consistent with alcohol use, *Centrality* had a significant negative effect whereas *Prestige* had a significant positive effect regardless of race/ethnicity. Unlike the findings for alcohol use, *Heterogeneity* appeared to have a strong facilitating effect across all racial/ethnic groups.

What both alcohol and marijuana use have in common is that when the interaction terms between race/ethnicity and network variables are incorporated, *Centrality*, *Prestige*, and *Density* had significant effects for the sample as a whole although the importance of *Centrality* and *Density* did vary by race/ethnicity. Apart from that the major difference is that *Heterogeneity* appeared to have a strong facilitating effect across all racial/ethnic groups for marijuana use but not for alcohol.

As expected the results revealed that attachment to parents is a strong constraining factor with regard to both alcohol and marijuana use. When the attachment to parents is

controlled, the effects of the network variables became stronger. Because juveniles can be attached both to parents and to peers, the principal influence here is not entirely clear. However, the findings seem consistent with Warr's (1993a) conclusion that attachment to parents may discourage adolescents from developing initial friendships with delinquent peers, but those ties are less constraining once exposure to delinquent youth occurs. In this study, peer influence is measured in terms of structural proximity. The findings indicate that adolescents are more likely to be affected by the friendship structure when attachment to parents is held equal. This further indicates that adolescents who report strong attachment to their parents are less likely to be involved in and therefore less influenced by their location in peer group structures. This suggests that when parental control is strong youth are less likely to select friends or be selected by others who are engaged in substance use. Given that, they should be less affected by peer group socialization processes.

The most salient finding for short-term alcohol and marijuana use is the effect of *Prestige*. *Prestige* shows a consistent positive effect on substance use regardless of race/ethnicity. This is partially consistent with Kreager and Staff's (2009) finding based on Cohen's (1955) theory of how subcultures are formed. According to Kreager and Staff, peer acceptance level is associated with the number of sexual partners boys have and especially boys from lower socioeconomic status backgrounds. Both findings suggest the possibility of a reverse causal effect, that is, because of one's past antisocial behavior an adolescent may be popular among peers.

When I examined the effects of network variables on later substance use, the findings with respect to alcohol use provide strong support for the hypothesis that adolescent friendship networks will impact future use as people enter their mid-twenties. For alcohol, *Centrality* and

Prestige were found to be positively associated with future use while *Density* showed a negative effect. This is also true for the measures of binge drinking and problem drinking at Wave III. Interestingly, the findings for later marijuana use and other illegal/unauthorized drug use are somewhat different. Here *Heterogeneity* in adolescent friendship groups is related to only for the use of these substances when the respondents were in their mid-twenties. Involvement in these more serious offenses appears to have less to do with one's position in early friendship groups than the type of groups in which they were involved. Nevertheless, the findings suggest that the effect of early alcohol and marijuana use on later alcohol, marijuana, and other illicit/unauthorized drug use is weakened, though only slightly, when adolescent network variables are controlled.

The major difference between alcohol and marijuana use is that the short-term network variables are more likely to be significant for marijuana use whereas the long-term network effects are relatively greater for both substances. In addition, *Density* affects both short-term and long-term alcohol use and *Heterogeneity* affects both short-term and long-term marijuana use. It is interesting to examine these differences in light of Sutherland's (1947) position that exposure to definitions favorable to the violation of the law vary in terms of frequency, duration, intensity and priority. These findings suggest that friendship networks established during the adolescent years will affect later drinking behavior because the associations with peers, and in this case those formed in school, are frequent and take on increasing importance through the adolescent years. These effects are perhaps particularly important for those who at some point begin using alcohol, which though illegal for youth, will eventually be "approved." In a sense, once peer groups are established this pattern is likely to continue over time. Because alcohol is generally considered to be a socially approved substance one's positions in

early friendship networks appear to be more important for later use. Marijuana use, on the other hand, is less likely to receive the same level of social approval from others. That is, any socialization to group expectations that occurred during early networks appears to carry over to later marijuana use.

The above appears to be related to the general trajectories identified for these substances. As adolescents reach legal age, drinking behavior is more likely to be approved; thus alcohol use in general showed an upward trajectory. On the other hand, marijuana use is illegal regardless of age; therefore, and consistent with Hirschi's notion of commitment, as individuals grow older and as they develop stakes in conformity, the trajectory for marijuana shows a downward direction. These trajectory patterns are generally consistent with the regression analyses.

As already noted, these data suggest that marijuana use is most likely to occur among isolated individuals located in less cohesive groups. If Orcutt (1978) is correct these individuals are likely engage in marijuana use over time for personal reasons. Individuals who were in heterogeneous groups during high school appear to be less likely to nominate others as friends. In heterogeneous groups, which are less cohesive, individuals may develop predisposition such as "going one's way" and the effect of *Heterogeneity* appeared to continue over time. However, there is some evidence that this relationship differs by race/ethnic group. For example, the effect of early drinking on later drinking and binge drinking was not found among Native Americans. Also, early marijuana use was not associated with later illicit/unauthorized drug use among African American and Native American youth.

Despite some limitations due to the composition of the school involved, the case study findings were generally consistent with those in the quantitative analyses. *Centrality* or active

nominations is not related to substance use whereas users are likely to have greater *Prestige* among their peers. Furthermore, the *Density* measure for users was lower than average, which is also consistent with findings from the quantitative analysis. Although the prevalence of substance use among the case study sample was very low, the results nevertheless revealed at least one unique function of network variables that was not apparent in the quantitative analysis. That is, substance users who shared structurally similar positions had similar levels of substance use whereas users who held dissimilar positions showed different levels of use. Identifying individuals who are in the similar positions in groups, particularly within school, may be useful for intervention strategies designed to assist substance uses.

As noted throughout, past research has rarely paid attention to structural proximity within friendship groups as this relates to substance use and perhaps delinquent behavior in general. Warr and Stafford (1991) report that one's delinquency involvement is not just the result of friends' attitudes; rather, other social learning concepts such as imitation may also influence one's behavior. Structural proximity would seem to be essential for an actor to observe and then imitate others' antisocial behavior. However, the findings from this study revealed that for the most part the effects of network variables on alcohol and marijuana use do not overlap in either the short-term or the long-term despite the strong correlation between the two. This may be explained by the fact marijuana users are more likely to use alcohol while alcohol users are not necessarily marijuana users. The data showed that 67 percent of marijuana users used alcohol as well whereas only 45 percent of alcohol users used marijuana concurrently. It would seem then, that there may be important differences between alcohol and marijuana use due to different legal definitions and general notions of acceptability. In addition,

and consistent with Orcutt's (1978) findings, the motivation for alcohol use tends to be social whereas the motivation for marijuana is likely to be personal.

Network analysis should help explain both the process of social selection as well as socialization based on structural proximity. Although both *Centrality* and *Prestige* identify one's position in a group, the effect of *Centrality* on behavior was not found to be as consistent as the effect of *Prestige*. While *Prestige* always indicates that an individual is the center of attention, *Centrality* does not. This may mean, of course, that *Prestige* is a better measure of one's location in a group. Whether or not that is the case it does appear, as Reckless (1961) argued, that *Prestige* serves as a "push" factor. *Heterogeneity*, it would seem, is also likely to function as a facilitating or "push" factor in the sense that it is associated with a lack of cohesion or *Density* within groups and therefore a lack of conventional social controls (see for example, Shaw and McKay 1942). On the other hand, *Density* appears to serve as a constraining or "pull" factor.

Limitations

Several limitations of the present study need to be addressed. First, as with most studies of delinquency and substance use, the distributions of these behaviors are highly skewed. As with studies of delinquency involvement (see Haynie 2001), the distributions of the dependent variables are highly skewed. This is particularly true for in-school self-report surveys because many serious delinquents and substance users have dropped out of school (Cernkovich et al. 1985). In this study, adolescents who participated in both the in-school survey and the at-home interviews at all three waves are perhaps even more unlikely to have engaged in or to report serious and excessive substance use.

Second, although I was able to measure the network variables at Wave I, comparable data were not available for Waves II and III. At Wave II, respondents were asked to nominate up to five friends for both sexes. However, because friends' ID numbers are not included I do not know who the respondents nominated. At Wave III, the respondents were asked only whether they could recognize ten randomly chosen classmates who went to the same school as they did and who appeared to the researchers to have similar background/characteristics. Thus I was unable to examine changes in friendship groups and the relationship between those changes and substance use.

Third, the measurement of marijuana use was not consistent throughout the three waves. In the first two waves, experience with marijuana use was measured in terms of frequency of use. At Wave III it was measured by a simple yes/no response. Thus, although I could address the question of whether the respondents had ever used marijuana during the past year, I was unable to measure levels of use comparable to Wave II.

Fourth, the case study sample includes very few minority students. Since the findings in the quantitative analysis suggest that racial/ethnic *Heterogeneity* was an important factor related to substance use, a sample school with a more racially heterogeneous student body would have been ideal. Unfortunately the small numbers of minority students in the schools that comprised the "saturated sample" did not permit a meaningful analysis.

Fifth, this study was conducted in part to examine the link between friendship networks and co-offending. Unfortunately, the Add Health data do not include a direct measure of co-offending. Thus, substance use, which often takes co-offending form, was used as the dependent variable. The strength of the Add Health data is that it does provide evidence of

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self-reported friendship networks whereas most studies of co-offending have been based on official data such as court records.[30] However, any notion of co-offending must be inferred.

Sixth, although the sample is weighted to be representative of all racial/ethnic groups, the sample size for Native Americans is quite small. This may have affected the level of statistical significance for some of the relationships reported. A larger sample size would be helpful to generalize the results to the entire population.

Finally, although the Add Health study provides a longitudinal dataset, I was only able to trace respondents' behavior into their mid-twenties (as of October 2009). When Wave IV data are available, they should permit further examination of the long-term effects of the network variables.

Policy Implications

Recently, Sherman (2002) addresses the development of tailored policies that are built on the "evidence-based paradigm." He describes this as follows:

> Evidence-based practice is a paradigm for making decisions. It requires learning as much as possible about cause and effect in professional practice, then mobilizing that information to guide practice toward producing more desirable results. The paradigm consists of proactively identifying as many sources and kinds of variation in practice as possible, in order to isolate the variations that measurably affect the desired outcomes. (2002: 220)

Based on the findings of this study it would seem that instead of policies targeting individual offenders as is traditionally done in our juvenile and criminal justice systems, we need to develop policies targeting groups and emphasize substance use education or prevention programs as well as intervention programs at the school level.

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[30] At present, there are only two distinct datasets that can be used to study co-offending: the Philadelphia co-offending study and the National Incident-Based Reporting System (NIBRS). Both are based on official data and can be obtained through the Interuniversity Consortium for Political and Social Research (ICPSR). Unfortunately, friendship networks cannot be detected in the Philadelphia study, although proximity relationships between co-offenders are identified.

Before turning specifically to the policy implications of this study, it is useful to keep in mind that during the mid-1980s when the "war" on drugs started, the prison population for drug related crime skyrocketed although new prison commitments for drug offenses have been stable (Bureau of Justice Statistics 2000; Sabol et al. 2009). This occurred despite the fact that over time there had been a general decrease in new prison commitments for some offenses such as robbery (National Corrections Reporting Program, 1998, 2003; Sabol et al. 2009). While new commitments to prison for drug related offenses have been relatively stable since the early 1990s, the percentage of drug offenders is at the highest level in the recent years (Bureau of Justice Statistics 2000; Sabol et al. 2009).

It is also the case that the number of offenders who were caught for liquor law and drug violations is highest at the age 18 and 19 (FBI 2008: Table 38). This has tightened budgets within the juvenile and criminal justice systems with the result that courts are overburdened and institutions are terribly overcrowded. Furthermore, these concerns should not be limited to illegal substance use, but also to persistent problem drinking, addiction to prescription drugs and related offenses that may at times be associated with crime and other dysfunctional lifestyles.

This study has focused on the relationships between friendship networks among youth and substance use. The findings suggest group-level approaches are necessary to control substance use among youth. Friendship group characteristics may very well be an important focus for group level intervention with juvenile substance users or potential users. For example, as the findings suggest, *Heterogeneity* appeared to have an important role in adolescent marijuana and other illegal/unauthorized drug use. However, being in heterogeneous groups is not necessarily a bad thing; rather, such groups could provide learning opportunities for

adolescents by exposure to diverse culture. An understanding of differences may promote

adolescent prudence, interest in others, and maturity. Thus, we have to find ways to integrate

those involved in heterogeneous groups into mainstream activities. Efforts to involve

adolescents in homogeneous groups in terms of common interests and goals and that maintain

conventional values/norms would seem to be a productive approach to temper current and

future use if this approach creates a sense of belonging among adolescents. Along with

common interests and goals, race/ethnicity may be particularly important because network

characteristics appear to function uniquely in some racial/ethnic groups. Whatever the

approach, it does seem clear that some form of intervention is necessary to be effective for

certain groups. However, we should consider that different approaches for alcohol and other

illegal drug use are necessary given the different legal definitions involved.

McCurley and Snyder (2008) report that 32 percent of alcohol users also used marijuana

and 81 percent of marijuana users also report alcohol use. The percentage of co-occurrence of

substance use in this study is, as noted earlier, slightly different from this report (45 percent of

alcohol users engaged in marijuana use while 67 percent of marijuana users also engaged in

alcohol use). However, this is close enough to suggest that co-occurrence of substance use

among youth is likely, and leads some legitimacy to concluding that early discovery of

substance problems and intervention at a group level may work by targeting high-risk

offending groups that include concurrent and higher level substance users at the school level if

this can be accomplished by not stigmatizing those involved.

Some suggest that legal/political interventions that crack down on juvenile offenses

committed by co-offenders will decrease the likelihood of substance use among adolescents.

However, based on the results of this research, cracking down on marijuana use is probably not

an effective strategy because it is typically committed by individuals who are loosely connected to others. Thus, random crack-downs may not capture many high-risk substance users nor affect them. Rather, such crack-downs are likely to have unintended negative results. Since substance users tend to be popular, being caught may intensify their popularity, which may in turn increase the level of substance use after release. A more effective policy would be to emphasize prevention through education and opportunities for involvement in the school and community to provide adolescents a greater "stakes in conformity."

For example, Akers (2000: 95) noted that some existing substance education or prevention programs rely on "social influence and skills strategies and techniques that reflect social learning assumptions." In these days the major sources of influence among adolescents are peers, media, and family, and they must learn how to resist negative influences from these sources. Akers notes that some programs that have been offered are peer-oriented and include "role-playing, socio-drama, and modeling drug-free behavior." (95) Although there are some variations in these programs, the core idea is early education and intervention.

When it comes to within school policies, rather than separating key individuals from the general population by taking away privileges such as participating in school-related activities, schools must find a way to get problem students more involved in social and educational programs. This may be particularly effective if done in collaboration with law enforcement. Since police officers know the reality of the criminal/juvenile justice system in terms of treatment of juvenile offenders, they can provide effective information, such as the processes of the justice system and the consequence of being caught, to juveniles to deter/prevent from substance use. This reality check may have a similar effect with regard to early stage of formal justice system to "Scared Straight" among adolescents, which is named after a 1978

documentary film (Akers 2000). Although we must keep in mind that many youth are not seriously involved in school activities, school administrators may nevertheless create appealing extracurricular activities and/or give positive incentives or rewards to increase their stakes in conformity. I believe that education rather than formal sanctions will be more effective and give adolescents a second chance for their future without stigmatizing them.

Lastly, identifying structurally equivalent or similar individuals within groups is important for early intervention. The case study revealed that substance users share similar positions. Once one substance user is identified, schools can provide early intervention with a group of youth by creating structural dissimilarity in a group by increasing the level of closeness between members or by introducing new non-delinquent members to the group to instill some positive effects.

Conclusion

As Sarnecki (2001: 168) notes, network analysis is "a theoretically neutral methodological tool" that appears to be particularly appropriate for studies of substance use. Network characteristics not only indicate how actors think about their relationships with others but also how others think about them. Unfortunately, although network scholars share core concepts, there is little agreement on definitions, specific features of social networks, and terminology (Fischer 1977, 33). With that in mind, researchers are required to provide their own definitions of terms and features before moving into analyses. They must specify the scope of the research, and what they want to measure and analyze. In order for network analyses to be used widely in the discipline of criminology/delinquency, scholars must work together to clarify their terminology and concepts.

The effect of social selection and socialization effects should be understood in the context of group dynamics rather than differences in personal characteristics. Peers or friendship groups are a major part of adolescent life as they grow older. The findings in this study suggest that much of what goes on during the adolescent years impacts both current and future behavior.

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Appendix A. Variable Descriptions

Variable	Description	Value
Age	Age was calculated based on the interview date in Wave I	13-18 years old
Sex	Biological Sex	Males=1, Females=0
African American		African American=1, else=0
Hispanic		Hispanic=1, else=0
Asian		Asian=1, else=0
Native American/American Indian		Native American/American Indian=1, else=0
Centrality	An actor's activeness within a group	Possible range (0-1)
Prestige	An actor's popularity within a group	Possible range (0-1)
Density	Cohesiveness of the group an actor belongs to	Possible range (0-1)
Heterogeneity	Racial diversity of the group an actor belongs to	Possible range (0-1)
Attachment to Parents	Level of attachment to parents	High=3, Moderate=2, Low=1
Drinking Level in Wave II	Frequency of drinking in the past 12 months in Wave II	Every day or almost every day=6, three to five days a week=5, once or twice a week=4, once a month or less=3, once or twice in the past 12 months=1, never=0
Drinking Level in Wave III	Frequency of drinking in the past 12 months in Wave III	Every day or almost every day=6, three to five days a week=5, once or twice a week=4, once a month or less=3, once or twice in the past 12 months=1, never=0
Marijuana Smoking Level in Wave II	Frequency of marijuana use in the past 12 months in Wave II	11 times and more=2, 1-10 times=1, none=0
Marijuana Smoking in Wave III	Experience of marijuana use in the past 12 months in Wave III	Yes=1, No=0
Binge Drinking in Wave III	Frequency of binge drinking in Wave III	Every day or almost every day=6, three to five days a week=5, once or twice a week=4, once a month or less=3, once or twice in the past 12 months=1, never=0
Problems caused by Alcohol in Wave III	Frequency of experiencing drink related problems in Wave III	High=2, Moderate=1, None=0
Other Drug Use in Wave III	Frequency of illicit/unauthorized drug use in Wave III	From Experienced all 8 drugs=8 to Never=0

Appendix B. Measurement of Alcohol Related Problems

Problem Description	Frequency
During the past 12 months, on how many days have you been drunk or very high on alcohol?	6= every day or almost every day, 5= 3 to 5 days a week, 4= 1 or 2 days a week, 3= 2 or 3 days a month, 2= once a month or less (3 to 12 times in the past 12 months), 1= 1 or 2 days in the past 12 months, 0=none
You had problems at school or work because you had been drinking.	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
You had problems with your friend s because you had been drinking.	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
You had problems with someone you were dating because you had been drinking.	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
Over the past 12 months, how many times were you hung over?	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
Over the past 12 months, how many times were you sick to your stomach or threw up after drinking?	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
Over the past 12 months, how many times did you get into a sexual situation that you later regretted because you had been drinking?	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
Over the past 12 months, how many times did you get into a physical fight because you had been drinking?	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never
Over the past 12 months, how many times were you drunk at school or work?	4= 5 or more times, 3= 3 or 4 times, 2=twice, 1=once, 0=never

Appendix C. Illicit Drug Use

Types of Drug	Value
Since June 1995, have you taken any of the following drugs without a doctor's permission?	
Sedatives or downers, such as barbiturates, sleeping pills, or Seconal?	Yes=1, No=0
Tranquilizers, such as Librium, Valium, or Xanax?	Yes=1, No=0
Stimulants or uppers, such as amphetamines, Prelud in, or speed?	Yes=1, No=0
Pain killers, such as Darvon, Demerol, Percodan, or Tylenol with codeine?	Yes=1, No=0
Steroids or anabolic steroids?	Yes=1, No=0
Since June 1995, have you used any kind of cocaine—including crack, freebase, or powder?	Yes=1, No=0
Since June 1995, have you used crystal meth?	Yes=1, No=0
Since June 1995, have you used any other types of illegal drugs, such as LSD, PCP, ecstasy, mushrooms, inhalants, ice, heroin, or prescription medicines not prescribed for you?	Yes=1, No=0