PICKING AND CHOOSING, ACCEPTING AND CHANGING: THE EFFECTS OF
SELECTION AND HARMONIZATION ON NETWORK STRUCTURE AND
CONTENT

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Homophily, the tendency for like to associate with like or for birds of a feather to flock together, is one of the most robust findings in all of social science. Despite its ubiquity and obvious importance, however, it is uncertain how much of this regularity derives from the tendency to become friends with those like ourselves (i.e. selection) as opposed to the tendency to become like those with whom we associate (i.e. harmonization). This dissertation grapples with the issue by proposing, first, that both forces play a role and, second, that the impact of one cannot be understood without also considering the effect of the other. After a review of the literature, theory is developed, data introduced, analytical techniques described, and then empirical analysis is undertaken. It is determined that several of the predicted combinations of selection and harmonization are, indeed, present and that these combinations can meaningfully inform our understanding of social life. Directions for future research are then discussed.

INTRODUCTION

It has been said that there are only two certainties in life: death and taxes. To this list sociologists can add a third certainty: that our friends will be very much like ourselves. While there are many ethnicities, most of us have friends with the same skin color. While there are many economic classes, most of us find mates of similar wealth and education. While there are many religions, most of us befriend those who worship our same god. And while there are many ideas- a seemingly infinite diversity of ideas- most of us are surrounded by those of like mind. This is the co-called "Homophily Principle" (Lazarsfeld and Merton 1954), the idea that like associates with like, or that birds of a feather flock together. This basic observation is one of the most robust findings in all of social science (e.g. McPherson, Smith-Lovin and Cook 2001) and constrains our relations in virtually every possible way: ethnically, religiously, sexually, musically, and intellectually. The wider world may be heterogeneous, but our own worlds are not. Our lives play out on islands of sameness lost in a vast sea of diversity.

How does this sameness come about? How is it that our associates can be so uniformly like ourselves? While many answers are possible, two in particular deserve attention: Harmonization and Selection. Harmonization argues that initially we are not similar to our associates, but instead grow more and more alike over time. Just as warm water poured into cold will disperse, leaving a single mass at a lukewarm temperature, so too are differences thought to diffuse throughout a social group. Ideas and beliefs, practices and behaviors spread through a population in a process of harmonization until

eventually everyone is the same, and diversity vanishes. Selection, alternatively, argues that the sameness of our local worlds is not the result of some lengthy process of diffusion, but instead is a consequence of how we build those worlds in the first place. Our social environments are composed of people who are, in most respects, the same because we make them that way. We obtain our friends from our places of work, our places of worship, our neighborhoods and our hobby groups. As a result those with whom we become friends are already like us. They do the same jobs, requiring the same education, for the same pay. They enjoy the same activities and are free to pursue them at the same times. Similarly, individuals who change religions, change hobbies, or obtain new levels of education will drift beyond their old social worlds. We choose, however inadvertently, to limit ourselves to the small corner of social space that we already occupy.

Ultimately, neither selection nor harmonization can account fully for the homogeneity of our social worlds. That sameness is a result of both the spread of ideas among associates and the selection of associates based on their existing similarity. At the same time, with two separate mechanisms encouraging homophily, it is necessary to ask why homogeneity does not produce stasis. If harmonization is too strong, new ideas will be throttled before they diffuse- victims of an intense pressure to conform to the beliefs of one's associates. If selection is too strong, ideas can never spread- a new adoption will be met with the loss of social ties permitting further diffusion thus isolating the new adopter. In either case, beliefs remain changeless and relationships intensely stable. The

world that we observe, however, is not changeless and while homogeneity reigns, change is frequent. How can we reconcile these facts?

The simple answer is that while selection or harmonization might, independently, produce a world of static homogeneity, in combination they produce the opposite. When an individual adopts a new idea selection may eliminate some of their ties to those who disagree but this lessens the pressure on that new adopter to conform. Similarly, harmonization may spread that new idea to additional associates. Selection protects novelty from destruction. On the other hand, selection processes generate new relationships between similar others and eliminate those between dissimilar others. Harmonization, by constantly re-defining who is and is not similar, ensures that relationships never grow completely and irrevocably static. Harmonization prevents social closure from becoming perfect. Like barrier islands thrown up by the ocean and eroded just as regularly, selection and harmonization generate the dynamic stability of human society by producing local islands of sameness in an always churning sea of variety.

This dissertation research will help determine the nature of the balance between these forces. The relative contributions of selection and harmonization will be compared, and their respective impacts on the social fabric charted. In this manner we can move closer to understanding how societies change, as well as how they can remain the same.

Chapter One will provide the background for the project. It will discuss the history of the homophily principle and introduce the central theoretical distinction between selection and harmonization. Lastly Chapter One will lay the groundwork for

thinking of selection and harmonization as complementary, rather than antagonistic, approaches to accounting for homophily.

Chapter Two will expand upon the theoretical discussion in Chapter One. In addition to reviewing the literature on selection and harmonization it will decompose each force into sets of three sub-components. The interaction of selection and harmonization will then be explored and ideal types will be developed for the various combinations.

Chapter Three will introduce the data set used for this study and explain why it is appropriate. I then describe the subsection of the data that are appropriate for this research and then describe the specific portion of the data to be used in the empirical analyses.

Chapter Four discusses the challenges of longitudinal network analysis and reviews existing research in the area. It then introduces the Siena longitudinal network analysis models and describes their strengths as well as weaknesses. Finally, their applicability to the current case is explained and an example is given of proper interpretation.

Chapter Five presents the results of the first set of Siena models, dealing with weight beliefs and behaviors. It begins with a review of the literature on the subject, followed by a discussion of the descriptive statistics for several critical variables. Siena parameters are then introduced and explained, the results of modeling are presented, and finally the implications of the findings are discussed.

Chapter Six presents of the results of the second set of Siena models, dealing with religious behaviors. It starts with a review of the relevant literature, presents the descriptive statistics and explains the Siena parameters in question. It then continues by reviewing the results of modeling and concludes with a discussion of the results.

Finally, Chapter Seven reviews the preceding, situates this project amidst the other literature in the field and discusses the possible avenues for future research. It concludes by advancing an argument that social network analysis must gradually shift away from a focus on information transmission and towards a focus on information processing.

CHAPTER 1: BACKGROUND

This chapter begins by describing social network analysis generally and the concept of homophily in particular. After reviewing the literature on homophily it continues to disentangle the concept into selection and harmonization, which are each discussed in greater detail. Finally, the relationship between selection and harmonization is discussed. Rather than competing explanations for homophily, selection and harmonization are complementary processes that cannot operate without each other.

Social Networks and Homophily:

The study of human social life has given birth to social network analysis: a method for investigating the specific links between individuals and organizations. Moreover, this method has yielded considerable insight in a relatively short period of time. Mark Granovetter (1973; 1995 [1974]) and Ron Burt (1992) have developed network theories that partially account for economic returns to individuals (Montgomery 1992; Bian 1997) as well as to groups (Uzzi 1996; Uzzi 1999; Mizruchi & Stearns 2001). These theories have entered the general literature on social capital (Feld 1981) and have been employed (Ibarra 1992; Montgomery 1994; Hansen 1999) to account for differential returns in a variety of circumstances. Social networks have helped explain the diffusion of ideas and information (Burt 1987) throughout a population, accounting for the adoption of innovations over time (Rogers 2003). Similarly, researchers are employing social networks to model the spread of disease throughout a population (Laumann et al.

1993; Moody 2002; Watts 2003). Other researchers have explained the emergence of oligarchy (Mayhew & Levinger 1976), modeled the co-constitution of individuals and groups (Breiger 1974), and evaluated the relative rates of association between demographic groups (Blau 1977) using social network concepts. Similar work has succeeded in charting the competition of voluntary associations (McPherson & Ranger-Moore 1991) and cultural forms (Mark 1998; Bonikowski 2005) using the social networks paradigm. Virtually every aspect of sociology can potentially be enhanced by attending to the networks that bind social actors together.

The substantial progress made in the area of social networks has also produced an important understanding about our world: uniformity, not diversity, dominates our local environment. Social network analysis has consistently shown that individuals who associate are likely to share a number of traits in common. This tendency, first noted by Lazarsfeld and Merton in 1954, has become known as *homophily*, or the preference[1] of like for like. Peter Blau (1977) grappled with this tendency and, along with the demographic frequency of particular groups, used it to explain interpersonal association patterns. His "primitive" theory of social structure has emerged as one of the most robust structural accounts for social life yet conceived. Research has confirmed that homophily is the rule, rather than the exception, for demographic traits such as race, sex, religion, age, and even level of education (Marsden 1987, 1988; McPherson, Smith-Lovin and Cook 2001).

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[1] While frequently described as a "preference" it is not necessary to assume that individuals genuinely prefer to associate with those like themselves. Later discussion will explain how structure can produce a tendency towards homophily even in the absence of individual preference.

Expanding upon Blau's theory, McPherson and Ranger-Moore (1991) developed a sociodemographic parameter space known as Blau Space (See also McPherson 2004) as a way to understand homophily and its effects upon social life. In Blau Space, axes are defined by particular demographic characteristics such as age, education, religion, and race. Individuals then occupy positions within this space determined by their particular combinations of traits. Obviously, one of the most interesting aspects of Blau Space is that not all possible locations are occupied by actual persons (e.g. there are relatively few eight year olds who have a college degree). As such, Blau Space allows us to detect the presence of social structure both in terms of regions that are relatively likely to be occupied as well as regions that are entirely barren of occupants.[2] McPherson and Ranger-Moore, building on earlier work by McPherson (1983) used this space to theorize about the competition of voluntary associations for a crucial resource: members. Like the competition of bacterial colonies for nutrients, voluntary associations must vie for the time and resources of their members in order to survive. This competition occurs in the context of social networks- interpersonal ties linking members to non-members provide both an avenue for obtaining new resources as well as a vulnerability through which current members can be lost. This perspective, evaluated later by McPherson, Popielarz and Drobnic (1992), has received significant support and is a productive way to model the rise, survival, and fall of organizations.

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[2] Both are examples of what Peter Blau (1977) referred to as "consolidation." If two traits are consolidated then knowledge of the value of one trait provides information about the value of the other trait. If two traits are intersected than knowledge of one provides no knowledge of the other. Obviously, traits can be consolidated or intersected to a greater or lesser extent.

Expanding beyond these beginnings, Noah Mark (1998) used Blau Space as a basis for his study of cultural constructs. He theorized that musical styles compete via Blau Space in much the same manner as voluntary associations, surviving by securing the time and resources of their fans. His research, using the General Social Survey, found that musical styles are localized to particular sociodemographic regions and that distinct competition effects can be detected in areas that are exploited by multiple musical styles. Additionally, Mark studied the degree to which a respondent was familiar with or weakly liked a particular musical style. As predicted, liking for and familiarity with a musical style is determined by the proximity of a respondent to the sociodemographic region where that style is most popular. Also as predicted, the tendency to be familiar with or weakly like large numbers of musical styles is associated with the number of styles that all occupy the same area of Blau Space as the respondent. Both effects can be understood with reference to social networks; because individuals tend to be demographically homophilous, occupying a region of Blau Space where a particular musical style is popular implies that one has associates who listen to that musical style. Similarly, occupying a region of Blau Space where many musical styles co-exist implies that one is friends with individuals who listen to a diverse set of musical styles and thus that one is exposed to and familiar with those many styles.

Bart Bonikowski (2005) developed these ideas further in his work on the same topic. While Mark used cross-sectional data from the GSS to evaluate his hypotheses, Bonikowski used McPherson's ecological theory of affiliation (1983) to a greater extent, developing predictions about how the exact area of Blau Space occupied by a particular

musical style would shift as a result of competition between styles. Musical styles are expected to move away from areas of high competition for resources and towards areas of relatively low competition- exactly the result that Bonikowski found. Thus, at a macro-level, it is possible to predict how ideas or cultural forms will move through a society by observing the level of competition they experience. Unfortunately, while innovative and highly informative, this research does not trace the specific paths of diffusion and thus does not cast light on the micro-level processes leading to these macro-level outcomes.

Bethany Bryson (1996) contributed to the study of homophily in cultural forms by asking a new question: do musical dislikes behave similarly to musical likes? She found that individuals who are alike in terms of education and social class (i.e. occupy the same region of Blau Space) also tend to dislike the same kinds of music. In this case, similarity exists in terms of what is avoided rather than what is coveted. Put another way, the relevant idea or cultural construct on which homophily is operating is not the musical style, but the undesirability of one or more musical styles. While this work is less explicitly based in social network terms, the strong implication is that social influence mediated by interpersonal ties is responsible for consensus on both likes and dislikes. In all of the preceding cases homophily is a powerful force both demographically and ideologically generating remarkable conformity among associates.

Homophily also has profound implications for social wellbeing. Ellison, Burr and McCall (1997) investigated the effects of religious homogeneity on suicide rates. While it might be expected that individual religious belief would reduce the tendency to commit suicide, Ellison et al. found a community-level effect. Specifically, they identified an

inverse relationship between the degree of religious homogeneity within a standard metropolitan statistical area and rates of suicide. In this case, community-level religious homogeneity afforded some protection from suicidality, echoing Emile Durkheim's seminal work (Suicide [1897] 1997) in showing that suicide is as much a function of the level of social cohesion as of individual inclination. In this case, building a social network defined by homophily provides significant benefits.

Renzulli, Aldrich and Moody (2000) come to a contrasting conclusion that homophily can prove damaging to individuals. They evaluated the effect of high concentrations of kin and high levels of demographic homogeneity in the networks of potential small business owners on economic success. It appears from their results that entrepreneurs with networks that are highly homogeneous and contain large proportions of kin (who are, themselves, likely to be homogeneous with respondents in many respects) are less likely to be successful than those whose networks include greater diversity. Since homophilous ties are likely to be directed to those who are local in Blau Space, they are unlikely to include novel individuals who bridge large amounts of social distance. As these bridging ties are important for obtaining new information and resources (Granovetter 1973; Burt 1992) homogeneous networks prove to be detrimental to the financial success of small business owners.

In similar research, Herminia Ibarra (1992) uncovered critical differences in the homophily of males and females in a small advertising firm. Higher status males exhibited sexual homophily for all types of relations, including instrumental ties useful for accomplishing workplace objectives and supportive emotional ties. In contrast, lower

status females maintained supportive ties with other females but more often had instrumental ties to males. Thus, in cases where demographic characteristics are associated with power differentials, the need to accomplish workplace goals may make homophily undesirable for the lower status individuals. Ibarra pursued this issue further using black and white middle managers (1995) and found that minority managers who were most likely to advance divided their networks in a similar fashion. Directing instrumental ties to whites while relying on homophilous ties for emotional support maximized the potential for upward mobility. Whites, in contrast, benefited most by directing all types of ties to other whites. In this second case, homophily on all types of relations is associated with relatively poorer outcomes for lower status individuals than for higher status individuals. In sum, it appears that homophily can have important material and emotional consequences, both positive and negative.

In addition to its use in accounting for patterns of cultural consumption, social wellbeing, and workplace success, homophily has served as a core assumption in the development of sampling techniques. In his "respondent driven sampling" Douglas Heckathorn (2002) used homophily to obtain reliable samples of hard-to-reach populations (e.g. drug users). To implement this technique researchers interview initial seed members of the population and then give them "tickets" to pass on to others who are suitable for the study. These tickets are individually numbered, allowing researchers to track how additional individuals are recruited into the study. As a result of homophily, drug users are more likely to know other drug users than is the population at large, thus allowing a highly efficient sample to be drawn by utilizing their social networks. The use

of the tickets permits weights to be developed so as to correct for the lack of independence between observations. This homophily-based technique thus allows accurate reliable data to be collected on populations that are otherwise nearly inaccessible.

While the importance of homophily is indisputable, the origins of this tendency, and the resulting homogeneity, are not fully understood. Researchers have to date employed two general approaches to explaining the homogeneity that characterizes social groups. These approaches are *selection* and *harmonization*.

Selection:

To understand selection it is helpful, first, to consider a typical day in the life of a typical person. They wake up in their own bed, prepare for their day and go to their usual work place using their customary means of transportation. At the end of their workday, they likely return home using the same transportation, have dinner, and either spend the evening engaging in leisure activities in their residence, caring for children, or going out to participate in civic or hobby groups. Each day this repeats until the weekend, when perhaps they sleep in a bit, do chores around the house, and perhaps take part in social events. The hobby groups and social events that they indulge in are, of course, their usual hobbies and social engagements. The day when they join a new group or try a new entertainment is an unusual one.

This account would obviously be poor subject matter for a novel but allows us to see the importance of social context. Our fictional "everyman" begins and ends his day in the same place- his home- surrounded by his neighbors. Those neighbors probably live where they do for the same reason as our everyman- they can afford it, and it is as convenient for them as possible. Likewise, if our everyman travels to work by bus or train, he is likely surrounded by others riding the bus or subway for the same reasons that he is- cost issues, lack of a car, or simple convenience. Similarly, if he drives, then he is *not* surrounded by those who use some other form of transportation. At his place of employment our everyman meets largely those who work for the same employer- if he works in a factory, he meets other factory workers, and if he works in an office he meets fellow office workers. Finally, if our everyman participates in civic or hobby groups he only meets people there who enjoy those same hobbies or are interested in the same civic issues.

The above discussion illustrates an important point: we spend most of our day, every day, surrounded by those who are similar to us. We live and travel among those of similar means, work with people who have similar educations and job skills, and enjoy our leisure time with those who share our interests. It is further the case that, as Peter Blau (1977) pointed out, we can only form a friendship with a person if we somehow come into contact with them. Friendships do not emerge from random number generators but rather from structural features of the social world. A hypothetical friendship that resulted from a casual meeting on a street corner would likely share this property- in order to meet, the potential friends have to be on the same corner of the same street in the

same city on the same day at the same time. Happenstance is not quite as unpredictable as we like to imagine. Even a friendship born from the internet is determined by similarity as the meeting emerges out of a particular website, focusing on a particular topic, and serving a particular group. This constraint ensures that if we only form friendships with those whom we contact, and we largely come into contact with others who are like us, then most of our friends will be very similar to ourselves.

This simple logic forms the basis of the selection account of homogeneity- groups of friends, groups of coworkers, neighbors in an apartment building, and members of voluntary associations are disproportionately likely to resemble each other not because they prefer associating with others like themselves, but because those who are similar are more likely to come into contact in the first place. It is primarily social structure that produces homogeneity, rather than some more esoteric process.

The selection perspective is given a particularly detailed elaboration in Peter M. Blau's *Inequality and Heterogeneity: A Primitive Theory of Social Structure* (1977). This seminal work used basic demographic principles to explain rates of inter-group association, among other things. Impressively, Blau successfully predicts both that members of a minority group will have higher rates of heterophilous association and that demographic availability will have an impact on social status. This latter insight has been extensively developed to help produce status construction theory (Ridgeway 1991), a highly successful social psychological explanation for status orders. Later researchers have extended and elaborated Blau's theory, but perhaps none have done so more enthusiastically than Miller McPherson. Working in combination with James Ranger-

Moore (1991), McPherson developed Blau Space, or a multidimensional parameter space in which individuals and entities can be positioned depending on their characteristics (McPherson 2004). Those with similar characteristics are placed close in Blau Space while those with dissimilar characteristics are placed more distantly. Thus, Blau Space simulates physical space in that separation in Blau Space translates into a decreasing likelihood of association.

A second, less-prominent, aspect of the selection hypothesis is that individuals may actually prefer on some level to associate with similar others (e.g. Carley 1991). While such individual preferences are limited in their effect to those persons available for association, and thus must exert less influence than structure, they likely still have some impact on association patterns. Preferences for similarity may be a result of either a liking of similarity, or an avoidance of dissimilarity. In the case of a preference for similarity, individuals who are similar to oneself may be easier to interact with due to a shared history and outlook. In this case attempting to interact with a dissimilar other requires a greater investment of energy, and may involve a larger degree of confusion and conflict-particularly in the early stages of a relationship when no common dyadic history exists. As a result, individuals will pursue relations with those who are similar, and either avoid friendships with those unlike them, or allow such heterogeneous relations to end at a higher rate. A simple example of this sort of selection might well be behavior at a party; an individual might select someone who looks as though they belong to a similar economic and social class for mingling because such a person seems familiar and

comforting. This preference for similarity then makes friendships with similar others more likely.

In the case of avoidance of dissimilarity, the relative statuses of the individuals are likely to play a role. Most human associations have a status ranking of some sort or develop one based on diffuse individual characteristics (Berger, Cohen, and Zelditch 1972; Berger, Conner and Fisek 1984). The presence of status differences has been shown to influence the interactional styles of group members, as well as to change the nature of the interaction itself (Berger, Conner, and Fisek 1984; Berger, Wagner and Zelditch 1985; Ridgeway, Berger and Smith 1985) even if the members are ostensibly equals. High status individuals typically prefer not to associate with those whose status is less than their own (Laumann 1965, 1966) while interaction with high status others is often desirable for lower status actors (e.g. Ibarra 1992). Thus, while individuals who come into contact in social groups are permitted to form friendships, they may choose not to do so with those of lower status. In this case, similarity emerges from an avoidance of a downward status differential, rather than pursuit of status similarity. Avoidance of dissimilar others may also be a result of fear or uncertainty. Different groups or subcultures have different styles of acting, and encounters between individuals from different subcultures can lead to considerable confusion. This may provoke anxiety and, thus, provoke avoidance from the individuals in question.

In combination these two forms of selection, structural selection and choice selection, constitute a powerful explanation for homogeneity. At the same time, however, selection has certain challenges that must be overcome. A selection-based argument for

similarity would seem to imply that individuals have a nearly perfect or frictionless ability to find groups like themselves and, when this is not possible, that conversions do not occur. The views of a given person should, therefore, be perfectly predictable based on certain characteristics- including demography. Unfortunately for selection, however, heterophilous relations do exist and individuals do change their minds. Indeed, research using the Blau Space approach is predicated on the idea that once individuals are brought into association by structural forces, attitudes and behaviors change to make associates more similar (Bonikowski 2005; Mark 1998). This implies that selection may not be the correct answer to the homogeneity problem in all instances and may not be a complete answer in any. To address these shortcomings, researchers have also pursued explanations based on the concept of harmonization.

Harmonization:

It began humbly, just one more charity drive. Donate a little money to cancer research, and be rewarded with a bright yellow band of silicone with the word "Livestrong" engraved on one side. At first, they appeared here and there but only rarely. Before long, somehow, this changed. Little yellow wristbands were everywhere, and on everyone. Like the ribbons that preceded them, the Lance Armstrong charity wristbands spawned an entire array of imitators- a veritable rainbow of wristbands showing support for everything from the Army, to marijuana legalization to Christianity. Whereas before

people might have regarded thin silicone wristbands as cheap or tacky, they had become a stylish accompaniment to any outfit.

The idea of a fad or craze is not new to anyone who has experienced adolescence, but it presents a genuine problem for the selection perspective. How do novel behaviors or attitudes spread through existing networks? Charity wristbands have not been in existence for a long time; people have not had the opportunity to select their associates based on their preference for, or avoidance of, the little silicone bands. How do we explain their rise, spread, and ultimate decline?

This challenge has helped to bring about the second approach to explaining homogeneity in social groups- harmonization. It is, at heart, a simple idea: when persons with different ideas or behaviors come into contact, their ideas rub off on one another, producing eventual consensus. In a sense, ideas, beliefs, behaviors, and practices spread through a population much as a virus or bacteria does. One person tells a friend, who tells a co-worker, who tells a family member, who tells a friend, and so on until the population has been exposed to the burgeoning infection. Rather than a world where people sort themselves into groups based on their interests, ideas become mobile and penetrate into existing groups.

Harmonization, often thought of as "diffusion," has been investigated by a number of scholars. In some of the earliest work (Gross 1942; Ryan and Gross 1943, 1951) researchers examined the diffusion of agricultural innovations through a farming community. This work provided some of the first insights into how, and why, new technologies are adopted by users. Later research by Coleman, Katz, and Menzel (1957,

1959, 1966) studied the manner in which doctors adopt new technologies, in this case a new antibiotic. They found, much as with farming, that doctors tend to adopt those behaviors that their associates have adopted. In an ironic sense the spread of an antibiotic strongly resembles the bacteria it is meant to combat. Work by Ronald Burt (1987) re-examined this data and found even more striking conclusions- it wasn't just that physicians adopted the behaviors of their associates, they actually adopted the behaviors of those with the most status- particularly if they themselves were of high status. More recently still Sarah Soule (1997) and her colleague David Strang (Strang and Soule 1998) have shown that innovative tactics used in protest events, and in deterring corporate raiders, can spread via diffusion. The ability of new ideas to emerge and spread from person to person is strongly supported. While there is far too much to discuss exhaustively, much of this research on diffusion is ably summarized in Everett Rogers' (2003) book *Diffusion of Innovations*, which deals with all aspects of the diffusion process.

Complicating the diffusion picture, and explaining my use of the term harmonization, is the zero-sum quality of some diffusing entities. Often a bacterial metaphor is used for diffusion- that an idea or approach spreads via social contact from person to person. Interestingly, however, not all ideas can spread freely in this manner. In some cases spreading an idea requires not merely communicating it to others, but also displacing an existing idea or set of ideas. Thus, conveying a slogan or advertising jingle is relatively easy, but convincing someone that they should switch soft drink brands may be more difficult. In order for one preference to be diffused, another must be swept away.

While the diffusion terminology is used both for ideas or practices that can spread freely, and for those that are opposed by existing rivals, I use the harmonization term to draw attention to the potential for conflict that is inherent to diffusion. Harmonization is not simply the spread of an idea, but the emergence of a consensus as to which idea should be adhered to.

Original ideas are not the only type of entity that can be diffused, however. Indeed, what is important is not so much that the idea is original, but rather only that it is new to a particular social context. A liberal joining a conservative discussion group would, almost inevitably, bring with them new ideas and new perspectives. Likewise a group that adds a new member may have to deal with their different views of what is and is not acceptable in polite discussion. Harmonization does not solely occur when new ideas emerge suddenly into society, but instead takes place nearly every day as groups add and lose members, or as friendship circles expand and contract. In this more mundane sense harmonization has been studied by social psychologists and others interested in interaction itself. Noah Friedkin's social influence model (Friedkin 2001) has provided one useful approach to dealing with harmonization in these settings.

Friedkin's model takes as its starting point two principles- that individuals have particular attitudes, and that those attitudes can change as a result of influence between interaction partners. Thus, a group can be reduced to a set of members (nodes) and relationships between them (ties). While it is true that any one person will only be influenced by those with whom they communicate, that influence can have its origins in third or fourth parties. So, if actor A influences B, and actor B is connected to C, then

actor A can influence C through the intermediary of actor B. As a consequence, even if all members of a group are not in communication with one another it is possible for them to develop a consensus opinion. Rather than developing ties with those we already resemble, diffusion and influence (collectively constituting harmonization) explain how we can gradually become more like those with whom we spend time- whether we resemble them to begin with or not. These sorts of harmonization events, stemming from new contacts between individuals carrying old ideas, should reach a sort of equilibrium in a society defined by the rates of mixing explored by Peter Blau (1977). When larger structural disruptions are taking place (e.g. economic depressions, wars, population movements, etc.) however, opportunities for new harmonization may be quite common.

Obviously many socio-demographic characteristics (i.e. *attributes*) like sex and ethnicity are, to put it mildly, unlikely to spread via this route. Nevertheless, many other socially relevant characteristics like political affiliation and religious ideas (i.e. *attitudes*) are susceptible to transmission.

Selection vs., Harmonization:

Selection and harmonization differ as theoretical explanations for homogeneity, but they also make different assumptions about the nature of the social world. It is these assumptions, rather than the theoretical points themselves, that point the way to a resolution of the selection/harmonization debate.

In the harmonization model network ties are treated as constant and the conversion of various members of a network to new attitudes becomes a function of the number of other infected individuals to whom they are tied (Robins et al. 2001; Robins et al. 2005). Thus, the attitudes in a network gradually harmonize through a process of influence and adoption, where individuals come to hold those attitudes that are held by their associates. By contrast, selection approaches to homogeneity often treat attitudes and attributes as fixed, and the network achieves homogeneity by creating or eliminating ties. In this scenario, the population of ideas and its distribution are effectively given and it is up to individuals to find those like-minded persons with whom they will get along. The problems with these views are apparent. For harmonization, the assumption that network ties are constant and unchanging is seriously flawed. Individuals regularly form and lose connections to others as a result of maturation, geographic mobility, job mobility, changes in marital status, and a host of other factors. As a result, social networks are far from fixed and unchanging. Similarly, the selection model has problems of its own in dealing with the attitudes and attributes of actors. While the attributes of a person, such as their sex and ethnicity, are unlikely to change no matter who they are in contact with, attitudes can and do change throughout the life course. A young man just starting a career may be in favor of higher tax rates but, after spending time among other businessmen, may shift to favor low taxes. A change in attitudes focal to a person's identity may take place as well, such as in religious conversion. Thus, while selection avoids the mistake of harmonization, recognizing that social ties are fluid and variable, it makes a mistake of its own: assuming that beliefs and ideas remain static.

Selection-oriented research into cultural constructs sometimes avoids this problem by positing that harmonization occurs very rapidly once individuals are brought into association by structure. In both Noah Mark's (1998) and Bart Bonikowski's (2005) work, movement into a new region of Blau Space predicts the adoption of the preferences that are locally dominant. In this case, two forces prevent harmonization from occurring throughout a social system: competition and lack of contact. In the case of the former, the variety of musical styles competing for members produces resistance to incursions by other styles. In the case of the latter, cleavages between areas of Blau Space allow preferences to pool in areas where contact between regions is limited. In either case, the explanations, while interesting, have greater difficulty in accounting for new entrants to a cultural system- new musical styles that somehow manage to expand and compete in a space that is already full of competitors.

Due to these clear shortcomings, few researchers would argue that only selection or harmonization actually take place. Instead, most would agree that both processes have a role to play. Moreover, the precise role that selection or harmonization plays likely depends in part on the social context in question. Under conditions of constraint where one has little ability to choose associates (e.g. the workplace) processes of harmonization may be more important. In such a circumstance since actors have no choice but to interact with a given set of others- ironically mimicking the assumptions of harmonization models- consensus can only emerge through attitudinal change. In more free-form social situations where constraint is considerably less powerful (e.g. friendship groups) selection may prove to be the dominant influence. It does, after all, require less energy to

interact with someone who agrees with you, than to convert someone who does not. Similarly, it's easier to form friendships with those you encounter regularly, than to find perfect strangers from vastly different walks of life.

While particular circumstances may emphasize one source of homogeneity over another, in most cases a balance must be struck. Often it will be possible to eliminate ties to those who are different from ourselves, or to send ties to those who are similar, but for a variety of reasons neither course of action may be most valued. Similarly, for individuals who participate in several groups, it may be impossible to adopt one set of attitudes that ensures similarity with all of one's associates. Each locus of association (Feld 1981) may, itself, demand different attitudes from a participant- and require that either that participant tolerate difference, or that she be a supremely competent social chameleon. Understanding how the balance is reached between selection and harmonization has clear implications for our knowledge of interaction.

The balance of selection and harmonization plays a role beyond explaining the emergence of particular groups, or even the homogeneity commonly observed among group members. Instead, the balance of selection and harmonization can explain the evolution of a group over time, and help account for the larger-scale success or failure of innovations to spread through established social contexts. Varying levels of selection and harmonization can determine how vulnerable a population is to new religious movements, how amenable it is to changes meant to enhance social justice, and how deeply into the past its collective memory can reach. Further, an understanding of what controls this balance could offer substantial benefits to society at large. In order to

understand how these processes interact and produce larger-scale social phenomena it is first necessary to understand them in a more detailed sense. In the next chapter, I develop theory to help us do just that.

CHAPTER 2: THEORY

This chapter begins by elaborating on selection and harmonization, the mechanisms introduced in Chapter One to account for homophily. The relevance of each of these factors to the development of social networks is examined in greater detail. Each of these forces is then decomposed into a set of related factors that should govern their operation. Combinations of selection and harmonization are then discussed and a set of four ideal-typical combinations of each are then outlined. Finally, the difference between attributes and attitudes is discussed and their implications for the evolution of social networks are examined.

Selection and Harmonization: A Synthesis:

Harmonization and selection explain the same type of phenomena in distinctly different ways but this is not to say that they are antithetical to one another. The key to merging these two perspectives is to recognize that they each favor a particular stage of group life. For harmonization models, where social ties are assumed to exist in an unchanging state, social groups are long-standing and stable. Relationships are established and predictable, therefore providing a ready avenue for the diffusion of ideas. Similarly, selection models often focus implicitly on the formative period of social groups. After all, when one forms or joins an association, one is selecting persons for association out of the available pool. Therefore, selection almost inevitably focuses on

the early stages of group life. Alternatively, selection models are also well-suited for dealing with small-scale or predictable movement between established groups, accounting for how individuals develop and eliminate ties over time. Both emphases, on stability and on emergence, fail to take account of the full richness of social life and, in so doing, leave open a strategy for merging their theoretical claims.

Selection's focus on the emergence of new groups ignores a key insight: most persons, at any particular time, are already members of existing groups. Most individuals are connected to a variety of formal or informal groups (e.g. family, coworkers, neighbors, etc.) and, as a consequence, may be experiencing overall stability in their social networks even if they are part of a newly-forming group. For example, when a young adult goes to college they may find themselves embedded in a variety of new social agglomerations- their dormitory, their major, clubs or fraternities, and so on- but they retain many of their older ties as well, such as their family relations, many of their religious connections, and perhaps even friendships. In less massive relocations, such as changing a job in adulthood, one's family ties, geographic residence, religious affiliation, and so on remain intact. Thus, despite the instability present in one area of a person's life, overall network stability is the rule. Given this, it is reasonable to ask if selection may play a role not simply in the formation of new homogeneous groups, but in the maintenance of homogeneity within existing groups.

Similarly, while harmonization models presume the existence of social relations, a presumption that is usually reasonable, they neglect the possibility that ties may change over time. Any time an attitude is adopted it introduces the possibility of further

contagion through the existing ties. Thus, when one member of a friendship group finds themselves enamored with a new political ideology, that ideology now has the opportunity to be adopted by other members of the group. However, a second opportunity is also introduced: the chance that an existing tie will die. While harmonization models emphasize the increasing homogeneity that results from diffusion in the long term, they often ignore the short-term reduction in similarity that diffusing attitudes generate. A person who adopts a liking for abstract art may be less similar to some of her previous friends than before she experienced the adoption event. At a larger level, in an essentially homogeneous group, the introduction of any new attitude causes a net decrease in homogeneity. Thus, while harmonization can be thought of as a homogenizing influence, it achieves this result by first increasing heterogeneity.

This paradoxical result can be demonstrated easily (Figure 1) by considering a hypothetical population of one hundred individuals who are homogeneous on their liking for political candidate A and dislike of political candidate B. If we were to calculate the Index of Qualitative Variation (IQV), a measure for the degree of diversity present in a group (Healey 2002), using these hypothetical data we would obtain a value of zero. This group has achieved perfect consensus. If a handful of these individuals- five or so- should waver in their support for candidate A and begin supporting candidate B, however, this perfect consensus would be broken. At first the change is minor but as more members of this group come to favor candidate B the IQV increases to its maximum when the population of one hundred is divided equally between candidate A and candidate B. The IQV, having reached a value of 1.0, indicates that the group has become as diverse as

possible. Only after this threshold has been achieved will further harmonization events

actually produce a decrease in overall diversity until, once more, homogeneity is

achieved.

Figure 1- Simulated Harmonization Sequence

In the event that our group of one hundred individuals is already divided between

two candidates when a preference for a third candidate enters, the result is effectively the

same: homogeneity decreases initially and only increases once the preference for one

candidate harmonizes past a threshold. Importantly, however, if individuals do associate

with similar others, then changes in the ideas or behaviors of an individual may cause

selection to occur in reverse- ties between individuals who are now dissimilar may be

lost. So, our political convert may provide a way for new ideas to diffuse to new

individuals, but she may find herself cut off from her previous friends who have little

interest in climbing aboard the bandwagon. Thus, selection pressures may lead both to

the formation of new ties, as well as to the death of existing ties, in the process making it

less likely that harmonization will eventually produce consensus. Further, harmonization

increases the sameness of the population (i.e. spreads to all elements) at the same time as

it sparks fractionalization and division.

It may at first seem that the death of ties must rely upon choice, rather than

structure. While this is partly true, it misses the important structural consequences of

harmonization. While it is difficult to causally link ideas to behaviors particular ideas and

behaviors do co-occur. This correlation has important implications for networks in general, and for harmonization and selection in particular. Individuals obtain relationships with similar others largely because similar others are more likely to come into contact- so, those who enjoy tennis and join tennis clubs are more likely to count tennis players among their associates than is the population at large. In this case, liking tennis and playing tennis (an idea and a behavior) are linked to the composition of a social network. It is important to consider, however, that any particular person has a limited amount of time and energy with which to maintain ties. This means that any particular person cannot add ties indefinitely, as a ceiling will be reached where the cost of adding an additional tie will exceed the resources of the ego. When this occurs existing ties must be lost in order for new ties to be formed. When an individual in an otherwise stable network adopts a new attitude or behavior (i.e. harmonizes with some of their associates) it may bring with it new associations. For example, taking up bowling in addition to tennis may cause the individual to enter a new group of potential associates: other individuals who spend time at the bowling alley. Moreover, involvement in this additional focus for social ties (Feld 1981) reduces the amount of time and energy available for maintaining and developing ties with tennis players. Therefore, selection may act to eliminate ties following adoption even without the involvement of choice simply by reducing the quantity of resources available for the existing set of ties. Thus, our political convert may find herself isolated from her past friends not because they prefer not to be converted, but rather because she is spending all of her time with other members of the faithful.

The potential for the death of ties as a result of increasing dissimilarity introduces a new dynamic to information spread. Unlike biological viruses, whose presence often cannot be detected until symptoms of infection are obvious (which is usually long after exposure and contagion), ideas and innovations are more easily observed. Vocalizations may reveal the presence of a belief, as might particular symbols, styles of dress, or mannerisms. As a result of this heightened observability, attitude spread is more easily hindered by selection pressures favoring homogeneity. In an environment of strong selection, new ideas may have difficulty spreading because, each time they come into contact with the uninfected, their channels of transmission (i.e. social ties) are severed. This effectively quarantines new ideas to those individuals who have already been harmonized. As with any contagion, an idea that is denied a vector to new hosts will remain contained to an existing set. Far from being eliminated, however, quarantined ideas might persist for years or decades through vertical transmission from parents to children despite the lack of horizontal transmission to new adults. A possible example of this sort of phenomenon might be the early stages of new religious groups. To the extent that new religious groups (e.g. Aum Shinrikyo or Heaven's Gate) fully absorb their members' time, they may force the loss of existing ties into the wider culture (Lalich 2004). This has the effect of, ironically, hampering the group's attempts to spread and become more mainstream by reducing the channels through which such spread can occur. Despite this, however, these groups may persist effectively indefinitely as children are raised in the group and replace members who age out, or leave voluntarily.

In an environment of weak selection, new ideas may spread more freely as the likelihood of tie death is considerably reduced. A possible example of this opposite extreme is the diffusion of movement ideology via mailed appeals for donations. In this case, "adoption" requires only a monetary donation and, otherwise, involves no serious expenditure of resources. As a result, selection effects will operate only weakly, if at all. Thus, a group of friends might be diverse in terms of memberships in a variety of social movement programs like the Sierra Club or the AARP without that diversity resulting in the loss of ties. More importantly so long as those ties persist the opportunity for further diffusion remains. At intermediate levels of selection, harmonization is a race against time, with the likelihood of adoption balanced against the probability that, at any particular moment, the dissimilarity in the relation will result in its termination. In such a case network rifts might open at the borders of a diffusing set of ideas, producing factionalization and channeling the diffusion into areas where the social ties are more durable. This process might effectively characterize contentious social issues like gay marriage. Rival camps emerge around a new set of ideas, and those ideas both spread to a wider group and provoke substantial negative reactions.

In addition to selection, harmonization may also vary in strength. Some ideas or behaviors may be more "virulent" than others, and therefore more prone to be adopted via casual contact. A highly virulent attitude might be able to spread despite selection pressures, much as the flu can spread despite autoimmune systems. This level of virulence might well characterize a fad or "craze" among teenagers, where the desirability of a particular object or behavior can be conveyed even at the first exposure.

Ironically, as is also the case with fads, the simplicity that affords an idea such high

virulence more than likely also limits the duration of its popularity. Alternatively, many

ideas and behaviors might have low virulence and be difficult to diffuse through casual

contact. In biological terms the HIV virus may be a good example; while exceedingly

deadly, it is an organism that can only spread via intimate contact and even then its

spread is not guaranteed. This second extreme is, perhaps, best characterized in the social

world by political views. Established ideas about how the world works are unlikely to

rapidly displace pre-existing rivals. Thus, a prolonged degree of contact should be

necessary in order for these ideas to move through a population. While many young

adults find their political views shifting towards the left during college (e.g. Newcomb

1943) this shift occurs slowly and does not proceed from start to finish within weeks after

arriving on campus. As with selection, there also exists a large intermediate space of

moderate virulence. Here, the likelihood of harmonization is not high, but is far from

unlikely, making the diffusion of ideas and behaviors much more unpredictable. In this

intermediate space we might plausibly find preferences for games and sports.

At a larger structural level, the balance of these forces can have a substantial

impact on network evolution. In regions of social space where selection pressures are

weak, network structures will remain relatively stable, allowing new ideas to pass

through existing relations much as the common cold passes from host to host. Because

there is only a weak preference for similarity, ties will be capable of enduring despite

substantial dissimilarity, ensuring that if homogeneity emerges it is largely due to

harmonization. In regions where selection pressures are strong, network structure will

also be relatively stable. New adoptions will be accompanied by high tie mortality, isolating the new adopters and preserving the existing structure of the network. In this way strong selection pressures would operate as a sort of impromptu quarantine preserving the existing homogeneity at the cost of thwarting any change, for good or ill. At intermediate levels of selection, however, matters may be quite different. Ties may persist long enough for harmonization to take place, exposing more individuals to the new ideas or innovations. At the same time, however, the relatively high likelihood that any particular adoption will result in a spate of tie deletions has the potential to generate considerable instability. New ideas will penetrate into the network via social ties even as many of these ties are deleted as a consequence of this penetration. The spreading attitude will, itself, produce structural holes (Burt 1992), splitting network regions apart and increasing the importance of bridging ties. On a deeper level, this network splitting may trigger additional harmonization and selection events. Individuals who sever ties to associates may themselves seek out new ties with which to replace them. These new ties may bring previously separated ideas into contact, leading to further harmonization and selection. Thus, the introduction of even a single new idea into a region of intermediate selection may shatter an existing equilibrium far beyond the spread of that single idea. This dynamic interaction of selection and harmonization may help us understand why human societies so rarely reach a truly static equilibrium.

Similarly, the level of virulence will have an important role to play. Ideas of high or intermediate virulence in a region of weak selection will spread throughout the population, but ideas of low virulence will spread more slowly despite the lack of

structural constraints. On the other hand low virulence in combination with high selection pressures should provide an effective block to diffusion. Even high selection, however, may be unable to hold back a highly virulent idea. At intermediate levels of virulence, the movement of an attitude through a population will depend significantly on the strength of selection, but will regardless be neither rapid, nor easily stopped. Ironically, the balance between selection and harmonization that most researchers agree exists is precisely what is required to produce a substantial amount of dynamism in the social environment.

It is clear that the balance between harmonization and selection pressures can powerfully influence social networks. Together, these forces both determine the structure of particular social networks, and determine the content of those networks.

Harmonization Factors:

Harmonization, or the convergence of attitudes in a given set of associates, is a process composed of several distinct parts. Each of these subparts has an impact on the rate of harmonization and, indeed, whether it will occur at all.

First, a particular attitude or idea can be characterized by its *virulence*. Virulence refers to the ease with which a particular idea, attitude, or belief can be transmitted through interpersonal contact. While all views doubtless have some non-zero level of virulence, not all ideas are equally easy to transmit. Some may involve larger amounts of information, may contradict existing ideas, or appear extremely unconventional on first exposure. All three of these factors could, potentially, reduce an idea's propensity to

spread. On the other hand, a new idea might be easily remembered, might integrate unusually well with existing beliefs, or might satisfy a psychological need of the individual. All of these characteristics might plausibly increase an idea's propensity to spread. While it would ideally be desirable to determine the factors that increase or decrease the virulence of particular ideas and develop measures for each of them, this is beyond the scope of the current project. Therefore, the concept of virulence is itself used to account for all of these unobserved factors that may make ideas more or less likely to spread. I thus define virulence as, *the ease with which an idea spreads as a result of factors endogenous to the idea.*

Second, similar in some ways to disease, the contagion of ideas and attitudes may be strongly affected by the characteristics of the host. As has been shown previously (Cohen & Zhou 1991; Markovsky & Thye 2001) claims made by high status individuals are more likely to be accepted than claims made by low status individuals. Moreover, individuals of high status have been shown to be more effective at transmitting ideas than those of low status (Burt 1987). We can thus think of the likelihood of harmonization as dependent on the *persuasion* of the current host. This concept is separable from virulence in that individuals can be more or less skilled in conveying an idea, just as ideas can be more or less easy to convey. In more colloquial terms, some products may sell themselves (high virulence, low persuasion) while others require considerable skill to sell (high persuasion, low virulence). Alternatively, a sufficiently persuasive individual can convince others of even a very bad idea. It is, of course, unnecessary that the persuasive individual have any intent to transmit the idea. A high status individual who adopts a

particular style of dress may inspire others to dress similarly, even if they are not making any explicit attempt to do so. I define persuasion as, *the ceteris paribus likelihood that a given type of individual can induce a given other to adopt an idea.*

Finally, individuals may differ in their *receptivity* to new ideas and attitudes. Just as individual differences in auto-immune function can make bacterial or viral infection more or less likely, so too can people vary in their propensity to adopt new ideas. Individuals with high receptivity may willingly adopt new ideas with little or no convincing, while others may prove resistant even to the most severe pressures. Often receptivity and social status may be related. Individuals of low status have few resources with which to resist new ideas and little reason to support the existing status quo. Similarly those of high status should prove quite capable of resisting new ideas, as well as motivated to preserve the existing ideological order (Berger et al. 1977). As with persuasion, receptivity is not the same as virulence- persons may be easier or harder to convince given ideas of equal virulence. It is important to note that receptivity is here proposed as a property of a particular kind of individual. As such, those with high levels of receptivity should prove to be particularly vulnerable to frequent changes of opinion. As a result, receptivity is a double-edged sword for a diffusing idea or ideas. The highly receptive are easy to harmonize, but they are unlikely to remain harmonized for long periods. Thus, the receptive may be the first individuals to adopt a new idea but they cannot ensure its long-term endurance within a group. I define receptivity as *the ceteris paribus likelihood that a particular kind of person will adopt a new idea.*

Selection Factors:

Selection, like harmonization, depends on a set of three interrelated mechanisms to produce its effects on social structure. Also, as with harmonization, the impact of each of these factors can change how an idea diffuses through a network. Of even greater consequence, the manner in which selection exerts influence will alter the structure of the network, thus changing the conditions that future ideas will confront during their diffusion.

First, selection depends upon *attraction*, or the tendency of individuals to form an association with similar others (see Skvoretz 1983 for an excellent treatment). This refers both to those who are similar in terms of *attributes*, or largely stable demographic characteristics, and *attitudes*, or opinions and ideas that can vary more freely. Attraction does not necessarily refer to the personal preferences of individuals, but may result from the social structural forces that bring individuals with particular characteristics into association. The attractive influence of education may be driven primarily by the tendency for individuals to work in educationally-homogeneous environments, and the class consequences of type of employment, rather than from any personal preference for alters with similar education levels. I define attraction as *the positive pressure towards association with particular others based on their attitudes or attributes.*

Second, selection can be conditioned on the strength of *repulsion*, or the push away from association with those who are dissimilar. It differs from attraction in that it may be socially important to avoid contact with certain kinds of others rather than

important to establish ties with certain persons. As an example, a politically liberal

college student might willingly establish ties with any of a number of international

students, but avoid doing so with a white South African. This avoidance of certain

properties, rather than specific pursuit of others, has already been detected for certain

social phenomena (e.g. Bryson 1996). As before, the operation of repulsion is not simply

a matter of individual preferences, but is also largely a consequence of social structure.

Individuals of middle or upper class may be structurally unlikely to spend time with those

of lower classes, but may mix relatively freely with each other. In this case, repulsion

more than attraction determines the pool of available alters, and helps to ensure a degree

of homophily. Repulsion also helps determine whether or not an existing tie dies

following an adoption event. If a member of an existing dyad adopts a new attitude, the

strength of the forces pushing the alters out of association (repulsion) will largely

determine whether or not the dyad survives. In a case of high attraction but low repulsion,

individuals may be brought into contact when they are the same in some manner and

persist in their friendship long after the similarity ends. When high repulsion is also

present, however, the loss of similarity will be matched by a concurrent loss of the social

tie. I define repulsion as *a negative pressure against association with particular others*

based on their attitudes or attributes.

It is important to note that both attraction and repulsion rely on the *salience* of a

particular attribute or attitude. Salience, or the importance of a characteristic for

interaction (Blau 1977; Skvoretz 1983), partly determines the strength of interpersonal

attraction and repulsion. Characteristics that are more important, or salient, are likely to

exert stronger attractive and repulsive forces than characteristics that are less salient.

Thus, while nose size and education level are both characteristics on which individuals

can be sorted, education level is far more salient for most social groupings than is nose

size. Therefore, association is more likely to be homogeneous on education level than on

nose size.

Finally, while attraction and repulsion both play a role during the initial formation

of a social network, their role does not come to an end once a tie has been formed. As

individuals adopt new ideas they become similar to others who have already adopted that

idea. This encourages the formation of new ties. Similarly, these adoptions increase

dissimilarity between persons and their existing alters who have not experienced

adoption. This adoption may provoke a repulsive reaction from the existing alters who

are newly dissimilar. In this case, however, repulsion and attraction are partly

counterbalanced by an additional force- the *inertia* of a social network. The formation of

new ties requires additional effort on the part of the individual. Similarly, eliminating

previous relations requires that the individual overcome established habit, and may

produce conflict with third parties who know both individual and alter. Thus, social

networks possess a type of inertia that tends to perpetuate existing ties, and reduce the

rate at which new ties form. This is particularly the case since any particular individual

has limited resources (e.g. time and money) with which to develop and maintain

relations. As a result, individuals may prove to be quite reluctant to abandon ties that

have existed for lengthy periods, even if normally repulsion would make an association

with the now-dissimilar alter virtually impossible. Similarly, they may refrain from

establishing ties with others whose characteristics (either attributes or attitudes) would normally make them highly desirable. Interestingly, while inertia may make the formation of new ties less likely it does not exert the same influence on the intensification of existing ties. Once a tie has been formed, it may be relatively less expensive to invest additional effort in that tie, rather than to develop a new tie. This process may account for attempts to bring associates from one focus into multiple foci (Feld 1981), and the deepening of relations over time. As a result of inertia, relations should tend to become more multiplex (i.e. involve multiple types of contact) over time, barring the introduction of a repulsive force. To sum up, I define inertia as *the tendency of established ties to persist in the face of dissimilarity, and for existing structural holes to remain unbridged despite similarity, as a consequence of habit and limited resources.*

Stable Configurations:

Particular social systems can be characterized by the relative strength of selection and harmonization. Considering each as a continuum, we can produce four ideal-typical combinations of these two factors. Collectively, they define the four extreme points in a two-dimensional space defining the stable, and unstable, states of real social networks.

When selection and harmonization are both weak, a condition of *stasis* can be said to exist. In such a world ties are unlikely to form quickly in response to the entry of similar individuals and are unlikely to die as a result of new dissimilarity. Thus, the structure of a network will remain effectively stable over long periods of time. Similarly,

with weak harmonization there is little pressure driving new ideas or attitudes further into the network. Likewise, with weak harmonization there is little pressure on the adopters of new ideas to conform with their associates. So, ideological diversity is possible, but at a stable level. As a consequence of these two factors neither the content of a network nor its structure alters very rapidly when in stasis.

At the other extreme, when harmonization and selection are both strong, we have a region of *brittleness*. The strong selection effect drives ties to rapidly form between those who are similar and to disappear in response to new dissimilarity. As a consequence a shift in similarity or dissimilarity will trigger a sudden reorganization of the network surrounding this change point. Likewise, when a new idea or attitude enters a network it may spread, driven on by harmonization, or may be forced out by conformity pressures. Further, if the new idea does spread, each new adoption will trigger additional structural changes. Thus, a change in this network is unlikely but, when it occurs, will shatter the existing configuration. This network is therefore only stable in the sense that it is resistant to change until the correct degree of force is applied, at which point it fractures dramatically and quickly.

When strong selection exists together with weak harmonization it is an area of *punctuation*. Rapid structural change accompanies new similarity and dissimilarity in such areas, but new ideas are not either rapidly spread or rapidly pushed out of the network. As a consequence when an individual adopts a new idea or behavior their existing connections to the group are severed. In response, they likely form new ties to those who are now similar, but leave their previous associates essentially untouched.

Structural change has been minimal and idea spread has been prevented. Thus, punctuation in some sense quarantines new ideas or innovations, preventing them from spreading more widely throughout the rest of the network.

Finally, when harmonization is strong and selection is weak an area of *contestation* is achieved. The structure in such an environment is relatively constant, with little drive to form or eliminate ties in response to similarity. At the same time, strong harmonization either spreads new ideas through a social system rapidly or presses them out of a network in response to conformity pressures. In this environment the challenge to stability derives from ideas moving through stable social relations and the content, but not the structure, is open to contestation.

All four of these ideal-typical combinations of selection and harmonization are summarized in Figure 2.

Figure 2- Selection by Harmonization: States

Associational Substrates:

The influence of selection and harmonization may be contingent, at least in part, on whether the characteristic is an attribute or an attitude. In his dissertation James Moody (1999) applied balance theory to the question of network configurations. Balance theory in its simplest form argues that two individuals who like each other will tend to share the same opinion of a third object. Likewise, two individuals who dislike each other

will tend to disagree in their assessments of a third object. Thus, friends will tend to both like or both dislike a kind of music or a third person. If this is not the case- if one friend likes the third person while the other friend dislikes them- it generates psychological tension. This tension will be resolved either by changing opinions of the third object (e.g. changing one's own opinion to match that of one's associates) or by eliminating a tie (e.g. terminating an association with someone who has different preferences). Moody considered the possible triads that could exist between two people and a third object and rated them according to whether they were balanced or unbalanced. Balanced triads were those that were not psychologically distressing and, therefore, likely to be maintained over time (e.g. ego and alter, who are friends, agree about a third object). Unbalanced triads, on the other hand, were displeasing and therefore likely to change (e.g. ego and alter, who are friends, disagree about a third object).

While a significant number of triads linking two actors and an object are possible, not all of them are immediately reachable from every other triad. Put differently, if only a single change is made either in an assessment of the third object or in a relation to the other actor, some triads can be easily converted into others. Other triads, however, cannot be achieved with only a single change, and must be approached through several different changes and, consequently, several intermediate triads. So, for example, if we begin with a case where no relations exist between the actors or the object and add a single tie, we can transition to one of several different triads, but we cannot transition to the a "saturated" triad where all possible relations exist. Instead, we must step sequentially through several different triads in order to reach this point of saturation.

Using this insight about triads, Moody produced two networks representing the possible attitude and attribute "triad transitions," or the paths through which one triad could be reached from another. These two networks are reproduced below in Figure 3. The types of triads are named according to the standard MAN labeling scheme. MAN refers to the number of Mutual, Asymmetric and Null arcs in each triad. A letter that sometimes follows the numeric portion of the label indicates whether the "direction" of the triad is "up," "down," or "cyclic." Thus, in a triad where all possible ties exist (i.e. each actor picks every other actor) we would apply the label "300," meaning that there are three mutual arcs, no asymmetric arcs, and no null arcs. Additionally, as all ties are mutual, there is no directionality to the triad and no letter is added at the end. Alternatively, if actor A selects actor B, and B selects C, but C is unconnected to A, we would label this triad "021C," indicating that there are no mutual arcs, two asymmetric arcs (A to B and B to C), one null arc (A to C) and that the triad is part of an incomplete cycle (A to B to C to A).

Because attitudes can change, the transition matrix for attitudes (referred to by Moody as "achieved objects") includes a greater diversity of connections. Additionally all triads are reachable from all others, though not necessarily in a single step, increasing the opportunities for random changes to produce both balanced and unbalanced configurations. For attributes, the situation is quite different. From any given unbalanced triad only one of the balanced configurations is reachable and a limited set of other unbalanced triads is available.

Figure 3- Triad Transition Networks

The significance of the triad transition networks is that we can expect balanced configurations of attributes to emerge more rapidly than balanced configurations of attitudes. If we assume that triad transitions are chosen effectively at random when the triad is unbalanced (i.e. that actors do not plan their triad transitions) then the reduced options available for attribute balance should guide individuals into stability relatively quickly. By contrast, the flexibility given to attitudes makes it more likely that random triad transitions will take longer to produce balance.

The implications of these findings are intriguing. A group of individuals who are brought into contact will inevitably develop a system of associations. In this system processes of both selection and harmonization will take place, with selection operating on both attitudes and attributes while harmonization operates only on attitudes. As attributes can only reach balanced configurations via selection, however, and this involves a greatly restricted set of possible triad transitions, it is likely that balance will be reached on attributes before it is reached on attitudes. Once this occurs any selection on attitudes that disrupts the attribute network might be expected to decrease balance more than it increases it, at least in the short term. Put another way, balance on attributes produces a local maximum that makes further changes to the social network less likely. Thus, a selection event that increases balance in terms of attitudes, but reduces it in terms of attributes, will likely produce no improvement, or even a net decrease, in total balance. Selection on attitudes that disrupts attribute networks will, thus, be avoided and achieving

balance on attitudes must then rely on harmonization. It appears likely that attributes produce a sort of associational substrate on which attitudes harmonize. This associational substrate may explain why accounting for attitudinal homophily via demographic variables has been so successful to date.

If this argument is correct we might reasonably make several predictions about selection and harmonization. First, when brought into association a group of previously unacquainted individuals will achieve homogeneity on attributes before doing so on attitudes. Second, it is less likely that a tie will change to achieve homogeneity on attitudes (selection) than that the attitude will change (harmonization). Third, selection that increases homogeneity on attitudes will occur primarily when both the previous and new associates are homogeneous with the ego on attributes. Finally, attitude homogeneity should be found where there is attribute homogeneity and, conversely, attitude heterogeneity is also likely to include attribute heterogeneity. Readers familiar with the homophily literature will recognize that this fourth prediction matches common empirical findings. The preceding three predictions, and the reasoning underlying them, provide the micro-level mechanisms that produce such a consistent macro-level effect.

In the preceding chapter I have explained the nature of selection and harmonization in some detail, decomposing each into a set of three factors. I then discussed the various ways that selection and harmonization can influence one another and why these influences are important, as well as how the differences between attributes and attitudes can be relevant. In the next chapter I introduce the data I use to explore selection and harmonization and discuss the characteristics of my sample.

CHAPTER 3: DATA

This chapter introduces the National Longitudinal Study of Adolescent Health and describes how it acquired the data used for this research. The advantages and disadvantages of this data source and the subset of data useful for analysis are described. The specific data used for this research is then summarized.

Survey Design:

In order to examine the evolution of a social network as a result of harmonization and selection, it is necessary to utilize overtime network data. This data must include both information on social ties as well as data on attitudes and attributes. All of these requirements are met by the National Longitudinal Study of Adolescent Health, or Add Health.

The Add Health is a nationally representative survey of adolescents in grades seven through twelve administered by the Carolina Population Center of the University of North Carolina.[3] This project has received funding from the National Institute of Child Health and Human Development, as well as numerous other federal agencies, and represents the largest and most comprehensive study of U.S. adolescents ever undertaken.

The Add Health includes a wide variety of different types of data including attitudes and beliefs about sex, disease, and illegal substances, urinalysis data to discover actual substance use levels, social network data tracking the associates of respondents, contextual information on respondents' home lives, and a variety of other factors. Importantly, these data have been gathered not just once, but over time in a series of waves. Since the first wave, collected in 1994, the Add Health project has followed many of its subjects into early adulthood and continues to track their progress, allowing researchers to gauge the relationship between adolescent characteristics and life outcomes. While the Add Health has its flaws, it provides some of the best data available on the process of maturation in American society.

The social network data in the Add Health is particularly impressive and forms the core of this dissertation research. While the total Add Health has over 25,000 respondents nationwide, a smaller set of twelve "saturation schools" provide the most complete network data. Within these schools the attempt was made to sample all students, yielding nearly-complete network data on 3,099 respondents. As schools are in many ways naturally bounded social networks, such data are unusually comprehensive. The collection of this network data was first carried out in wave I of the Add Health, and then repeated in wave II, providing a pair of network snapshots separated in time. In the first such snapshot, while respondents should be rooted in highly homogeneous sets of associations, some number of them will be connected to alters who differ in terms of attitudes or attributes. These differences reflect the fact that, while stability predominates in many social networks, disagreement and difference are also persistent parts of any real

group. Attitudes shift over time and so some amount of attitude dissimilarity should

always be present. Similarly, attribute differences make association less likely, but not

impossible. Therefore, at any given time some ties should incorporate attitude or attribute

heterogeneity. Comparing this momentary network snapshot to a second sample taken

later in time permits me to analyze the evolution of the social networks in these schools

as a result of selection and harmonization. In total, of the original sample size, 2,225

respondents are available from these saturation schools at time one and time two,

allowing a thorough examination of network evolution.

The precise wording of the network question asked in the Add Health data

collection is as follows:

"List your closest < Male/Female > friends. List your best < Male/Female > friend first,
then your next best fiend, and so on. < Girls/Boys > may include < Boys/Girls > who are
friends and < Boyfriends/Girlfriends >"

Students were provided with a roster of names drawn from their school, allowing

them to find the full name of their associate. Additionally, this roster method provides an

aid to recall, allowing students to remind themselves of friends they might otherwise

forget. In addition to this roster, an option was provided so that respondents could

indicate a friendship with someone not included on the roster. While it is possible to

determine from this how many students have friendships beyond the school context, no

further data is available about these individuals. I do not analyze them here, but very few

respondents in my school of interest chose this option. Additionally, I analyze only

respondents who are present in both waves of data. This unavoidably excludes some

seniors who graduated in the interim, but is necessary due to limitations in my analytic techniques. Due to the preference for association within grade however (e.g. Chapter Five) this has a relatively minor impact.

The collection of the Add Health data occurred in several distinct phases within each wave. The primary type of data collection was via a nearly-complete in-school survey of adolescents. Paper forms were distributed to all students present in school on the day of data collection and all students were asked to participate. This attendee sample was then supplemented by in-home interviews conducted by a member of the research team. In the Add Health in general respondents surveyed in-home were selected at random from those who participated in the in-school survey. This phase of surveying utilized both face-to-face interviews, as well as an A/CASI (Audio Computer Assisted Self Interview) system which allowed the respondents to complete sensitive portions of the survey in relative privacy, using headphones to listen to the questions and a computer to respond. This methodology allowed the adolescents maximum freedom to respond truthfully to questions about sexual activity, desires, drug use, and other issues without the risk of disclosing to parents, other family, or friends. Moreover, as even the interviewer was unaware of the respondent's answers this methodology avoided many potential interviewer effects. In the case of the saturation schools, instead of a random sample, the attempt was made to conduct in-home interviews with all students. Thus, the saturation schools in many ways provide the richest and most complete data for network analysis. Finally, in addition to the standard in-home interview components, a number of bio assays were performed in the in-home interviews, including tests for drugs and STDs.

As this data is not employed in the current project, I do not consider it further here. In wave II this same data was collected from those who participated in the first wave of data collection.

While adolescents present their own unique problems in research, they comprise an ideal population of interest for this study. There are two reasons why adolescents are so valuable for this research: the natural boundaries on their associations and the diversity of the population as a whole. Adolescents are compelled to spend a significant portion of their time within the school context, spending eight or more hours a day in physical proximity to the same group of people. Moreover, as most schools serve the local geographic areas, the school population is resident within a limited area. As a result, the school provides a naturally bounded social network. Associations within school are likely to reflect associations outside of the school context. Further, these associations are likely to comprise a large proportion of the adolescents' total ties, particularly as many of the subjects have known each other since childhood and have moved through the educational system together. While adults have often had a considerable period to develop relations with a variety of others, many of whom may derive from contexts other than the one in which the individual is currently lodged, adolescents have not had this time. Their relatively lesser experience means that the school context more fully contains their associations than similar institutions do for adults. For adults, in contrast, association is defined by multiple overlapping foci of association and ties may knit one together with co-workers, co-religionists, and neighbors. Thus, while many of the same dynamics

likely play out for both adults and adolescents, it is relatively easier to obtain the needed data from adolescents.

The second advantageous property of adolescents also stems from their relative lack of life experience. In this case, however, this is an advantage not because it limits their contacts, but because adolescents are not set in their ways. As a result, considerable experimentation occurs in this population. Put another way, the distribution of ideas and behaviors has yet to reach an equilibrium state. As a consequence, the introduction of new ideas and attitudes should be more frequent among adolescents than among adults, and their adoption is likely to occur somewhat more readily within this population. The result is that it will be easier to observe harmonization events among adolescents than in the adult population. This property certainly implies that extending my findings to adult populations will require some modifications, but it is likely that the differences will be ones of scale rather than of kind. Adolescents will behave similarly to adults, but in a compressed timeframe. Along similar lines, while schools draw from a relatively restricted geographic region, they are still often sites of considerable diversity. Members of a number of racial, ethnic, class, and other groups will be merged into the overall student population. While it is certainly the case that large diverse groups offer considerable opportunities for homogeneous subgroups to form (McPherson and Smith-Lovin 1982) it is also true that diverse associations cannot form in the complete absence of difference. Even with the existence of cliques and small friendship groups there remain opportunities for contact with those who are different and, thus, significant chances for both selection and harmonization to occur.

While the saturation schools often encompass substantial diversity, it is also important to keep their structural influences in mind. In order for students to attend a given school they must reside within its geographic area. This, at a minimum, constrains the sample to those teens who live nearby and, thus, forces all such respondents to be more similar to one another than is the population at large. Moreover, the prevalence of informal residential segregation by class and race means that some of the diversity within a geographic area may not be represented within a particular school. As such, it is important to keep in mind that structural forces have already induced a certain amount of selection prior to the beginning of this study.

Sample Characteristics:

As the data are nationally representative, the sample drawn from the saturation schools is similar to the nation as a whole. The adolescents are split approximately equally between males and females, with 48.24% female and 51.76% male. Racially, the sample is predominantly white (53.73%) with blacks (16.49%), Native Americans (3.39%), Asians (18.27%), and those of other non-white race (12.64%) making up most of the remainder (Table 1). Approximately 710 respondents (22.95%) self-identify non-exclusively as Hispanic (Table 2) reflecting the growing importance of this group.

Table 1- Basic Demographics

Table 2- Hispanic Students

Discussion of race in these data is complicated by the presence of several multiracial respondents. Roughly 5.33% of the sample identifies themselves as multiracial. Of these individuals, 93.51% are biracial and 6.49% are triracial. The most common single multiracial type is White/Indian, which encompasses 46 respondents. It is difficult to speculate with any certainty on the associational consequences of multiracial identity. Likely two factors are of primary importance: the respondent's apparent racial membership and their racial identity. Apparent racial membership reflects the racial assignment that observers make based on the respondent's appearance.[4] Thus, multiracial individuals who appear to fit clearly within a specific category (e.g. Caucasian) will likely be treated that way by others. Unfortunately, research suggests (Herman 2007) that observers are unlikely to correctly determine a given person's actual ethnic background, and so it is difficult to predict the social impact of a multiracial background from respondent self-report data. Racial identity, or the respondent's own self-assessed race, is more likely to prove useful as it will have an impact on that person's selection events. In other words, if one identifies as African American then one will enter into contexts containing other African Americans. At the same time, if racial identity differs too much from apparent racial membership, the respondent will continually be struggling to win reciprocated ties from others who perceive a difference between them. Alternatively multiracial identity could either enhance sociability, essentially allowing individuals to

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[4] It is, of course, true that race is itself a social constructed concept. Nevertheless, for any particular observer at a specific moment in time, the available categories of race are provided by their society and as such can be taken as givens.

pass more fluidly between two otherwise distinct communities or, possibly more likely, impair the multiracial individual's ability to take part in either group's culture. On the other hand, individuals of multiracial birth may be exposed to a more diverse set of ideas and as a result may themselves act as significant loci of harmonization. In effect, multiracial persons may be the carriers of an unusual diversity of attitudes and therefore stand a better chance of setting off new harmonization events. While the number of multiracial persons in these data is relatively small, examining their impact on harmonization and selection processes in future studies may well be informative. For the current study, relatively few of the respondents identify as multi-racial and, as a consequence, they should not significantly complicate analysis (Table 3).

Approximately half of those who report Hispanic ethnicity claim other non-white race (54.38%). Additionally, 38.14% of Hispanics identify themselves as white and, together with other non-white Hispanics, account for the majority of all Hispanics.

Table 3- Multiracial Respondents

While a significant percentage of the sample is Hispanic relatively few respondents were born outside of the U.S. or off of American soil. Only 12.56% report that they were not born in the U.S. or on U.S. soil abroad. Despite this relatively small number, 17.66% report that English is not the primary language spoken at home (Table 1). These figures suggest that substantial immigration into the United States is taking place, and that much of this immigration involves bringing children into the country. The

difference between these quantities, however, implies that almost as many of these immigrants are having their children after arrival.

Finally, the distribution of grade levels at Wave I reflects a concentration in the sophomore and junior years. These two years account for 55.22% of the total sample, indicating that most of the respondents are not entirely new to their social environments. Likewise, the majority of students have at least one year left in high school before departing for college, vocational school, or the employment market. As such, their attention should still be relatively focused on the school environment and their school-based concerns, and not oriented towards the future. This is beneficial for the present study in that it will limit the tendency of the respondents to allow relationships to lapse either because they no longer expect to have time for them, or in the interest of new extra-scholastic ties that better prepare the respondent for their next life stage. Finally, 2.23% of the respondents report not presently taking part in school. This is not expected to pose a problem for this research both because the number of such students is low and because many of their associates are still likely to be drawn from their own age cohort and, therefore, they remain rooted into the extended school social environment.

The preceding describes the saturated schools as a whole but for the purposes of this study I focus on a single school that I term Black River High School. I limit my study to a single school because my chosen method of analysis (see Chapter Four) is unable to accommodate more than one school at a time. Additionally, the computational burden imposed by my analytic method forces me to balance the benefits of additional power (generated by a larger sample size) against the drawbacks of extended computation times

(generated by larger networks). As such, Black River provides a good balance between power and mathematical tractability. Black River has certain other benefits (discussed below) centering on its relatively high degree of ethnic homogeneity. While this limits my ability to study the impact of ethnicity on association, it eliminates a potential barrier to association that is already well-understood, thereby permitting the study of new areas about which less is known. While I cannot identify Black River directly, I can indicate that it is a public high school in a rural area of the Midwestern United States.

The population of Black River (Table 4) is slightly more male (52.52%) than female (47.48%) and is overwhelmingly white in ethnicity (98.92%). While each of the other races (Black, Native American, Asian, and Other) is represented at Black River it is almost always in the form of multiracial individuals. Almost all multiracial individuals claim to be at least part Caucasian and the most common type of multiracial individual is White/Indian. Approximately one percent of the population identifies as Hispanic and nearly all of those individuals also identify as Caucasian. Less than one percent of the respondents at Black River were not born in the United States or on U.S. soil. Most individuals who were not born on U.S. soil self-identify as white. Less than one half of one percent report not speaking English in the home but all such individuals identify as white. Black River is, therefore, composed almost entirely of Caucasian, native-born individuals who speak the same language in the home as they do at school. Of those students at Black River who are not native born and do not speak English in the home, almost all belong to the largest native ethnic group.

Table 4- Black River Basic Demographics

The population at Black River high school is also slightly younger than in the saturation schools generally with a plurality of the students in ninth grade (29.03%). The largest other single group of students found in the sophomore year (tenth grade), accounting for 27.92% of the population. Collectively, these two grades account for 56.95% of the student body. While this distribution of grade levels is somewhat different from that in the saturation school population at large, it is relatively advantageous for my purposes. Because more of these students are at an earlier stage in their education there is a lesser chance that they are beginning to think about future life stages and disconnect with their present associates. Additionally, their relative youth permits more opportunity to adopt and shed behaviors and beliefs, essentially making selection and harmonization easier to detect. In a school skewed towards the older grades we would expect greater stability and, therefore, fewer opportunities to observe shifts of these types. Additional descriptive statistics are provided in the substantive chapters.[5]

With such rich data it is necessary to identify an appropriately capable analytic method. In the next chapter, after a brief discussion of the complications of analyzing longitudinal network data, I introduce my analytic approach: the Siena longitudinal network model.

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[5] A breakdown of the types of multiracial individuals is omitted as it might permit the reader to uniquely identify the school I refer to as "Black River" and, therefore, would violate the security requirements for use of the Add Health data.

CHAPTER 4: METHODS OF ANALYSIS

This chapter discusses the pitfalls of analyzing social network data in general and longitudinal network data in particular. It then introduces the Siena longitudinal network analysis model and explains how it avoids many of these difficulties. Technical details of the modeling procedure are briefly discussed and structural features of the network are explained. Finally, proper interpretation is described using an extended example.

The History of Dynamic Network Analysis:

The challenge in investigating the joint impact of selection and harmonization has always been one of observation. Network data are most commonly gathered in a cross-section. This provides a network snapshot at one point in time which is often extremely detailed but leaves open the issue of change. As a result, assumptions must be made about the dynamic behavior of networks. One of the most common assumptions, that networks are in a state of equilibrium when sampled, is probably reasonable. Many networks are not new and therefore have had the opportunity to reach a stable state. While this process has been described theoretically (Friedkin 2001), however, it remains to be empirically validated. It is additionally the case that there is theoretical reason to doubt that networks are able to arrive at a true equilibrium state (Moody 1999). If this is the case then equilibrium for a social network is defined by constant movement and change, rather than a static configuration of relations. Under these circumstances, an

understanding of a network at any one single moment in time will require an understanding of the patterns of change that characterize that network.

Other assumptions about cross-sectional network data are less reasonable. It is sometimes assumed for example that network structure is the result of individual preferences. It is well understood, however, that many constraints can guide network formation both by encouraging some types of ties and discouraging others. Gwen Moore (1990) provides one example of the operation of constraints in her examination of male and female social networks. While she employs ego-network data from the General Social Survey she explains a substantial amount of the difference in male and female network composition through factors such as employment and child rearing that typically impact males and females differently. Thus, in this case, it appears that men and women do not "choose" different kinds of networks but, rather, are guided into them. Unfortunately, a full understanding of the role of constraints in shaping networks is impossible to develop without the ability to study network change through time.

Attempts to examine the dynamic behavior of networks have been relatively sparse, but are growing in frequency. One of the first studies of network change is Sampson's study of association patterns in a monastery (Sampson 1968). This early work tracked both changes in association as well as patterns of regard. While not originally intended as network research, his in-depth depiction of a small group of highly regimented individuals developing informal approaches to social control has set an example for future researchers. It has, additionally, provided a classic data set that is often used in describing both network concepts and new analytic methods (e.g. Bonacich

and Lloyd 2004; Reitz 1988). At the same time, however, Sampson did not set out to conduct a network study and largely constructed his dataset of relationships through recall. Thus there is significant room for methodological improvement.

In a less cloistered setting, Theodore Newcomb (1961) used residents in a college dormitory as a sample population to study friendship formation. His results suggest that stability predominates after a brief period of haphazard relationship building, and that harmonization plays a significant role. At the same time, his subjects exchanged room and board for their participation in the study and, as such, had a strong motivation to remain in the same context. Put differently, individuals who might naturally have changed residences to avoid each other may have remained in the dormitory for economic reasons, thus granting harmonization an unfair advantage. This external influence may have made selection almost impossible, obscuring any impact that it might otherwise have had.

James Moody (1999) used the Add Health data in his dissertation research to identify the determinants of friendship formation. He was able to validate the importance of balance theoretic ideas to the formation of relationships as well as show that both harmonization and selection do take place in an adolescent population. His excellent study, however, predated the advanced models that I use (see below) and so provides only a hint at how selection and harmonization mutually influence each other. Additionally, he spends relatively less time examining how various ideas and behaviors might constrain friendship formation and, instead, focuses on demographic variables. While certainly interesting, these sorts of relations represent only a substrate for other

types of associations and do not answer questions about the movement of ideas through a population.

Finally, McPherson, Smith-Lovin and Brashears (2006) used two waves of ego-network data to study changes in the average American discussion network over a period of twenty years. The General Social Survey, a representative sample of all non-institutionalized American adults, has gathered data on American ego-networks at two points in time: 1985 and 2004. This survey asks respondents with whom they discuss "important matters" and then gathers specific information on up to five alters. This includes the alters' age, race, education, religion, and sex. They found that the average size of a strong tie network has declined by one person over the period studied. Unfortunately, while this is one of the most representative network studies to date, its reliance on ego-network data from different sets of respondents means that it is impossible to determine how individual networks evolve over time. It is additionally difficult to be certain that a downward trend is in evidence, given that only two time points are available. What can be inferred is that the equilibrium state of American social networks is tending towards a smaller size, but the manner in which this change is occurring is presently unknown.

These existing studies, while certainly not the only work on dynamic networks, provide useful context for the study of selection and harmonization. Nevertheless, none of these studies take the relationship between selection and harmonization as a primary focus of study. Additionally, none of them use the sophisticated longitudinal models that my dissertation employs. Thus, I add to the literature both by exploiting new

developments in modeling as well as by directing attention specifically towards the issue of selection and harmonization.

The Add Health data represents not only one of the largest network datasets available, but also one of the few that has any over-time information. As a result, it provides a unique opportunity to explore the effects of selection and harmonization, as well as to see how these forces generate network structure. With this over-time data it is possible to determine if similarity precedes tie formation (selection), or if tie formation precedes similarity (harmonization). Likewise, it is possible to examine whether a decrease in similarity results in the loss of that relationship. More concretely, the Add Health data comprise two distinct survey waves, each including social network data. We may, therefore, observe changes between these two times and relate those changes to conditions at time one. Ties between alters with dissimilar attitudes are more likely to disappear between time one and time two. Similarly, individuals who have similar attitudes but no social tie should be more likely to develop such a tie than those with dissimilar attitudes. Both of these processes represent selection effects. Similarly, the adoption of new attitudes should be more likely if an individual is tied to one or more alters who have dissimilar attitudes. More specifically, alters should become more similar in terms of attitudes over time as harmonization takes place. While both of these processes will operate simultaneously, the over time component of the data permits the disentangling of each process, and allows for serious investigation of their mutual impact on social networks.

At a more complex level, the techniques I employ would hypothetically allow me to examine how these effects express themselves at a larger structural level. While, as a result of harmonization, attitudes will likely converge over time, the rates with which particular regions of the network converge should be determined by their connectivity. As selection breaks ties between dissimilar alters, we can reasonably expect more and less isolated network regions to emerge. These sectors of the network will act as extended cliques, maintaining relative homogeneity internally, while remaining distinct from their more distant clique neighbors. Put another way, extended structural holes may form between particular network regions, gradually opening into chasms. Each of these chasms will act to impede the spread of new information even as they insulate and protect existing attitudes and behaviors. As a result, the level of selection will not only produce dyadic effects, but can also rewire the entire network. In this way it should be possible to see how the balance of selection and harmonization actually produces particular higher-level network structures that will themselves influence the possible success of later harmonization. Duncan Watts (1999; 2003) and others (Boase & Wellman 2001; Huang et al. 2004) have shown that network structures may become susceptible to epidemics at certain connectivity-based thresholds. My research argues that such epidemics may be stymied by the impact of similar previous events. Human social network structures may be more adaptive than we have previously considered, altering to contain spreading attitudes and ideas. While many of these higher-order effects cannot be addressed in the current study, as only two time points are available and I can only examine a single school, future work should be able to compensate for this somewhat by comparing

different schools and seeing how their differing large-scale structures are related to smaller scale selection processes.

Within the context of the Add Health data it should be possible to evaluate several of the theoretical assertions made above. The Add Health contains questions identifying both the five closest male and the five closest female friends that the respondent has.[6] For each of these alters data is gathered on grade level, as well as a variety of other characteristics. The large number of different behaviors and beliefs that are recorded by the Add Health will also permit me to investigate a series of different contexts. This should allow me to identify several of the ideal-typical combinations of selection and harmonization discussed in Chapter Two. Beyond this theoretical value, such an examination will also serve a useful substantive function, allowing me to cast light on how adolescents develop and maintain particular behaviors and beliefs. Some habits developed in adolescence may persist for years or decades and, as a result, understanding this period of maturation is critically important.

Modeling Approach:

While the Add Health data are appropriate for this study, the selection of methods for analysis is equally critical. Traditionally, longitudinal network data have been very difficult to analyze due to the intense level of dependence between observations. This dependence has made deterministic solutions impossible and often imposed an

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[6] That is to say a maximum of five male and five female ties. Respondents are not compelled to nominate that many individuals.

insurmountable computational burden on researchers. Fortunately, procedures now exist for analyzing network data of this complexity.

Initial data preparation and analysis used the Stata statistical package. This powerful, and flexible, application is capable of most common statistical procedures, as well as a number of uncommon procedures. Stata will be useful for basic description of the data as well as for parsing the dataset into a form usable in the second stage of research. Stata will not, however, suffice for stochastic longitudinal network analysis.

The network analysis itself employs a Markov Chain Monte Carlo method to develop a stochastic model of network behavior (Snijders 2001). This approach has several desirable properties for the current research. First, it is actor-oriented and therefore includes the assumption that large-scale network phenomena are constructed out of repeated smaller-scale processes. As such, a tendency towards densely interlinked cliques does not occur because the cliques themselves are favored, but rather because preferences towards reciprocity (i.e. if actor i selects actor j, then actor j also selects actor i) are high. Similarly, the size of cliques may be partly determined by other actor-level characteristics. If transitive triples are preferred (i.e. if i selects j, and j selects k, then i also selects k) but there is an avoidance of sending more than two ties at a time, then most individuals will be situated within tight transitive triads with few connections beyond them. In such a case cliques will be numerous, small, and isolated. An example of the sort of small-scale structural characteristics that can be modeled using this approach is provided in Figure 4.

This focus on the development of higher-order effects out of dyadic interactions is critical for a simple reason: most individuals do not develop their networks strategically. Instead, networks emerge because individuals make idiosyncratic choices without necessarily considering the larger strategic concerns. Certainly the importance of "networking" has become more widely recognized in recent decades, but even with such recognition the ability of any individual actor to determine their own position and then act on it is limited (Krackhardt 1987). Thus, were an individual to desire to prune their network for some purpose they would be unlikely to possess the necessary information. Even if such intentions existed, and the knowledge was available, an individual might refrain from sculpting their network lest they commit what Ronald Burt (1992) refers to as an, "interpersonal flatulence." Trimming one's contacts into their most advantageous form in too obvious a manner is likely to provoke resentment from associates and ultimately prove counterproductive. Thus, even individuals who have the ability and desire to attempt to build their networks from the top down may prove unwilling to do so. This is not, of course, to imply that individuals never deliberately develop ties for strategic reasons, but rather only that such behavior is not common. I model a world where individuals make their associative choices based on their assessment of local structure, rather than some grand Machiavellian scheme. As a result, while self-interested individuals likely send ties to those who appear most advantageous given their own position, they may miss still more valuable opportunities that are not immediately apparent. The model therefore builds an account of social behavior without making unrealistic assumptions about human cognitive ability and resources.

Secondly, my approach is advantageous because it allows the fitting of parameters for each of the smaller level structural properties specified by the researcher. I employ the Siena longitudinal network analysis software[7] which uses the Robbins-Monro (1951) process to iteratively determine parameter values. This method-of-moments procedure iteratively determines the set of parameters that are most likely to account for the observed network if, indeed, the structural form of the model has been specified correctly. The result of this process can then be assessed using standard errors to determine if the calculated parameters are, indeed, statistically distinct from zero.

Figure 4- Structural Features of a Network

Third, because each node in a network might, hypothetically, have its own preferences for reciprocity, transitivity, and a host of other structural features, the number of parameters that can be specified rapidly exceeds the available data by many orders of magnitude. As a result, it is necessary to constrain some parameters in order to make the model estimable. These constraints are most commonly imposed by forcing all nodes to share the same parameters, which is equivalent to an assertion that members of a particular network or group share the same basic tendency towards reciprocity, transitivity, or some other basic network feature. This is comparable to the regression assumption of random errors- that a single common relationship between the variables of interest exists and deviations from this relationship are due to errors in measurements or

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[7] All models are estimated using Siena v.3.1 developed by Tom Snijders and his associates.

random perturbations. In my case, a basic preference for reciprocity is assumed to be held in common among individuals and differences from this basic level are effectively random variation. More complex patterns of constraint are also possible and in this case useful. Homogeneity constraints can be imposed on particular sub-sets of nodes, while allowing those sub-sets to differ from one another, in a manner that is intuitively similar to the process of generating interaction effects in regression models. So, males might be constrained to share the same parameters, and females might be constrained to share the same parameters, but males and females could differ from each other. So long as the number of such groups included in the model does not deplete the available degrees of freedom, this flexible approach to constraint permits the comparison of various sub-groups within the same network. By making the specification of constraints flexible, differences may be allowed in parameter values both between groups and over time.

Finally, this approach can accommodate the study of traits and attitudes in addition to network parameters. The model in general, and Siena in particular, regards attributes, attitudes and behaviors as belonging to one of three classes of variables. First, they can be time-invariant independent variables. These are factors that may influence network structure or dependent variables but that are stable themselves throughout the span of the research. So, biological sex would in most cases be a time-invariant independent variable in that it will not change but can impact patterns of association. Second, there are time-variant independent variables. These are similar to the time-invariant case above except that these variables are permitted to change as a result of exogenous factors. So, in a group of students grade (i.e. first, second, third, etc.) will

periodically change as a consequence of aging but not as a result of respondent behavior or preferences. It is important to note that time-variant independent variables can only be included when data are available from three or more time points. If there are fewer than three available waves of data (as in this dissertation) it is impossible to calculate the parameters accurately and they, effectively, reduce to the simpler time-invariant case. Lastly, there are dependent variables. In this case in addition to modeling the development of the network as a set of structural relations among participants it is possible to model the value of an additional variable or variables as a consequence of those structural relations or of other variables in the model. So, for example, we might examine the impact of the network structure on grade point average. In such a case the network itself becomes both an independent variable- predicting GPA- as well as a dependent variable that is modeled in its own right. It is additionally important to note that Siena can accommodate more than one dependent variable in a given model, though it is limited to a combined total of approximately eleven independent and dependent variables.

To understand how this fits together in an actual model, consider for a moment high school students. We might be interested in student grade point averages but, given that high school is a stressful time, we might also be interested in the degree of happiness reported by students. These then become our dependent variables. We then can propose various independent variables that might impact these factors such as sex and parental socio-economic background. Finally, we must take the structure of the network itself into account. Good students likely provide mutual support for each other's study habits.

Likewise poor students thwart one another's efforts to improve their grades. A change in someone's network, however, might decrease happiness even if it raises one's GPA. In the eventual model we specify the dependant variables and the network in a relationship of mutual causation and the independent variables as influencing both network structure and the dependent variables without themselves being affected in return.

Figure 5- Example Model

I model network change using a continuous-time Markov Chain Monte Carlo (MCMC) approach. As such, the data are taken to be observations of an otherwise ongoing process and changes are made at stochastically determined times. While the Markov chain typically requires dyadic independence- that each individual two-person relationship be unaffected by others- actual social relations are unlikely to behave in this manner. Obviously, one relationship can impact another, giving rise to the expression, for example, that the enemy of my enemy is my friend. The relationship between two other people can influence my relationship to either or both of them violating the assumptions of the Markov chain approach. To deal with this problem, model parameters are constrained and freed in alternation, gradually converging on a set of stable parameter estimates.

To account for the pattern of changes in a social network, this research utilizes the assumption that individual actors strive to produce the most positively evaluated configuration of ties possible. Put another way, individuals prefer that their networks be a

certain way and will take action to achieve that state. This may mean that actors prefer

reciprocity, that they desire demographic similarity, or that they prefer attitudinal

similarity, but whatever is "pleasing" to the actors will guide their selection of alters and

choice of behaviors. It is important to note that these preferences are not necessarily

regarded as conscious or purposeful on the part of the actors. A preference for

transitivity, for example, may reflect the simple reality that two people who know each

other are more likely to share mutual friends than two people who do not know each

other. In this case there is no necessary desire for transitivity on the part of the actors, but

the model proceeds as though there were. While it is not necessary to disabuse the

mathematical model of this illusion it is necessary to keep this caveat in mind when

interpreting effects.

These preferences, be they positive or negative, are embodied in the objective

function, a quantity that reflects the degree of satisfaction an actor feels for the current

state of their social network. When the value of the objective function is high the actor is

very satisfied and, therefore, unlikely to make changes to their network. When the value

is low, however, the actor is dissatisfied and very likely to make changes to their

network. All parameters in these models reflect the effect that a particular structural,

behavioral, or attitudinal change will have on the objective function and decisions are

made by actors so as to maximize the value of the objective function. Equation 1 gives a

simplified formulation of the objective function.

Eq. 1: $f_i(\beta, x) = {}^{L}\Sigma_{k=1} \beta_k s_{ik}(x)$

Where:

    i is the actor making a choice

    x is an adjacency matrix

    β_k is a vector of parameters

    $s_{ik}(x)$ is a set of effects

Actors are further assumed to have no memory of past relations, reacting only to the present state of the network (in accordance with the principles of a Markov chain) and have perfect knowledge of the present state of the network. Finally, actors are assumed to make decisions without constructing long-range plans, reflecting the somewhat short-sighted nature of human decision making. Finally, when actors make a change, the decision to add or remove a tie is made randomly. Once this random choice has been made, however, which tie they add or remove is determined by the level of benefit the change will produce, with a random component inserted by the model to reflect the fact that decisions are not always made wisely.

To illustrate how this works, let's consider a hypothetical set of parameters as well as a hypothetical social network. The parameters selected for this example are: number of ties, reciprocity, transitivity and sex homophily. Number of ties, with a negative coefficient (-4.00), simply reflects that each tie an individual maintains costs them time and energy. Thus, net of other effects, adding ties to random others is unlikely to be a rewarding experience. Reciprocity, with a positive coefficient (+3.00), reflects

that individuals prefer to take part in relationships that are mutual rather than unrequited. Transitivity, with a positive coefficient (+1.5), indicates that it is generally pleasing for us to have relationships with the friends of our own friends. Finally, sex homophily has a positive coefficient (+2.5), indicating that relationships tend to be segregated by sex.

Table 5- Hypothetical Parameters

We can now imagine two friends, Steven and Bill, who have a stable dyad. Into this relation, however, comes Sarah, Bill's new beau. This presents Steven with a dilemma as he is now lodged in an intransitive triad- he does not have a relationship with the associate of his friend Bill. Steven can resolve this situation in one of three ways. First, he can permit the intransitive triad to persist and accept the negative consequences of not developing a friendship with Sarah. We can calculate the value of Steven's objective function if he chooses this course: he has one tie, that one tie is reciprocated, he is not a part of any transitive triads, and his one tie is sexually homophilous. So, his objective function is worth $f_i(\beta,x)= -4(1) + 3(1) + 1.5(0) + 2.5(1)$ or 1.5.

Figure 6- Intransitive Solution

Next, Steven could develop a tie to Sarah, closing the transitive triad. We can, again, calculate the value of Steven's objective function which now contains two ties, one of which is reciprocated, one transitive triad, and one sexually homophilous relationship.

So, the new value of his objective function is $f_i(\beta,x)$= -4(2) + 3(1) + 1.5(1) + 2.5(1) or -1. If we assume that Sarah is receptive to Steven's friendship, however, and that she reciprocates his tie then the value of the objective function becomes 2. This implies, unsurprisingly, that were Sarah not to return Steven's friendship he would likely grow frustrated and discontinue his efforts at developing a relationship.

Figure 7- Unreciprocated Transitive Solution

Figure 8- Reciprocated Transitive Solution

Finally, Steven can choose to withdraw his friendship with Bill, eliminating the intransitive triad without developing a new relationship. In this case, because Steven has no friendships, the value of his objective function becomes zero. While being a social isolate does not impose any costs in this model, it also does not realize any benefits. Thus, in this case, we would predict that if Sarah is receptive to Steven's friendship then he is most likely to close the transitive triad by developing a friendship with her (i.e. Reciprocated Transitive Solution). If, on the other hand, she spurns Steven's friendship, then he is most likely to simply maintain the existing relationship with Bill and accept the intransitive triad (i.e. Intransitive Solution).

Figure 9- Isolate Solution

In summary, the model selects an actor at random and grants them the opportunity to make a single change to their network: add a relation, delete a relation, or change an attitude or behavior. What they elect to do depends on the course of action that will yield the largest objective function. A new actor is then chosen and new choices are made with the process iterating so as to allow us to determine the fit of the model to data. While this method relies on a simulated network and therefore does not allow us to replicate the exact sequence of events that produced the observed network, we should produce a network that has the same properties as the observed network. Therefore we can use a stochastic model of network evolution despite our lack of detailed information about the events occurring between observations.

At this point attentive readers have no doubt noticed my use of a language of preferences and tendencies. It is therefore natural to ask if this means that I view actors as rational, maximizing the benefits that they obtain from their networks. While I do not want to go too far and assert that humans do not act rationally, I also do not wish to give the false impression that I believe them to be flawlessly logical in their behavior. I take the theoretical stance that humans do behave strategically but, in most cases, simply continue to do what is pleasant and stop that which is unpleasant. Additionally, while it may be convenient to discuss effects like transitivity as though individuals find them rewarding, it is instead likely the case that transitive structures are simply more likely to emerge under certain conditions. In other words, a variety of structural forces outside the control of any actor are subsumed into a "preference" for a particular outcome. As the model treats actors as though they are strategic planners, however, I adopt a matching

language to ease the explanation of the model itself. I do not, however, intend the reader to take this to mean that I believe that the model is a reflection of true human processes. It is a mathematical abstraction that is useful for understanding the world but, nonetheless, is not a perfectly faithful reproduction of it.

While a powerful modeling technique there are certain weaknesses that must be taken into account. First, this approach is extremely computationally intensive. The Robbins-Monro process is advantageous in that it is highly robust and distribution free, allowing us to produce parameter estimates without making (potentially unsupportable) assumptions about the underlying parameter distributions. Unfortunately, however, it is inefficient and requires a substantial amount of data as well as a large number of iterations in order to reach stable estimates. As a result producing models using some of the smaller schools present in the Add Health data can require as much as thirty-six hours. Larger schools, such as Black River High School, can take weeks to produce stable parameter estimates.[8] It is, therefore, necessary to carefully plan models in advance and making incremental improvements to model fit is prohibitively difficult.

The second serious drawback is that Siena can only deal with approximately eleven actor-level variables at a time. This is true regardless of whether these are time-invariant independent variables, time-variant independent variables, or dependent variables. This means that only a handful of actor level factors can be included in any given model. This drawback is partially mitigated by two interrelated factors: first, that the desirability of parsimony makes models incorporating large numbers of variables

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[8] The most time-intensive model I have run to date required forty-four days of computation to reach convergence with typical models requiring between one and two weeks.

inherently less valuable than simpler, more straightforward models. As a result this issue is less a drawback and more an inconveniently strong motivator to keep predictive models simple. Second, while the total number of variables is strongly limited, Siena is capable of estimating interactions between any of these variables. Thus, it is more accurate to say that Siena can accommodate eleven actor-level main effects, as well as a large assortment of interactions among these variables, and between these variables and structural features of the network itself. While this does allow the eleven variable restriction to be bypassed to some extent a large number of interactions will, inevitably, produce power issues. Thus, whenever possible models are made minimally complex.

The third and final serious drawback of this approach is that multiple starting configurations are required. As a result any set of parameters may be a result of the particular starting values used by the procedure. This possibility can be avoided by estimating parameter values using a large number of iterations and by repeating analyses several times to ensure that parameter estimates are stable. In the former approach, increasing the number of iterations provides the algorithm with more time to escape local maxima and converge on the actual preferred parameter values. In the second case, repeated analyses allow the researcher to confirm that the same parameter estimates result from a variety of initial values, conclusively ruling out the influence of an unfortunate seed.

Having described the analytic method employed in this paper, the data utilized and the theoretical foundation I can now turn to some of the results that have emerged

from this research. I begin with an issue of significant interest to both adults and

adolescents: weight beliefs and behaviors.

CHAPTER 5: WEIGHT BELIEFS AND BEHAVIORS

This chapter presents the first set of model results. It begins by discussing the literature pertaining to obesity and eating disorders. It then describes the conflict over the prevalence of traditional eating disorders. Descriptive statistics are then presented that both provide information on the nature of the Black River population and lay the foundation for focusing attention on obesity rather than traditional eating disorders. Model parameters are then explained, model results are presented, and a discussion of findings concludes the chapter.

Background: Weight and Adolescence:

Americans are too fat. Such is the conclusion one must unavoidably reach from the deluge of scientific and journalistic articles focused on American eating habits and, especially, on the value of our body mass index. The body mass index, or BMI, is a ratio of weight to height that is used by the medical community to diagnose unhealthy levels of overweight or underweight.[9] While not without its detractors (Campos 2004; Gaesser 2002) it has proven to be useful in predicting certain forms of disease. Indeed, a high BMI is associated with a variety of negative health outcomes including diabetes, hypertension and premature death (Flegal et al. 2005; USDHHS 2001). These findings have led to the development of a BMI-based set of categories roughly describing a

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[9] BMI is calculated by dividing a person's weight in pounds by the square of their height, in inches, and multiplying the result by the constant 703.

person's weight condition. These categories are, in ascending order, Starvation (<16.5), Underweight (16.5-18.5), Normal (>18.5-25), Overweight (>25-30), Obese (>30-40) and Morbidly Obese (>40). As one might guess from the names, health risks stemming from excessive body weight are greatest in the "morbidly obese" category while the health risks stemming from insufficient body weight are greatest in the "starvation" category.

The development and deployment of the body mass index has come hand in hand with a concern for the general level of fitness evidenced by the population. In recent years that concern has grown into alarm as BMIs have continued to climb. Heini and Weinsier (1997) found that between 1976 and 1991 the prevalence of overweight and obesity in the United States increased by roughly 31%. This work was supplemented by Flegal et al. (2002) who found an additional 24% gain between 1994 and 2000. Chang and Lauderdale (2005) find similarly that in the years between 1971 and 2002 the percentage of Americans who are classed as "obese," has increased by 23% to 31%. Research by Hedley et al. (2004) finds that as much as 66% of American adults may presently be obese with no signs of a decline. This problem is not limited to adults as it appears that worldwide over twenty-two million children may be overweight and the number of American children who are overweight has doubled in the last twenty to thirty years (Deckelbaum and Williams 2001). Estimates of the economic costs of obesity as a result of increased sickness, medical expenses and lost work time among other things are sobering. Estimates range from as high as $99.2 billion dollars (Wolf and Colditz 1998) to as low as $75.2 billion dollars (Allison, Zannolli and Narayan 1999). The lowest estimates, however, factor in the reduced life expectancy of the seriously obese, thereby

reducing the total medical expenses they can incur. While considerable research remains to be done on the precise consequences of obesity the pattern of results is clear: overweight and obesity is a serious and growing health problem that has the potential to slow the economy and shorten lives. Further, this problem is not limited to adults and, instead, is observed among children and adolescents. As obesity in childhood is one of the best predictors of obesity in adulthood (Deckelbaum and Williams 2001) this has serious implications for the future.

As obesity among children and adolescents is growing as a concern, other long-standing dietary issues remain. The opposite problem- consuming too few calories- is also an issue for adolescents and, in particular, adolescent girls. In its most severe states this issue takes the form of anorexia nervosa and bulimia nervosa- the two best-known eating disorders.

In anorexia nervosa (American Psychiatric Association 2000) the sufferer develops an unhealthy and inaccurate belief about their own body size and weight, viewing it as excessively large and unattractive. In reaction to this, the individual avoids eating whenever possible. Unsurprisingly, consumption of food is met with feelings of extreme guilt and self-loathing. A prolonged contest with anorexia nervosa can result in extreme loss of body weight, kidney disease, difficulty regulating body temperature and death. Pharmaceutical diet aids may also be employed and are often abused by anorexic individuals adding to the renal complications of the disorder. In effect, anorexic individuals starve themselves into permanent injury or death. Alternatively, in bulimia nervosa (American Psychiatric Association 2000), patients continue to eat but

subsequently eliminate this food before it can be fully absorbed. This elimination may include the use of laxative agents meant to hasten the progress of food through the digestive tract but can also be accomplished through induced vomiting. A cycle of binging and purging results wherein patients gorge themselves on high fat, high sugar foods, experience a profound sense of guilt, and subsequently vomit the food back out. In addition to the risk of serious reductions in body weight, bulimia nervosa also carries the added dangers of frequent abdominal convulsions and damage to tooth enamel from regurgitated stomach acid.

Because of the social stigma attached to eating disorders like anorexia nervosa and bulimia nervosa it is difficult to determine their prevalence in the population. Research by Jones et al. (2000) suggests that as few as 4% to as many as 10% of adolescent girls may suffer from eating disorders of this type. The same research found that an additional 8%-14% of respondents may display eating disorder-like behaviors that do not satisfy diagnostic criteria. These findings reinforce earlier research (Shisslak, Crago and Estes 1995) suggesting that the number of individuals with partial eating disorders is approximately double the number with active clinical disorders. Similar research by Colton, Olmsted and Rodin (2007) found that as many as 14.7% of females aged 9-13 display some degree of disordered eating, though the actual prevalence of eating disorders in this group is low. In combination these findings suggest that as much as a quarter of adolescent females display at least some of characteristics of an eating disorder if not a full case. In support of this contention, Carter, Stewart and Fairburn (2001) found using a sample of over eight hundred adolescent girls that, within the two

weeks prior to surveying, 4% self-induced vomiting, 1% used laxatives improperly and 8% reported regular binge eating. In contrast, Hoek (2006) estimated the rates of anorexia nervosa and bulimia nervosa among females aged 15-24 at 0.3% and 1% respectively, suggesting that the eating disorder problem is not as serious as some studies imply.

We can speak, then, of two kinds of eating disorders: the type we are more familiar with that produce underweight and a second type that result in growing overweight. It appears that adolescents are trapped between the Scylla of obesity and the Charybdis of anorexia/bulimia. Indeed, we are trapped with them as our efforts to combat one of these dangers may drive them towards the other. If we are to have some chance of guiding youth to a healthy adulthood it is critical that we understand how all types of eating disorders develop and are maintained. Anthropologist Mimi Nichter provides some assistance in this area with her book "Fat Talk" (2000). She argues that the incidence of eating disorders is dramatically overestimated by typical survey methods. Specifically she finds that while many adolescent girls display a high level of concern with their appearance and a significant level of dissatisfaction with their body size, these concerns do not translate into regular and consistent dieting behaviors. Instead, a girl who claims to have stopped eating as a method of weight loss in the past week may have simply not eaten lunch or breakfast but subsequently consumed dinner. From the girl's perspective she did stop eating for one day, or at least intended to, but broke her fast relatively quickly. Indeed dieting may not take as severe a form as a standardized survey might suggest and many girls appear to use dissatisfied speech about their weight (i.e. 'fat talk') as a way of bonding with and gaining sympathy from their peers rather than as a signal of

their true feelings or intentions. This implies that weight beliefs as well as behaviors surrounding weight may be highly socially determined. It additionally suggests that without understanding the social context of adolescents, we may not be able to adequately diagnose the extent of the eating disorder problem.

Further support for the idea that weight is a social, rather than personal, issue emerges from research performed by Nicholas Christakis and James Fowler (2007). They analyzed multiple waves of data from the Framingham Heart Study, a longitudinal project intended to identify some of the long-term and intergenerational correlates of serious heart disease. Using this pool of over twelve thousand respondents they very cleverly derived limited social networks from the available data and examined the relationship between obesity and interpersonal association. The results of this effort are striking: it appears that the obesity status of one's associates has an impact on the likelihood that one will become obese. Specifically, a person with an obese friend experiences a 57% increase in their own likelihood of becoming obese, a person with an obese sibling experiences a 40% increase in their own likelihood, and a person with an obese spouse experiences a 37% increase in their own likelihood. Given the longitudinal nature of these data, it is possible to say with some certainty that these findings are not the result of selection but, rather, derive from harmonization processes. We appear to adopt the weight of our associates rather than select others of the same weight as ourselves. Interestingly, despite the importance of weight for evaluations of attractiveness and therefore to attracting romantic partners, it appears that effects were substantially greater for individuals of the same sex. As people (Marsden 1988) find most of their

friends from within their own sex (i.e. sex homophily) this implies that much of this influence is occurring via friendship networks. Finally, geographic propinquity appears to be unrelated to the tendency to harmonize in terms of weight- what matters is the social connection rather than simply residing in the same environment. The sobering implication of this research is that as the number of Americans who are obese rises so too will the pressure on the remaining members of the population to, themselves, become obese.

Immediately we must ask the question: how do these results translate to the adolescent population? The existing literature suggests that, indeed, obesity is a significant and growing problem for adolescents yet, at the same time, multiple studies point to the high incidence of eating disorders among the adolescent population. Which is the true story? Most likely both stories are, to some extent, correct. Much as in the adult population obesity in adolescents is likely present and growing. As such we can expect long term problems with obesity as today's adolescents reach adulthood. At the same time, while Mimi Nichter's research suggests that the rate of eating disorders in adolescents may be dramatically overestimated it does confirm that there are substantial pressures on adolescent girls to control their weight and that these pressures have been integrated into their social environment. While not technically an eating disorder, the trend towards increased obesity combined with the social pressures favoring thinness may lead many females to oscillate between dieting behavior and more typical consumption patterns, or to engage in what is known as yo-yo dieting. Such repeated fluctuations in weight have been implicated as a health risk in their own right and may be

responsible for at least some of the perceived risks of being overweight (Ernsberger and Koletsky 1993, Ernsberger et al. 1996, 1999). Nonetheless, Christakis and Fowler's research focuses on adults, not adolescents, and Mimi Nichter's research is rooted in ethnography. To test some of these ideas it will be necessary to perform a quantitative study of an adolescent population. Moreover, this study should ideally include social network variables to account for the strong social factors influencing obesity and weight loss behavior. Finally, confirming Christakis and Fowler's findings will require longitudinal data. All of these requirements are met by the Add Health data and methods used in this project.

It is possible that selection and harmonization could both play a role in controlling weight beliefs and behaviors at Black River High School. First, the pressures on adolescents to achieve and maintain popularity are fierce and may provide motivation to avoid connection to unpopular individuals. This tendency may be particularly strong for adolescent females, whose popularity derives largely from whom they associate with rather than what they do (Moody 1999). For males, whose popularity is determined by their group memberships and activities rather than social relations, pressures towards selection may be relatively smaller. On the other hand, the existing research by Christakis and Fowler (2007) suggests that weight may be subject to harmonization rather than selection and Nichter's research (2000) implies, similarly, that monitoring and controlling weight is a socially integrative function for many students. This implies, as well, that weight will be controlled by harmonization instead of selection. Given the weight of research to date it seems most likely that weight beliefs and behaviors will be subject to

strong harmonization paired with weak selection, and thus are an example of what I term "contestation."

<u>Weight Beliefs and Behaviors: Descriptive Statistics:</u>

I begin this analysis by considering the basic outline of beliefs and actions surrounding weight at Black River High School. Using data gathered by Add Health personnel it is possible to calculate the body mass index for each student. This BMI can then be used to determine how many students are presently overweight, obese, or morbidly obese. Similarly, it is possible to determine how many students are underweight.

During wave 1 of data collection the average body mass index for students at Black River was 22.87 with a standard deviation of 4.26, placing the average student within the category defined as "normal" by the centers for disease control. The smallest BMI observed during this time period is 13.81 while the maximum is 44.30, corresponding to the "starvation" and "morbidly obese" categories respectively. Thus, while the average BMI is, indeed, in the normal range unhealthy variation is still present. Examining the sexes separately, males in Wave 1 have an average BMI of 23.18 with a standard deviation of 4.21. Minimum BMI is 15.66 (very underweight) while maximum is 44.30. For females the average BMI is 22.52 with a standard deviation of 4.29. Minimum BMI is 13.81 (starvation) while maximum is 42.59 (morbidly obese). It thus appears that there is slightly less variability in male BMI than in female BMI and this

difference occurs at the bottom end of the weight distribution. Despite the small magnitude of the difference in BMI, it appears that females do have a significantly lower BMI than males (t= -2.25, p< .05). In this wave 21.01% of the adolescents in Black River (20.59% of males and 21.48% of females) can be classified as overweight or heavier. In contrast, only 7.25% can be classed as underweight (5.95% of males and 8.70% of females). The difference in the number of males and females who are either over or underweight is not statistically significant even at the .05 level.

During wave 2 of data collection the average BMI at Black River increased to 23.30 (t= 5.22, p< .001) with a standard deviation of 4.52. While this change is statistically significant, the average student remains within the normal range. The minimum BMI in wave 2 is 15.66 (very underweight) while the maximum was 46.07 (morbidly obese). It therefore appears that the increase in BMI is being felt at both the high and low ends of the BMI scale. Males in wave 2 had an average BMI of 23.65 with a standard deviation of 4.47. The increase from wave 1 is small but statistically significant (t= 3.81, p< .001). The minimum male BMI was 16.04 (underweight) while the maximum was 44.63 (morbidly obese). Females in wave 2 had an average BMI of 22.91 with a standard deviation of 4.55. The increase from wave 1 is also small but statistically significant (t= 3.57, p< .001). The minimum female BMI was 15.66 (very underweight) while the maximum was 46.07 (morbidly obese). In wave 2 male BMI is significantly greater than female BMI (t= 2.06, p< .05) but the magnitude of the difference is less than one point. Despite the overall increase in body mass, the gap separating average male BMI from average female BMI increases from 0.66 in wave 1 to

0.74 in wave 2. Thus, it appears that while everyone is gaining weight males are gaining

it faster. This may be a consequence of the greater pressure on females to maintain a low

body weight. In this wave 24.80% of the students at Black River (25.23% of males and

24.32% of females) can be categorized as overweight or heavier. Only 6.56% of students

in wave 2 can be classed as underweight (4.26% of males and 9.12% of females). While

there is no significant difference in the percentage of males and females who are

overweight or heavier, there is a significantly larger proportion of females who are

underweight than males (t= 2.46, p< .01) in wave 2. Additionally, while the proportion of

students overall who are underweight in wave 2 is not significantly different from wave

1, there has been a significant overall increase in the proportion who are overweight or

heavier (t= 3.23, p< .001). There are no significant differences between waves in the

proportions of females or males who are underweight, suggesting that the new difference

between males and females in wave 2 is at least partly the result of their differential rates

of weight gain rather than accelerating drives towards weight loss.

Table 6- Weight Beliefs and Behaviors: Descriptive Statistics

It is useful to know about the actual body mass of students at Black River, but this

does not tell us how they feel about their weight. Fortunately, the Add Health asks

students how they perceive their weight. Response options vary from "very underweight"

to "very overweight." In wave 1 the modal response (50.60%) was "about the right

weight" with the second largest single group (28.97%) reporting that they are "slightly

overweight." In total, 33.06% of Black River students in wave one believe that they are slightly to very overweight, in contrast to the 21.01% who have BMIs that would be classed as some type of overweight. Among males 57.89% consider their body weight to be "about the right weight" with the next largest group (19.58%) considering themselves to be slightly underweight. Only 20.14% of males in wave 1 consider themselves to be overweight, which matches quite well with the 20.59% of them whose BMIs would qualify as overweight. Among females 42.53% consider themselves to be "about the right weight" with the second largest group (40.51%) considering themselves to be slightly overweight. In total 47.35% of females in wave 1 consider themselves to be slightly or very overweight, vastly exceeding the 21.48% who have BMIs that are overweight or heavier. In wave 2 the modal response remains "about the right weight" (53.88%) with "slightly overweight" remaining the most popular second option (29.32%). In total 33.12% of Black River students consider themselves slightly or very overweight, a figure only slightly different from the one found in wave 1, but still in excess of the 24.80% of students who would be classed as at least overweight. Among males 58.73% consider themselves to be "about the right weight" with 21.08% now considering themselves to be "slightly overweight." This is a reverse of the trend in wave 1 when more men considered themselves to be slightly underweight than slightly overweight. In total 23.19% of males consider themselves to be overweight in some way while their BMI indicates that 25.23% of them actually are overweight. Thus, in wave 2 males generally underestimate their body mass. Among females 48.49% think of themselves as having "about the right weight," but 38.46% believe that they are "slightly overweight." Fully 44.15% of females

in wave 2 believe that they are slightly to very overweight, which significantly exceeds the 24.32% who have BMIs in that range. Interestingly, however, while the actual proportion of females who are overweight has increased from wave 1 to wave 2, the proportion who believe themselves to be overweight has decreased. That said, female perceptions of personal weight are still grossly at odds with reality.

Using the Add Health we can also determine how many individuals are attempting to lose weight at the time of each wave. In the first wave 33.65% of Black River students (18.54% of males and 50.38% of females) were attempting to lose weight while in the second wave 32.86% of students (15.66% of males and 52.01%% of females) had the same intentions. In both waves the proportion of males attempting to lose weight was smaller than the proportion whose BMIs actually indicated overweight while for females the pattern was reversed.

We now know something about BMI and obesity in Black River, but what about the more traditional types of eating disorders? It is possible, employing the above variables, to develop a rough estimate of the number of students who are suffering from active or sub-threshold eating disorders. I define a student as *disordered* if they meet three criteria: their BMI is below normal, they perceive themselves as normal weight or heavier, and they are presently attempting to lose weight. Using these criteria in wave 1 fewer than ten students (all female) qualify as disordered. In wave 2 the number is essentially unchanged. Using this definition, additionally, none of the students identified as disordered in wave 1 remain disordered in wave 2.

Given limitations in the data (i.e. a number of students failed to indicate whether they were presently attempting to lose weight) I define an individual as *potentially disordered* if their BMI is below normal and their perception of their weight is normal to above normal. Using this definition there are 20 potentially disordered students (mostly female) in wave 1 and 19 potentially disordered students (mostly female) in wave 2. Fewer than ten students (almost entirely female) are potentially disordered in both waves. Even using this more expansive definition, however, the peak number of potentially disordered students observed in these data does not exceed roughly 3% of the total student population. Using the more restricted disordered criteria, less than 1% of the student population appears to be disordered in any wave. If we focus only on adolescent females, less than 5% ever appear to be even potentially disordered. To the extent that these results can be trusted, then, it appears that the lower estimates of the prevalence of anorexia nervosa and bulimia nervosa are supportable. It seems that Mimi Nichter's concerns about the overestimation of eating disorders in survey research may be justified.

Given that the apparent prevalence of eating disorders in these data is low, the overall increase in obesity is of greater concern. Overall, both males and females gain in BMI between wave 1 and wave 2, implying that the gain in overall body size seen among adults has its roots in youth. The question remains, however, as to how this weight gain is facilitated. Both Nichter's and Christakis and Fowler's work suggests strongly that we cannot understand weight gain without understanding social context. Thus, to cast greater light on how American adolescents are gaining weight, it is necessary to take a network perspective.

Weight Beliefs and Behaviors: Basic Variables and Effects:

Deploying models to examine weight beliefs and behaviors requires that I define several classes of variables. First, there are the dependent variables, second the time-invariant independent variables, and finally the network structure itself. As discussed previously (Chapter Four) the network and dependent variables reciprocally influence one another and are both influenced by the independent variables. Additionally, as discussed in Chapter Four, these parameters are discussed as reflecting the preferences or tendencies of individuals but this is simply a convenient abstraction for the purposes of the model. In reality, many of these "preferences" reflect drives or constraints that are beyond the control of the respondent and, indeed, often beyond their awareness.

Three dependent variables are selected for the study of weight beliefs and behaviors: actual body mass index, respondent perceptions of their own weight and intentions to lose weight. Thus, the variables selected reflect reality, perceptions and finally planned responses. In all cases variables are distinct from effects. In other words, a single variable (e.g. BMI) can be used in a variety of ways in the same model, such as a predictor of the number of ties an individual develops, how popular they are, etc. As such, the same variable may appear multiple times as it is used in a succession of effects.

The first dependant variable is the body mass index of students at Black River High School (BMI). This measure is calculated using the weight and height information determined by Add Health interviewers. As this information is gathered by the

interviewers, rather than by self-report, it is not subject to respondent bias (e.g. the inflation of height or minimization of weight). These data, then, are taken as indicating the respondent's true weight condition. It is important to keep in mind that, because the BMI is a ratio of respondent weight to respondent height, increases in overall weight as a consequence of maturation will not be sufficient to alter the BMI itself. Additionally, for every student who gains height before "filling out" there is likely another student who gains weight prior to a growth spurt. As such, mean BMI scores should still indicate, at least roughly, degree of overweight.

The second dependent variable is the respondent's opinion of their own weight (perception). This weight perception can range from very underweight to very overweight with "about the right weight" making up the middle category. It is important to note that this variable is a relative measure encapsulating essentially two judgments. The first judgment is the actual body weight of the respondent while the second is the appropriate weight for someone like the respondent. If either of these judgments is skewed by social or personal factors it can alter the response selected. Put another way, an individual who correctly assesses their own weight but believes that people like them should be significantly lighter will report feeling overweight. At the same time, a person who has a solid grasp of the appropriate body size for a person like themselves, but believes that they are substantially over this limit will also report feeling overweight. Thus, there are several ways that a disconnect between true BMI and self-perceptions can occur. I study this variable in addition to true BMI because a person's behavior is likely strongly linked to their beliefs about themselves. A person who is not overweight, but believes that they

are, may take actions that harm them. Even if they take no action, a negative self-image can itself lower quality of life. On the other hand, a correct perception of oneself as overweight is most likely necessary for provoking weight loss behaviors and arresting the "obesity epidemic."

Finally, respondent intentions to lose weight are included as a dependent variable (weight loss). The Add Health survey includes a question asking whether the respondent is intending to lose weight, gain weight, or stay the same weight. I use a dummy variable equaling one when the respondent intends to lose weight. It is reasonable to assume that dieting, exercise, or both may be necessary in order to avoid weight gain over the course of a person's life. Additionally, given the amount of attention focused on body image in high school we might reasonably expect that a large number of students routinely plan to lose weight.

Selection or harmonization could occur on any of these variables but I expect that harmonization will predominate. Thus, students are more likely to adopt the BMI, weight perceptions, and weight loss intentions of their associates than they are to alter their associations to produce similarity on these features. A series of models will be estimated to evaluate selection and harmonization.

A number of different network effects are also included in the models dealing with weight. Particularly, effects are included for outdegree, reciprocity, transitivity and number of actors at distance 2. Outdegree refers to the number of individuals a respondent selects as friends. Thus, if I were to pick two individuals as friends my outdegree would be two; if I were to pick one individual as a friend my outdegree would

be one. At a very simple level outdegree reflects the returns to the respondent from expanding their network. When other structural variables are included it reflects the returns from directing ties to additional randomly selected others. In practice, then, outdegree tends to encapsulate the expense incurred as a result of developing social ties. Thus, a positive coefficient indicates that additional ties provide additional rewards, while a negative coefficient indicates that ties are costly and will not be developed or maintained without certain compensations (i.e. other coefficients that are positive rather than negative).

Reciprocity simply reflects a tendency to develop mutual relationships. If I select an individual as a friend and that person selects me in return then we have a mutual or reciprocated relationship. If I choose an individual as a friend and they do not choose me in return, then our relationship is unreciprocated or unmutual. If the coefficient for reciprocity is positive it means that mutual relationships are more rewarding than unmutual. If, on the other hand, the coefficient is negative then unmutual relations are preferred.

Transitivity reflects the old adage that the friend of my enemy is my enemy, or that the enemy of my enemy is my friend. In other words, our relationship with a certain other may be determined by our mutual relationships with a third person. In this particular instance, however, transitivity refers to the tendency to become friends with the associates of our immediate friends. So, I will tend to become acquainted with the friends of my friends. It is important to note that this is not necessarily the result of any deliberate action or process. Rather, because two people have the same friend in common

it is more likely that they will come into contact and, in turn, develop a relationship of their own. The first, and most important, prerequisite for a relationship is simply that each member become aware of one another's existence. A positive coefficient indicates that respondents become acquainted with the associates of their friends while a negative coefficient indicates that they tend not to be acquainted.

Finally, the actors at distance two effect simply accounts for the reach of a network. In order to understand this effect it is helpful to define the first and second order network. A first order network is composed of one's own associates whereas a second order network is made up of the associates of one's friends. Thus, if my friend Steven has a friend of his own, Bill, Steven is in my first order network while Bill is in my second order network. Importantly, if the transitivity effect described earlier plays out and I become acquainted with Bill directly then he moves from my second order network into my first order network. Thus, the second order network consists of those associates of my friends to whom I am NOT directly connected. An actors at distance two effect simply indicates whether or not there is a tendency to prefer associates who increase the size of one's second order network. A positive coefficient indicates that associates with many alters of their own are preferred whereas a negative coefficient indicates that associates with many alters of their own are shunned. This effect is one way to detect a preference for association with socially active individuals as opposed to those with a similar level of social activity. Additionally, in combination with other parameters (e.g. transitivity) it helps us to detect the presence of cliques.

Finally, a number of independent variables are included in the models. These include respondent sex (female), respondent relocation (moved), school attendance status (in-school), grade, and race. Each of these variables is incorporated into a set of effects primarily influencing the network structure itself.

Given the strong tendencies towards homophily observed in an enormous variety of studies (e.g. McPherson, Smith-Lovin and Cook 2001) respondent sex is included as a control variable. Specifically, a dummy variable equaling one when the respondent is female and zero when he is male is used. This variable is then used in three distinct network effects, termed "ego," "alter," and "selection." An ego effect tests whether or not being female increases the number of ties an individual directs outward. So, a positive coefficient indicates that females choose more others as friends than do males. An alter effect, in contrast, reflects the tendency for females to be chosen by others. So, if females are more popular as associates than males, there should be a positive coefficient. Finally, a selection effect is simply testing for selection on sex. A positive coefficient indicates that females tend to associate with females and males tend to associate with males. A negative coefficient, on the other hand, would point to primarily heterophilous association. Harmonization on sex, of course, is impossible within the time scale of the Add Health data.

Many, if not most, students in high school have been moving through the educational system with their age cohort for eight or more years. As a consequence, it is reasonable to assume that many networks are relatively well-developed upon entry to the high school environment. Some students, however, may experience an amount of

geographic mobility that disrupts this stable set of relationships. This can range in scope from a cross-town move, that shifts students into new school districts, or an inter-city or inter-state move that entirely removes the teen from their existing context. In either case, an accurate picture of the social network may rely upon knowing whether or not a given respondent has been relocated in the past. Thus, a variable "Moved" is included that equals 1 if the respondent has moved in the last five years and 0 otherwise. It is specifically included as an ego effect, meaning that the model tests whether or not having moved changes the number of others an individual selects as friends. A positive coefficient indicates that a respondent who has recently moved selects more others as associates while a negative coefficient indicates that a respondent who has moved selects fewer.

Most students in the sample currently attend school. However, some students may be suspended or expelled from school. While we can reasonably expect that these events will not disrupt such an individual's network of close ties, we would also expect that their wider network of distant associations would be altered. Additionally, it seems possible that students who attend school may be enjoined by their parents to stop associating with someone who has been expelled and, likewise, that an expelled student may spend more time with other students in the same circumstances. To test this I include a selection effect for school attendance status. A positive coefficient indicates that association is more likely between those of the same school attendance status while a negative coefficient indicates that it is less likely.

While students can, and do, form friendships with others at different ages most students spend the majority of their time in grade-specific contexts. As a result there are significant structural factors guiding students into association with those who are in the same academic grade. This tendency is only reinforced by the qualitative jumps between various phases of childhood- the movement from elementary to middle to high school. Each divide separates grades temporarily from those ahead of or behind themselves. As a consequence we would expect most relationships to develop, and be maintained, between those of the same grade. To take account of this factor a selection effect is included for school grade. A positive coefficient indicates a preference for association with those of the same grade, while a negative coefficient indicates an avoidance of association with those of the same grade.

Finally, race is included as a variable of interest. In many different contexts a person's ethnicity influences their associations. Particularly, most association occurs between those of the same race. In Black River there are relatively few students who are non-white and, as such, we would expect most white students to associate with other white students and non-white students to associate quite frequently with white students (Blau 1977). At the same time, it remains possible that race is highly salient in this school and so a selection effect is included to determine if students preferentially develop friendships with those of the same race. A positive coefficient indicates that racial similarity is likely in relationships while a negative coefficient indicates that it is unlikely.

In addition to the variables and effects described above there are also a final set of effects that deserve mention. The first or "rate" effects indicate the number of opportunities that a given respondent has to make a change to their network or behavior between the survey waves. It is important to keep in mind that these effects do not reflect the actual number of changes made but only the number of opportunities for change. Such effect are estimated by comparing the degree of difference between the networks at wave 1 and at wave 2 and determining an average number of changes each actor would need to make in order to achieve a difference of the observed magnitude. In a crude sense, then, the rate parameters reflect the degree of difference between time points or the amount of volatility in the network. These rate effects can be attached either to the network, indicating the number of chances to develop or eliminate a social tie, or they can be attached to dependent variables, reflecting the number of chances the respondent has to increase or decrease the variable by one step. To a limited extent a larger rate parameter indicates that there is more change in this feature of the network while a smaller rate parameter indicates less change. As a last point, it is important to note that the rate function is the only parameter that does NOT refer to the objective function. It is, instead, simply an indicator of how many chances actors have to make a change. Secondly, dependent variables have an associated "tendency effect," which simply reflects an overall increase or decrease in the dependent variable throughout the study. This effect is similar to an error term in regression in that it absorbs the variation in the dependent variable that has not been accounted for using the current set of independent variables. At the same time, however, this tendency effect may be responding both to

omitted variables within the scope of the model as well as to larger level context effects.

A positive tendency effect means that the dependent variable tends to increase over time

(or, in the case of dichotomous variables, become more frequent) net of the variables in

the model while a negative tendency effect means the opposite. More specifically, the

tendency effect is the change in the objective function to be had as a result of altering the

dependent variable by one.

Weight Beliefs and Behaviors: Dynamic Models:

Modeling the interaction of weight behaviors and beliefs proceeds in several

steps. First, a basic model is estimated that includes the structural effects and independent

variables outlined above. In addition to these baseline effects it also adds selection effects

for the dependent variables of interest. This allows me to determine if students at Black

River High School select alters of the same BMI, the same weight perceptions, or the

same weight loss intentions more often than those who are different. The second model

retains these and adds harmonization effects for each of the three dependent variables.

This allows me to determine if respondents become more like their associates in terms of

BMI, weight perceptions, and weight loss intentions while controlling for selection

effects on all three. This model produces a direct contrast between selection and

harmonization allowing me to separate the effects of each from the other. Finally, the

third model retains the preceding effects and adds interactions between the various

dependent variables. Specifically, it allows BMI to influence weight perceptions, weight

perceptions to influence BMI, and for BMI and weight perceptions to both impact the individual's intention to lose weight. All models are presented in Table 7.

Beginning with model one, the basic rate effect of 10.80 (p< .001) indicates that most respondents have slightly less than 11 opportunities to change their relationships between wave 1 and wave 2. The outdegree effect (-16.16, p<.001) indicates that relationships at Black River are costly to develop and maintain. This high cost, in comparison to other parameters, for each additional tie, however, can be offset by the more rewarding elements of such relations. Both reciprocity (2.48, p<.001) and transitivity (0.09, p< .05) are positive, indicating that Black River students prefer mutual relations and tend to develop associations with the friends of their own friends. Additionally, the actors at distance two effect is negative (-1.43, p< .05) indicating that there is an avoidance of individuals who have a large number of associates to whom one is not directly tied. More realistically, in combination with the earlier reciprocity and transitivity effects, this suggests that networks at Black River tend to form into densely-interlinked clusters rather than expansive non-redundant webs. As such, these statistical results match many of our recollections of high school life.

Turning to the independent variables we find a negative alter effect for females (-2.25, p<.01) paired with a positive ego effect (2.06, p< .05). In combination these effects indicate that while females are more active in sending friendship ties to others than are males, males are more likely to be the recipients of these ties. This pattern in general suggests a degree of status inequality with males occupying a position of greater status than females (see Brashears 2008 for more on this issue). Regardless, however, the

selection effect for females is positive (3.32, p< .001) indicating that overall sex homophily is a predominant feature of the network. Interestingly the variable accounting for the effect of geographic mobility is non-significant, suggesting that adolescent networks rebound fairly readily from disruption. At the same time the selection effects for both school attendance status (10.10, p< .05) and grade (2.81, p< .01) are positive. Thus, most individuals spend time with those who also attend (or do not attend) school and are members of their same grade. Finally, the selection effect for race is non-significant.

Before examining the effects of BMI, weight perception and weight loss intentions we should briefly consider how these effects stack up. The outdegree effect above is quite large and negative (-16.16) suggesting that ties are so expensive as to be unlikely. However this cost assumes that the ties are to randomly selected others. If we relax this assumption and propose that the ties are directed to others of the same grade who also attend school with the respondent, the negative outdegree effect is nearly overwhelmed (i.e. -16.16(1) + 10.10(1) + 2.81(1)= -3.25). If the tie is then reciprocated by the selected alter, and that alter is of the same sex as the respondent, we find that the tie becomes profitable rather than costly (i.e. -3.25 + 2.48(1) + 3.32(1)= +2.55). As such, these coefficients tell us not that networks will be small at Black River but, rather, that for a tie to persist for any length of time it must include certain beneficial characteristics to counterbalance the costs. On a larger level, these results indicate that students at Black River are overwhelmingly friendly with same-grade members of their school, primarily associate with those of the same sex, and form dense clusters of friends. It is also likely

that females send ties to males more frequently than males do to females, and probably serve as the primary network bridges between male and female subcomponents.

When we examine the dependent variables we find that only one effect attains statistical significance. It appears that there is a negative and significant alter effect associated with body mass index (-0.03, p< .05). This indicates that as BMI increases one's popularity as an alter declines or, more bluntly, Black River High School students avoid developing friendships with the obese. Interestingly, however, there are no significant selection effects for BMI, weight perception or weight loss intentions. Students do not preferentially develop relationships with those of similar status on any of these three variables. This is particularly noteworthy in light of the consistent alter effect associated with BMI- it appears that students avoid friendships with those of high BMI regardless of their own BMI status. While the seriously overweight may be, in some ways, an oppressed minority, they do not appear to be a minority with any sense of in-group loyalty or identity.

Finally, we must consider the rate and tendency effects for the dependent variables. The largest rate effect is for BMI and suggests that students can change their body mass index slightly more than four times between wave 1 and wave 2 (p< .01). The rate effects for weight perceptions (0.46, p< .01) and weight loss intentions (0.50, p< .01) are much smaller, suggesting that while beliefs about weight are relatively stable body mass is more flexible. Examining the tendency effects shows that BMI tends to increase (0.14, p< .05) over time while intentions to lose weight become less frequent (-0.87, p< .05). Weight perceptions show no tendency to either increase or decrease over time,

suggesting that the overall increase in BMI is not tied to an overall increase in the views students have of their weight. This provides additional evidence that body mass and weight perceptions may not be tightly coupled to one another.

Moving on to the second model we find that the basic structural effects and independent variable effects decline substantially in magnitude but remain consistent in both direction and significance. This implies that a significant amount of the impact of some of these parameters actually originates in the effects now included in the model. Importantly, while a negative and significant alter effect for BMI persists (-0.01, p< .05) none of the weight-related selection effects attain significance. It still appears that Black River students do not choose others in a way that increases similarity on any of these factors.

The rate effects for BMI, weight perceptions and weight loss intentions increase slightly in magnitude but remain stable in terms of the direction of effect and significance. The tendency effects, likewise, are largely stable though the coefficient for weight loss intentions does enjoy a respectable jump in magnitude from -0.87 to -0.96.

Examining the harmonization effects we find that both BMI (2.03, p< .05) and weight perceptions (4.53, p< .05) appear to respond to social influence. Moreover, the effect is stronger for weight perceptions than it is for actual BMI. Thus, it appears that Black River students converge on the same body mass index and the same weight perceptions as their associates. Despite this overall pattern, however, there is no significant harmonization effect observed for weight loss intentions. Despite popular and media accounts to the contrary it does not appear that adolescents adopt the weight loss

behavior of their peers. An adolescent is no more likely to develop an intention to lose weight if their associates have these intentions than if their associates lack them. At the same time, however, if an adolescent's associates believe themselves to be overweight that adolescent is more likely to develop the same belief and, likewise, if those associates are overweight the adolescent is likely to develop the same weight.

Finally, moving to the third model, I add several interaction effects between the dependant variables. In model three the structural and independent variable effects remain relatively unchanged from model two. The selection effects are non-significant and the alter effect for BMI remains unchanged from model two. The rate and tendency effects for BMI, weight perceptions and weight loss intentions identified in model two gain in magnitude in model three, suggesting that there are both more opportunities to make changes to these variables as well as a more consistent movement in a particular direction. The weight loss intentions tendency effect is particularly noteworthy, increasing in magnitude from -0.96 to -7.71.

While the harmonization effects for both BMI (2.64, p< .05) and weight perceptions (5.58, p< .05) increase in magnitude relative to model two, the harmonization effect for weight loss intentions remains non-significant. There appears to be no direct effect of social pressure on one's intention to lose weight. Turning to the interaction effects, it appears that BMI influences the respondent's perception of their own weight (0.11, p< .05) as well as that weight perceptions influence actual BMI (0.11, p< .05). Thus, as one's BMI increases it is more likely that weight perception will increase and, likewise, if weight perceptions rise so too will BMI. This finding is not surprising as, in

the absence of some kind of disorder, we would expect that self-assessment and actual weight should remain at least roughly coupled. However, while it appears that weight perception has a significant and positive impact on weight loss intentions (1.92, p< .05) there is no comparable effect from body mass index. Thus, while an increase in one's perceived body weight can trigger a weight loss response, BMI is unable to have a similar effect. Put bluntly, it does not matter how high BMI climbs as a weight loss intention will only emerge when a respondent perceives themselves as overweight, but not necessarily when they actually are overweight.

Table 7- Results: Weight Beliefs and Behaviors

Based on the results of these models we can reach several conclusions. First, it appears that, as predicted, weight beliefs and behaviors are subject to harmonization rather than selection. Body mass index is at least roughly apparent to outside observers and, as such, could have been a basis on which to choose associates. Yet, despite this, we do not observe Black River students associating with those who are similar to themselves. The most we do observe is a general, and apparently universal, avoidance of those with very high BMIs. The same is true for weight perceptions and weight loss intentions. These characteristics do not draw individuals into association. In contrast, it does appear that one's individual BMI can influence the BMI of a close associate. This supports the earlier research by Christakis and Fowler (2007) in showing that obesity is indeed at least partly socially determined. These results go beyond theirs, however, by showing that in

addition to BMI our perceptions of our own weight may be determined by our peers. If our peers view themselves as fat, we are more likely to view ourselves the same way. At the same time however if our peers view themselves as having an appropriate weight or even being underweight then we will likely share this opinion even if we are actually overweight. It may be that far from being driven into perilous diets, adolescence may be the start of a lifelong tradition of associates excusing one another's weight gain. This work also goes beyond Christakis and Fowler's research by showing that weight loss intentions- which are surely key to any effort to bring obesity under control- are not influenced by actual body mass index. Instead, triggering an intention to lose weight appears to require convincing the respondent that they are overweight in the first place. In the presence of a social network that harbors messages to the contrary this may be a nearly impossible task. It thus appears that we may be in the undesirable position of having to tell people that they are fat, frequently and emphatically, in the hopes of overwhelming the countervailing influence of their associates. A basic diagram of the mechanisms uncovered in model three is provided in Figure 10 below.

Figure 10- Weight, Weight Beliefs, and Weight Behaviors

Given the serious attention paid to weight by adolescent girls, as well as the concern with combating negative body image in this population, it is worthwhile to consider whether female sex has any direct impact on the above mechanisms. Model four re-estimates the same parameters included in model one, above, but adds interactions

between female sex and weight perception as well as female sex and weight loss intentions. Given the concerns with female self-image as well as female weight loss behavior, these are clearly the most relevant variables.

In model four the structural parameters are generally comparable to those observed in model two. Reciprocity and transitivity remain preferred, males remain more popular for association than females, females associate with more others than do males, and sex homophily continues to predominate. Selection does not take place for body mass index, weight perceptions or weight loss intentions though BMI remains inversely related to desirability as an association partner (-0.01, p< .05). As in earlier models there is a tendency for BMI to increase between wave 1 and wave 2 (0.14, p< .05) as well as an opposite trend for weight loss intentions (-1.05, p< .05). It thus still appears that body mass generally increases over time and plans to lose weight become less frequent. Examining the effect of female sex reveals that being female has no impact on one's perception of weight but does significantly increase one's likelihood of intending to lose weight (2.11, p< .01). Based on this model, then, it seems that female sex does not influence the likelihood that a person will judge themselves to be overweight, but it does raise the likelihood that they will intend to lose weight anyway. In other words, it appears in this case that plans to lose weight are in some sense divorced from the perception that one's current weight is unhealthily high.

While these results are provocative it may be that being female is not, itself, sufficient to produce this effect and instead females are simply more often located in networks that harbor certain ideas. This may seem to be a distinction without a difference

but can be illustrated with reference to epidemiology. In the early stages of the AIDS epidemic the disorder was referred to as GRID, an acronym for Gay Related Immune Disorder. In this early phase the HIV virus was most often found in the U.S. among homosexual males. However, while homosexual males were most often afflicted, it was not being gay that produced the illness but, rather, simply that their demographic group became a reservoir for the contagion. In this case it was not the men who produced the illness but rather their networks. In a similar sense, it may not be that femaleness somehow triggers an intention to lose weight but rather that their interpersonal networks may harbor these ideas more often then male networks. To evaluate the possibility that it is, once more, the networks that matter rather than being female I estimate a fifth model that reintroduces the harmonization effects from model three. In this model the female effect on weight loss intentions is retained but the effect of femaleness on weight perceptions is dropped in order to preserve degrees of freedom.

The structural effects of model four remain essentially constant in model five with one exception: the negative coefficient associated with the actors at distance two effect increases substantially in magnitude (-0.89, p< .01). This effect simply reinforces the strong tendency for individuals to become linked to the friends of their associates. As before, the selection effects for BMI, weight perception and weight loss intentions remain unchanged and the alter effect for BMI remains negative and significant (-0.02, p< .05). Of the tendency effects observed in model four only the one for BMI remains significant in this model (0.14, p< .05) while the tendency effect for weight loss intentions loses significance. Thus, it appears that even after controlling for the effects of female sex a

consistent rise in BMI is still evident among Black River students. As in model three, both weight perceptions (6.19, p< .05) and BMI (2.71, p< .05) respond to harmonization. It still appears that adolescents develop the same body mass indexes and weight perceptions as their associates. Also like model three, BMI appears to impact weight perceptions (0.12, p< .05) and weight perceptions impact BMI (0.12, p< .05). Finally, as with model three, weight perceptions have an influence on weight loss intentions (1.93, p< .05) while BMI has no significant effect. Finally, in contrast to model four, female sex no longer appears to have a significant effect on weight loss intentions. Thus, it appears that once harmonization is taken into account there are no significant differences between males and females in their intentions to lose weight.

Discussion:

The models of weight behaviors and beliefs provide us with a great deal to think about. It appears that, as predicted, harmonization not selection dominates in these sorts of networks. While it may be intuitively appealing to believe that individuals form relations with those of similar stature and body image this does not appear to be the case. Instead, it appears that both our beliefs about ourselves as well as our true body mass are influenced by those around us. If our friends believe themselves to be fat, we will believe ourselves to be fat as well. Moreover, this process appears to work equally for both males and females and accounts for the greater tendency for females to intend to lose weight than males. It is not that females simply are more likely to harbor such intentions but

rather, because of their networks, are more likely to harmonize on such intentions. As intuitively charming as it might be to claim that men are from mars and women from venus, it appears that both males and females are overwhelmingly similar.

That female networks harbor certain messages about weight that are absent from male networks, and that this accounts for the differing rates of weight loss intentions, is an important finding. It demonstrates that it is not being female, per se, that leads to heightened weight loss as well as points the way towards new approaches to intervening in adolescent weight. Many existing approaches to weight loss focus on the individual- an approach which these results call into question. The problem is not that individuals are more or less inclined towards weight loss but, rather, that networks produce a heightened or reduced sensitivity towards body weight. We do not pressure each other to lose weight but, instead, pressure each other to believe that we need to. That weight loss intentions follow from the development of such beliefs is hardly surprising, but will require alterations in the way that we approach weight loss.

It is also clear from these results that, while eating disorders remain terrible and highly debilitating problems, we should not overstate their prevalence. Despite the overwhelming popularity of weight loss intentions among females there do not appear to be very many individuals who could be described as eating disordered. Instead, it appears that Mimi Nichter's arguments that many surveys fail to take into account the lived experience of adolescent girls may be valid. While many adolescent females intend to lose weight, a tiny minority have the combination of body mass and self-perceptions that suggest disordered thinking. Additionally, despite the prevalence of weight loss

intentions among females, overall weight gain remains the norm. If adolescence is the period of greatest risk for eating disorders it appears that we may have been overestimating the danger they pose to the population at large. Again, it cannot be overstated that eating disorders are a serious problem for the individuals who suffer from them, but their presence in the population may be so limited as to prevent them from being a significant social issue.

The overall conclusion provided by these results is that our concern should be focused not on eating disorders as usually conceived but, instead, on controlling the movement towards obesity. While perceptions of weight do change upwards, BMI increases even more rapidly, suggesting that social pressure may be restricting our recognition of the true extent of our weight problems. We may have to face the possibility that a new kind of eating disorder is emerging in which a person's true body size vastly exceeds their self-perceived size. It moreover seems to be the case that this is not an isolated problem or individual disorder but, instead, is born from and sustained by interpersonal networks. Our friendships provide us with emotional support and entertainment but they may also be making us fat. Dealing with this aspect of the obesity epidemic will not be easy. Reducing obesity may require imposing a sort of "artificial selection," essentially severing some ties between individuals who would mutually reinforce each other's weight behaviors and steering at risk individuals towards associations with those who have healthier behaviors. Ironically, however, while this approach superficially resembles a support group it is nothing of the sort. Support groups meant to enable weight loss may well be ineffective for the simple reason that weight loss

intentions do not appear to be subject to harmonization. Instead, individuals must conclude through social pressure that they are too large and, as a result, initiate corrective behavior. We may thus be in the unenviable position of needing to tell people, in no uncertain terms, that they are too fat while simultaneously forcing them into social groups that will reinforce the same message. It seems obvious that the experience will be so aversive as to be nearly impossible to maintain without the use of extreme measures. A simpler solution might be to attempt to harness the normal peer pressure at work in adolescent relationships to produce the desired effect, though this may also prove to be too unpleasant to consider.

In discussing weight behaviors and beliefs it is additionally necessary to ponder the differences between males and females. While it appears that males and females are essentially similar in how they react to weight issues, it is also the case that males gain weight at a greater rate than do females. This is likely the result of the different concentrations of ideas about weight perceptions in the networks of males and females. It may therefore be most useful to try and introduce ideas about weight into male networks, rather than focusing on the already saturated networks of females. In addition to hopefully restricting the now runaway weight gain observed among males it may have a bleed over effect, providing limited reinforcement to the females who develop ties into male networks. As males are also, at present, vastly less likely to suffer from anorexia nervosa or bulimia nervosa, this approach also has the advantage of minimizing the risks of pursuing a more intense anti-obesity strategy.

Much remains to be determined about weight beliefs and behaviors but this research confirms Christakis and Fowler's central findings. Weight appears to be a socially transmitted disease. This work additionally confirms the utility of the networks approach generally, and dynamic networks particularly, to public health issues. Further research attending to the diverse implications of selection and harmonization for weight is clearly warranted.

While we have learned a great deal about harmonization it remains to be determined if other combinations of selection and harmonization exist in the empirical world. I address this issue in the next chapter which focuses on another increasingly important issue in American life: religion.

CHAPTER 6: RELIGIOUS BEHAVIORS IN ADOLESCENCE

This chapter introduces the second set of model results. It begins by reviewing the literature on adolescent religiosity and how religiosity interacts with social networks. It then presents a set of descriptive statistics that provide a general outline for religious behavior at Black River. The basic parameters are introduced and model results are presented. Finally the findings are discussed.

Background: Religious Behaviors:

Sociology in many ways owes its development to religion. In the early days of the discipline Max Weber used religion as a way to explain the rise of a newly dominant economic system, reducing religious belief from a transcendental force to a causal variable (Weber 2002). Parallel with this effort, Emile Durkheim formulated his theory of religious life, asserting that religion is merely the collective feeling that develops when a community rallies around a common focus (Durkheim 1995). Religion for Durkheim thus became something that is explained by social life. Karl Marx (1844) most famously referred to religion as the "opium of the people," viewing it as a distraction, masking class struggle in the interests of the powerful. Sociology was born from the effort to understand religion and use it to explain the social world. Ironically enough, to the extent that religion can be charted, measured, and explained by social science it is reduced to a

phenomenon of the natural world and subservient to that which has done the charting, measuring, and explaining.

Given that the study of religion itself can be viewed as minimizing religious faith, at least to an extent, it is hardly surprising that the "secularization hypothesis" has enjoyed such robust health. Emile Durkheim himself supposed that supernatural religions would be superseded by consciously designed sociological faiths that provided the same integrative benefits without the supernatural side effects. Auguste Comte famously viewed a major role of sociology to be the crafting of new religious beliefs that would be better suited to modern society. As the modern age began, it was taken as a given that society would become increasingly secular and much effort was expended in the attempt to monitor this titanic shift (Chavez 1989; Tschannen 1991; Weigert and Thomas 1970; Yamane 1997). It must have come as a surprise to some, then, when secularization did not spread its wings and take flight.

Far from withering away over the course of the twentieth century, religion has endured and may be gaining in importance (Duke and Johnson 1989; Hadden 1987; Jacobson 1992; Roozen, McKinney and Thompson 1990). The rise of radical Islam outside of the United States has, in some ways, been matched by the rise of radical Christianity within. Some authors (Beyer 1994) have suggested that this may be a consequence of increasing globalization. Caught amidst a deluge of cultural products from core nations, peripheral and semi-peripheral peoples turn to a revival of traditional religion as a way to preserve their culture. Likewise, suffering under the effects of economic shifts core peoples react in much the same way, soothing their uncertainty

about the economic future with recourse to prophetic teachings. While this is an interesting hypothesis, there may be little point in trying to explain the continuing survival of religious faith. As a set of worldviews and beliefs (Stark 2001) that have exerted a profound influence on mankind for centuries, that have weathered all manner of prophetic disconfirmations (Dein 2001; Festinger 1956; Tumminia 1998; Weiser 1974) and social contradictions (Mahaffy 1996; Thumma 1991), it was perhaps foolish to propose that religion would be so easily banished in the first place.

Regardless of the position one takes in the secularization debate it is clear that religion remains a vibrant part of modern society. Likewise the study of religion continues with considerable vigor. Scholarly attention has been paid, for example, to the impact of religion on issues as diverse as homosexual rights (Fulton, Gorsuch and Maynard 1999; Laythe, Finkel and Kirkpatrick 2001; McFarland 1989), social justice (Clydesdale 1999; McFarland 1989; Regnerus, Smith and Sikkink 1998), abortion (Williams 1982; Woodrum and Davison 1992), genetic engineering and research (Ellison and Musick 1995), and foreign affairs (Nelson 1988; Smidt 2005). Given the potentially substantial influence that religion exerts over many aspects of social life this sustained attention is clearly warranted.

While religion can and often does exert an influence throughout the life course it is important to distinguish two specific stages: childhood and adulthood. During childhood religious adherence is largely determined by parents and family members with little conscious choice on the part of the young person. As such, the level of religious activity displayed by youth is relatively uninformative. Likewise, they may accept the

religious assertions of their parents or guardians uncritically, believing as they are told to believe. In adulthood, by contrast, one can expect that religious behavior emerges from decisions or choices made by the individual (though certainly not in the absence of social pressure). Likewise, religious belief in adulthood is the result of internalization of religious values or conscious decision making rather than the imposition of authority figures. This suggests that a crossover point must exist between the externally regulated faith of childhood and the internally regulated faith of adulthood. A number of scholars have suggested that at least the beginning of this crossover resides in that period in which so many transitions take place: adolescence.

The relationship between religion and adolescence is, indeed, complex and still very much in dispute. Dudley and Laurent (1989) examined religious alienation among teenagers and found that while most of their sample were not alienated, a minority did display some signs of displeasure with the faith. The quality of an adolescent's relationship with their religious professionals and, to a lesser extent, parents and church associates were found to be inversely related to alienation, suggesting the importance of a firm social network. At the same time, however, it was also the case that adolescents found perceived hypocrisy to be alienating. Specifically, parents or religious personnel who failed to live up to the tenets of the faith exerted an alienating pressure on these young women and men. This largely conforms to an expectation that adolescence is a time of transition between childish idealism and adult pragmatism. Other research (Gunnoe and Moore 2002) has found that respondent ethnicity and the religious attendance of peers are the best predictors of religiosity during late adolescence. While

this later research did find that factors such as religious schooling and maternal emphasis on religion were important, the overall conclusion of this work must be that adolescents have not developed fully internal reasons for attending religious services. As a consequence, they are inclined to adopt or, at least, accede to the religious practices of their peers and other significant others. A similar assertion is put forth by Potvin and Lee (1982) who evaluate the relationship between internal religious belief and outward religious practice. They find that while initially practice appears to determine belief, maturation gradually shifts this relationship until belief determines practice. Thus, research tends to indicate that adolescents are indeed balanced on the cusp between internally-motivated and externally-motivated religious participation.

Perhaps owing to the uncertainty of adolescence itself it is unclear what ultimately happens to religiosity following adolescence. Johnson (1997) suggests that the formal education obtained in adolescence may erode religious faith in general or, alternatively, might produce a "fissure." Specifically, he suggests that some individuals may grow substantially less religious as a result of formal education while others increase in their religiosity. Thus, a sort of polarization may strike religion during adolescence ultimately producing two distinct types of young adults. His research, employing multinomial logit modeling, finds that a general decrease in religious fervor does occur in adolescence but that there are nevertheless tantalizing hints that some polarization may be taking place. Elizabeth Ozorak's earlier work (1989) finds indications that polarization does, indeed, take place during adolescence but suggests that it may set in relatively late as part of an overall developmental process. Polarization serves, in her view, as part of the total project

undertaken by adolescents to separate themselves from their parents and take on a fully

adult role. Given that her research utilizes older subjects than Johnson's later work, it is

possible that his failure to identify strong signs of polarization is a consequence of

observation at too early a stage. In contrast to this work, Smith et al. (2003) find that most

American adolescents display a moderate to high degree of religiosity and that this

religiosity does not appear to decline with age, suggesting that either polarization does

not occur or that the poles are sufficiently balanced as to prevent the mean from drifting

consistently. Other research by Scott Myers (1996) examines parental influences on the

religiosity of adult children. This work determines that while life events have an

influence, parental religiosity remains one of the strongest predictors of the religiosity of

adult children. This suggests that while erosion or polarization may occur in adolescence,

it is at least partly ameliorated by later life events, returning apostates to the fold. Based

on the existing literature it is uncertain exactly what may take place religiously in

adolescence.

Beyond our concern about the consequences of religious belief for society at large

it is important to consider that religiosity may have concrete effects for adherents. Mark

Regnerus (2003) finds that religious involvement is associated with emotional and

physical health, educational attainment and family well-being among other things. At the

same time, his research identifies very few differences in these benefits across

denominations, suggesting that the social benefits of religion may be strongly implicated

in these effects rather than any direct impact of doctrine. Along similar lines, Stack and

Wasserman (1992) found that involvement in churches was negatively related to suicide

ideology. Here too, however, the important variable appeared to be social integration via the conduit of religion rather than religious belief itself. Markstrom-Adams (1991) found that the practices and beliefs of a religious group could actually constrain the dating options of adherents. Further, this constraint operated partly independently of the dictates of demographic availability (Blau 1977) and may play a significant role in determining marital outcomes. Given the importance of heterogamy for class mobility this research suggests that some religious groups may be less able to alter their social position than others regardless of their actual level of performance or worthiness for esteem. Even later in life the religious practices and beliefs developed by adolescents may have an impact. McIntosh, Sykes and Kubena (2002) found that elderly who had regular assistance were likely to draw this help from their church-based social networks. The implication is that religious attitudes and practices cemented in adolescence can have a dramatic effect on an individual's later life. In total, this work implies that religion warrants study not only because of its effects on wider society but for its influence over individual life outcomes.

While much remains to be determined about how religion intersects with modern life and, in particular, with adolescent life it is clear that many of its effects may derive from social networks. By providing a focus in which individuals may form ties (Feld 1981) religion can act as an organizing influence. Along similar lines, however, by acting as such a focus religion may discourage individuals from forming ties with those of different faiths, contributing to the overall segmentation of society. Viewed from a different perspective, religion isn't simply inherited from parents but may also be transmitted horizontally through conversion events. Indeed, religions such as Christianity

that include an evangelical theological tradition may place considerable emphasis on such horizontal transmission. Such an emphasis may produce anything from face-to-face confrontations (e.g. visits form the Jehovah's witnesses), long-range travel (e.g. missionary trips), and television advertisements to the production and distribution of written materials specifically intended to lead to conversion (e.g. "Chick tracts"). Such activities may even take place between closely-related branches of the same religious tradition- for example, during a bus ride in Catholic Florence I once encountered a pair of Mormon missionaries working hard to spread the gospel.

A number of studies have already examined the relevance of religion for social life. Peter Marsden (1988) used sophisticated log-linear models to examine religion in American social networks. Using the 1985 General Social Survey networks data, he determined that preferences towards association with those like oneself account for virtually all of the association between respondent and alter religion once demographic availability was taken into account. While not speculating on whether this effect was due to selection or harmonization, Marsden's work demonstrates that religion does serve as a focus for association and a powerful one at that. Related work by Brashears (Forthcoming) used similar log-multiplicative models to determine if the propensity for homophily differed by sex. While his results showed that males and females are identical to one another in their preferences for those of the same religion, they appear to differ in how much social distinction separates dissimilar others from themselves. Put another way, while male and female Protestants regard Catholics as less desirable association partners than other Protestants, the degree to which they are less desirable depends upon

sex. Indeed, Brashears found that while males and females agree in terms of the relative differences between various religious groups, males perceived substantially less social distance separating members of these faiths than did women. This suggests that, for women, religious homophily may prove to be a more powerful force and their ability to develop social ties to the religiously dissimilar may be curtailed. Hugh Louch (2000) used network data to determine the effect of religion on network integration. In his work he considered networks to be integrated to the extent that a focal ego's alters also maintained a relationship with each other. Unintegrated networks, in contrast, lacked connections between ego's alters. He found that when two alters shared the same religious views they were 45% more likely to also report a relationship. While Louch referred to religion as "…largely a matter of choice" (2000: 58), his research was unable to disentangle selection from harmonization. Thus it is impossible to determine whether his association reflects the spread of religious ideas or the consequences of religious constraint.

The perspective that religion is more a consequence of harmonization than selection may receive some support from research by Mears and Ellison (2000) examining the propensity of individuals to consume "New Age" materials. While not a coherent religion in itself, "New Age" has a number of metaphysical or quasi-religious assertions and can be seen as a rival to existing faiths. In their work, however, Mears and Ellison find that the strongest predictor of purchasing "New Age" goods is membership in a network that includes other purchasers of "New Age" goods. Given that their study is comprised of residents from a strongly conservative Protestant region it is unlikely that

respondents were raised in "New Age" households. Instead, this seems more likely to be a consequence of the spread of "New Age" ideas through social networks. While interesting, it is nonetheless important to note several drawbacks to this research. Particularly, there is no guarantee that the respondents viewed "New Age" practices as belonging to a rival or distinct metaphysical tradition. Additionally Mears and Ellison obtained the information on social ties via an ego network method. As such, it is impossible to determine if those who consumed "New Age" products indeed were likely to count other "New Age" devotees among their friends or, instead, if they were simply more likely to believe that they did. Finally, research by Robert Wuthnow (2003) suggests that religion may not only exert a pressure towards homophily, but also a drive towards heterophily of a different sort. Specifically, he finds that membership in certain religious traditions may encourage the development of relationships with those of a different, and lower, social class. Given that there is an overall preference for association with those of similar or greater status (See Brashears 2008 for a discussion), such an effect is of significant interest. At the same time, Wuthnow finds no effect of religious attendance on this likelihood and only limited denominational impacts, so it is difficult to know how seriously these results should be taken.

As has been made clear in the preceding discussion, religion represents an important part of social and individual life that demands examination. Further, it appears to heavily influence, and be influenced by, social networks. Despite this importance and the research that has already been completed on networks and religion it remains to be determined whether selection or harmonization plays a greater role. Indeed, based on the

existing literature it seems highly likely that both selection and harmonization play a role and that religious networks will exhibit the properties of what I term "brittleness" (Figure 2). Finally, it seems likely that some of the most interesting effects of religion and social networks may play out during adolescence. I therefore embark upon an analysis of selection and harmonization in religion among adolescents using the data drawn from the Add Health.

Religious Behaviors: Descriptive Statistics:

As in Chapter Five, I begin this analysis of religion by considering the basic outline of religious belief and practice in Black River High School. While several measures of religiosity are available in these data I attend specifically to two that are of particular importance: self reported frequency of attendance at religious services and self reported frequency of prayer. I regard frequency of religious attendance as important because it reflects a non-trivial investment of time and energy and thus, in some ways, is the best indicator of the respondent's true commitment to their faith. Additionally, attendance at places of worship produces a new focus of association that may play a role in developing and maintaining relationships. As such, it is important to take note of this important factor. At the same time, however, my data derive from an adolescent sample and thus religious attendance is at least somewhat under the control of parents or other authority figures. Teens who are compelled to attend religious services may not fully realize the network-expanding benefits of such a focus and thus attendance is, by itself,

an insufficient measure of religiosity. Frequency of prayer, on the other hand, is less amenable to parental regulation. While authority figures may be able to compel at least an outward appearance of prayer it is difficult to impossible to force an adolescent to engage in genuine prayer, making this variable a more useful indicator of religious feeling. In combination, then, these two variables provide a reasonable gauge of the state of religious belief among students at Black River.

As a beginning we should examine the popularity of various religious options at Black River. While the original Add Health data allows denominational membership to be broken down in great detail, utilizing all possible response options in a single school would produce an unacceptably small number of entries in each cell. To compensate for this I collapse the religion categories to Baptist, non-Baptist Protestant, Catholic, Born Again, [10] Mormon, Jewish, No Religion and Other. In Wave 1 the school population is predominantly Christian with 74.54% of all students reporting membership in some related denomination, excluding the Latter-Day Saints.[11] This implies that the opportunities for religious homophily are excellent for Christians and rather poor for those of other faiths. Nevertheless, appearances can be deceiving as the total Christian population is divided into several denominational clusters. A closer examination shows that approximately 6% of the students identify as Baptist, 20% as non-Baptist Protestants and 29% as Catholic. Finally, 19% of respondents specifically identify as Born Again Christians. Thus, while Black River is dominated by Christians overall, no one

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[10] Those who identify as "Born Again" are not counted as members of the other religious denominations.
[11] I exclude members of the Latter-Day Saints not based on theology but on the social effects of the faith. For example, Markstrom-Adams (1991) found that teens belonging to the LDS church tended to avoid dating those of other Christian faiths and vice versa.

denomination holds an overwhelming majority. Catholics form the largest block with "Born Again" Christians and non-Baptist Protestants effectively tied for second place. It is unclear, however, how cohesive these groups are as the label may conceal a variety of internal cleavages or a total lack thereof. Of the non-Christians less than one percent identify as Jews, less than one percent identify as Mormons, and roughly 3% identify as "Other." Interestingly, the largest block of non-Christians are those who profess no religion, making up almost 22% of the students. Thus, it appears that the religiously uncommitted are actually the second largest block of students after Catholics. It is important, however, that we do not assume that these students are atheists or agnostics. In all likelihood many of them possess some variant of belief but do not identify with any specific denomination or, possibly, religious tradition.

Table 8- Religious Behaviors: Descriptive Statistics

Moving on to Wave 2 we see that the proportion identifying as Christian declines modestly, but significantly (t= -2.88, r< .01), to approximately 72%. While this indicates that Christians maintain a solid majority, that majority also appears to be weakening as time goes on. Further analysis reveals that all those who were Christian in Wave 1 and are no longer Christian in Wave 2 have switched to the "no religion" category. There appear to have been no conversion events from Christianity to another distinct non-Christian faith. Interestingly, while there were 31 conversions to some variant of Christianity between Wave 1 and Wave 2, virtually all of those individuals originally

derived from the "no religion" category with only a handful coming from "Other." It thus

appears quite likely that those with "no religion" are primarily a pool of unaffiliated, but

still potentially religious, adolescents. Moving on to the breakdown of religions in Wave

2, approximately 5% identify as Baptists, 23% as non-Baptist Protestants and 26% as

Catholics. When compared to Wave 1 there has been no significant change in the

proportion of Baptists, but a significant increase in the proportion of non-Baptist

Protestants (t= 1.95, r< .05) as well as a significant decrease in the proportion of

Catholics (t= -3.28, r< .001). The growth in non-Baptist Protestants appears to have

occurred primarily at the expense of Catholics with those claiming "no religion" and

Born Again Christians contributing as well. Among non-Christians, in Wave 2 Mormons

and Jews collectively account for less than one half of one percent of all students and

"Other" accounts for 4%. For Jews and Mormons the decrease appears to be primarily a

result of sample attrition rather than any conversion events or, put differently, all subjects

but one who reported their faith as either Jewish or Mormon in Wave 1 remain Jewish or

Mormon in Wave 2. The single exception converted from Judaism to "Other," and thus it

is impossible to say exactly what the nature of the theological shift may have been. The

increase in those claiming "Other" religion is statistically significant (t= 2.05, r< .05) and

appears to have occurred primarily at the expense of non-Baptist Protestants with a

smattering of others from the other Christian denominations as well as Jews and those

with no religion. Finally, almost 24% of respondents in Wave 2 report adhering to no

religion, an increase that is statistically significant (t= 2.10, r< .05). Unsurprisingly, the

growth in the "no religion" category occurred evenly at the expense of all four Christian

categories. The pattern we observe in these data is one of overall denominational stability. While fluctuation does occur between the different Christian faiths it mostly takes the form of movement into and out of the "no religion" option. Relatively few conversion events are observed between the various Christian denominations.

While denominational membership is important there is no necessary reason to assume that adolescents regard it as more than a label. To determine how their religion actually matters in their lives it is necessary to examine their behaviors. I begin this process by exploring their level of religious attendance. The Add Health records this information in a series of levels that I have recoded into the approximate number of days the students attend services in a given year. The resulting variable ranges from a low of zero to a high of fifty-two (i.e. weekly). While it is undoubtedly the case that some students attend religious activities more frequently than once a week the data are insufficient to distinguish these individuals from their lower-attending peers. Thus, the reader should keep in mind that a value of fifty-two means, in actuality, at least fifty-two times a year. In Wave 1 the mean number of religious services attended was 20.86 with a standard deviation of 20.50, equating to somewhat less often than once every other week. The modal response was zero religious services a year, accounting for 39.66% of respondents. It is important to note, however, that this total includes those who reported adhering to no religion and, as a consequence, were not asked about their religious attendance. After zero services per year the next most frequent response was fifty-two per year accounting for 24.97% of respondents. Collectively, those who attend weekly or

approximately every other week account for just over 48% of the total sample, suggesting

that frequent religious attendance is typical of Black River students.

In Wave 2 the mean level of religious attendance decreases slightly, but

significantly, to 19.15 services a year with a standard deviation of 19.88. This change,

while small, is statistically significant (r< .001). As before the modal level of attendance

is zero services per year, but a slightly smaller percentage of the respondents (39.55%)

report this level than they did in Wave 1. In contrast to Wave 1, the second most popular

attendance option in Wave 2 is 26 times per year, accounting for 23.92% of the

respondents. Those reporting monthly attendance of religious services also increase to

15.15% of the total respondents while those claiming weekly attendance decrease to

21.37% of the students. In total, these changes suggest that while the mean level of

religious attendance has declined it is not because students are drifting towards

irreligiousness. Instead there appears to be a general moderation of religious attendance

with the middle categories gaining at the expense of the high and low extremes. Such a

change is at least somewhat suggestive of a harmonization effect and does not resemble

what we normally think of as polarization.

The Add Health includes a measure of the frequency with which a respondent

prays, which I also recode to number of times per year. In Wave 1 the mean number of

times per year that Black River students pray is 106.51 with a standard deviation of

152.83. Thus, while on average a Black River student prays once every three days there is

a considerable amount of variation in this average. The modal number of times these

students pray is, as with attendance, zero accounting for 29.96% of all respondents. As

before, however, this figure includes those respondents who indicated no religion and thus were not asked about their prayer behavior. The next most frequently selected response was 365 times a year, or daily, accounting for 25.58% of the students. Again, it must be noted that given limitations in the data those students who pray more frequently than once a day cannot be distinguished from those who only pray a single time per day. In combination, those who pray daily and those who pray weekly account for 46.90% of all respondents, suggesting that prayer is a regular activity among Black River students.

In Wave 2 the mean frequency of prayer declines to 95.55 times per year with a standard deviation of 148.37. While not an enormous shift, this change is statistically significant ($t= -3.34$, $r< .001$). Like Wave 1 the modal level of prayer is zero times per year accounting for 32.85% of the respondents. The second most frequent level of prayer was daily, accounting for 22.97% of Black River students. Indeed, combining the two highest levels of prayer accounts for 40.99% of the respondents, suggesting that prayer remains a powerful force at Black river high school.

Based on these descriptive statistics it appears plausible that a general decline in religious fervor may take place during high school and, at least on the surface, polarization seems unlikely. Yet, is this the full story? Is it the case that all students decline equally in religious belief? Or could it be, as the literature suggests, that patterns of association play a significant role in determining religiosity in adolescence? To find out I employ models to tease out the nature of the relationship between selection and harmonization.

Religious Behaviors: Basic Variables and Effects:

Deploying the models to examine religious behaviors requires that I define

several classes of variables. First, there are the dependent variables, second the time-

invariant independent variables, and finally the network structure itself. As discussed

previously (Chapter Four) the network and dependent variables reciprocally influence

one another and are both influenced by the independent variables. Additionally, as

discussed in Chapter Four, these parameters are discussed as reflecting the preferences or

tendencies of individuals but this is simply a convenient abstraction for the purposes of

the model. In reality, many of these "preferences" reflect drives or constraints that are

beyond the control of the respondent and, indeed, often beyond their awareness.

Additionally, the reader should keep in mind that variables are not the same as effects.

The same variable may appear in multiple effects.

Two variables of interest are selected in this chapter, frequency of religious

attendance and frequency of prayer. Additionally, while not of focal interest, respondent

religion is included in some models as a control.

The first dependant variable is the respondent's self reported frequency of

religious attendance (religious attendance). This can range from a low value of zero to a

maximum value of weekly attendance. To simplify interpretation and model estimation I

recoded the original Add Health variable to reflect the approximate number of times per

year that a respondent attends religious services. So, an individual who attends once per

week would receive a code of 52. As I indicated above, the data do not permit me to

distinguish those who attend services more frequently than once per week from those who attend weekly.

The second dependent variable is the respondent's self reported frequency of prayer (prayer). While religious attendance can be compelled by parents, individual prayer cannot. As such, this variable may provide a better gauge of the student's actual religiosity while the former indicates more about the extent to which they have access to a religious community. This variable is also recoded to indicate the number of times per year the respondent prays and thus ranges from zero to three hundred and sixty five- or in other words from never to daily. Again, as with religious attendance, it is impossible to distinguish those who pray more often than once a day from those who do so a single time a day. Nonetheless, we can be reasonably confident that those who pray on a daily basis are displaying a fairly strong degree of religious commitment.

Selection or harmonization could occur on any of these variables and I expect that evidence of both selection and harmonization will be detected. The importance of religion to society as well as its ability to spread through networks gives us reason to believe that neither process will overwhelm the other. A series of models will be estimated to evaluate selection and harmonization and determine if this hypothesis is true.

Common Model Effects: A Review:

As in the weight behavior and belief models estimated in Chapter 5, these models include a number of common effects. The discussion of these effects from Chapter 5 is reproduced here for the reader's convenience.

A number of different network effects are also included in the models dealing with religion. Particularly, effects are included for outdegree, reciprocity, transitivity and number of actors at distance two. Outdegree refers to the number of individuals a respondent selects as friends. Thus, if I were to pick two individuals as friends my outdegree would be two; if I were to pick one individual as a friend my outdegree would be one. At a very simple level outdegree reflects the returns to the respondent from expanding their network. When other structural variables are included it reflects the returns from directing ties to additional randomly selected others. In practice, then, outdegree tends to encapsulate the expense incurred as a result of developing social ties. Thus, a positive coefficient indicates that additional ties provide additional rewards, while a negative coefficient indicates that ties are costly and will not be developed or maintained without certain compensations (i.e. other coefficients that are positive rather than negative).

Reciprocity simply reflects a tendency to develop mutual relationships. If I select an individual as a friend and that person selects me in return then we have a mutual or reciprocated relationship. If I choose an individual as a friend and they do not choose me in return, then our relationship is unreciprocated or unmutual. If the coefficient for

reciprocity is positive it means that mutual relationships are more rewarding than unmutual. If, on the other hand, the coefficient is negative then unmutual relations are preferred.

Transitivity reflects the old adage that the friend of my enemy is my enemy, or that the enemy of my enemy is my friend. In other words, our relationship with a certain other may be determined by our mutual relationships with a third person. In this particular instance, however, transitivity refers to the tendency to become friends with the associates of our immediate friends. So, I will tend to become acquainted with the friends of my friends. It is important to note that this is not necessarily the result of any deliberate action or process. Rather, because two people have the same friend in common it is more likely that they will come into contact and, in turn, develop a relationship of their own. The first, and most important, prerequisite for a relationship is simple propinquity. A positive coefficient indicates that respondents become acquainted with the associates of their friends while a negative coefficient indicates that they tend not to be acquainted.

Finally, the actors at distance two effect simply accounts for the reach of a network. In order to understand this effect it is helpful to define the first and second order network. A first order network is composed of one's own associates whereas a second order network is made up of the associates of one's friends. Thus, if my friend Steven has a friend of his own, Bill, Steven is in my first order network while Bill is in my second order network. Importantly, if the transitivity effect described earlier plays out and I become acquainted with Bill directly then he moves from my second order network into

my first order network. Thus, the second order network consists of those associates of my

friends to whom I am NOT directly connected. An actors at distance two effect simply

indicates whether or not there is a tendency to prefer associates who increase the size of

one's second order network. In combination with other parameters it can also provide a

gauge of the tendency to form cliques. A positive coefficient indicates that associates

with many alters of their own are preferred whereas a negative coefficient indicates that

associates with many alters of their own are shunned. This effect is one way to detect a

preference for association with socially active individuals as opposed to those with a

similar level of social activity.

Finally, a number of independent variables are included in the models. These

include respondent sex (female), respondent relocation (moved), school attendance status

(in-school), grade, and race. Each of these variables is incorporated into a set of effects

primarily influencing the network structure itself.

Given the strong tendencies towards homophily observed in virtually every study

of association ever undertaken (e.g. McPherson, Smith-Lovin and Cook 2001) respondent

sex is included as a control variable. Specifically, a dummy variable equaling one when

the respondent is female and zero when he is male is used. This variable is then used in

three distinct network effects, termed "ego," "alter," and "selection." An ego effect tests

whether or not being female increases the number of ties an individual directs outward.

So, a positive coefficient indicates that females choose more others as friends than do

males. An alter effect, in contrast, reflects the tendency for females to be chosen by

others. So, if females are more popular as associates than males, there should be a

positive coefficient. Finally, a selection effect is simply testing for homophily developed via friendship choices. A positive coefficient indicates that females tend to associate with females and males tend to associate with males. A negative coefficient, on the other hand, would point to primarily heterophilous association. Harmonization on sex, of course, is impossible within the time scale of the Add Health data.

Many, if not most, students in high school have been moving through the educational system with their age cohort for eight or more years. As a consequence, it is reasonable to assume that many networks are relatively well-developed upon entry to the high school environment. Some students, however, may experience an amount of geographic mobility that disrupts this stable set of relationships. This can range in scope from a cross-town move, that shifts students into new school districts, or an inter-city or inter-state move that entirely removes the teen from their existing context. In either case, an accurate picture of the social network may rely upon knowing whether or not a given respondent has been relocated in the past. Thus, a variable "Moved" is included that equals one if the respondent has moved in the last five years and zero otherwise. It is specifically included as an ego effect, meaning that the model tests whether or not having moved changes the number of others an individual selects as friends. A positive coefficient indicates that a respondent who has recently moved selects more others as associates while a negative coefficient indicates that a respondent who has moved selects fewer.

Most students in the sample currently attend school. However, some students may be suspended or expelled from school. While we can reasonably expect that these events

will not disrupt such an individual's network of close ties, we would also expect that their wider network of distant associations would be altered. Additionally, it seems possible that students who attend school may be enjoined by their parents to stop associating with someone who has been expelled and, likewise, that an expelled student may spend more time with other students in the same circumstances. To test this I include a selection effect for school attendance status. A positive coefficient indicates that association is more likely between those of the same school attendance status while a negative coefficient indicates that it is less likely.

While students can, and do, form friendships with others at different ages most students spend the majority of their time in grade-specific contexts. As a result there are significant structural factors guiding students into association with those who are in the same academic grade. This tendency is only reinforced by the qualitative jumps between various phases of childhood- the movement from elementary to middle to high school. Each divide separates grades temporarily from those ahead of or behind themselves. As a consequence we would expect most relationships to develop, and be maintained, between those of the same grade. To take account of this factor a selection effect is included for school grade. A positive coefficient indicates a preference for association with those of the same grade, while a negative coefficient indicates an avoidance of association with those of the same grade.

Finally, race is included as a variable of interest. In many different contexts a person's ethnicity influences their associations. Particularly, most association occurs between those of the same race. In Black River there are relatively few students who are

non-white and, as such, we would expect most white students to associate with other white students and non-white students to associate quite frequently with white students (Blau 1977). At the same time, it remains possible that race is highly salient in this school and so a selection effect is included to determine if students preferentially develop friendships with those of the same race. A positive coefficient indicates that racial similarity is likely in relationships while a negative coefficient indicates that it is unlikely.

In addition to the variables and effects described above there are also a final set of effects that deserve mention. The first or "rate" effects indicate the number of opportunities that a given respondent has to make a change to their network or behavior between the survey waves. It is important to keep in mind that these effects do not reflect the actual number of changes made but only the number of opportunities for change. These effects are estimated by comparing the network in wave 1 to that in wave 2 and then determining the average number of changes necessary for actors to produce the observed shifts. These rate effects can be attached either to the network, indicating the number of chances to develop or eliminate a social tie, or they can be attached to dependent variables, reflecting the number of chances the respondent has to increase or decrease the variable by one step. To a limited extent a larger rate parameter indicates that there is more change in this feature of the network while a smaller rate parameter indicates less change. It is important to note that the rate parameters are the only parameters that do NOT refer to a shift in the objective function. Instead, they indicate the number of times a respondent is permitted to make a change to their objective

function. Secondly, dependent variables have an associated "tendency effect," which simply reflects an overall increase or decrease in the dependent variable throughout the study. This effect is relatively similar to an error term in that it absorbs the variation in the dependent variable that has not been accounted for using the current set of independent variables. At the same time, however, this tendency effect may be responding both to omitted variables within the scope of the model as well as to larger level context effects. A positive tendency effect means that the dependent variable tends to increase over time (or, in the case of dichotomous variables, become more frequent) net of the variables in the model while a negative tendency effect means the opposite. Specifically, a tendency effect is the change that will occur in the objective function for a one unit change in a variable.

Religious Behaviors: Dynamic Models:

To examine selection and harmonization in religion I estimate a series of models. The first model includes only the control variables, basic network effects, and selection effects for religious attendance and frequency of prayer. The second model eliminates effects non-significant in model 1 in order to preserve degrees of freedom for subsequent analysis. The third model then adds the harmonization effects. I then discuss the results to this point and describe subsequent analysis.

Beginning with model one (Table 9) the basic rate parameter is positive and significant (13.51, p< .001) indicating that, on average, Black River students have

approximately 13 opportunities to change their social network connections between Wave 1 and Wave 2. Outdegree is negative and significant (-4.04, p< .001) reinforcing the conclusion from Chapter Five that ties impose costs on students. The effects for reciprocity (1.97, p< .001), transitivity (0.28, p< .001) and actors at distance two (-0.07, p< .05) are all significant and indicate that relations among Black River students tend to form into tight clusters of reciprocated relations and closed triads. However, while the negative actors at distance two effect suggests that clustering is present in these networks, it is probably not overpowering. Cross-connections between different social circles still exist.

Turning to the independent variables we find that there is a negative alter effect for females (-0.26, p<.01) as well as a positive ego effect (0.16, p< .05) and a positive selection effect (0.37, p< .01). These parameters indicate that, as in Chapter Five, females are less attractive as alters than are males but have a greater tendency to direct ties outwards to others than do males. Finally, sex homophily appears to be present with females more likely to develop friendships with other females and males more likely to develop friendships with other males.

Moving on, it does not appear that networks are adversely affected if the respondent has moved recently. On the other hand there do appear to be significant selection effects for school attendance status (0.39, p< .05) and grade (2.51, p< .001) indicating that most students are friends with those who attend the same school and, particularly, those in the same grade. A negative selection effect is observed for race (-

0.26, p< .05), most likely produced by the handful of non-white students who, for

structural reasons, have a high level of association with those of other races.

Shifting our focus to the dependent variables of interest, it does not appear from

this model that prayer behavior has any impact on the attractiveness of a respondent as an

associate, or their tendency to direct ties outwards, and that prayer is not subject to

selection pressures. Indeed, it appears that a propensity of pray is irrelevant to one's

social network. In contrast, while religious attendance appears to have no impact on the

attractiveness of an individual to others it does appear to increase the number of ties

directed outwards by the respondent (0.006, p< .05). It also appears that selection is

present for religious attendance with individuals forming ties more readily with those

who share their own attendance practices (0.34, p< .05). Finally, it appears that

respondents do not preferentially associate with those of their own religion, a result that

is somewhat surprising. Finally, considering the tendency effects it appears that there is a

slight downward trend to prayer behavior (-0.96, p< .05) and no significant trend to

religious attendance. So, based on model one, it appears that selection is present, at least

for religious attendance, that attending religious services more frequently increases the

number of others a respondent will select as friends, and that there is an overall tendency

towards decreased levels of prayer behavior.

Model two eliminates non-significant ego and alter effects to preserve degrees of

freedom. The network effects and independent variable effects remain essentially

unchanged and are not discussed again here. Retaining the selection effect for prayer we

find that it remains non-significant but has begun to approach significance. Interestingly,

it appears to have a negative coefficient, suggesting that students at Black River may actually prefer to form relationships with those who do NOT have the same level of prayer behavior as themselves. This would reflect a preference for heterophily rather than homophily but, at present, is highly speculative given the lack of significance. Ego (0.007, p< .05) and selection (0.34, p< .05) effects for religious attendance remain significant and exert approximately the same influence as in model one. Thus, higher religious attendance produces a larger number of friendship nominations and individuals tend to associate with those who have a similar level of religious attendance. Finally, it still appears that prayer behavior is generally in decline in these data (-0.96, p< .05) while religious attendance remains essentially stable. Thus, based on model two, it seems that the main conclusions of model one are upheld.

Model three eliminates the non-significant selection parameter for prayer and adds parameters for harmonization on prayer and religious attendance. As before, the network effects and independent variables do not change markedly and are not reanalyzed here. With the addition of these harmonization effects it appears that religious attendance continues to be linked to a tendency to select larger numbers of others for association (0.007, p< .05) but the selection effect for religious attendance loses significance. Despite this loss, however, the coefficient remains in the same direction and of approximately the same strength, missing significance by only a very small amount. The reasons for this loss of significance become more apparent when we turn to the harmonization effects. While there appears to be no significant tendency for respondents to adopt the prayer behavior of their associates there do appear to be significant

harmonization effects for religious attendance. Yet, these effects are somewhat surprising as they appear to be negative (-.78, p< .05). So, it appears as though contact over time causes students in Black River to adopt *different* levels of religious attendance from one another rather than the same level. This is, in effect, an anti-harmonization finding and is extremely surprising.

Table 9- Results: Prayer and Religious Attendance Frequency

At this point it is helpful to pause and take stock of our findings. Thus far it appears that one's frequency of prayer has no impact on social networks whatsoever. Such a result is surprising but perhaps should not be excessively so as prayer is often a private affair. Thus it may not provide a focus for association or be easily observable by others. At the same time, praying can be and is done in a social setting and, as such, the lack of any noticeable result is unexpected. Indeed, while a selection effect for prayer was nearly significant in model two the coefficient was negative, suggesting that there may be a tendency to avoid forming relationships with those who pray at the same frequency as oneself. This result, while non-significant, should be considered in conjunction with the effects identified in model three. In the third model it appears that religious attendance may be subject to a sort of anti-harmonization, with associates driving each other to different levels of attendance rather than towards the same level. Moreover, this surprising result seems to overpower a drive towards selection on religious attendance. The results of this analysis are, in a word, puzzling.

In seeking to explain these findings I am forced to consider the literature on religious polarization. A genuine debate exists on whether or not adolescent religiosity moves in a single direction or, to the contrary, is characterized by movement of various groups towards more divergent positions. If polarization does indeed operate in this population then such a process might be responsible both for the null results identified for prayer and the surprising negative harmonization identified for religious attendance. To deal with this possibility I generated a new set of dummy variables indicating when a respondent was a member of the highest category of prayers, the lowest group of prayers, the highest group of religious attendees, and the lowest group of religious attendees. These revised dependent variables were then added to models functionally similar to the first three described above. Model four (Table 10) adds these four variables, replacing the earlier measures of religious attendance and prayer, and estimates ego and alter effects for each. Model five then eliminates non-significant effects from Model four and adds selection effects. Model six both trims some non-significant effects from Model five and tests whether or not the results are being generated by religious homophily. Finally, Model seven adds harmonization effects.

As with the earlier discussion of model fit, the shift to Model four does not substantially alter the network effects or independent variable effects. Moving to the new dependent variables we begin to understand what has been happening. It appears that high levels of church attendance do not produce a notable difference in either one's attractiveness as an alter or in one's propensity to direct ties outwards. In contrast, low church attendance both reduces one's attractiveness as an alter (-0.17, $p < .05$) and lowers

one's propensity to direct ties outwards (-0.27, p< .05). In combination this implies that while there is no network benefit to be had in high church attendance as opposed to moderate levels, low levels of attendance may impose a network penalty. In essence, failing to attend church denies access to a potentially useful focus for association but, once this focus has been obtained, additional time spent does not have a noticeable impact. Turning to prayer behavior it appears that neither high levels of prayer nor low levels have any impact on one's desirability as an associate or tendency to develop ties. An ego effect for high levels of prayer, suggesting that praying at a high level makes one more likely to send ties to others, is nearly significant but nevertheless falls short. Thus, these initial results suggest that, as anticipated, it may be that the impact of prayer and attendance behaviors are not be consistent throughout their range. Turning to the tendency effects, it appears that there is a decreasing likelihood that respondents will pray at the highest level (-1.92, p< .01) as well as a decreasing likelihood that respondents will attend religious services at the highest level (-1.50, p< .01). There appear to be no consistent trends in either direction among low attendees and low prayers. Thus, there seems to be a general decline in religiosity from Wave 1 to Wave 2 but not a gain among the irreligious.

Moving to Model five, non-significant ego and alter effects for the four dependent variables are removed and selection effects are added. As before, the parameters for the network effects and independent variables are largely unchanged from model four. Beginning with the ego and alter effects from the previous model it appears that while low religious attendance continues to exert a negative influence on one's desirability as a

discussion partner (-0.43, p< .05) it no longer has an impact on propensity to send ties

outwards. Shifting our focus to the selection effects we find that selection does not appear

to be present for those with high levels of religious attendance or those with low levels of

prayer. Those with low levels of religious attendance approach significance but do not

achieve it while those with high levels of prayer are subject to a negative and significant

selection effect (-0.24, p< .05). From this model it thus appears that while those who

attend church infrequently are less desirable as associates, those who pray very frequently

regard each other as undesirable as well. The tendency effects identified in model four

remain essentially unchanged in model five.

In Model six[12] the network effects and independent variable effects remain

largely constant with the exception of the actors at distance two effect, which decreases

in magnitude but remains significant (-0.11, p< .05). This implies that, controlling for

other effects in the model, the respondents do not appear to be as averse to sprawling

networks as we previously thought. That said, the negative and significant coefficient still

indicates a tendency towards clustering rather than open network structures. Low levels

of church attendance continue to reduce the desirability of the respondents as association

partners (-0.26, p< .05) but do not influence the number of ties directed outwards by low

church attendees. There still does not appear to be any selection based on low church

attendance status but the parameter approaches significance more closely in this model

than in the preceding model. This suggests that there may be a selection effect present if

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[12] Note that this model omits the variables for low levels of prayer as well as high levels of attendance in order to preserve degrees of freedom. As these effects were non-significant in model five and are reintroduced in model seven, this is not viewed as a serious hindrance to the reliability of these findings.

other opposing effects are properly controlled for. Those with high levels of self reported

prayer still appear to be subject to a negative and significant selection effect (-0.23, p<

.05) and thus it appears that those who pray at the highest levels prefer not to associate

with others who exhibit a similar level of prayer. Finally, there does not appear to be any

significant selection based on religion itself. Turning to the tendency effects, it appears

that there is still a decline from Wave 1 to Wave 2 in the likelihood of exhibiting a high

level of prayer (-1.51, p< .01). In short, then, this model reinforces the findings of Model

five: those who attend church infrequently are less attractive as associates and those who

pray frequently appear to avoid associating with one another. Further, controlling for

respondent religion does not appear to eliminate these effects.

Table 10- Results: High/Low Frequency of Prayer and High/Low Frequency of Religious

attendance

Finally we come to Model seven, which introduces the harmonization effects. The

network and independent effects remain largely unchanged from Model six and are not

discussed again here. The exception is the actors at distance two effect which recovers

some of its lost magnitude (-0.13, p< .05) and continues to indicate that clustering is

present in these networks. As in Model four we do not observe selection on high religious

attendance status. We do, however, continue to note that those who attend services

infrequently are less popular as association partners (-0.29, p< .05) but direct

approximately the same number of ties outwards as their higher church attending peers.

In this model, however, the parameter for selection among low church attendees becomes significant (0.35, p< .05) indicating that those who attend church infrequently tend to develop ties to one another more readily than to those with other church attendance status. This effect is interesting in light of the lack of a clear and obvious focus for such individuals to meet in, such as church provides to the more religious. Moving on, those with high levels of self reported prayer are still less likely to form ties with each other than they are with those of other prayer status (-0.23, p< .05). Finishing the selection effects, those with low levels of prayer are no more or less likely to develop connections to each other than anyone else. As in previous models there appears to be a significant downward trend to high church attendance (-1.77, p< .05) with no corresponding trend among the low attendance group. Thus high attendees become less numerous over time but low attendees to not appear to be benefiting from this shift. There is a similar downward trend in the frequency of high prayers (-1.63, p< .05) without a corresponding upward trend in low prayers. It appears from these results that in general adolescent religiosity may moderate somewhat, declining at the highest levels, but does not appear to be tending towards complete disappearance. Rather, there seems to be a simple retreat from the highest levels of religious participation.

Only one of the harmonization parameters added in Model seven achieves significance, although a second parameter suggestively approaches significance. It appears that individuals tend to converge on low church attendance to a significant degree (0.66, p< .05). This is not true of high levels of church attendance, interestingly, nor of high levels of prayer contrary to our perhaps naïve expectations. More intriguing,

the harmonization parameter for low prayer begins to approach significance. While I would not say that it approaches significance closely, it is noteworthy if only because the selection effect for low church attendance achieves significance only when the harmonization effect for low prayer behavior is also included. Presumably, those who do not attend church are unlikely to pray frequently and, so, these parameters may be at least somewhat related to one another.

In summary, Model seven provides us with an enhanced understanding of how religion and social networks interact in adolescence. The puzzling results obtained in the first three models become more understandable when we break out the extremes of these categories. We have detected both selection and harmonization in these data, as expected, but unexpectedly these processes seem to be acting more strongly on those at the lowest levels of religious adherence. While participation in a religious community may provide a focus for association (as suggested by the negative alter parameter associated with low church attendance) it seems that a lack of attendance can operate in a similar way. Also interesting, it appears that a sort of anti-homophily pressure exists for those who exhibit high levels of prayer. An adolescent who prays frequently will avoid association with those who pray a similar amount and favor association with those who pray less. The reasons for this reaction are not yet fully known but a persuasive explanation is suggested below.

<u>Discussion:</u>

These models provide us with considerable insight into adolescent social networks and religious behavior. The fears of some scholars that adolescence may mark a period of apostasy and withdrawal from religious life appear to be unfounded. Religion is a significant influence in the lives of many adolescents and appears to remain so, at least within the span of these data. At the same time, it does appear that young adults may pull back from the highest levels of religious adherence shifting towards a more moderate stance without necessarily moving overall towards the lowest levels of religious behavior. The trend effects identified in models four through six support this interpretation: adolescents are becoming less religious but not irreligious.

While moderation may be the order of the day for adolescent religion we should not confuse moderation with disinterest. It appears that religion can and does exert an influence on the social networks of American adolescents, however this effect is not entirely what we might have expected. While we did identify both selection and harmonization in these data, as predicted, both occurred for those with the lowest levels of church attendance. Additionally, it appears possible (though not as yet certain) that harmonization may also be present for the lowest levels of prayer. Similar effects were not, however, detected for high levels of church attendance or high levels of prayer. It appears that church attendance and prayer behavior can harmonize downwards but not upwards. Similarly, lack of attendance serves as a basis for association but not high attendance.

More puzzling, while selection was detected for those with high levels of prayer the sign of this effect was negative. The interpretation, therefore, is that individuals who pray a great deal tend to avoid selecting other individuals who pray frequently as associates. This is opposite what we would generally expect from homophily and begs explanation. Before we fear that homophily, one of the most robust findings in all of social science, is at risk, however, we should keep in mind that not all characteristics may be equally salient, or socially important. Those who engage in high levels of prayer are likely to be very religiously devout. Likewise, this suggests that these individuals will be most deeply involved not only in their religions, but also in their individual denominations and congregations. This will doubtless provide them with opportunities for contact with many others who are members of the same congregation but simultaneously reduce their opportunities for contact with those from other congregations. Indeed, the heightened religiosity of the high prayers may make them more sensitive to religious differences and thereby reluctant to pursue friendships with those of differing faiths. In short, then, while there may be a significant number of high praying individuals in Black River High School as a whole there may be relatively few who belong to any one particular congregation. As a consequence, these high praying persons may be more likely to develop friendships with co-congregationalists rather than with other high praying individuals who attend a different congregation, denomination, or religion. Thus, the anti-homophily detected in these results may very well be a result of

more powerful homophily on a characteristic (congregation) that is beyond the ability of these data to detect.[13]

Assuming that the explanation for the negative selection effect is correct or, at least, not too far wrong, we can begin to construct a model for religion and association in adolescence. These results suggest that the religious communities in Black River have taken on a sort of hub and spoke configuration. Each religious group, based in denominations or individual congregations, may constitute a distinct basis for association. At high levels of religiosity this basis may be overpowering, producing the negative selection effects identified in my models. At the same time, as religiosity declines there may be less of a tendency to avoid contact with different others. At the lowest levels of religiosity- zero church attendance and zero prayer- there appears to be a burgeoning cohesion. Those who have almost no religiosity in a sense appear to all be the same, and respond to each other as such, while those of increasing religiosity are all different.

Figure 11- The Structure of Adolescent Religion

We are left with a social system in which decreasing religiosity produces increasing similarity to a wide variety of others, while increasing religiosity produces increased distinction. Those at the heights of religiosity are very well integrated within their local communities but, at the same time, are separated from many others by an

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[13] Efforts to interact the high prayer selection effect with religion are ongoing. Such an interaction requires custom programming of the Siena software, however, and has not yet been completed to my satisfaction. A more detailed analysis interacting denomination with the high prayer selection effect is impractical because many denominations have few members in the Black River sample.

unbridgeable social gulf. For those at the lowest levels of religiosity, no similar social gulfs exist but, at the same time, there is a lack of a single institutional focus for association. While they are no less social than their more religious peers, this lack probably accounts for their apparently lower desirability as discussion partners. In a sense, despite this lower desirability, those with low religiosity act as the glue holding the social system together. In that those with low religiosity apparently make few distinctions between one another they provide a common ground linking all of the more specific religious groups. At the same time, however, this group is subject to both selection and harmonization pressure, suggesting that it may be somewhat insular and self-sustaining if not prone to grow.

Additional research could be, and clearly should be, done on religion in adolescence. These findings, however, allow future research to be targeted more carefully. While there is limited support for polarization accounts, it also suggests that polarization does not occur evenly at both the high and low ends of the religiosity scale. Instead, those who are least religious may be most likely to form a mutually-supporting subgroup. Among those with higher levels of religion there may, in fact, be a trend towards overall moderation. Thus, the true pattern may be one in which the highly religious become moderately religious and the irreligious maintain or increase their degree of irreligiousness. These results also paint a more complex picture of the social impacts of religion than we had previously anticipated. While religious communities may, indeed, provide a focus for association this is a focus that can and does impose significant social hurdles to association with others. Thus, religion may simultaneously

integrate and fragment the social world and may do so with particular strength if the focus is on the congregational rather than denominational level. Indeed, this suggests that in some ways the rise of the mega church may be a good thing for overall social connection. The vast size of a megachurch widens the pool of available others that adolescents may choose from thereby at least partly sidestepping the disintegrating consequences of church participation. Finally, this research confirms that both selection and harmonization may act in the same domain and that this interaction can produce interesting dynamics. Further exploration of these dynamics as they pertain to religion as well as to other focal areas is clearly desirable.

CHAPTER 7: DISCUSSION AND CONCLUSIONS

Homophily is one of the most robust findings in social science and this research has found no evidence to the contrary. Nonetheless, it is unwise for sociology to acknowledge the importance of homophily and consider the case to be closed. To the contrary, its very importance requires that we spend time and energy exploring its implications. In this dissertation I have attempted to contribute to this effort in a number of ways. In Chapter One I disentangled the related but analytically distinct concepts of selection and harmonization. Selection represents the active development of relations to those who already possess similar traits to oneself. Thus, if friendship networks are predominantly of the same sex, this is almost certainly a consequence of selection. Harmonization, in contrast, represents the spread of traits through existing friendship or communications networks. Much as rumors may spread through a group other values, beliefs and behaviors may spread in a similar fashion. In Chapter Two I argued that beyond merely being different routes to the same final goal (homogeneity), these two forces have substantially different implications for the social world. These implications were explored in some detail with attention paid to how the balance of each might impact the operation of the other. Strong selection pressures can serve not only to produce ties to those who are similar but also to eliminate ties to those who are dissimilar. Such tie losses have the additional consequence, however, of curtailing the available channels for harmonization. Thus, strong selection can overwhelm and prevent harmonization from taking place. Harmonization, in contrast, can short-circuit selection if it proceeds rapidly

enough. After all, if individuals harmonize on a new idea or belief rapidly enough, their mutual tie to each other may be reinforced and persevere even at the expense of other ties. Finally, at intermediate levels of both selection and harmonization networks may attain dynamic stability, constantly shifting and contorting as new ideas spread and network ties alter in response to harmonization. This exploration of the theoretical foundations of homophily is the first main contribution of this research.

Beyond the elucidation of theoretical principles, however, this work presents an empirical investigation of selection and harmonization. In Chapter Three I introduced a valuable data set derived from the National Longitudinal Study of Adolescent Health (Add Health). The Add Health data represent one of the richest sources of longitudinal network data yet obtained and deserve to be the subject of serious scrutiny. At the same time, these data are difficult and time-consuming to work with which has, perhaps, reduced the degree of attention that they have received. Nonetheless, they are unrivalled for the study of dynamic networks and this project serves in part to highlight their usefulness. In Chapter Four I then introduced a new and advanced approach to studying dynamic networks. Networks are a difficult area for study in part because, in contrast to other realms of social science, they cannot be modeled as composed of independent bits. Instead, the very power of the networks approach relies on the understanding that a social network is at once a single entity and a collection of sub-parts. Indeed, as a metaphor the term "network" implies just this as it introduces both the network as a single thing while, simultaneously, provoking the question, "a network of what?" To deal with the unavoidable dependence between the actors in network models I introduced and

employed the Siena longitudinal network analysis software. While by no means perfect, this approach remains superior to many other available solutions and allows us to explore the forces that guide the evolution of social networks. My discussion of both these data and the analytic techniques represents the second notable contribution of this research, showing how existing datasets can be used to answer some of the most pressing questions in network analysis as well as hopefully encouraging a new generation of data collection and analytical technique development.

While theory development is important and the discussion of data and technique is useful to the discipline, neither can substitute for solid empirical evaluation. Thus, this study does not stop with a discussion of selection and harmonization nor a description of how they might be studied but proceeds to actually explore how these forces play out in data. In Chapter Five this took the form of a study of weight beliefs and behaviors. The result was the discovery that both perceptions of one's body size as well as actual body mass were determined in part by harmonization and that selection did not appear to play a role in either of these domains. Moreover, it appears that while perceptions influence actual body mass and actual body mass influences perceptions, only perceptions have an impact on the intention to lose weight. For a nation that is facing a serious and growing obesity rate, this finding is sobering. In Chapter Six my exploration of selection and harmonization focused on religiosity. In the process I discovered a complex picture in which those who participate least frequently in religious services and activities appear to form a cohesive subgroup. At the same time, it became apparent that individual religions, denominations and congregations may exert both an integrative influence as well as a

disintegrative one. High levels of religiosity may help to orient friendship and association networks to a focus on one's own faith or place of worship to the potential exclusion of those of different faiths. Those with the lowest levels of participation, however, appear to have no such inclination. In a sense, all the different kinds of irreligious people are the same while the many varied kinds of religious people are all different. Instead of the traditional view of religion as mere difference and an aid to social cohesion we, instead, see the picture as though in negative: with the fragmented networks of the religious bound together by the relative cohesiveness of the irreligious.

The consequences of this empirical investigation may be felt in two distinct areas: the study of adolescents and the study of homophily more generally. Starting with the former, adolescents are an important group in almost any society. This importance is not derived from their current involvement in government or industry where they are unlikely to hold positions of significant import. Instead, adolescents are important because they will one day be adults and as adults they will hold positions of influence. Children who successfully negotiate the turbulent period of adolescence to become healthy productive adults can contribute substantially to the wellbeing of their society as well as prove more capable of securing health, happiness and prosperity for themselves. Adolescents who drift into undesirable or dangerous behaviors, on the other hand, may compromise their health and happiness for years to come, denying themselves the benefits of their society and imposing a burden on those around them. Thus, the future success of a society is in many ways dependent on the current success of its adolescent population. Despite the inevitable importance of the adolescent population, however, it is in many ways

understudied. My dissertation, in focusing on adolescents, plays a role in correcting this deficiency. Indeed, its findings about weight beliefs and behaviors provide food for thought in our ongoing battle with obesity. To the extent that health behaviors developed and reinforced in adolescence may persist throughout the life course it is crucial that we understand where these behaviors come from. Having identified the sources and mechanisms, it may then become possible to intervene and encourage positive health behaviors. While long regarded as a cosmetic issue only, obesity can and does impose a health cost on the individual and society that may be comparable to widespread use of tobacco. Unlike cigarettes, however, we cannot simply prevent adolescents from purchasing or using food, and so we must explore more behaviorally-oriented solutions to the obesity crisis. Combating obesity will require not merely understanding the social conditions that produce it, but also the social conditions necessary to support a solution.

In the case of religion, these results are similarly important. Religion has been in the past, and may continue to be, a divisive topic for many Americans. The rise of the religious right in the United States as well as the political strength of religious leaders worldwide should be sufficient to demonstrate that the interaction of religious communities in a pluralistic society can be fraught with difficulty. Nevertheless, religious organizations engage in a great deal of philanthropic work and may well be an indispensable mechanism for the generation of social support and social capital. This research helps us to understand how religion is affected during the period of adolescence and, similarly, how this influences friendship networks. Specifically, it identifies two parallel needs: that religious students be encouraged to develop ties to those of other

faiths and that irreligious students be discouraged from closing themselves off from others. Indeed, surprisingly enough, it appears that our concern with the effects of religion may have blinded us to the consequences of irreligiousness, which serves as a basis for association to a degree we had not previously anticipated. Moreover, irreligiousness appears to exert a harmonizing influence, drawing individuals into the fold at a rate sufficient to at least guarantee the stability of the population. At the opposite extreme, adolescents who embed themselves most deeply in their own religious communities may do so at the expense of cross-cutting ties beyond it. While this doubtless produces returns for the individual in terms of social support it may impose even higher costs from the loss of wide ranging integrative ties. While this research suggests quite strongly that extreme levels of religiosity are unlikely to be a product of adolescence it, at the same time, gives us reason to believe that religion in adolescence may be a source of global disconnection even as it produces local cohesion.

In terms of homophily more generally this research is a significant advance. Researchers have long known that selection and harmonization are both relevant to social life but much uncertainty has remained about their relative impacts. Moreover, too often we have approached the problem as though selection OR harmonization plays a role. To the contrary, both may often be related and an understanding network evolution can only be based on a grasp not only of each individually but also of both jointly. This research is not the final word on this subject and any claim to the contrary would be intolerably arrogant. Nonetheless, it is an important attempt to model both processes. By conceptualizing four "ideal typical" mixtures of selection and harmonization I have

provided anchors against which future research may chart a course. Further, I have not

only proposed the existence of these anchors, but identified two of them in the empirical

world. As expected, weight beliefs and behaviors are dominated by harmonization rather

than selection and are an example of what I term "contestation." In this region of social

space different ideas, beliefs and behaviors directly compete for dominance, pushing

back and forth through a relatively tranquil social network. Also as expected religious

behaviors appear to be subject to both selection and harmonization, occupying a zone that

I term "brittleness." While potentially stable for lengthy periods, these brittle networks

can undergo massive changes if and when new ideas enter the mix or old ideas are raised

to new levels of salience. While there are certainly no guarantees, there is reason to

expect that the remaining two ideal-typical combinations of selection and harmonization

will also be identified. Once all four are identified we may then explore the space

between them. Clearly, not all phenomena should fall into one of these four classes.

Instead, these can be thought of as the extremes, defining the boundaries of homophily in

human social systems. Over time our understanding of how the strength of selection and

harmonization varies, and how their varying strengths influence one another, can only

improve.

Figure 12- State Space for Selection and Harmonization

While this research is an important contribution to the literature substantial further

research waits to be done. First and foremost additional studies need to focus on the

interaction between selection and harmonization. Disentangling these two forces, however, unavoidably requires the acquisition of new data. Because selection and harmonization are so deeply intertwined the only practical way to distinguish the one from the other in many environments is through the use of longitudinal data. Unfortunately, high quality longitudinal network datasets are generally lacking. This lack is not attributable to disinterest in studying dynamic networks but, rather, likely owes to the difficulty of collecting such data. Ideally studying selection and harmonization requires data on the ties linking individuals to others, or what is known as an adjacency matrix. Unfortunately these matrices are most valuable when there is little to no missing data. This is a tall order at any one moment in time, but in order to study networks longitudinally it is necessary to repeat such a feat a number of times. Moreover, as individuals will naturally enter and exit the network over time researchers must be analytically prepared to deal with such changes. To date these requirements have placed the hurdles to longitudinal research impractically high. In the future, however, both obstacles can and will be overcome. As more communication shifts to an electronic format it may become possible to precisely record patterns of association while, nonetheless, anonymizing the participants. One promising strategy involves the use of java applets to track the co-presence of cellular telephones, allowing researchers to note not only electronic conversations but also physical proximity between individuals. This strategy has the additional advantage that it could be implemented as a part of a voluntary social networking application like MySpace and, thus, would allow for informed consent to be obtained. Other similar research techniques will likely also become available soon

permitting researchers to gather data in a passive manner and thereby reduce the burden on respondents. Along similar lines, new analytic techniques are enjoying a period of substantial development as computational resources increase. As computing power rises solutions to previously intractable analytic problems should become more common.

Once these and other data problems are solved researchers can focus on studying the dynamics of idea spread and its interaction with selection. Profitable areas for this research include those already examined in this dissertation- weight beliefs and religious behaviors- in addition to many others. In particular, much work can and should be done on the spread of public health information and practices. While antibiotics were once hailed as the salvation of mankind, it is apparent that many are losing their effectiveness as bacteria evolve increased resistance. While we are in little danger of losing the advantages of modern medical science it is evident that we must become more cautious in our use of antibiotics, preserving them for serious conditions and employing them in a manner not likely to produce long-term problems. Actually implementing such policies, however, may prove quite difficult in a culture that has grown accustomed to cures that come from pills. Along similar lines, as we cut back on our use of antibiotics it will be necessary to expand other public sanitation and health measures in order to restrict the spread of infectious agents. Hand washing and other sanitary practices will grow in importance and mechanisms must be developed to encourage their adoption. Research should also focus attention on issues of politics and education. In the former case, much remains to be understood about why individuals choose to advocate for particular policies or cast votes for particular candidates. Some of the answers to these questions doubtless

lie in knowledge of how views circulate through networks and, indeed, how these views may constrain the evolution of the network. Are we doomed to degenerate into a pair of warring camps? Is it all but impossible to maintain common ground? Additional research can help to deal with these difficult questions. Education, as well, may benefit from studies in this area. As our economy becomes ever more reliant on advanced technology so too must we ensure that the average worker is prepared to take advantage of the opportunities. Insights into selection and harmonization may allow future educators to structure schools and classrooms in ways that facilitate the absorption of course information and curtail more disruptive elements of the school experience. Finally, as we learn more about how selection and harmonization combine in a variety of domains we will be able to explore how selection or harmonization in one domain impacts another. In Chapter Six we saw evidence that homophily on denomination or congregation may be powerful enough to overwhelm homophily of another sort. As our knowledge of these phenomena expands it will become increasingly possible to determine exactly how such cross-domain interactions impact our lives.

Beyond studying selection and harmonization this research path will eventually enable the construction of models that use networks as information processing, rather than simply transmitting, structures. While it is of course well known that knowledge and influence move through network ties it is less often said that these movements may cause alterations in the information itself. Much as in the classic game of "Telephone," each retransmission of an idea is a chance for novelty to be introduced even if only in the form of errors. However, this novelty is likely not purely random but is instead partly

determined by the social position of the transmitter, the messages he or she has received from others, and the material circumstances of the transmission. Thus, networks may systematically alter the content that passes through their web of social ties. By understanding this systematic change we can gain significant insight into collective action, decision making processes, and even fads. While this dissertation does not attempt to model networks in this fashion it does lay the initial foundation for such a study. It embarks upon dynamic network analysis and contributes to this increasingly important area of study. Similarly, it helps to chart out the nature of selection, which both determines the availability of channels for communication and acts as a sort of "switch" activating and deactivating channels. Likewise, this research helps fill in our understanding of harmonization allowing us to better predict how, and when, information will spread. Pursuing this research direction may lead to network models of impressive sophistication and utility.

Much remains to be learned about selection and harmonization but this work is an important step in the right direction. Theory has been developed, techniques for carrying out investigations described, and two of the four ideal typical combinations have been identified. Along the way we have learned important lessons about adolescence, obesity, and religion in the United States. Future work will doubtless continue to be fruitful and help us to understand how our world is shaped by the manner in which we choose, and are affected by, our friends.

APPENDIX A- TABLES

Table 1- Basic Demographics

	n	% of Sample
Sex		
Female	1014	50.32
Male	1001	49.68
Race		
White	899	44.73
Black	321	15.97
Native American	27	1.34
Asian	372	18.51
Other	284	14.13
Biracial	97	4.83
Other Multiracial	10	0.50
Immigrant Status		
Born U.S.	1740	86.57
Non-English Home	404	20.1
Grade 7	238	11.84
8	249	12.39
9	108	5.37
10	619	30.8
11	611	30.4
12	131	6.52
Not in School	45	2.24

Table 2- Hispanic Respondents

	N	% of Sample
Hispanic- Total	540	26.87
Hispanic- White	187	34.63
Hispanic- Black	8	1.48
Hispanic- N.A.	23	4.26
Hispanic- Asian	13	2.41
Hispanic- Other	269	49.81
Hispanic- Multiracial	38	7.04

Table 3- Multiracial Respondents

	% of Sample
Biracial	
White/Black	11.21
White/N.A.	14.95
White/Asian	12.15
White/Other	23.36
Black/N.A.	10.28
Black/Asian	5.61
Black/Other	5.61
N.A./Asian	1.87
N.A./Other	1.87
Asian/Other	3.74
Triracial	
White/Black/N.A.	5.61
White/N.A./Other	0.93
White/N.A./Asian	0.93
Black/N.A./Other	0.93
Quadracial	
White/N.A./Asian/Other	0.93

Table 4- Black River Descriptive Statistics

	% of Sample
Sex	
Female	52.52
Male	47.48
Race	
White	98.92
Black	0.24
Native American	3.49
Other	0.6
Immigrant Status	
Born U.S.	99.52
Non-English Home	0.36
Grade	
9	29.03
10	27.92
11	22.46
12	20.6

Table 5- Hypothetical Siena Parameters

Effect	Coefficient
Numer of Ties	-4.00
Reciprocity	3.00
Transitivity	1.5
Sex Homophily	2.5

Table 6- Weight Beliefs and Behaviors: Descriptive Statistics

	BMI				Percent Overweight		Percent Underweight	
	Wave 1		Wave 2		Wave 1	Wave 2	Wave 1	Wave 2
	Mean	SD	Mean	SD				
All	22.87	4.26	23.3	4.52	21.01%	24.80%	7.25%	6.56%
Male	23.18	4.21	23.65	4.47	20.59%	25.23%	5.95%	4.26%
Female	22.52	4.29	22.91	4.55	21.48%	24.32%	8.70%	9.12%

	Weight Perceptions					
	Wave 1			Wave 2		
	All	Male	Female	All	Male	Female
Very Underweight	1.44%	2.29%	0.51%	0.95%	0.90%	1.00%
Slightly Underweight	14.90%	19.68%	9.62%	11.89%	17.17%	6.02%
About the Right Weight	50.60%	57.89%	42.53%	53.88%	58.73%	48.49%
Slightly Overweight	28.97%	18.54%	40.51%	29.32%	21.08%	38.46%
Very Overweight	4.09%	1.60%	6.84%	3.80%	2.11%	5.69%

	Weight Loss Intentions		
	All	Male	Female
Wave 1	33.65%	18.54%	50.38%
Wave 2	32.86%	15.66%	52.01%

	Eating Disorders					
	Wave 1			Wave 2		
	All	Male	Female	All	Male	Female
Disordered	0.37%	0%	0.37%	0.74%	0.36%	1.53%
Potentially Disordered	2.41%	0.92%	4.08%	3.04%	1.52%	4.75%

Table 7- Results: Weight Beliefs and Behaviors

	Model 1	SE	Model 2	SE	Model 3	SE	Model 4	SE	Model 5	SE
Base Rate	10.80***	0.95	13.78***	0.50	13.66***	0.54	13.71***	0.43	13.92***	0.57
Outdegree	-16.16***	0.20	-3.68***	0.20	-3.83***	0.21	-4.20***	0.21	-3.60***	0.24
Reciprocity	2.48***	0.16	1.96***	0.07	1.96***	0.07	1.95***	0.06	1.99***	0.07
Transitivity	0.09*	0.04	0.21***	0.01	0.24***	0.02	0.27***	0.01	0.15**	0.03
Actors at Distance 2	-1.43*	0.42	-0.45**	0.05	-0.27**	0.04	-0.08*	0.02	-0.89**	0.14
Female: Alter	-2.25**	0.39	-0.28**	0.05	-0.28**	0.05	-0.28**	0.05	-0.32**	0.07
Female: Ego	2.06**	0.34	0.16*	0.05	0.17*	0.06	0.18*	0.05	0.17*	0.06
Female: Selection	3.32***	0.25	0.35*	0.07	0.36*	.07	0.39*	0.08	0.37*	0.09
Moved	-0.05	0.07	.001	0.04	-0.0003	0.04	-0.0001	0.04	0.002	0.04
In-school Selection	10.10*	0.18	0.52*	0.18	0.50*	.019	0.63*	0.17	0.65*	0.22
Grade Selection	2.81**	0.31	2.47***	0.13	2.49***	0.13	2.48***	0.14	2.43***	0.17
Race Selection	-0.30	0.34	-0.25*	0.08	-0.24*	0.08	-0.22*	0.07	-0.26*	0.07
BMI: Alter	-0.03*	0.01	-0.01*	0.01	-0.01*	0.01	-0.01*	0.006	-0.02*	0.007
BMI: Selection	0.16	0.33	0.04	0.22	0.08	0.23	0.02	0.19	0.20	0.25
Perception Selection	0.34	0.38	0.40	0.32	0.04	0.09	0.03	0.06	0.04	0.09
Weight Loss Selection	-0.03	0.28	-0.08	0.06	-0.08	0.11	-0.06	0.07	-0.10	0.13
Rate: BMI	4.04**	0.44	4.25***	0.38	4.33***	0.30	4.04***	0.25	4.29***	0.36
Rate: Perception	0.46**	0.45	0.58**	0.06	0.60***	0.06	0.46***	0.04	0.60***	0.07
Rate: Weight Loss	0.50**	0.07	0.50**	0.06	0.90**	0.14	0.62**	0.07	1.13*	0.23
BMI: Tendency	0.14*	0.06	0.14*	0.03	-0.22	0.15	0.14*	0.02	0.14*	0.03
Perception: Tendency	0.05	0.09	0.19	0.11	0.17	0.13	0.05	0.08	0.17	0.16
Perception: Effect of Female							-0.12	0.16		
Weight Loss: Tendency	-0.87*	0.18	-0.96*	0.35	-7.71*	1.65	-1.05*	0.23	-2.78	2.13
Weight Loss: Effect of Female							2.11**	0.39	3.98	2.79
BMI: Harmonization			2.03*	0.43	2.64*	0.66			2.71*	0.58
Perception: Harmonization			4.53*	1.00	5.58*	1.54			6.19*	1.72
Weight Loss: Harmonization			-0.07	0.17	-0.28	0.23			-0.79	1.07
BMI: Effect of Perception					0.11*	0.05			0.12*	0.05
Perception: Effect of BMI					0.11*	0.04			0.12*	0.05
Weight Loss: Effect of BMI					0.12	0.07			0.36	0.25
Weight Loss: Effect of Perception					1.92*	0.43			1.93*	0.99

Table 8- Religious Behaviors: Descriptive Statistics

	Religious Affiliation			Religious Attendance	
	Wave 1	**Wave 2**		**Wave 1**	**Wave 2**
Baptist	5.85%	4.63%	**Times per Year:**		
Non-Baptist Protestant	20.46%	23.44%	**0**	39.66%	39.55%
Catholic	29.48%	25.84%	**12**	14.98%	15.15%
Mormon	0.24%	0.16%	**26**	23.39%	23.92%
Jewish	0.49%	0.16%	**52**	24.97%	21.37%
No Religion	21.80%	23.60%			
Born Again[1]	18.76%	18.02%	**Mean**	20.86	19.15
Other	2.92%	4.15%	**SD**	20.50	19.88

	Prayer	
	Wave 1	**Wave 2**
Times per Year:		
0	29.96%	32.85%
6	11.81%	13.08%
12	11.33%	13.08%
52	21.32%	18.02%
365	25.58%	22.97%
Mean	106.51	95.55
SD	152.83	148.37

[1] Born again respondents are exclusive of the other Christian denominations.

Table 9- Results: Prayer and Religious Attendance Frequency

Effect	Model 1		Model 2		Model 3	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Rate	13.5102***	0.542	13.4877***	0.819	13.5528***	0.8662
Outdegree	-4.0353***	0.209	-4.0201**	0.7199	-4.0087***	0.1939
Reciprocity	1.9713***	0.0708	1.9711**	0.2249	1.9769***	0.0696
Transitivity	0.2758***	0.0132	0.2751***	0.0267	0.277***	0.0142
Actors at Distance 2	-0.0668*	0.0225	-0.0695*	0.0235	-0.0604*	0.0277
Female: Alter	-0.2632**	0.0491	-0.2676*	0.0656	-0.2582**	0.0512
Female: Ego	0.1579*	0.0555	0.1628	0.0991	0.1682	0.113
Female: Selection	0.3714**	0.0702	0.3703*	0.1282	0.3691**	0.0676
Moved: Ego	0.0158	0.0462	0.0145	0.0416	0.0085	0.0428
In-school: Selection	0.3937*	0.1856	0.3804	0.5744	0.3644*	0.1538
Grade: Selection	2.5108***	0.1665	2.511***	0.1351	2.5056***	0.1465
Race: Selection	-0.2576*	0.0713	-0.2569*	0.1128	-0.2533*	0.1038
Prayer: Alter	-0.0857	0.1142				
Prayer: Ego	0.0576	0.1293				
Prayer: Selection	-0.2053	0.1981	-0.1984	0.1042		
Religious Attendance: Alter	0.0011	0.0022				
Religious Attendance: Ego	0.0062*	0.0021	0.0069*	0.0027	0.0072*	0.0022
Religious Attendance: Selection	0.3383*	0.1462	0.3355	0.168	0.3036	0.1626
Religion: Selection	-0.001	0.0841	0.0094	0.0854		
Rate: Prayer	0.7056**	0.1127	0.7078**	0.1007	0.7072**	0.1121
Rate: Religious Attendance	311.063	161.7361	311.062***	24.7155	342.4006***	22.5618
Rate: Religion	3.2923***	0.3202	3.2939***	0.3004		
Prayer: Tendency	-0.9636*	0.2062	-0.9621*	0.3516	-0.9394	0.5038
Prayer: Harmonization					0.0152	0.362
Religious Attendance: Tendency	0.0078	0.0042	-0.0079	0.005	-0.0023	0.0061
Religious Attendance: Harmonization					-0.7784*	0.2022
Religion: Tendency	0.1114*	0.0352	0.1109*	0.0358		

Table 10- Results: High/Low Frequency of Prayer and High/Low Frequency of Religious Attendance

Effect	Model 4 Coefficient	SE	Model 5 Coefficient	SE	Model 6 Coefficient	SE	Model 7 Coefficient	SE
Rate	13.6828***	0.4702	13.6756***	0.4445	13.6658***	0.5682	13.7121***	0.5798
Outdegree	-3.912***	0.1975	-3.7909***	0.2753	-3.9604***	0.2553	-3.9153***	0.2652
Reciprocity	1.9756***	0.0677	1.9909***	0.0637	1.9748***	0.0746	1.9747***	0.0681
Transitivity	0.2631***	0.0147	0.2155***	0.0135	0.2636***	0.0137	0.2575***	0.0148
Actors at Distance 2	-0.1052*	0.0327	-0.4025**	0.062	-0.1058*	0.0245	-0.1318*	0.0325
Female: Alter	-0.2603**	0.0497	-0.2756**	0.0534	-0.2618**	0.05	-0.2635**	0.0517
Female: Ego	0.1707*	0.0527	0.1688*	0.0531	0.1658*	0.0594	0.1701*	0.0562
Female: Selection	0.3725**	0.0687	0.3687*	0.076	0.3781**	0.0699	0.3788*	0.0808
Moved: Ego	0.0249	0.0393	0.021	0.0404	0.0188	0.0421	0.0232	0.0442
In-school: Selection	0.3829*	0.1652	0.5275*	0.2153	0.4082*	0.1801	0.431*	0.1866
Grade: Selection	2.4771***	0.134	2.4599***	0.1358	2.4776***	0.1291	2.4705***	0.1421
Race: Selection	-0.2755*	0.0675	-0.2921*	0.0802	-0.2747*	0.0758	-0.2754*	0.0717
High Attend: Alter	0.0258	0.0725						
High Attend: Ego	0.1255	0.0723						
High Attend: Selection			-0.0367	0.072			-0.046	0.089
Low Attend: Alter	-0.1682*	0.0808	-0.4281*	0.1352	-0.2634*	0.0797	-0.2852*	0.0833
Low Attend: Ego	-0.2659*	0.0744	0.0117	0.1589	-0.0547	0.1048	-0.0343	0.1186
Low Attend: Selection			0.4082	0.233	0.296	0.1611	0.3453*	0.1616
Pray High: Alter	-0.0011	0.0691						
Pray High: Ego	0.1379	0.0751						
Pray High: Selection			-0.2373*	0.0832	-0.229*	0.0789	-0.2305*	0.0819
Pray Low: Alter	0.0371	0.0798						
Pray Low: Ego	0.108	0.0829						
Pray Low: Selection			-0.0989	0.0966			-0.0797	0.0979
Religion: Selection					-0.0458	0.0757		
Rate: High Attend	0.516**	0.0873	0.5131**	0.0659			0.5141**	0.0753
Rate: Low Attend	0.4366**	0.0506	0.4359**	0.0519	0.436**	0.0548	0.5052**	0.069
Rate: Pray High	0.7044**	0.0905	0.7054**	0.0896	0.705**	0.0783	0.7062**	0.1081
Rate: Pray Low	0.4649**	0.0567	0.464**	0.061			0.545**	0.0953
Rate: Religion					3.2932***	0.2867		
High Attend: Tendency	-1.9203**	0.2412	-1.9225**	0.2516			-1.7708*	0.568
High Attend: Harmonization							0.0949	0.3624
Low Attend: Tendency	-0.0135	0.2043	-0.0156	0.237	-0.015	0.1856	0.634	0.3565
Low Attend: Harmonization							0.6574*	0.2537
Pray High: Tendency	-1.5027**	0.1794	-1.5029**	0.1783	-1.5061**	0.1832	-1.63*	0.4285
Pray High: Harmonization							-0.0709	0.2005
Pray Low: Tendency	-0.3526	0.2025	-0.3537	0.1937			0.9331	0.6877
Pray Low: Tendency							1.2073	0.7671
Religion: Tendency					0.1116*	0.0358		

APPENDIX B- FIGURES

Figure 1- Simulated Harmonization Sequence
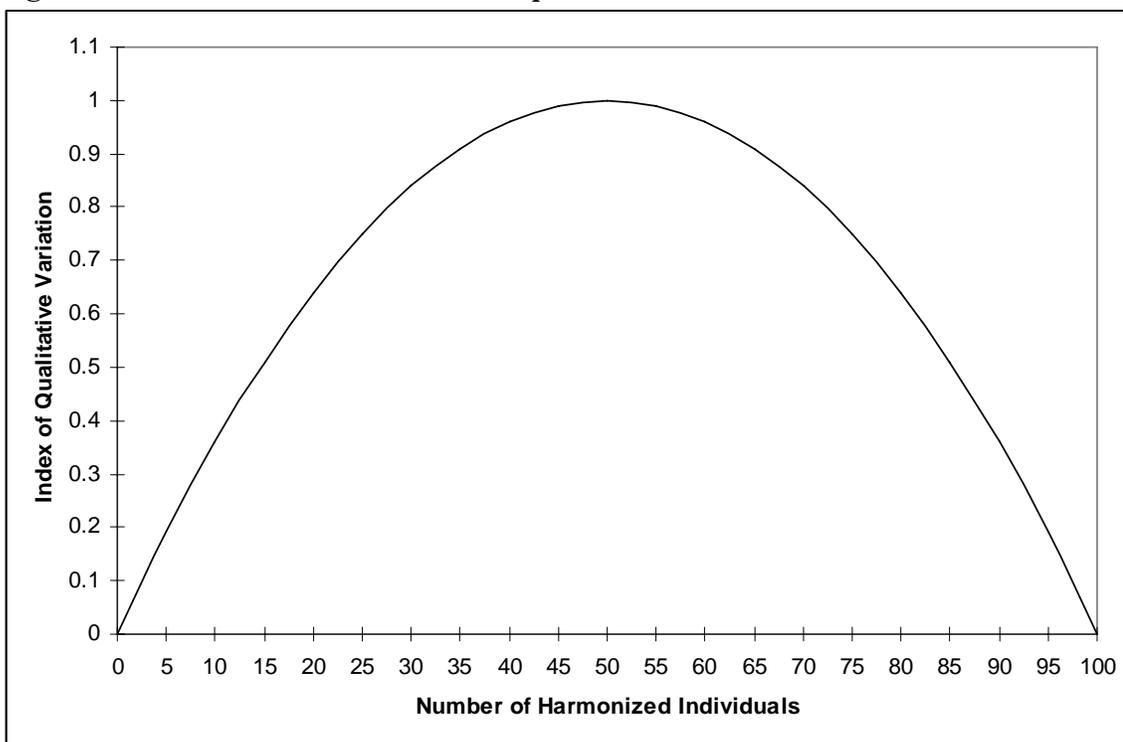
Figure 2- Selection by Harmonization States

Network Configurations

	Contestetation (quasi-stable)	Brittleness (unstable)
Strong	• Low structural change • Fast/slow idea spread	• Sudden structural change • Fast/slow idea spread
Harmonization	Stasis (stable)	Punctuation (stable)
Weak	• Low structural change • Slow idea spread	• Sudden structural change • Slow idea spread

Weak   *Strong*

Selection

Figure 3- Triad Transition Networks (Moody 1999: Figure 1, Panels A&B)

Panel A: Attitude Transitions.
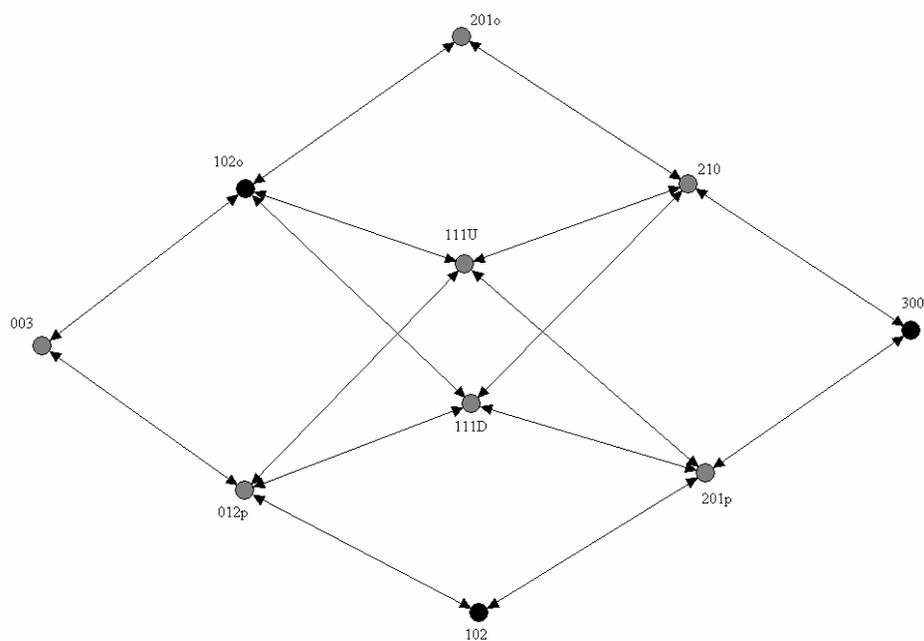

Panel B: Attribute Transitions.
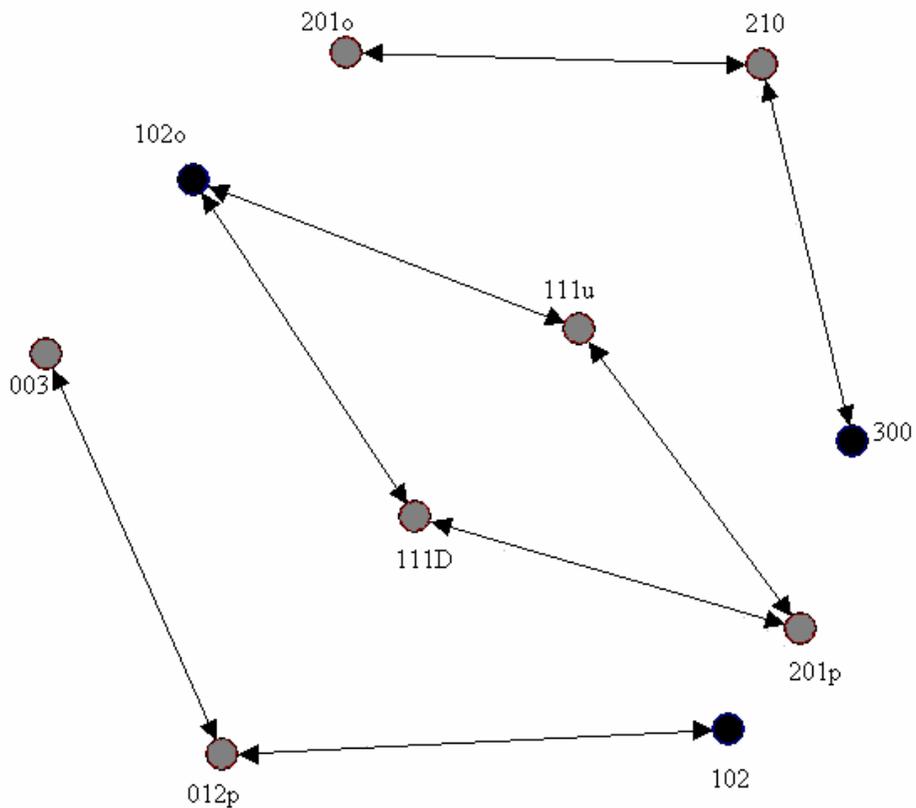
Black nodes are balanced (stable), grey nodes are unbalanced (unstable).

Figure 4- Structural Features of a Network

Name	Structure	Description
Density:		The tendency for ties to be present.
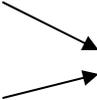
Two-in-Stars: Two ties directed to a common alter.

Two-Mixed-Stars: A two-step unreciprocated chain.

Two-out-Stars: Two ties directed outwards by the same alter.

Reciprocity: Mutual selection among a pair of alters.

Three-Cycles: chooses A. Actor A chooses B, who chooses C, who
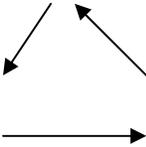
Transitive Triads: chooses C. Actor A chooses B who chooses C, A
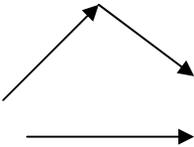
"The friend of my friend is my friend."

Reciprocal Mixed Stars: A combined unreciprocated and reciprocated structure.
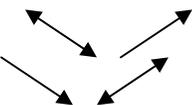
Figure 5- Example Model
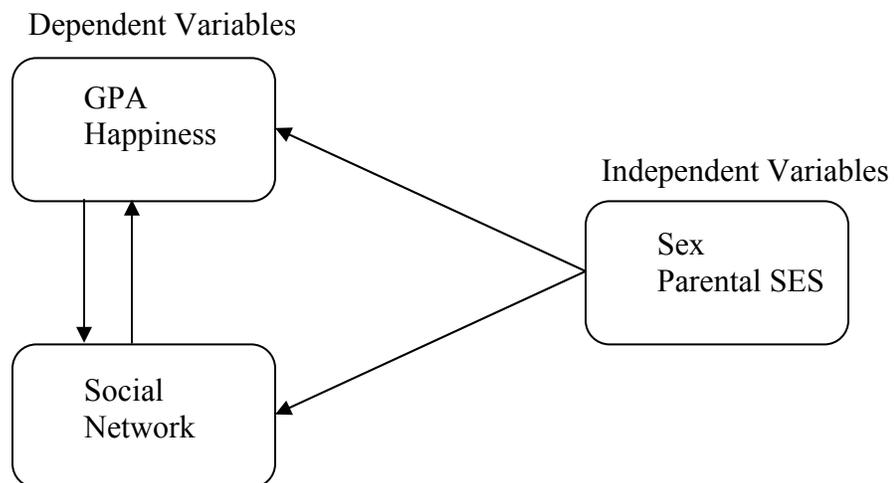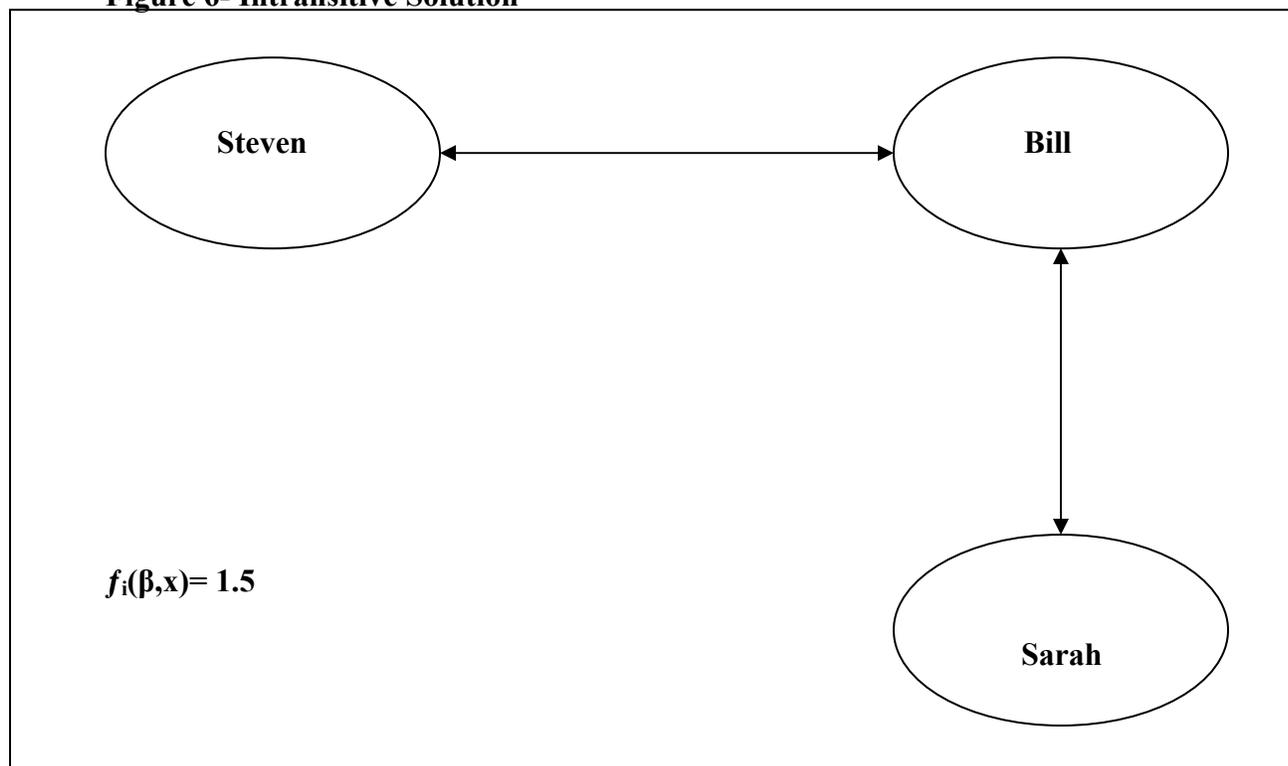
Dependent Variables

Independent Variables

Figure 6- Intransitive Solution

$f_i(\beta,x)= 1.5$

Figure 7- Unreciprocated Transitive Solution

$f_i(\beta,x)= -1$

Figure 8- Reciprocated Transitive Solution

$f_i(\beta,x)= 2$
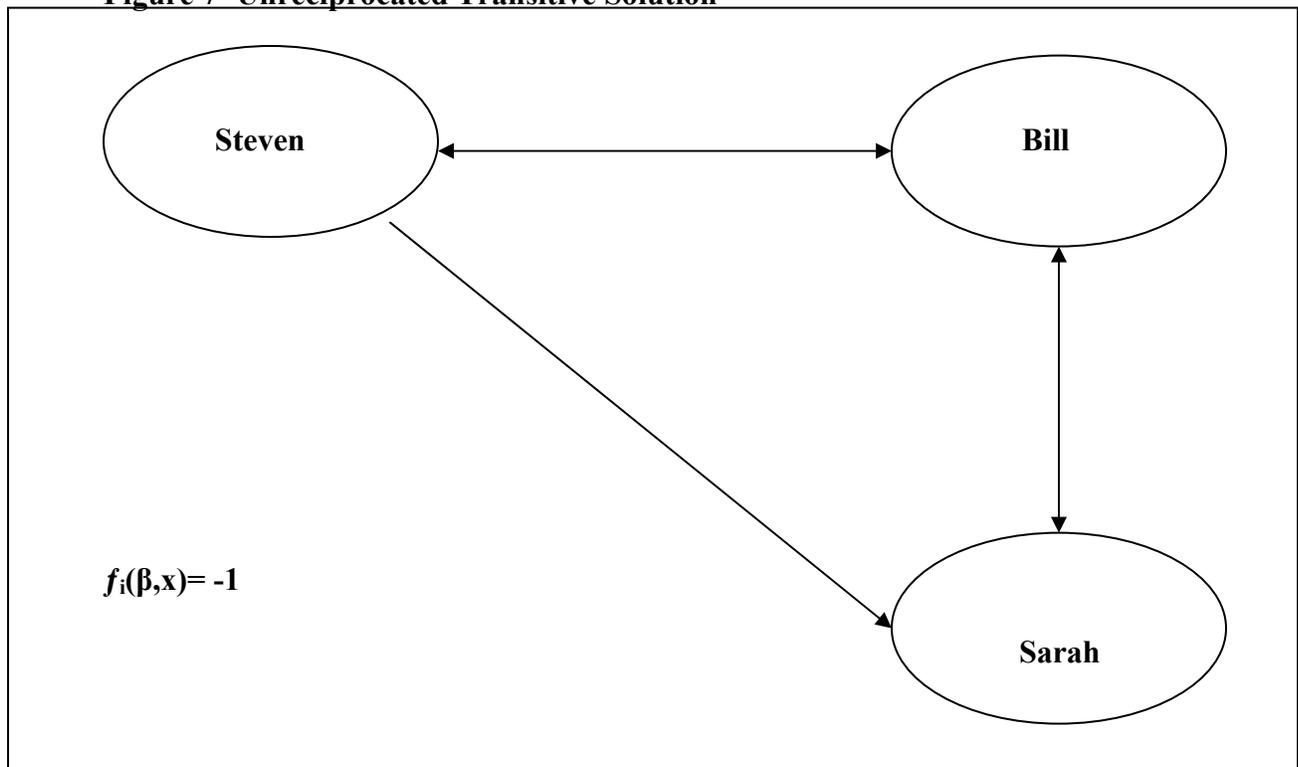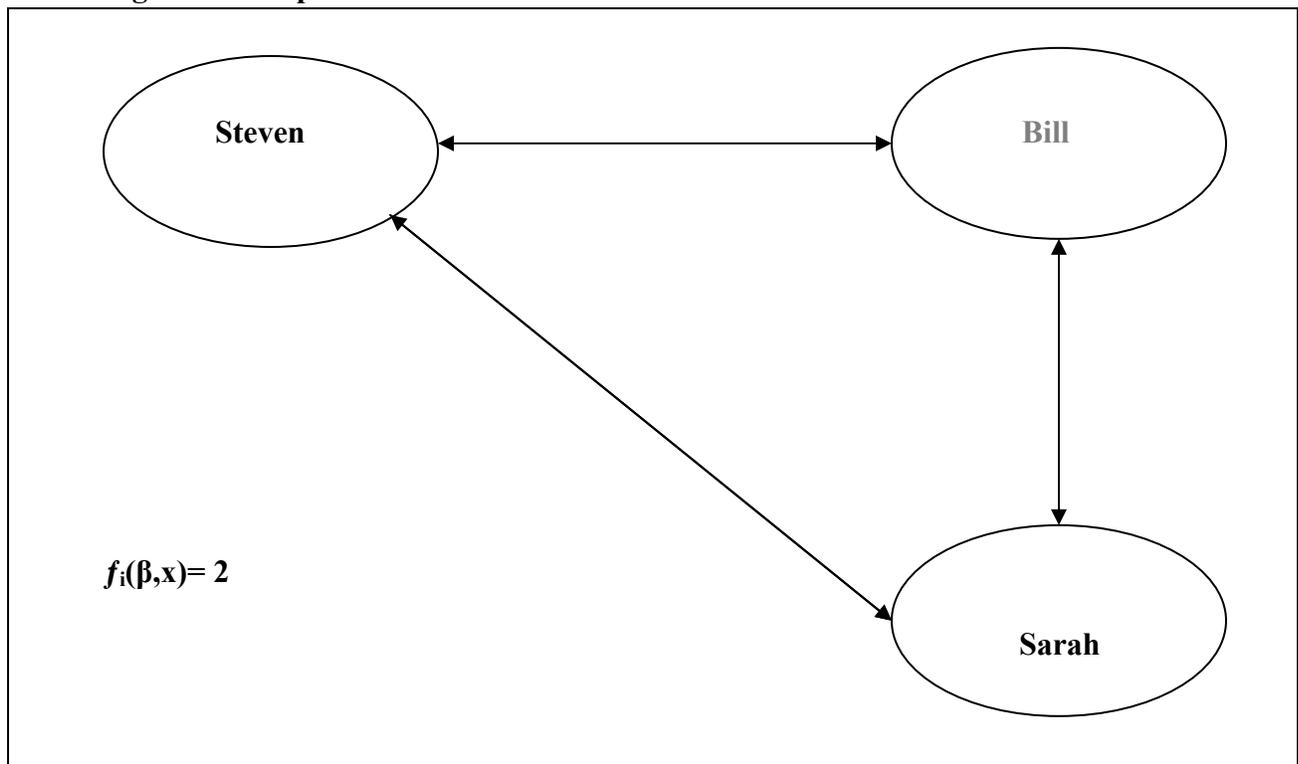
Figure 9-Isolate Solution

$f_i(\beta,x)= 0$
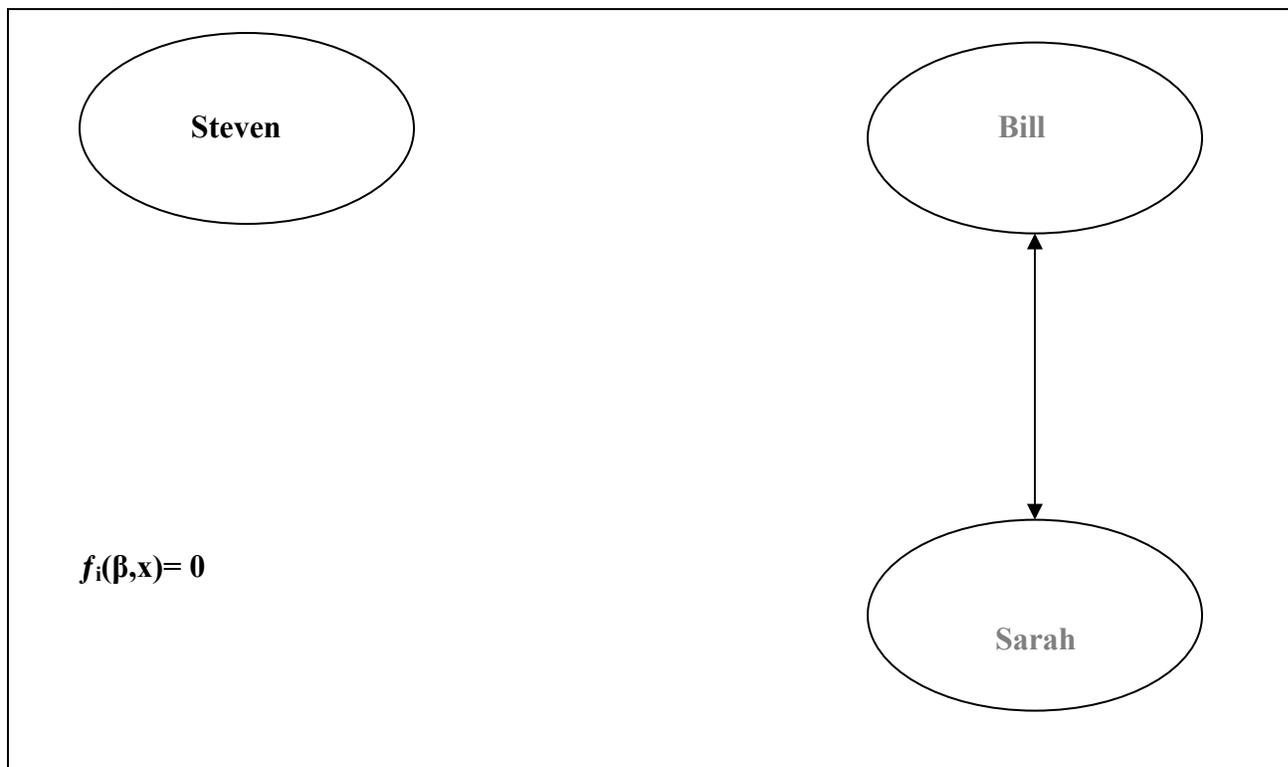
Figure 10- Social Influences on Weight, Weight Beliefs and Weight Behaviors
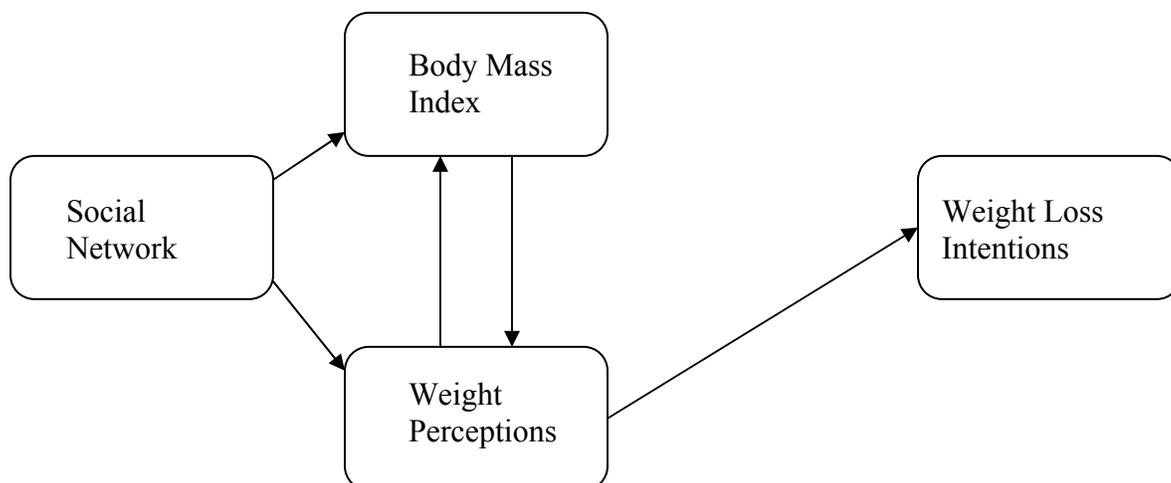
Figure 11- The Structure of Adolescent Religion and Association
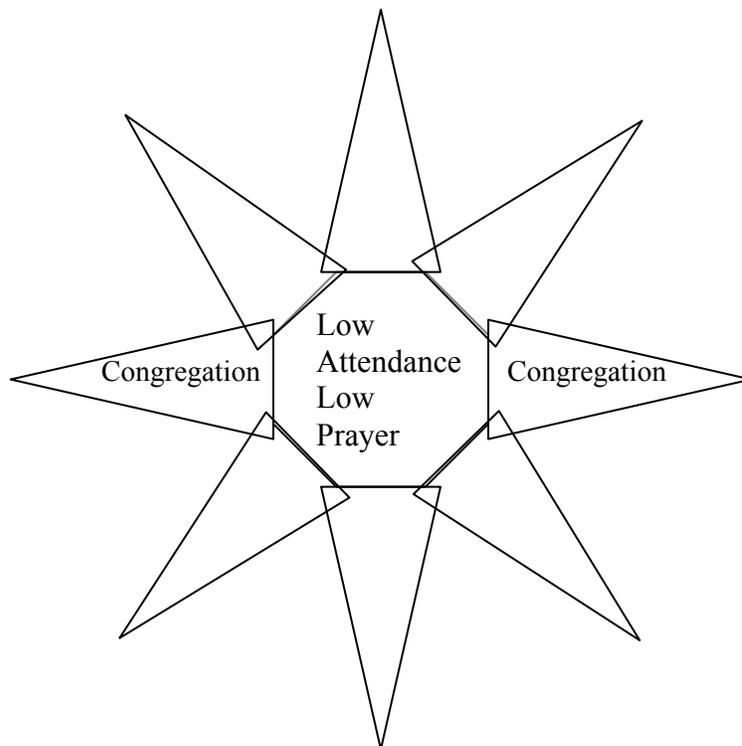
Figure 12- State Space for Selection and Harmonization

Selection

Contestation	**+**	*Brittleness*
Harmonization **-**		**+**
Stasis	**-**	*Punctuation*

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