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SIBLING INFLUENCE:

THE MODERATING EFFECTS OF SIBLING SOCIAL STATUS

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ABSTRACT

This dissertation examines sibling social status as a moderator of sibling influence for delinquency and substance use in adolescence. Namely, I test whether siblings with higher outdegree, indegree, or reach in the school social network have more influence than those with lower measures of social status. Drawing on existing literature, I then assess how sibling dyad gender composition, sibling age gap, and number of siblings affect this core relationship. Lastly, I conduct exploratory analyses using social status as an outcome to evaluate whether and how sibling behavior, sibling social status, and mutual peers affect our own standing in the social network. Similar analyses are conducted using data from two longitudinal datasets: PROSPER and Add Health. HLM and APIM models are used to account for nesting of individuals within sibling dyads, genetic relatedness, and reciprocal influence of one sibling on another. Results show that sibling influence is indeed greater when siblings have higher social status. This is further pronounced for siblings of the same gender and, to some extent, close in age. Sibling behavior and social status do not emerge as statistically significant predictors of one's own social status. However, the presence and number of mutual peers are both associated with increases in our own social status, even after controlling for our social standing in a prior wave. Genetics account for little, if any, variation in these social processes. Limitations, implications, and directions for future research are discussed in the concluding chapter.

TABLE OF CONTENTS

LIST OF TABLES vi

LIST OF FIGURES vii

ACKNOWLEDGEMENTS viii

Chapter 1. INTRODUCTION 1

SIBLINGS AS MODELS 2

CHALLENGES 4

INNOVATIONS 5

OUTLINE OF SUBSEQUENT CHAPTERS 6

Chapter 2: DATA AND MEASURES 8

DATA 8

PROSPER 9

ADD HEALTH 16

Chapter 3. SIBLING SOCIAL STATUS AS A MODERATOR OF INFLUENCE 21

PEERS & SOCIAL STATUS 22

PARENTS, PEERS, & SIBLINGS: COMPETING SOURCES OF INFLUENCE 25

SOCIAL LEARNING 27

SIBLINGS & BEHAVIORAL SIMILARITY 30

SIBLING SOCIAL STATUS AS A MODERATOR 31

GENETICS 34

ASSESSING SIBLING INFLUENCE 35

DATA & METHOD 35

DESCRIPTIVES 38

PROSPER 38

ADD HEALTH 40

SIBLING INFLUENCE IN PROSPER 42

SIBLING INFLUENCE IN ADD HEALTH 48

MODERATION BY SIBLING SOCIAL STATUS 52

CONCLUSION 66

Chapter 4. BEYOND SIMPLE MODERATION EFFECTS 69
GENDER & AGE GAP 69
NUMBER OF SIBLINGS 70
DATA & METHOD 72
GENDER IMPACT 73
AGE GAP IMPACT 78
NUMBER OF SIBLINGS IMPACT 84
JOINT EFFECTS OF GENDER COMPOSITION & AGE GAP 93
CONCLUSION 96
Chapter 5: SOCIAL STATUS AS AN OUTCOME 98
SIBLING SOCIAL STATUS & MUTUAL FRIENDS 98
SIBLING BEHAVIOR AND SOCIAL STATUS 102
METHODOLOGY & DATA 105
RESULTS: PROSPER 107
RESULTS: ADD HEALTH 116
GENETIC VARIATION 122
CONCLUSION 126
Chapter 6: CONCLUSION 130
REVIEW OF KEY FINDINGS 131
IMPLICATIONS 134
LIMITATIONS 137
DIRECTIONS FOR FUTURE RESEARCH 139
REFERENCES 142

LIST OF TABLES

Table 1: PROSPER Wave One Demographic Characteristics for One-Sibling Families…….39
Table 2: PROSPER Variable Means in One-Sibling Families by Wave……..40
Table 3: Add Health Sibling Pair Demographic Characteristics……...…42
Table 4: Odds Ratios of Some versus No Substance Use in PROSPER One-Sibling Families...46
Table 5: Unstandardized Regression Coefficients for Continuous Use/ Delinquency Outcomes in PROSPER One-Sibling Families……...47
Table 6: APIM Models for Add Health Analyses of Sibling Influence……...……51
Table 7: APIM Models in PROSPER 100 Matched Sibling Subset……56
Table 8: APIM Models in Add Health for Sibling Social Status Moderation……..62
Table 9: Sibling Gender Composition Moderation of Sibling Influence in Add Health……..75
Table 10: Sibling Age Gap Moderation of Sibling Influence in Add Health……...81
Table 11: Moderation by "Older Sibling has Highest Status" for Sibling Influence in Add Health……87
Table 12: Moderation by "Younger Sibling has Highest Status" for Sibling Influence in Add Health……91
Table 13: Social Status Correlations among Siblings in PROSPER 100 Sibling Pair Subset…108
Table 14: Correlations among Mutual Friends and Social Status by Sibling in PROSPER 100 Sibling Pair Subset……...109
Table 15: APIM Models for Indegree Outcome in PROSPER 100 Matched Sibling Subset....113
Table 16: APIM Models for Outdegree Outcome in PROSPER 100 Matched Sibling Subset..114
Table 17: APIM Models for Reach Outcome in PROSPER 100 Matched Sibling Subset……115
Table 18: Social Status Correlations among Siblings in Add Health……116
Table 19: Correlations among Mutual Friends and Social Status by Sibling in Add Health…..116
Table 20: APIM Models for Indegree Outcome in Add Health……...……..120
Table 21: APIM Models for Outdegree Outcome in Add Health……...121
Table 22: APIM Models for Outdegree and Indegree Outcomes in Add Health—Full Siblings (333 pairs) ….....125

LIST OF FIGURES

Figure 1: APIM Model Diagram……..37
Figure 2: Interaction Plots for Sibling Social Status Moderation for Past Month Drinking in PROSPER……..57
Figure 3: Interaction Plots for Sibling Social Status Moderation for Delinquency in PROSPER……..58
Figure 4: Interaction Plot for Sibling Social Status Moderation for Delinquency in Add Health…….64
Figure 5: Interaction Plot for Sibling Social Status Moderation for Marijuana Use in Add Health…….65
Figure 6: Interaction Plot for Substance Use Outcome Gender Composition Moderation in Add Health…….76
Figure 7: Interaction Plot for Marijuana Use Outcome Gender Composition Moderation in Add Health…….77
Figure 8: Interaction Plot for Delinquency Outcome Age Gap Moderation in Add Health…….82
Figure 9: Interaction Plot for Marijuana Use Outcome Age Gap Moderation in Add Health…….83
Figure 10: Interaction Plot for Substance Use Outcome "Older Sibling Has Highest Status" Moderation in Add Health……. 88
Figure 11: Interaction Plot for Drinking Outcome "Younger Sibling Has Highest Status" Moderation in Add Health……. .92
Figure 12: Joint Contributions of Age Gap and Gender Composition to Sibling Social Status Moderation in Add Health……..……95

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Chapter 1. INTRODUCTION

Most Americans today grow up in a household that includes at least one sibling (U. S. Census Bureau 2012). Whether that brother or sister is present at our birth or arrives later on, the sibling relationship often endures even as others (dating partners, friends, etc.) come and go. Siblings, as a result, are in a strong position to influence and shape our behavior and attitudes as we age. They model behavior, affect our choice of and exposure to peers, compete with us for the attention and affection of parents, and serve as long-term companions (Feinberg, Solmeyer, and McHale 2012; Hetherington, Reiss, and Plomin 1994; Lempers and Clark-Lempers 1992).

Although many aspects of sibling influence (the impact of one sibling's behavior on another's) are of interest to sociologists, developmental psychologists, criminologists and others, this dissertation will focus on sibling influence for substance use and delinquency during adolescence. As I will detail in later chapters, adolescence is a time period during which many individuals will initiate and increase involvement in these problem behaviors. While frequency of delinquency and substance use generally decline in early adulthood, problem behavior in adolescence can have negative consequences for later health, employment, relationships, and any of a number of other areas of concern. Thus, these behaviors during adolescence have long been a source of interest to researchers across fields.

In this dissertation, I step back from an examination of overall sibling influence for these outcomes to look, more specifically, at how a sibling's social success or failure among peers

(social status) might affect their behavioral influence during adolescence. Broadly speaking, social status refers to one's rank or position in a social hierarchy such as a peer group, family, school, or society at large. Social status may be based on inherent characteristics (age, sex, race, etc.) or can be acquired through skill, education, behavior, and the like (i.e. occupation). In this dissertation, I focus on sibling social status in the peer network as indicated by the number of friends a person has in the school peer network.

In this and later chapters, I argue that a sibling's social status will condition the extent to which we emulate his or her substance use and delinquent behavior in adolescence. In other words, why would we want to copy the behavior of a sibling who is unpopular or ostracized? It seems more likely that we may want to emulate the behavior of a sibling who has established success among peers (i.e. is popular). After all, popularity, as will be discussed in a later chapter, is of profound importance to adolescents as they attempt to establish their emerging identities. Our siblings, in this sense, can serve as models of both behavior and social consequences of behavior.

SIBLINGS AS MODELS

Much of what I argue in later chapters of this dissertation is derived from Social Learning theories (Akers 2009; Burgess and Akers 1966a). These theories propose that we learn our behavior by observing the behavior of models that include individuals, the media, and other sources. We are particularly likely to model the behavior of those we especially value, see frequently, or encounter in childhood (Sutherland 1939). We also learn to select some behaviors over others based on how these behaviors are received by others. Some behaviors are rewarded or condoned while others are punished (Akers 2009).

As is argued in the sibling influence literature, it is quite likely that siblings serve as models of behavior during adolescence as well as other periods of the life course. Not only are siblings typically close in age and share a home, but they often have overlapping peer networks and may attend the same schools in childhood and adolescence (Hetherington et al. 1994). As a result, we would expect them to serve as valued and age-relevant models of behaviors that include substance use and delinquency. Later in this dissertation, I discuss some of the existing research literature that confirms this expectation.

My focus, however, is not on sibling behavioral influence by itself, but on sibling social status as a potential moderator of sibling influence. Drawing on Social Learning theories, I propose that siblings not only model behavior, but also model how behavior is received in the social context. Like ourselves, our siblings are embedded in peer networks. The status of our siblings in these peer networks likely affects our perceptions of which behaviors and characteristics are associated with popularity and which are not. Whether or not these perceptions are accurate, the behaviors we emulate may be conditioned by these perceptions. Why, for instance, would we wish to emulate the behavior of an unpopular sibling? In other words, we vicariously learn the social consequences of behavior from the experiences of our siblings and choose those behaviors that appear to have the greatest social reward. Particularly in the case of younger siblings modeling older siblings, these arguments are akin to anticipatory socialization. This is the notion that we develop prior knowledge and an understanding of behavioral expectations and consequences before we actually experience an event or social context ourselves.

Based on prior literature and these theoretical expectations, this dissertation will attempt to answer the three key research questions listed below. Each will be addressed separately in a later empirical chapter (chapters 3, 4, & 5).

1. How does sibling social status moderate sibling influence for delinquency and substance use?
2. How is this relationship affected by key factors identified in the literature such as gender composition, age gap, or number of siblings?
3. How might sibling behavior and sibling social status impact one's own social status?

CHALLENGES

Testing whether sibling social status indeed moderates sibling influence poses several data structure and methodological challenges that I address in this dissertation. First, I need data that includes measures of social status and behavior for multiple siblings in a family. Since many studies follow individuals rather than families, this substantially limits the number of datasets that can be used to test for sibling social status moderation. Further, I need data that includes reliable and specific measures of social status. Rather than a general measure of popularity or perceived popularity that is used by some studies (see Craine et al. 2009 for example), ideally I would like measures of social status that are more objective such as number of friends, number of individuals perceived to be friends, social reach in a peer network, etc. These measures allow me to examine the various dimensions of social status among peers. In Chapter Three, I describe how each dimension of social status can be informative.

A second challenge is that I would ideally like to study sibling social status moderation with data that incorporates identical measures for each sibling. Since sibling influence may be reciprocal, having the same measures for each sibling allows me to examine how siblings

influence one another without being restricted to examining only one direction of influence. Reciprocal influence also presents a methodological challenge. How do I isolate the effect of one sibling versus another? In Chapter Three, I detail Actor-Partner Interdependence Models (APIM), which allow me to tease out the influence each sibling has on another and him/ herself. Relatedly, since I examine multiple siblings in a family, I must utilize a method that accounts for the nested structure of such data (also described in Chapter Three).

Lastly, the ideal data for testing my research question should also be longitudinal. A cross-sectional dataset would not allow me to examine how a sibling's behavior and social status interact to affect later behavior. Cross-sectionally, I would only be able to assess how sibling social status and sibling behavior correlate with current substance use and delinquency. From this, I could not infer that sibling social status and behavior influence one's current behavior. In Chapter Two, I describe two datasets that together help me to address these data structure and methodological concerns.

INNOVATIONS

My dissertation makes several contributions to the existing sibling influence and peer influence literature. First, as heretofore discussed, I examine sibling social status as a potential moderator of sibling influence. Although the existing literature has identified factors such as age and gender as moderators, to my knowledge only one existing study (Craine et al. 2009) has addressed sibling social status as a moderator. This study is discussed in more detail in Chapter Three. Second, my methods allow me to test whether influence and social status moderator stem from older siblings to younger siblings (as much of the literature suggests), or whether influence and social status moderation can be more reciprocal in nature. Third, I test sibling influence and social status moderation effects for both delinquency and substance use, examining each

substance independently as well as within a joint measure of overall substance use. Existing research suggests that the links among social status, delinquency, and various forms of substance use differ somewhat. An analysis of these multiple outcomes allows me to tease out these differences. Lastly, by drawing on two datasets for my analyses, my dissertation incorporates within-study replication using two, independent samples of adolescents. My findings are bolstered when replicated in two different samples.

OUTLINE OF SUBSEQUENT CHAPTERS

To establish that sibling social status indeed serves as a moderator for sibling influence, I need to first demonstrate that there is an association between one sibling's delinquency and substance use and the later delinquency and substance use of other siblings (i.e. sibling influence). This goal is accomplished in the first empirical chapter of this dissertation, Chapter Three. Chapter Two details the data and measures that I draw on for this and subsequent empirical chapters. In Chapter Three, I also discuss and account for the possible influence of genetics in my analytic models. I test for sibling social status moderation in Chapter Three by adding multiplicative interaction terms to models demonstrating sibling influence overall. One question I also address is whether it matters if the "influencing" sibling is the younger or older of the pair. Much in the literature suggests that older siblings influence the behavior of younger siblings, but not vice versa. I test this proposition in Chapter Three.

In Chapter Four, I consider the added complexities that arise when age gap, gender, and number of siblings are considered alongside the basic moderation effects of sibling social status. These analyses will be isolated to the Add Health data given the small number of cases with full sibling social network data in PROSPER. I assess the possible role of age gap as the literature

suggests that less sibling influence will be present when siblings have a wider age gap. For gender, the literature suggests variation in effects by both gender (male vs female) and gender composition (opposite versus same-sex in dyad).

In Chapter Four, I will broaden analyses to more fully examine sibling influence for those with more than one sibling. However, since each sibling engages in substance use and delinquency to a different degree, and may play a very different role in his/ her social network, this is a complex undertaking. I will use measures that test whether the sibling with the highest social status of the family is most influential as well as whether sibling influence diminishes overall as family size increases. These analyses will be limited to the Add Health data.

In my final empirical chapter, Chapter Five, I consider social status as an outcome. Although my primary goal is to assess whether sibling social status serves as a moderator, some theory also suggests that sibling delinquency, substance use, and social status might also impact one's own social status. In this chapter, I largely repeat analyses from Chapters Three and Four with social status measures as outcomes. In Chapter Six, I review the key findings from each of the empirical chapters as well as address implications of my research and some possible future directions of inquiry.

Chapter 2: DATA AND MEASURES

DATA

To investigate the role of sibling social status in sibling influence for substance use and delinquency I need data that meets three minimum requirements. First, I need data that not only identifies siblings but also contains detailed measures of sibling behavior and status in peer networks. As many studies follow individuals rather than families, this is a substantial requirement. Second, I need data that involves adolescents identifying their friends within a social network. These friendship nominations will allow me to identify peer group boundaries and measure social status. Lastly, my data need to be longitudinal so that I can assess the impact of a sibling's behavior and social status on an adolescent's behavior and social status at a later time.

I draw on two datasets that at least partially meet these requirements, PROSPER (Promoting School-Community-University Partnerships to Enhance Resilience) and Add Health (National Longitudinal Study of Adolescent Health), discussed in the paragraphs that follow. PROSPER is useful for this dissertation because it contains five waves of data and many school peer networks, allowing for identification of numerous aspects of social status and a strong longitudinal analysis. However, it contains somewhat weak measures of sibling behavior and sibling social status and relies on a sample of adolescents that is not nationally representative. Thus, I complement analyses in the PROSPER data by drawing on Add Health. Although Add Health only provides two waves of adolescent data for my analyses, these data have very strong measures of sibling behavior, sibling social status, and sibling relations. Further, Add Health includes a large sample of adolescents from across the United States.

PROSPER

The PROSPER (Promoting School-Community-University Partnerships to Enhance Resilience) data were collected as part of a larger project evaluating the effects of a school-based substance use intervention program for young adolescents. Participating PROSPER schools are located in 28 communities in Iowa and Pennsylvania (Kreager, Rulison, and Moody 2011; Spoth et al. 2004, 2007). These communities are predominately rural and were selected such that at least 15% of the student body in each school is eligible to receive a reduced-price or free lunch (Lippold, Greenberg, and Feinberg 2011). Schools were matched on basic demographic characteristics and then half were randomly assigned to participate in substance use intervention programs in the 6th and 7th grade years (Spoth et al. 2007). The PROSPER project administered in-school surveys to all students in two 6th grade cohorts, surveying each cohort annually through 12th grade (Kreager et al. 2011; Siennick and Osgood 2012). Two surveys were conducted during the 6th grade year (in Fall and Spring) in order to assess the impact of the substance use intervention programs. The first, conducted during the Fall, served as a pre-test and occurred before the intervention programs were administered. In-school survey topics include substance use, friends, family processes, and school attachment, among others.

This dissertation specifically draws on data from a subsample of students from the second cohort that was randomly selected for a more intensive set of in-home interviews, surveys, and family observations (Spoth et al. 2004). Although 2,267 families were selected for the in-home data collection, only 979 participated (Lippold et al. 2011). A comparison of these families to the overall PROSPER sample indicates that these students may be less at-risk for problem behavior, including substance use (Lippold et al. 2011). This subsample of 6th graders also completed the in-school survey component. However, the in-home data include four rather than

five waves because the Spring sixth-grade data collection was omitted for the in-home sample (Spoth et al. 2004).

Since the in-home questionnaire does not address peers, peer group information and peer behavior are assessed using the in-school questionnaire completed by all respondents. As part of the in-school PROSPER questionnaire, students are asked to list the names of one or two of their best friends as well as up to five other friends in their same grade and school (Kreager et al. 2011; Siennick and Osgood 2012). Because students are asked to limit their friendship nominations by grade and school, data from one individual can be linked to the data for each of his or her friends. These nomination links are used to define friendship networks (Kreager et al. 2011; Siennick and Osgood 2012). Although the proposed study uses only the in-home subsample of the PROSPER students, each member of the subsample can be linked to his or her friendship network in the core PROSPER project and to the data corresponding to those friends.

There are a number of key advantages associated with data of this form. First, the data are longitudinal and span a long enough time frame to assess temporal trends. Second, the data contain rich measures of friendship and popularity, allowing for determination of not only social status within a group, but also the social status of an individual's social group within the overall school network. These two characteristics of the PROSPER data are an improvement over existing research.

IDENTIFYING SIBLINGS

As part of the in-home questionnaire, respondents provided a full household roster of all individuals in the home, their ages, their education (or grade in school), and their relationship to the respondents. These data identify the age, gender, and grade-level of all siblings. Roughly

80% of individuals in the subsample have at least one sibling, and most siblings are very close in age. As a result, when I refer to PROSPER data, I will distinguish between the "target adolescent" and his/her siblings. Since the PROSPER project focused on students in two 6th grade cohorts, in most of the PROSPER families only one child personally completed the survey instruments. As a result, measures of behavior and social status for this target student differ from measures used for siblings (i.e. siblings did not complete their own surveys).

Two other data limitations require some care in analysis and sample selection. First, the in-home questionnaire does not address actual or perceived sibling social status. To address this shortcoming, I examine sibling social status effects within the subset of respondents (100 sibling pairs) who have a sibling in one of the PROSPER cohorts. Detailed social network data of the form described above are available for these siblings. Although no longer a representative sample, this subset of respondents will allow me to replicate findings from the Add Health sample (discussed below). Analysis of sibling behavioral influence, however, can capitalize on the larger in-home sample.

A second shortcoming is that the in-home questionnaire only asks respondents to report how many of their siblings engage in certain behavior, not which siblings do so. This limits my ability to determine which sibling(s) is influential using these data. To address this issue, I restrict main analyses to the 432 families (44% of the sample) where the target child has only one sibling in the first wave of in-home data collection. This restriction allows for exact identification of all sibling demographic characteristics. To investigate the possibility that households with more siblings may be qualitatively different in some way than those with only a single sibling dyad, I test several models assessing the effect of number of siblings and whether a giving sibling has the highest social status in a family in Chapter 4.

PROSPER LIMITATIONS

Several limitations, in addition to those discussed previously, warrant a brief note here. First, the PROSPER data were collected from schools in small towns and rural areas with a predominately white population. As a result, findings from the proposed study may not be generalizable to other adolescent populations, such as urban, at-risk youth. Second, measures of sibling closeness and conflict are quite limited in the data. These variables may be influential moderators and mediators. Lastly, genetic relatedness information is only available for the subset of 100 sibling pairs identified in the two PROSPER cohorts. Even this information is quite limited; zygosity for twin pairs is not always known. As a result, examination of genetic contributions to sibling influence will be isolated to the Add Health data.

PROSPER MEASURES

SIBLING SUBSTANCE USE & DELINQUENCY

Detailed sibling substance use and delinquency measures are, unfortunately, not available for most of the in-school sample except for the subset of respondents (100 sibling pairs) who have a sibling in one of the PROSPER cohorts. For key analyses, measures of sibling delinquency and substance use in the PROSPER data are derived from an in-home survey question asking respondents to report how many of their brothers, sisters, or step-siblings engaged in a list of specified activities during the past 12 months. These activities include smoking cigarettes, using alcohol without parental consent, using marijuana and other drugs, skipping school, theft of less than $25, theft of greater than $25, and vandalism. Respondents indicate whether none, one, two, or three or more of their siblings engaged in each of these

behaviors. As I limit most analyses to one-sibling families, I can isolate which sibling engaged in these behaviors.

From these item-level responses, I create a count measure for substance use of the number of items for which respondents report some sibling use (ranges 0 to 3, based on three substance use items). I create an equivalent measure for the five delinquency items in this question series (ranges 0 to 5). These measures from the previous wave will serve as explanatory variables to assess how sibling behavior in one wave affects individual outcomes in later waves. When I examine sibling social status effects in the subset of respondents with complete network data for siblings (100 sibling pairs), I will be able to use the same substance use and delinquency measures for all adolescents and their siblings, drawn from the in-school survey (measures described below).

TARGET ADOLESCENT SUBSTANCE USE & DELINQUENCY

Although measures of substance use for target adolescents were also collected as part of the in-home surveys, these measures will be obtained from the in-school survey, as individuals may be more likely to report these behaviors in an anonymous school setting. For the target adolescent, I use measures of alcohol use, smoking, and marijuana use, considered separately since prior literature has indicated that predictors of substance use may vary by substance. A question series on the in-school survey asks students to report how often in the last month they smoked cigarettes, drank alcohol, and smoked marijuana. Response choices for each item were not at all, one time, a few times, about once a week, and more than once a week. These responses will be dichotmozied as never (0) or one or more times (1).

Individual delinquency is calculated from 12 dichotomized in-school survey items asking respondents to report how many times in the past year they engaged in certain delinquent behaviors including vandalism, theft of less or greater than $25, and truancy, among others (range 0-12). Each individual item is dichotomized as never or at least once. I will use Item Response Theory scaling for these and the substance use items. Although taking a sum of delinquency or substance use items is a simple and intuitive approach, it presents a few key problems. First, most respondents will report that they did not use a particular substance and did not engage in a particular delinquent act (Osgood, McMorris, and Potenza 2002). Thus, individual delinquency and substance use items are heavily skewed, a phenomenon I observe in both the Add Health and PROSPER data. Further, items tend to be heavily correlated, meaning that the resulting summative score will also be skewed as well as limited to a few low sums (Osgood et al. 2002). A second problem is that with summative scores we generally assume that an increase of one unit for one item produces a one-unit increase in the sum, regardless of the item considered (Osgood et al. 2002). However, at least for delinquency, items vary greatly in the severity of the behavior. Should a one-unit increase in frequency of car theft be weighted the same as a one-unit increase in frequency of lying to parents? Likely not, so a different method of combining individual delinquency or substance use items is needed.

For this dissertation, I use Item Response Theory scaling (hereafter termed IRT) for delinquency and substance use. IRT makes use of mathematical models that map item-level responses for a set of items to a position on a latent, continuous, equal-interval variable (Osgood et al. 2002). Specifically, I use measures created using Samejima's Graded Response Model. The Graded Response Model specifies a function that maps the underlying latent trait to probabilities of item-level responses (Samejima 1997). This specific model handles items with

ordered polytomous responses (Samejima 1997). Post-estimation produces Empirical Bayes predicted values on this latent variable. These predicted values are what I refer to as IRT scaled delinquency and substance use measures.

SOCIAL STATUS

Target adolescent social status will be measured using indegree (number of incoming friendship nominations), outdegree (number of outgoing friendship nominations), and reach (number of individuals within two ties). One weakness of the PROSPER data is that the social network data collected with the in-school PROSPER surveys do not provide comparable social network or social status information for many siblings. As mentioned previously, analyses focused on sibling social status will utilize social network data from the subset of respondents (100 sibling pairs) who have a sibling within one of the two PROSPER cohorts. Since siblings must be very close in age to appear in the two cohorts, 100 is necessarily much smaller than the total number of PROSPER respondents with siblings. However, such an analysis allows me to examine the long and short-term longitudinal effects of sibling social status and behavior as well as capitalize on the detailed social network data available through the PROSPER project. Such detailed data has not been used in prior studies and allows for an examination of popularity, status, and other network-related factors without being limited to only the status perceptions of a younger sibling. Further, various aspects of social status can be examined both independently and as a unit.

In addition to controls previously noted, I control for respondent state (accounting for the place-randomization of the study), school treatment condition, gender, race/ ethnicity, whether the respondent lives in a two-parent family, and whether the respondent received free or reduced-

price lunches. I do not control for age since all target students were in the same grade in the initial wave. To make PROSPER analyses with the one-sibling sample more similar to Add Health analyses, I include a control for whether the sibling data is from the older sibling as well as interact this control variable with sibling behavior. This allows me to assess whether the influence of sibling behavior varies by birth order within the sibling dyad.

ADD HEALTH

The National Longitudinal Study of Adolescent Health (Add Health) is a longitudinal study of a nationally representative sample of individuals who were in grades 7 through 12 in 1994 (Harris et al. 2006). These individuals have been surveyed in four waves and were ages 24 to 34 at the time of the most recent interview in 2007/2008. Parents, siblings, school administrators, and partners of these individuals have also been included in one or more waves of the study. The purpose of Add Health is to study health and risk behaviors, predictors of these behaviors, later trajectories of health and risk behaviors, and related topics. Such a broad scope has allowed researchers from many different fields to capitalize on these data (Harris et al. 2006).

The sampling design of Add Health is school-based. Namely, 80 high schools were selected as representative of the United States as a whole (Harris et al. 2006). One "feeder" school (lower level schools that send graduates to these high schools) was selected with probability proportional to the number of students contributed to the high school (Harris et al. 2006). This selection resulted in pairs of feeder and high schools in 80 communities across the United States (Harris et al. 2006). As some communities did not have feeder schools with the desired grade range (7-12), there are a total of 132 schools in the core Add Health sample (Harris et al. 2006). Students in grades 7 through 12 (more than 90,000 individuals) completed in-school

questionnaires in Wave 1 of the Add Health study (Harris et al. 2006). Topics include friendships, health, risk behaviors, household information, and school-related activities and performance, among others.

In addition to the in-school questionnaires, a stratified (by grade and sex) random subsample of approximately 200 students from each of the 80 pairs of schools was selected to participate in detailed home interviews (n = 20,745) (Harris 2011). These interviews addressed topics such as employment, criminal activity, peers, and health, among others. In addition to this core sample, interviews were also conducted with a number of special oversamples based on ethnicity, disability status, and genetics (Harris 2011). An additional oversample was interviewed to garner information about peer networks (Harris 2011).

My analysis of sibling influence is made possible by the genetic oversample. This sample includes pairs of siblings with varying degrees of genetic relatedness (Harris et al. 2006). Although full siblings were not oversampled (many were automatically included in the study by chance), twins and half siblings were included with certainty (Harris et al. 2006). Some non-related pairs (adolescents raised together but not genetically related), were also included in the genetic oversample. In total, there are 3,086 pairs of individuals that can broadly be described as siblings (an additional 53 pairs in the genetic sample are non-related and include aunts/ uncles, spouses, etc.) (Harris et al. 2006). These include 784 twin pairs, 1,251 full sibling pairs, 442 half-sibling pairs, and 662 non-related sibling pairs (Harris et al. 2006). Each member of these pairs was administered the same questionnaires and reside in the same home environment (Harris et al. 2006).

The design of Add Health also allows for social network analysis. As part of the in-school questionnaire, respondents in Wave 1 were asked to nominate their five closest female

friends and five closest male friends from a roster that included names of students from either of the two schools in a given community. Network measures described below are based only on schools with response rates of 50% or higher (n = 129) (National Longitudinal Study of Adolescent Health 2001). Friendship nominations were also included as part of the in-home survey in Wave 1, allowing me to examine sibling social status.

Wave 2 interviews, administered in 1996 (one year after the first wave), were conducted in-home with nearly the same sample as the Wave 1 in-home interviews (n = 14.738) (Harris 2011). However, respondents who were only part of the Wave 1 disabled sample and respondents in the 12th grade at Wave 1 who were not included in the genetic sample were excluded from Wave 2 interviews (National Longitudinal Study of Adolescent Health n.d.). Additionally, 65 adolescents in the genetic sample who were not interviewed at Wave 1 were included in the Wave 2 interview (National Longitudinal Study of Adolescent Health n.d.).

ADD HEALTH LIMITATIONS

Friendship nominations of the sort described above were also included in the Wave 2 in-home interviews. However, full social network data is only available for a subset of "saturated schools" for which all students were selected for in-home interviews (Harris 2011). As such, measures like indegree, outdegree, reach, and so on (described below) are unavailable outside of these saturated schools. Further, some respondents were only asked to name one male and one female friend as opposed to five of each gender. These challenges will be further discussed in Chapter Five.

Unfortunately, it is not possible to compute sample weights for adolescents outside of the core probability sample of Add Health (Chantala 2001). As a result, 35% of pairs in the genetic

sample are missing sample weight information for at least one member of the pair (Chantala 2001). All Add Health analyses in this dissertation will be unweighted for this reason. However, by omitting sample weights, my results cannot be interpreted as nationally representative (Chantala 2001).

As noted previously, Add Health includes two waves of data that span the period of adolescence. Unfortunately, this does not allow me to examine how sibling influence might change over a longer period. To compensate for this and other limitations discussed above, I complement my analyses in Add Health with comparable analyses drawing on data from the PROSPER study.

ADD HEALTH MEASURES

SOCIAL STATUS

As with the PROSPER data, individual social status will be measured using indegree (number of incoming friendship nomination), outdegree (number of outgoing friendship nominations), and reach (number of individuals within two ties). These measures are obtained for individuals and siblings included in the genetic sample. Stata's MI (multiple imputation) procedure was used to impute missing values of indegree, outdegree, and reach for siblings with sufficient data on other measures (sex, age, etc.).

DELINQUENCY & SUBSTANCE USE

Adolescent cigarette use is indicated by a survey question asking respondent how many days in the past 30 days they used cigarettes. Respondents are also asked how many times in the past 30 days they have used marijuana. To make these measures comparable to those in the

PROSPER data, responses will be dichotomized as never (0) or once or more (1). For drinking, a survey question asks respondents how often they used alcohol in the past 12 months. Response choices range from every day (1) to never (7). This response will also be dichotomized. Adolescent delinquency is measured using a 15-item delinquency scale asking respondents to report how often they engaged in certain behaviors during these past 12 months. The behaviors included assault, vandalism, and theft, among others, and are similar to the PROSPER data delinquency items. As with the PROSPER data, I perform analyses using IRT scaled delinquency and substance use measures. Here, I create these measures using Samejima's Graded Response Model implemented using the GLAMM module in the Stata software (with the oprobit link) (Samejima 1997).

In addition to the above, my analyses will include controls for gender, race/ ethnicity, and age for each sibling. Sibling age gap, birth order, and sibling gender composition are addressed as potential moderators in Chapter 4. My analyses also account for genetic relatedness with details discussed in the empirical chapters.

Chapter 3. SIBLING SOCIAL STATUS AS A MODERATOR OF INFLUENCE

This chapter tests the key hypothesis of this dissertation: that sibling social status moderates sibling influence for delinquency and substance use. Specifically, I examine sibling influence during the period of adolescence. Although siblings may be influential in early childhood or later life as well (Cicirelli 1989; Dunn 1988), substance use onset and experimentation surfaces and becomes relatively normative during the teen years. In 2009, for instance, approximately 72% of a nationally representative sample of students in grades 9 through 12 admitted to having tried alcohol at some point (Center for Disease Control n.d.). Within the past 30 days, roughly 24 % of this same sample had at least one binge-drinking episode of at least five drinks in a row, 21% had used marijuana, 12% had used inhalants, and 23% received or were offered an illegal drug from someone on school property (Center for Disease Control n.d.). Other forms of delinquency are prevalent in adolescence as well. Involvement in criminal activity rises through these years and peaks in the late teens (for most crimes), declining thereafter, a phenomenon known as the age-crime curve (Lauritsen 1998; Steffensmeier et al. 1989).

An adolescent's decision to engage in substance use or delinquency may be affected by a number of individuals in an adolescent's social network including teachers, coaches, peers, parents, siblings, and others. Not only are these behaviors often performed in the context of unstructured peer socializing (Osgood et al. 1996, 2013), but adolescents are also minors, still under the daily supervision of parents or other legal guardians. As such, family members and peers are each likely to exert some influence over the substance use and delinquent behavior of adolescents. Peers, for example, can influence behavior by conferring or denying social status

for key behaviors. However, siblings can also model behavior, demonstrate how peers react to certain behaviors, or provide access to illicit substances or opportunities for delinquent behavior.

PEERS & SOCIAL STATUS

As individuals who are close in age (relative to parents, teachers, and others), siblings not only model behavior directly, but can also demonstrate how peers react to certain behaviors. An adolescent, for instance, can observe whether a sibling's peers seem to encourage or support his/her use of alcohol or cigarettes. An adolescent can also observe the instances in which a sibling is ridiculed or ostracized for engaging in certain behaviors. This serves as a form of vicarious reinforcement, whereby adolescents learn the consequences of behavior by observing these consequences for their siblings (Warr and Stafford 1991). Further, this can be construed as a process of anticipatory socialization; adolescents modify their behavior because they anticipate finding themselves in similar social situations at a later time (Merton and Kitt 1950). In this manner, siblings can model the relationship between behavior and one's social standing among peers. This social standing is what I refer to as social status.

The precise meaning of social status, however, warrants some clarification. Cillessen and Marks (2011) distinguished between two types of social status in adolescent peer groups: popularity and likeability. Popularity refers to one's visibility and connectedness in the peer network. I, instead, examine likeability, which refers to being accepted and well-liked by peers (Bukowski, Hoza, and Boivin 1993a; Cillessen et al. 2011). While it might seem that being popular should equate to being well-liked, this is not always the case in adolescent peer groups (Bukowski et al. 1993a; Eder 1985). In other words, no single measure of social status, whether conceptualized as popularity or likeability, yields a complete understanding of peer processes.

In this dissertation, I make use of three measures of the "likeability" notion of social status, applying concepts from social network analysis to adolescents' friendship networks. The first, *indegree*, refers to the number of persons who perceive an individual as a friend. Indegree tells us the degree to which a person is well-liked by peers; a high indegree would indicate that an adolescent has certain attributes that are desirable in a peer network. However, not all of these perceived friendships will be reciprocated. Thus, I also use a measure of *outdegree*, the number of persons an individual perceives as friends. This measure is of interest because it may indicate the extent to which an adolescent feels connected to others in the network. A person with high outdegree is indicating that he/she has many friends, even if these friendships are not reciprocated in actuality.

Lastly, I consider *reach*, the number of persons within two friendship ties of an individual (friends or friends of friends). This measure indicates a person's degree of connectedness in a peer network. Although outdegree and indegree are informative about direct friendship ties, reach indicates the number of additional persons who may be influential (or influenced) through their ties to the friends of an individual. In other words, reach is informative about the broader peer network of an individual, including both direct and indirect ties.

The peer context indicated by the measures above is of particular importance in a study of adolescents. As children enter this period of the life course, self-identity comes to be defined by one's acceptance by and involvement with peers. Unlike young children, adolescents are given greater freedom to interact with peers, particularly in unstructured activities (Furstenberg 2000; Warr 2002); this occurs just as adolescents are developing their own self-conceptions. As a result, peer acceptance, loyalty and conformity to the peer group, and status within the peer

group become strongly tied to adolescent self-identity (Warr 2002). Adolescents fear ridicule and gossip (exclusion) as threats to self-identity (Warr 2002).

This fear of ridicule can motivate certain behaviors (Warr 2002), including substance use and delinquency. Allen and colleagues (2005), for example, found that popular adolescents are likely to increase behaviors that are socially approved by peers, including substance use and delinquency. Santor, Messervey, and Kusumakar (2000), as another example, found that adolescents scoring high on peer pressure (feeling pressured by peers to perform certain behaviors) engaged in more illicit substance use, were more likely to engage in theft, and had more positive attitudes towards sex. These patterns were also observed for those scoring high on peer conformity (tendency to adopt behaviors socially approved by the peer group) and those scoring high on the tendency to engage in behaviors to gain popularity (Santor et al. 2000). Similarly, Ennett and colleagues (2006) found that adolescents with greater social status and closer social network proximity to peers who engage in substance use were more likely to use tobacco, alcohol, or marijuana. In this study, Ennett and colleagues measured social status using indegree, reach, betweenness centrality (the extent to which a person "connects" pairs of individuals in a network), and Bonacich power centrality (the connectedness of one's peers). Proximity was measured by whether one's best friend used illicit substances, number of those in one's peer group who did so, and one's distance (number of ties needed to link) to the nearest substance user. In this dissertation, I follow Ennett's example by also using multiple indicators of social status to gain a clearer picture of social phenomenon.

In sum, existing research indicates that peers have the potential to strongly influence behavior through reinforcement (positive or negative) of behavior. However, as stated previously, sibling influence may occur through demonstrating what behavior yields positive or

negative reinforcement among peers. Further, siblings expose one another to a wider social network that may impact social status or behavior. As such, siblings can play a significant role in peer processes that affect substance use and delinquency. The relative influence of peers, siblings, and others, however, is likely in flux during adolescence.

PARENTS, PEERS, & SIBLINGS: COMPETING SOURCES OF INFLUENCE

In the transition from childhood to adolescence, individuals shift from a family or parent orientation to a peer orientation (Aquilino 1997; Bowerman and Kinch 1958; Fuligni et al. 2001; Grotevant and Cooper 1986). Not only does conflict with parents increase during this period (Lempers and Clark-Lempers 1992), but adolescents also spend less time with parents and more time with same-age peers (Bowerman and Kinch 1958; Fallon and Bowles 1997; Fuligni et al. 2001; Lam, McHale, and Crouter 2012; Steinberg and Monahan 2007). Social time with parents (time when the child is with parents, but possibly with other people also) decreases through the adolescent period (Lam et al. 2012). However, time with siblings continues to rival and often exceed time spent with parents across adolescence (Fallon and Bowles 1997). An individual may spend more time with a sibling in adolescence than with any other family member. Existing research also indicates that the presence of close sibling relationships decreases time spent with same-age peers (Fallon and Bowles 1997), suggesting that siblings can "replace" peers to a certain extent. As such, siblings are positioned to have a great deal of influence on adolescent behavior.

Specifically, I argue that siblings serve as potentially influential peers and models of behavior during the period of adolescence. There are several reasons this would be the case. First, although fertility rates declined from an average of three children per woman in 1935 to an

average of two children per woman in 1960 (Kirmeyer and Hamilton 2011), most individuals have siblings. Currently, the U.S. Census estimates that 79 percent of children under 18 years of age have at least one sibling residing in the household (U. S. Census Bureau 2012). Like parents, siblings are part of the core family unit, serving as a potential source of influence outside of (or in addition to) the school and peer contexts. Unlike parents, however, siblings more closely resemble peers in age, suggesting that siblings may be more akin to peers. However, adolescent siblings, unlike peers, do not choose one another (Feinberg et al. 2012). As such, we would expect to see some differences between sibling relationships and peer relationships.

Continuing this line of thought, sibling relationships and peer relationships appear to have overlapping but distinct functions in adolescence. Adolescents perceive parents, for example, as a stable source of affection and positive emotional support, but not as companions. In contrast, friends are viewed as sources of intimacy and companionship (Furman and Buhrmester 1985; Lempers and Clark-Lempers 1992). Likewise, siblings are perceived as strong sources of intimacy and companionship for adolescents, although not quite so much as friends (Furman and Buhrmester 1985; Lempers and Clark-Lempers 1992). Further, adolescents feel that they have an equal amount of power in their relationships with siblings and peers (Furman and Buhrmester 1985). One key difference between sibling and peer relationships, however, is that sibling relationships are a substantial source of conflict for adolescents, whereas friendships have a fairly low level of conflict (Feinberg, Solmeyer, and McHale 2012; Lempers and Clark-Lempers 1992). Some of this conflict may derive from individuals being able to select friends, but not siblings; forced contact would be expected to produce some measure of friction in a relationship. Friendships, for example, can be terminated if conflict emerges. Adolescent sibling relationships, however, must be maintained. The level of conflict among siblings is more

pronounced for same-sex sibling pairs and siblings who are closer in age (Furman and Buhrmester 1985).

Given these observations, siblings and peers serve similar functions for adolescents, but are not entirely equivalent relationships. My focus on siblings extends research on peer influence by detailing influence stemming from an involuntary relationship characterized by a mixture of companionship and conflict. The influence processes themselves, however, are likely quite similar.

SOCIAL LEARNING

Thus far, I have repeatedly noted that siblings directly model behavior as well as model peer reactions (positive and negative reinforcement) to that behavior. I have also implied that observing siblings and their social status among peers will impact an individual's behavior and his/ her relations with peers. However, I have yet to fully outline the theory that leads me to these expectations, namely social learning theories. These theories explain not only similarities between siblings and between peers, but also the precise processes that lead to these similarities. Further, social learning theories help to explain the role of social status in sibling influence, a topic I return to shortly.

Primarily housed in the field of Developmental Psychology, social learning theories propose that individuals learn behaviors by observing others, modeling the behavior of others, and through the reinforcement and punishment of behavior (Bandura and McCelland 1977). Specifically, children learn partly by copying the behavior of parents and others, particularly when that behavior appears to be rewarded or otherwise acceptable (Bandura and McCelland 1977). This sort of learning occurs from infancy onward (Hanna and Meltzoff 1993). However,

children do not imitate all persons equally; some persons are considered more relevant models than others (Perry and Bussey 1979). As one example, children are more likely to model the behavior of same-sex individuals, including same-sex siblings and parents (Perry and Bussey 1979). This may partly explain the tendency for same-sex siblings to be similar on a variety of outcomes (Rowe, Rodgers, and Meseck-Bushey 1992; Trim, Leuthe, and Chassin 2006).

In the context of crime and delinquency, social learning concepts were first clearly outlined and advocated by Edwin Sutherland (1939) as Differential Association Theory. In his theory (presented as a set of nine propositions), Sutherland proposed that crime is learned, much like any other behavior. Specifically, individuals learn "definitions" (attitudes, values, rationalizations, etc.) that are favorable, neutral, or unfavorable to law violation and delinquency (Sutherland 1939). These definitions may be crime-specific (techniques, motives, etc.) or general (Sutherland 1939). Crime and delinquency occur when an individual internalizes more definitions favorable to law breaking than unfavorable to law breaking (Sutherland 1939). Not all sources of definitions are equal, however. The degree of internalization depends upon the frequency of exposure, priority of exposure (how early in life), duration of exposure, and the importance of the source to the individual (Matsueda 1988; Sutherland 1939).

Although still widely recognized and advocated by researchers today, Sutherland's Differential Association Theory suffers from a key weakness: it fails to specify *how* definitions are learned (Matsueda 1988). Recognizing this weakness, Ronald Akers(2009) and Robert Burgess expanded on Differential Association Theory by drawing on learning concepts from the field of psychology (Burgess and Akers 1966b). The appropriately renamed "Differential Association-Reinforcement Theory" incorporates the concepts of differential reinforcement and imitation/ modeling within the key tenets of Sutherland's original theory (Akers 2009).

Specifically, Akers argued that behaviors are likely to occur and be repeated if positive reinforcement (or anticipated reinforcement) occurs (2009). Attitudes, values, and other "definitions" may also be learned in this way (Akers 2009). Further, individuals learn by watching the behavior of others and observing the consequences of that behavior for others (Akers 2009).

As is quite relevant for the present study, Akers(2009) argued that individuals are likely to adopt the behavior of those they positively regard. Sutherland (1939) also made this point, and termed the tendency for individuals to weight what they learn based on the nature of the source *intensity*. Would siblings be considered such a source? The literature suggests this is the case. Not only do siblings reside (in most cases) with one another, but they also express many positive aspects of their relationships. In one study, roughly 93 percent of sixth-graders discussed sibling companionship and 65 percent expressed admiration of their siblings (Furman and Buhrmester 1985). Although conflict was also a common theme in discussions with these children, results suggested that sibling relationships were viewed as positive in many respects (Furman and Buhrmester 1985). Thus, one sibling may emulate another simply because the sibling is a valued, primary model of behavior whose approval and acceptance is also valued. A further source of sibling influence, drawn from Sutherland's (1939) Differential Association Theory, is that siblings could provide knowledge necessary for delinquent or criminal acts. For example, an older sibling may be able to provide illicit substances or knowledge regarding how to obtain them. Each of these arguments suggests that we would observe behavioral similarity among siblings, as is formally stated in the hypothesis below.

Hypothesis: Adolescents whose siblings report greater substance use or delinquency will report more involvement in these behaviors as well.

SIBLINGS & BEHAVIORAL SIMILARITY

Much in the existing literature has confirmed the expectations of social learning theories for peer and sibling influence overall. Namely, siblings appear to be similar in a variety of domains. Within adolescent sibling dyads, for example, Gamble, Card, and Jin Yu (2010) found a weak to moderate correlation between siblings' self-representations (self-evaluations of competence and worth). Other research has shown that risk behavior, peer competence, and the sports/ arts interest of an older sibling are all positively associated with those of a younger sibling (Whiteman, McHale, and Crouter 2007). Other areas where sibling similarity has been found include sexual behavior, health risk behavior, and substance use, among others (McHale, Bissell, and Kim 2009; Whiteman et al. 2007).

The concordance of adolescent siblings for substance use and delinquency, in particular, has been well-documented. For alcohol, research by Trim, Leuthe, and Chassin (2006) as well as Fagan and Najman (2005) indicated that younger sibling use is predicted by older sibling use, even after controlling for important confounders such as use at a previous time period, parental use/ abuse, shared familial experiences, and mutual peers, among other factors (Fagan and Najman 2005; Trim et al. 2006). Fagan and Najman (2005) obtained parallel results for tobacco use among adolescents.

Patterns of sibling delinquency concordance are similar to those for substance use. Slomkowski and colleagues (2001), for example, found high sibling similarity for both sisters and brothers, although stronger similarity for sisters . Additionally, Lauritsen's (1993) research

indicated that adolescent delinquency is concentrated among households. Namely, 10% of households in the sample accounted for 76% of all delinquent acts reported (Lauritsen 1993:399). Similarly, Rowe, Rodgers, and Meseck-Bushey found that the correlation for delinquency in same-sex sibling dyads was roughly 0.30 for brothers, 0.28 for sisters, and 0.21 for mixed-sex sibling pairs (1992). As with substance use, delinquency of a sibling predicts one's own delinquency (Lauritsen 1993; Rowe et al. 1992).

Nevertheless, both research and experience demonstrate that siblings also may differ greatly in personality or behavior. Social learning among siblings does not appear to be a process of perfect socialization. In this case, what factors moderate sibling influence? Are some siblings or types of siblings more influential than others? In this chapter, I examine sibling social status as one factor that may moderate the effect of one sibling's substance use and delinquency on another's.

SIBLING SOCIAL STATUS AS A MODERATOR

Given the importance of peers for adolescents, it seems logical that peer context might moderate the influence of sibling substance use and delinquency in some way. More specifically, a sibling's popularity with peers might moderate his/her influence on other siblings. Akers' (2009) elaboration of social learning theory argued that individuals are more likely to adopt behavior that appears to bring positive consequences. As discussed previously, peer acceptance and social status with peers are central to adolescent identity. An adolescent will not emulate behavior that he/ she thinks will result in social exclusion or punishment by peers. As such, social learning theories imply that the degree to which one sibling mimics the behavior of another is conditional on social reactions to the behavior. Therefore, if an individual perceives

that his/her sibling is being "rewarded" for delinquency or substance use by popularity and high social status, he/she is more likely to replicate these behaviors in an effort to obtain these same rewards. Rephrased in the negative, those with unpopular or low social status siblings may be less likely to emulate their siblings because they have learned that delinquency and substance use lead to negative rather than positive social outcomes. These arguments suggest the following hypothesis.

Hypothesis: Sibling concordance for delinquency and substance use will be greater for adolescents whose siblings have high social status.

To date, only one existing study has investigated the potential influence of one sibling's social status on another sibling's social status or behavior during adolescence. This research, by Craine and colleagues(2009), suggested that the effect of siblings on delinquency is moderated by sibling social status. Using a sample of 587 adolescent sibling pairs from rural Iowa, Craine and colleagues (2009) questioned each sibling about their behavior and questioned younger siblings about the perceived popularity of the older sibling in the household. Results indicated that, among female younger siblings, younger siblings perceiving their older siblings to be popular reported lower levels of delinquency (Craine et al. 2009). Further, having a popular older brother led to greater concordance for delinquency within the sibling pair (Craine et al. 2009). These findings indicated that older sibling popularity moderated the influence of one sibling's behavior on another. This is consistent with social learning theories, which suggest that adolescents will emulate behaviors of siblings that they perceive as socially rewarding.

In sum, Craine's (2009) research and social learning theories indicate that sibling social status conditions the effects of one sibling's delinquent behavior on another. However, a number of questions remain unanswered and there remains a large gap in the literature examining sibling

influence and social status. First, how might sibling social status condition sibling effects on adolescent substance use? Although Craine and colleagues (2009) found such an effect for delinquency, effects for substance use are an unknown. Osgood and colleagues (2013) found that alcohol use is positively related to popularity, meaning that adolescents are more likely to select drinkers as friends than non-drinkers. In other words, adolescents may view drinking as a desirable trait associated with higher social status. Kreager and colleagues (2011), in contrast, find that delinquent peer groups are less central to overall school networks, have lower social status, and less cohesion than other social groups. Thus, delinquency may be perceived by adolescents as an undesirable social characteristic. Moderation by sibling social status may differ based on a sibling's behavioral consistency with desirable and undesirable social traits. Second, how might sibling effects differ in a more diverse sample that includes urban jurisdictions, a greater number of minorities, and so on?

Additionally, how might the measurement of popularity and social status impact results? Craine and colleagues (2009) used measures of perceived sibling popularity, but other datasets capitalize on more objective measures of adolescent social status (from full network data and friendship nominations). It is unknown how the results from Craine et al (2009) might differ when using these measures instead. Further, it is possible that certain aspects of social status might have different moderating effects. Osgood and colleagues (2013) found that high indegree (often being named as a friend) was associated with increased drinking among adolescents while outdegree (naming friends) was not associated with drinking at all. These findings show that the relation between behavior and social status differs based on which aspect of social status is examined. Another possibility is that some forms of popularity might be more desirable than others. For example, being connected to many individuals throughout a peer network (reach)

may be more desirable than having many friends overall (in/outdegree). One might argue that an adolescent will be more likely to emulate the behavior of a sibling with a valued form of social status. As such, my use of indegree, outdegree, and reach measures go beyond the more general popularity measure devised by Craine et al (2009).

GENETICS

Before I describe the specific data and method to be used for analyses in this chapter, some attention must be given to a characteristic of sibling relationships that is not typical of peers: genetic relatedness. As is well-known, identical twins share 100% of their genetic material, full siblings and dizygotic twins share 50% of their genetic material, half-siblings share 25% of their genetic material, and non-related siblings share none of their genetic material with one another. However, genetics alone cannot account for all sibling similarities and differences. More than 40% of the respondents assessed by Daniels and Plomin (1985), for example, report experiences that differ from those of their siblings in areas including parental treatment, peer groups, and subjective experiences of events such as divorce, romantic relationships, and family problems. These differences are not significantly related to genetics and are believed to originate with environmental variation either inside or outside of the home (Daniels and Plomin 1985). As such, the social environment, including siblings and peers is of paramount importance in understanding adolescent behavior. Regardless, however, I take care to account for possible variation by genetic relatedness in models drawing on data from Add Health (where measures of genetic relatedness are available for each sibling pair).

ASSESSING SIBLING INFLUENCE

DATA & METHOD

For analyses testing overall sibling influence for delinquency and substance use, I make use of the one-sibling sample in PROSPER and the full sample of sibling pairs in Add Health (see Chapter Two for detail on these subsamples). The one-sibling sample in PROSPER is used because this is the only way to isolate specific sibling characteristics and behaviors in the in-home PROSPER data. A key assumption of standard OLS (ordinary least-squares) regression is that observations are independent of one another. However, siblings share family environments and potentially genetics that may violate this assumption. Thus, clustering of individuals within families is problematic for standard regression techniques. Additionally, repeated measures of an individual over time are likely to be correlated. Again, this violates the assumption of independent observations. Further, it is likely that sibling influence is bidirectional, meaning that siblings influence one another concurrently. In PROSPER, given my limited measures of sibling behavior, I address these concerns using three-level Hierarchical Linear Modeling with individuals nested within schools/ communities. Analyses will be based on cases with complete data on all variables in a particular model.

In Add Health, I address these issues using Actor-Partner Interdependence Models (APIM) implemented in the Stata software with individuals nested within sibling dyads within genetic relatedness types (full/half siblings, MZ and DZ twins, cousins, unrelated but raised together). This nesting structure allows me to assess sibling effects both within and across degrees of genetic relatedness. Additionally, my use of APIM statistically corrects for sibling interdependence (Cook and Kenny 2005). These models require a variable that distinguishes one sibling from another (Cook and Kenny 2005). A simple younger versus older sibling dummy

variable is sufficient for these purposes. For twins, I randomly assign siblings to be "younger" or "older."

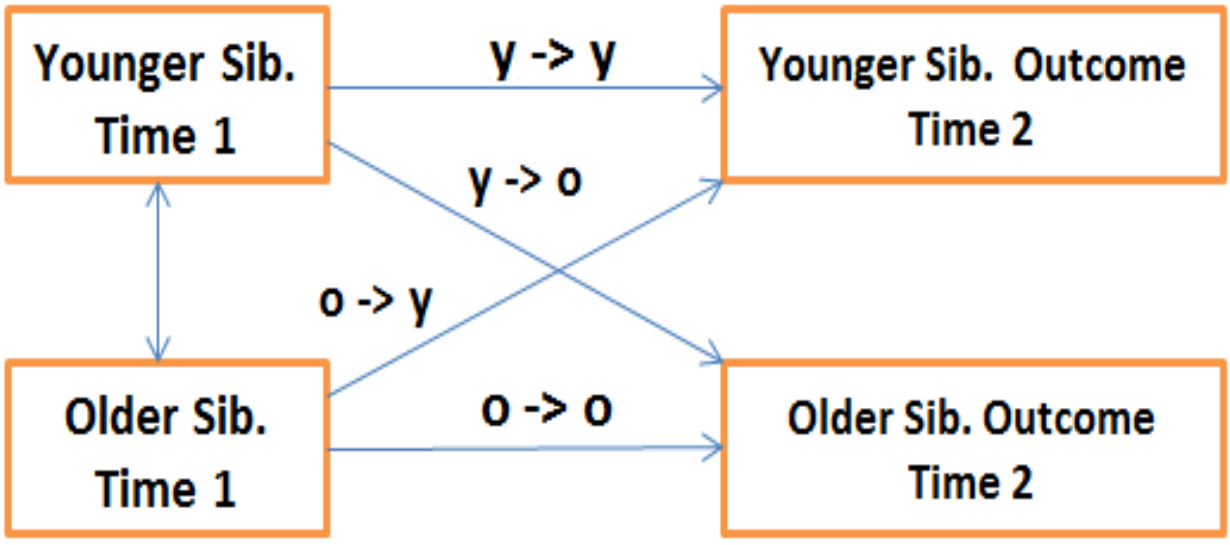
Six constructed dummy/ interaction variables allow me to examine the first sibling's influence on the second sibling and vice versa as well as the influence of earlier wave outcomes on later outcomes for each sibling (see Cook and Kenny 2005 for further explanation; also see Figure 1). The first two of these constructed variables indicate whether the Y outcome for a particular record belongs to the first or second sibling in the pair. Since I identify each person as either the younger or older of a sibling pair, I have one dummy variable indicating whether a person is the younger sibling (sibling 1), and another dummy variable indicating whether a sibling is the older sibling (sibling 2). These two sibling indicator variables serve as the intercepts in these multilevel APIM models, rather than the single intercept that is typical in hierarchical linear models; this method of implementing APIM is also termed a "two-intercept" model (Cook and Kenny 2005). In other words, I have an intercept for each sibling rather than one intercept for the sibling pair.

Next, I multiply a predictor variable for the first sibling by the dummy variable "sibling 1" to create an "actor" term for the first sibling. This variable will take on the predictor values for the first sibling for records in which the first sibling's outcome is the Y variable. The variable will have values of 0 for all other records. In other words, coefficients of this variable will indicate the effect of the first sibling's behavior in one wave on his/ her own behavior in later waves. Similarly, I also multiply a predictor variable for the second sibling by the dummy variable "sibling 2" to create an "actor" term for the second sibling. As before, this variable will take on the predictor values for the second sibling for records in which the second sibling's

outcome is the Y variable (0's for all other records). Coefficients of this variable will indicate the effect of the second sibling's behavior in one wave on his/ her own behavior in later waves.

Lastly, I create "partner" terms for the APIM models. To do this, I multiply a predictor variable for the first sibling by the dummy variable "sibling 2" to create a variable that will take on the predictor values for the first sibling for records in which the second sibling's outcome is the Y variable. Coefficients for this variable will represent the effect of the first sibling's behavior in one wave on the second sibling's behavior in later waves. Similarly, I multiply a predictor variable for the second sibling by the dummy variable "sibling 1" to create a variable that will take on the predictor values for the second sibling for records in which the first sibling's outcome is the Y variable. Coefficients for this variable will represent the effect of the second sibling's behavior in one wave on the first sibling's behavior in later waves.

Figure 1: APIM Model Diagram



Together, these six variables will test the influence of a particular sibling on him/ herself, the influence of one sibling on another, and will allow each sibling to have a separate intercept in

analysis. All of these variables are entered into the model simultaneously, allowing me to test whether direction of influence travels from older to younger sibling, from younger sibling to older sibling, or whether influence is truly reciprocal in nature (see Figure 1). To test for moderation by sibling social status, I multiply social status measures by the partner terms of the APIM model, including both the multiplicative terms and main effects. I do not create interaction terms with actor variables because all of my hypotheses refer to the interaction between the social status and behavior of one's sibling, not of oneself. One drawback of the APIM models is that they become complex with multiple predictor variables, as both actor and partner effects need to be modeled for each. As a result, I omit an analysis of gender composition, age gap, and other key factors in this chapter (these will be discussed in Chapter Four). However, all models include controls for gender of each sibling, age of each sibling, and race of each sibling (white vs. nonwhite). For the sake of simplicity, I do not show these effects in tables.

DESCRIPTIVES

PROSPER

Basic demographic characteristics of the one-sibling PROSPER sample (n=432) at Wave One are presented in Table 1 as means and proportions. Most of the target children are white, unsurprising since the PROSPER project predominately sampled from rural areas and the Midwest. Most target children also reside in a two-parent household, although these parents may be step or biological. Due to the deliberate attempt to sample schools with a large proportion (at least 15%) of students receiving free or reduced-price student lunches (an indication of poverty), this sample includes a higher proportion of such students than is typical in a more general sample. One interesting difference between the demographic characteristics of target children

and their siblings is age. As Table 1 indicates, siblings are roughly two years younger, on average. Roughly 38 percent of the target children are the younger sibling in the one-sibling families. However, most siblings are fairly close in age. Lastly, even with limiting myself to the in-home sample and then to one-sibling families, there remains a fairly even gender divide. Roughly half of the target children are male, and half of the siblings of these children are male.

Table 1: PROSPER Wave One Demographic Characteristics for One-Sibling Families

	Target Child	**Sibling**
Proportion Male	0.47 (.50) n= 419	0.5 (0.50) n = 432
Mean Age in Years	12.94 (1.40) n = 432	10.90 (4.12) n = 430
Proportion White	0.88 (0.32) n = 410	--
Proportion Living with Two Parents	0.77 (0.42) n = 389	--
Proportion Receiving Free or Reduced-Price School Lunch	0.31 (0.45) n = 389	--

*n = 432 families. Standard deviations reported in parentheses.

Means of key predictors and outcome variables for the PROSPER one-sibling families are presented in Table 2. Since these variables change over time, I present means/ proportions by wave. For each of the past month dichotomous substance use measures (0 = no use, 1 = some use), we see an increase in use over time, consistent with findings in the literature that indicate increased substance use and experimentation in the teen years. This increase is also indicated by trends in the substance use variety score and IRT score for substance use. Drinking is consistently the more frequently used substance of the three. Sibling substance use also increases with time, although we cannot directly compare sibling and target child means due to differences in measurement.

Like substance use, involvement in delinquent activities increases with time, as indicated by the delinquency variety score and IRT score. However, note that the modal response to delinquency items is 0; most individuals engage in few if any delinquent behaviors, resulting in a low mean on the delinquency variety score. My use of the IRT score as an alternative measure

helps to correct for this phenomenon. Although not as consistent a pattern, means for the sibling delinquency variety score also increase with time. Again, however, the sibling delinquency measure cannot be directly compared to the target child measures due to differences in measurement. In sum, it appears that both target children and siblings in this sample engaged in increased substance use and delinquency over time.

Table 2: PROSPER Variable Means in One-Sibling Families by Wave

	Wave 1	**Wave 2**	**Wave 3**	**Wave 4**	**Wave 5**
Past Month Smoking	0.02 (0.13) n = 394	0.03 (0.17) n = 323	0.03 (0.17) n = 300	0.10 (0.30) n = 299	0.15 (0.36) n = 250
Past Month Drinking	0.06 (0.23) n = 394	0.09 (0.28) n = 323	0.12 (0.32) n = 300	0.20 (0.40) n = 298	0.28 (0.45) n = 250
Past Month Marijuana Use	--	--	--	0.03 (0.17) n = 295	0.07 (0.26) n = 250)
IRT Substance Use (Range -0.07 to 2.23)	0.02 (0.35) n = 394	0.06 (0.41) n = 323	0.11 (0.50) n = 300	0.32 (0.75) n = 297	0.50 (0.86) n = 250
Substance Use Variety (Range 0 to 3)	0.08 (0.33) n = 394	0.12 (0.38) n = 323	0.17 (0.51) n = 300	0.42 (0.89) n = 297	0.62 (1.04) n = 250
Sibling Substance Use Variety (Range 0 to 3)	0.20 (0.53) n = 402	0.26 (0.64) n = 339	0.31 (0.69) n = 323	0.39 (0.78) n = 339	0.63 (1.00) n = 318
Delinquency Variety Score (Range 0 to 9)	0.59 (1.31) n = 392	0.61 (1.29) n = 322	0.61 (1.36) n = 298	0.88 (1.71) n = 296	0.90 (1.92) n = 250
IRT Delinquency (Range -0.34 to 1.97)	-0.04 (0.54) n = 392	-0.02 (0.56) n = 322	-0.02 (0.55) n = 298	0.09 (0.66) n = 296	0.06 (0.68) n = 250
Sibling Delinquency Variety (Range 0 to 5)	0.29 (0.73) n = 402	0.29 (0.88) n = 321	0.24 (0.70) n = 318	0.31 (0.79) n = 334	0.42 (0.97) n = 315

*n = 432 at Wave One. Standard deviations reported in parentheses.
Note: There were no incidents of past-month marijuana use in this sample in the first three waves.

ADD HEALTH

Basic demographic characteristics of the Add Health sibling sample (n = 3,086 pairs) are presented in Table 3 as means and proportions. As noted above, APIM models require a variable the uniquely identifies each member of a dyad. For my purposes, I used age as such an indicator. However, since some respondent sibling pairs are twins, I randomly assigned these siblings to

either the "younger" or "older" category. Table 3 presents demographic characteristics based on this categorization.

As this table shows, there is an even gender split in the sample and about 60% of adolescents are of the same gender as their sibling within the sibling pair. Siblings average 1.65 years apart in age, with an average age of 15.33 in the first wave of data collection. As with the PROSPER sample, most respondents are white. However, Add Health includes an oversampling based on race/ ethnicity that leads to a greater proportion of blacks and other ethnic groups than might otherwise be expected in a perfectly nationally representative sample. In particular, Add Health oversampled middle and upper class blacks. Proportion smoking or using marijuana in the past month increases from one wave to the next, as we would expect. Overall though, changes are modest. This may be since the Add Health adolescents are beyond the early adolescent substance use initiation period. As far as social status is concerned, both indegree and outdegree average approximately 4 to 5. Reach is much higher since it refers to total reach through any and all friendship ties, not just the number of peers within two ties as is indicated by the PROSPER reach measure.

Interestingly, proportion drinking in the past year and mean delinquency variety scores actually decrease from wave one to wave two. This may reflect attrition of "high risk" adolescents from the sample, however. Kalsbeek and colleagues (2002), found that adolescent's households were less likely to be contacted and more likely to be unable to participate for follow-up study if the adolescent reported smoking within the past 30 days in the prior wave. Adolescent's households were also less likely to be contacted for follow-up study if the family income was not above the poverty threshold in the prior wave or if the family had lived at the address for a brief period of time (Kalsbeek et al. 2002). Another possibility that may explain

the decline is survey fatigue (Lauritsen 1998). Respondents may be reporting no involvement in certain delinquent or substance use behaviors in an effort to shorten the length of the survey (Lauritsen 1998). As AddHealth is an extensive survey covering many topics, this is certainly a possibility.

Table 3: Add Health Sibling Pair Demographic Characteristics

	"Younger" sibling	**"Older" Sibling**
Prop. Male	0.50 (0.50) n = 5584	
Prop. Same Sex as Sibling	0.60 (0.49) n = 5584	
Mean Sibling Age Gap in Years	1.65 (1.49) n = 5306	
Prop. White	0.60 (0.55) n = 6130	
Prop. African American	0.26 (0.50) n = 6130	
Prop. American Indian	0.04 (0.32) n = 6130	
Prop. Asian	0.08 (0.37) n = 6130	
Prop. Other Race	0.10 (0.39) n = 6130	
Prop. Of Hispanic Origin	0.18 (0.54) n = 6130	
Mean Age	15.33 (1.64) n = 3051	16.77 (1.55) n = 3075
Prop. Past Month Smoking W1	0.29 (0.46) n = 2572	0.33 (0.47) n = 2602
Prop. Past Month Smoking W2	0.32 (0.47) n = 2744	0.33 (0.47) n = 2767
Prop. Past Month Drinking W1	0.50 (0.50) n = 3021	0.58 (0.49) n = 3052
Prop. Past Month Drinking W2	0.43 (0.49) n = 2758	0.51 (0.50) n = 2780
Prop. Past Month Marijuana W1	0.11 (0.32) n = 2987	0.15 (0.36) n = 3013
Prop. Past Month Marijuana W2	0.14 (0.35) n = 2699	0.16 (0.37) n = 2715
Mean IRT Substance Use W1	-0.09 (0.88) n = 3035	0.06 (0.93) n = 3063
Mean IRT Substance Use W2	-0.06 (0.86) n = 2769	0.05 (0.87) n = 2797
Mean IRT Delinquency W1	-0.02 (0.85) n = 3039	-0.05 (0.83) n = 3062
Mean IRT Delinquency W2	0.04 (0.78) n = 2772	-0.04 (0.77) n = 2797
Delinquency Variety W1	2.47 (2.64) n = 3010	2.38 (2.58) n = 3046
Delinquency Variety W2	1.97 (2.26) n = 2753	1.74 (2.16) n = 2784
Mean Total Reach W1	517.54 (458.43) n = 1815	564.18 (488.94) n = 2079
Mean Indegree W1	5.00 (4.19) n = 1815	4.47 (3.69) n = 2079
Mean Outdegree W1	4.37 (3.06) n = 1815	4.20 (3.04) n = 2079

*Standard deviations reported in parentheses.

SIBLING INFLUENCE IN PROSPER

To establish that sibling social status indeed moderates sibling influence for delinquency and substance use, I first test whether sibling influence is present for these outcomes in the PROSPER and Add Health one-sibling samples. For the PROSPER data, I use demographic

characteristics, sibling substance use, sibling delinquency, birth order, and other basic controls to predict target child substance use and delinquency within three-level hierarchical linear models. In these models, observations are nested within individuals within schools/ communities. Dichotomous outcomes utilize logistic regression, with the results presented in Table 4 as odds ratios for ease of interpretation. In all models, sibling behaviors are lagged by one wave so that I am examining the effects of sibling behavior in one wave on target child behavior in the next wave. These variables are centered (with the exception of dichotomous predictors) so that sibling behavior can be better interpreted as a main effect in the presence of interactions. All models use only cases complete on all variables in the model. Thus, attrition, skipped waves, and item-level missing data result in reduced sample sizes (indicated in the footnotes of each table). Recall, however, that I used Stata's MI procedure to impute missing values for indegree, outdegree, and reach for siblings with sufficient data on other measures.

As can be seen in Table 4, sibling substance use in a prior wave is consistently a statistically significant predictor of past month smoking, even after the addition of other controls including prior wave smoking. With all controls added to the model, having a sibling who smoked in the prior wave nearly doubles one's odds of smoking in the past month. This effect was not moderated by whether the sibling was older or younger than the target child. However, most target children in the PROSPER data are the oldest of the sibling pair. Throughout this series of models, prior wave smoking is the strongest predictor of current wave smoking.

Table 4, however, indicates that these effects vary by substance. For past month drinking, sibling substance use initially emerges as a significant predictor. However, this effect fails to achieve statistical significance in the presence of other controls, suggesting that the influence effect may be driven by other factors for this substance use outcome. The effect of

sibling substance use for marijuana use, however, is statistically significant in the presence of controls. As with smoking, prior wave substance use is the strongest predictor of current wave substance use. For these outcomes, again, effects were not moderated by whether the sibling was older or younger than the target child. Across the three substances, those from two-parent families were less likely to use substances in the past month, a common finding in the literature.

The last two rows in Table 4 list variance components for each model. For smoking, the Level1-2 variance component in the null model was 1.17 (non-significant) while the Level 3 variance component in the null model was 0.03 (non-significant). As one would expect, most variation in substance use, indicated by the variance components, is between individuals rather than between communities. The same is observed for drinking and marijuana use where the null model Level 1-2 variance components are 1.14 ($p<0.01$) and 0.26 (non-significant) respectively and the null model Level 3 variance components are 0.16 ($p<0.05$) and 0.12 (non-significant) respectively. As the models in Table 4 show, although sibling substance use accounts for some between-individual variation, most is accounted for by one's own substance use in the prior wave. For marijuana use, there is little variation in this outcome to be explained at the outset.

Table 5 displays results for the continuous delinquency and substance use outcomes. As with the dichotomous substance use outcomes, prior wave sibling substance use is associated with a significant increase in substance use on the IRT scale. Specifically, a one unit increase in past wave sibling substance use is associated with a 0.11 increase in the past month substance use IRT score. This effect holds even in the presence of other controls and was not moderated by whether the sibling was older or younger than the target child. One control variable emerged as statistically significant in this model; those from two-parent families are less likely to use substances in the past month, just as I observed with the dichotomous outcomes from Table 4.

For the IRT delinquency score, sibling delinquency failed to achieve statistical significance as a predictor in the presence of control variables. As with the dichotomous outcome models, the strongest predictor of current behavior is prior wave behavior, here prior wave delinquency.

As before, the last two rows in Table 5 list variance components for each model. For substance use the null model Level 1-2 variance component is 0.11 ($p<0.01$) while the null model Level 3 variance component is 0.004 (non-significant). For delinquency, these values for the null model are 0.18 ($p<0.01$) and 0.003 (non-significant) respectively. As in Table 4, most variation in these continuous outcomes is between individuals rather than between communities. As Table 5 indicates, although some variation is accounted for by sibling behavior, most is attributable to one's own past wave behavior.

In sum, the results presented in these tables show significant sibling influence stemming from both substance use and delinquency in the PROSPER data, depending on the outcome being considered. This partially supports my hypothesis that adolescents whose siblings report greater substance use or delinquency will report more involvement in these behaviors as well. Yet, this seems to be the case for substance use and not delinquency. Further, most variation is explained by one's on past wave behavior rather than the behavior of one's sibling. However, main effects of sibling substance use continue to be statistically significant predictors even after controlling for one's own substance use and delinquent behavior in the prior wave as well as a number of other controls.

Table 4: Odds Ratios of Some versus No Substance Use in PROSPER One-Sibling Families

	Past Month Smoking			Past Month Drinking			Past Month Marijuana Use		
Intercept	0.06**	0.04**	0.04**	0.20**	0.11**	0.32+	0.02**	0.01**	0.08+
Sibling Sub. Use Variety	2.99** (2.22,4.04)	1.87** (1.17,2.99)	2.04** (1.38,3.02)	1.65** (1.15,2.36)	1.26 (0.93,1.72)	1.31+ (0.96,1.78)	2.43** (1.34,4.41)	1.44 (0.93,2.24)	1.57* (1.01,2.46)
Older Sibling	1.01 (0.71,1.44)	1.09 (0.66,1.80)	1.01 (0.59,1.73)	0.65* (0.43,0.99)	0.78 (0.49,1.24)	0.75 (0.49,1.14)	0.93 (0.37,2.33)	1.14 (0.47,2.81)	1.33 (0.48,3.64)
Older Sib.* Sub. Use	0.61* (0.41,0.91)	0.79 (0.45,1.39)	0.70 (0.41,1.21)	1.27 (0.92,1.75)	1.11 (0.70,1.77)	1.09 (0.71,1.69)	0.77 (0.33,1.81)	1.30 (0.72,2.35)	1.08 (0.56,2.08)
Two-Parent Family	--	--	0.59* (0.36,0.95)	--	--	0.66+ (0.42,1.04)	--	--	0.26** (0.14,0.49)
Free/ Reduced Lunch	--	--	0.89 (0.50,1.57)	--	--	0.74 (0.50,1.09)	--	--	0.46 (0.17,1.29)
Male	--	--	0.92 (0.57,1.51)	--	--	0.87 (0.54,1.40)	--	--	1.10 (0.50,2.41)
White	--	--	1.36 (0.53,3.45)	--	--	0.81 (0.48,1.35)	--	--	0.54 (0.13,2.29)
Wave	--	--	1.00 (0.80,1.25)	--	--	0.89 (0.74,1.07)	--	--	1.01 (0.70,1.45)
State	--	--	0.91 (0.53,1.57)	--	--	1.05 (0.65,1.70)	--	--	1.06 (0.58,1.93)
Treatment	--	--	1.58+ (0.97,2.57)	--	--	0.97 (0.60,1.59)	--	--	0.68 (0.34,1.38)
Prior Wave Behavior	--	22.04** (13.12,37.01)	25.16** (12.99,48.69)	--	13.85** (9.73,19.71)	14.43** (10.44,19.94)	--	21.86** (9.09,52.57)	9.55** (1.86,48.92)
Level 1-2 Variance Component	1.08	0.002	0.002	1.003*	0.37	0.34	0.00004	0.007	0.003
Level 3 Variance Component	0.03	0.02	0.01	0.14*	0.12*	0.10*	0.03	0.11	0.10

a. All sibling measures are lagged by one wave and continuous measures are centered for ease of interpretation.
b. Confidence Intervals displayed in parentheses. Variance components untransformed.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Estimates based on 344 cases with sufficient data for calculation of all models

Table 5: Unstandardized Regression Coefficients for Continuous Use/ Delinquency Outcomes in PROSPER One-Sibling Families

	IRT Substance Use			IRT Delinquency		
Intercept Coef	0.25**	0.15**	0.30**	0.05	0.05*	0.13
Sibling Substance Use Variety	0.29** (0.08)	0.11* (0.05)	0.11* (0.05)	--	--	--
Sibling Del.. Variety	--	--	--	0.17+ (0.09)	0.04 (0.03)	0.03 (0.03)
Older Sibling	-0.11* (0.05)	-0.03 (0.04)	-0.04 (0.04)	-0.07 (0.05)	-0.03 (0.04)	-0.03 (0.04)
Older Sib.* Sib. Behavior	-0.10 (0.09)	-0.06 (0.07)	-0.07 (0.07)	-0.10 (0.12)	0.07 (0.06)	0.07 (0.06)
Two-Parent Family	--	--	-0.10* (0.04)	--	--	-0.04 (0.05)
Free/ Reduced Lunch	--	--	-0.03 (0.04)	--	--	0.04 (0.05)
Male	--	--	-0.03 (0.05)	--	--	0.04 (0.04)
White	--	--	0.01 (0.06)	--	--	-0.004 (0.07)
Wave	--	--	-0.02 (0.01)	--	--	-0.004 (0.02)
State	--	--	-0.00004 (0.04)	--	--	-0.03 (0.03)
Treatment	--	--	0.001 (0.05)	--	--	-0.06 (0.04)
Prior Wave Behavior	--	0.53** (0.05)	0.53** (0.05)	--	0.65** (0.03)	0.64** (0.04)
Level 1-2 Variance Component	0.09**	0.01	0.01	0.17**	0.03**	0.03**
Level 3 Variance Component	0.001	0.004*	0.004*	0.005	0.002*	0.002*

a. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
b. All sibling measures lagged by one wave and continuous measures are centered for ease of interpretation
c. Standard errors indicated in parentheses.
d. Estimates based on 344 cases with sufficient data for calculation of all models.

SIBLING INFLUENCE IN ADD HEALTH

Since the Add Health data contains detailed sibling behavioral and social status measures as well as an indicator of sibling genetic relatedness, I make use of APIM models with individuals nested within sibling pairs within genetic relatedness types. Early analyses (results not displayed) showed that missing data for social network and other measures reduced the number of sibling pairs used in analysis by nearly two-thirds. Missing social status measures contributed the most to this decreased analytical sample size. Losing this many cases has the potential to bias estimates. As a result, I created five datasets with imputed values for the social status measures using Stata's MI (multiple imputation) procedure. Stata combines the results (adjusting standard errors) from the multiple datasets to yield results shown in Table 6.

As mentioned previously, siblings were distinguished by age with twins randomly assigned to the younger and older groups. In Table 6, effects are indicated by direction of influence between younger and older siblings. Recall that APIM models estimate the effect of a sibling's behavior on him/ herself and the effect of one sibling on another. All effects are estimated in the same model. Note that prior wave behavior is captured by the "actor" effects, as these indicate the effect of one's own past behavior on one's current behavior. All models include controls for the gender, race (white/ nonwhite), and age of each sibling, although these effects are not shown in the tables for the sake of brevity.

Table 6 displays APIM models testing for sibling influence for delinquency and substance use. Variance components are included in the last two rows of this table. For past month smoking, drinking, and marijuana use, Level 1-2 null model variance components are 1.75 ($p<0.05$), 1.32 ($p<0.05$), and 6.64 ($p<0.05$). Level 3 null model variance components for these dichotomous outcomes are $1.2e^{-10}$ (non-significant), $2.00e^{-9}$ (non-significant), and $2.22e^{-7}$ (non-

significant). The latter values indicate that there is negligible, if any, genetic-level variation for these dichotomous outcomes to explain, leading me to estimate and display the two-level models in Table 6 instead (individuals within sibling pairs). Continuous outcomes, however, still include nesting within genetic relatedness. For substance use and delinquency, Level 1-2 null model variance components are 0.56 ($p<0.05$) and 0.42 ($p<0.05$), respectively. Level 3 null model variance components for these continuous outcomes are 0.04 ($p<0.05$) and 0.04 ($p<0.05$), respectively. As these values indicate, most variation, as would be expected, is between sibling pairs rather than between genetic relatedness types. As can be seen in Table 6, actor and partner behavioral predictors account for about half of the between-sibling pair variance.

For past month smoking, drinking, and marijuana use (odds ratios), Table 6 shows that past month substance use of sibling and self in Wave 1 both increase odds of past month use of these substances. Effects for self are much larger, but sibling partner effects are still quite sizeable. Although results for controls are not shown, male gender of either sibling was not a statistically significant predictor for past month smoking or drinking. Older sibling male gender, however, did increase the odds of past month marijuana use ($p<0.05$). White race of either sibling increased the odds of both past month smoking and drinking, but was not a significant predictor of past month marijuana use. Odds of past month smoking also significantly increased with the age of the younger sibling. Odds of past month drinking increased with the age of both siblings. Overall, these results are consistent with the increase in substance use and initiation across the teen years. Age, however, was not a significant predictor of past month marijuana use, perhaps reflecting the low base rates of marijuana use across both waves of the Add Health data.

Main results for the continuous IRT scored outcomes are quite similar. For both, the behavior of both sibling and self in Wave One significantly increases current IRT scores. This is

net of controls. Although not shown, results for control variables do differ between the two outcomes. For IRT delinquency white race (of either sibling) was not a significant predictor of delinquency net of other variables in the model. Either sibling being of white race, however, was a significant predictor of increased substance use. Delinquency appeared to decline with age for both siblings while substance use increased with age for both siblings. This was apparent in the descriptive statistics for the Add Health sample. Male gender of the younger sibling was not a statistically significant predictor of IRT delinquency, although having a male older sibling does increase current delinquency by 0.07 net of other controls ($p < 0.001$). For IRT substance use, gender was not a statistically significant control variable.

To summarize, both self and sibling behavior in a prior wave significantly increased the likelihood of substance use and delinquency in the current wave. These effects held even in the presence of controls for gender, age, and race. Further, these effects held even in models that account for genetic relatedness. Results from Add Health are consistent with those of the PROSPER sample for the IRT substance use, IRT delinquency, and past month smoking outcomes. For past month drinking and marijuana use, Add Health results identify sibling influence that did not maintain statistical significance in the PROSPER data after the addition of control variables. This may reflect the differences in samples or modeling strategies (HLM versus APIM; genetic nesting in Add Health). In particular, the Add Health sample is much larger, leaving me greater statistical power to detect significant effects. However, results are generally consistent for the two datasets.

Table 6: APIM Models for Add Health Analyses of Sibling Influence

	Past Month Smoking (Odds Ratios)	Past Month Drinking (Odds Ratios)	Past Month Marijuana Use (Odds Ratios)	IRT Substance Use Score	IRT Delinquency Score
individual n	3932	5410	5185	5463	5483
Younger → Younger	16.65** (11.69,23.71)	5.23** (4.28,6.39)	12.94** (8.39,19.97)	0.56** (0.02)	0.44** (0.02)
Older → Older	22.88** (15.92,32.89)	6.72** (5.46,8.27)	10.71** (7.28,15.74)	0.59** (0.01)	0.48** (0.02)
Younger → Older	2.38** (1.77,3.19)	1.55** (1.28,1.86)	3.13** (2.11,4.66)	0.09** (0.02)	0.05** (0.01)
Older → Younger	2.53** (1.90,3.36)	1.73** (1.43,2.09)	2.20** (1.52,3.18)	0.10** (0.01)	0.11** (0.01)
Level 1-2 Variance Component	0.90**	0.62**	1.29**	0.20**	0.17**
Level 3 Variance Component	--	--	--	0.03	0.02

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. All sibling measures are lagged by one wave
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Variance components untransformed
e. Confidence intervals displayed in parentheses for odds ratios. Standard errors displayed in parentheses for continuous outcomes.

MODERATION BY SIBLING SOCIAL STATUS

The primary question of this chapter is whether or not sibling social status moderates sibling influence for substance use and delinquency. Now that I have established sibling influence overall, I test for moderation by indegree, outdegree, and reach. In the PROSPER data I use APIM models with the 100 matched sibling pairs in the two PROSPER cohorts (see Table 8). These data are used because they contain detailed social status measures for each sibling. In these models, observations are nested within individuals within sibling dyads. Although 100 pairs is a very small sample in which to find statistically significant effects, these results may at the very least indicate directionality. Control variables are omitted from the PROSPER APIM models due to the limited sample size.

Tests for sibling social status moderation use multiplicative interaction terms between each social status measure (indegree, outdegree, reach) and each behavioral measure (IRT scores, dichotomous substance use measures). This results in 15 total models. However, for the sake of brevity, I only display statistically significant or marginally significant results. Further, there was not enough variation in marijuana use in this small subsample to allow me to examine marijuana use as an outcome (leaving me with 12 total models). For each model, the primary predictor is prior wave outcome behavior. Interactions with social status measures are presented separately by sibling. Continuous social status and behavioral measures are centered to ease interpretation of interaction terms.

Variance components are displayed across the last two rows of Table 7 for each model. The Level 1-2 null model variance components for drinking, substance use, and delinquency are 0.23 ($p<0.05$), 0.03 ($p<0.05$), and 0.30 ($p<0.05$). The Level 3 null model variance components

for these outcomes are 0.64 (non-significant), 0.10 ($p<0.05$), and 0.17 ($p<0.05$). As can be seen from Table 7, predictors in these models account for most of the Level 1-2 variation.

As the results from Table 7 show, there are very mixed moderation effects of sibling social status that vary by outcome and type of social status considered. Since these are centered variables, main effects of continuous predictors can be interpreted as the effect of a one unit increase in a particular variable for a person considered "average" on all other predictors (as opposed to a person with 0 indegree/ outdegree/ reach, no delinquent behavior, etc.). Interaction terms reflect the degree to which a sibling with higher social status (as measured by indegree, outdegree, and reach) will have more, less, or about the same influence for substance use and delinquency. Across all models in Table 7, a one-unit increase in one's own prior wave substance use or delinquent behavior is associated with an increase in current wave behavior. Effects of sibling prior wave behavior are non-significant and vary in direction across models. Main effects of one's own or a sibling's social status on one's behavior are generally non-significant across models.

Across models in Table 7, interactions between sibling behavior and social status are positive for younger siblings and negative for older siblings. These effects are small in magnitude for the continuous outcomes while they are fairly large in magnitude for past month drinking. The direction of these effects indicates that younger siblings with higher social status are more influential for behavior, a finding consistent with my hypotheses. In contrast, older siblings with higher social status are less influential for these outcomes, a finding which runs counter to my expectations. These general trends were also observed for the outcomes of past month smoking (not shown as interactions were non-significant).

These interactions are shown graphically in Figures 2 and 3, with the exception of the marginal interactions for substance use and the reach interaction for delinquency (due to small magnitude of effect). In both figures, the lightly shaded columns reflect having a sibling with a lower social status (a standard deviation below the mean), while the more darkly shaded columns indicate those with sibling with above average social status. Differences in height between the columns demonstrate variation in predicted values for the outcome based on sibling social status. Each cluster of columns represents sibling dyads with differing sibling involvement in problem behavior. In Figure 2(A), the figure displays the general tendency for younger siblings to be more influential when they have higher outdegree, here reflected as one standard deviation above the mean. The exception to this trend is shown by the nearly equal predicted probabilities across levels of social status when only the older sibling reported drinking in the prior wave. This deviation from the general trend (also observed in Figures 2(C) and 2(B)) may simply result from the "influencing" sibling not engaging in the problem behavior that theory would suggest is influential.

Figure 3 graphically displays the sibling social status by delinquency interactions. As both of these are continuous variables, I examine behavior and status both one standard deviation above the mean and one standard deviation below the mean. Unless indicated otherwise, the behavior/ status of the unlisted sibling is held at the mean (which is 0 for these centered variables). As Figure 3(A) shows, graphical trends match the positive interaction trend indicated in Table 7 (larger predicted values for higher social status). The two exceptions are for when younger siblings or older siblings have lower than average levels of delinquency in the prior waves. In these cases, as noted previously, the failure for the graphical trend to match the other groups may simply be because the "influencing" sibling is not engaging in the problem behavior

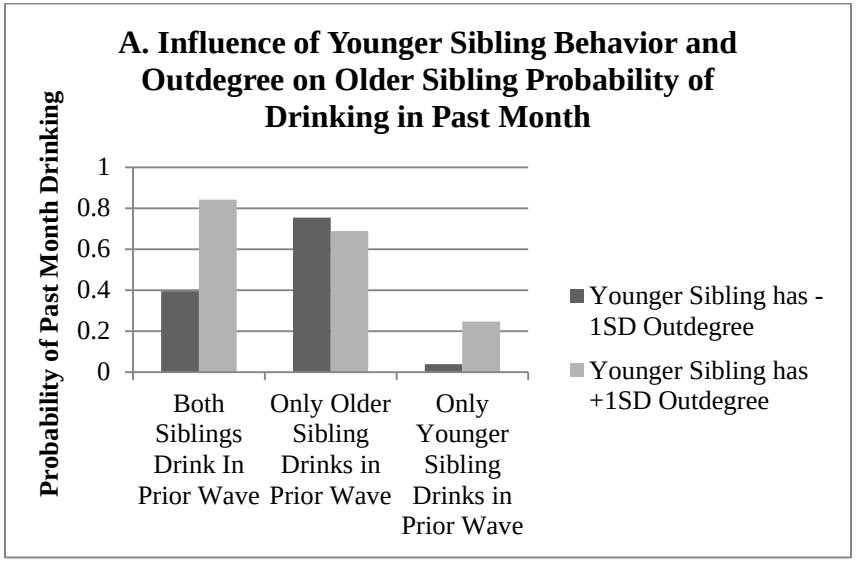
of interest, here delinquency. Similarly, most trends in Figure 3(B) match the downward trend that would be expected from the negative interaction term in Table 7 for the interaction between older sibling delinquency and older sibling outdegree. Here, the only deviations are when older siblings or younger siblings have below average delinquency in the prior wave (likely due to the reasons noted above).

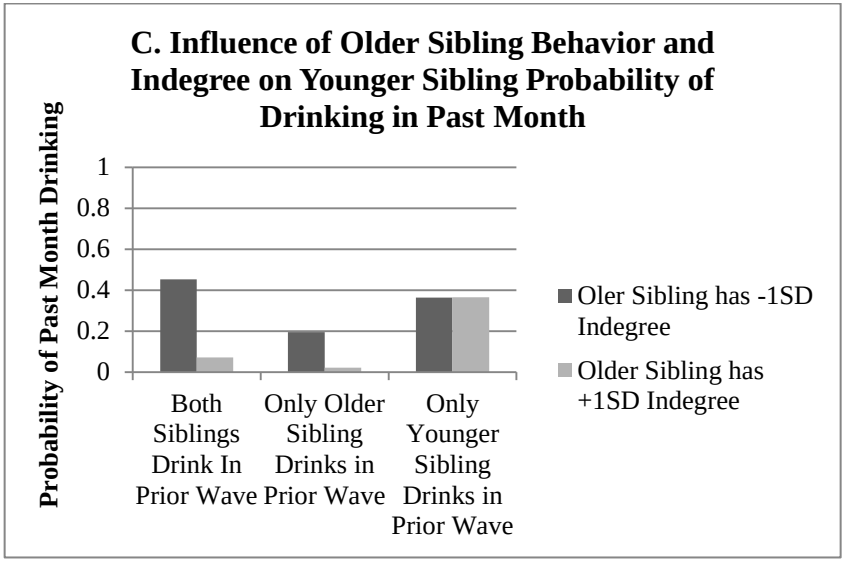
Table 7: APIM Models in PROSPER 100 Matched Sibling Subset

	Past Month Drinking (Odds Ratios)			IRT Substance Use		IRT Delinquency		
Younger → Younger	4.43** (2.33,8.41)	3.52** (1.91,6.48)	5.05** (1.89,13.56)	0.43** (0.10)	0.35** (0.09)	0.76** (0.07)	0.73** (0.07)	0.77** (0.06)
Older → Older	19.52** (7.17,53.12)	9.04** (3.57,22.89)	14.29** (5.43,37.53)	0.63** (0.10)	0.61** (0.10)	0.77** (0.04)	0.76** (0.04)	0.76** (0.04)
Younger → Older	0.60 (0.26,1.39)	0.84 (0.17,4.21)	0.60 (0.24,1.51)	0.01 (0.12)	-0.09 (0.15)	0.09 (0.05)	0.10 (0.06)	0.07 (0.05)
Older → Younger	1.80 (0.80,4.07)	0.33 (0.09,1.25)	1.73 (0.84,3.58)	0.05 (0.05)	-0.08 (0.06)	-0.10 (0.07)	-0.06 (0.06)	-0.10 (0.06)
Younger Sibling Behavior * Status	2.65** (1.85,3.79)	1.04 (0.78,1.39)	1.15** (1.07,1.23)	0.13+ (0.07)	0.003 (0.04)	0.05 (0.04)	0.04* (0.02)	0.01 (0.005)
Older Sibling Behavior * Status	0.84 (0.56,1.27)	0.56* (0.32,0.98)	1.003 (0.91,1.11)	-0.04 (0.04)	-0.06+ (0.03)	-0.05* (0.02)	-0.03 (0.02)	-0.01** (0.004)
Younger → Older Outdegree	0.86 (0.74,1.01)	--	--	0.001 (0.02)	--	0.01 (0.02)	--	--
Older → Younger Outdegree	1.05 (0.91,1.20)	--	--	0.004 (0.02)	--	-0.01 (0.02)	--	--
Younger → Older Indegree	--	1.07 (0.95,1.19)	--	--	0.02 (0.02)	--	0.004 (0.02)	--
Older → Younger Indegree	--	0.95 (0.82,1.09)	--	--	-0.03* (0.02)	--	-0.004 (0.02)	--
Younger → Older Reach	--	--	1.01 (0.98,1.04)	--	--	--	--	0.001 (0.004)
Older → Younger Reach	--	--	0.96* (0.93,1.00)	--	--	--	--	-0.005 (0.005)
Younger → Younger Status	1.00 (0.87,1.14)	1.09 (0.82,1.19)	1.05* (1.02,1.08)	-0.01 (0.02)	0.02 (0.02)	-0.01 (0.02)	-0.01 (0.01)	0.003 (0.003)
Older → Older Status	1.10 (0.95,1.27)	0.95 (0.83,1.08)	0.995 (0.97,1.02)	-0.004 (0.02)	-0.01 (0.02)	-0.002 (0.02)	0.003 (0.01)	-0.001 (0.003)
Level 1-2 Variance Component	0.05	0.11	0.01	0.01	0.01	0.003	0.002	0.004
Level 3 Variance Component	0.48	0.45	0.48	0.04*	0.05	0.03*	0.03*	0.02*

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave and continuous predictors are centered
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Confidence intervals displayed in parentheses for odds ratios. Standard errors are displayed in parentheses for continuous outcomes.
e. Estimates based on 90 sibling pairs with complete data for all models
f. Variance components unstandardized

Figure 2: Interaction Plots for Sibling Social Status Moderation for Past Month Drinking in PROSPER





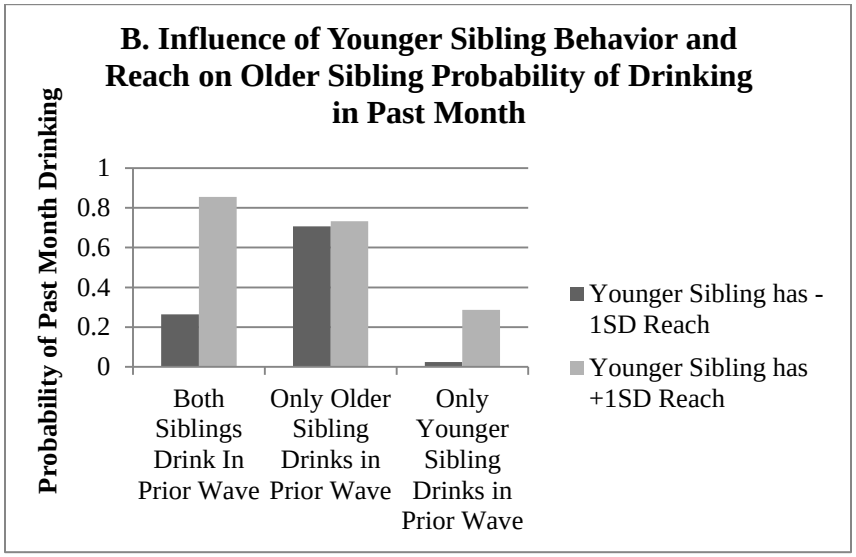
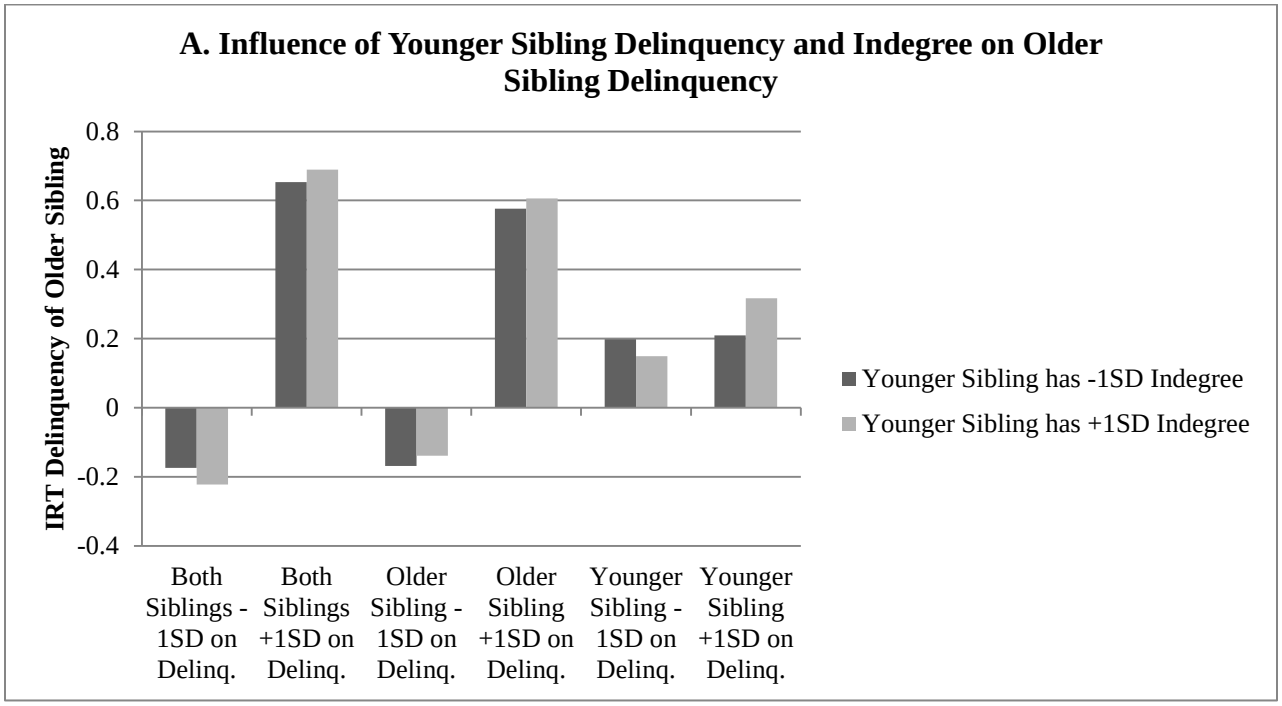
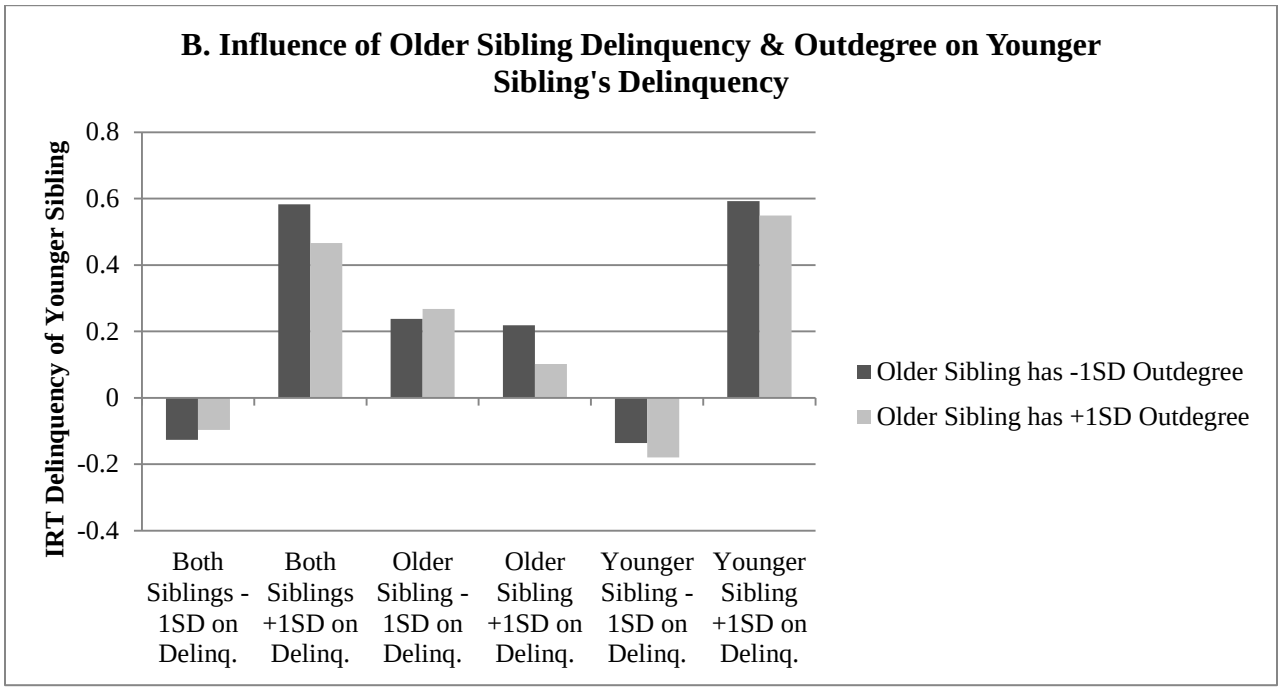


Figure 3: Interaction Plots for Sibling Social Status Moderation for Delinquency in PROSPER





As these results demonstrate, the moderating effects of sibling social status vary greatly by type of substance use and/or delinquency outcome. Further, some types of social status moderate these outcomes while others do not. This suggests that sibling social status moderation of sibling influence for delinquency and substance use is a complex social phenomenon. However, the PROSPER matched sibling pairs constitute a very small sample and the proportion of significant interactions is low given the number of tests, perhaps for this reason. Thus, I test for sibling social status moderation in a larger sibling sample, namely Add Health. Further, the Add Health data allow me to control for sibling genetic relatedness, which may account for some of the sibling moderation effect.

I account for genetic relatedness in the Add Health sample by performing the APIM models as I did with the 100 matched pair PROSPER sample, but with an additional layer of nesting. I nest sibling pairs within genetic relatedness types. In the sample of 3,086 sibling pairs, there are 201 cousin pairs, 452 dizygotic twin pairs, 1251 full sibling pairs, 442 half-sibling pairs, 289 monozygotic twin pairs, 408 unrelated adolescents raised together, and 43 sibling pairs with undetermined genetic relatedness. I group the latter with those who are unrelated but raised together.

Since Add Health social network data is missing for schools with less than a 50% response rate and missing for a number of siblings, interactions between social network measures, particularly between one sibling and another, result in a fair amount of missing data. As a result, I impute values for indegree, outdegree, and reach in Wave One using behavioral and demographic predictors in the imputation model. As with the PROSPER APIM results, I display only key effects in the table to follow, although controls were included for the age, race, and sex of each sibling. For the sake of simplicity, I only present results where I find statistically

significant or marginally significant evidence of moderation. However, the same 15 models were tested. Continuous predictors (indegree, outdegree, reach, IRT scores) are centered for ease of interpretation.

Results of the Add Health APIM models for sibling social status moderation are shown in Table 8. This table only displays models for which I identified a statistically significant or marginally significant interaction between sibling social status and sibling behavior. The last two rows indicate variance components for each model. Null model Level 1-2 variance components for delinquency, substance use, and marijuana use were 0.35 ($p<0.05$), 0.52 ($p<0.05$), and 1.47 ($p<0.05$), respectively. More than half of this variation is explained by these moderation models. Null model Level 3 variance components for these outcomes were 0.04 ($p<0.05$), 0.02 (non-significant), and $6.02e^{-12}$ (non-significant), respectively. As these values indicate, there is very little variance between genetic relatedness types to explain. Most variation lies between sibling dyads, as one would expect. For the marijuana and IRT substance use outcomes, the variance components for Level 3 were essentially zero (indicating negligible or no variation at this level to explain), so I present here two-level analyses (individuals within sibling dyads).

As Table 8 shows, I detected statistically significant interactions and/or marginally significant ($p<0.10$) effects for the IRT substance use, IRT delinquency, and past month marijuana use outcomes. Unlike those observed in the PROSPER subsample, these effects indicate, across outcomes, that siblings with higher social status have more influence. In particular, it is the social status of the older sibling in these dyads that moderates older sibling influence. Effects are similar in magnitude to those from PROSPER. The one exception to these trends is for overall substance use, where a negative interaction with younger sibling social status

is observed. This may be a chance finding, however. Even for models that did not detect statistically significant interactions (models not shown), I observed interaction terms in the positive direction. Note, though, that the marijuana models are likely unreliable due to large standard errors and odds ratio estimates; this is likely attributable to low base rates in the sample as well as stability in use across waves. For models using sibling reach as moderator, I observed only null effects (i.e. effects at or very near 0). Across all models, one's own behavior and the behavior of a sibling remained strong and statistically significant predictors of current wave outcomes. Main effects of one's own and sibling social status, however, were non-significant.

Of the controls (sex, age, and white race for each sibling), only having a male older sibling emerged as a statistically significant predictor of past month marijuana use. Namely, having a male older sibling increased the odds of past month marijuana use. This positive effect of an older male sibling was also apparent in the model for the IRT Delinquency outcome. For IRT Delinquency, sibling age also emerged as a significant predictor, with delinquency declining with increased age of either sibling. This is consistent with the descriptive statistics for delinquency in the Add Health sample.

Table 8: APIM Models in Add Health for Sibling Social Status Moderation

	IRT Delinquency	IRT Substance Use	Past Month Marijuana Use (Odds Ratios)	
Younger → Younger	0.46** (0.02)	0.59** (0.02)	18.96** (8.59,41.86)	19.36** (8.78,42.67)
Older → Older	0.48** (0.02)	0.61** (0.02)	15.34** (7.55,31.15)	15.16** (7.55,30.44)
Younger → Older	0.05* (0.02)	0.08** (0.02)	4.21** (1.99,8.91)	4.49** (2.10,9.59)
Older → Younger	0.12** (0.02)	0.12** (0.02)	3.04** (1.58,5.82)	3.27** (1.72,6.23)
Younger Sibling Behavior * Status	0.003 (0.005)	-0.01* (0.005)	0.93 (0.74,1.16)	0.94 (0.799,1.10)
Older Sibling Behavior * Status	0.02** (0.006)	-0.008 (0.005)	1.23* (1.01,1.51)	1.18* (1.001,1.40)
Younger → Older Outdegree	--	--	0.999 (0.91,1.09)	--
Older → Younger Outdegree	--	--	0.93 (0.85,1.02)	--
Younger → Older Indegree	-0.005 (0.005)	-0.001 (0.005)	--	1.01 (0.94,1.08)
Older → Younger Indegree	0.001 (0.005)	-0.002 (0.005)	--	0.91* (0.83,0.99)
Younger → Older Reach	--	--	--	--
Older → Younger Reach	--	--	--	--
Younger → Younger Status	0.006 (0.005)	-0.001 (0.005)	0.94 (0.87,1.03)	0.99 (0.92,1.05)
Older → Older Status	0.005 (0.006)	0.007 (0.005)	0.93+ (0.86,1.01)	0.98 (0.91,1.06)
Sibling Pairs	1225	1224	1193	1193
Level 1-2 Variance Component	0.13**	0.16**	1.52**	1.49**
Level 3 Variance Component	0.02	--	--	--

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Substance use, delinquency, and social status predictors are lagged by one wave and continuous predictors are centered for ease of interpretation
c. Asterisks denote statistical significance (**: $p< 0.01$, *: $p< 0.05$, +: $p<0.10$)
d. Confidence intervals displayed in parentheses for odds ratios. Standard errors are displayed in parentheses for continuous outcomes.

Graphs of statistically significant interaction effects in the Add Health sample are displayed in Figures 4 and 5. I omit a graph of the substance use interaction as it is the one inconsistent effect from Table 8. For Figure 4, since delinquency and outdegree are both continuous measures, note that I use the same formatting and groupings seen in Figure 3 for the PROSPER data. As presented in Figure 4, trends generally match the positive interaction effect between older sibling delinquency and older sibling indegree (greater predicted values for higher social status). The exceptions (equal column height) are when only the behavior of the younger sibling deviates from the mean. As discussed with the PROSPER interaction plots, however, this may simply reflect that these are cases when the "influencing" sibling is not engaging in the problem behavior of interest. Thus, we would not expect these individuals to be as influential in the ways I suggested based on social learning arguments.

Interaction effects are presented for past month marijuana use as an outcome in Figure 5. As seen in both Figure 5(A) and Figure 5(B), predicted probabilities of smoking marijuana are quite high when the younger sibling has already reported marijuana use in the prior wave. This is indicative of behavioral stability. Otherwise, across both figures, predicted probabilities are higher when the older sibling has higher social status. The only exception (wen column height is higher for lower social status) is when the older sibling did not actually use marijuana in the prior wave. As noted previously, this deviation is not clearly explained by theory.

Figure 4: Interaction Plot for Sibling Social Status Moderation for Delinquency in Add Health

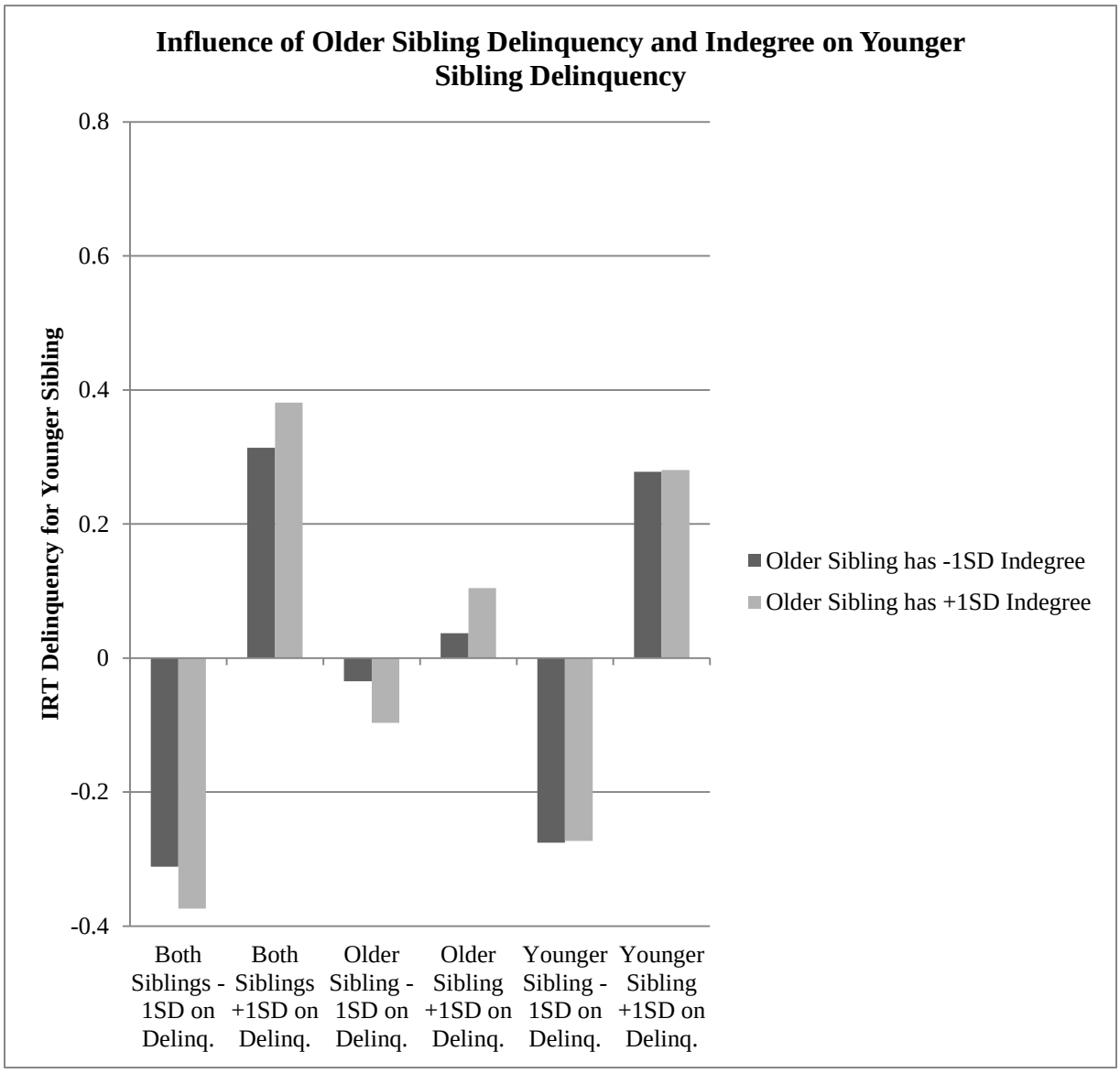
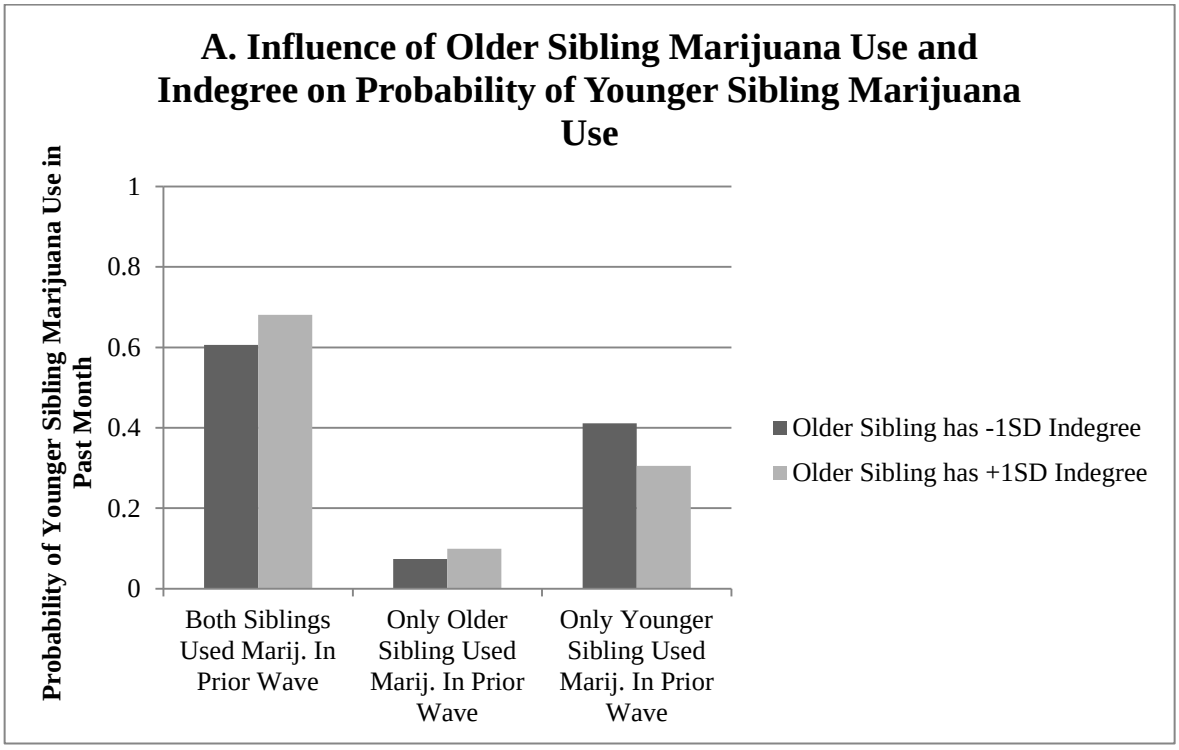
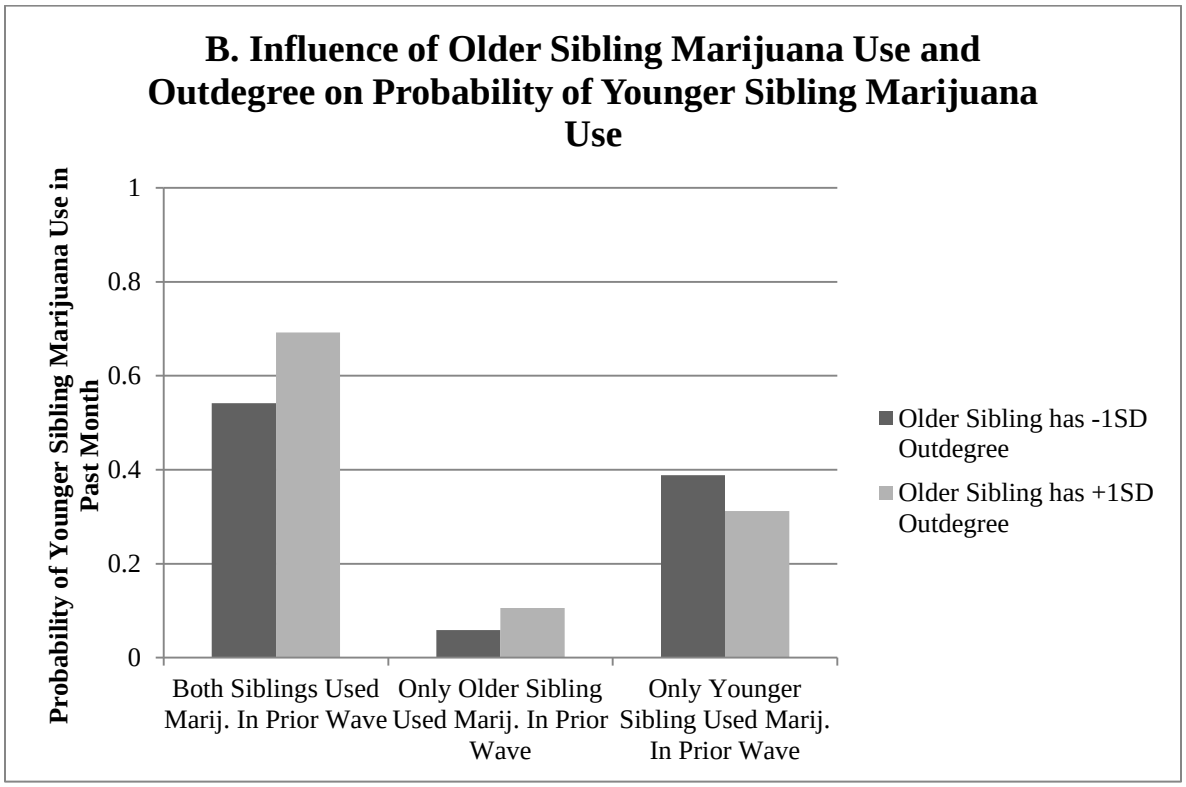


Figure 5 Interaction plots for Sibling Social Status Moderation for Marijuana Use in Add Health





CONCLUSION

The results from this chapter indicate four important findings. First, there appears to be significant sibling influence for the substance use and delinquency outcomes I consider in this dissertation. This continues to be the case after controlling for substance use and delinquent behavior in the prior wave as well as a number of other controls. These results support my hypothesis that adolescents whose siblings report greater substance use or delinquency will report more involvement in these behaviors as well.

Second, effects for moderation by sibling social status are mixed. Both within and across datasets, the emergence of statistically significant sibling social status moderation effects varied by outcome and by measurement of social status (indegree, outdegree, reach). In general, however, interaction effects tended to be positive, supporting my hypothesis that sibling concordance for substance use and delinquency will be greater for adolescents whose siblings have high social status. Most interaction effects occur with indegree and outdegree, with few for reach (possible reasons for this are discussed below). Unfortunately, the number of significant interaction effects found is quite limited given the number of tests and outcomes. Further analysis is needed to establish the complex patterns and extent of sibling social status moderation.

Third, genetics appear to account for very little variation in sibling influence. Genetics-level variance components for the APIM models in the Add Health data indicate scant, if any, variation stemming from this additional layer of nesting. As a result, I had to omit this layer of nesting from a number of models. My findings indicate that social status moderation of sibling influence is not significantly driven by the genetic relatedness of siblings.

Lastly, results indicate several key differences between sibling social status moderation effects in the PROSPER subsample and those in the Add Health sample. First, only in

PROSPER was network reach a significant moderator of sibling influence. It may be the case that a sibling's total reach in the social network is more difficult to perceive than the direct connections represented by indegree and outdegree. For example, an adolescent is likely to know roughly how many friends his/ her sibling has; these values should approximate indegree and outdegree. It is far more difficult to guess how many friends those sibling peers have (which is how we conceptualize reach). As a result, sibling network reach is likely less salient in sibling social learning processes which rely heavily on observation and perception. As the PROSPER analyses were based only on 90 sibling pairs, moderation by sibling network reach may reflect a small and selective sample.

Another difference lies in whether the interaction effect is statistically significant for the older or younger sibling. In Add Health, moderation effects appear to be more apparent for older sibling influence on younger siblings than vice versa. This is consistent with the social learning argument that younger siblings perceive a connection between the problem behavior of older siblings and their popularity. Although problem behaviors may not have actually contributed to the popularity of the sibling, this perception may motivate younger siblings to emulate problem behaviors. In the PROSPER sample, in contrast, younger sibling interaction terms were those that emerged as statistically significant. This, again, may be the result of a very small and selective subsample.

In the next chapter, I assess whether key control variables such as age gap, gender composition, or number of siblings affect the basic moderation effects of sibling social status observed in this chapter. The literature suggests that less sibling influence will be present when siblings have a wider age gap. For gender, the literature suggests variation in effects by both gender (male vs female) and gender composition (opposite versus same-sex in dyad). The

literature also suggests that siblings, particularly those close in age, may share peers, possibly affecting sibling influence processes. I will also broaden analyses to more fully examine sibling influence for those with more than one sibling. However, since each sibling engages in substance use and delinquency to a different degree, and may play a very different role in his/ her social network, this is a complex undertaking. I will use measures including number of siblings in a family as well as the "highest" status of any sibling (using indegree, outdegree, and reach).

Chapter 4. BEYOND SIMPLE MODERATION EFFECTS

The last chapter established that sibling influence is apparent for both delinquency and substance use. Further, there appears to be some limited evidence for moderation by sibling social status. Several key factors, not yet considered in this dissertation, may moderate social learning processes however. As social learning theories suggest, some individuals are perceived as more relevant models of behavior than others. This is likely the case even among siblings. For instance, we may view an older sibling as a more knowledgeable and experienced model of behavior than a younger sibling because they have already navigated certain events, social situations, etc. Indeed, most studies find that older sibling behavior influences younger sibling behavior, but not vice versa (Fagan and Najman 2005; S. D. Whiteman et al. 2007; Whiteman, McHale, and Crouter 2007). This is largely consistent with my findings in the last chapter. In the present chapter, I examine gender, age gap, and number of siblings as other potential moderators of sibling influence and sibling social status moderation.

GENDER & AGE GAP

First, a sibling who is much older or younger may not be as influential as one who is close in age. Due to an age gap, these siblings may not spend as much time together or may not share mutual peers, limiting exposure and observational learning. As such, social learning theories would lead us to expect less sibling influence when siblings are far apart in age. Trim and colleagues (2006), for example, found that older sibling alcohol use positively influenced younger sibling alcohol use, but only among sibling pairs with a low age gap.

Second, social learning theories would also lead us to expect greater modeling and hence greater behavioral similarity among same-sex siblings. Further, peer groups tend to be fairly

homogenous on gender, suggesting that same-sex siblings might be more likely to have overlapping peer groups than opposite-sex siblings (Brechwald and Prinstein 2011). Available research evidence is consistent with the expectations of social learning theories. Trim and colleagues (2006), for example, found that older sibling substance use is predictive of younger sibling use at later time period, but only for same-sex sibling pairs. Similarly, Rowe and Gulley (1992) found that correlations for substance use and delinquency are much lower for mixed-sex sibling pairs than for same-sex sibling pairs. Social Learning theory arguments regarding age and gender are reflected by the following hypothesis.

Hypothesis: Sibling concordance for substance use and delinquency will be greater for siblings close in age and/or of the same sex than for those with a larger age gap or of the opposite sex.

NUMBER OF SIBLINGS

In addition to gender and age gap, number of siblings may also affect the nature of sibling influence and sibling social status moderation. Overall, a larger number of siblings is predictive of adolescent delinquency (Fischer 1984; Tygart 1991). LeFlore (1988), for example, identified number of siblings as a family structure variable that partially distinguishes delinquents from non-delinquents. Specifically, those in the delinquent group in his study had significantly more siblings than those in the non-delinquent group. Conversely, Robins and colleagues (1975) found that children with fewer siblings were less likely to be delinquent in their sample of children of urban black males. This result held even when both parents of the child had a history of arrest, a strong risk factor for delinquency (Robins et al. 1975).

Several explanations for the family size--delinquency link have been suggested. First is that a large family size increases competition for parental resources including attention,

affection, and supervision. This competition and strain may lead to coping through delinquency and association with delinquent peers (Agnew 2006; Tygart 1991). Tygart (1991), for example, finds that the greater rates of delinquency in larger families are driven by greater delinquency among the middle children in the birth order. The author argues that since parents may be more likely to show favor to eldest and youngest children, middle children are those most likely to vie for parental attention and affection (Tygart 1991).

Second is that a large family size may be associated with problematic socioeconomic circumstances or living conditions (Fischer 1984). Each of these has known associations with delinquency, particularly through effects on family functioning (Laub and Sampson 1988). Kidwell (1981) found, for instance, that having more siblings leads to the perception that parents are more punitive and less supportive. Kidwell cautions, however, that we cannot fully grasp the influence of siblings without considering sibling age gap, number of siblings, birth order, and gender concurrently. Accounting for these factors is the purpose of the present chapter.

Specifically, I argue that number of siblings may affect sibling influence and social status moderation by exposing an individual to multiple models of behavior and social approval. Siblings will vary in social status, involvement in problem behavior, as well as quality of relations with one another. In a family with more than two siblings, we cannot fully understand sibling influence purely at the dyad level. In this chapter, I test two possibilities for how number of siblings may affect an individual's delinquency or substance use. First, in a large family, it is possible that the influence of any one sibling is diminished. Second, the sibling with the highest social status may be the most influential. This sibling may be perceived as the most socially successful and thus the most likely to be emulated of all siblings.

DATA & METHOD

Given the number of moderators I intend to test in this chapter, analyses will be limited to the Add Health data to preserve statistical power. I test for moderation by sibling gender composition and age gap by adding these and appropriate multiplicative interaction terms to the APIM models I used to test sibling social status moderation in Chapter Three. Age gap is measured as the gap in years between the age of one sibling and another. Gender composition is a dichotomous variable indicating whether both siblings are of the same sex (1) or not (0).

I test for the impact of number of siblings also using only Add Health data, as these data have the most detail about individual siblings. To do this, I first create a variable indicating the number of siblings in each family. Each sibling pair in a family has the same value for "number of siblings." Unfortunately, since some families have more than one sibling pair, this violates assumptions of independence and may bias results. Thus, I limit analyses focusing on number of siblings to only one sibling pair per family. When there are multiple pairs, I choose the pair with the lowest pair ID number. With this more restricted dataset (2,593 sibling pairs in total), I include multiplicative terms among the "number of siblings", sibling social status, and sibling behavioral predictors to test whether sibling influence and social status moderation might simply diminish with increased family size.

To further address how number of siblings might be influential, I next construct dummy control variables indicating whether each sibling has the highest indegree and outdegree of a particular family of siblings (separate indicator for each status measure). These are used to form multiplicative interaction terms with sibling social status and behavior. These terms test whether siblings with the "highest" social status are more influential. As these variables are sibling specific and not the same across all sibling pairs in a family, I conduct these analyses using the

full sample of sibling pairs in Add Health (i.e. more than one sibling per family may be in the data).

GENDER IMPACT

To assess gender composition impact, I added a control variable for same sex sibling dyad (0/1) to the models from Table 8. This variable is interacted with social status and behavior to form two and three-way interaction terms. This variable set replaces the simple controls for sibling gender that have been present in previous models. Controls for age and race of each sibling remain in the model, although not shown for the sake of brevity. Results for gender impact using the same sex dyad interaction terms are presented in Table 9. As with the previous chapter, the same 15 models are tested with only statistically or marginally significant results shown. Continuous predictor variables are centered for ease of interaction interpretation.

The last two rows of Table 9 indicate variance components for each model. Null model Level 1-2 variance components for substance use and marijuana use (as before) were 0.52 ($p<0.05$) and 1.47 ($p<0.05$), respectively. More than half of this variation is explained by these moderation models. Null model Level 3 variance components for these outcomes were 0.02 (non-significant) and $6.02e^{-12}$ (non-significant), respectively. As these values indicate, there is very little variance between genetic relatedness types to explain. Most variation lies between sibling dyads, as one would expect. For the marijuana and substance use outcomes, the variance components for Level 3 were essentially zero (indicating negligible or no variation at this level to explain), so I present here two-level analyses (individuals within sibling dyads).

As the results from Table 9 indicate, sibling dyad gender composition has a marginally statistically significant effect on sibling social status moderation for two outcomes: IRT substance use and past month marijuana use. For both outcomes, effects are quite similar.

Having a sibling of the same gender increases the effects of social status moderation by older siblings. In other words, we are even more likely to emulate the behavior of a "popular" older sibling if he or she is of the same gender. Although non-significant, models not shown also indicated interaction effects in this direction. These findings provide some limited support for my hypothesis that sibling concordance for substance use and delinquency will be greater for siblings of the same sex than for those with of the opposite sex. For substance use overall, the effect is observed for indegree. For marijuana use, it is observed for indegree instead.

To ease interpretation, interaction effects are shown graphically in Figures 6 and 7. The substance use outcome interaction is shown in Figure 6, while the interaction for marijuana use is shown in Figure 7. In Figure 6, differences between same-sex and opposite-sex dyads are unclear. Predicted values for dyads in which older siblings score below average on substance use are more pronounced in same-sex pairs, supporting my hypothesis. However, magnitudes seem about even for sibling dyads where the older sibling scored above average on substance use in the prior wave. Across groups, predicted value magnitudes are greater with greater indegree of the older sibling. One exception is for opposite-sex dyads where the older, "influencing" sibling scored below average on substance use in the prior wave. This is a deviation I have consistently observed in prior figures. As seen in Figure 7, predicted probabilities of the younger sibling smoking marijuana are quite high if the younger sibling has already reported use in the prior wave. This is reflective of behavioral stability. Within opposite-sex dyads, columns are nearly of equal height across groups (suggesting little, if any, moderation by social status). Within same-sex dyads, in contrast, there is much more pronounced moderation by sibling social status (the exception being when the older sibling does not engage in the problem behavior).

Table 9: Sibling Gender Composition Moderation of Sibling Influence in Add Health

	IRT Substance Use	Past Month Marijuana (Odds Ratios)
Younger → Younger	0.59** (0.02)	19.62** (8.56,44.95)
Older → Older	0.60** (0.02)	16.10** (7.68,33.75)
Younger → Older	0.03 (0.04)	3.69* (1.14,11.88)
Older → Younger	0.10** (0.04)	1.90 (0.67,5.40)
Younger → Older Outdegree	--	0.96 (0.82,1.11)
Older → Younger Outdegree	--	0.99 (0.86,1.14)
Younger → Older Indegree	0.01+ (0.007)	--
Older → Younger Indegree	0.001 (0.008)	--
Younger → Younger Status	0.0002 (0.005)	0.94 (0.86,1.02)
Older → Older Status	0.008 (0.005)	0.93+ (0.85,1.01)
Same Sex (0/1)	-0.03 (0.03)	0.92 (0.61,1.39)
Younger Sibling Behavior * Younger Sibling Status	-0.02* (0.01)	1.02 (0.69,1.49)
Older Sibling Behavior * Older Sibling Status	-0.02* (0.01)	0.98 (0.68,1.41)
Same Sex*Younger Sibling Behavior	0.07 (0.05)	1.32 (0.32,5.43)
Same Sex* Older Sibling Behavior	0.04 (0.04)	2.06 (0.59,7.22)
Same Sex* Younger Sibling Status	-0.02* (0.01)	1.07 (0.89,1.28)
Same Sex* Older Sibling Status	-0.004 (0.01)	0.91 (0.75,1.09)
Same Sex*Younger Sibling Status*Younger Sibling Behavior	0.01 (0.01)	0.87 (0.54,1.40)
Same Sex* Older Sibling Status* Older Sibling Behavior	0.02+ (0.01)	1.41+ (0.90,2.12)
Sibling Pairs	1224	1193
Level 1-2 Variance Component	0.17**	1.60**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Substance use, delinquency, and social status predictors are lagged by one wave. Continuous predictors are centered for ease of interpretation.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Confidence intervals displayed in parentheses for odds ratios. Standard errors are displayed in parentheses for continuous outcomes.

Figure 6: Interaction Plot for Substance Use Outcome Gender Composition Moderation in Add Health

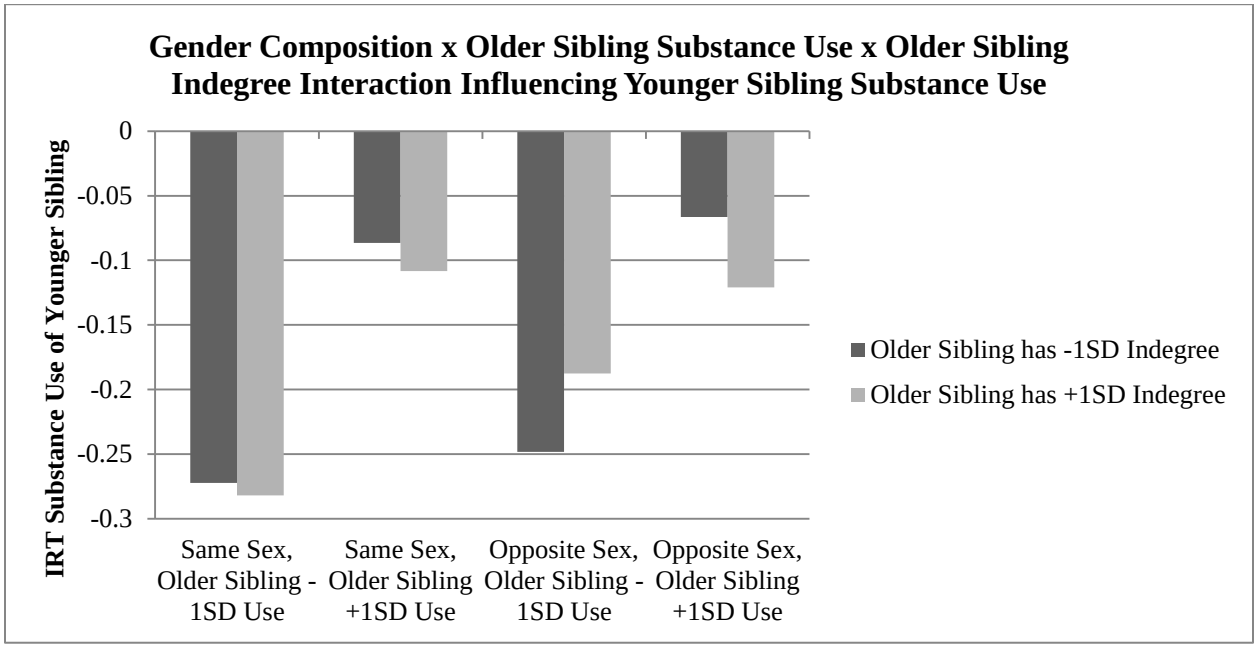
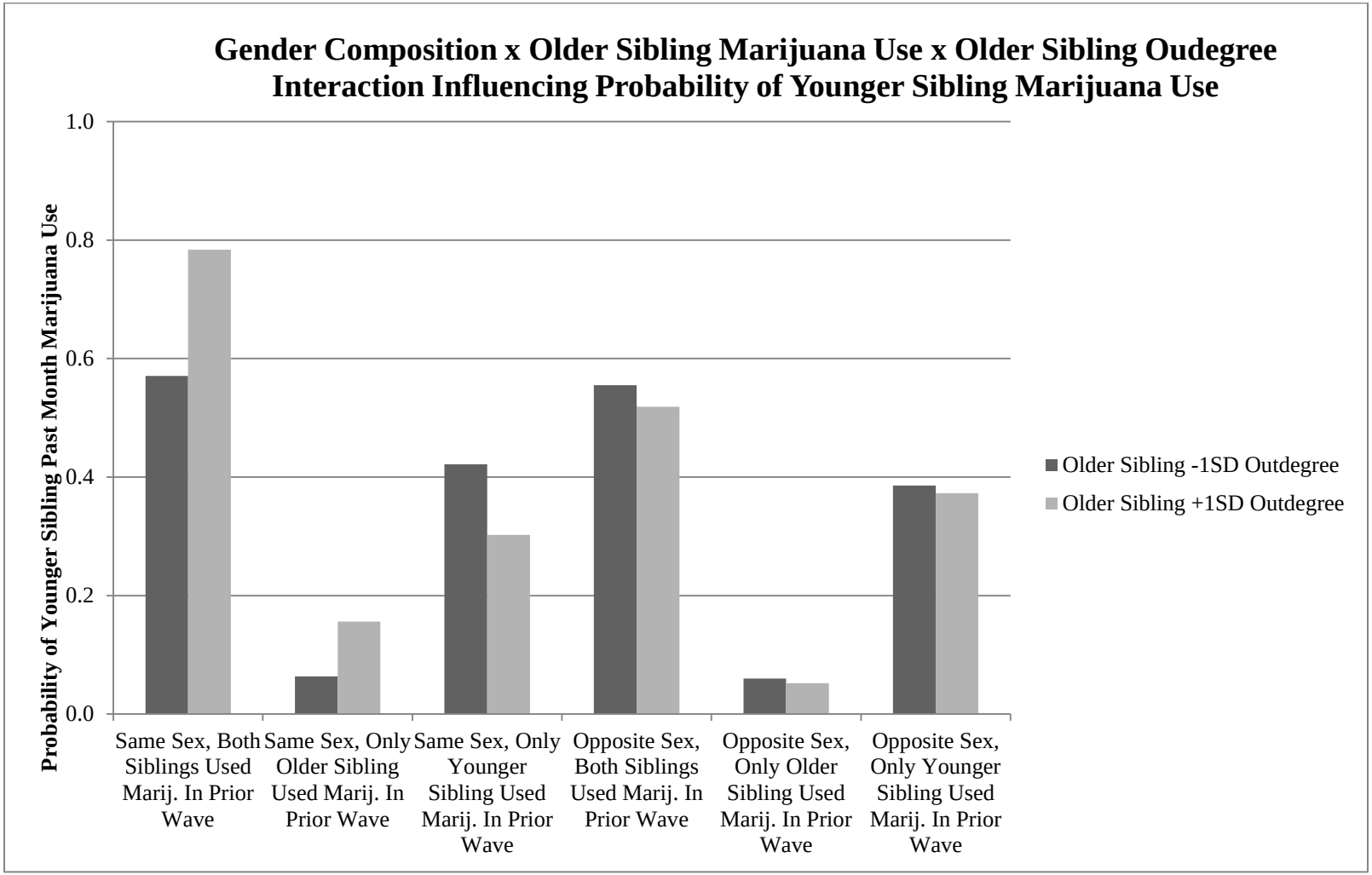


Figure 7: Interaction Plot for Marijuana Use Outcome Gender Composition Moderation in Add Health



AGE GAP IMPACT

I turn now to age gap as a potential modifier of the sibling social status moderation effects we observed in the previous chapter. To assess age gap impact, I added a control variable for age gap (measured in years) to the models from Table 8. This variable is interacted with social status and behavior to form two and three-way interaction terms. This variable set replaces the simple controls for sibling age that have been present in previous models. Controls for gender and race of each sibling remain in the model, although not shown for the sake of brevity. Results for age gap impact using the age gap interaction terms are presented in Table 10. As with the previous chapter, the same 15 models are tested with only statistically significant results shown. Continuous predictor variables are centered for ease of interpreting the interaction terms.

The last two rows of Table 10 indicate variance components for each model. Null model Level 1-2 variance components for delinquency and marijuana use were 0.35 ($p<0.05$) and 1.47 ($p<0.05$), respectively. More than half of this variation is explained by these moderation models. Null model Level 3 variance components for these outcomes were 0.04 ($p<0.05$) and $6.02e^{-12}$ (non-significant), respectively. For the marijuana use outcome, the variance components for Level 3 were essentially zero (indicating negligible or no variation at this level to explain), so I present here two-level analyses (individuals within sibling dyads).

As results from Table 10 indicate, age gap significantly modifies the moderation effect of older sibling outdegree for IRT delinquency influence. Specifically, a wider age gap decreases the moderating effects of older sibling outdegree. In other words, a wider age gap appears to decrease the degree to which one emulates an older sibling who perceives him/ herself as having

many peers (outdegree). This is consistent with my hypothesis that sibling concordance for delinquency will be greater for siblings close in age than for those with a larger age gap.

As three-way interactions like these are often difficult to visualize, I present the interaction in graphical form in Figure 8 for selected values of sibling delinquency, outdegree, and age gap (+/- a standard deviation from the mean). Unless otherwise indicated, other predictors (including those for the other sibling in the pair) are held at their mean. Comparing column heights for sibling pairs with below average and above average age gap in Figure 8, there is a slightly greater difference in height between levels of social status for those sibling dyads close in age versus those more spread in age. This trend towards positive interaction effects for older siblings was also observed in models with non-significant interaction effects, although these models are not displayed in Table 10.

Interestingly, we see an effect in the opposite direction for past month marijuana use when sibling social status is measured using outdegree. For this outcome, a wider age gap actually increases the moderating effects of older sibling outdegree. In other words, a wider age gap appears to increase the degree to which one emulates an older sibling who believes he/ she has many friends (outdegree). This is contrary to what we would expect from Social Learning theory. A graph of this interaction is displayed in Figure 9 to assist with interpretation. Overall, differences in column heights show greater sibling social status moderation for those sibling dyads more spread apart in age. The exceptions to this pattern are for when neither sibling used marijuana in the prior wave (little evidence of any social status moderation) and for when only the younger sibling used marijuana in the prior wave (direction of influence is negative rather than positive). The latter is the trend observed throughout this dissertation that

occurs when the “influencing” sibling did not engage in the problem behavior of interest in th prior wave.

Table 10: Sibling Age Gap Moderation of Sibling Influence in Add Health

	IRT Delinquency	Past Month Marijuana (Odds Ratios)
Younger → Younger	0.46** (0.02)	17.35** (7.67, 39.22)
Older → Older	0.47** (0.02)	15.39** (7.46, 31.72)
Younger → Older	0.04+ (0.02)	2.78* (1.22, 6.33)
Older → Younger	0.11** (0.02)	2.86** (1.41, 5.80)
Younger → Older Outdegree	0.006 (0.006)	0.99 (0.91, 1.09)
Older → Younger Outdegree	0.003 (0.006)	0.92+ (0.83, 1.01)
Younger → Younger Outdegree	0.01+ (0.006)	0.94 (0.86,1.02)
Older → Older Outdegree	-0.02** (0.006)	0.93 (0.86,1.01)
Age Gap in Years	-0.01 (0.01)	1.08 (0.93, 1.26)
Younger Sibling Behavior * Status	-0.003 (0.008)	0.91 (0.70, 1.18)
Older Sibling Behavior * Status	0.008 (0.007)	1.35** (1.08, 1.69)
Age Gap*Younger Sibling Behavior	-0.04 (0.03)	0.41** (0.22, 0.78)
Age Gap* Older Sibling Behavior	0.05 (0.03)	0.86 (0.53, 1.39)
Age Gap* Younger Sibling Status	0.006 (0.005)	0.99 (0.93, 1.05)
Age Gap* Older Sibling Status	-0.001 (0.005)	0.93* (0.87, 1.00)
Age Gap*Younger Sibling Status*Younger Sibling Behavior	0.003 (0.006)	0.99 (0.81, 1.21)
Age Gap* Older Sibling Status* Older Sibling Behavior	-0.01* (0.006)	1.21* (1.02, 1.44)
Sibling Pairs	1176	1150
Level 1-2 Variance Component	0.15**	1.56**
Level 3 Variance Component	0.03	--

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Substance use, delinquency, and social status predictors are lagged by one wave with continuous predictors centered.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Confidence intervals displayed in parentheses for odds ratios. Standard errors are displayed in parentheses for continuous outcomes.

Figure 8: Interaction Plot for Delinquency Outcome Age Gap Moderation in Add Health

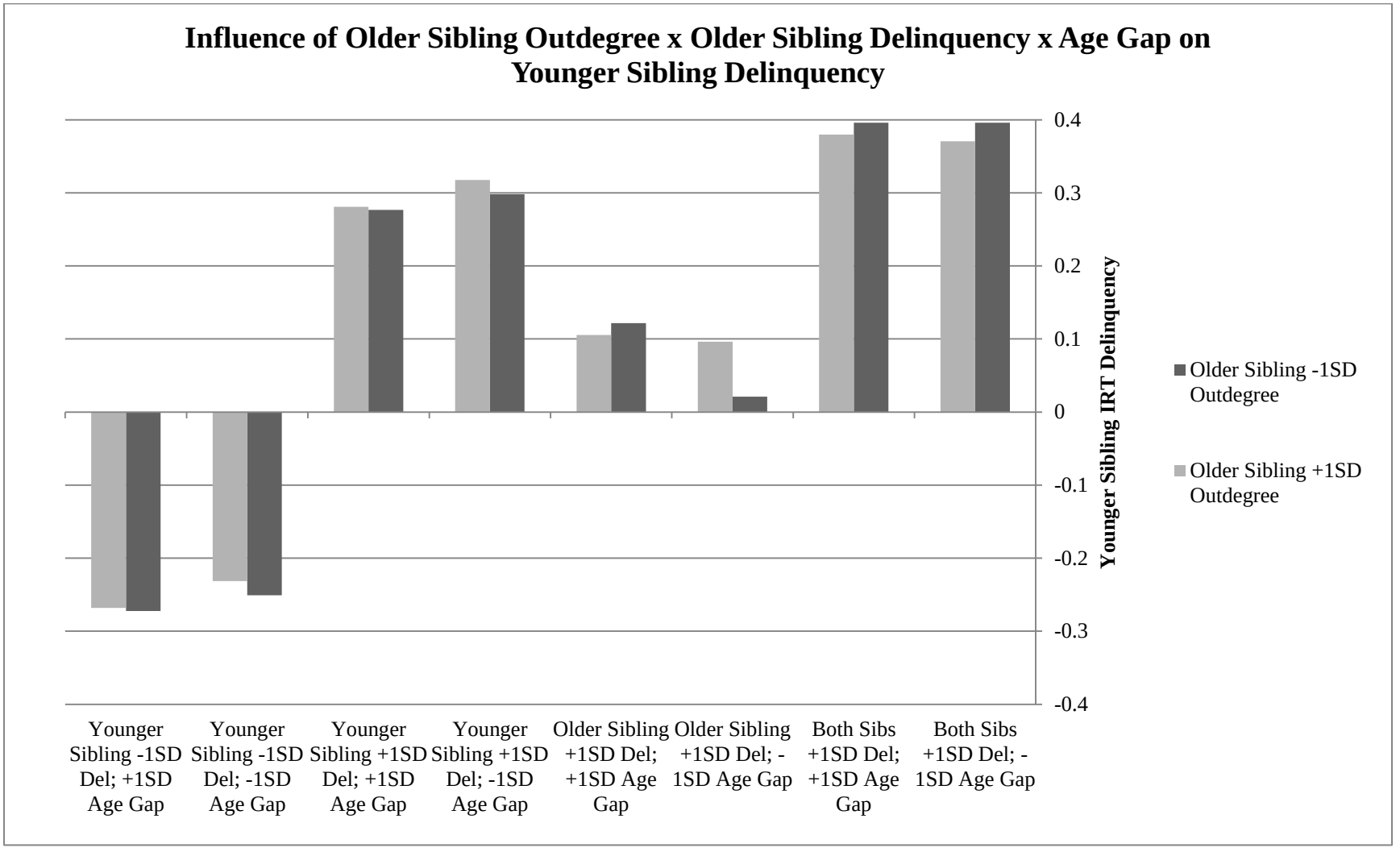
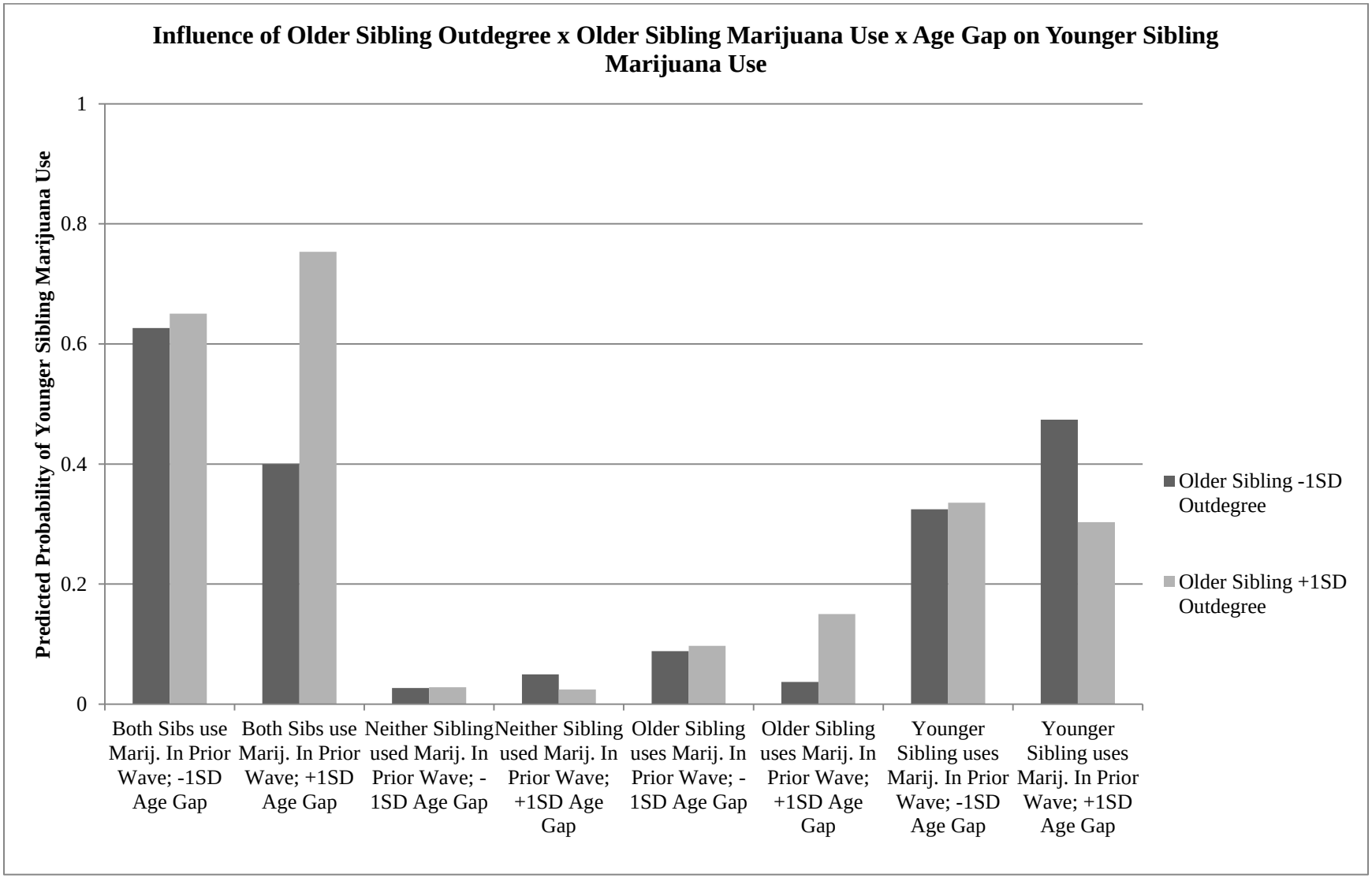


Figure 9: Interaction Plots for Marijuana Use Outcome Age Gap Moderation in Add Health



NUMBER OF SIBLINGS IMPACT

I now turn to potential moderation stemming from number of siblings. To assess this possibility, I added a control variable for number of siblings to the models from Table 8, although I used a more restricted sample where there is only one sibling pair included in analysis per family. The "number of siblings" variable is interacted with social status and behavior to form two and three-way interaction terms. Controls for gender, race, and age of each sibling remain in the models, although not shown for the sake of brevity. As with the previous chapter, the same 15 models are tested. However, in no model did number of siblings emerge in even a marginally statistically significant interaction.

Taking a closer look at non-significant interaction terms (results not shown), the direction of interaction effects varies by social status measure and by outcome. I observed positive interactions with outdegree and indegree for delinquency, substance use of the younger sibling, smoking of the older sibling, and drinking (indegree only). I observed negative interactions with outdegree and indegree for substance use of the older sibling, smoking of the younger sibling, and drinking (outdegree only). Reach interactions were always too near zero to assess the direction of effects. That these effects vary so widely lends credence to my suspicion that the marginally significant marijuana result is due to chance. In general, there is little if any evidence that number of siblings in a family significantly moderates the social status by sibling influence interaction I observed in the last chapter. Effects fail to achieve statistical significance even in a large sample of sibling pairs.

My failure to identify significant evidence of moderation by number of siblings does not necessarily indicate that there are no differences in sibling influence and social status moderation in families with multiple sibling pairs. Perhaps it is the most popular sibling who carries more

influence in larger families. To test this possibility, I create dichotomous variables that indicate whether the older sibling in the sibling pair has the highest outdegree in the family and whether the older sibling in the sibling pair has the highest indegree in the family. Identical measures are created as indicators for whether younger siblings fit these characteristics. I omit these measures for reach, as reach has not emerged as a statistically significant moderator in any analyses to this point.

After creating these basic indicators, I interact each with sibling behavior and social status as I did for my tests of gender composition and age gap. The difference here, however, is that I only add these sets of interaction terms to models with matching social status. In other words, the "highest outdegree" interactions are only added to models assessing outdegree as a moderator of sibling influence. Likewise, the "highest indegree" interactions are only added to models assessing indegree as a moderator of sibling influence. As a result, I test 5 models for each of the 4 sets of interaction terms, for a total of 20 models. As before, all models include controls for the age, gender, and race of each sibling, although effects of control variables are not displayed in tables. All models are tested within the full sample of sibling pairs, rather than the one-pair-per-family subset I used to test the overall impact of number of siblings.

Models with statistically significant or marginally significant interactions for older siblings having the highest social status in a family are displayed in Table 11. Those for younger siblings are displayed in Table 12. The last two rows of each table indicate variance components for each model. The null model Level 1-2 variance component for substance use (as before) was 0.52 ($p<0.05$). More than half of this variation is explained by the moderation model in Table 11. The null model Level 3 variance component for this outcome was 0.02 (non-significant). As these values indicate, there is very little variance between genetic relatedness types to explain.

Most variation lies between sibling dyads, as one would expect. For the substance use outcome, the variance component for Level 3 was essentially zero (indicating negligible or no variation at this level to explain), so I present here two-level analyses (individuals within sibling dyads).

In Table 11, only one interaction with "older sibling has highest status" emerged as statistically significant at the 0.05 level. This model measured social status by indegree. Here, the direction of the effect is positive, but only for the three-way interaction with younger sibling behavior and social status. This would imply that younger siblings have more influence when their older sibling holds the highest social status in a family. Overall, however, non-significant interactions with younger sibling behavior and social status were negative, indicating effects in the opposite direction. The one exception was for past month drinking, where the non-significant interaction terms for both siblings were positive. Although these results generally support my argument that the most popular sibling in a family might hold more influence, the lack of statistically significant effects overall should be interpreted with caution.

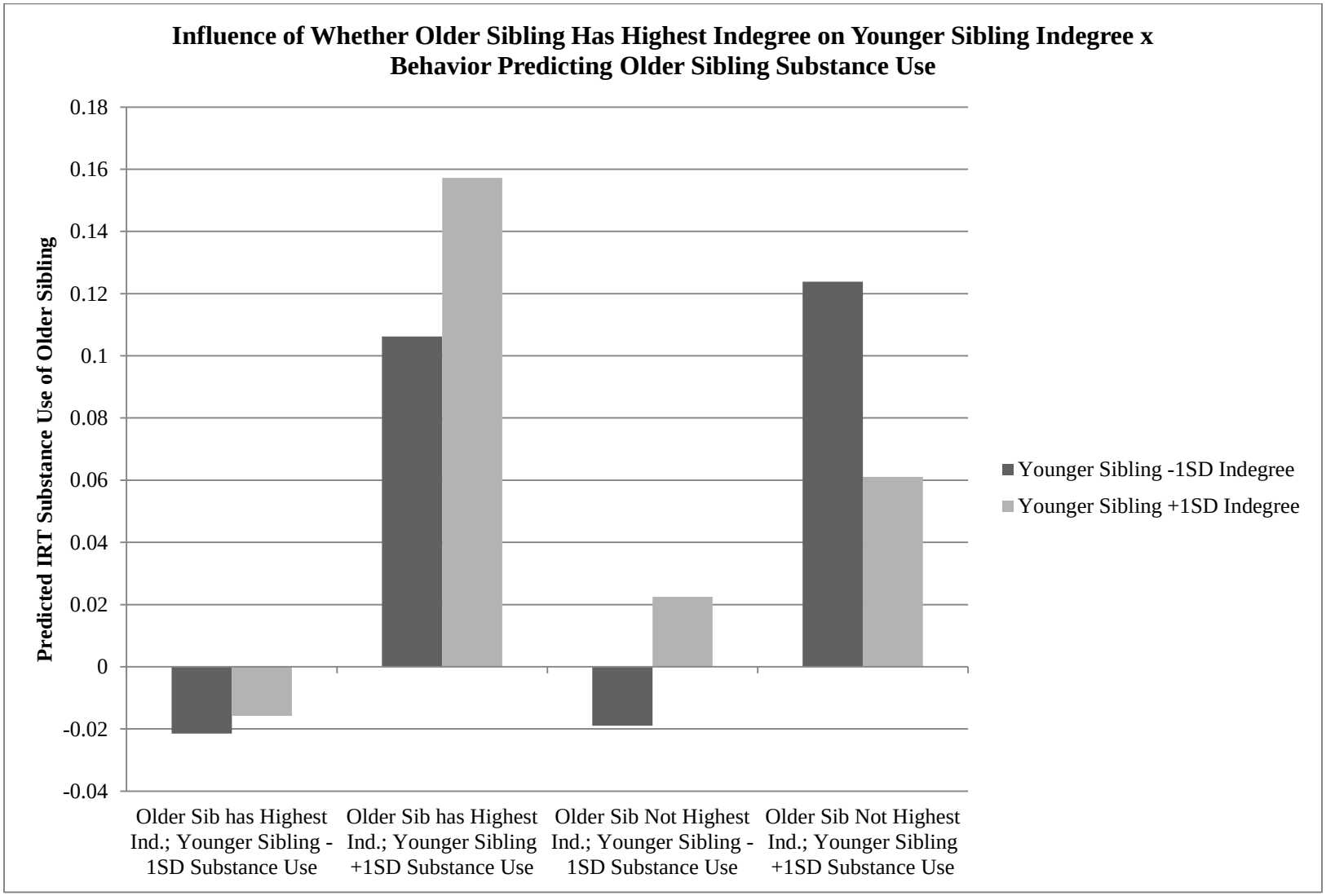
To assist with interpretation, a graph of this interaction is presented in Figure 10. As can be seen in that figure, if the older sibling has the highest social status in a family and the younger sibling has above-average substance use in the prior wave, then younger sibling influence increases with indegree. If the older sibling has the highest social status in a family and the younger sibling has below-average substance use in the prior wave, then this relationship does not emerge. Effects for those whose older siblings do not hold the highest social status in the family are unclear and difficult to interpret.

Table 11: Moderation by "Older Sibling has Highest Status" for Sibling Influence in Add Health

	IRT Substance Use
Younger → Younger	0.59** (0.02)
Older → Older	0.61** (0.02)
Younger → Older	0.07* (0.03)
Older → Younger	0.15** (0.03)
Younger → Younger Indegree	-0.0002 (0.01)
Older → Older Indegree	0.006 (0.007)
Younger → Older Indegree	-0.002 (0.006)
Older → Younger Indegree	-0.006 (0.01)
Older Sib has Highest Status – Ind/ Out (0/1)	0.009 (0.04)
Younger Sibling Behavior * Status	-0.02* (0.007)
Older Sibling Behavior * Status	0.002 (0.009)
Highest Status*Younger Sibling Behavior	0.05 (0.05)
Highest Status*Older Sibling Behavior	-0.03 (0.04)
Highest Status* Younger Sibling Status	0.008 (0.01)
Highest Status* Older Sibling Status	0.006 (0.01)
Highest Status*Younger Sibling Status*Younger Sibling Behavior	0.02* (0.01)
Highest Status* Older Sibling Status* Older Sibling Behavior	-0.02 (0.01)
Sibling Pairs	1224
Level 1-2 Variance Component	0.16**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Substance use, delinquency, and social status predictors are lagged by one wave. Continuous predictors are centered for ease of interpretation.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance component unstandardized.

Figure 10: Interaction Plot for Substance Use Outcome "Older Sibling Has Highest Status" Moderation in Add Health



Models with statistically significant or marginally significant interactions for younger siblings having the highest social status in a family are displayed in Table 12. The null model Level 1-2 variance component for past month drinking was 0.84 ($p<0.05$). Less than half of this variation is explained by the moderation model in Table 12. The null model Level 3 variance component for this outcome was $3.37e^{-10}$ (non-significant). As these values indicate, there is very little, if any, variance between genetic relatedness types to explain. Most variation lies between sibling dyads, as one would expect. For the past month drinking outcome, the variance component for Level 3 was essentially zero (indicating negligible or no variation at this level to explain), so I present here two-level analyses (individuals within sibling dyads).

As this table shows, no statistically significant or marginally significant interaction effects were apparent for social status measured by outdegree. Among the non-significant interactions, however, the three-way interaction effects tended to be positive for the younger sibling and negative for the older sibling. These results seem to suggest that younger siblings may have more influence when they have the highest outdegree in a family. One statistically significant interaction effect emerged with social status measured as indegree. This negative interaction (odds ratio < 1) with younger sibling drinking and indegree suggests indicates that younger siblings may have less influence when the younger sibling has the highest social status in a family. Overall, non-significant interactions for the younger sibling having the highest indegree in the family tended to be negative in direction for both siblings.

To assist with interpretation of the significant interaction I identified, a graph of this interaction is presented in Figure 11. As can be seen in this figure, differences in bar heights (indicating sibling social status moderation) tend to be more pronounced when the younger

sibling does not have the highest indegree in the family. This is consistent with the direction of the interaction identified in Table 12.

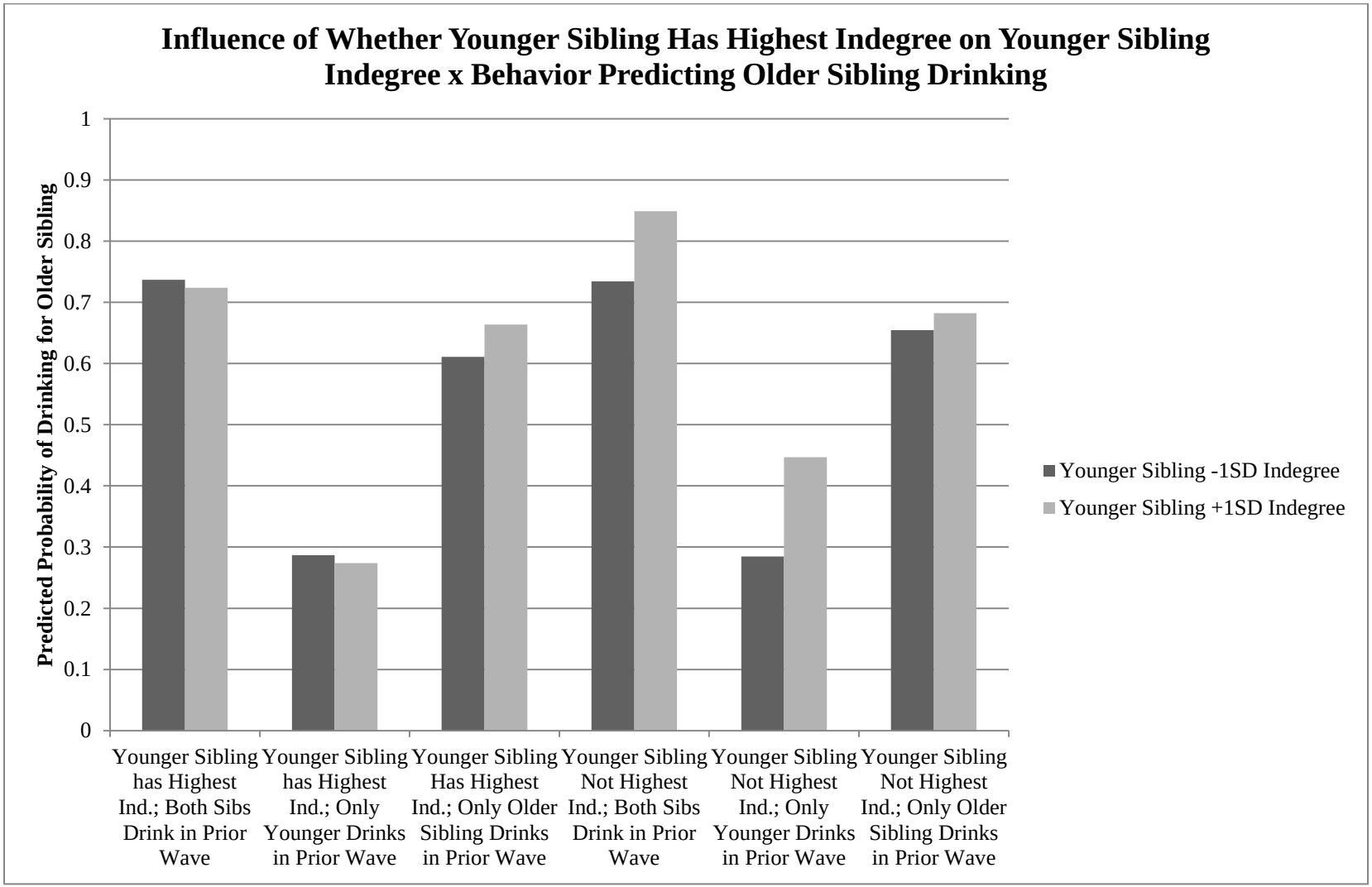
Overall, there does not appear to be any effect of number of siblings on the sibling social status moderation effect I identified in the last chapter. When I test whether it matters whether a sibling has the highest social status in a family, effects are mixed. I find one statistically significant negative interaction and one statistically significant positive interaction. Further, the graphs of these trends vary in their predictions for certain dyad types. As a result, there does not appear to be clear and convincing evidence that the sibling with the highest social status in a family has a more pronounced social status influence than other siblings.

Table 12: Moderation by "Younger Sibling has Highest Status" for Sibling Influence in Add Health

	Past Month Drinking (Odds Ratios)
Younger → Younger	5.58** (4.09, 7.62)
Older → Older	6.95** (5.02, 9.62)
Younger → Older	1.95** (1.23, 3.09)
Older → Younger	1.51+ (0.97, 2.34)
Younger → Younger Indegree	1.06* (1.01, 1.12)
Older → Older Indegree	1.02 (0.96, 1.07)
Younger → Older Indegree	1.02 (0.92, 1.14)
Older → Younger Indegree	1.07 (0.97, 1.17)
Younger Sibling Behavior * Status	1.12 (0.97, 1.30)
Older Sibling Behavior * Status	0.96 (0.85, 1.07)
Younger Sib has Highest Status (0/1)-- Indegree	0.87 (0.59, 1.28)
Highest Status*Younger Sibling Behavior	0.79 (0.44, 1.40)
Highest Status*Older Sibling Behavior	1.06 (0.62, 1.82)
Highest Status* Younger Sibling Status	1.02 (0.90, 1.15)
Highest Status* Older Sibling Status	0.91 (0.79, 1.04)
Highest Status*Younger Sibling Status*Younger Sibling Behavior	0.84* (0.71, 0.998)
Highest Status* Older Sibling Status* Older Sibling Behavior	0.95 (0.81, 1.13)
Sibling Pairs	1218
Level 1-2 Variance Component	0.68**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Substance use, delinquency, and social status predictors are lagged by one wave. Continuous predictors are centered for ease of interpretation.
c. Asterisks denote statistical significance (**: $p< 0.01$, *: $p< 0.05$, +: $p<0.10$)
d. Confidence intervals displayed in parentheses for odds ratios. Variance component unstandardized.

Figure 11: Interaction Plots for Drinking Outcome "Younger Sibling Has Highest Status" Moderation in Add Health



JOINT EFFECTS OF GENDER COMPOSITION & AGE GAP

Heretofore, I have only examined the potential moderating impact of gender composition, age gap, and number of siblings separately. However, it may be the case that sibling influence is especially pronounced in sibling pairs that have a set of characteristics. For example, perhaps sibling influence is greater in sibling pairs where siblings are both of the same sex *and* close in age. Although no consistent statistically significant interaction effects emerged with number of siblings, I did identify both gender composition and age gap as potential moderators of the interaction between sibling behavior and sibling social status. In this subsection, I present and discuss selected graphs that illustrate how age gap and gender composition might jointly impact sibling social status moderation of sibling influence.

To create these graphs, I conducted age gap interaction analyses separately by gender composition (same versus opposite sex) within the Add Health full sample of sibling pairs. Although not all possible graphs are shown, I display a few here to illustrate that age gap and gender composition of sibling pairs can be jointly informative. In all graphs, I assume that the older sibling has above average prior wave scores (+1SD) on the behavior while behavior of the younger sibling is held at the mean. All graphs display interactions focusing on older sibling influence on younger siblings, as this is most often indicated in the literature, my analyses, and is best supported theoretically.

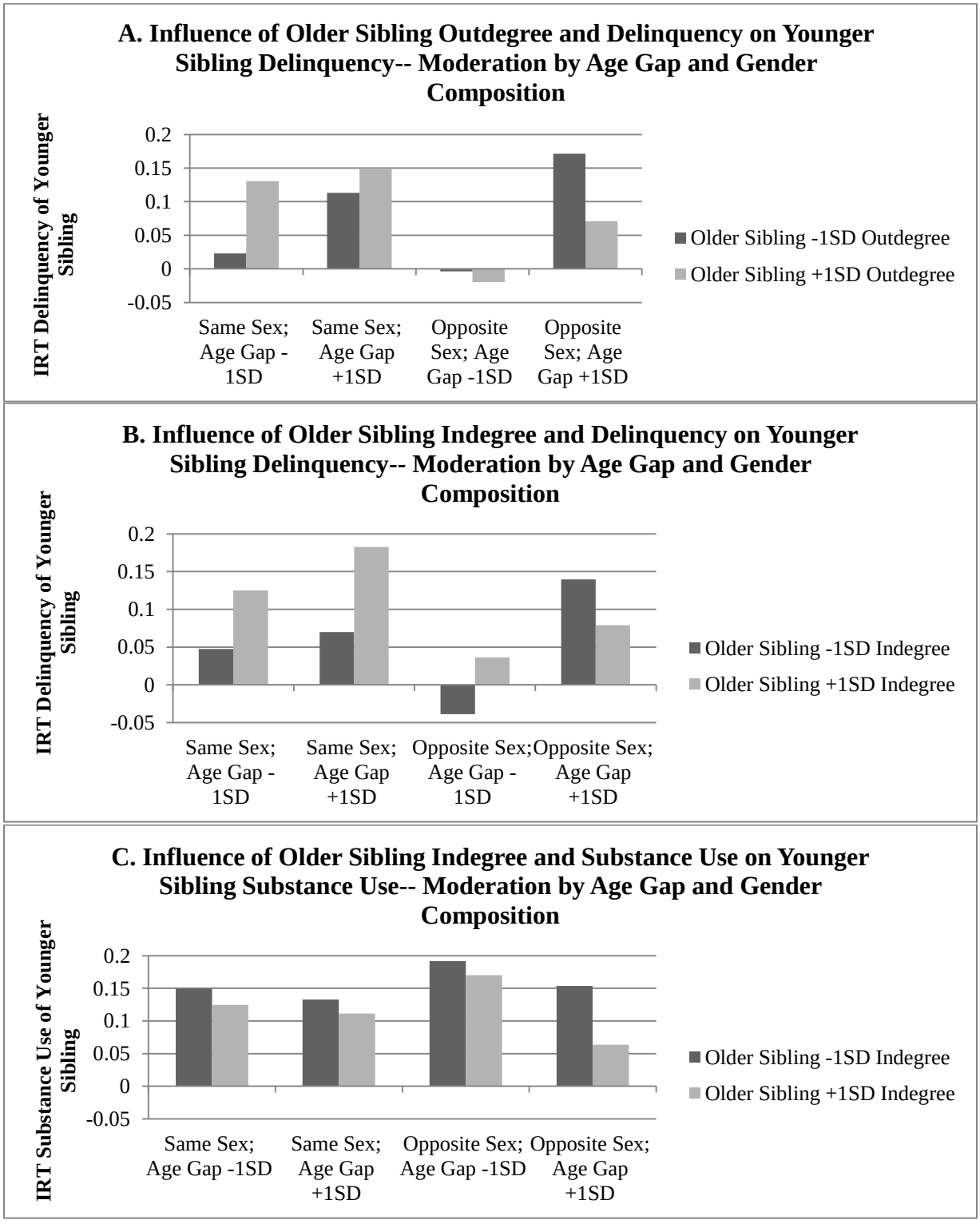
Three selected graphs, all for continuous outcomes, are shown in Figure 12. As these graphs illustrate, sibling social status moderation varies by both age gap and gender composition. Here, trends by age gap also vary by whether siblings are of the same sex or opposite sex. In Figure 12(A), for example, there is a clear difference in social status moderation between same-sex and opposite-sex dyads. For opposite sex dyads, differences by age gap are unclear and

difficult to interpret. For same-sex dyads, however, there is much more pronounced sibling social status moderation for those dyads close in age (note column height differences).

In Figure 12(B), which displays trends for the delinquency outcome with social status measured by outdegree, trends also diverge based on both age gap and gender composition. They are similar to trends observed for outdegree in Figure 12(A). In Figure 12(B), there is no clear pattern for opposite-sex sibling dyads. However, for same-sex dyads, there is visible social status moderation for dyads close and more spread in age. Interestingly, the column height difference appears more pronounced for those more spread in age. In Figure 12(C), in contrast, there are no clear patterns, regardless of age gap or gender composition

As all of these figures demonstrate, examining age gap or gender composition in isolation is not fully informative of patterns in sibling social status moderation. Only together do we some of the trends noted in these figures. Thus, readers should keep in mind that the trends discussed in this chapter are meant to highlight the influence of various moderators (age gap, etc.) and not to belittle the importance of viewing them as part of a greater whole.

Figure 12: Joint Contributions of Age Gap and Gender Composition to Sibling Social Status Moderation in Add Health



CONCLUSION

This chapter examined three key moderators that might affect sibling social status moderation effects: gender composition, age gap, and number of siblings. Given sample size constraints, all these analyses were conducted using Actor-Partner-Interdependence Models (APIM) with the Add Health data. As I observed in the previous chapter, variation by genetic relatedness (MZ twin, DX twin, half-siblings, etc.) was not statistically or substantively significant. Variance components for this layer of nesting were generally very close to zero, even in null models, suggesting that there was very little variation at that level to explain. This was the case regardless of outcome or moderator considered, again suggesting that genetics account for very little of this social process. Overall, there is little evidence that gender composition, age gap, or number of siblings significantly or consistently moderates the sibling social status moderation effects I detailed in the previous chapter. The mixed direction of effects for age gap and status of siblings in the family are not clearly interpretable, and no statistically significant effects emerge when I consider number of siblings overall.

Gender composition results, although only marginally statistically significant, indicated that sibling social status moderation effects are magnified for same-sex sibling pairs across outcomes considered. This is consistent with the existing research literature which suggests that social learning processes are more pronounced for same-sex dyads as same-sex individuals are perceived as more relevant models than those of the opposite sex. This finding is also consistent with literature that demonstrates that friendship groups in early to mid-adolescence are characterized by gender homophily (Brechwald and Prinstein 2011; McPherson, Smith-Lovin,

and Cook 2001). In other words, many friendship groups are composed of all males or all females.

In both the current chapter and the previous I have considered sibling social status as a moderator of sibling influence for delinquent and substance use behavior. In the next chapter, I consider another possibility. Perhaps sibling social status is to some degree transferable. In other words, does having a high status sibling make a person more likely to have higher social status him/ herself? Also, to what degree do mutual peers impact sibling social status moderation and sibling influence overall? After all, we know that many siblings are close in age and may share peers. The next, and final, empirical chapter examines this exploratory question to extend current understanding of the role of sibling social status in sibling influence processes.

Chapter 5: SOCIAL STATUS AS AN OUTCOME

In the previous two chapters, I demonstrated that not only does sibling substance use and delinquency influence our own behaviors in these domains, but that the social status of our siblings conditions this influence. Overall, I find that sibling influence is more pronounced as the indegree and outdegree of a sibling increase. This is not a simple relationship, however. I observed this moderation effect more often for older sibling influencing younger siblings than vice versa, and effects are stronger within same-sex sibling pairs in particular. These findings are consistent with arguments drawn from Social Learning theories which suggest that individuals, such as siblings, can model both behavior and social consequences of behavior.

In the present chapter I extend this understanding of sibling behavioral and social status influence by focusing on a very different outcome: the social status of other siblings. In other words, I consider whether the behavior and social status of one's siblings influence one's own social status in the peer network. I also examine the prevalence and impact of siblings' mutual peers in this social context. The existing research on this topic and the theoretical basis for my hypotheses are outlined in the sections to follow.

SIBLING SOCIAL STATUS & MUTUAL FRIENDS

Before I proceed further, I first need to detail why we would expect to find any sort of relationship between one sibling's social status and another's. In other words, would we expect siblings to be similar or different on measures of social status? Is sibling social status actually predictive of one's own social status? Unfortunately, the existing research literature directly

addressing these questions is scant, leading my work in this chapter to be largely exploratory. However, some lines of research do point to some answers to these questions.

First, recall that most sibling pairs are likely to share a certain degree of genetic material. Identical twins share 100%, full siblings and dizygotic twins share 50%, half-siblings share 25%, and non-related siblings share none of their genetic material with one another. Thus, sibling social similarities may have some genetic basis. It was for this reason that I incorporated genetic relatedness as an additional layer of nesting in Add Health analyses in all chapters of this dissertation. Within the Add Health data in particular, Fowler and colleagues (2011) found evidence of peer group homophily and heterophily based on several known genes (Fowler et al. 2011). As a result, siblings who share these genes may choose or be chosen by peer groups with these genotypes leading siblings to have similar peer groups. Studies of other samples have also identified friendship group homophily based on genes (Christakis and Fowler 2013). Ruston and Bons (2005), as another example, find that monozygotic twins choose friends and spouses more similar to those of their co-twins than dizygotic twins. In other words, there is partially a genetic basis for choosing a friend/ spouse similar to oneself.

This genetic basis may be mediated by behavior or shared environment, however. Siblings, for example, may have the same or similar environments with regards to parental resources, location of residence, family events, etc. that shape behavior and perhaps even influence social desirability. Siblings may also share behaviors or characteristics that result in similar social consequences. A 2009 study by Burt, for instance, elaborates on the known link between a serotonin gene polymorphism and popularity during adolescence (Burt et al. 2007). She found that this link was mediated by adolescent rule-breaking behavior. In other words, this genetic variation was associated with a behavior that is perceived as desirable during

adolescence, an argument the author linked to Moffitt's "adolescent-limited offenders" (Moffitt 1993). Some work has also found at least a weak link between siblings' shared environment and sibling similarity for certain behavioral or personality traits (see Rose et al. 1990 as an example). Similarity on these characteristics, in turn, might lead to similarity in desirability among peers. Although genetics are not a focus of my research, these findings in the literature lead me to expect sibling similarity on social status, whether based on genes, behavior, or other social tendencies that I note below.

A social explanation for sibling social status concordance, and perhaps the simplest, is that siblings may expose individuals to wider social networks than they might otherwise encounter. Thus, if one sibling has many friends, he/she may be able to introduce or expose other siblings to these peers, resulting in a larger peer network for other siblings (i.e. higher adolescent social status). This phenomenon is observed in dating partners. Derek Kreager and Dana Haynie (2011), for example, find that dating partners serve as network bridges between peer networks. With regard to siblings, the peers of a sibling might choose to befriend his/ her other siblings because they often see these individuals (when visiting the home, at school, etc.) or simply because their positive regard for the one sibling "rubs off" on other siblings by association. The arguments above are known by social network terminology as *transitivity*, the tendency for someone to befriend the friends of their friends. Indeed, a number of studies have established this trend in social networks (Jin, Girvan, and Newman 2001; Mercken et al. 2009; Newman and Park 2003). As a result, it makes sense to expect that if a sibling has many friends, other siblings might experience a boost in social status as they befriend (or are befriended by) their sibling's friends. Sibling social status, in this sense, would be positively predictive of one's own social status, as reflected in the following hypotheses:

Hypothesis: Siblings will display concordance for social status.

Hypothesis: The social status of one sibling will positively influence that of other siblings.

As noted above, the social network notion of transitivity leads me to expect that siblings will have a tendency to befriend their siblings' friends (and vice versa), leading to increased social status and overlapping peer groups. Existing research has determined that siblings often share friends in adolescence. Drawing on the Arizona Sibling Study, Rowe and colleagues (see Hetherington et al. 1994) find that roughly 76% of brothers, 74% of sisters, and 64% of mixed-gender siblings ages 10 to 16 years share at least one mutual friend. Most of those with mutual friends have 2 or 3 friends in common, although about 10% of sibling pairs share 7 or more friends (Hetherington et al. 1994). Time spent with these mutual friends is also non-trivial. Approximately 47% of brothers, 35% of sisters, and 25% of mixed-gender siblings with mutual friends report spending time with these friends sometimes, often, or always (Hetherington et al. 1994). Further, research has found that popular individuals are more likely to have mutual peers than less popular individuals (Bukowski, Hoza, and Boivin 1993b). These findings are not unexpected as siblings are generally close in age and have similar backgrounds and environments.

However, transitivity is not universal. If siblings are far apart in age or of a different gender, for example, an individual may arguably be less likely to befriend the friends of his/ her siblings. Peer groups, as discussed previously in this dissertation, are often formed based on homophily. Thus, transitivity and the development of mutual friendship ties may be dependent upon some of the individual characteristics I have analyzed in other chapters. If siblings share none or fewer friends, influence of siblings on social status may be more muted. Thus, I expect that the

presence of mutual friends will actually condition the influence of a sibling's social status. This is stated formally in the following hypothesis:

> *Hypothesis: Siblings will have more influence on one another's social status when they share mutual friends (or share more of these friends) than when they do not.*

SIBLING BEHAVIOR AND SOCIAL STATUS

In this chapter, I also examine one other avenue through which siblings may influence our social status: sibling behavior. One possibility for social status influence through sibling behavior concerns access to illicit substances or opportunities for deviant behavior. As Moffitt details in her taxonomy of delinquency in adolescence, minor forms of delinquency and substance use become popular during this period of the life course (Moffitt 1993). Moffitt argues that Adolescence-limited offenders mimic the delinquent and substance use behavior of those who have been persistently involved in these behaviors over time (life-course persistent offenders). Drawing on this theory, I propose that access to illicit substances or opportunities for deviance may boost an individual's social status among peers. Access can occur through siblings if siblings engage in these behaviors or know of these opportunities. Thus, having a sibling engaging in these behaviors may boost one's own social status as a result of one's ties to a point of access (i.e. the sibling).

Among disadvantaged urban youth, parents are the most common source of alcohol (Hearst et al. 2007). However, other sources including older siblings, friends, parties, and adults of legal drinking age become more common sources over time (Hearst et al. 2007; Wagenaar et al. 1993). A study by Hearst and colleagues (2007) identified the sources of alcohol, tobacco, and other drugs among adolescents more precisely. The results of this study indicate that roughly 25% of adolescents (grades 6, 9, and 12) list family members as a source of alcohol and tobacco;

15% list family members as a source of other drugs. In grades 9 and 12, more than 65% of adolescents list friends as a source of alcohol, tobacco, and other drugs (Hearst et al. 2007). As these results show, siblings and peers are important points of access for illicit substances. As a result, a sibling's involvement in problem behaviors may positively affect one's own social status if adolescents view an individual as a point of access or opportunity.

Sibling behavior, however, might also be argued to have a negative impact on one's own social status. As Erving Goffman details, *stigma* is a characteristic or behavior that results in social ostracism (Goffman 2009). Stigmatized groups in the U.S. include the mentally ill and convicted felons, among others. In adolescence, certain behaviors or characteristics, including the ones listed above, are also stigmatizing. If our siblings hold these characteristics or engage in these behaviors, we may find ourselves stigmatized by association. In adolescent social networks, stigma may be reflected by fewer individuals nominating a person as a friend (i.e. reduced social status), reduced interaction with peers, or even bullying. Unlike other relationships, such as friendships, we cannot fully disassociate from our families to prevent this stigma, at least during childhood and adolescence. As Lewis writes in a chapter on shame and stigma (University and London 1998), siblings of stigmatized children take on a great deal of burden within the family as parents attempt to manage the stigmatized child. This burden may lead to poor coping (Agnew 2006) and problem behaviors that negatively impact social status.

One example of sibling stigma by association from the literature is mental illness. Presenting individuals with vignettes about an individual and his/ her sibling with mental illness, Phelan found that the belief that genes contribute to mental illness led individuals to distance themselves socially from the sibling of the mentally ill individual (Phelan 2005). Corrigan and colleagues (2006) find comparable effects for drug abuse. Specifically, they find that the

families of those with drug dependencies are stigmatized and that families, including siblings, are blamed for relapses and failure to adhere to treatment (Corrigan et al. 2006). These and other studies suggest that a sibling's behavior or characteristics can have social consequences in adolescence as well as other periods of the life course (Cumming and Cumming 1965; Frierson 2012).

Although substance use overall is generally associated with increased popularity in adolescent social networks (Moody et al. 2011), other behaviors may be viewed as socially undesirable. While minor forms of delinquency are generally viewed positively, hostile behavior among peers, for instance, is viewed as less socially acceptable (Allen et al. 2005). Likewise, heavy sibling involvement in delinquency or related behaviors may violate acceptable norms and lead to stigma. Although the stigma by association argument is tentative at best, it suggests that sibling behavior may be predictive of decreases in individual social status. In other words, the behaviors of our close friends and family members may reflect on ourselves to some degree. Given that this argument contradicts that of access points, I refrain from proposing a directional hypothesis at this point.

My analyses in this chapter build on the prior literature in a few key ways. First, I empirically test whether social status of a sibling is predictive of one's own social status. Much of the existing literature has focused on various aspects of the sibling relationship (conflict, warmth, etc.), but not on the actual social standing of one's sibling. My research, instead, homes in on how siblings fit into our peer context. Second, I extend prior descriptive work on siblings' mutual friends by assessing whether the number of such friends conditions sibling effects on social status. Third, I empirically test whether sibling behavior in adolescence has any measurable impact on our own social status. Although existing research has documented stigma

based on some forms of sibling behavior and has identified siblings as point of illicit substance access, it is unclear whether the social consequences of these behaviors/ characteristics extend to siblings. In the next section, I detail the methodology and data I use to test these possibilities.

METHODOLOGY & DATA

This chapter will draw on both the Add Health and PROSPER data. For the PROSPER data, analyses are conducted with the 100 sibling pair subsample where full network data is available for both siblings across waves. Using these data, I generate a measure indicating the number of friends shared by each sibling pair, by wave. I also create a dichotomous version of this variable. Mutual friends are simply those individuals both siblings identify as one of their seven nominated friends. This, however, presents an issue of confounding with outdegree. Following the convention of other authors (Haynie and McHugh 2003), I split the outdegree count into "mutual friends" and "unique friends" for each sibling pair. In total, mutual friends are identified by 20 sibling pairs in Wave One, 30 pairs in Wave Two, 24 pairs in Wave Three, 30 pairs in Wave Four, and 28 pairs in Wave Five.

Recall that many of the siblings in this small subsample are twins; the subsample consists of those siblings who happened to be included in the two PROSPER cohorts which are one year apart. Since respondents were asked to identify only peers in the same school and grade, siblings in different cohorts are not able to name mutual peers. The one exception to this is for those individuals who were held back or jumped a grade and thus moved into the same cohort as a sibling at some point during the study; this is not common in the data. Siblings sharing a cohort, however, are able to nominate the same individuals as friends. Thus, we might expect to see more mutual friends in this small subsample due to the narrow age gap and number of twin pairs.

Although not a representative subsample by any means, it allows for a replication of analyses I also conduct using Add Health data.

In Add Health, the first wave of data includes full social network data across the schools in the sample, as many of these data were collected as part of the in-school sample. In the second wave, however, full social network data is only available for a subset of "saturated schools" for which all students were selected for in-home interviews in the first wave (Harris 2011). As such, measures like indegree, outdegree, reach, and so on are unavailable outside of these saturated schools. Although this sample is less representative than the full set of schools overall, it does allow for an exploratory examination of siblings' impact on social status during adolescence.

A total of 3,702 adolescents across 16 schools were included in the saturated sample in Wave One (Harris 2011). Roughly 75% of these respondents participated in the second wave of data collection. In Wave Two, 2,729 adolescents were asked to nominate up to 5 of their closest female friends and 5 of their closest male friends. Although an additional 12,009 respondents were asked to nominate one friend of each gender, I do not use these individuals in analysis because I cannot accurately calculate measures such as indegree or outdegree with this limitation on number of friendship nominations allowed. Within the Wave Two sibling pairs subsample, 1,002 individuals (501 sibling pairs) were included in "saturated schools" with full network data collected for both siblings in the pair (an additional 145 individuals do not have appropriate sibling data to consider social status as an outcome).

Using the Add Health data, I construct a measure that indicates the number of mutual friends shared by each sibling dyad. As in the PROSPER data, I create count measures of mutual friends and unique friends for each sibling dyad. A total of 74 sibling pairs (~15%) share at least one friend in Wave One and 81 pairs (~16%) share at least one friend in Wave Two. This is

substantially lower than the reported percentage of siblings with mutual peers in the Arizona Sibling Study (>60%) (see Hetherington et al. 1994), although this may reflect the older and wider age range of the Add Health sibling pairs; the Arizona Sibling Study figures are based on siblings ages 10-16. Haynie and McHugh (2003), using Add Health data, note that 36% of siblings share a mutual friend. The lower percentage I observe is partially due to the sample restrictions I imposed on the data in order to allow an assessment of social status as an outcome (saturated schools only, etc.). Haynie and McHugh also exclude cousins, half-siblings, and unrelated sibling pairs from their analyses (Haynie and McHugh 2003), genetic groupings that I include in my own analyses but have a lower likelihood of having mutual friends.

As in other chapters, I measure social status in Add Health using indegree and outdegree. I omit social reach since that social status measure has failed to emerge as a statistically or substantially significant factor in all prior Add Health-based analyses. Predictors will include measures of both self and sibling behavior and social status at prior waves. As in other chapters, I use APIM models to specify the influence of self and sibling on social status as an outcome. Controls for Add Health match those used in prior chapters. Control variables are omitted from the PROSPER APIM models due to the limited sample size. As before, Add Health analyses nest individual within sibling pairs within genetic relatedness types while PROSPER analyses nest observations within individuals within sibling pairs. Further nesting within the PROSPER 100 sibling subsample is not feasible due to sample size concerns.

RESULTS: PROSPER

My first hypothesis in this chapter stated that siblings will display concordance for social status. This statement can be assessed by examining the correlations between self and sibling measures of indegree, outdegree, and reach by wave in the PROSPER data. These correlations

are displayed in the tables below (13 & 14), with statistically significant correlations ($p < 0.05$) indicated by asterisks. Note that measures of mutual and unique friends will be lagged by one wave in all subsequent analyses. As Table 13 shows, siblings are moderately and significantly correlated for indegree, outdegree, and reach, providing support for my first hypothesis. Table 14 displays correlations among mutual peers and various measures of social status for each sibling. Here, correlations are moderately high for outdegree and indegree, but are fairly weak for reach. Recall, though, that my measure of mutual friends is created by examining how many named friends are identified by both siblings in a sibling pair. Since the number of nominated friends is what I call outdegree, the number of mutual friends is necessarily a portion of outdegree. As such, the two measures are highly related, leading me to consider both unique and mutual friends. However, correlations do not indicate whether one sibling's behavior, social status, or shared friends in one wave are actually *predictive* of an individual's social status in a later wave (my second hypothesis). For this, I turn to APIM-based analyses in the PROSPER data.

Table 13: Social Status Correlations among Siblings in PROSPER 100 Sibling Pair Subset

	Outdegree	**Indegree**	**Reach**
Wave 1	0.28*	0.49*	0.31*
Wave 2	0.57*	0.45*	0.68*
Wave 3	0.22	0.60*	0.51*
Wave 4	0.14	0.58*	0.60*
Wave 5	0.35*	0.39*	0.49*
Across All Waves	0.32*	0.52*	0.54*

Table 14: Correlations among Mutual Friends and Social Status by Sibling in PROSPER 100 Sibling Pair Subset

Younger Sibling	**Outdegree**	**Indegree**	**Reach**
Wave 1	0.44*	0.38*	0.24
Wave 2	0.39*	0.25*	0.24*
Wave 3	0.34*	0.37*	0.25*
Wave 4	0.34*	0.05	0.12
Wave 5	0.40*	0.37*	0.21
Across All Waves	0.38*	0.28*	0.22*
Older Sibling			
Wave 1	0.33*	0.63*	0.30*
Wave 2	0.32*	0.27*	0.14
Wave 3	0.36*	0.41*	0.18
Wave 4	0.28*	0.23*	0.19
Wave 5	0.33*	0.44*	0.15
Across All Waves	0.33*	0.38*	0.20*

Results from the APIM models using PROSPER data are presented in Tables 15 through 17 (for indegree, outdegree, and reach respectively). Each table includes models that assess the impact of substance use, delinquency, and prior wave social status on current social status. Further, I also examine the impact of measures of the number of mutual and unique friends reported by sibling dyads. Recall that each of these models is based on the 100 sibling pair subset in PROSPER, although only 75 sibling pairs had sufficient data for these analyses (namely social status data). For ease of interpretation, all continuous predictors are centered. Note that the last two interaction terms in each table refer to the interaction between number of mutual friends reported by a dyad and the social status of one's sibling. In other words, this interaction tests whether the influence of a sibling's social status on one's own social status is conditioned (stronger or weaker) by number of mutual friends. This is a test of my third hypothesis.

In Tables 15 through 17, variance components are presented in the last two rows. Null model Level 1-2 variance components for the indegree, outdegree, and reach outcomes are 0.89 ($p<0.05$), 0.57 ($p<0.05$), and 8.36 ($p<0.05$), respectively. Null model Level 3 variance

components for these outcomes are 6.11 ($p<0.05$), 0.87 ($p<0.05$), and 84.20 ($p<0.05$), respectively. Most of this variation is explained by the models that include measures of both mutual and unique friends, delinquency, and social status. Little is explained by self and sibling behavior alone, however. As one would expect, one's own social status in the prior wave accounts for much of the variation in current wave social status.

As results in Table 15 show, the delinquency or substance use of one's sibling has no statistically significant impact on one's indegree once we account for social status in the prior wave. Further, sibling indegree in the prior wave does not seem to impact an individual's indegree in the current wave. Thus, I fail to find support for my second hypothesis when indegree is considered as a social status outcome. Likewise, I fail to find support for my third hypothesis that the influence of a sibling's social status on our own social status will be greater when sibling share more friends. Instead, results from Table 15 imply that the influence of an older sibling's indegree on a younger sibling's indegree is actually decreased as the number of mutual friends increases. This may indicate that an older sibling's social status influence is more muted when peer groups overlap.

Results for outdegree as an outcome measure (shown in Table 16) differ somewhat from those for indegree. Similar to before, Table 16 shows that the delinquency or substance use of one's sibling has no statistically significant impact on one's outdegree. Also like before, sibling outdegree in the prior wave does not seem to impact an individual's outdegree in the current wave. However, when I consider measures of shared and unique friends separately, it is apparent that number of mutual friends in the prior wave positively impacts current wave outdegree. This is the case even when the number of unique friends of self and sibling in the prior wave are also included in the model. Thus, it appears that shared friends are influential for outdegree, although

the total number of friends nominated by a sibling is not. However, there is no statistically significant interaction between number of mutual friends and the social status of one's sibling. Thus, I fail to find support for my third hypothesis that the influence of a sibling's social status on one's own social status will be strengthened as number of mutual friends increases.

Table 17 displays findings for reach as an outcome measure. Effects are largely non-significant. Neither the delinquency nor substance use of one's sibling has a statistically significant impact on one's outdegree. Also like before, sibling social reach in the prior wave does not seem to impact an individual's reach in the current wave. Unlike the previous two tables, however, neither number of mutual friends nor unique friends considered separately influence one's reach in the current wave. Only one's own social reach in the prior wave is a statistically significant predictor of social reach in the current wave. Further, there is no statistically significant interaction between number of mutual friends and the social status of one's sibling. Thus, I fail to find support for my third hypothesis that the influence of a sibling's social status on one's own social status will be strengthened as number of mutual friends increases. Here, I find only a null effect.

Given these results, it appears that neither sibling behavior nor social status have a statistically significant predictive impact on one's own social status. However, sharing peers with a sibling does affect one's social status in some ways. Results considering reach as an outcome were non-significant. However, these results are tested on a very small and unrepresentative subset of the PROSPER sample, with data for these analyses drawn from only 75 sibling pairs. As a result, it is very difficult to generalize from these findings. For this reason, I conduct these same analyses in the Add Health data. Although the sibling pairs enveloped within the saturated schools of Add Health cannot be considered representative, this

replication allows me to assess whether I see the same or similar results across samples. If I do, I can have more confidence in the results and can generalize to a limited extent. As reach has consistently failed to emerge as a significant predictor or outcome, I omit reach as an outcome in the Add Health analyses. I turn to these analyses in the next section of this chapter.

Table 15: APIM Models for Indegree Outcome in PROSPER 100 Matched Sibling Subset

Indegree: Younger → Younger	0.70** (0.07)	0.70** (0.08)	0.81** (0.08)	--	--	0.78** (0.08)
Older → Older	0.63** (0.07)	0.62** (0.08)	0.67** (0.07)	--	--	0.67** (0.08)
Younger → Older	0.05 (0.07)	0.05 (0.07)	0.05 (0.07)	--	--	0.06 (0.07)
Older → Younger	0.05 (0.08)	0.04 (0.08)	0.09 (0.07)	--	--	0.09 (0.07)
IRT Use: Younger → Younger	--	--	--	0.36 (0.95)	--	--
Older → Older	--	--	--	-1.17** (0.41)	--	--
Younger → Older	--	--	--	-0.66 (0.68)	--	--
Older → Younger	--	--	--	0.01 (0.81)	--	--
IRT Del.: Younger → Younger	--	--	--	--	-1.15 (0.69)+	-0.49 (0.42)
Older → Older	--	--	--	--	-0.40 (0.42)	-0.08 (0.31)
Younger → Older	-	--	--	--	-1.50** (0.57)	-0.08 (0.36)
Older → Younger	--	--	--	--	-0.70 (0.49)	-0.30 (0.26)
Unique Friends: Younger → Younger	--	0.03 (0.14)	-0.08 (0.12)	--	--	-0.07 (0.12)
Older → Older	--	-0.02 (0.09)	-0.04 (0.09)	--	--	-0.04 (0.09)
Younger → Older	--	-0.07 (0.08)	-0.08 (0.08)	--	--	-0.09 (0.08)
Older → Younger	--	0.08 (0.09)	0.07 (0.09)	--	--	0.07 (0.10)
Number of Mutual Friends	--	0.06 (0.15)	0.09 (0.15)	--	--	0.06 (0.14)
Mutual Friends * Younger Sib Indegree	--	--	-0.07 (0.05)	--	--	-0.07 (0.05)
Mutual Friends* Older Sib Indegree	--	--	-0.12** (0.04)	--	--	-0.11** (0.04)
Level 1-2 Variance Component	0.35	0.36	0.59	0.90	0.87	0.03
Level 3 Variance Component	1.15**	1.08**	0.59+	5.99**	5.44**	1.10**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave. Continuous predictors are centered.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance components unstandardized.
e. Estimates based on 75 sibling pairs with complete data for all models

Table 16: APIM Models for Outdegree Outcome in PROSPER 100 Matched Sibling Subset

Outdegree: Younger → Younger	0.55** (0.08)	--	0.52** (0.08)	--	--
Older → Older	0.41** (0.07)	--	0.38** (0.07)	--	--
Younger → Older	0.10 (0.07)	--	0.07 (0.07)	--	--
Older → Younger	-0.04 (0.08)	--	-0.07 (0.08)	--	--
IRT Use: Younger → Younger	--	--	--	-0.73+ (0.42)	--
Older → Older	--	--	--	-0.70** (0.17)	--
Younger → Older	--	--	--	-0.04 (0.41)	--
Older → Younger	--	--	--	0.34 (0.41)	--
IRT Del.: Younger → Younger	--	--	--	--	-0.79* (0.36)
Older → Older	--	--	--	--	-0.21 (0.28)
Younger → Older	--	--	--	--	-0.24 (0.32)
Older → Younger	--	--	--	--	-0.06 (0.27)
Unique Friends: Younger → Younger	--	0.47** (0.08)	--	--	
Older → Older	--	0.40** (0.07)	--	--	
Younger → Older	--	-0.05 (0.06)	--	--	
Older → Younger	--	0.08 (0.06)	--	--	
Number of Mutual Friends	--	0.61** (0.07)	0.15+ (0.08)		
Mutual Friends * Younger Sib Outdegree	--	--	0.05 (0.06)	--	--
Mutual Friends* Older Sib Outdegree	--	--	-0.03 (0.06)	--	--
Level 1-2 Variance Component	0.04	0.12	0.04	0.50	0.54
Level 3 Variance Component	0.36*	0.25*	0.30*	0.84**	0.79**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave. Continuous predictors are centered.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance components unstandardized.
e. Estimates based on 75 sibling pairs with complete data for all models

Table 17: APIM Models for Reach Outcome in PROSPER 100 Matched Sibling Subset

Reach: Younger → Younger	0.60** (0.08)	0.56** (0.10)	0.61** (0.13)	--	--	0.61** (0.14)
Older → Older	0.47** (0.07)	0.49** (0.09)	0.52** (0.09)	--	--	0.53** (0.11)
Younger → Older	0.03 (0.07)	0.01 (0.08)	-0.004 (0.08)	--	--	0.01 (0.08)
Older → Younger	-0.07 (0.06)	-0.05 (0.07)	-0.08 (0.08)	--	--	-0.09 (0.08)
IRT Use: Younger → Younger	--	--	--	-1.53 (3.16)	--	--
Older → Older	--	--	--	-0.56 (2.12)	--	--
Younger → Older	--	--	--	-0.12 (2.89)	--	--
Older → Younger	--	--	--	3.44 (3.09)	--	--
IRT Del.: Younger → Younger	--	--	--	--	-4.06+ (2.42)	-3.93* (1.79)
Older → Older	--	--	--	--	1.23 (2.39)	-0.31 (1.75)
Younger → Older	--	--	--	--	-3.84+ (2.08)	0.05 (1.53)
Older → Younger	--	--	--	--	-0.81 (1.52)	0.76 (1.50)
Unique Friends: Younger → Younger	--	0.44 (0.66)	0.20 (0.77)	--	--	0.23 (0.74)
Older → Older	--	-0.51 (0.40)	-0.58 (0.39)	--	--	-0.69+ (0.39)
Younger → Older	--	-0.54 (0.43)	-0.54 (0.42)	--	--	-0.62 (0.42)
Older → Younger	--	0.31 (0.47)	0.26 (0.46)	--	--	0.27 (0.46)
Number of Mutual Friends	--	0.20 (0.77)	0.12 (0.77)	--	--	-0.09 (0.77)
Mutual Friends * Younger Sib Reach	--	--	-0.06 (0.06)	--	--	-0.06 (0.06)
Mutual Friends* Older Sib Reach	--	--	-0.06 (0.05)	--	--	-0.03 (0.05)
Level 1-2 Variance Component	1.49	1.71	1.26	7.70	10.84	0.59
Level 3 Variance Component	34.94**	31.89**	32.21**	85.12**	77.63**	31.59**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave. Continuous predictors are centered.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance components unstandardized.
e. Estimates based on 75 sibling pairs with complete data for all models

RESULTS: ADD HEALTH

As in the PROSPER data, I first determine whether siblings will display concordance for social status. This can be assessed by examining the correlations between self and sibling measures of indegree and outdegree for the first two waves of Add Health data. These correlations are displayed in the table below, with statistically significant correlations ($p < 0.05$) indicated by asterisks. Recall that these correlations and subsequent analyses are limited to sibling pairs in the saturated schools of the Add Health sample, as these are individuals for whom social status data will be available for both siblings across the two waves. As Table 18 shows, self and sibling social status are moderately and significantly correlated for indegree and outdegree, providing further support for my hypothesis. Correlations between number of mutual peers and various measures of social status in Table 19 indicate that the number of mutual friends is also positively associated with social status, although number of mutual friends is part of outdegree. However, correlations do not indicate whether one sibling's behavior or social status in one wave are actually *predictive* of an individual's social status in a later wave. For this, I turn to APIM-based analyses in the Add Health data.

Table 18: Social Status Correlations among Siblings in Add Health

	Outdegree	**Indegree**
Wave 1	0.20*	0.37*
Wave 2	0.40*	0.27*

Table 19: Correlations among Mutual Friends and Social Status by Sibling in Add Health

Younger Sibling	**Outdegree**	**Indegree**
Wave 1	0.19*	0.20*
Wave 2	0.28*	0.18*
Older Sibling		
Wave 1	0.18*	0.22*
Wave 2	0.38*	0.24*

Results from the APIM models using Add Health data are presented in Tables 20 and 21 for indegree and outdegree, respectively. Each table includes models that assess the impact of substance use, delinquency, and prior wave social status on current social status. Further, I also add in measures of the number of unique and mutual friends reported by sibling dyads. Recall that each of these models is based on 501 sibling pairs for whom full social status data is available; specifically, these are sibling pairs drawn from saturated schools within the Add Health design framework. Although not presented in tables, all models include controls for each sibling's gender, race, and age. Continuous predictors are centered for ease of interaction interpretation. Across models, individuals are nested within sibling pairs within genetic relatedness types, just as in other chapters.

Variance components are presented in the last two rows of each table to assist in interpretation. Null model Level 1-2 variance components for the indegree and outdegree outcomes are 1.31 ($p<0.05$) and 1.54 ($p<0.05$), respectively. Null model Level 3 variance components for these outcomes are 0.60 ($p<0.05$) and 0.49 ($p<0.05$) respectively. As these values demonstrate, most of the variance that needs to be explained is at the sibling dyad level rather than between genetic relatedness types. As shown in Table 20, models containing indegree terms reduced Level 3 variance components to zero, leading me to remove this layer of nesting from these particular models. This may indicate some genetic basis for social status, at least when measured by indegree. Across Tables 20 and 21, behavioral terms explain little of the variance at either level. Overall, the models shown in Tables 20 and 21 explain little variance compared to those from prior chapters. This suggests that other factors may be at work that I have not included in my models (see Conclusion chapter for a discussion of these).

As results in Table 20 show, neither sibling behavior nor sibling indegree in wave one have a statistically significant impact on indegree in the current wave. As would be expected, one's own indegree in the prior wave is a consistently statistically significant, positive predictor. Interestingly, in models that include counts of both unique and mutual friends, unique peers do not seem to have a statistically significant impact over that of mutual friends. Indeed, a positive interaction between number of mutual friends and the indegree of the younger sibling suggests that the influence of the younger sibling's indegree increases as the number of mutual friends increases. This may mean that the younger sibling's influence acts through mutual friends. Although this finding supports my third hypothesis, social learning theories generally suggest that we would observe this effect for older siblings, not for younger siblings. Another interesting finding to note in Table 20 is that there appears to be significant variation by type of genetic relatedness in models that focus on substance use and delinquency. However, no main effects in these models, besides the controls, are statistically significant. I consider genetic variation in a later section of this chapter.

Results when outdegree is considered as an outcome, displayed in Table 21, are similar. Neither the delinquency nor substance use of one's sibling has a statistically significant impact on one's outdegree. However, sibling outdegree in the prior wave does not seem to positively and significantly impact an individual's outdegree in the current wave. When I consider measures of shared and unique friends separately, it is apparent that number of mutual friends in the prior wave as well as the number of unique friends of one's sibling positively impact current wave outdegree. Further, there is a positive interaction between number of mutual friends and older sibling outdegree, which suggests that the influence of an older sibling's outdegree is

magnified as number of mutual friends increases. This finding provides support for my third hypothesis.

In sum, there is no evidence that sibling delinquency or substance use have a statistically significant impact on one's own social status. Sibling social status influence for one's own social status was only statistically significant for outdegree. However, there is evidence across outcomes that having mutual friends is influential, even when I account for number of unique friends held by each sibling. Positive interactions between number of mutual friends and the social status of one's sibling indicate that the influence of social status is greater when siblings hold more friends in common. Thus, I find partial support for my second hypothesis and a fair bit of support for my third hypothesis. I now turn to the question of genetic variation, as models that focus on sibling behavior indicated significant variation by genetic relatedness type.

Table 20: APIM Models for Indegree Outcome in Add Health

Indegree: Younger → Younger	0.38** (0.04)	0.36** (0.04)	0.37** (0.04)	--	--
Older → Older	0.28** (0.04)	0.26** (0.04)	0.25** (0.04)	--	--
Younger → Older	0.04 (0.04)	0.03 (0.04)	0.03 (0.04)	--	--
Older → Younger	0.04 (0.04)	0.02 (0.04)	0.02 (0.04)	--	--
IRT Use: Younger → Younger	--	--	--	0.04 (0.12)	--
Older → Older	--	--	--	-0.09 (0.11)	--
Younger → Older	--	--	--	0.04 (0.12)	--
Older → Younger	--	--	--	0.17 (0.11)	--
IRT Del.: Younger → Younger	--	--	--	--	-0.03 (0.12)
Older → Older	--	--	--	--	-0.05 (0.12)
Younger → Older	-	--	--	--	0.01 (0.12)
Older → Younger	--	--	--	--	-0.02 (0.12)
Unique Friends: Younger → Younger	--	0.04 (0.05)	0.03 (0.05)	--	--
Older → Older	--	0.04 (0.05)	0.06 (0.05)	--	--
Younger → Older	--	-0.04 (0.05)	-0.02 (0.05)	--	--
Older → Younger	--	0.05 (0.05)	0.04 (0.05)	--	--
Number of Mutual Friends	--	0.46** (0.16)	0.26 (0.17)	--	--
Mutual Friends * Younger Sib Indegree	--	--	0.19** (0.05)	--	--
Mutual Friends* Older Sib Indegree	--	--	0.02 (0.07)	--	--
Level 1-2 Variance Component	0.89**	0.85**	0.87**	1.18**	1.17**
Level 3 Variance Component	--	--	--	0.59**	0.58**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave. Continuous predictors are centered.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance components unstandardized.
e. Estimates based on 501 sibling pairs with complete data for all models

Table 21: APIM Models for Outdegree Outcome in Add Health

Outdegree: Younger → Younger	0.20** (0.05)	--	0.21** (0.05)	--	--
Older → Older	0.19** (0.05)	--	0.19** (0.05)	--	--
Younger → Older	0.10+ (0.05)	--	0.11* (0.05)	--	--
Older → Younger	0.11* (0.05)	--	0.11* (0.05)	--	--
IRT Use: Younger → Younger	--	--	--	-0.07 (0.13)	--
Older → Older	--	--	--	0.07 (0.12)	--
Younger → Older	--	--	--	-0.15 (0.13)	--
Older → Younger	--	--	--	0.05 (0.12)	--
IRT Del.: Younger → Younger	--	--	--	--	-0.08 (0.13)
Older → Older	--	--	--	--	0.05 (0.13)
Younger → Older	-	--	--	--	-0.19 (0.13)
Older → Younger	--	--	--	--	-0.08 (0.13)
Unique Friends: Younger → Younger	--	0.21** (0.05)	--	--	--
Older → Older	--	0.19** (0.05)	--	--	--
Younger → Older	--	0.09+ (0.05)	--	--	--
Older → Younger	--	0.12* (0.05)	--	--	--
Number of Mutual Friends	--	0.63** (0.20)	0.28 (0.19)	--	--
Mutual Friends * Younger Sib Outdegree	--	--	0.14 (0.12)	--	--
Mutual Friends* Older Sib Outdegree	--	--	0.14* (0.08	--	--
Level 1-2 Variance Component	1.23**	1.21**	1.21**	1.34**	1.33**
Level 3 Variance Component	0.24	0.25	0.28	0.37*	0.36*

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance components unstandardized.
e. Estimates based on 501 sibling pairs with complete data for all models

GENETIC VARIATION

Unlike analyses in prior chapters, variance components in Tables 20 and 21 indicate that there may be some significant variation by type of genetic relatedness, at least for models that focus on the influence of sibling behavior on social status. Note though that all main effects in these models failed to achieve statistical significance. Ideally, I would want to assess whether effects are stronger when siblings are more closely related (twins versus half-siblings, for instance). Unfortunately, my constrained Add Health sample required for analysis of social status as an outcome (501 sibling pairs) prevents me from being able to fully address this question. Recall that I limited my analytic sample to siblings in saturated schools as these would have full Wave Two social network data. Due to the nature of sample selection, most of the sibling pairs in this constrained sample are full siblings (333 sibling pairs), while the rest are fairly evenly split among cousins (38 pairs), DZ twins (20 pairs), half-siblings (38 pairs), MZ twins (16 pairs), and unrelated siblings (66 pairs). Only one or two pairs in each of the cousin, half-sibling, or unrelated sibling pair categories even shared a mutual friend. The sample sizes for each of the twins groups are simply too small to allow for the complex, multilevel models that I use in this dissertation. However, estimates for full siblings considered as a separate group are shown in Table 22 as a comparison to those shown previously in this chapter.

As before, variance components are presented in the last row of Table 22. Since I am examining models within one type of genetic relatedness there is no Level 3 variance component. Null model Level 1-2 variance components for indegree and outdegree in this sample are 1.27 ($p<0.05$) and 1.64 ($p<0.05$), respectively. As the values in Table 22 indicate, much of this variance can be attributed to the social status predictors themselves, rather than to

any of the behavioral constructs. This fits with what one might expect; social status in a prior wave is a better predictor of current wave social status than other measures.

As seen in Table 22, results for indegree are largely the same as those observed in Table 20. Neither sibling behavior nor sibling indegree in wave one have a statistically significant impact on indegree in the current wave. As would be expected, one's own indegree in the prior wave is a consistent statistically significant, positive predictor. Among full siblings (Table 22), there are no statistically significant main effects for number of unique or mutual friends. In Table 20, in contrast, there was a significant main effect of number of mutual friends. However, in both tables, a positive interaction between number of mutual friends and the indegree of the younger sibling suggests that the influence of the younger sibling's indegree increases as the number of mutual friends increases. Overall, there appear to be few differences between results for the full siblings and those for siblings of all genetic relatedness types. One key exception is that among full siblings, older sibling substance use has a marginally significant, positive impact on indegree. This effect holds even when number of mutual and unique peers are accounted for by the model.

Effects for outdegree differ markedly from those observed for siblings of all genetic relatedness types. In Table 22, there are no statistically significant main effects or interaction effects. In Table 21, in contrast, number of mutual friends in the prior wave as well as the number of unique friends of one's sibling positively impact current wave outdegree. Further, there is a positive interaction between number of mutual friends and older sibling outdegree, which suggests that the influence of an older sibling's outdegree is magnified as number of mutual friends increases. That I do not observe these same effects when examining full siblings suggests that these effects may be driven by siblings with other degrees of genetic relatedness.

Unfortunately, small sample sizes and limited variation in measures for these other groups precludes me from taking this examination further.

Table 22: APIM Models for Outdegree and Indegree Outcomes in Add Health—Full Siblings (333 pairs)

	Indegree				Outdegree		
Status: Younger → Younger	0.40** (0.04)	--	0.40** (0.04)	--	0.89 (1.53)	--	--
Older → Older	0.24** (0.05)	--	0.23** (0.05)	--	-0.59 (1.02)	--	--
Younger → Older	0.003 (0.04)	--	0.003 (0.04)	--	1.08 (1.63)	--	--
Older → Younger	0.04 (0.05)	--	0.04 (0.05)	--	-0.78 (1.17)	--	--
IRT Use: Younger → Younger	--	-0.08 (0.15)	0.11 (0.18)	--	--	-0.20 (0.17)	--
Older → Older	--	-0.05 (0.14)	-0.06 (0.17)	--	--	-0.001 (0.15)	--
Younger → Older	--	0.03 (0.15)	0.05 (0.18)	--	--	-0.16 (0.16)	--
Older → Younger	--	0.34* (0.14)	0.30+ (0.16)	--	--	0.04 (0.15)	--
IRT Del.: Younger → Younger	--	--	--	0.02 (0.15)	--	--	0.03 (0.16)
Older → Older	--	--	--	-0.06 (0.16)	--	--	-0.20 (0.17)
Younger → Older	--	--	--	0.16 (0.15)	--	--	-0.03 (0.16)
Older → Younger	--	--	--	0.11 (0.16)	--	--	-0.05 (0.17)
Unique Friends: Younger → Younger	0.07 (0.05)	--	0.06 (0.05)	--	-0.63 (1.54)	--	--
Older → Older	0.10+ (0.06)	--	0.10+ (0.06)	--	0.81 (1.03)	--	--
Younger → Older	-0.03 (0.05)	--	-0.03 (0.05)	--	-0.95 (1.65)	--	--
Older → Younger	0.02 (0.06)	--	0.02 (0.06)	--	0.92 (1.18)	--	--
Number of Mutual Friends	0.11 (0.20)	--	0.05 (0.20)	--	0.32 (1.51)	--	--
Mutual Friends * Younger Sib Status	0.22** (0.06)	--	0.23** (0.06)	--	0.06 (0.15)	--	--
Mutual Friends* Older Sib Status	-0.05 (0.07)	--	-0.03 (0.07)	--	0.18 (0.12)	--	--
Level 1-2 Variance Component	0.74**	1.12**	0.76**	1.11**	1.25**	1.38**	1.39**

a. Arrows indicate direction of influence from one sibling to another or to him/herself
b. Social status and behavioral predictors are lagged by one wave. Continuous predictors are centered.
c. Asterisks denote statistical significance (**: p< 0.01, *: p< 0.05, +: p<0.10)
d. Standard errors are displayed in parentheses. Variance components unstandardized.

CONCLUSION

This chapter began with an exploratory aim: to assess the influence of siblings on one's own social status. Unlike prior chapters, here I considered social status as an outcome rather than purely as a predictor or moderator. Given prior literature, I hypothesized that siblings would be similar on measures of social status, that siblings would positively influence the social status of one another, and that the influence of siblings for social status would be conditioned by the number of mutual peers. These hypotheses were tested using the PROSPER 100 matched pair subset and a subset of the Add Health data for which friendship data was collected for both siblings in Wave Two. The results provide partial support for these hypotheses. As in other chapters of this dissertation, however, recall that any conclusions drawn from these two samples should be regarded as exploratory as neither sample is representative of a clearly defined population. Both data subsets used in this chapter were used simply due to data availability. I reiterate these and other limitations in the concluding chapter of this dissertation.

This chapter has established that sibling social status measures are moderately and significantly correlated, suggesting the sibling concordance for social status that I posited in my first hypothesis. However, further analyses found very limited evidence that a sibling's social status was actually predictive of one's own social status, as I suggested in my second hypothesis. Although I observed in Add Health that sibling outdegree was positively predictive of one's own outdegree, this effect was not apparent in the subset of full sibling pairs. As correlations reveal, sibling social status concordance is already present at the first wave of data collection in both datasets. From this, it is apparent that some other factor besides sibling influence may explain why siblings hold similar social status. As I discussed earlier in this chapter, the existing

research has suggested that choice of peers and social status have some genetic origins. In other words, similar environments at home and similar genes jointly contribute to similarities in the sibling peer environments. A fair bit of variation at the genetic level still needs explanation. This may be one explanation for the existing concordance at Wave 1 and its relative stability thereafter. Available data and sample size prohibited me from fully investigating this possibility.

In my analyses, I have also not considered whether something besides sibling delinquent behavior or sibling social status could serve as a vehicle for sibling social status influence. Future research may benefit from an examination of one possibility in particular: the dynamics of the sibling relationship. As Dunn and McGuire write in their review of the topic, existing research has identified few, if any, consistent or clear links between sibling relationship quality and peer relations (Brody 1998; Dunn and McGuire 1992). Abramovitch and colleagues (1986), for instance, find no consistent link between sibling interactions and peer interactions among 5-year olds (Abramovitch et al. 1986). Berndt and Bulleit (1985), likewise, found no consistent or statistically significant links between sibling interactions in the home and peer interactions at school among preschoolers (Berndt and Bulleit 1985). Kitzmann and colleagues (2002) found that only children were less popular and less accepted by peers than those with siblings, but the nature and predictors of this link remained unknown (Kitzmann et al. 2002). These studies, unfortunately, are not very informative for a study of adolescents given their focus on younger age groups.

Some researchers, in contrast to those above, have identified positive associations between sibling relationship characteristics and peer relationship characteristics. These positive associations may result in sibling similarity for social status. McCoy and colleagues (1994), for instance, found a positive association between sibling relationship warmth and the quality of an

individual's relationship with a best friend among youth ages 4 to 11 years (McCoy et al. 1994). Sibling relationship conflict, in contrast, was negatively associated with the quality of an individual's relationship with a best friend (McCoy et al. 1994). Although this study addressed relationship quality rather than social status directly, it might be expected that those who are able to establish higher quality and more positive relationships with peers might have social skills that result in greater popularity or social status. If both siblings translate positive social skills into the peer environment, they would be expected to develop similar social standing with peers.

Similarly, Low and colleagues (2012) have suggested that individuals with negative sibling relationships (i.e. characterized by aggression, competition, etc.) may seek out similar relationships among peers, leading to association with delinquent peer groups (Low et al. 2012). Existing research has determined that these groups may have lower social status (Kreager et al. 2011). Thus, negative sibling relationships may lead siblings to develop peer relations that result in both siblings having lower social status (i.e. sibling similarity for social status). Future research is needed to assess the exact role of sibling relationship quality, warmth, conflict, and other measures such as these for adolescent social status as an outcome. These factors are omitted from this dissertation in order to maintain a more narrow research focus.

In this chapter, I did find some support for my third hypothesis that the influence of one sibling's social status on another's will be moderated by number of mutual peers. However, the direction of this effect varied too widely to make any firm conclusions about the social process at work. In PROSPER this interaction tended to be negative while it was positive in Add Health. Generally, the interaction tended to be negative with regards to younger siblings and non-significant for older siblings. This suggests that younger siblings seem to have less social status influence when siblings have more friends in common. This is consistent with the argument that

siblings may expose us to a wider peer network that influences our social status. An overlapping peer network would be expected to decrease the effect of having more friends.

Chapter 6: CONCLUSION

At the outset of this dissertation, I outlined three key questions that I hoped to address in the course of my research. First, does sibling social status serve as a moderator of sibling influence for delinquency and substance use? Here, I investigated whether adolescents are more likely to emulate the problem behaviors of a sibling with high social status (i.e. more "popular") than one with low social status. Second, how do known moderators such as age gap, sibling dyad gender composition, and number of siblings affect this relationship? Specifically, I examined whether sibling social status moderation is more pronounced for siblings of the same gender or those close in age. I also analyzed whether moderating effects are diminished in larger families and whether the certain siblings (those with the highest social status) are more influential than others. Lastly, does sibling behavior and social status significantly impact one's own social status in adolescence? Each empirical chapter in this dissertation addressed these questions in turn.

In this concluding chapter, I review the key findings from this dissertation with a focus on whether analyses provided support for my hypotheses. Second, I discuss some of the implications of this research, both theoretical and practical. Third, I note some of the limitations of my data and analytical strategy. Although outlined elsewhere, these limitations identify areas where future research could improve upon my work. In this chapter, I detail some of the questions that remain unanswered by this dissertation and how future research might extend our understanding of the link between spheres of sibling and peer influence.

REVIEW OF KEY FINDINGS

In my first empirical chapter (Chapter Three), I set out to establish the basic premise of this dissertation: whether sibling social status indeed moderates sibling influence for delinquency and substance use. Drawing on Social Learning theories, I developed two core hypotheses:

> *Hypothesis 1: Adolescents whose siblings report greater substance use or delinquency will report more involvement in these behaviors as well.*
>
> *Hypothesis 2: Sibling concordance for delinquency and substance use will be greater for adolescents whose siblings have high social status.*

As in prior literature on the topic, my analyses in both the PROSPER and Add Health datasets found strong positive evidence for sibling influence on substance use and delinquency, supporting my first hypothesis. Namely, self and sibling substance use and delinquency in a prior wave were strong, positive and statistically significant predictors of these behaviors in the current wave. These effects were found regardless of type of substance considered and regardless of whether the problem behavior outcome was modeled as continuous or dichotomous.

Support for my second hypothesis in Chapter Three was more mixed. In the PROSPER data, results demonstrate that younger siblings are more influential when they have higher social status while older siblings are actually less influential when they have higher social status. In the Add Health data, older siblings are more influential when they have higher social status while no interaction between social status and behavior was apparent for younger siblings. However, the outcomes for which I identify statistically significant interaction effects differ between the two datasets. This may simply be a result of the PROSPER subset's limited size and the differing demographic characteristics of the two samples. Recall that the PROSPER sibling pairs tend to be younger and are more likely to be of white race. In general, however, most interactions

between sibling behavior and social status are positive, providing some support for my hypothesis that sibling influence will be more pronounced when the "influencing" sibling has greater social status in the peer network. Variation by genetic relatedness (investigated in the Add Health data) was either negligible or non-existent across all models.

In my second empirical chapter (Chapter Four), I extended these analyses by examining how moderators identified by the literature might affect sibling social status moderation. In Chapter Four, I focused on sibling dyad gender composition, sibling age gap, and number of siblings. Based on prior literature, I proposed the following hypothesis:

> *Hypothesis: Sibling concordance for substance use and delinquency will be greater for siblings close in age and/or of the same sex than for those with a larger age gap or of the opposite sex.*

I did not propose a specific hypothesis regarding number of siblings since existing literature was inconsistent in theoretical approach and findings related to this moderator. Instead, I investigated the influence of family size and whether it is the sibling with the highest social status in a family that might be the most influential. All analyses were limited to the Add Health data, as the PROSPER subset was too small to maintain adequate statistical power.

Analyses in Chapter Four partially demonstrate that sibling social status moderation is more pronounced in same-sex sibling dyads (marginally significant effects), but specifically in those where the "influencing" sibling participated in or was above average in involvement in the problem behavior of interest in the prior wave. To explain in layman's terms, popular siblings are more influential for delinquency and substance use in same sex dyads than in opposite-sex dyads. This finding is consistent with prior literature which suggests greater sibling influence in same-sex pairs and supports my core hypothesis from this chapter. Findings for age gap moderation, however, are limited (results for two different outcomes vary in direction), although

they suggest that popular siblings are more influential in sibling pairs with a lower age gap. This is consistent with my hypothesis and with Social Learning theories. Further analyses in Chapter Four indicate that age gap and gender composition make contributions to understanding social status moderation together was well as separately. In other words, there is variation by gender composition within sibling pairs close and far apart in age; there is also variation within same and opposite-sex pairs based on age gap. Although patterns are as would be expected after examining these variables separately, findings indicate that variables such as these help to explain why sibling influence might be more pronounced among certain types of sibling pairs than others (pairs that are both same-sex and close in age, for example). My analyses, however, failed to find support for the argument that number of siblings or their relative social status might be influential for sibling social status moderation.

In my final empirical chapter (Chapter Five), I conducted exploratory analyses to assess whether sibling behavior and social status affect one's own social status. Given data constraints, these analyses were limited to the Add Health sibling pairs captured within saturated schools (schools for which everyone submitted friendship nominations) and sibling pairs within the PROSPER 100 sibling subset (where full network data is available for the pair). Prior literature led me to pose the following hypotheses:

> *Hypothesis 1: Siblings will display concordance for social status.*
>
> *Hypothesis 2: The social status of one sibling will positively influence that of other siblings.*
>
> *Hypothesis 3: Siblings will have more influence on one another's social status when they share mutual friends (or share more of these friends) than when they do not.*

Descriptive analyses within both datasets established substantial support for the first hypothesis, namely that social status among siblings tends to be moderately to highly correlated.

I find only partial support, however, for my second and third hypotheses. First, even when analyses are conducted separately for full siblings, there is little or no evidence that the behavior or social status of a sibling is a statistically significant predictor of one's own social status. As I discussed previously, this may be because sibling social status concordance and stability seem to predate the first wave of data collection, perhaps the result of genetic or shared environment. It may also indicate that some other factor I did not consider (sibling relationship dynamics, for instance) is the means through which siblings influence social status. Regardless, however, the number of mutual peers held by a sibling dyad did significantly condition the main effects of sibling social status. Although this direction of this effect, unlike I hypothesized, was generally negative. This would suggest that siblings have less influence when they share more friends in common, contradicting my argument that sibling influence on social status might be due to exposure to a wider peer network (i.e. shared friends).

To summarize further, I corroborate existing research evidence that, during adolescence, siblings have substantial and significant influence on our behavior. This is the case even when we take an adolescent's own past behavior into account. I also find support for my core argument that siblings with higher social status are more influential. As in prior literature, I find at least partial support for the argument that sibling influence (here moderated by social status) is more pronounced for same-sex sibling pairs and siblings close in age. Lastly, I identify mutual peers as a significant moderator of sibling influence for social status. The implications of these findings are discussed in the next section.

IMPLICATIONS

The results detailed in this dissertation have a number of implications, both for intervention purposes and for our theoretical understanding of family processes and families in

general. I begin by discussing the former. Each year, a great deal of state, Federal, and private funding is earmarked for programs that aim to prevent adolescent problem behaviors including substance use and delinquency, the same outcomes I considered in this dissertation. These programs generally either focus on the peer/ school environment (*DARE*, for example), or exclusively on the family environment (family relations, resolving family conflict, parenting skills, etc.). Just as my dissertation links the sibling and peer environments of adolescents, one implication of my research is that adolescent interventions can and should incorporate aspects of both the peer and family spheres of influence. This is especially the case when we consider siblings as critical links between the family and peer environments.

Currently, there exist a number of intervention programs for adolescents focusing on the sibling dyad and improving relations among siblings (Feinberg et al. 2012; Kramer and Radey 1997). These programs aim to prevent problem behaviors and improve the quality of sibling relationships by targeting the sibling dyad for intervention. *More Fun with Sisters and Brothers*, for instance, is a program geared towards siblings ages 4 to 8 and aims to reduce sibling conflict by teaching children better emotion regulation (Kennedy and Kramer 2008). *Siblings are Special*, similarly, is an after-school program for siblings in the 2nd to 5th grade age range (Feinberg et al. 2013). The program incorporates both siblings and parents and teaches children key social skills that help to improve sibling relations, and possibly peer relations as well (Feinberg et al. 2013). A number of other, similar programs are in existence (Feinberg et al. 2012).

Just as there are family-focused intervention programs, there are also many school-based and peer-focused intervention programs geared towards preventing problem behaviors such as substance use and delinquency. *Life Skills Training*, for example, is a school-based program

often targeted to the middle school age range (Botvin, Griffin, and Nichols 2006). This program teaches students skills that include effective communication, asserting rights and wishes with peers, and problem-solving, among others (Botvin et al. 2006). Many other programs such as this one teach children and adolescents social skills, drug-resistance skills, and other social tools that may prevent problem behavior.

The social process I identify in this dissertation, however, shows that the worlds of family and peers really are linked, as least through siblings. Results of this dissertation confirm that sibling influence varies based on a sibling's social standing with peers. These findings imply that adolescents are more likely to copy the behavior of popular siblings than unpopular siblings. As a result, siblings may be a key source of influence in an adolescent's social context. The intervention-based programs I note above may be improved by recognizing and incorporating this sibling-peers link into existing curricula.

One way to do this within peer-based interventions would be to highlight that peer pressure (the pressure to conform) can happen even within families. Just because our sibling engages in certain behaviors does not mean that we should do so. Peer-based intervention programs can also be improved by emphasizing my finding that sibling social status and behavior do not seem to predict our own social status. Thus, our siblings are not a path to popularity. Family-focused interventions might be improved by acknowledging that sibling relationships extend into schools and other contexts; sibling relationships may to some degree be a training ground for social skills that may later be used in the peer context. As such, our interventions in the family may affect how siblings choose their peers. Drawing in some of the peer-related intervention elements may thus be helpful for some families.

This dissertation has also highlighted the continued importance of siblings for adolescents, even in light of changing family structures. During the last 50 years, research has documented a number of major trends in marriage, divorce, cohabitation, and fertility that constitute the "second demographic transition." Today, Americans are more likely to delay marriage, there is more selection on education and socioeconomic status for marriage, more cohabitation before marriage, and individuals with higher education are more likely to marry overall (Cherlin 2010; Schoen, Landale, and Daniels 2007). However, roughly half of all marriages can be expected to end in divorce (Cherlin 2010; Lesthaeghe and Neidert 2006). During the last few decades, there has been an increase in cohabitation, partners "living apart together," multi-partnered fertility, non-marital births, and children with another parent in the home (Cherlin 2010). Americans today are more likely to delay childbearing than in the past. These changes are what some term the "second demographic transition" in the United States, a set of trends that emerged in the 1960's and 1970's (Cherlin 2010; Lesthaeghe and Neidert 2006; Mclanahan 2004). That this dissertation has identified siblings and their relations with peers as a key source of influence demonstrates the continued importance of the family for adolescent problem behaviors, even with so many changes in U.S. families overall. Siblings, in particular, remain a strong source of familial influence.

LIMITATIONS

Although certain limitations of my research have already been noted throughout this dissertation, I summarize a few key concerns here. First, neither the PROSPER subsamples nor the Add Health sibling pairs sample are fully representative of sibling dyads nationwide. The PROSPER sample, if you recall, is drawn from primarily rural areas in Iowa and Pennsylvania, with a focus on schools were a significant portion of the student body receive free or reduced-

price school lunches. As such, the subsamples are drawn from a population that has a greater proportion of rural, white and perhaps impoverished individuals than we might observe in a nationally representative sample. In analyses, I further limit the representativeness of the sample by focusing on one-sibling families. Although the core Add Health sample (excluding genetic oversampling) is representative of 7th through 12 grades across the U.S. at that time, oversamples and further sample restrictions required for analyses result in a sample that is no longer nationally representative. Add Health, for example, oversamples middle-class blacks as well as siblings with varying degrees of genetic relatedness. Further, when I discussed social status as an outcome, I was limited to a small subset of schools where all students and siblings were asked for friendship nominations. The resulting sample was certainly not nationally representative. Although this limitation was my primary rationale for conducting similar analyses in both datasets, results (particularly differences between the two datasets) must be interpreted with this caution in mind.

Second, I rely on secondary data for my research. As a result, I am dependent on pre-constructed measures that may or may not have been designed with research questions such as mine in mind. In particular, the PROSPER in-home sample lacks detailed and equivalent questionnaires for siblings. Analyses, instead, drew on a selective and small subset of sibling pairs who happened to be captured within the two cohorts (and thus had equivalent, detailed measures across siblings). Add Health largely corrected this limitation as all siblings completed the same questionnaires. Add Health, however, lacks friendship nominations in the second wave for the full sample of sibling pairs, restricting my analysis of social status as an outcome. Further, both datasets are plagued by missing data on a number of key measures. Although

multiple imputation helped to correct for this concern, it did not fully eliminate loss of information for cases with insufficient data for imputation.

Lastly, although the APIM models I use throughout the dissertation are excellent tools for analyzing the effects of one sibling on him/herself and on one another, they do not address twin pairs well. Since APIM models require dyad members to be clearly identified (by age or gender for example), twins are very difficult to assign to coherent groups. In this dissertation, I randomly assigned twins to the "younger" or "older" sibling category. Constraining effects to be the same for older and younger twin siblings helps, but specialized models designed for twins (Carlin et al. 2005) may be better suited for this purpose for researchers with a key interest in twins.

DIRECTIONS FOR FUTURE RESEARCH

Although this dissertation has forwarded understanding of how sibling and peer influence overlap, a number of questions remain unanswered that may prove fruitful grounds for future research. First, I only briefly examined the issue of genetics. I did this by nesting sibling pairs within genetic relatedness types so that I could assess variation in social process between twins, full siblings, half-siblings, etc. While I did not identify substantial genetic variation in my first two empirical chapters, there did appear to be some variation by genetics when social status was considered as an outcome. This exploratory finding suggests that future work might benefit from more detailed analysis, particularly by better addressing twins (see Limitations discussion above). Further, existing research has determined that some behaviors (like substance use) are more heritable than others (McGue, Elkins, and Iacono 2000; Merikangas KR et al. 1998). As such, expanding sibling research to include certain parental variables (like parent substance use) may help researchers trace the transmission of problem behaviors from parent to sibling to self.

Relatedly, I also did not examine parent-child relations in this dissertation, choosing instead to narrow my focus to the sibling dyad. However, past research has determined that although siblings usually live together and share many of the same environmental characteristics (poverty, for example), each sibling is also exposed to a unique environment (Daniels and Plomin 1985). Part of this non-shared environment is the distinct relationship that each child has with his/ her parent(s). Thus, although siblings share parental figures, their relationships with these individuals may differ. Parent-child relationship characteristics such as warmth, communication, conflict, time spent together, etc. may also have some impact on each sibling and on the way siblings interact with one another. Some researchers, for instance, have argued that siblings compete with one another for parental attention and love, leading some siblings to "deidentify" or attempt to distinguish their behavior from that of other siblings (Schachter et al. 1976; S. D. Whiteman et al. 2007). Although not a perspective I considered in this dissertation, the addition of parent-child dynamics to analyses may help to examine the possibility.

Lastly, I did not examine sibling relationship characteristics such as conflict, time with the sibling, etc. It is possible that sibling social status moderation is more pronounced when siblings have a warm, close relationship than when they do not. Further, time spent with a sibling may dictate the degree of social and observational learning that occurs. Future research may benefit from considering this additional moderator as it relates to the link between sibling influence and sibling social status. Sibling relationship measures may also help to explain sibling similarity for social status, a possibility I did not examine in this dissertation.

In sum, the questions that remain unanswered by this dissertation are generally those that incorporate factors beyond the sibling-peers link. Namely, parent-child relations, genetics, and sibling relationship characteristics may all condition or clarify my findings in this dissertation. It

is my goal that the research outlined in this dissertation will serve as a starting point for further work linking the worlds of siblings and peers. Even as family structures and relations change with time, siblings continue to be a strong and lasting influence on our behavior. Likewise, particularly during adolescence, our peers shape our behavior and guide our choices. To further our comprehension of behavioral change and initiation during adolescence, we really need to understand how both sources of influence combine to influence our behavior. My hope is that this dissertation serves as only one study that forms a bridge between two strong lines of existing research.

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EDUCATION

2014	Ph.D., Crime, Law & Justice, The Pennsylvania State University Committee: D. Wayne Osgood (chair), Alan Booth, Mark Feinberg, Derek Kreager, Julie Horney Dissertation Title: *Sibling Influence: The Moderating Effects of Sibling Social Status* Quantitative Methods Certificate
2011	M.A., Crime, Law & Justice, The Pennsylvania State University (GPA: 3.97) Committee: David Johnson (chair), Paul Amato, and Jeremy Staff Thesis: *Family Structure & Perceived Victimization Risk: An International Comparison*
2009	M.S., Mathematics, Virginia Polytechnic Institute & State University (GPA: 3.81)
2007	B.A., Mathematics & Sociology, Summa Cum Laude, Lynchburg College (GPA: 3.98)

TEACHING EXPERIENCE

2013	Web Design for SOC406: Sociology of Deviance, Penn State University
2013	CRIM100: Introduction to Criminal Justice, Penn State University
2012	SOC406: Sociology of Deviance, Penn State University
2011	CRIM100: Introduction to Criminal Justice, Penn State University
2010 & 2014	Teaching Assistant for SOC400W: Senior Research Seminar, Penn State University
2010	SOC/CRIM012: Introduction to Criminology, Penn State University
2009-10	Teaching Assistant for CRIM250W: Research Methods in Criminal Justice, Penn State University
2008	MATH1205: Calculus, Virginia Tech
2008	Summer Web Course Coordinator for MATH1114 (Linear Algebra) & MATH1016 (Elementary Calculus), Virginia Tech
2007-09	Math Emporium Staff, Virginia Tech
2005-07	PASS Leader for Liberal Arts Math and Calculus, Lynchburg College

JOURNAL ARTICLES

Osgood, D. W., Feinberg, M. E., Wallace, L., & Moody, J. (2013) Group Position and Substance Use. *Addictive Behavior*. [In Press]

Osgood, D. W., Ragan, D. T., Wallace, L., Gest, S. D., Feinberg, M. E., & Moody, J. (2013). Peers and the emergence of substance use: Influence and selection in adolescent friendship networks. *Journal of Research on Adolescence*. 23: 500-512.

RESEARCH INTERESTS

Criminology, Juvenile Delinquency, Juvenile Justice, Family Processes, Social Networks