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Three Studies Exploring Genetic and Social Influences on the Association Between Religiosity and Substance Use Behaviors

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ABSTRACT

Jason Alan Freeman: Three Studies Exploring Genetic and Social Influences on the Association Between Religiosity and Substance Use Behaviors
(Under the Direction of Michael J. Shanahan and Guang Guo)

Research exploring the relationship between religiosity and substance use behaviors typically find a significant inverse association between those two phenomena. One implicit assumption of these studies is that the relationship between religiosity and substance use behaviors functions in a similar way for all individuals within a population. However, some research has shown that the association between religiosity and substance use behaviors may differ between certain sub-groups within a population. In this dissertation I explore three factors that may lead to variation in the association of religiosity and substance use. I explore variation across family status (i.e. marital and parental status); variation across the life course (between adolescence and early adulthood) and variation due to genetic factors. I find that 1) the association between religiosity and smoking is stronger among married parents compared to other groups; 2) the association between religiosity and alcohol use increases between adolescence and early adulthood; and 3) there is genetic component of the covariance of religiosity and substance use behaviors that increases between adolescence and early adulthood. My findings reveal the need for researchers exploring the association between religiosity and substance use to take into account potential variation in that relationship.

To my mother Debra Ann Freeman and my grandmother Mamie Joyce Freeman. Without you none of this would be possible. Thank you. I will miss you always

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I would also like to acknowledge the help of the faculty and staff of the 2014 International Workshop on Statistical Genetic Methods for Human Complex Traits. The faculty and staff of the workshop provided instruction on how to properly conduct research using twin data. The also answered my questions and provided much of the syntax that I used for my analyses.

Lastly, I'd also like to acknowledge the help of Rosemary Russo who proofread chapter 2 of this dissertation. And I'd like to give special recognition to my colleagues Shawn Bauldry, Micah Roos and Hexuan Liu who provided helpful methodological advice at various points throughout the research process.

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INTRODUCTION

The consequences of substance use behaviors (e.g. smoking, alcohol use, etc.) exact a significant cost on U.S. society. For example, according to data from the U.S. Department of Health and Human Services (2014), for the years 2009-2012 smoking cost the U.S. more than 289 billion dollars annually. These costs include direct medical costs as well as lost productivity. As a result, factors that reduce the frequency of substance use behaviors carry an inherent indirect benefit for U.S. society—assuming they do not exact significant costs themselves. One such factor is religiosity, which studies consistently find is beneficial for the health and well-being of individuals (see Mochon, Norton and Ariely 2011).

Studies exploring the association between religiosity and substance use behaviors consistently find a significant inverse association between those two phenomena. For example, in a meta-analysis conducted by Yeung and Colleagues (2009), the researchers find that youth religiosity has a moderate, yet significant, weighted mean correlation ($Z_r = 0.16$) with substance use behaviors.

While these studies show that an association between religiosity and substance use behaviors exists, they typically ignore potential variation in the association between religiosity and substance use behaviors, even though there is some evidence for variation in the association between these two phenomena. For example, a study by Wallace and colleagues (2007) revealed that the level of religiosity in the school that an individual attends interacts with their level of his or her personal religiosity to

moderate his or her levels of substance use behaviors. Specifically, they found that individuals who were highly religious and who also attended a highly religious school were less likely to binge drink or use marijuana than individuals who were highly religious who attended a less religious school. The failure to explore potential variation in the association between religiosity and substance use behaviors is problematic because it likely provides an inaccurate view of the association. This inaccurate view could lead researchers who explore the relationship between religiosity and substance use behaviors to unintentionally present an excessively positive view of the association between religiosity and substance use behaviors in cases where religiosity has no association, or potentially a negative association, exacerbating the negative effects of substance use on the individual.

This dissertation addresses the problematic absence of research exploring variation in the association between religiosity and substance use behaviors by addressing three potential sources of variation in the association, they are: Variation across sub-groups of the population; variation across the life course; and variation due to genetic factors. I explore these potential sources of variation using data from the National Longitudinal Study of Adolescent to Adult (Add) Heath and a variety of methods which include linear regression models, negative binomial regression models, ordinal logistic regression models and bivariate Cholesky decomposition models.

In the remainder of this dissertation, I begin by reviewing the literature on the relationship between religiosity and substance use behaviors. In this section I describe the explanations that have been put forward to explain the association between religiosity and substance use behaviors as well as the weaknesses within the literature on the association between religiosity and substance use behaviors. After I review the literature on the association between religiosity and substance use behaviors. I then describe the theories surrounding the etiology of variation in the association between religiosity and substance use behaviors. In this section I draw on an expanded version of the moral communities thesis, which posits that the proportion of the co-religionists within an environment may

influence the strength of the association between religiosity and an individual's behavior. I also draw on a concept known as "behavioral disinhibition", which is an underlying genetic liability towards substance use and risk-taking behavior, to explain variation in the association between religiosity and substance use behaviors due to genetic factors. After I describe the theories surrounding the etiology of variation in the association between religiosity and substance use behaviors I then summarize my empirical chapters (2-4). In this section I discuss the basic research questions I address in each chapter; the major hypothesis or hypotheses of each chapter; and the general findings for each chapter. After I summarize my empirical chapters I present the empirical chapters in detail. I then present the general conclusions for the dissertation based on results from my analyses. And I conclude the dissertation by describing the implications that this dissertation has for future of research exploring the association between religiosity and substance use behaviors. I begin by reviewing the Literature on the association between religiosity and substance use behaviors.

A REVIEW OF THE LITERATURE ON THE ASSOCIATION BETWEEN RELIGIOSITY AND SUBSTANCE USE BEHAVIORS

Research exploring the association between religiosity and substance use behaviors date back to the 1960's (Gorsuch and Butler 1976). Despite an early finding by Hirschi and Stark (1969) which revealed that children who attend religious services are no more likely than non-attenders to accept ethical principles and are only slightly more likely than non-attenders to respect conventional authority, most contemporary studies find that religiosity is inversely associated with substance use behaviors (Stark 1996; Yeung, Chan, and Lee 2009).[1] This is the case across racial groups (Wallace et al. 2003) as well as for both males and females (Yeung et al. 2009). Many of the studies exploring the association between religiosity and substance use behaviors utilize samples of adolescents and young adults (Yeung et al. 2009). This is likely because substance use is more prevalent among adolescents and early adults compared to older adults and children (Johnston et al. 2014; Johnston, Bachman, and Schulenberg 2011).

Explanations for the Association. Several explanations have been put forward to explain the inverse association between religiosity and substance use behaviors. Early on individuals cited fear of divine punishment as the reason religious individuals were less likely to use drugs or alcohol compared to non-religious individuals (Hirschi and Stark 1969; Stark 1996). However, this particular view has largely fallen out of favor due to lack of empirical evidence to support it. One common explanation that is cited among contemporary researchers is the influence of prohibitions on substance use behaviors by religious groups. For example, Michalak and colleagues (2007) find that followers of religious groups that forbid the use of a particular substance are more likely to abstain from using that substance than other groups. This effect is especially true if individuals view their religious group as their primary

[1] **For examples** of a contemporary studies with null findings see Good and Willoughby 2006 and Page 1997.

reference group (Chawla et al. 2007). In regards to alcohol use in particular, religious prohibitions have a significant influence on rates of use. Religious groups that explicitly forbid alcohol use (e.g. Mormons and Muslims) tend to have lower rates of alcohol use while religious groups that do not explicitly forbid alcohol use or have more liberal attitudes toward alcohol use (e.g. Liberal Protestants) tend to have higher rates of alcohol use. In fact, the religious group within the U.S. with the highest levels of alcohol use are Catholics, who use alcohol as a sacrament during religious ceremonies (Engs, Diebold, and Hanson 1996; Kang Sim et al. 2013).

Another explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors is the fact that religious individuals often have lower levels of life stress than non-religious individuals (Ellison 1994). These lower levels of life stress which would likely to lead to lower levels of substance use because individuals often turn to substances such as tobacco and alcohol to cope with stressors. Wills, Yaeger, and Sandy (2003) find that negative life events have a weaker impact on both initial substance use and the growth of substance use over time among religious individuals compared to non-religious individuals. These findings replicate previous findings from similar studies (see Strawbridge et. al 1998; Kendler, Gardner, and Prescott 1997; Krause 1997).

A third explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors is the positive influence of religiosity on pro-social behaviors, such as self-control. Several studies find that individuals with higher levels of self-control tend to have higher levels of religiosity (e.g. Muraven et al. 2006; Muraven et al. 1998; Geyer and Baumeister 2005, p. 418) and lower levels of substance use (Vazsonyi, Pickering, Junger, & Hessing, 2001; Wood, Pfefferbaum, & Arneklev, 1995). In a study done by Desmond, Ulmer and Bader (2013), the researchers find that religious youth tend to exhibit higher levels of self-control, which partially mediates the effect of an adolescents' religiosity on his or her marijuana use and drinking. They also find evidence for an

interaction between religiosity and self-control where self-control has a greater impact on alcohol use among individuals with low levels for religiosity.

A fourth explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors, particularly among adolescents and children, is the influence of parental religiosity. Prior to early adulthood, when individuals typically achieve increased personal autonomy, an individual's religiosity is largely the product of the religiosity of their parent. As a result, an inverse association between an individual's religiosity and their levels of substance use behaviors is likely to be at least partially driven by the religiosity of their parents. Evidence for this comes from the research of Foshee and Hollinger (1996). They find that maternal religiosity during adolescence is associated with lower rates of alcohol use, over and above personal religiosity. Because the personal autonomy of individuals typically increases from adolescence to early adulthood, it is likely that the association between parental religiosity and adolescence substance use behavior diminishes over time and largely vanishes by adulthood.

It is likely that a combination of some or all of these explanation at least partially explain the association between religiosity and substance use behaviors. More research needs to be done in order to gain a deeper understanding of the factors that drive the association between religiosity and substance use behaviors.

Weaknesses within the Literature. The literature on the association between religiosity and substance use behaviors suffers from several weaknesses. First, there is a lack of standardization of religiosity and substance use measures across studies (Moscati and Mezuk 2014; Booth and Martin 1998). Within the literature on the association between religiosity and substance use, concepts such as religiosity, religious involvement, and even spirituality are used interchangeably. Studies also often lack

a measure of reliability of the religiosity measure and do not discuss the validity of the measures used (Wong, Rew, and Slaikeu 2010).

Second, studies that explore the association between religiosity and substance use behaviors often use a single item to measure religiosity. This is problematic because religiosity is a multi-dimensional concept that cannot be fully measured with a single item (Idler et al. 2003). However, studies consistently find a significant inverse association between religiosity and substance use; regardless of the measure of religiosity and/or substance use used (Yeung et al. 2009).

Third, most studies on religion and substance use behaviors use cross-sectional data. As a result, most studies exploring the association between religious and substance use behaviors treat the association as a time-invariant. As I will reveal in chapter 3, the association between religiosity and alcohol use varies between adolescence and early adulthood.

Finally, studies examining the relationship between religiosity and substance use behaviors among adolescents and young adults often lack a clear theoretical framework connecting religiosity and substance use behaviors. While a few studies have posited explanations for the association between religiosity and substance use behaviors (e.g. religious prohibitions against substance use), most studies only present a statistical association between religiosity and substance use behaviors and fail to clearly put forward a theoretical model explaining why they believed a statistical association existed in the first place. Next, I will describe the theories that I draw on the explain potential variation in the association between religiosity and substance use behaviors.

While these weaknesses likely lead to a distorted view of the association between religiosity and substance use behaviors, it should be noted that studies consistently find an inverse association between religiosity and substance use behaviors. However, even this consistently finding is likely a distortion due to the fact that an implicit assumption of research exploring the association between

religiosity and substance use behaviors is that the association is uniform across sub-groups of the population and across time.

THEORETICAL FRAMEWORK: VARIATION IN THE ASSOCIATION BETWEEN RELIGIOSITY AND SUBSTANCE USE BEHAVIORS

This dissertation focuses on three largely ignored types of variation in the association between religiosity and substance use behaviors, which are: Variation across sub-groups of the population; variation across the life course; and variation due to genetic factors. Previous research has described potential mechanisms that could lead to each type of variation. In this section I describe how these potential mechanisms might lead to each type of variation.

Variation Across Sub-Groups of the Population. One potential type of variation in the association between religiosity and substance use is variation across sub-groups of the population. A mechanism that could explain this variation was described by Mark Regnerus in his work "Moral Communities and Adolescent Delinquency: Religious Contexts and Community Social Control" (2003). Regnerus described an expanded version of Rodney Stark's Moral Communities thesis. The original moral communities thesis posits that rather than personal religiosity discouraging deviant behavior, it is actually the influence of co-religionists within one's social context that discourages deviant behaviors. The moral communities thesis was Stark's answer to critiques of the popular "hellfire thesis", which argued that individuals avoid behaviors that deviate from their religious teachings because of fear of divine sanctions. Critiques of the hellfire thesis have focused on an inconsistent link between personal religiosity and levels of delinquency. Stark found that contexts with low levels of religiosity, such as the West Coast of the United States, had higher levels of delinquency than contexts with higher levels of religiosity. Stark also posited that in contexts where religious norms are stronger (e.g. a religious congregation), an individual's religiosity may become more salient, which increases its influence on their behaviors. In other words, the religiosity of a social context acts as a "light switch", activating the influence of an individual's religiosity on their behavior (Regnerus 2005:268).

Research reveals that the influence of an individual's religiosity on his or her behaviors, including substance use behaviors, can vary depending on the proportion of the individual's co-religionists—defined as individual's who share the same religion— inhabiting that individual's environment (Regnerus 2003; Wallace et al. 2007). One potential mechanism that may explain this variation in the influence of religiosity on an individual's behavior across environments is variation in plausibility structures, which are groups of like-minded individuals who support and reinforce each other's shared beliefs, across environments (Regnerus 2007; Berger 1967). Within environments where there are more co-religionists, shared religious beliefs are more likely to be supported, which make them more salient in relation to an individual's behaviors. Conversely, in environments with fewer co-religionists, religious beliefs may not have the same level of social support or may even be discouraged. For example, Abu-ras, Ahmed and Arfken (2010) find that Muslim college students in the U.S. who were more involved in religious activities, and therefore more integrated into networks of co-religionists, were less likely to drink than Muslim students less involved in religious activities, and therefore less integrated into networks of co-religionists.

Subsequent scholars have found evidence for this thesis by exploring the interaction between personal religiosity, contextual religiosity, and deviance. For example, Regnerus (2003), using data from the National Longitudinal Study of Adolescent to Adult Health, found an interaction between individual-level measures of conservative Protestantism and conservative Protestant homogeneity on both the school and community level. He found that individuals who self-report as "born-again"; attend religiously homogeneous schools; and reside in religiously homogeneous communities report significantly lower levels of theft than born-again Protestants in contexts where they are a religious minority. Stark's "light switch" thesis was expanded to substance use behaviors as well. Wallace and Colleagues (2007) found that the level of religiosity in the school that an individual attends interacts with their level of personal religiosity to moderate levels of substance use behaviors. Specifically, they

found that individuals who were highly religious and who also attended a highly religious school were less likely to binge drink or use marijuana than individuals who were highly religious who attended a less religious school. However, Bahr and Hoffman (2008) using Add Health data, found no interaction between personal religiosity and contextual religiosity.

Variation across the Life-Course. While there is an extensive literature on variation in personal religiosity across the life course, there are no studies exploring variation in contextual religiosity across the life course. The strongest evidence for potential variation in the association between religiosity and substance use behaviors across the life course comes from the literature on variation in personal religiosity across the life course. Because early adulthood is the point in the life course where individuals are least likely to be involved in religion, young adults are less likely to be part of religious contexts such as religious congregations. However, it is not known if the larger contexts that young adults inhabit (e.g. universities, workplaces) are less religious than the contexts they inhabit during adolescence (i.e. school, family environment).

So overall there is a possibility that the association between religiosity and substance use behaviors varies across time, no studies had previously explored this before this dissertation. In chapter 3 I explore whether or not the association between religiosity and substance use behaviors vary between adolescence and early adulthood.

Genetic Component of the Association Between Religiosity and Substance Use Behaviors. The best candidate for an underlying genetic mechanism linking religiosity and substance use behaviors is a concept known as "behavioral disinhibition". Behavioral disinhibition is an umbrella term used to refer to a genetic liability for substance use behaviors and externalizing behaviors. Behavioral disinhibition is relevant to research exploring the etiology of the covariance between religiosity and substance use behaviors because having lower levels of religiosity has been conceptualized as a form of risk-taking

behavior. Miller and Stark (2002) argue that males are typically less religious than females largely due to their greater propensity to engage in risk-taking (impulsive) behaviors compared to females. Extending this argument, behavioral disinhibition drives individuals towards lower levels of religiosity while simultaneously driving individuals towards higher levels of substance use behaviors. Evidence for this hypothesis comes from the fact that during the transition from adolescence to adulthood, levels of religiosity among individuals tend to reach their lowest levels of the life course (Uecker, Regnerus, and Vaaler 2007) while levels of substance use behaviors tend to reach their highest levels (Johnston et al. 2011). This is simultaneous with an increase in the genetic component of the covariance between religiosity and substance use behaviors (Kendler and Myers 2009).

Both twin studies and candidate gene studies reveal evidence for the existence of behavioral disinhibition. Twin studies reveal the heritability of behavioral disinhibition to be approximately 80% (Krueger et al. 2002; Young et al. 2000). In addition, Hendershot and colleagues (2011) find that the cholinergic muscarinic receptor 2 gene (CHRM2), which codes for a muscarinic acetylcholine receptor subtype, is associated with latent measures of substance use and overall behavioral disinhibition. The muscarinic acetylcholine receptor subtype encoded by CHRM2 (M2 receptors) serve diverse functions, including inhibition of adenylate cyclase activity, modulation of potassium channels, and regulation of acetylcholine release and dopamine signaling (Volpicelli and Levey 2004; Threlfell et al. 2010; Woolf and Butcher 2011).

There is strong evidence that a common set of genes underlies the association between religiosity and substance use behaviors. This evidence largely comes from research on behavioral disinhibition, an underlying genetic liability for substance use behaviors and risk-taking behaviors. Applying Miller and Stark's conceptualization of declines in religiosity as a form of risk taking behaviors, there is a strong likelihood that a common set of genetic factors influence both substance use behaviors and declines in religiosity.

So overall there are solid theory-based reasons for expecting there to be variation in the association between religiosity and substance use behavior. In the next section I will describe my specific research questions, hypotheses, and results. I will present my research questions, hypotheses and results in more detail in my empirical chapters (chapters 2-4). I conclude the dissertation by describing my overall conclusions based on my empirical findings and the implications that this dissertation has for future research on the association between religiosity and substance use behaviors.

SUMMARY OF EMPIRICAL CHAPTERS

Chapter 2. In chapter 2 I explore the question, "Does the association between religiosity and substance use behaviors (i.e. smoking, alcohol use) vary across family statuses (i.e. marital statuses and parental statuses)?" My main hypothesis is that the association between religiosity and substance use behaviors is stronger for individuals with "traditional" family statuses (e.g. married individuals) compared to individuals with "nontraditional" family statuses (e.g. single parents, cohabitating individuals). My hypothesis is based on the idea that individuals with traditional family statuses—in particular married parents—are more likely to be well integrated into social networks with religious individuals (Stolzenberg, Blair-Loy, and Waite 1995). As a result, the plausibility of their religious beliefs is more likely to be supported and reinforced by like-minded co-religionists (e.g. other married parents within the same congregation), which will increase the influence of their beliefs on their behaviors, including substance use behaviors.

Overall, I find that the association between religiosity and smoking is stronger for married parents relative to single parents and cohabitating individuals, which provides partial support for the expanded version of Stark's hypothesis. This study reveals the need to explore variation in the association between religiosity and substance use behaviors in particular, and religiosity and health in general.

Chapter 3. In chapter 3 I explore the question, "Does the slope of the association between religiosity and substance use behaviors (i.e. smoking, alcohol use) vary between adolescence and early adulthood?" Previous studies have found that the strength of the association between religiosity and an individual's behavior is moderated by the level of religiosity of the context that individual inhabits. As a result, if there is variation in the religiosity of the contexts that an individual inhabits between adolescence and during early adulthood then there will also be variation in the strength of the

association between religiosity and substance use behaviors across those two life stages. However, because there is no compelling evidence to show that there are more (or fewer) co-religionists inhabiting the environments of young adults compared to adolescents I hypothesize that the slope of the association between personal religiosity and substance use behaviors will not differ between adolescence and early adulthood.

Overall I find that the association between religiosity and alcohol use is stronger during early adulthood compared to adolescence. This seems to indicate that the contexts that individuals inhabit during early adulthood are more religious than the contexts inhabited by individuals during adolescence. These findings reveal the need for further study of the mechanisms that lead to variation in the association between religiosity and human behavior.

Chapter 4. In chapter 4 I explore the question, "Do genetic factors at least partially explain the covariance of religiosity and substance use behaviors and does the genetic component of the covariance between religiosity and substance use behaviors vary between adolescence and early adulthood?" There is strong evidence that a common set of genes underlies the association between religiosity and substance use behaviors. This evidence largely comes from research on behavioral disinhibition, an underlying genetic liability for substance use behaviors and risk-taking behaviors. Applying Miller and Stark's conceptualization of declines in religiosity as a form of risk taking behaviors, there is a strong likelihood that a common set of genetic factors influence both substance use behaviors and declines in religiosity. This leads me to my first hypothesis of this study which is that genetic factors at least partially explain the covariance between religiosity and substance use behaviors.

While there is strong evidence for a genetic component of the covariance between religiosity and substance use behaviors, it is likely that this genetic component increases between adolescence and early adulthood. Evidence for this comes from research that shows that the proportions of the variance

due to genetic factors for both religiosity and substance use behaviors are smaller during adolescence compared to early adulthood. As a result, if a common set of genetic factors influence both religiosity and substance use behaviors then it is likely that the influence of the genetic factors will be smaller during adolescence compared to early adulthood. This leads me to the second hypothesis of this study which is that there is a significant increase in the proportion of the covariance between religiosity and substance use behaviors due to genetic behaviors between adolescence and early adulthood.

Overall I find a significant increase in the proportion of the covariance between religiosity and substance use behaviors explained by genetic factors between adolescence and early adulthood. This finding reveals the need to control for genetic factors in research on the association between religiosity and substance use behaviors.

CHAPTER 2: DOES FAMILY STATUS MODERATE THE ASSOCIATION BETWEEN RELIGIOSTY AND SUBSTANCE USE BEHAVIORS

The consequences of substance use behaviors (i.e. smoking, alcohol use, etc.) exact a significant cost on U.S. society. For example, according to data from the U.S. Department of Health and Human Services (2014), for the years 2009-2012 smoking cost the U.S. more than 289 billion dollars annually. These costs include direct medical costs as well as lost productivity. As a result, factors that reduce the frequency of substance use behaviors carry an inherent indirect benefit for U.S. society—assuming they do not exact significant costs themselves. One such factor is religiosity, which studies consistently find is beneficial for the health and well-being of individuals (see Mochon, Norton and Ariely 2011).

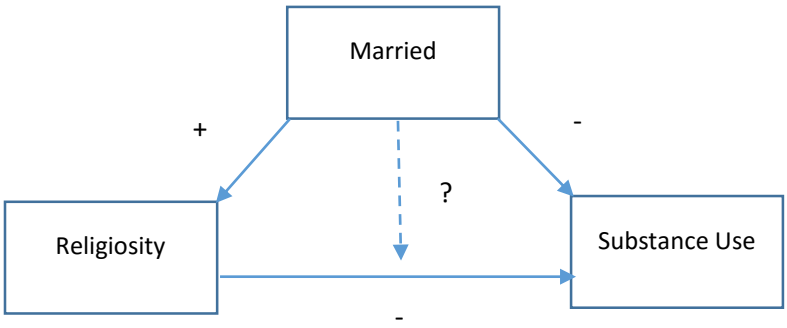
In studies exploring the association between religiosity and substance use behaviors researchers consistently find a significant inverse association between those two phenomena (Bahr and Hoffman 2008; Wallace and Colleagues 2007). For example, in a meta-analysis conducted by Yeung and Colleagues (2009), the researchers find that youth religiosity has a moderate, yet significant, weighted mean correlation ($Z_r = 0.16$) with substance use behaviors.

While these studies show that an association between religiosity and substance use exists, they typically ignore potential variation in the association across sub-groups within the population. The failure to explore potential variation in the association between religiosity and substance use behaviors is problematic because it likely leads to researchers and the general public having an inaccurate view of the nature of the association between religiosity and substance use behaviors. This is because research reveals that the influence of an individual's religiosity on his or her behaviors, including substance use

behaviors, can vary depending on the proportion of the individual's co-religionists—defined as individual's who share the same religion— inhabiting that individual's environment (Regnerus 2003; Wallace et al. 2007). One potential mechanism that may explain this variation in the influence of religiosity on an individual's behavior across environments is variation in plausibility structures, which are groups of like-minded individuals who support and reinforce each other's shared beliefs, across environments (Regnerus 2007; Berger 1967). Within environments where there are more co-religionists, shared religious beliefs are more likely to be supported, which make them more salient in relation to an individual's behaviors. Conversely, in environments with fewer co-religionists, religious beliefs may not have the same level of social support or may even be discouraged. For example, Abu-ras, Ahmed and Arfken (2010) find that Muslim college students in the U.S. who were more involved in religious activities, and therefore more integrated into networks of co-religionists, were less likely to drink than Muslim students less involved in religious activities, and therefore less integrated into networks of co-religionists.

Using data from the National Longitudinal Study of Adolescent to Adult (Add) Health I test whether or not the association between religiosity and substance use behaviors differs across family statuses (i.e. marital statuses and parental statuses). My main hypothesis is that the association between religiosity and substance use behaviors is stronger for individuals with "traditional" family statuses (e.g. married individuals) compared to individuals with "nontraditional" family statuses (e.g. single parents, cohabitating individuals). My hypothesis is based on the idea that individuals with traditional family statuses—in particular married parents—are more likely to be well integrated into social networks with religious individuals (Stolzenberg et al. 1995). As a result, the plausibility of their religious beliefs is more likely to be supported and reinforced by like-minded co-religionists (e.g. other married parents within the same congregation), which will increase the influence of their beliefs on their behaviors, including substance use behaviors.

Figure 1.2: Moderating Effects of Being Married on the Association between Religiosity and Substance Use.



In the remainder of this study I will lay out and test my arguments for why the association between religiosity and substance use behaviors differs across family statuses. Figure 1.2 shows a conceptual model of these arguments. Within the model, family status has a positive influence on religiosity and a negative influence on substance use behaviors. In addition, religiosity is shown to have a direct negative influence on substance use behaviors. In the next section will describe the literature on the association between religiosity and substance use behaviors, family status and religiosity, and family status and substance use behaviors. I will then describe the theoretical framework that I draw upon to explain the part of the conceptual model that is least understood—whether or not family status influences the association between religiosity and substance use behaviors.

RELIGIOSITY AND SUBSTANCE USE BEHAVIORS

Despite an early finding by Hirschi and Stark (1969) which revealed that children who attend religious services are no more likely than non-attenders to accept ethical principles and are only slightly more likely than non-attenders to respect conventional authority, most contemporary studies find that

religiosity is negatively correlated substance use behaviors (Stark 1996; Yeung et al. 2009).[2] This is the case across racial groups (Wallace et al. 2003) as well as for both males and females (Yeung et al. 2009). Many of the studies exploring the association between religiosity and substance use behaviors utilize samples of adolescents and young adults (Yeung et al. 2009). This is likely because substance use is more prevalent among this population than any other (Johnston et al. 2014, 2011).

Explanations for the Inverse Association. Several explanations have been put forward to explain the inverse association between religiosity and substance use behaviors. Early on individuals cited fear of divine punishment as the reason religious individuals were less likely to use drugs or alcohol compared to non-religious individuals (Hirschi and Stark 1969; Stark 1996). However, this particular view has largely fallen out of favor due to lack of empirical evidence to support. One common explanation that is cited among contemporary researchers is the influence of prohibitions on substances use behaviors by religious groups. For example, Michalak and colleagues (2007) find that followers of religious groups that forbid the use of a particular substance are more likely to abstain from using that substance than other groups. This effect is especially true if individuals view their religious group as their primary reference group (Chawla et al. 2007). In regards to alcohol use in particular, religious prohibitions have a significant influence on rates of use. Religious groups that explicitly forbid alcohol use (e.g. Mormons and Muslims) tend to have lower rates of alcohol use while religious groups that do not explicitly forbid alcohol use or have more liberal attitudes toward alcohol use (e.g. Liberal Protestants) tend to have higher rates of alcohol use. In fact, the religious group within the U.S. with the highest levels of alcohol use are Catholics, who use alcohol as a sacrament (Engs, Diebold, and Hanson 1996; Kang Sim et al. 2013).

[2] For examples of a contemporary studies with null findings see Good and Willoughby 2006 and Page 1997.

Another explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors is the fact that religious individuals often have lower levels of life stress than non-religious individuals (Ellison 1994). These lower levels of life stress which would likely to lead to lower levels of substance use because individuals often turn to substances such as tobacco and alcohol to cope with stressors. Wills, Yaeger, and Sandy (2003) find that negative life events have a weaker impact on both initial substance use and the growth of substance use over time among religious individuals compared to non-religious individuals. These findings replicate previous findings from similar studies (see Strawbridge et. al 1998; Kendler, Gardner, and Prescott 1997; Krause 1997).

A third explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors is the positive influence of religiosity on pro-social behaviors, such as self-control. Several studies find that individuals with higher levels of self-control tend to have higher levels of religiosity (e.g. Muraven et al. 2006; Muraven et al. 1998; Geyer and Baumeister 2005, p. 418) and lower levels of substance use (Vazsonyi, Pickering, Junger, & Hessing, 2001; Wood, Pfefferbaum, & Arneklev, 1995). In a study done by Desmond, Ulmer and Bader (2013), the researchers find that religious youth tend to exhibit higher levels of self-control, which partially mediates the effect of an adolescents' religiosity on his or her marijuana use and drinking. They also find evidence for an interaction between religiosity and self-control where self-control has a greater impact on alcohol use among individuals with low levels for religiosity.

A fourth explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors, particularly among adolescents and children, is the influence of parental religiosity. Prior to early adulthood, when individuals typically achieve increased personal autonomy, an individual's religiosity is largely the product of the religiosity of their parent. As a result, an inverse association between an individual's religiosity and their levels of substance use behaviors are likely to be at least partially driven by the religiosity of their parents. Evidence for this comes from the

research of Foshee and Hollinger (1996). They find that maternal religiosity during adolescence is associated with lower rates of alcohol use, over and above personal religiosity. Because the personal autonomy of individuals typically increases from adolescence to early adulthood, it is likely that the association between parental religiosity and adolescence substance use behavior diminishes over time and largely vanishes by adulthood.

It is likely that a combination of some or all of these explanation at least partially explain the association between religiosity and substance use behaviors. More research needs to be done in order to gain a deeper understanding of the factors that drive the association between religiosity and substance use behaviors.

Weaknesses within the Literature. The literature on the association between religiosity and substance use behaviors suffers from several weaknesses. First, there is a lack of standardization of religiosity and substance use measures across studies (Moscati and Mezuk 2014; Booth and Martin 1998). Within the literature on the association between religiosity and substance use, concepts such as religiosity, religious involvement, and even spirituality are used interchangeably. Studies also often lack a measure of reliability of the religiosity measure and do not discuss the validity of the measures used (Wong, Rew, and Slaikeu 2010).

Second, studies that explore the association between religiosity and substance use behaviors often use a single item to measure religiosity. This is problematic because religiosity is a multi-dimensional concept that cannot be fully measured with a single item (Idler et al. 2003). However, studies consistently find a significant inverse association between religiosity and substance use; regardless of the measure of religiosity and/or substance use used (Yeung et al. 2009).

Third, most studies on religion and substance use behaviors use cross-sectional data. As a result, most studies exploring the association between religious and substance use behaviors treat the

association as a time-invariant. This is problematic because research has shown that levels of both religiosity (Smith and Snell 2009, p. 211-256; McCullough et. al 2005; Ingersoll-Dayton, Krause and Morgan 2002; Argyle and Beit-Hallahmi 1975) and substance use behaviors (Johnston et al. 2009a; Johnston et al. 2009b) are dynamic across the life. As a result, it is possible that the association between those two phenomena also vary across the life course.

Finally, studies examining the relationship between religiosity and substance use behaviors among adolescents and young adults often lack a clear theoretical framework connecting religiosity and substance use behaviors. While a few studies have posited explanations for the association between religiosity and substance use behaviors (e.g. religious prohibitions against substance use), most studies only present a statistical association between religiosity and substance use behaviors and fail to clearly put forward a theoretical model explaining why they believed a statistical association existed in the first place.

While these weaknesses likely lead to a distorted view of the association between religiosity and substance use behaviors, it should be noted that studies consistently find an inverse association between religiosity and substance use behaviors. However, even this consistently finding is likely as distortion due to the fact that an implicit assumption of research exploring the association between religiosity and substance use behaviors is that the association is uniform across sub-groups of the population and across time.

Within the literature on the association between family status and religiosity, a common finding is that religiosity tends to increase once individuals begin the family formation process. For example, as is shown in figure 1.2, religiosity tends to be higher among married individuals compared to unmarried individuals. This is also the case for being a parent compared to being a non-parent. Several factors have been put forward to explain the increase in religiosity that accompanies family formation. Three factors that I will describe here are 1) socialization of children, 2) religion-based resources, and 3) homophily.

Socialization of Children. Parents, in particular parents who grew up within a religious tradition, often turn to religion a source of moral teachings for their children. Even atheist parents attend religious services at a higher rate than atheist non-parents (Ecklund and Lee 2011). In fact, one of the strongest indicators of whether an individual maintains his or her religious beliefs throughout the life course is the strength of his or her parents' religiosity (Abu-Ras, Ahmed, and Arfken 2010; Smith and Snell 2009, p. 214). One potential benefit that parents may seek by turning towards religion is the life-long religious adherence of their children with all of its subsequent benefits, such as lower mortality risk compared to non-adherents (Hummer et al. 1999). Also, some parents, particularly parents from conservative Protestant denominations, may turn toward religion because they see the socialization of their children into a religious tradition as part of their parental duties (Bartkowski 2007; p. 512).

Coupled with the desire to make their children life-long adherents of a faith, many parents believe that religious socialization promotes the cultivation of prosocial values and behaviors in their children. In fact, there is some evidence for the validity of this belief. For example, Bartkowski and colleagues (2008) find that maternal and paternal religious attendance increased levels of prosocial behaviors such as self-control and interpersonal skills. Religion has also been found to strengthen the bonds between parents and children (Bartkowski and Xu 2000; King 2003; Pearce and Axinn 1998;

Wilcox 2002). Conversely, some have argued that religious socialization can also have negative impacts on long-term well-being due to the increased use to corporal punishment among some religious adherents, namely Conservative Protestants (Ellison and Sherkat 1993). However, there is little evidence to support this claim (see Bartkowski 2007, pp. 512-514).

Religion-Based Resources. Both married couples and parents may choose to turn toward religion because they are attracted to religion by the unique resources that religious congregations can provide them. Many religious congregations attempt to be "marriage-friendly environments" (Wilcox 2006, p. 102) by providing resources that specifically cater to families (Schleifer and Chaves 2014). These include child care services; organized activities for children such as day camps; marriage counseling; material support in the form of school supplies; as well as non-material resources such as moral teachings and socialization into the religious group. In addition, religious teachings that psychologically link the family unit to some transcendent reality (e.g. "Honour thy father and thy mother: that thy days may be long upon the land which the Lord thy God giveth thee", Exodus 20:12 KJV) may lend legitimacy to the family unit; thereby strengthening its influence. These resources have been found to have significant benefits for families. For example, Booth and Colleagues (1995) find that increases in religiosity are associated with increases in marital quality. Also, studies show that individuals with strong religious beliefs are more emotionally nurturing and supportive than non-religious parents (Barkowski 2007; p. 513; Wilcox 2006, p. 108).

Homophily. Married couples and parents may turn to religion because religious congregations provide spaces where religious couples can meet and interact with co-religionist peers. Evidence for this comes from studies such as one conducted by Stolzenberg, Blair-Joy and Waite (1995) where they found that individuals who marry and have children at similar ages as most of their peers are more likely to participate in religion compared to individuals who follow unconventional pattern. There are several potential reasons for this homophily among religion adherents. First, religious adherents may hold

stereotypes or negative biases against older and/or younger religious adherents that discourage them from seeking interactions with those adherents. Second, religious adherents may feel that adherents who are similar to themselves can better empathize with their unique challenges (e.g. socializing young children into the faith). Third, religious adherents may seek to expand their friendship networks beyond the religious congregation and may feel that other adherents who are similar to themselves may grant them access to larger networks of individuals who are also similar to them. Lastly, religious adherents may seek similar co-religionists because they feel those co-religionists will be able to provide social capital that is specifically useful to people like themselves (e.g. knowledge of low-cost school supplies if they also have school-aged children).

Homophily among religious adherents may also have the latent function of strengthening social bonds within congregations. Shared experiences, beliefs, rituals and identities among religious adherents can bolster connections between individuals and increase the influence of social norms within the congregation. Those norms may be beneficial to individuals within the congregations by discouraging certain negative behaviors. For example, Durkheim (1897) found that religious groups with greater social solidarity (e.g. Catholics and Jews) tend to have lower levels of suicide. Durkheim argued that social integration within religious groups reduces anomie, which in turn reduces the likelihood of suicide.

Marriage or Parenthood? One point of contention within literature on family status and religiosity is the question of the specific aspect of family status that is believed to "cause" increased religious involvement. Some scholars argue that marriage has an independent influence on religious involvement regardless of parental status. For example, Wuthnow (2007) argues that marriage has much stronger influence on religious involvement and that recent declines in religiosity are largely explained by young adults delaying marriage or avoiding marriage altogether. However, some scholars argue that parental status is the sole driver of increases in religious involvement. For example, Schleifer

and Chaves (2014), using fixed effects models, find that the only factor that increases religious involvement across the life course is having a school-aged child. This finding supports Bahr's (1970) Family Life Cycle model which argues that church attendance increases after marriage and peaks if couples have school-age children, presumably because the parents attend church and send their children to Sunday school. Despite the strength of Chaves's finding, there is still no consensus on the question of which aspect of family status influences religious involvement. As a result, it is not clear as to what aspect of family status may moderate the association between religiosity and substance use behaviors.

FAMILY STATUS AND SUBSTANCE USE BEHAVIORS

Studies exploring the association between religiosity and substance use behaviors primarily show that married individuals use substances a lower rate than other groups. For example, Merline and Colleagues (2004) find that among 35-year-olds in the Monitoring the Future study, married individuals were significantly less likely to use cocaine than unmarried individuals.

Marriage likely influences substance use in several ways. First, the social and physical environments of individuals tend to change once they get married. Marriage often includes a change of residence for one or both partners. Marriage partners often spend less time "hanging out" with friends who have high levels of substance use (Bachman et al. 1997). Even if individuals don't change location, marriage partners may withdraw from existing social networks to spend more time developing the marital bond, isolating themselves from friends with high levels of substance use (Wallerstein 1994; Erickson 1968). In addition, Married individuals may see themselves as more "adult" than their single friends, and begin to exhibit behaviors that they feel are more conducive to an adult status, such as lower levels of substance use.

Married couples also tend to have higher levels of life satisfaction and lower levels of life stress. As was described above, greater levels of life satisfaction and lower levels of life stress tend to lead to lower levels of substance use. One potential reason that marriage may increase life satisfaction and decrease life stress is that it is typically accompanied by increased social support (Heinz et al. 2009). While single individuals may turn to substances using friends or substance such as alcohol and tobacco to deal with stress; married individuals often have the added option of turning to a spouse, spouse's family or married friends. The fact that marriage is also protective against depression and suicide (Miller-Tutzauer, Leonard, & Windle, 1991) provides further evidence that marriage-based social support helps alleviate distress, which may lead to lower levels of substance use.

Some studies also show that becoming a parent is associated with lower levels of substance use (Yamaguchi and Kandel 1985b); though other studies show no effect after controlling for marital status (Bachman et al. 1997; Burton et al. 1996). In addition, studies show that getting divorced (Bachman et al. 1997), as well as cohabitating or remaining single during early adulthood (Newcomb 1987; Bachman et al. 1984) are associated with higher levels of substance use behaviors. Divorce may increase substance use by cutting individuals from social support that was available to him or her during marriage. Also the trauma of the divorce itself may force some individuals to turn toward substance use as a coping strategy. Cohabitating may be linked to increased substance use due to lower traditionalism and higher deviance among people who choose to cohabit outside of marriage (Newcomb, 1987; Thornton, Axinn, & Hill, 1992; Yamaguchi & Kandel 1985a).

THEORETICAL FRAMEWORK: MODERATING EFFECT OF FAMILY STATUS ON THE ASSOCIATION BETWEEN RELIGIOSITY AND SUBSTANCE USE.

To explain the potential moderating effects of family status on the association between religiosity and substance use behaviors I draw on the expanded version of Rodney Stark's moral communities thesis that was described by Mark Regnerus in his work "Moral Communities and Adolescent Delinquency: Religious Contexts and Community Social Control" (2003). The original moral communities thesis posits that rather than personal religiosity influencing behavior, it is actually the influence of co-religionists within one's social context that discourages deviant behaviors. The moral communities thesis was Stark's answer to critiques of the popular "hellfire thesis", which argued that individuals avoid behaviors that deviate from their religious teachings because of fear of divine sanctions. Critiques of the hellfire thesis cited an inconsistent link between personal religiosity and levels of delinquency. Stark found that contexts with low levels of religiosity, such as the west coast of the United States, had higher levels of delinquency than contexts with higher levels of religiosity. Stark also posited that in contexts where religious norms are stronger (e.g. a religious congregation), an individual's religiosity may become more salient, which increases its influence on their behaviors. In other words, the religiosity of a social context acts as a "light switch", activating the influence of an individual's religiosity on their behavior (Regnerus 2005:268).

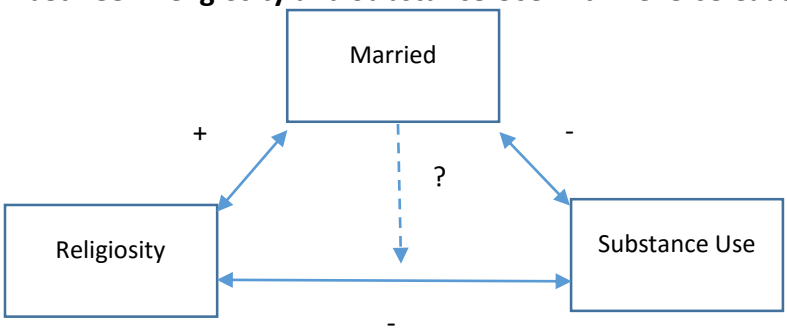
Subsequent scholars have found evidence for this thesis by exploring the interaction between personal religiosity, contextual religiosity and deviance. For example, Regnerus (2003), using data from the National Longitudinal Study of Adolescent to Adult Health, found an interaction between individual-level measures of conservative Protestantism and conservative Protestant homogeneity on both the school and community levels. He found that individuals who self-report as "born-again" attend religiously homogeneous schools and reside in religiously homogeneous communities report significantly lower levels of theft than born-again Protestants in contexts where they are a religious

minority. Stark's "light switch" thesis was expanded to substance use behaviors as well. Wallace and Colleagues (2007) found that the level of religiosity in the school that an individual attends interacts with their level of personal religiosity to moderate levels of substance use behaviors. Specifically, they found that individuals who were highly religious and who also attended a highly religious school were less likely to binge drink or use marijuana than individuals who were highly religious who attended a less religious school. However, Bahr and Hoffman (2008) using Add Health data, found no interaction between personal religiosity and contextual religiosity.

The moral communities thesis explains potential variation in the association between the religiosity and substance use behaviors across family status because, as has been described in previous research, the social and physical environments inhabited by married couples and parents is often very different than the social and physical environments inhabited by single and cohabitating individuals (Bachman et al. 1997). Married individuals are more likely to be part of religious congregations than non-married individuals (Becker and Hofmeister 2001; Hood and Nock 1999; Miller and Stark 2002; Stolzenberg et al. 1995; Thornton, Axinn, and Hill 1992; Tilley 2003). Also, married individuals are also more likely to be in social networks with other married couples, who as I described above, are typically more religious than non-married individuals. Also, married couples are less likely to be part of environments where alcohol is prevalent (e.g. bars, fraternity parties, etc.) compared to non-married individuals and cohabitating individuals. As has been described previously, religious environments can form plausibility structures where religious beliefs are reinforced. Because married individuals are more likely to be part of religious networks and within religious environments, the plausibility of beliefs that discourage substance use is more likely to be reinforced compared to individuals who are cohabitating or single. Also, because married individuals are less likely to be in environments where alcohol is prevalent, their beliefs surrounding substance use are less likely to be challenged. Based on the increased presence of married individuals within religious environments (e.g. religious congregation,

religious networks) and decreased presence in environments where alcohol is prevalent (e.g. bars, fraternity parties, etc.) I have formulated my hypothesis which states that *the association between* religiosity and substance use behaviors will be stronger for married individuals compared to single or cohabiting individuals.

Figure 2.2: Moderating Effects of Being Married on the Association between Religiosity and Substance Use with Reverse Causation.



REVERSE CAUSATION

Even though there are compelling reasons to believe that religiosity influences substance use behaviors; marital status influences religiosity; and marital status influences substance use behaviors, there is also reason to believe the association goes in the reverse direction. For example, Uecker and Colleagues find that alcohol use and marijuana use predict declines in religiosity between adolescence and early adulthood. Also, both religiosity (Bramlett and Mosher 2002) and substance use (Leonard, Smith, and Homish 2014) have been found to influence an individual's likelihood to marry. Figure 2.2 is a revised conceptual model, including reverse causality. Estimating the moderating influence of family status on the association between religiosity and substance use behaviors is problematic in this model because it is impossible isolate the effects of marital status on religiosity, substance use, or the association of those two phenomena.

Figure 3.2: The Moderating Effects of Being Married on the Association between Religiosity and Substance Use, Controlling for Reverse Causation.

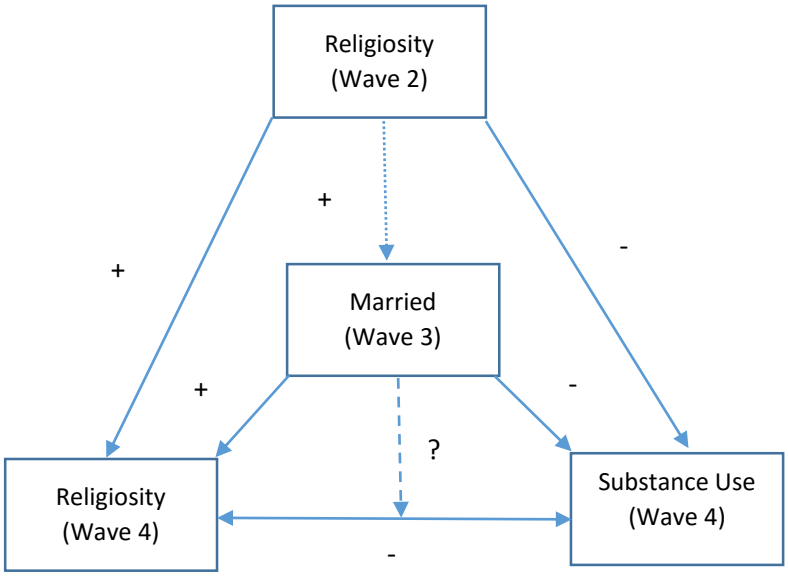


Figure 3.2 presents the specific remedy to the problem that I implement in my analyses. In figure 3.2 marital status is measured prior to religiosity and substance use behaviors. I also include measures of religiosity and substance use taken prior to the measure of marital status. By including a measure of marital status that was taken prior to the measurement of religiosity and substance use behaviors, and controlling for the effects of religiosity and substance use behaviors on marital status, I can isolate the influence of marital status on the association between religiosity and substance use behaviors.

Also, because of data limitations I am forced to use contemporaneous measures of religiosity and substance use behaviors. While it would be ideal to have a measure substance use behavior that is taken after the measure of religiosity, the actual causal order of the association between religiosity and

substance use behaviors is not important in determining whether or not the association between religiosity and substance use behaviors varies by family status.

Table 1.2: Descriptive Statistics (N=9,322) by Wave								
Variables	**Wave I**		**Wave II**		**Wave III**		**Wave IV**	
	%/Mean (S.D)	Max.-Min.	%/Mean (S.D)	Max.-Min.	%/Mean (S.D)	Max.-Min.	%/Mean (S.D)	Max.-Min.
Dependent Variable								
Smoking			5.22 (10.39)	0-30			7.72 (12.42)	0-30
Alcohol Use								
None			0.55				0.27	
1-2 Days			0.14				0.11	
Once a Month or Less			0.12				0.16	
2-3 Days a Month			0.08				0.17	
1-2 Days a Weeks			0.07				0.19	
3-5 Days a Week			0.03				0.08	
Every day or Almost Every day			0.01				0.03	
Independent Variable								
Religiosity								
Attendance at Religious Services*			1.72 (1.21)	0-6			1.64 (1.61)	0-6
Importance/Salience of Religion*			2.00 (1.09)	0-4			1.53 (0.89)	0-3
Participation in Religious Activities*			1.03 (1.15)	0-6			0.59 (1.19)	0-6
Moderating Variable								
Family Status								
Married Parent					0.08			
Married Non-Parent					0.06			
Single Parent					0.07			
Single Non-Parent					0.66			
Cohabitating Parent					0.05			
Cohabitating Non-Parent					0.08			
Covariates								
Age					21.62 (1.63)	18-27		
Male	0.45							
White (Ref.)	0.55							
Hispanic	0.15							
Black	0.21							
Asian	0.07							
Other	0.03							
Education					2.58 (0.92)	0-5		
Income					9.50 (2.93)	0-14		
Parental Alcohol Use	0.15							
Parental Smoking	0.28							
Parental Attendance at Religious Services*	1.79 (1.14)	0-3						
Parental Importance/Salience of Religion*	2.61 (0.63)	0-3						
Delinquency					0.89 (2.15)	0-26		
Trouble Getting Along with Teacher*	0.87 (0.97)	0-4						
Trouble Paying Attention in School *	1.22 (1.01)	0-4						
Trouble Getting Homework Done*	1.17 (1.06)	0-4						
Trouble Keeping Mind Focused*	1.83 (1.82)	0-3						
Peer Substance Use					1.73 (1.22)	0-3		
Non-Religious (Ref.)					0.26			
Conservative Protestant					0.25			
Mainline Protestant					0.15			
Catholic					0.24			
Other Protestant					0.09			
Non-Christian					0.10			
Family Status Change**					0.49			
* Indicator for Latent Variable **Family Status Change Between Wave III & Wave IV								

DATA AND METHODS

Add Health. The data for these analyses come from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative longitudinal survey of adolescents

and young adults obtained from an initial in-school survey of middle- and high school students conducted from September 1994 to April 1995. In total, 90,118 adolescents who attended 80 high schools and 54 feeder schools (both public and private) took part in the initial interview. During the months of April through December 1995, a sample of the in-school respondents (stratified by gender and grade) were selected to participate in an in-home face-to-face interview (Wave I). This sample included 20,745 individuals. These respondents have been followed up three times over the past 15 years for a total of four waves of in-home data collection.

I use data collected at all 4 waves of the Add health study In-Home Sample (N=20,745). Cases were not included in the analysis if 1) they had missing values for sex, or race during Wave I (N=5,565); 2) they were missing values for age during Wave III; 3) they had missing values for marital status during Wave III (N=5,577) or, 4) they have missing values for substance use during Wave IV (N=5,247). In addition, due to the oversampling of certain groups within the sample (e.g. black adolescents with a parent with a college degree), samples weights are utilized in the analyses. Therefore, cases were deleted if they are missing sample weights (N=11,353). This leaves a total analytic sample of 9,322 cases.

Table 2.2: Attrition Analysis				
Variables	No Cases Dropped (N=20,745)	Missing Weights Cases Dropped (N=9,421)	Missing Variable Cases Dropped (N=12,902)	Analytic Sample (N=9,322)
	%/Mean (S.D)	%/Mean (S.D)	%/Mean (S.D)	%/Mean (S.D)
Dependent Variable				
Smoking (Wave IV)	7.92 (12.54)	7.72 (12.43)	7.72 (12.43)	7.72 (12.42)
Alcohol Use (Wave IV)				
None (Wave IV)	28%	27%	28%	27%
1-2 Days (Wave IV)	11%	11%	11%	11%
Once a Month or Less	15%	15%	15%	16%
2-3 Days a Month (Wave IV)	16%	17%	17%	17%
1-2 Days a Weeks (Wave IV)	19%	19%	19%	19%
3-5 Days a Week (Wave IV)	8%	8%	8%	8%
Every day or Almost Every day (Wave IV)	3%	3%	3%	3%
Independent Variable				
Religiosity				
Attendance at Religious Services*	1.64 (1.61)	1.64 (1.61)	1.66 (1.61)	1.64 (1.61)
Importance/Salience of Religion*	1.54 (0.88)	1.53 (0.89)	1.54 (0.88)	1.53 (0.89)
Participation in Religious Activities*	0.60 (1.21)	0.59 (1.19)	0.60 (1.21)	0.59 (1.19)
Moderating Variable				
Family Status				
Married Parent	9%	8%	9%	8%
Married Non-Parent	6%	6%	6%	6%
Single Parent	7%	7%	8%	7%
Single Non-Parent	64%	66%	63%	66%
Cohabitating Parent	5%	5%	5%	5%
Cohabitating Non-Parent	8%	8%	8%	8%
Covariates				
Age	21.96 (1.77)	21.62 (1.63)	21.92 (1.77)	21.62 (1.63)
Male	49%	45%	46%	45%
White (Ref.)	50%	55%	53%	55%
Hispanic	17%	15%	21%	15%
Black	23%	21%	7%	21%
Asian	7%	7%	2%	7%
Other	3%	3%	3%	3%
Education	2.57 (0.95)	2.58 (0.92)	2.59 (0.94)	2.58 (0.92)
Income	9.58 (2.94)	9.50 (2.93)	9.52 (2.95)	9.50 (2.93)
Parental Alcohol Use	16%	15%	15%	15%
Parental Smoking	28%	28%	28%	28%
Parental Attendance at Religious Services*	1.77 (1.15)	1.79 (1.15)	1.79 (1.15)	1.79 (1.14)
Parental Importance/Salience of Religion*	2.62 (0.62)	2.61 (0.62)	2.62 (0.62)	2.61 (0.63)
Delinquency	0.89 (02.20)	0.90 (2.17)	0.88 (2.14)	0.89 (2.15)
Trouble Getting Along with Teacher*	0.87 (0.97)	0.87 (0.97)	0.86 (0.96)	0.87 (0.97)
Trouble Paying Attention in School *	1.23 (01.04)	1.22 (1.02)	1.23 (1.03)	1.22 (1.01)
Trouble Getting Homework Done*	1.20 (1.09)	1.18 (1.07)	1.19 (1.07)	1.17 (1.06)
Trouble Keeping Mind Focused*	0.83 (0.82)	0.83 (0.82)	0.83 (0.81)	1.83 (1.82)
Peer Substance Use	1.71 (1.23)	1.73 (1.22)	1.72 (1.22)	1.73 (1.22)
Non-Religious (Ref.)	26%	26%	0.26	0.26
Conservative Protestant	25%	25%	0.25	0.25
Mainline Protestant	14%	12%	0.12	0.15
Catholic	25%	25%	0.24	0.24
Other Protestant	9%	8%	0.08	0.09
Non-Christian	10%	6%	0.07	0.10
Family Status Change**	30%	49%	0.50	0.49
Smoking (Wave II)	5.17 (10.35)	5.22 (10.39)	5.21 (10.38)	5.22 (10.39)
Alcohol Use (Wave II)				
None (Wave II)	56%	55%	55%	55%
1-2 Days (Wave I)	14%	14%	14%	14%
Once a Month or Less (Wave II)	12%	12%	12%	12%
2-3 Days a Month (Wave II)	8%	8%	8%	8%
1-2 Days a Weeks (Wave II)	7%	7%	7%	7%
3-5 Days a Week (Wave II)	3%	3%	3%	3%
Every day or Almost Every day (Wave IV)	1%	1%	1%	1%
Religiosity (Wave				
Attendance at Religious Services*	1.67 (1.22)	1.72 (1.21)	1.71 (1.21)	1.72 (1.21)
Importance/Salience of Religion*	1.97 (1.10)	2.00 (1.09)	2.00 (1.09)	2.00 (1.09)
Participation in Religious Activities*	0.97 (1.21)	1.02 (1.22)	1.02 (1.22)	1.03 (1.15)

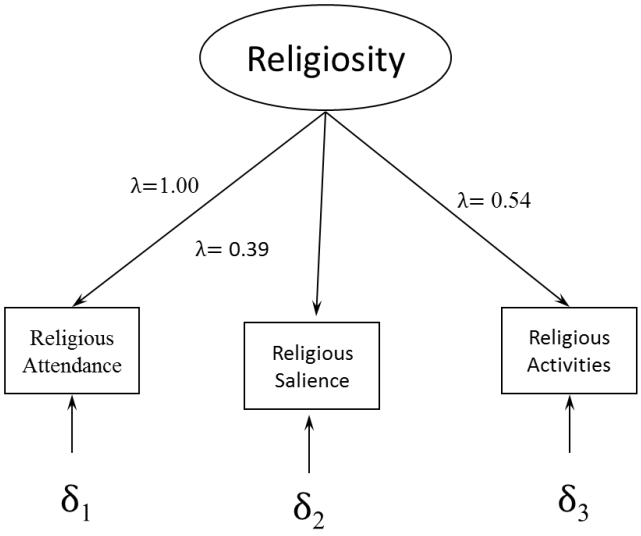
Sample Attrition. One potential problems of listwise deletion is the potential of bias due to patterns of missingness not being random. This would be evidenced by significant differences in the full sample and the sample in which cases have been deleted. Table 2.2 displays the full sample prior to listwise deletion; the sample after cases with missing sample weights are deleted; the sample after cases with missing variables are deleted; and the analytic sample. Table 2.2 reveals few differences across the samples. The full sample has a slightly higher proportion of males compared to the other samples. While this difference is small, it may strengthen the moderating effect of marriage on the association between religiosity and substance use behaviors due to the fact that marriage tends to have a greater influence on the behaviors of males compared to females. Also, the frequency of smoking is slightly higher in the full sample compared other samples. This may limit the generalizability of this sample to the general population. However, overall, these results indicate that it is not likely that the excluded cases will significantly bias the results.

Substance Use Behaviors. For my analyses I utilize two measures of substance use behaviors as dependent variables: Frequency of smoking and frequency tends to have a greater influence on the behaviors of males compared to females. of alcohol use. Frequency of smoking is a measure based on the question, "During the past 30 days, how many days did you smoke cigarettes." This is a count variable, ranging from 0 to 30. Table 1.2 indicates that the mean level of smoking within the sample is a little over 7 days in the previous 30 days. Frequency of alcohol use is a measure based on the question, "During the past 12 months on how many days did you drink alcohol". This variable is composed of 7 categories with 0 indicating "no days", and 6 indicating "every day or almost every day." Table 1.2 indicates a large percentage of the sample (27%) hadn't drank any alcoholic beverage in the past 12 months.

Religiosity. The concept of religiosity has been notoriously hard to define over the years. The general consensus among scholars of religion is that religion is a multi-dimensional concept; though

there is no consensus on the precise number of dimensions. For parsimony within my analyses I focus on one dimension of religiosity known as religious involvement. I borrow my conceptualization of religiosity from the work of Kogan and colleagues (2005) who describe religious involvement as an overarching concept that influences an individual's religious beliefs and behaviors. To measure religiosity, I utilize a latent construct that I estimate using 3 indicator variables: Attendance at religious services, participation in religious activities, and religious salience/importance. The first indicator variable, attendance at religious services, is an ordinal variable based on the question, "In the past 12 months, how often did you attend religious services?" Responses range from 0 to 6 with 0 indicating "no attendance" and 6 indicating "more than once a week. The second indicator variable, religious salience, is a measure based on the question, "How important is religion to you?" Responses to this question were coded into two variables that range from 0 to 3 with 0 indicating a response of "not important at all" and 3 indicating "very important". Lastly, the third indicator variable, participation in religious activities, is an ordinal measure based on the question, "Many churches, synagogues, and other places of worship have special activities outside of regular worship services--such as classes, retreats, small groups, or choir. In the past 12 months, how often have you taken part in such activities?" Responses range from 0 to 6 with 0 indicating "no attendance" and 6 indicating "more than once a week".

Figure 4.2: Latent Religiosity Variable



The latent religiosity variable utilized in my analyses is based Kogan and colleagues (2005) who used it to uncover risk and protective factors for substance use among African American high school dropouts. Figure 4.2 illustrates the relationship between the latent religiosity variable and each indicator variable. The coefficient (λ) of the first indicator, attendance at religious services, is constrained to 1 to ensure that the model is identified. In regards to the other two indicators, both religious salience (λ=0.39) and attendance at religious activities (λ=0.54) have a positive association with the latent religiosity variable. As a result, a 1-unit change in the latent religiosity variable corresponds to a 1 standard deviation change in that variable.

Family Status. I utilize a 6 category variable to measure family status as my moderating variable. The categories are married parent, married non-parent, single parent, single non-parent, cohabitating

parent, cohabitating non-parent. Individuals are considered to be married if they indicate that one of the members of their household is their husband or wife. Similarly, Individuals are considered to be cohabitating if they indicate that a household member is partner, boyfriend or girlfriend. In addition, respondents are considered parents if they indicated that they have a son or a daughter living in their residence. Single individuals are individuals who are not married or cohabitating and do not have a child in the residence. As indicated by Table 1.2, most individuals in the sample were single non-parents (Mean=0.66) during Wave III.

Covariates. Covariates for age, sex, race and educational attainment are included in each model. As indicated in Table 1.2, Ages within the sample at Wave III range from 18 years old to 27 years old with a mean age of approximately 28 years old. Age is included as a covariate because studies show that religiosity and substance use behaviors function differently at different ages. For example, according to the 2009 Monitoring the Future study, 15% of 8th graders report using alcohol in the past 30 days (Johnston et al. 2009a). This number increases to 44% among 12 graders and increases further during late adolescence to 53% of 19 and 20 year olds; 73 % of 21 and 22 year olds and 78% among 23 and 24 year olds (Johnston et al. 2009a; Johnston et al. 2009b). Age is also related to the concept of the "life course", which Shanahan and Macmillan define as an age-graded sequence of roles, opportunities, constraints, and events that shape the biography from birth to death; because at various ages behavioral expectations in regards to religion and substance use behaviors tend to vary. For example, it is largely unacceptable to smoke or use alcohol prior to age 18, during the period of the life course known as adolescence. However, these behaviors become normative after 18 and into the early 20's, during the period of the life course known as early adulthood. As a result, it is important to control for age as a proxy for differences in behavioral expectations related to differences in life stage.

In regards to gender, just over ½ of the sample self-identified as female (53%) and a similar percentage self-identified as non-Hispanic White (54%). Educational attainment is measured as the

highest level of education completed by the respondent. Educational attainment ranges from 0 = ≤ 8th grade to 5 = professional training beyond a four-year college/university. The modal level of education within the sample is a high school diploma, with approximately 44% of respondents indicating that a high school diploma is their highest level of education. Household income is measured as total income from all sources before taxes and deductions. Most respondents reported their household income in dollars. A few preferred to report a range; the midpoints of the indicated ranges were used for these respondents. Household income was logged for this analysis, which reduced the likelihood of a non-linear relationship between income and substance use.

Religious affiliation is a variable that is loosely based on the coding scheme put forward by Steensland and colleagues (2000). The largest religious group within the samples is Conservative Protestant (25%), followed closely by Catholics (24%). Religious affiliation is a separate dimension from religious involvement, the variable I use as my independent variable because religious affiliation includes racial/ethnic characteristics (i.e. Jewish Identity, African American Baptists) and/or strong beliefs (i.e. Mormons; Seventh-Day Adventists). It is important to control for religious affiliation because certain religious groups have strict prohibitions on substance use (i.e. Mormon; Seventh-Day Adventists).

In addition, variables are included to control for parental characteristics, they are: Parental religiosity, parental alcohol use, and parental smoking. Parental religiosity is latent variable based on two measures of parental religiosity: Parental religious attendance and parental religious salience. Parent religious attendance is a categorical variable ranging from 0-3 with 0 indicating never and 3 indicating more than once a week. Also, previous studies have found that measures of self-control and peer substance use moderates the relationship between religiosity and substance use, as a result I include measures of both variables as covariates. To control for reverse causation (see Figure 3.2) I include measures of religiosity and substance use behaviors from Wave II. Lastly, because I utilize a

measure of family status in Wave III with measures of religiosity and substance use behaviors from Wave IV, I include a variable that controls for changes in family status between Wave III and Wave IV.

ANALYTIC STRATEGY

Because our measure for smoking is a count variable, treating them as continuous and using linear models can yield inconsistent and inefficient estimates of parameters. A better approach assumes the counts of delinquency are generated from a Poisson distribution. We estimated a Poisson regression model and, as expected, found overdispersion—the variance exceeded the mean count of smoking—which, if ignored, can result in inefficient estimates of coefficients and downwardly biased standard errors (Long 1997). Consequently, we turned to a negative binomial model, which allows the count of smoking events to vary across individuals, and therefore, the variance to exceed the mean. Also, because Add Health includes siblings and oversamples certain groups within the sample, each analysis accounts for sample structure using survey weights that adjust for the unequal probabilities of selection and sample attrition. The general form of the equation modeling smoking behavior is as follows:

$$\text{Log}(\text{Smoking}_{ij}) = \alpha + \beta_1 \text{Relig}_{ij} + \beta_2 \text{Status}_{ij} + \beta_3 \text{ReligXStatus}_{ij} + \beta_4 \text{Covariates}_{ij} + \varepsilon_{ij} \qquad [1];$$

where Smoking_{ij} represents a count of smoking events for individual i in sibling pair j; β_1 represents the slope for religiosity for individual i in sibling pair j; β_2 is the slope for family status for individual i in sibling pair j; β_3 is the slope for the interaction for individual i in sibling pair j; β_4 represents the slope for the covariates for individual i in sibling pair j and ε represents error for individual i in sibling pair j.

Because alcohol use is a categorical variable I utilized ordinal logistic regression analysis to estimate frequency of alcohol use. The general form of the equation modeling smoking behavior is as follows:

$$\text{Logit}(\text{Drinking}_{ij}) = \alpha+\beta_1\text{Relig}_{ij}+ \beta_2\text{Status}_{ij} + \beta_3\text{ReligXStatus}_{ij} + \beta_4\text{Covariates}_{ij} \quad [2];$$

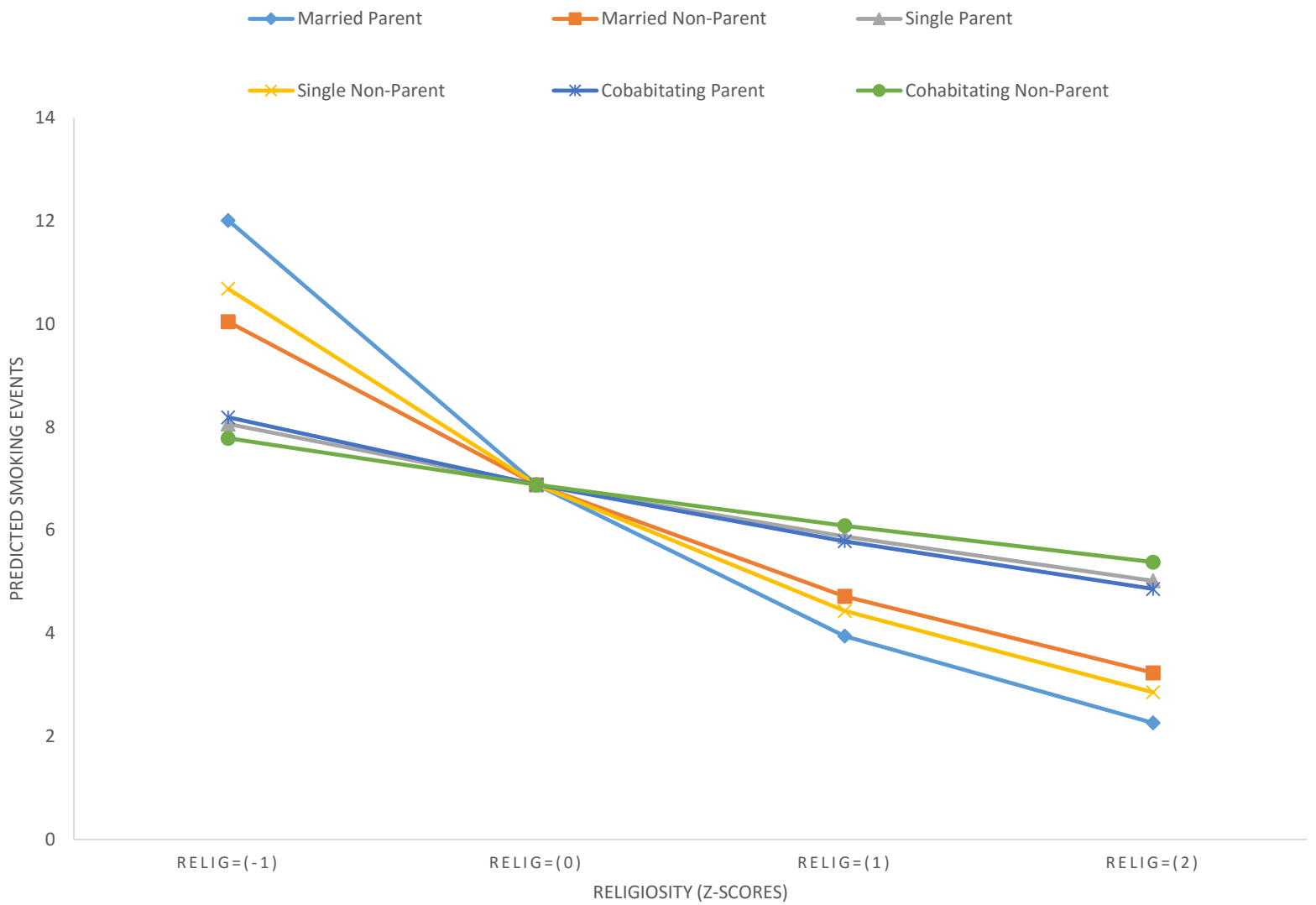
where Drinking_{ij} represents the logged odds of moving the next category of alcohol use for individual i in sibling pair j; β_1 represents the slope for religiosity for individual i in sibling pair j; β_2 is the slope for family status for individual i in sibling pair j; β_3 is the slope for the interaction for individual i in sibling pair j; β_4 represents the slope for the covariates for individual i in sibling pair j and ε represents error for individual i in sibling pair j.

Missing Data. Because some variables include a significant number of missing values such as income (N=458) and peer substance use (N=351), multiple imputation by chained equations (MICE) is used to impute missing values. MICE uses a series of imputation models fitted to each variable to estimate missing cases based on the arbitrary patterns for continuous, binary, ordinal, cardinal, or count variables (e.g., White et al., 2011). Specifically, we estimated 5 datasets based on all the variables in our models, and report estimates that are averaged across these datasets.

Table 3.2: Univariate Models and Models of Mediating and Moderating Effects of Family Status on the Association between Religiosity and Substance Use Behaviors (N=9,322)								
	Smoking Models				**Alcohol Use Models**			
Variables	**Bivariate Models**	**Covariate Models**	**Mediating Models**	**Moderating Models**	**Bivariate Models**	**Covariate Models**	**Mediating Models**	**Moderating Models**
Religiosity, Wave IV	-0.434*** (-0.504,-0.364)	-0.388*** [-0.464,-0.312]	-0.384*** [-0.461,-0.306]	-0.521*** [-0.711,-0.330]	-0.510*** (-0.568,-0.452)	-0.439*** [-0.497,-0.381]	-0.432*** [-0.490,-0.374]	-0.337*** [-0.485,-0.190]
Age	-0.017 (-0.055, 0.021)	-0.068** [-0.110,-0.026]	-0.071** [-0.114,-0.027]	-0.072** [-0.116,-0.028]	-0.082*** (-0.129,-0.034)	-0.136*** [-0.170,-0.102]	-0.116*** [-0.152,-0.081]	-0.116*** [-0.152,-0.081]
Male	0.198*** (0.108,0.287)	0.143* [0.009,0.276]	0.181* [0.038,0.324]	0.183* [0.041,0.324]	0.689*** (0.588, 0.790)	0.536*** [0.433,0.639]	0.490*** [0.377,0.602]	0.490*** [0.377,0.602]
Hispanic	-0.553*** (-0.770, -0.336)	-0.464*** [-0.704,-0.224]	-0.489*** [-0.732,-0.247]	-0.496*** [-0.741,-0.252]	-0.465*** (-0.662, -0.269)	-0.261** [-0.419,-0.104]	-0.250** [-0.409,-0.091]	-0.247** [-0.407,-0.087]
Black	-0.477*** (-0.655, -0.300)	-0.088 [-0.267,0.091]	-0.119 [-0.305,0.066]	-0.126 [-0.310,0.057]	-0.876*** (-1.056, -0.696)	-0.266** [-0.439,-0.092]	-0.304*** [-0.479,-0.129]	-0.309*** [-0.483,-0.136]
Asian	-0.432*** (-0.743, -0.121)	-0.239 [-0.522,0.044]	-0.248 [-0.535,0.039]	-0.243 [-0.532,0.045]	-0.366* (-0.698, -0.035)	-0.298* [-0.548,-0.047]	-0.324** [-0.569,-0.079]	-0.318* [-0.562,-0.075]
Other	0.189 (-0.029, 0.407)	0.034 [-0.196,0.265]	0.027 [-0.204,0.259]	0.019 [-0.209,0.248]	0.277 (-0.581, 0.027)	-0.271 [-0.616,0.074]	-0.277 [-0.627,0.073]	-0.276 [-0.624,0.073]
Education, Wave III	-0.418*** (-0.469,-0.367)	-0.328*** [-0.390,-0.266]	-0.309*** [-0.376,-0.242]	-0.315*** [-0.381,-0.250]	0.333*** (0.259,0.406)	0.352*** [0.275,0.429]	0.324*** [0.246,0.401]	0.323*** [0.245,0.401]
Income, Wave III	0.005 (-0.011,0.022)	-0.002 [-0.021,0.016]	-0.004 [-0.023,0.014]	-0.005 [-0.024,0.013]	-0.006 (-0.025,0.012)	0.002 [-0.016,0.019]	0.002 [-0.015,0.019]	0.002 [-0.016,0.019]
Religiosity, Wave II	-0.194*** (-0.243, -0.145)	0.066* [0.005,0.127]	0.064* [0.004,0.124]	0.066* [0.006,0.126]	-0.082 (-0.143,-0.022)	0.092** [0.024,0.159]	0.093** [0.025,0.160]	0.094** [0.027,0.161]
Smoking, Wave II	0.044*** (0.041,0.047)	0.039*** [0.035,0.043]	0.038*** [0.034,0.043]	0.039*** [0.035,0.043]	0.006* (0.001,0.011)	-0.002 [-0.007,0.004]	-0.001 [-0.007,0.004]	-0.001 [-0.007,0.004]
Alcohol Use, Wave II	0.141*** (0.113,0.168)	0.051* [0.011,0.090]	0.050* [0.010,0.090]	0.050* [0.009,0.091]	0.203*** (0.156,0.251)	0.162*** [0.110,0.214]	0.163*** [0.110,0.216]	0.163*** [0.111,0.215]
Conservative Protestant, Wave III	-0.200** (-0.342,-0.058)	0.126 [-0.026,0.278]	0.129 [-0.022,0.280]	0.113 [-0.038,0.265]	-0.677*** (-0.836,-0.517)	-0.259*** [-0.402,-0.116]	-0.241** [-0.383,-0.098]	-0.243** [-0.387,-0.099]
Mainline Protestant, Wave III	-0.258*** (-0.394, -0.122)	-0.009 [-0.161,0.144]	-0.002 [-0.154,0.149]	-0.011 [-0.162,0.141]	-0.002 (-0.155, 0.151)	0.064 [-0.068,0.196]	0.067 [-0.064,0.198]	0.066 [-0.066,0.198]
Catholic, Wave III	-0.231** (-0.372, -0.092)	-0.001 [-0.161,0.160]	-0.014 [-0.177,0.149]	-0.022 [-0.186,0.143]	0.031 (-0.148, 0.210)	-0.026 [-0.186,0.135]	-0.034 [-0.194,0.127]	-0.037 [-0.199,0.125]
Other Protestant, Wave III	0.195 (-0.120, 0.511)	0.075 [-0.132,0.281]	0.069 [-0.140,0.278]	0.057 [-0.161,0.275]	-0.124 (-0.552, 0.304)	-0.262** [-0.425,-0.099]	-0.254** [-0.418,-0.090]	-0.251** [-0.415,-0.086]
Non-Christian, Wave III	0.334* (0.011, 0.659)	-0.061 [-0.238,0.115]	-0.056 [-0.231,0.120]	-0.068 [-0.245,0.109]	-0.123 (-0.496,0.251)	-0.002 [-0.187,0.182]	-0.000 [-0.187,0.186]	-0.007 [-0.194,0.180]
Delinquency, Wave III	0.065*** (0.047, 0.083)	0.042*** [0.018,0.066]	0.042*** [0.019,0.065]	0.039*** [0.017,0.061]	0.083*** (0.053, 0.113)	0.014 [-0.014,0.042]	0.011 [-0.017,0.039]	0.010 [-0.018,0.038]
Peer Substance Use, Wave III	0.133*** (0.093, 0.172)	0.130*** [0.079,0.180]	0.130*** [0.080,0.181]	0.131*** [0.081,0.181]	0.592*** (0.539,0.644)	0.424*** [0.372,0.477]	0.417*** [0.365,0.469]	0.416*** [0.364,0.468]

Self-Control, Wave I	0.208*** (0.166,0.250)	0.031 [-0.020,0.082]	0.028 [-0.022,0.078]	0.027 [-0.023,0.077]	0.119*** (0.059,0.179)	0.059 [-0.000,0.118]	0.059 [-0.001,0.119]	0.058 [-0.001,0.118]
Parental Smoking	0.497*** (0.404,0.590)	0.214*** [0.098,0.331]	0.207*** [0.092,0.322]	0.203*** [0.087,0.319]	-0.213** (-0.333,-0.092)	-0.189** [-0.323,-0.055]	-0.185** [-0.320,-0.051]	-0.189** [-0.323,-0.055]
Parental Alcohol Use	0.301*** (0.205,0.399)	0.048 [-0.067,0.164]	0.034 [-0.082,0.149]	0.049 [-0.067,0.166]	-0.130 (-0.284,0.024)	0.038 [-0.114,0.189]	0.044 [-0.111,0.198]	0.048 [-0.106,0.201]
Parental Religiosity	-0.193*** (-0.233, -0.153)	-0.047 [-0.100,0.006]	-0.044 [-0.097,0.008]	-0.041 [-0.094,0.011]	-0.082*** (-1.174, -0.974)	-0.000 [-0.069,0.068]	0.002 [-0.067,0.070]	0.001 [-0.067,0.069]
Family Status Change	-0.117** (-0.197,-0.036)	-0.215*** [-0.324,-0.105]	-0.260*** [-0.374,-0.145]	-0.276*** [-0.392,-0.160]	0.037 (-0.061,0.134)	-0.132** [-0.228,-0.035]	-0.177*** [-0.281,-0.074]	-0.177** [-0.281,-0.073]
Married Non-Parent	-0.420*** (-0.649,-0.191)		-0.185 [-0.472,0.101]	-0.180 [-0.460,0.100]	0.116 (-0.155,0.387)		-0.074 [-0.355,0.206]	-0.046 [-0.339,0.248]
Single Parent	-0.021 (-0.227, 0.186)		0.130 [-0.122,0.383]	0.109 [-0.142,0.361]	-0.049 (-0.324,-0.313)		0.118 [-0.178,0.414]	0.116 [-0.178,0.410]
Single Non-Parent	-0.211** (-0.367, -0.055)		-0.049 [-0.211,0.112]	-0.048 [-0.213,0.116]	0.903*** (0.706,1.100)		0.310** [0.093,0.526]	0.309** [0.095,0.524]
Cohabitating Parent	0.297** (0.111,0.483)		0.259 [-0.015,0.533]	0.302* [0.021,0.582]	0.279* (0.002,0.556)		0.129 [-0.170,0.428]	0.174 [-0.134,0.482]
Cohabitating Non-Parent	0.164 (-0.006,0.334)		0.236* [0.018,0.453]	0.317** [0.080,0.554]	0.954*** (0.682,1.227)		0.330* [0.052,0.609]	0.372* [0.088,0.657]
Religiosity*Married Non-Parent***				0.123 [-0.173,0.418]				-0.195 [-0.437,0.048]
Religiosity*Single Parent				**0.303*** **[0.025,0.581]**				0.063 [-0.178,0.304]
Religiosity*Single Non-Parent				0.085 [-0.123,0.293]				-0.130 [-0.283,0.023]
Religiosity*Cohabitating Parent				**0.378*** **[0.071,0.686]**				0.052 [-0.251,0.355]
Religiosity*Cohabitating Non-Parent				**0.387**** **[0.127,0.647]**				0.015 [-0.236,0.266]
Constant	3.586*** [2.699,4.473]	3.639*** [2.709,4.568]	3.704*** [2.752,4.656]	3.695*** [2.739,4.650]				
Cut Point 1						-2.380*** [-3.141,-1.620]	-1.857*** [-2.667,-1.048]	-1.865*** [-2.678,-1.052]
Cut Point 2						-1.779*** [-2.538,-1.021]	-1.255** [-2.061,-0.449]	-1.263** [-2.072,-0.453]
Cut Point 3						-1.004** [-1.755,-0.254]	-0.477 [-1.277,0.323]	-0.484 [-1.287,0.318]
Cut Point 4						-0.126 [-0.866,0.613]	0.404 [-0.388,1.196]	0.398 [-0.396,1.193]
Cut Point 5						1.325*** [0.579,2.072]	1.858*** [1.057,2.660]	1.855*** [1.050,2.660]
Cut Point 6						2.984*** [2.217,3.750]	3.518*** [2.686,4.350]	3.515*** [2.680,4.351]

FIGURE 5.2 RELIGIOSITY PREDICTING SMOKING EVENTS BY FAMLY STATUS



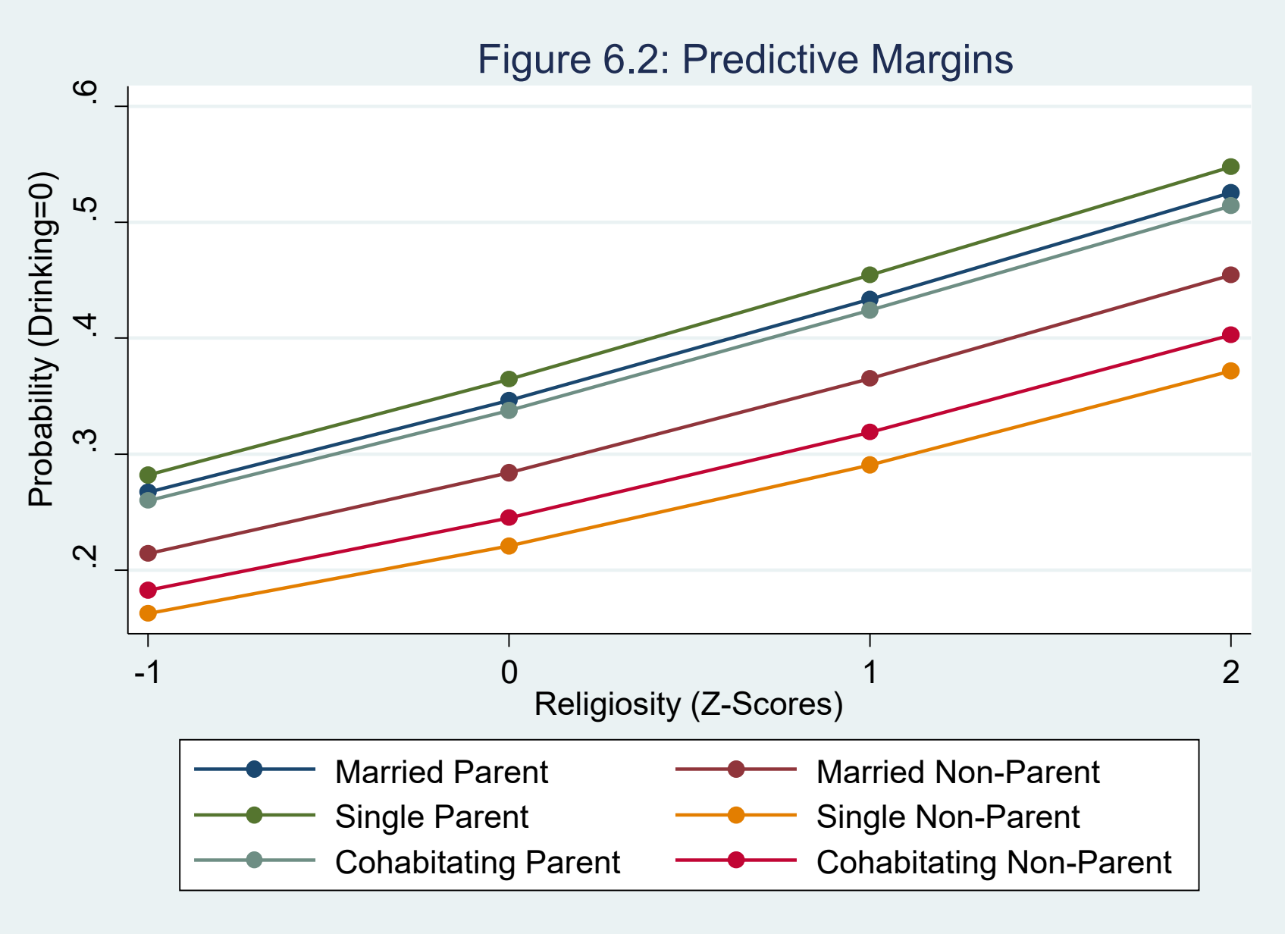


Figure 6.2: Predictive Margins
Probability (Drinking=0)
.2
.3
.4
.5
.6
-1
0
1
2
Religiosity (Z-Scores)
Married Parent
Single Parent
Cohabitating Parent
Married Non-Parent
Single Non-Parent
Cohabitating Non-Parent

RESULTS

Table 3.2 and figures 5.2 and 6.2 reveal several key findings. First, findings replicate previous research that shows a consistent inverse association between religiosity and substance use behaviors (Moscati and Mezuk 2014; Yeung et al. 2009). For example, the bivariate models show that religiosity has a significant inverse association with both smoking (β= -0.434; c.i. =-0.504, -0.364) and alcohol use (β= -0.510; c.i. =-0.568, -0.452). The covariate models show that the association between religiosity and both smoking (β= -0.388; c.i. =-0.464, -0.312) and alcohol use (β= -0.439; c.i. =-0.497, -0.381) holds when covariates are added to the model. Lastly, the mediating models show that the association between religiosity and both smoking (β= -0.384; c.i. =-0.461, -0.306) and alcohol use (β= -0.432; c.i. =-0.490, -0.374) also holds when family status is added to the models.

In addition, the models provide partial support for my hypothesis which argues that the association between religiosity and substance use behaviors will be stronger from married individuals compared to single or cohabitating individuals. For example, the moderating model shows that the association between religiosity and smoking is weaker for single parents (β= 0.109, c.i. = -0.142, 0.361), cohabitating non-parents (β= 0.317, c.i. = 0.080, 0.554), and cohabitating parents (β= 0.302, c.i. = 0.021, 0.582) compared to married parents (β= -0.521, c.i. = -0.711,-0.330), the omitted reference group. Figure 5.2 illustrates this finding. In Figure 5.2 the slope for the association between religiosity and smoking is steeper for married parent compared to single parents, cohabitating parents and cohabitating non-parents. Conversely, the slopes for the association between religiosity and smoking for married non-parents (β= -0.180, c.i. = -0.460, 0.100) and single non-parents (β= -0.048, c.i. = -0.213, 0.116) is not significantly different than the slope for married parents.

In regards to alcohol use, there is no support for my hypothesis. The moderating model on Table 3.2 for alcohol use shows no significant difference in the slopes for the association between religiosity and alcohol use across family status. Figure 6.2 also illustrates this finding. Figure 6.2 provides the marginal effects for religiosity predicting that the respondent did not use alcohol in the last 12 months. As you can see, the slopes do not differ across family statuses.

CONCLUSIONS

In my analyses I explored whether or not the association between religiosity and substance use behaviors varies across family statuses. To explain potential variation of the association across family status I drew on an expanded version of Rodney Stark's moral communities thesis which posits that an individual's religiosity becomes more salient in regards to his or her behaviors in environments where co-religionists are the majority.

Overall, my findings indicate that the association between religiosity and smoking is stronger for individuals in "traditional" family statuses that more conducive to integration into religious networks compared to "non-traditional" family statuses. Specifically, the association between religiosity and smoking is significantly stronger for married parents, married non-parents, and single non-parents compared to single parents, cohabitating parents and cohabitating non-parents. This is likely because Christianity—whose adherents in one form or another make up 64% of my sample—has strict prohibitions against non-marital sex. As a result, individuals perceived as engaging in non-marital sex or having engaged in non-marital sex in the past, such as cohabitating couples and single parents, are likely to face stigma from Christians and Christian congregations. This may lead to these individuals avoiding Christian groups and/or Christians rejecting inclusion of these individuals from their congregations and/or social networks. As was described previously, personal religiosity becomes more salient for

individual behaviors when individuals are in environments where the majority are co-religionists. Because of the stigma surrounding non-marital sex, single parents and cohabitating individuals are less likely to be in these environments, which means their religiosity will be less salient in regards to their behaviors, including substance use behaviors.

While variation in the religiosity of environments inhabited by individuals with varying family statuses moderated the association between personal religiosity and smoking, no such moderating effect was apparent for alcohol use. This is likely because alcohol use is not stigmatized to the same degree as smoking within U.S. society or even among religious groups. While some religions, such as Mormonism and Islam, strictly prohibit alcohol use; other religious groups, such as the adherents of Catholicism, are more likely to use alcohol than other groups (Engs et al. 1996; Kang Sim et al. 2013). As a result, the moderating effect of religiosity on alcohol use may be denominational-specific; which would not have been picked up by these analyses. To test this possibility, I ran sensitivity analyses to explore whether of the not the finding differed for Catholics compared to another religious group that discourages alcohol use, conservative Protestant. Table 4.2 reveals significant interactions for religiosity and smoking within the conservative Protestant sample that matches the findings for the full sample. Conversely, within the Catholic sample the only interaction found was a stronger association between religiosity and smoking for married non-parents compared to married parents. In addition, Table 4.2 shows no evidence for an inverse association between religiosity and substance use behaviors within the Catholic sample.

Weaknesses of This Study. There three major weaknesses within this study. First, the association between religiosity and substance use measures are explored cross-sectionally. As a result, I cannot establish a clear time order between the religiosity and substance use behaviors. As I described previously, substance use behaviors can influence an individual's level of religiosity (Uecker et al. 2007). However, this fact is not significantly problematic for my analyses for two reasons. First, my main goal

for this study is explore whether or not there is variation in the association between religiosity and substance use behaviors. The time-order of the association is immaterial to whether or not this variation exists. While I cannot test the specific theories that I put forward at the beginning of the article, I can test the specific hypotheses I generated based on those theories. The second reason that the cross-sectional nature of this study is not significantly problematic is because previous longitudinal studies have established that religiosity does influence substance use behaviors across the life course. For example, Moscati and Mezuk (2014) found that changes in religiosity between adolescence and adulthood influence an individual's level of substance use. Because of these studies, it is not imperative for me to establish a time order.

The second major weakness of this study is that I do not have a direct measure of contextual religiosity. While the theories that I put forward specifically mention contextual religiosity, there are no measures of contextual religiosity within the Add health for Wave III or Wave IV. However, again, because the main focus of theses analyses is to explore whether or not there is variation in the association between religiosity and substance use behaviors across family status, it is immaterial whether or not it is actually contextual religiosity that is driving this variation.

A third major weakness of this study is the use of a measure of alcohol use frequency rather than a measure of problem drinking behaviors (e.g. binge drinking) as a dependent variable. While excessive drinking is universally condemned by Christianity of other major religions within the U.S., non-excessive alcohol use is tolerated, and even encouraged, at varying levels across religious sects. For example, while religious groups such as Seventh-Day Adventists and Mormons, and Muslims prohibit alcohol consumption, groups such as the American Catholic Church utilize alcohol as a sacrament in religious services. As a result, the same stigma that prevents religious individuals from smoking or using alcohol in excess may not be present for moderate alcohol use. For future research I will explore whether or not the association between religiosity and problem alcohol use is moderated by family

status. There is the possibility that because problem alcohol use carries a similar stigma as smoking that family status will moderate the association between religiosity and problem drinking behaviors in addition to the association between religiosity and smoking.

Implications for Future Research. This study reveals several implications for future research. For example, while this study explored variation in the association between religiosity and substance use behavior among young adults, future studies should explore variation in this association among middle-aged and other adults. As individuals move through the life course, their levels of substance use behaviors tend to decline. This may lead to their being less variation across family status groups, because single parents and cohabitating individuals become more like their married and single non-parent counterparts. However, there is a potential that the variation does not change at all. Only additional research with older cohorts can solve this mystery. Studies of older adults can also include family statuses that are typical of that period of the life course including individuals whose children have level the home, also know and "empty-nester"; and individuals who are widowed.

Future research could also explore variation in the association between religiosity and types of substance use other than smoking and alcohol use across family statuses. For example, David Brizer (1993) found that attendance at religious services has a significant negative association with prescription drug abuse. Because prescription drug abuse, like smoking, carries a strong stigma, there is a strong likelihood that the association between religiosity and prescription drug abuse varies across family status in a similar manner as religion and smoking. Future studies can confirm if this is in fact that case.

In addition, future studies can also explore variation in the association between religiosity and substance use behaviors with samples that are majority non-Christian. Various religious groups and cultures have differing levels of stigma toward smoking and alcohol use and differing levels of stigma toward family statuses such as single parents and cohabitating individuals. While some societies and

religious groups strictly prohibit certain types of substance use and certain non-marital sex, other cultures and religious groups may have relatively liberal attitudes toward both phenomena. This likely leads to significant levels of variation across family status in some cultures and very little variation in others.

Lastly, future studies should explore variation in the association between religiosity and substance use behaviors across multiple dimensions of religiosity. While I chose to conceptualize religiosity as an overarching concept influencing both behaviors and beliefs, future studies may treat beliefs and behaviors as separate dimensions. For example, Bradshaw and Ellison (2008) measured religiosity as four factors based on eight separate indicators. Previous research reports a significant inverse association between religiosity and substance use behaviors regardless of the measure of religiosity utilized in the analysis, findings that suggest my findings would be robust to different measurement strategies for religiosity.

In conclusion, future studies should take into account potential variation in the association between religion and health. These studies would increase significantly what is known about the relationship between these two phenomena and uncover, to a greater extent, the true level of complexity of the relationship between religion and substance use.

CHAPTER 3: DOES THE ASSOCIATION BETWEEN RELIGIOSITY AND SUBSTANCE USE BEHAVIORS VARY ACROSS THE LIFE COURSE?

Studies exploring the association between religiosity and substance use behaviors typically find a significant inverse association between those two phenomena; regardless of the measure of religiosity and/or substance use behavior used in the analysis (Yeung et al. 2009). This is the case across racial groups (Wallace et al. 2003) as well as for both males and females (Yeung et al. 2009). Many of these studies utilize samples of adolescents (i.e. 11-18 years old) and young adults (e.g. 20-35 years old) (Yeung et al. 2009). This is likely because substance use is more prevalent among these stages of the life course compared to others (Johnston et al. 2014, 2011).

Despite the extensive use of adolescent and young adult samples, it is not well understood whether the association between religiosity and substance use behaviors functions in a similar manner at these separate life stages. It is possible that the association between religiosity and substance use behaviors varies between adolescence and early adulthood if the level of religiosity of the environments that individuals inhabit varies between those two life stages. Research has shown that increased levels of religiosity within an individual's environment, measured and the proportion of co-religionists within an individual's environment, will lead to a stronger association between an individual's religiosity and his or her behavior(Regnerus 2003; Wallace et al. 2007). It is important that we uncover whether or not the association between religiosity and substance use behaviors varies between adolescence and early adulthood because variation in the association between religiosity and substance use between these life stages could lead to differing results solely based on the ages of the individuals within the sample (e.g. 11-14 vs. 21-24) that a researcher chooses to use.

Using data from the National Longitudinal study of Adolescence to Adult (Add) Health I test whether or not the association between religiosity and substance use behavior differs between adolescence and early adulthood. In the remainder of this study I first provide a general overview of the life course approach to sociology. Second I review the literature on the ways in which religiosity and substance use varies across the life course, specifically between adolescence and early adulthood. Next, I describe the explanations that have been put forward to explain the association between religiosity and substance use behaviors. After that I put forward my own theory and hypothesis about potential variation in the association between religiosity and substance use behaviors. I conclude this study by presenting my data and methods; analytic strategy; results; and conclusions. I begin by reviewing the literature on the ways that religiosity and substance use behaviors vary across the life course.

WHAT IS THE LIFE COURSE?

Key Concepts. The life course approach to sociology emerged during the 1970's as an analytic tool to study the changes that occur at the individual and societal level as a person ages (for a detailed description of the intellectual origins of the life course see Marshal and Mueller 2003). Key to understanding the life course approach to sociology is understanding the distinction between concept of the "the life course" and the "the life course paradigm". Michael J. Shanahan and Ross Macmillan (2008) define the concept of the life course as "the age-graded sequence of roles, opportunities, constraints and events that shape the biography from birth to death". In other words, it's the sequence of roles, opportunities, events, and constraints that individuals experience throughout their life that differ by age. This differs from the life course paradigm which Shanahan and Macmillan define as a set of concepts, principles, ideas and methods that informs how researchers study a particular phenomenon. Over the years the life course paradigm has been applied to a variety of phenomena including economic

inequality (Schafer, Ferraro and Mustillo 2011), health (Pavalko and Wilson 2011), protest movements (Caren, Ghoshal and Ribas 2011), and religion (Dillon 2007).

In addition to understanding the difference between concept of the life course and the life course paradigm, in order to have a clear understanding of life course sociology it is useful to understand two additional concepts: Trajectories and transitions. Shanahan and Macmillan (2008) define a developmental trajectory as "change and constancy in the same behavior of disposition over time." Developmental trajectories (also referred to as careers) can occur across long swathes of the life course or short time spans and occur in varying domains such as work, education or even criminality. For example, Terrie Moffitt (1993) theorized the existence of two types of developmental trajectories in the domain of criminality (criminal careers) which she refers to as "life-course persistent" and "adolescence-limited" offending. Life-course persistent offending occurs when individuals continue criminal behavior well past the adolescent stage and can lead to long-term incarceration and/or constant recidivism. Adolescence-limited offending is much more common than life-course persistent offending and typically ends as individual's transition to adulthood. Embedded in developmental trajectories are transitions, which Elder (1985) defines as "changes in state that are more or less abrupt." Transitions include an exit from and entrance into particular social role (what Elder describes as a state) and the particular transitions that an individual experiences defines his or her life course trajectory. Differences in life course transitions (i.e. getting into college vs. going to jail) can lead to differing developmental trajectories (i.e. continued educational attainment vs. life-course persistent offending) and eventually to very different life course outcomes (i.e. middle-class status vs. long-term incarceration).

Origins. The intellectual origins of the life course paradigm, as used in North American context (see Marshal and Mueller 2003 for a comparison of the life course paradigm as used in Europe versus

North America), can be traced to Glen Elder's pivotal work *Children of the Great Depression* (1974). In that work Elder applied key life course principles in order to explain differences in economic outcomes between two cohorts of young men who were born in the 1920-21 time period and the 1928-29 time period respectively. Elder found that a group of boys born during 1920-1921 time period tended to have *fewer* enduring adverse effects from hardship faced during the Great Depression compared to those born during the 1928-1929 time period. The differences in outcomes, Elder concluded, was due to the fact that the later cohort experienced deprivation at a more vulnerable period of human development followed by the stresses of growing up during the war years. The earlier cohort, by contrast, experienced the prosperous period just prior to the Great Depression during the most vulnerable period of their development and benefited economically by being able to participate in the war directly or back at home during the mobilization. These principles (which Elder describes in detail in Elder 1996) allowed Elder to connect the discrete events of an individual's life, the social context in which he or she develops, as well as the discrete events of the lives of those develop alongside the individual within that social context.

VARIATION IN RELIGIOSTY AND SUBSTANCE USE ACROSS THE LIFE COURSE

Variation in Religiosity across the Life Course. Studies exploring variation in religiosity across the life course typically identify distinctive population sub-groups with differing religious trajectories (Smith and Snell 2009, p. 211-256; McCullough et. al 2005; Ingersoll-Dayton, Krause and Morgan 2002; Argyle and Beit-Hallahmi 1975). These trajectories typically come in 4 distinct forms, they are: Increasing religiosity, stable religiosity, decreasing religiosity, and curvilinear patterns of religiosity in which a significant decrease in religiosity is followed by an increase in religiosity over the remainder of the life course (Petts 2009; McCullough et. al. 2005; Ingersoll-Dayton, Krause and Morgan 2002; Fowler 1981;

and Argyle and Beit-Hallahmi 1975). Declines in religiosity are much more common than stability or increases in religiosity. For example, Petts (2009) grouped individuals into six distinct groups based on their patterns of attendance at religious services, which are: Nonattenders, occasional attenders, frequent attenders, early declining attenders, gradual declining attenders and late declining attenders. Frequent attenders, occasional attenders and non-attenders show stable or increasing levels of religious attendance over time and comprise approximately 33% of the sample; while early declining attenders, gradual declining attenders and late declining attenders show a significant drop in religiosity during early adulthood and make up the remaining (≈67%) of the sample. Similarly, Uecker, Vaaler and Regnerus (2007) find that 69% of individuals attend religious services less frequently during early adulthood than adolescence.

A number of studies have tried to explain the decline in religiosity between adolescence and early adulthood. For example, Uecker, Vaaler and Regnerus (2007) used Add Health data to uncover the factors that predict declines in religiosity from adolescence to early adulthood. Previous research argued that factors such as the secularizing effects of post-secondary education; cognitive dissonance due to the deviation of norms; and life course factors such as marriage led to declines in religiosity during early adulthood. One weakness of these studies, however, was that they often used cross-sectional data and retrospective measures of religiosity to explore religious decline. Uecker, Vaaler and Regnerus, using longitudinal data, found that several factors influenced differing dimensions of religiosity. These factors include not being from a biologically intact two parent family, not attending or completing post-secondary education, cohabitating, non-marital sexual behavior and substance use. Uecker, Vaaler and Regnerus find that these factors were stronger predictors for declines in attendance at religious services compared to religious salience and religious disaffiliation, respectively.

Variation in Substance Use Behaviors across the Life Course. Similar to research exploring religiosity across the life course, studies find that levels of substance use behaviors are also dynamic across the life course. For example, according to the 2009 Monitoring the Future study, 15% of 8th graders report using alcohol in the past 30 days (Johnston et al. 2009a). This number increases to 44% among 12 graders and increases further during late adolescence to 53% of 19 and 20 year olds; 73 % of 21 and 22 year olds and 78% among 23 and 24 year olds (Johnston et al. 2009a; Johnston et al. 2009b). Binge drinking, defined as "drinking 5 or more drinks during a single occasion", is reported to be 25% among 12th graders and rises to 37% among college students (Johnston et al. 2009b).

Unlike religiosity, which is present in high levels during childhood, substance use behaviors are virtually non-existent prior to adolescence. However, during adolescence, the onset of substance use behaviors is common, and typically increases over a number of years. This change in behavior tends to coincide with social and biological changes that also occur during this period (Windle et al. 2009). Changes in the brain lead to increased impulsivity and substance use (Steinberg 2008) and the influence of peers increases (Windle et al. 2009). Levels of substance use behaviors peak during early adulthood, concomitant with increases in impulsive behaviors and transitioning out of the parental home.

EXPLANATIONS FOR THE ASSOCIATION BETWEEN RELIGIOSITY AND SUBSTANCE USE BEHAVIORS

Several explanations have been put forward to explain the inverse association between religiosity and substance use behaviors. Early on individuals cited fear of divine punishment as the reason religious individuals were less likely to use drugs or alcohol compared to non-religious individuals (Hirschi and Stark 1969; Stark 1996). However, this particular view has largely fallen out of favor due to lack of empirical evidence to support it. One common explanation that is cited among contemporary researchers is the influence of prohibitions on substances use behaviors by religious groups. For

example, Michalak and colleagues (2007) find that followers of religious groups that forbid the use of a particular substance are more likely to abstain from using that substance than other groups. This effect is especially true if individuals view their religious group as their primary reference group (Chawla et al. 2007). In regards to alcohol use in particular, religious prohibitions have a significant influence on rates of use. Religious groups that explicitly forbid alcohol use (e.g. Mormons and Muslims) tend to have lower rates of alcohol use while religious groups that do not explicitly forbid alcohol use or have more liberal attitudes toward alcohol use (e.g. Liberal Protestants) tend to have higher rates of alcohol use. In fact, the religious group within the U.S. with the highest levels of alcohol use are Catholics, who use alcohol as a sacrament (Engs, Diebold, and Hanson 1996; Kang Sim et al. 2013).

Another explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors is the fact that religious individuals often have lower levels of life stress than non-religious individuals (Ellison 1994). These lower levels of life stress which would likely to lead to lower levels of substance use because individuals often turn to substances such as tobacco and alcohol to cope with stressors. Wills, Yaeger, and Sandy (2003) find that negative life events have a weaker impact on both initial substance use and the growth of substance use over time among religious individuals compared to non-religious individuals. These findings replicate previous findings from similar studies (see Strawbridge et. al 1998; Kendler, Gardner, and Prescott 1997; Krause 1997).

A third explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors is the positive influence of religiosity on pro-social behaviors, such as self-control. Several studies find that individuals with higher levels of self-control tend to have higher levels of religiosity (e.g. Muraven et al. 2006; Muraven et al. 1998; Geyer and Baumeister 2005, p. 418) and lower levels of substance use (Vazsonyi, Pickering, Junger, & Hessing, 2001; Wood, Pfefferbaum, & Arneklev, 1995). In a study done by Desmond, Ulmer and Bader (2013), the researchers

find that religious youth tend to exhibit higher levels of self-control, which partially mediates the effect of an adolescents' religiosity on his or her marijuana use and drinking. They also find evidence for an interaction between religiosity and self-control where self-control has a greater impact on alcohol use among individuals with low levels for religiosity.

A fourth explanation that is commonly put forward to explain the inverse association between religiosity and substance use behaviors, particularly among adolescents and children, is the influence of parental religiosity. Prior to early adulthood, when individuals typically achieve increased personal autonomy, an individual's religiosity is largely the product of the religiosity of their parent. As a result, an inverse association between an individual's religiosity and their levels of substance use behaviors are likely to be at least partially driven by the religiosity of their parents. Evidence for this comes from the research of Foshee and Hollinger (1996). They find that maternal religiosity during adolescence is associated with lower rates of alcohol use, over and above personal religiosity. Because the personal autonomy of individuals typically increases from adolescence to early adulthood, it is likely that the association between parental religiosity and adolescence substance use behavior diminishes over time and largely vanishes by adulthood.

It is likely that a combination of some or all of these explanation at least partially explain the association between religiosity and substance use behaviors. More research needs to be done in order to gain a deeper understanding of the factors that drive the association between religiosity and substance use behaviors.

VARIATION IN THE ASSOCIATION BETWEEN RELIGIOSITY AND SUBSTANCE USE BEHAVIORS ACROSS THE LIFE COURSE

To date only a few studies have explored variation in the association between religiosity and human behaviors. Most of these studies have drawn upon an expanded version of Rodney Stark's moral communities thesis to explain this variation. Rodney Stark (1996) posited that in contexts where there are a higher proportion of an individual's co-religionists (e.g. a religious congregation) an individual's religiosity will have a stronger influence on his or her behaviors. This is because co-religionists serve to reinforce religious beliefs which make them more salient in the life of the individual. In other words, co-religionists act as a "light switch", activating the influence of an individual's religiosity on their behavior (Regnerus 2005:268).

Subsequent scholars have found evidence for this thesis by exploring the interaction between personal religiosity, contextual religiosity and deviance. For example, Regnerus (2003), using data from the National Longitudinal Study of Adolescent to Adult Health, found an interaction between individual-level measures of conservative Protestantism and conservative Protestant homogeneity on both the school and community level. He found that individuals who self-report as "born-again" attend religiously homogeneous schools and reside in religiously homogeneous communities report significantly lower levels of theft than born-again Protestants in contexts where they are a religious minority. Stark's "light switch" thesis was expanded to substance use behaviors as well. Later, Wallace and Colleagues (2007) found that the level of religiosity in the school that an individual attends interacts with their level of personal religiosity to moderate levels of substance use behaviors. Specifically, they found that individuals who were highly religious and who also attended a highly religious school were less likely to binge drink or use marijuana than individuals who were highly religious who attended a less religious

school. However, Bahr and Hoffman (2008) using Add Health data, found no interaction between personal religiosity and contextual religiosity.

Variation in Contextual Religiosity across the Life Course. While there is an extensive literature on variation in personal religiosity across the life course, there are no studies exploring variation in contextual religiosity across the life course. The strongest evidence for potential variation in the association between religiosity and substance use behaviors across the life course comes from the literature on variation in personal religiosity across the life course. Because early adulthood is the point in the life course where individuals are least likely to be involved in religion, individuals are less likely to be part of religious contexts such as religious congregations. However, it is not known if the larger contexts that young adults inhabit (e.g. universities, workplaces) are less religious than the contexts they inhabit during adolescence (i.e. school, family environment). Because there is no compelling evidence to show that there are more (or fewer) co-religionists inhabiting the environments of young adults compared to adolescents I hypothesize that *the slope of the association between personal religiosity and substance use behaviors will not differ between adolescence and early adulthood.*

Table 1.3: Descriptive Statistics By Wave (N=8,998)				
	Wave I		Wave IV	
Variables	**Mean (SD)/%**	**Min.-Max.**	**Mean (SD)/%**	**Min.-Max.**
Smoking	4.24 (9.50)	0-30	7.28 (12.16)	0-3
Alcohol Use	1.10 (1.45)	0-6	2.30 (1.79)	0-6
Independent Variable				
Religiosity				
Attendance at Religious Services*	1.76 (1.19)	0-3	1.29 (1.07)	0-3
Importance/Salience of Religion*	2.05 (1.05)	0-3	1.52 (0.88)	0-3
Participation in Religious Activities*	1.09 (1.23)	0-3	0.48 (0.87)	0-3
Covariates				
Age	15.65 (1.67)	11-18	28.57 (1.71)	24-34
Male	44%	0-1	43%	0-1
White (Ref.)	59%	0-1	58%	0-1
Hispanic	14%	0-1	15%	0-1
Black	19%	0-1	19%	0-1
Asian	5%	0-1	5%	0-1
Other	2%	0-1	3%	0-1
Income	7.29 (2.80)	1-12	8.18 (2.47)	1-12
Delinquency	1.64 (2.97)	0-33	1.37 (2.96)	0-23
Non-Religious (Ref.)	12%	0-1	18%	0-1
Conservative Protestant	27%	0-1	20%	0-1
Mainline Protestant	24%	0-1	13%	0-1
Catholic	25%	0-1	21%	0-1
Other Protestant	7%	0-1	22%	0-1
Non-Christian	4%	0-1	4%	0-1
* Indicator for Latent Variable				

DATA AND MEASURES

Add Health. The data for these analyses come from Wave I and Wave IV the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative longitudinal survey of adolescents and young adults obtained from an initial in-school survey of middle- and high school students conducted from September 1994 to April 1995. In total, 90,118 adolescents who attended 80 high schools and 54 feeder schools (both public and private) took part in the initial interview. During the months of April through December 1995, a sample of the in-school respondents (stratified by gender and grade) were selected to participate in an in-home face-to-face interview (Wave I). This sample included 20,745 individuals. These respondents have been followed up three times over the past 15 years for a total of four waves of in-home data collection.

Because the Chow test used to compare the association between religiosity and substance use behaviors across the life course requires independent group (see Analytic Strategy), the overall sample

was split into two independent samples using random assignment. The measures of respondents taken at wave I were used for group 1 and the measures of respondents taken at wave IV were used for group 2. Also, because some siblings were included in the sample as a result of a convenience sample taken in wave III, one respondent from each sibling pair was randomly selected and excluded from the analytic sample.

In addition to the changes to the sample for the chow test. Cases were not included in the analysis if 1) they had missing values for sex (N=2) or race/ethnicity (N=10); 2) they were missing values for age during Wave I (N=5); or 3) they had missing values for substance use during either Wave I or Wave IV (N=383). In addition, due to the oversampling of certain groups within the sample (e.g. black adolescents with a parent with a college degree), samples weights are utilized in the analyses. Therefore, cases were deleted if they are missing sample weights (N=5,945). Also, in order to compare individuals who were adolescents during Wave I and young adults who had transitioned out of their parental homes by Wave IV, cases were also dropped if the respondent was older than 18 years old during Wave I (N=311) and had not transitioned out of their family home by Wave IV (N=3,249). This leaves a total analytic sample of 8,998 cases evenly divided into adolescent and early adult sub-samples.

Table 2.3: Attrition Analysis (Descriptive Statistics)						
Variables	No Cases Dropped (N=20,745)	Missing Weights Cases Dropped (N=14,800)	Missing Variable Cases Dropped (N=15,272)	Cases Older than 18 at Wave I dropped (N=20,191)	Cases Living with Parents at Wave IV Dropped (N=11,979)	Analytic Sample* (N=8,998)
	%/Mean (S.D)	%/Mean (S.D)	%/Mean (S.D)	%/Mean (S.D)	%/Mean (S.D)	%/Mean (S.D)
Wave I Variables						
Dependent Variable						
Smoking	4.28 (9.55)	4.27 (9.54)	4.26 (9.54)	4.26 (9.53)	4.38 (9.67)	4.24 (9.50)
Alcohol Use	1.09 (1.48)	1.09 (1.46)	1.08 (1.45)	1.09 (1.47)	1.12 (1.46)	1.10 (1.45)
Independent Variable						
Religiosity						
Attendance at Religious Services*	1.73 (1.20)	1.75 (1.20)	1.75 (1.20)	1.73 (1.20)	1.75 (1.19)	1.76 (1.19)
Importance/Salience of Religion*	2.05 (1.05)	2.07 (1.04)	2.07 (1.05)	2.05 (1.05)	2.06 (1.04)	2.05 (1.05)
Participation in Religious Activities*	1.05 (1.23)	1.09 (1.23)	1.09 (1.23)	1.06 (1.22)	1.10 (1.23)	1.09 (1.23)
Covariates						
Age	15.70 (1.75)	15.66 (1.73)	15.63 (0.13)	15.61 (1.67)	15.69 (1.72)	15.65 (1.67)
Male	49%	47%	46%	49%	45%	44%
White (Ref.)	50%	53%	53%	51%	57%	59%
Hispanic	17%	16%	16%	17%	15%	14%
Black	23%	22%	22%	22%	20%	19%
Asian	7%	6%	6%	7%	5%	5%
Other	3%	3%	3%	3%	3%	2%
Income	6.91 (2.85)	7.02 (2.79)	7.04 (2.79)	6.93 (2.84)	7.16 (2.80)	7.29 (2.80)
Delinquency	1.91 (3.45)	1.83 (3.31)	1.84 (3.33)	1.92 (3.46)	1.75 (3.23)	1.64 (2.97)
Non-Religious (Ref.)	12%	12%	12%	12%	19%	12%
Conservative Protestant	28%	29%	29%	28%	29%	27%
Mainline Protestant	23%	23%	24%	23%	23%	24%
Catholic	26%	25%	25%	26%	25%	25%
Other Protestant	6%	6%	6%	6%	6%	7%
Non-Christian	4%	4%	4%	4%	4%	4%
Wave IV Variables						
Dependent Variable						
Smoking	7.92 (12.54)	7.90 (12.53)	7.87 (12.51)	7.93 (12.55)	7.38 (12.25)	7.28 (12.16)
Alcohol Use	2.23 (1.81)	2.24 (1.81)	2.24 (1.81)	2.25 (1.81)	2.29 (1.78)	2.30 (1.79)
Independent Variable						
Religiosity						
Attendance at Religious Services*	1.27 (1.08)	1.27 (1.08)	1.27 (1.08)	1.27 (1.08)	1.29 (1.08)	1.29 (1.07)
Importance/Salience of Religion*	1.54 (0.88)	1.54 (0.89)	1.54 (0.88)	1.54 (0.89)	1.54 (0.89)	1.52 (0.88)
Participation in Religious Activities*	0.48 (0.87)	0.48 (0.87)	0.47 (0.87)	0.48 (0.87)	0.48 (0.87)	0.48 (0.87)
Covariates						
Age	28.57 (1.79)	28.60 (1.78)	28.57 (1.79)	28.50 (1.73)	28.62 (1.77)	28.57 (1.71)
Male	49%	47%	46%	49%	45%	43%
White (Ref.)	50%	53%	53%	51%	57%	58%
Hispanic	17%	16%	16%	17%	15%	15%
Black	23%	22%	22%	22%	20%	19%
Asian	7%	6%	6%	7%	5%	5%
Other	3%	3%	3%	3%	3%	3%
Income	8.07 (2.64)	8.11 (2.63)	8.10 (2.62)	8.09 (2.64)	8.09 (2.53)	8.18 (2.47)
Delinquency	1.48 (3.01)	1.47 (3.00)	1.47 (3.00)	1.48 (3.02)	1.42 (2.98)	1.37 (2.96)
Non-Religious (Ref.)	18%	18%	18%	18%	19%	18%
Conservative Protestant	20%	20%	20%	20%	20%	20%
Mainline Protestant	12%	12%	12%	12%	13%	13%
Catholic	22%	22%	22%	22%	21%	21%
Other Protestant	24%	24%	24%	24%	23%	22%
Non-Christian	4%	4%	4%	4%	4%	4%
*Wave I and Wave IV are separate individuals.						

Sample Attrition. One potential problems of listwise deletion is the potential of bias due to patterns of missingness not being random. This would be evidenced by significant differences in the full sample and the sample from which cases have been deleted. Table 2.3 displays the full sample prior to listwise deletion; the sample after cases with missing sample weights are deleted; the sample after cases with missing variables are deleted; and the analytic sample. Table 2.3 reveals few differences across the samples. First, the full sample has a slightly higher proportion of males compared to the other samples. Second, Mean Income in the wave I in the analytic sample is significantly higher (Mean=7.29) than the Full sample (Mean=6.91). Third, in wave IV the analytic sample includes a higher proportion of white respondents (58%) compared to the full sample (50%). while delinquency in the analytic sample is significantly lower (Analytic sample=1.91; Full sample=1.64). Lastly, in wave IV in the full sample the mean of smoking (Mean=7.92) is higher compared to the analytic sample (Mean=7.28) while the mean of alcohol use (2.23) is lower compared to the analytic sample (2.30). Overall, these results indicate that it is not likely that the excluded cases will significantly bias the results.

Substance Use Behaviors. As Table 1.3 indicates, all of the measures I use for my analyses are taken at both Wave I and Wave IV. I utilize two measures of substance use behaviors as dependent variables: Frequency of smoking and frequency of alcohol use. Frequency of smoking is a measure based on the question, "During the past 30 days, how many days did you smoke cigarettes." This is a variable that ranges from 0 to 30. Table 1.3 indicates that the mean level of smoking within the sample is a little over 4 days in the previous 30 days during Wave I and a little over 7 days in the last 30 days during Wave IV. Frequency of alcohol use is a measure based on the question, "During the past 12 months on how many days did you drink alcohol". This variable ranges from 0 indicating "no days", and

6 indicating “every day or almost every day.” Table 1.3 indicates that the means level of alcohol use increases from 1 to 2 days in the past 12 months during Wave I to once a month during Wave IV.

Religiosity. The concept of religiosity has been notoriously hard to define over the years. The general consensus among scholars of religion is that religion is a multi-dimensional concept; though there is no consensus on the precise number of dimensions. For parsimony within my analyses I focus on one dimension of religiosity known as religious involvement. I borrow my conceptualization of religiosity from the work of Kogan and colleagues (2005) who describe religious involvement as an overarching concept that influences an individual’s religious beliefs and behaviors. I utilize a measure of religiosity taken at Wave I and Wave IV as my independent variable. This measure of religiosity is a latent construct that I estimate using 3 indicator variables taken at each wave: Attendance at religious services, participation in religious activities, and religious salience/importance. The first indicator variable, attendance at religious services, is based on the question, “In the past 12 months, how often did you attend religious services?” Responses range from 0 to 6 with 0 indicating “no attendance” and 6 indicating “more than once a week. The second indicator variable, religious salience, is a measure based on the question, "How important is religion to you?" Responses to this question were coded into two variables that range from 0 to 3 with 0 indicating a response of “not important at all” and 3 indicating “very important”. The third indicator variable, participation in religious activities, is based on the question, “Many churches, synagogues, and other places of worship have special activities outside of regular worship services--such as classes, retreats, small groups, or choir. In the past 12 months, how often have you taken part in such activities?” Responses range from 0 to 6 with 0 indicating “no attendance” and 6 indicating “more than once a week”.

The latent religiosity variable utilized in my analyses is based on a similar latent variable that was utilized by Kogan and colleagues (2005) who used it to uncover risk and protective factors for

substance use among African American high school dropouts. The coefficient of the first indicator, attendance at religious services, is constrained to 1 to ensure that the model is identified. In regards to the other two indicators, both religious salience and attendance at religious activities have a positive association with the latent religiosity variable. As a result, a 1-unit change in the latent religiosity variable corresponds to a 1 standard deviation change in that variable.

Covariates. Covariates for age, sex, race, household income and religious affiliation are included in each model. Household income is measured as total income from all sources before taxes and deductions. Most respondents reported their household income in dollars. A few preferred to report a range; the midpoints of the indicated ranges were used for these respondents.

Religious affiliation is a variable that is loosely based on the coding scheme put forward by Steensland and colleagues (2000). The largest religious group within the samples is Conservative Protestant (25%), followed closely by Catholics (24%). Religious affiliation is a separate dimension from religious involvement, the variable I use as my independent variable because religious affiliation includes racial/ethnic characteristics (i.e. Jewish Identity, African American Baptists) and/or strong beliefs (i.e. Mormons; Seventh-Day Adventists). It is important to control for religious affiliation because certain religious groups have strict prohibitions on substance use (i.e. Mormon; Seventh-Day Adventists).

ANALYTIC STRATEGY

To test whether the slope of the association between religiosity and substance use behaviors I fit separate multivariate regression models predicting substance use for each wave of Add Health that I'm using (i.e. Wave I = Adolescence and Wave IV = early Adulthood). I then compare the regression

coefficients for religiosity using a Chow Test. Chow tests are statistical tests of whether the two coefficients of two linear regressions on different data are equal. One key assumption of Chow tests is that the groups from with the linear regression coefficients are estimated are independent. To adhere to this assumption, I randomly split the Add Health sample into two independent groups where respondents do not overlap. Also, because the sample includes some sibling pairs which were collected as a convenience sample, one member of each sibling pair was selected for the final analytic sample. For group 1 regression coefficients are estimated using data collected at wave I while for group 2 regression coefficients are estimated using data collected at wave IV. Equations 1 and 2 illustrates the basic structure of each multivariate regression equation with Smoking and the outcome:

$$Smoking_{w1} = \alpha_{w1} + \beta_{1\,w1} Relig_{w1} + \beta_{2\,w1} Covariates_{w1} + \varepsilon_{w1} \quad [1]$$

$$Smoking_{w4} = \alpha_{w4} + \beta_{1\,w4} Relig_{w4} + \beta_{2\,w4} Covariates_{w4} + \varepsilon_{w4} \quad [2]$$

where β_1 represents the slope for religiosity and β_2 represents the slope for the covariates and ε represents the error term. In order to compare β_1 for Wave I and Wave IV I stack combine these two equations to create equation 3:

$$Smoking = \beta_{1\,w1} Relig_{w1} + \beta_{2\,w1} Covariates_{w1} + \beta_3\, wave1 + \varepsilon_{w1} + \beta_{1\,w4} Relig_{w4} + \beta_{2\,w4} Covariates_{w4} + \beta_3\, wave4 + \varepsilon_{w4} \quad [3]$$

In equation 3 I include dummy variables for Wave I and Wave IV and I do not include and overall constant term. The Chow test can then be used to test whether $\beta_{1\,w1} = \beta_{1\,w4.}$ In general Chow test are used to test whether the coefficients in two linear regressions on different data sets are equal. The null hypothesis the Chow test in my analysis is that the $\beta_{1\,w1} - \beta_{1\,w4}=0.$ The test statistic follows the F distribution with k and N1 + N2 – 2k degrees of freedom.

Missing Data. Because some variables include a significant number of missing values, multiple imputation by chained equations (MICE) is used to impute missing values. MICE uses a series of imputation models fitted to each variable to estimate missing cases based on the arbitrary patterns for continuous, binary, ordinal, cardinal, or count variables (e.g., White et al., 2011). Specifically, we estimated 5 datasets based on all the variables in our models, and report estimates that are averaged across these datasets.

Table 3.3: Religiosity and Covariates Predicting Substance Use with Cross-Wave (Adolescence and Early Adulthood) Interactions(N=8,998)						
	Smoking			Alcohol Use		
	Adolescence (Aged 11-18) Full Model	Early Adulthood (Aged 25-32) Full Model	Chow Test of Difference in Religiosity Coefficents	Adolescence (Aged 11-18) Full Model	Early Adulthood (Aged 25-32) Full Model	Chow Test of Difference in Religiosity Coefficents
Religiosity	-2.106*** [-2.589,-1.622]	-2.640*** [-3.236-2.044]	F(1, 128) = 1.55 Prob > F= 0.2148	-0.183*** [-0.228,-0.138]	-0.380*** [-0.455,-0.306]	F(1, 128) = 23.97 Prob > F= 0.0000
Age	1.193*** [0.982,1.404]	-0.018 [-0.319,0.283]	---	0.258*** [0.227,0.288]	-0.066** [-0.111,-0.020]	---
Male	-1.819*** [-2.448,-1.190]	0.784 [-0.198,1.767]	---	-0.159** [-0.265,-0.052]	0.669*** [0.517,0.820]	---
Hispanic	-3.435*** [-4.569,-2.301]	-2.167** [-3.603,-0.732]	---	-0.182 [-0.372,0.008]	-0.403** [-0.652,-0.155]	---
Black	-4.625*** [-5.477,-3.773]	-4.043*** [-5.522,-2.564]	---	-0.275** [-0.464,-0.087]	-0.058 [-0.271,0.156]	---
Asian	-1.297 [-3.003,0.409]	0.194 [-2.700,3.088]	---	-0.397** [-0.658,-0.136]	0.044 [-0.351,0.439]	---
Other	-0.215 [-2.843,2.412]	1.509 [-1.443,4.462]	---	-0.274** [-0.481,-0.067]	0.001 [-0.306,0.307]	---
Conservative Protestant	2.704** [0.853, 4.555]	2.925*** [1.070,4.781]	---	0.409*** [0.194,0.623]	-0.289* [-0.524,-0.053]	---
Mainline Protestant†	1.830 [0.558,2.969]	0.436 [-1.304,2.177]	---	0.338*** [0.141,0.536]	0.439*** [0.187,0.691]	---
Catholic†	1.659 [-0.074,3.392]	1.011 [-0.562,2.583]	---	0.465*** [0.274,0.655]	0.206 [-0.033,0.446	---
Other Christian	1.786 [-0.320,3.891]	2.895*** [1.332,4.458]	---	0.104 [-0.167,0.376]	-0.045 [-0.304,0.214]	---
Other Non-Christian	2.177 [-0.265,4.619]	-0.317 [-3.165,2.531]	---	0.336** [0.096,0.575]	0.364* [0.071,0.658]	---
Logged Income	-0.220** [-0.382,-0.057]	-0.829*** [-1.050,-0.607]	---	0.021 [-0.007,0.049]	0.105*** [0.072,0.138]	---
Delinquency	0.824*** [0.630,1.017]	0.193*** [0.041,0.346]	---	0.186*** [0.164,0.207]	0.010 [-0.016,0.037]	---
Constant	-13.574*** [-17.144,-10.004]	13.620*** [4.856,22.384]	---	-3.519*** [-4.005,-3.033]	3.047*** [1.808,4.286]	---
95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$						

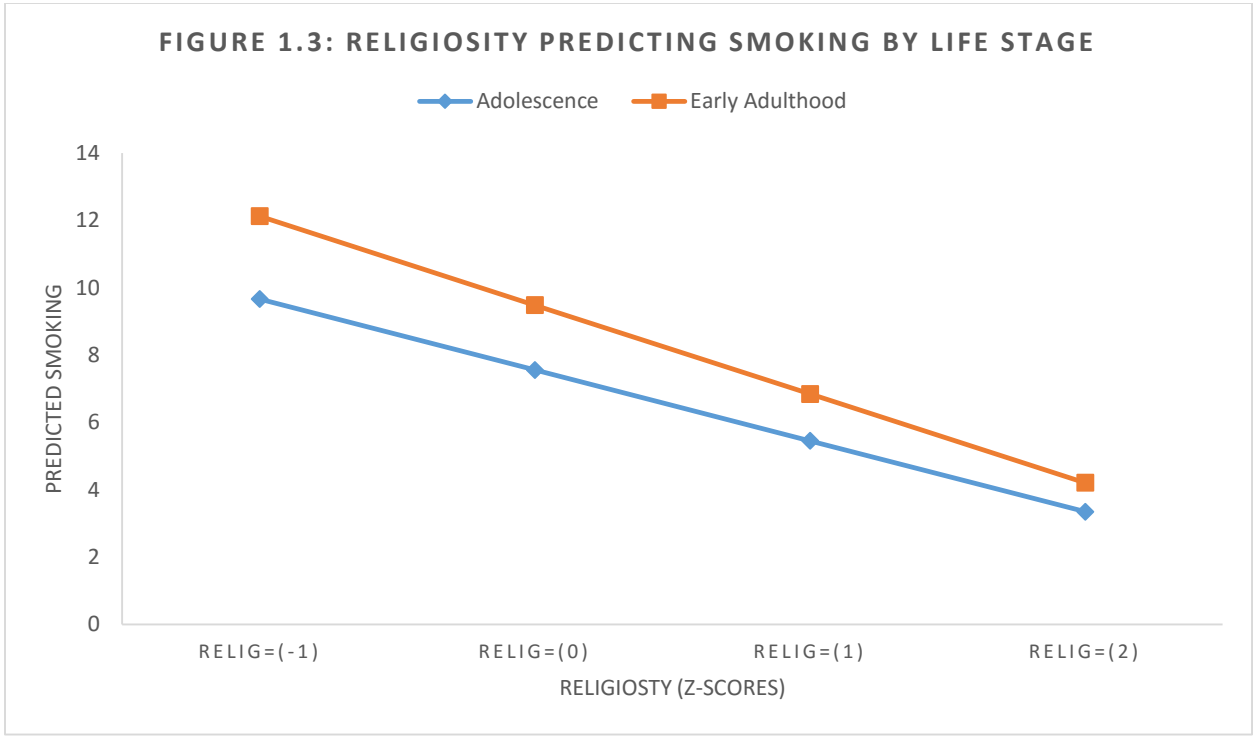
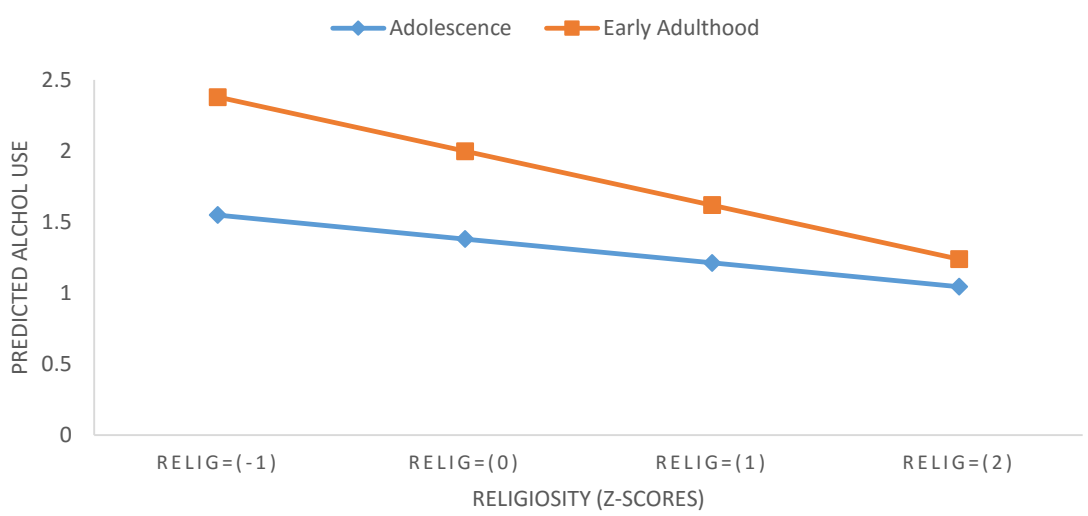


FIGURE 1.3: RELIGIOSITY PREDICTING SMOKING BY LIFE STAGE
Adolescence
Early Adulthood
PREDICTED SMOKING
14
12
10
8
6
4
2
0
RELIG=(-1)
RELIG=(0)
RELIG=(1)
RELIG=(2)
RELIGIOSTY (Z-SCORES)

FIGURE 2.3: RELIGIOSITY PREDICTING ALCOHOL USE BY LIFE STAGE



RESULTS

Looking at Table 3.3, religiosity has a significant negative association with smoking in adolescence (β= -2.106, c.i. = -2.589, -1.622) and early adulthood (β= -3.236, c.i. = -2.044, -2.268) as well as alcohol use in adolescence (β= -0.183, c.i. = -0.228, -0.138) and early adulthood (β= -0.380, c.i. = -0.455, -0.306). This finding replicates findings from previous research which typically finds a significant inverse association between religiosity and substance use behaviors (Moscati and Mezuk 2014; Yeung et al. 2009). The Chow test results reveal that the association between religiosity and alcohol use differs significantly between adolescence and early adulthood (F [1, 128] = 23.97 Prob > F= 0.0000). Figure 2.3 illustrates this major finding. Figure 2.3 shows that during adolescence the association between religiosity and substance use behaviors is fairly weak. The finding seems to indicate the level of religiosity in the contexts inhabit during early adulthood are more religious then the contexts the individuals inhabit during adolescence.

In regards to the association between religiosity and smoking there is no evidence of a change in the association between adolescence and early adulthood. Figure 2.3 illustrates this. While the level of smoking is lower during adolescence compared to early adulthood, the slope of the association between religiosity and alcohol use does not differ between adolescence and early adulthood. This may indicate that contextual religiosity may not influence the association between religiosity and smoking. Wallace and Colleagues (2007) found that while contextual religiosity influences the influence between religiosity and marijuana use, they found that contextual religiosity have not influence on the association between religiosity and binge drinking and the association between religiosity and smoking.

DISCUSSION

In my analyses I explored whether the association between religiosity and substance use behaviors varies between adolescence and early adulthood. To explain potential variation of the association across between those time periods I drew on an expanded version of Rodney Stark's moral communities thesis which posits that an individual's religiosity becomes more salient in regards to his or her behaviors in environments where co-religionists are the majority.

Overall, my findings indicate that the association between religiosity and alcohol use is stronger for individuals during early adulthood compared to adolescence. Previous studies have found that the influence of religiosity on an individual's religiosity is stronger in environments with a higher proportion of co-religionists. This is because co-religionists tend to reinforce religious beliefs, which strengthen their influence on behavior. The findings seem to indicate that the environments inhabited by individuals during early adulthood is more religious than the environment inhabited by individuals during adolescence. The association between religiosity and smoking, however, shows not such variation. This may indicate that contextual religiosity may not influence the association between religiosity and smoking. Wallace and Colleagues (2007) found that while contextual religiosity influences the influence between religiosity and marijuana use, they found that contextual religiosity have not influence on the association between religiosity and binge drinking and the association between religiosity and smoking.

Weaknesses of This Study. There three major weaknesses within this study. The first major weakness of this study is the use of linear regression models to predict smoking and alcohol use, which are non-linear. I utilized linear regression for these analyses because Chow Tests are only useful when comparing linear models. While other studies have treated substance use as a continuous measure as

well; for future research I will seek a way to compare the regression coefficients of non-linear models and see if I can replicate my findings.

The second major weakness of this study is the fact that the association between religiosity and substance use measures is explored using cross-sectional data. As a result, I cannot establish a clear time order between the religiosity and substance use behaviors. As I described previously, substance use behaviors can influence an individual's level of religiosity (Uecker et al. 2007). However, this fact is not significantly problematic for my analyses for two reasons. First, my main goal for this study is explore whether or not there is variation in the association between religiosity and substance use behaviors. The time-order of the association is immaterial to whether or not this variation exists. While I cannot test the specific theories that I put forward at the beginning of the article, I can test the specific hypotheses I generated based on those theories. The second reason that the cross-sectional nature of this study is not significantly problematic is because previous longitudinal studies have established that religiosity does influence substance use behaviors across the life course. For example, Moscati and Mezuk (2014) found that changes in personal religiosity between adolescence and adulthood influence an individual's level of substance use. Because of these studies, it is not imperative for me to establish a time order.

The third major weakness of this study is that I do not have a direct measure of contextual religiosity. While the theories that I put forward specifically mention contextual religiosity, there are no measures of contextual religiosity within the Add health for Wave III or Wave IV. However, again, because the main focus of theses analyses is to explore whether or not there is variation in the association between religiosity and substance use behaviors across family status, it is immaterial whether or not it is actually contextual religiosity that is driving this variation.

Implications for Future Research. This study reveals the need to explore variation in the association between religiosity and substance use behaviors in particular, and religiosity and health in

general. Future studies exploring the association between religiosity and health should at least consider potential variation across sub-groups. For example, in studies of religiosity and health, when feasible, researchers should explore potential variation by sex and race. In addition, while this study explored variation in the association between religiosity and substance use behavior between adolescents and young adults, future studies should explore variation in this association between young adults and older adults. As individuals move through the life course, the religiosity of their environments may change, which influences the strength of the association between religiosity and their behaviors. Future studies can also explore variation in the association between religiosity and substance use behaviors with samples that are majority non-Christian.

Also, future studies should explore variation in the association between religiosity and substance use behaviors across multiple dimensions of religiosity. While I chose to conceptualize religiosity as an overarching concept influencing both behaviors and beliefs, future studies may treat beliefs and behaviors as separate dimensions. For example, Bradshaw and Ellison (2008) measured religiosity as four factors based on eight separate indicators. Previous research reports a significant inverse association between religiosity and substance use behaviors regardless of the measure of religiosity utilized in the analysis, findings that suggest my findings would be robust to different measurement strategies for religiosity.

In conclusion, future studies should take into account potential variation in the association between religion and health. These studies would increase significantly what is known about the relationship between these two phenomena and uncover, to a greater extent, the true level of complexity of the relationship between religion and health.

CHAPTER 3: DOES THE PROPORTION OF THE COVARIANCE BETWEEN RELIGIOSITY AND SUBSTANCE USE BEHAVIORS DUE TO GENETIC FACTORS VARY BETWEEN ADOLESCENCE AND EARLY ADULTHOOD?

Studies exploring the association between religiosity and substance use behaviors (i.e. smoking, alcohol use) consistently find an inverse association between those two phenomena (Moscati and Mezuk 2014; Yeung et al. 2009). A number of mechanisms have been put forward to explain this association including religious prohibitions against substance use behaviors (Chawla et al. 2007; Michalak, Trocki, and Bond 2007); lower life stress due to religious beliefs that leads to lower levels of substance use; increased self-control due to religious beliefs that lead to lower levels of substance use; and parental prohibitions on substance use behaviors that are based on parental religiosity (Foshee and Hollinger 1996).

Another set of mechanisms that may partially explain the association between religiosity and substance use behaviors that have not been explored are genetic factors. Genetic factors have been found to partially explain the variance of both religiosity and substance use behaviors (see Button and Colleagues 2011 for a review of this research). Because genetic factors contribute to the variance of religiosity and substance use behaviors, there is a possibility that a common set of genes at least partially account for the covariance of those two phenomena. For example, a gene related to poor health may prevent individuals from attending religious services, but increase their likelihood of turning to smoking or alcohol use to cope with poor health. It is important to uncover whether or not genetic factors at least partially account for the association between religiosity and substance use behaviors because if a common set of genes influence both religiosity and substance use behaviors, but is not

accounted for in analyses, researchers will obtain inflated estimates of the association between religiosity and substance use behaviors.

If there is a common set of genes that influence both religiosity and substance use behaviors, it is likely that this common set of genetic factors has a stronger influence during early adulthood compared to adolescence. This is because studies have shown that the heritability of both religiosity and substance use behavior increases between adolescence and early adulthood(Button et al. 2011). As a result, it is possible that the influence of common genes on both religiosity and substance use behaviors may differ between adolescence and early adulthood. At least one study has explored the question of whether there is a genetic component to the relationship between religiosity and substance use behaviors and whether this genetic component changes between adolescence and early adulthood. Kenneth S. Kendler, M.D. and John Myers, M.S. (2009), using data from Virginia Adult Twin Study of Psychiatric and Substance Use Disorders (VATSPSUD), decomposed the correlation of religiosity and substance use behaviors into shared environmental, unshared environmental, and genetic components. They found that the proportion of the correlation due to shared environmental factors decreased significantly between adolescence and adulthood while the proportion of the correlation between religiosity and substance use behaviors due to genetic factors increased significantly during that same time period.

While Kendler and Myers' study marks a significant advancement in our understanding of the genetic etiology of the covariance between religiosity and substance use behaviors, it suffers from two major weaknesses. First, their analytic sample only included males. As a result, it is not known if their findings are generalizable to females within the population. Several studies reveal significant sex differences in the heritability of religiosity and substance use behaviors separately. These studies point toward the potential of sex differences in the proportion of the covariance of religiosity and substance

use behaviors due to genetic factors because, assuming their findings are true, they open up the possibility that a common set of genes drive sex differences in both religiosity and substance use behaviors. One caveat, however, is that evidence for sex differences in the heritability of religiosity and substance use behaviors is mixed. For example, Winter and Colleagues (1999), using a Finnish sample of 2265 twin boys and 2521 twin girls found a significantly higher heritability for boys (a^2=0.22) compared to girls (a^2=0.11). However, Truett and Colleagues (1992), using a sample of American and Australian youth, find higher heritability for females (a^2=21%) compared to males (a^2=0%). Similarly, early research exploring the heritability of alcohol use find higher heritability for males compared to females (Legrand, McGue, and Iacono 1999), while later studies did not find this difference.

Second, Kendler and Myer's study used retrospective measures for adolescent religiosity and substance use. Respondents were asked about their levels of substance use and frequency of religious participation within a given range of ages (i.e. ages 8–11, 12–14, and 15–17). These reports are subject to recall bias due to the fact that the respondents were mostly in their 30's and 40's when asked about their religiosity and substance use behaviors; a gap of at least 15 years between the behaviors and reports.

Using data from the National Longitudinal Study of Adolescent to Adult (Add) Health and bivariate Cholesky decomposition models I test whether or not genetic factors partially explain the covariance between religiosity and substance use behaviors and if there are differences in the covariance between religiosity and substance use behaviors between adolescence and early adulthood. In the remainder of this study I first review the literature on the genetic etiology of religiosity and substance use behaviors, respectively. I then review the literature on behavioral disinhibition, an underlying genetic liability for impulsivity and substance use behaviors that may link religiosity and substance use behaviors. Lastly I describe empirical evidence that suggests that the covariance between

religiosity and substance use behaviors due to genetic factors varies between adolescence and early adulthood. I begin by describing the genetic etiology of religiosity.

THE GENETIC ETIOLOGY OF RELIGIOSITY AND SUBSTANCE USE BEHAVIORS

Traditionally the etiology of religiosity has been conceptualized as being purely social. However, researchers are beginning to explore the biological etiology of various dimensions of religiosity (See Bradshaw 2008 for a description of some of this research). Prominently, studies utilizing candidate genes have linked genetic factors to a dimension of the Temperament and Character Inventory (TCI) called "Self-Transcendence," a measure that describes an individual's level of spirituality[3]. Self-transcendence is of particular interest to scientists exploring the genetic etiology of religiosity because several studies have found self-transcendence to be heritable. For example, Kirk, Eaves and Martin (1999) found that 37% of the variance in self-transcendence among males and 41% of the variance in self-transcendence among females are due to genetic factors.

To date only two candidate gene studies have examined the genetic etiology of self-transcendence. The more famous of these studies was done by Dean Hamer (2004), who explored whether a variant of the vesicular monoamine transporter 2 (VMAT2) gene was significantly associated with the self-transcendence scale. The VMAT2 gene is a gene located on the long arm (i.e. q-arm) of chromosome 10 in humans and plays a crucial role in the brain, facilitating the release of neurotransmitters such as dopamine and serotonin into the synaptic cleft. Researchers have found that Inhibition of the functioning of the VMAT2 gene by amphetamines leads to increased levels of

[3] The scale originally consisted to three dimensions of personality thought to be genetic: Novelty seeking, harm avoidance and reward dependence, however; the TCI was later expanded to include 4 additional dimensions of personality: Persistence, self-directedness, cooperativeness and self-transcendence. These additional measures were included based on "a synthesis of information about social and cognitive development and descriptions of personality development in humanistic and transpersonal psychology" (Cloninger, Svrakic, and Przybeck 1993).

neurotransmitters such as dopamine and serotonin in the brain. Hamer argued that the increased levels of these neurotransmitters in the brain might foster sensations similar to those of mystical experience. Hamer found that possessing certain variants of the VMAT2 gene had a significant positive association with self-transcendence. However, to date, Hamer's finding has not been successfully replicated.

The other study to link a candidate gene to self-transcendence was done by Comings and colleagues (2000), who explored whether variation in the 48-Repeat variant of the DRD4 gene is associated with increased levels of self-transcendence. Like VMAT2, the DRD4 gene plays a role in regulating levels of dopamine in the brain. In humans the DRD4 gene is located at the 11q15.5 region of the genome. Variation in the 48-Repeat base pair region of the DRD4 gene has been associated with the trait "Novelty Seeking," an item of the TCI that measures the inherent activation or initiation of behaviors linked to responses to novelty, impulsivity, extravagance in approach to reward cues, loss of temper, and avoidance of frustration. However, a meta-analysis done by Munafò and colleagues (2007) found no significant association between novelty-seeking and variation in the 48-Repeat base pair region of the DRD4 gene. Comings found a significant positive association between variation in the 48-Repeat base pair region of the DRD4 gene and self-transcendence. Like Hamer's study, there has been no successful replication of the finding.

Because of the lack valid consistent evidence from molecular genetic studies of religiosity, twin studies provide evidence for the genetic etiology of religiosity, despite some criticisms of these type of studies (see Barnes et al. 2014 for a description of the criticisms of twin studies). Most studies that have examined the heritability of religiosity during adolescence and adulthood separately find heritability to be very small during adolescence, ranging from 0% to 22%, and much higher during adulthood, ranging from 27% to 62% (Boomsma et al. 1999; Bradshaw and Ellison 2008; D'Onofrio et al. 1999; Eaves et al. 2008; Koenig et al. 2005; Koenig, McGue, and Iacono 2008; Winter et al. 1999). Despite the number of

studies that have looked at the heritability of religiosity during adolescence and adulthood separately, only three studies have examined the change in heritability across the life course (Button et al. 2011; Koenig et al. 2005, 2008). Like the previous studies that examined the heritability of religiosity at only one-time point, these studies find that the heritability of religiosity increases significantly between adolescence and adulthood. For example, Button and Colleagues (2011) explored the etiology of religious change, measured as religious values and religious attendance, in a mixed-sex group of twins where measures of religiosity were taken at ages 12-18 and ages 17-29. The researchers find that heritability of religious values increases from 29% during the age 12-19 assessment to 41% in during the age 17-29 assessment; and the heritability of religious attendance increases from 9% in during the 12-18 assessment to 34% in during the age 17-29 assessment. Overall, these studies reveal that genes play a significant role in the religiosity of adults and little or no role in the religiosity of adolescents.

THE GENETIC ETIOLOGY OF SUBSTANCE USE BEHAVIORS

Tobacco Use. The most studied area in regards to the genetic etiology of substance use behaviors is the body of literature exploring the genetic etiology of tobacco use (Treutlein and Rietchel 2011). The earliest success in this area came from behavioral genetic studies involving twins. Twin studies that explored the genetic etiology of tobacco use consistently found non-trivial heritability for tobacco use. For example, McGue, Elkins and Iacono (2000) reported heritability for tobacco use that range between 40% and 60%.

In addition to behavioral genetic studies (i.e. twin studies, adoption studies) exploring the genetic etiology of tobacco use, molecular genetic studies have identified specific genetic polymorphisms associated with tobacco use. One type of molecular genetic study is known as a linkage study. Linkage studies seek to identify physical segments of the genome that are related to a particular

trait. Over the years linkage studies have revealed specific areas of the human genome that are specifically related to tobacco use. For example, a linkage study by Li (2008) identified thirteen regions located in chromosomes 3-7, 9-11, 17, 20 and 22 which show strong evidence of association with various smoking-related phenotypes.

In addition to linkage studies, Genome-wide Association Studies (GWAS) have been used to uncover the genetic etiology of a variety of phenomena. GWAS identify statistical associations between a specific type of genetic polymorphism, known as a single nucleotide polymorphisms (SNP), and a particular trait. Over the years GWAS have identified several SNPs that are associated with smoking behaviors. Many of these SNPs are associated with the metabolism of (or affinity for) nicotine, a stimulant drug that is found in tobacco. For example, GWAS meta-analyses have confirmed that the genetic polymorphisms in the region of chromosome 19, which codes for *CYP2A6*, an enzyme related to the metabolism of nicotine to cotinine, are related to the number of cigarettes smoked per day (Schoedel et. al 2004).

While linkage studies and GWAS link specific regions of the genome or genetic polymorphisms to tobacco use, these findings are largely inconsistent across studies. The most consistent finding in regards to the genetic etiology of tobacco use is the association between tobacco use and a set of genes known as the nicotinic acetycholine receptor (nAChR) genes, located in the 15q25 chromosomal region of the human genome. nAChR genes moderate the effect of nicotine on the brain through the subunits that make up the nAChRs. Each subunit is coded by an individual nAChR gene and the various subunits have differing affinities for nicotine. Nicotine, like other drugs, increases the concentration of dopamine (DA) in the nucleus accumbens (NAc), a region of the brain linked to positive reinforcement in learning tasks as well as to impulsive behaviors (Steinberg 2008), and also changes in mental state, mood, perception and behavior. Nicotine increases DA concentration in the NAc by first binding with the

nAChRs. This binding increases the firing rate of dopaminergic neurons in the midbrain ventral tegmental area (VTA), which causes the psychotropic effects of tobacco use. After a brief period, receptors desensitize and inhibitory GABAergic interneurons located in the VTA decrease dopaminergic neuron activity. Seven SNPs in nAChR genes have been consistently linked to variation in nAChR subunit affinity for nicotine. The most biologically plausible association found to date is the non-synonymous SNP rs16969968 in the CHRNA5 gene. Individuals with two copies of the minor "A" allele are twice as likely to have nicotine dependence compared to those who do not (Greenbaum and Lerer 2009). This mutation causes a substitution of the amino acid aspartic acid with the amino acid asparagine. The other six SNPs that have been consistently found to be associated with smoking-related phenotypes are: rs578776, rs1051730 and rs3743078 located in the gene CHRNA3; rs684513 and rs637137 located in gene CHRNA5; and rs3813567 located in gene CHRNB4 (Greenbaum and Lerer 2009).

To sum, a variety of methods have uncovered a genetic etiology for smoking behaviors. Linkage studies point to particular chromosomal regions linking chromosomal regions and tobacco use while GWAS have uncovered specific genetic polymorphisms predicting tobacco. One weakness of these studies is that their findings are somewhat inconsistent. However, twin studies have consistently uncovered a genetic etiology of tobacco use, though they do not identify specific genes or chromosomal regions.

Alcohol Use. The second largest body of literature exploring the genetic etiology of substance use behaviors is the body of research linking genetic factors and alcohol use. Dating back to the 1950's, studies using inbred mice strains have shown a significant difference in alcohol use due to genetic factors. Behavioral genetic studies estimate the heritability of alcohol dependence among humans to be between 40% and 60% in both males and females.

The prime candidates for genetic polymorphisms related to alcohol use are located in genes associated with the metabolism of alcohol. Most alcohol taken into the body is eliminated through a two stage process that occurs in the liver. The first stage of this process occurs when alcohol is converted into the chemical acetaldehyde by the enzyme alcohol dehydrogenase (ADH). This stage of the process is controlled by genes in the chromosomal region 4q22. The second stage occurs when acetaldehyde is oxidized to acetic acid by the enzyme aldehyde dehydrogenase (ALDH). This stage of the process is controlled by genes that code for ALDH, located the chromosomal region 12q24. In addition to these genetic polymorphisms, molecular genetic studies have consistently shown that possessing one or two copies of the "A" allele of non-synonymous SNP rs1229984, located in the gene ADH1B (also known as ADH2) has a preventive effect against alcoholism. The "A" allele of rs1229984 leads to a substitution of the amino acid histidine arginine for the amino acid histidine. Similarly, the 504lys allele of the ALDH2 gene, a mitochondrial gene, has been linked to lower levels of alcohol use. Both variants lead to higher levels of acetaldehyde in the body which cause adverse physical effects such as facial flushing, nausea, headache and rapid heartbeat after drinking. These effects are likely the chief mechanisms linking the genetic variants to lower alcohol use.

Thus, the evidence for the genetic etiology of alcohol use is substantial, but less voluminous than the genetic etiology of tobacco us. However, like tobacco use, GWAS identify specific genetic factors, but provide inconsistent findings. Also like tobacco use, twin studies provide consistent findings, but do not identify specific genetic factors.

BEHAVIORAL DISINHIBITION AND THE COVARIANCE OF RELIGIOSITY AND SUBSTANCE USE BEHAVIORS

The best candidate for an underlying genetic mechanism linking religiosity and substance use behaviors is a concept known as "behavioral disinhibition". Behavioral disinhibition is an umbrella term

used to refer to a genetic liability for substance use behaviors and externalizing behaviors. Behavioral disinhibition is relevant to research exploring the etiology of the covariance between religiosity and substance use behaviors because having lower levels of religiosity has been conceptualized as a form of risk-taking behavior. Miller and Stark (2002) argue that males are typically less religious than females largely due to their greater propensity to engage in risk-taking (impulsive) behaviors compared to females. Extending this argument, behavioral disinhibition drives individuals towards lower levels of religiosity while simultaneously driving individuals towards higher levels of substance use behaviors. Evidence for this hypothesis comes from the fact that during the transition from adolescence to adulthood, levels of religiosity among individuals tend to reach their lowest levels of the life course (Uecker et al. 2007) while levels of substance use behaviors tend to reach their highest levels (Johnston et al. 2011). This is simultaneous with an increase in the genetic component of the covariance between religiosity and substance use behaviors (Kendler and Myers 2009).

Both twin studies and candidate gene studies reveal evidence for the existence of behavioral disinhibition. Twin studies reveal the heritability of behavioral disinhibition to be approximately 80% (Krueger et al. 2002; Young et al. 2000). In addition, Hendershot and colleagues (2011) find that the cholinergic muscarinic receptor 2 gene (CHRM2), which codes for a muscarinic acetylcholine receptor subtype, is associated with latent measures of substance use and overall behavioral disinhibition. The muscarinic acetylcholine receptor subtype encoded by CHRM2 (M2 receptors) serve diverse functions, including inhibition of adenylate cyclase activity, modulation of potassium channels, and regulation of acetylcholine release and dopamine signaling (Volpicelli and Levey 2004; Threlfell et al. 2010; Woolf and Butcher 2011).

Thus, there is strong evidence that a common set of genes underlies the association between religiosity and substance use behaviors. This evidence largely comes from research on behavioral

disinhibition, an underlying genetic liability for substance use behaviors and risk-taking behaviors. Applying Miller and Stark's conceptualization of declines in religiosity as a form of risk taking behaviors, there is a strong likelihood that a common set of genetic factors influence both substance use behaviors and declines in religiosity. This leads me to my first hypothesis (H1) which is that *genetic factors at least partially explain the covariance between religiosity and substance use behaviors.*

VARIATION IN THE PROPORTION OF THE COVARIANCE OF RELIGIOSITY AND SUBSTANCE USE BEHAVIORS DUE TO GENETIC FACTORS

Genetic Factors. While there is strong evidence for a genetic component of the covariance between religiosity and substance use behaviors, it is likely that this genetic component increases between adolescence and early adulthood. Evidence for this comes from research that shows that the proportions of the variance due to genetic factors for both religiosity and substance use behaviors are smaller during adolescence compared to early adulthood. As a result, if a common set of genetic factors influence both religiosity and substance use behaviors then it is likely that the influence of the genetic factors will be smaller during adolescence compared to early adulthood. This leads me to the second (H2) hypothesis of this study which is that *there is a significant increase in the proportion of the covariance between religiosity and substance use behaviors due to genetic behaviors between adolescence and early adulthood.*

Table 1.4 Descriptive Statistics						
	Full Sample (Pairs=358)		MZ Twin Pairs (Pairs=136)		DZ Twin Pair (Pairs=222)	
Variable	Mean (S.D)/%	Min-Max	Mean (S.D)/%	Min-Max	Mean (S.D)/%	Min-Max
Male	0.50	0-1	0.49	0-1	0.50	0-1
Adolescence (Aged 12-18)						
Age	15.56 (1.56)	12-18	15.72 (1.45)	13-18	15.46 (1.62)	12-18
Attendance at Religious Services	1.66 (1.22)	0-3	1.71 (1.21)	0-3	1.63 (1.23)	0-3
Religious Salience	1.93 (1.11)	0-3	2.02 (1.05)	0-3	1.88 (1.15)	0-3
Participation in Religious Activities	1.12 (1.25)	0-3	1.29 (1.30)	0-3	1.02 (1.21)	0-3
Smoking	5.41 (10.61)	0-30	5.37 (10.79)	0-30	5.44 (10.51)	0-30
Alcohol Use	1.17 (1.50)	0-6	1.11 (1.53)	0-6	1.20 (1.49)	0-6
Early Adulthood (Aged 25-32)						
Age	28.43 (1.62)	25-32	28.60 (1.57)	25-32	28.32 (1.64)	25-32
Attendance at Religious Services	1.20 (1.06)	0-3	1.39 (1.10)	0-3	1.09 (1.02)	0-3
Religious Salience	1.37 (0.90)	0-3	1.49 (0.91)	0-3	1.31 (0.89)	0-3
Participation in Religious Activities	0.45 (0.87)	0-3	0.56 (0.96)	0-3	0.38 (0.80)	0-3
Smoking	8.52 (12.77)	0-30	7.06 (12.07)	0-30	9.42 (13.13)	0-30
Alcohol Use	2.57 (1.80)	0-6	2.24 (l.83)	0-6	2.77 (1.75)	0-6

N=Number of Non-Missing Cases in Full Sample

MZF=Monozygotic (Identical) Female Twin Pairs; DZF=Dizygotic (Fraternal) Female Twin Pairs; MZM=Monozygotic (Identical) Male Twin Pairs; DZM=Dizygotic (Identical) Male Twin Pairs;

DZO=Monozygotic (Identical) Male-Female Twin Pairs

DATA AND MEASURES

Add Health. The data for these analyses come from Wave I and Wave IV the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative longitudinal survey of adolescents and young adults obtained from an initial in-school survey of middle- and high school students conducted from September 1994 to April 1995. In total, 90,118 adolescents who attended 80 high schools and 54 feeder schools (both public and private) took part in the initial interview. During the months of April through December 1995, a sample of the in-school respondents (stratified by gender and grade) were selected to participate in an in-home face-to-face interview (Wave I). These respondents have been followed up three times over the past 15 years for a total of four waves of in-home data collection.

Analytic Sample. All the data for these analyses come from the sibling sub-sample of Add Health. The Add Health study oversampled twin pairs identified in the in-school survey, and this sample design enables these analyses. Respondents who reported during Wave I that they had a full sibling or a twin were included in the pairs roster, and of the 3,139 pairs who were asked, 83 percent (n = 2,612) agreed to take part in the study. Any respondents who were singletons (i.e. had no sibling) were not included in my analyses. To avoid the potential of biased estimates of heritability of genetic covariance due to racial confounding. the sample was confined to white respondents. Cases were also not included in the analysis if they had missing values for substance use during either Wave I or Wave IV. Lastly, in order to compare individuals who were adolescents during Wave I and early adults who had transitioned out of their parental homes by Wave IV, cases were also dropped if the respondent was older than 18 years old during Wave I and had not transitioned out of their family home by Wave IV. This leaves a total analytic sample that includes 358 cases. The total analytic sample includes 136 monozygotic twin pairs and 222

dizygotic (fraternal) male-female twin pairs. The analytic sample is 50% male and the twins in the analytic sample range from age 12 to 18 during adolescence and 25 to 32 during Wave IV.

Representativeness. One criticism of Twin models is that they are not representative of the general population. This criticism is largely due to research that has found that twins tend to differ from the general population in in a number of ways. For example, twins tend to be born of lower birth weight than singletons (Martin, Hamilton, and Osterman 2012). Also, twins tend to score a few points lower on standardized IQ tests (Voracek and Haubner 2008). In addition, twins are more likely to be born to older parents compared to singletons (Martin, Hamilton, and Osterman 2012). However, studies have explored whether or not twins systematically differ from singletons on a range of antisocial behaviors and antisocial personality traits (see Moffitt 2005). In regards to Add Health specifically, Barnes and Boutwell (2013) found that the subpopulation of twins available in the Add Health data was statistically representative of the broader and nationally representative sample of singletons on most measures of personality development, behavioral tendencies, and social outcomes. And like previous studies, they also found no significant difference between twins and singletons in regards to antisocial behaviors.

Substance Use Behaviors. As Table 1.4 indicates, all of the measures I use for my analyses are taken at both Wave I and Wave IV. For my analyses I utilize two measures of substance use behaviors as dependent variables: Frequency of smoking and frequency of alcohol use. Frequency of smoking is a measure based on the question, "During the past 30 days, how many days did you smoke cigarettes." This is a count variable, ranging from 0 to 30. Table 1.4 indicates that the mean level of smoking during adolescence is approximately 5.5 days out of the last 30 days, while the mean level of smoking during early adulthood is approximately 8.5 days out of the last 30 days. Frequency of alcohol use is a measure based on the question, "During the past 12 months on how many days did you drink alcohol". This variable ranges from 0 indicating "no days", and 6 indicating "every day or almost every day." Table 1.4

indicates that the means level of alcohol use during adolescence is 1 to 2 days, while the mean level of alcohol use during early adulthood is 3 to 12 days in the past 12 months.

Religiosity. The concept of religiosity has been notoriously hard to define over the years. The general consensus among scholars of religion is that religion is a multi-dimensional concept; though there is no consensus on the precise number of dimensions. For parsimony within my analyses I focus on one dimension of religiosity known as religious involvement. I borrow my conceptualization of religiosity from the work of Kogan and colleagues (2005) who describe religious involvement as an overarching concept that influences an individual's religious beliefs and behaviors. For my analyses I utilize a measure of religiosity as my independent variable. This measure of religiosity is a latent construct that I estimate using 3 indicator variables taken at each wave: Attendance at religious services, participation in religious activities, and religious salience/importance. The first indicator variable, attendance at religious services, is an ordinal variable based on the question, "In the past 12 months, how often did you attend religious services?" Responses range from 0 to 6 with 0 indicating "no attendance" and 6 indicating "more than once a week. The second indicator variable, religious salience, is a measure based on the question, "How important is religion to you?" Responses to this question were coded into two variables that range from 0 to 3 with 0 indicating a response of "not important at all" and 3 indicating "very important". Lastly, the third indicator variable, participation in religious activities, is an ordinal measure based on the question, "Many churches, synagogues, and other places of worship have special activities outside of regular worship services--such as classes, retreats, small groups, or choir. In the past 12 months, how often have you taken part in such activities?" Responses range from 0 to 6 with 0 indicating "no attendance" and 6 indicating "more than once a week". The Cronbach's Alpha for the religiosity measure is 0.81 during adolescence and 0.77 during early adulthood.

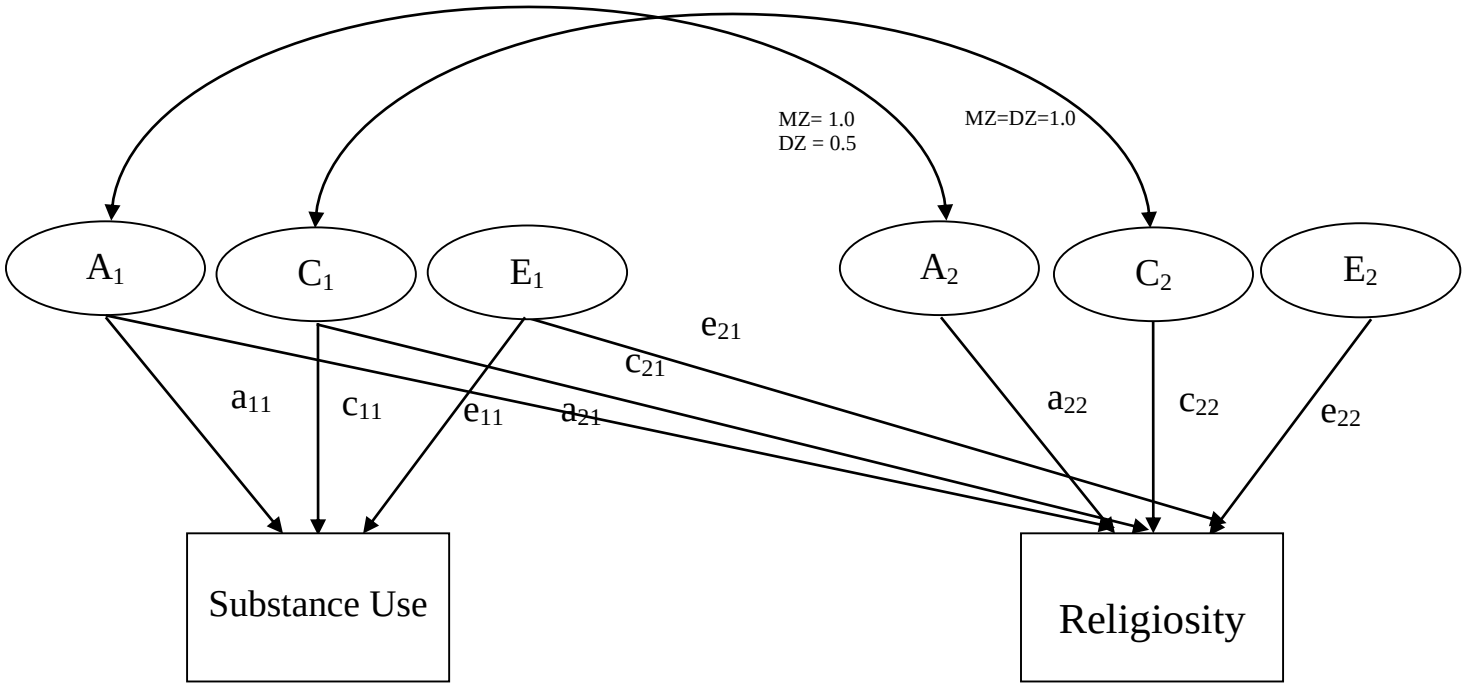
The latent religiosity variable utilized in my analyses is based on a similar latent variable that was utilized by Kogan and colleagues (2005) who used it to uncover risk and protective factors for substance use among African American high school dropouts. The coefficient of the first indicator, attendance at religious services, is constrained to 1 to ensure that the model is identified. In regards to the other two indicators, both religious salience and attendance at religious activities have a positive association with the latent religiosity variable. For interpretation purposes the latent religiosity variable was normalized so that it has mean of 0 and a standard deviation of 1. As a result, a 1-unit change in the latent religiosity variable corresponds to a 1 standard deviation change in that variable.

Summary of Findings from Table 1.4. Table 1.4 shows mean levels of age, religiosity indicators and substance use behaviors for adolescence and early adulthood across twin types and between adolescence and early adulthood. According to Table 1.4 monozygotic twins are slightly older, are slightly more religious and use substances slightly less than dizygotic twins. In addition, respondents tend to be more religious during adolescence compared to early adulthood and tend to use substances at a higher level during early adulthood compare to adolescence. Difference of means tests (available upon request) indicate that the differences shown in Table 1.4 are all significant at the 0.05 level. These differences match previous research which finds that religiosity significant drops between adolescence and early adulthood (Uecker et al. 2007) and that substance use increases from adolescence to early adulthood (Johnston et al. 2014).

Table 2.4: Bivariate Twin Correlations						
Adolescence (Aged 12 – 18)						
	Monozygotic Twins (N=241)			**Dizygotic Twins (N=394)**		
	Religiosity	Smoking	Alcohol Use	Religiosity	Smoking	Alcohol Use
Religiosity	1.000			1.000		
Smoking	-0.238***	1.000		-0.188***	1.000	
Alcohol Use	-0.169**	0.411***	1.000	-0.168**	0.470***	1.000
Early Adulthood (Aged 25-32)						
	Monozygotic Twins (N=241)			**Dizygotic Twins (N=394)**		
	Religiosity	Smoking	Alcohol Use	Religiosity	Smoking	Alcohol Use
Religiosity	1.000			1.000		
Smoking	-0.245***	1.000		-0.250***	1.000	
Alcohol Use	-0.236***	-0.048	1.000	-0.285***	0.082	1.000

Bivariate Twin Correlations. Table 2.4 presents the bivariate correlations for religiosity and substance use behaviors across wave for monozygotic and dizygotic twins. Table 2.4 indicates that religiosity is negatively associated substance use behaviors for both monozygotic and dizygotic twins during both adolescence and early adulthood. During adolescence the correlation between religiosity and smoking seems to be significantly larger for monozygotic twins (r=-0.238) compared to dizygotic twins (r=-0.188). Also, during early adulthood the correlation between religiosity and alcohol use is somewhat smaller for monozygotic twins (r=-0.236) compared to dizygotic twins (r=-0.285). Also, there does not appear to be a significant correlation between smoking and alcohol use during early adulthood.

Figure 1.4: Bivariate Cholesky Decomposition Model



ANALYTIC STRATEGY

To test my hypotheses, I utilize bivariate Cholesky Decomposition Models, illustrated in Figure 1.4. Cholesky Decompositions models utilize the comparison of intraclass cross-trait correlations of monozygotic and dizygotic twin pairs to estimate the effect of additive genetic effects (A), shared environmental effects (C) and unique environmental effects/measurement error (E) variables on the correlation of observed variables. The underlying assumptions of this model include: Intraclass correlations of 1.0 for additive genetic effects for monozygotic twins; no correlation between genetic effects and shared environments which leads to intraclass correlations of 1.0 for share environments for both monozygotic and dizygotic twins; and no correlations between unique environment and any other variance component. While these assumptions likely do not reflect nature perfectly, a study done by Visscher and colleagues (2006) find that, on average, these assumptions hold for random samples of twins.

One implicit assumption of our model is that our observed phenotypes are linear functions of the underlying latent variables A, C and E. Based on this assumption, our model yields the following two equations:

$$\text{Substance Use Behavior} = a_{11}A_1 + c_{11}C_1 + e_{11}E_1 \quad (1)$$

and

$$\text{Religiosity} = a_{21}A_1 + a_{22}A_2 + c_{21}C_1 + c_{22}C_2 + e_{21}E_1 + e_{22}E_2 \quad (2)$$

where a^{11}, c^{11} and e^{11} are the path coefficients estimating the effect of the variance components A1, C_1 and E_1 on measures of substance use behaviors; a^{22}, c^{22} and e^{22} are the path coefficients estimating the effect of the variance components A_2, C_2 and E_2 on measures of religiosity; and a^{21}, c^{21} and e^{21} are the

path coefficients estimating the effect of the variance components A_1, C_1 and E_1 on measures religiosity. Figure 1.4 yields the following 4 X4 expected covariance matrix:

Table 3.4: Expected Variance-Covariance Matrix for Bivariate Cholesky Decomposition Model

	Twin 1 **Relig$_1$**	**Twin 1** **P$_2$**	**Twin 2** **Relig$_1$**	**Twin 2** **P$_2$**
Twin 1 **Relig$_1$**	$a^2_{11}+ c^2_{11}+ e^2_{11}$			
Twin 1 **P$_2$**	$a_{11}a_{21} + c_{11}c_{21} + e_{11}e_{21}$	$a^2_{22}+ a^2_{21}+ c^2_{22}+ c^2_{21}+ e^2_{22}+ e^2_{21}$		
Twin 2 **Relig$_1$**	$\alpha * a^2_{11}+ c^2_{11}$	$\alpha * a_{11}a_{21} + c_{11}c_{21}$	$a^2_{11}+ c^2_{11}+ e^2_{11}$	
Twin 2 **P$_2$**	$\alpha * a_{11}a_{21} + c_{11}c_{21}$	$\alpha * a^2_{22}+ 1.0/0.5a^2_{21}+ c^2_{22}+ c^2_{21}$	$a_{11}a_{21} + c_{11}c_{21}+e_{11}e_{21}$	$a^2_{22}+a^2_{21}+c^2_{22}+c^2_{21}+e^2_{22}+e^2_{22}$

Note: The covariance estimates are estimated with the constant α which is 1.0 for MZ pairs and 0.5 for DZ pairs, reflecting the percentage of shared alleles.

Two key assumptions of bivariate Cholesky decomposition models, in addition to the ones described above, are that 1) the variables are logically ordered and 2) that variance components of trait 2 do not influence the observed values of trait 1. The ordering of the variables in this model is chosen based on previous research indicating the influence of substance use behaviors on religious decline (Uecker, Regnerus and Vaaler 2007; Bryant, Choi and Yasuno 2003; Benda and Toombs 2002). It should be noted that the ordering of the variables in the bivariate Cholesky decomposition model does not affect the fit of the model (Neale, Røysamb and Jacobson 2006).

All variables are created in Stata 13.0 and imported into the OpenMx package of the R software environment where the analyses were conducted. OpenMX uses FIML to account for missing data. Age is a covariate in each of the models.

Model Estimation. The models described above are estimated by maximum likelihood methods using OpenMx. OpenMx provides estimates for each model parameter by numerical search for the parameter values that minimize a function that is twice the difference between the likelihood of the data under the model to be tested and the likelihood for the perfectly fitting model. To compare each model, I utilize the Akaike Information Criterion (AIC). The AIC is calculated using the following equation:

$$AIC = 2k-2\ln(L) \quad (3)$$

where k is the number of parameters in the model and L is the MLE for the model. The model with the smallest AIC is deemed the model with the best fit. While the AIC is useful for comparing non-nested models, it has several drawbacks which include not having a distribution, which means difference tests can cannot be used to compare AICs. Also standard AICs are not applicable for small sample, so an adjustment for small samples (see Burnham and Anderson 2002 and Hurvich and Tsai 1989 for an explanation of the AICs for small samples) is necessary. However, overall, AICs are useful for the purposes of this paper**.**

Table 4.4: Proportion of Covariance due to Genetic (a^2), Shared Environmental (c^2) and Unshared Environmental Factors (e^2) during Adolescence (Aged 12 – 18) and Early Adulthood (Aged 25-32) (N=358 pairs)

	Adolescence (Aged 12 – 18)				**Early Adulthood (Aged 25-32)**			
Religiosity & Smoking	**AIC**	**a^2**	**c^2**	**e^2**	**AIC**	**a^2**	**c^2**	**e^2**
Cholesky ACE	**3643.690**	**0.55**	**0.40**	**0.05**	**4074.155**	**0.81**	**0.09**	**0.10**
Cholesky AE	3584.211	0.92	0.00	0.08	4075.514	0.88	0.00	0.12
Cholesky CE	3543.885	0.00	0.78	0.22	4079.281	0.00	0.62	0.38
Cholesky E	3830.65	0.00	0.00	1.00	4159.399	0.00	0.00	1.00
Religiosity & Alcohol Use								
Cholesky ACE	**1237.053**	**0.00**	**1.00**	**0.00**	1773.522	0.00	1.00	0.00
Cholesky AE	1275.941	0.92	0.00	0.08	**1767.873**	**0.51**	**0.00**	**0.49**
Cholesky CE	1238.046	0.00	1.00	0.00	1795.442	0.00	1.00	0.00
Cholesky E	1523.962	0.00	0.00	1.00	1863.103	0.00	0.00	1.00

Note: Non-significant p-values ($p > 0.05$) and low AIC (relative to other models) indicate acceptable model

Cell entries are: ACE model (containing genetic, shared environmental and nonshared environmental factors)/reduced model (shared environmental factor dropped)/reduced model (genetic factor dropped)/reduced model (genetic factor and shared environmental factor dropped).

Age is a covariate in each of the models.

RESULTS

Table 4.4 reveals a significant increase in influence of genetic factors on the covariance of religiosity and substance use behaviors between adolescence and early adulthood. First, Table 3.4 reveals that the best fitting model for the covariance of religiosity and smoking during adolescence is the full ACE model (AIC=3643.690). The proportion of the covariance of religiosity and smoking due to genetic factors (a^2) during adolescence is 55%. This proportion is much larger than the proportion of the correlation between religiosity and smoking due to genetic factors uncovered by Kendler and Myers (2009) which was around 38% between ages 15 to 17. Table 4.4 also reveals that during early adulthood the proportion of the covariance of religiosity and smoking due to genetic factors is 81%, which again, is much larger than the proportion of the correlation between religiosity and smoking due to genetic factors found during adulthood (a^2=58%) by Kender and Myers. Differences between his study and Kendler and Myers' studies may reflect differences in the sample and the effect of recall bias.

Table 4.4 also reveals that the proportion of the covariance of religiosity and alcohol use due to genetic factors also shows a significant increase. The best fitting model for the covariance of religiosity alcohol use during adolescence is the full ACE model (AIC=1237.053). For this model the shared environment explains the total covariance of religiosity and alcohol use. This may mean that the only factor that drives the relationship between religiosity and alcohol during adolescence is the family's collective beliefs about religion and alcohol use. Examining the covariance between religiosity and alcohol use, Table 3.4 reveals that the best fitting model is the AE model. The proportion of the covariance between religiosity and substance use behaviors is 0.51.

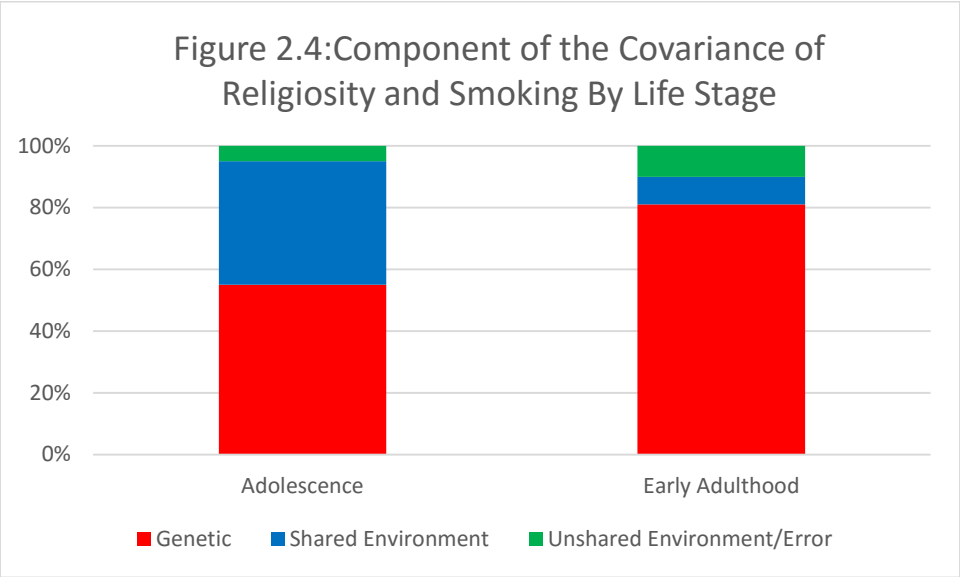


Figure 2.4:Component of the Covariance of Religiosity and Smoking By Life Stage
100%
80%
60%
40%
20%
0%
Adolescence
Early Adulthood
Genetic
Shared Environment
Unshared Environment/Error

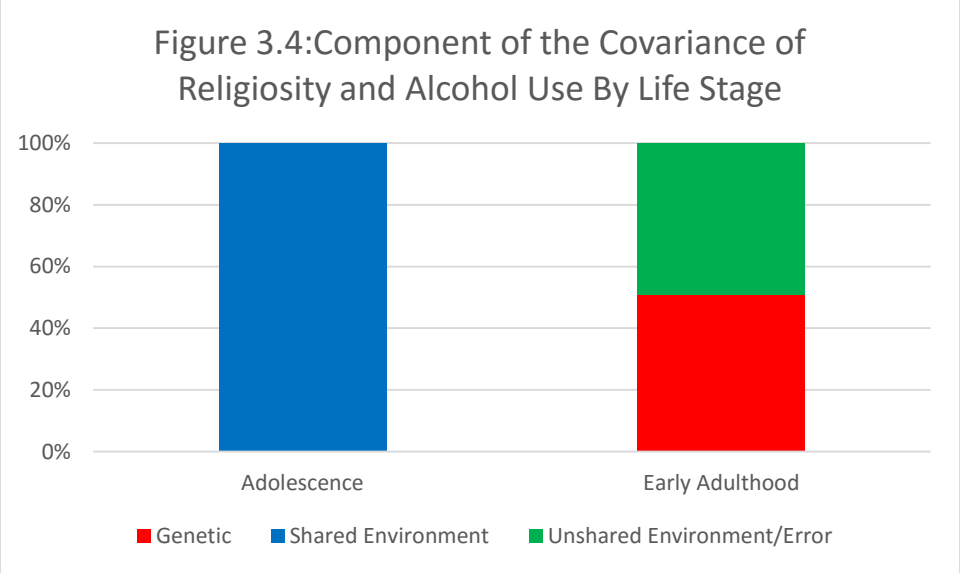


Figure 3.4:Component of the Covariance of Religiosity and Alcohol Use By Life Stage
100%
80%
60%
40%
20%
0%
Adolescence
Early Adulthood
Genetic
Shared Environment
Unshared Environment/Error

DISCUSSION

In my analyses I explored whether the proportion of the covariance between religiosity and substance use behaviors due to genetic factors increases from adolescence to early adulthood. To explain this increase I draw on research exploring behavioral disinhibition, an underlying genetic liability toward substance use behaviors and risk-taking behaviors. To explain the potential variation in the proportion of the covariance between religiosity and substance use behaviors due to genetic factors I draw on research exploring differences in the heritability of religiosity and substance use behaviors between adolescence and early adulthood. My argument is that desistance from religiosity, which typically happens between adolescence and early adulthood, is a form of risk-taking behavior. As a result, the increase in the heritability of religiosity and substance use behaviors that typically occurs concurrently with the decrease in religiosity and increases in substance use likely reflects an increase in behavioral disinhibition.

Overall, my findings indicate a significant increase in the proportion of the covariance between religiosity and substance use behaviors due to genetic factors between adolescence and early adulthood. This finding supports my main hypotheses which state that 1) there is a genetic component of the covariance between religiosity and substance use behaviors; and 2) the genetic component of the covariance between religiosity and substance use behaviors. During adolescence a little over ½ (55%) of the covariance between religiosity and smoking is due to genetic factors. The proportion increases by almost ½ (47%) between adolescence and early adulthood. Figure 2.4 illustrates this point clearly. Once individuals transition out of the family home the relationship between religion and smoking is largely due to common genes that influence both traits. Similarly, but to a greater extent, the covariance between religiosity and alcohol use increases from 0% during adolescence to 51% during early

adulthood. This finding is compatible with previous research that found that the heritability of both religiosity and substance use behaviors increases from adolescence to early adulthood.

These findings may indicate that during adolescence factors such religious beliefs within the family surrounding substance use; sanctions against substance use due to religious beliefs and religion-based norms within the family regarding substance use may have strong influence on an individual's substance use behaviors he or she lives in the family home. This influence wanes, however, once he or she transitions out of the family home into his or her own residence. And once they've transitioned out of the family home, his or her personal characteristics (i.e. risk-taking preference), that may be influenced by genetic factors, would have a greater influence on his or her substance use behaviors. Jeremy Freese (2008) described this phenomenon with his concept of a "phenotypic bottleneck". According to Freese, genes influence behavior and subsequent outcomes (almost) exclusively via their effects on individual-level characteristics.

*Limitations***.** A key limitation of this study is the fact that the sample consists entirely of individual's who self-identify as non-Hispanic White. While limiting the sample to Whites attenuated the risk of behavioral disinhibition, it means that our findings cannot be generalized to non-White populations. In addition, underlying assumptions of twin models often call their validity into question. The violation of one assumption in particular could significantly bias these results. The equal environments assumption, which is the assumption that the environments of monozygotic twins are no more or less similar than dizygotic twins allow us to identify our models by holding the correlation in both shared environments for by monozygotic twins and dizygotic twins to 1.0. A violation of this assumption would not only make it impossible for us to identify our models, it would also call into question validity of the twin method itself. However, studies have tested this assumption using misidentified twins (e.g. dizygotic twins identified as monozygotic twins) and from these studies there is

little evidence that the assumption is violated in most analyses or that any violations biased results (Evans and Martin 2000).

Directions for Future Research. For future research, this analysis should be replicated using a larger more representative sample with a larger number of substance use phenotypes. For example, David Brizer (1993) found that attendance at religious services has a significant negative association with prescription drug abuse. In addition, Schepis and Krishnan-Sarin (2008) found that prescription drug abuse is associated with risk-taking. As a result, it is likely that a similar set of genes influence both religiosity and prescription drug abuse.

In addition, in future research I will also explore alternative models in addition to the bivariate Cholesky decomposition models. I conceptualize behavioral disinhibition as an over-arching genetic disposition that influences the genetic component of the variance of both religiosity and substance use behaviors; thus, the Cholesky decomposition model tests whether or not the genetic components of one trait (i.e. substance use behaviors) influences the phenotype of another trait (i.e. religiosity). An alternative test a common pathway model. Studies such as a 2000 study by Young and colleagues titled, "Genetic and Environmental Influences on Behavioral Disinhibition", utilized the common pathway to explore whether or not behavioral disinhibition partially or total explained the covariance of attention deficit hyperactivity disorder (ADHD), conduct disorder (CD), substance use behaviors (SUB) and novelty seeking (NS). A future study could include religious decline along with the other disorders and test whether or not the common pathway model, bivariate Cholesky decomposition model, or another model (i.e. independent pathway model) best explains the genetic covariance of those traits.

Also, because it has been revealed that genes associated with smoking and alcohol use are also associated with religiosity, candidate genes for studies exploring the genetic etiology of religiosity can be identified from studies that find genetic associations for smoking and alcohol use phenotypes. For

example, genes associated with the coding of nicotinic acetylcholine receptors (nAchRs) could be explored for possible associations with religiosity phenotypes, in particular attendance at weekly religious services. In addition, while genes shared with smoking and alcohol use phenotypes explained some of the increase in the heritability of religiosity from adolescence to early adulthood, a significant amount of the variance in religiosity in religion due to genes is yet to be uncovered. Another set of phenotypes that may share genes with religiosity are personality phenotypes. Studies find that various personality traits, in particular agreeableness and conscientiousness, are correlated with religiosity (Emmons et al. 2008; Wink et al. 2007).

Lastly, future studies should explore variation in the association between religiosity and substance use behaviors across multiple dimensions of religiosity. While I chose to conceptualize religiosity as an overarching concept influencing both behaviors and beliefs, future studies may treat beliefs and behaviors as separate dimensions. For example, Bradshaw and Ellison (2008) measured religiosity as four factors based on eight separate indicators. Previous research reports a significant inverse association between religiosity and substance use behaviors regardless of the measure of religiosity utilized in the analysis, findings that suggest my findings would be robust to different measurement strategies for religiosity.

CHAPTER 5: CONCLUSIONS AND IMPLICATIONS

CONCLUSIONS

This dissertation highlights the need to explore variation in the association between religiosity and substance use behaviors. Previous studies have treated the association between religiosity and substance use behaviors as a static relationship that functions in a similar fashion across all subgroups the of the U.S. population and across he life course. The finding of this dissertation have subsequently called this treatment into questions. Specifically, I find that 1) the association between religiosity and substance use behaviors varies across family status; 2) the association between religiosity and smoking is stronger for individuals in "traditional" family statuses; and 3) genetic factors inflate the association between religiosity and substance use behaviors during early adulthood.

Based on these findings I have drawn three major conclusions. First, it is likely that the association between religiosity and smoking has been attenuating over time and will continue to attenuate into the future. I base this conclusion on the fact that individuals with the association between religiosity and smoking is stronger among traditional family statuses (e.g. married parents), and these family statuses are currently in decline within the U.S. For example, according to data from the Department of Health and Human Services (2012) rates of cohabitation increased from 3% in 1982 to 11% in the 2006-2010 timeframe. In addition, age at first marriage increased significantly for both males and females during that sample time period. If the proportion of individuals within U.S. society who have "traditional' family statuses continues decline, then the relative weakness of the association between religiosity and smoking among individuals with non-traditional statuses will become the norm.

The second major conclusion I draw from my empirical findings it that the mechanisms that lead to variation in the association between religiosity and smoking differs from the mechanisms that lead to variation in the association between religiosity and alcohol use. The is largely evident from the fact that 1) family status moderates the association between religiosity and smoking and not the association between religiosity alcohol use; and 2) life stage moderates the association between religiosity and alcohol use and not the association between religiosity and smoking. Based on my understanding of the literature on the association between religiosity and substance use behaviors and the moral communities thesis I posit that the expanded version to Rodney Stark's Moral Communities thesis explains the variation between religiosity and smoking; but not the association between religiosity and alcohol use. I base this supposition on the fact that studies show that individuals with traditional family statuses; in particular married parents; are more likely to be members of religious congregations than individuals with non-traditional family statuses (Stolzenberg, Blair-Joy, and Waite 1995). Conversely, there is no compelling evidence that the level of religiosity of the contexts that individuals inhabit differs between adolescence and early adulthood. One possible mechanism that that could explain variation the association between religiosity and alcohol use between adolescence and early adulthood is the greater stigma the accompanies smoking compared to alcohol use. While legal and familial factors may limit alcohol use during adolescence (e.g. laws against sell of cigarettes and alcohol to minors; family rules regarding smoking and alcohol use; family norms surrounding smoking and alcohol among youth), during early adulthood smoking remains stigmatized (e.g. restrictions on where individuals can smoke) and alcohol becomes normative for a large proportion of the population. As a result, religion becomes the primary determinant of whether or not an individual use alcohol (e.g. religious prohibitions on alcohol use among Mormons; the use of alcohol in religious ceremonies among Catholics) and only one determinant among several of whether or not and individuals chooses to smoke.

A third major conclusion based on my empirical findings is that the influence of genetic factors on religiosity and substance use behaviors likely inflates the association between those two traits during early adulthood. Similar to a study by Kendler and Myers (2009) I find that genetic factors explain little or none of the covariance of religiosity and substance use behaviors during adolescence and most or all of the covariance in religiosity and substance use behaviors during early adulthood. These findings may indicate that during adolescence factors such religious beliefs within the family surrounding substance use; sanctions against substance use due to religious beliefs and religion-based norms within the family regarding substance use may have strong influence on an individual's substance use behaviors he or she lives in the family home. This influence wanes, however, once he or she transitions out of the family home into his or her own residence. And once they've transitioned out of the family home, his or her personal characteristics (i.e. risk-taking preference), that may be influenced by genetic factors, would have a greater influence on his or her substance use behaviors. Jeremy Freese (2008) described this phenomenon with his concept of a "phenotypic bottleneck". According to Freese, genes influence behavior and subsequent outcomes (almost) exclusively via their effects on individual-level characteristics.

IMPLICATIONS.

Implications for Future Research. One major implication that this dissertation has for future research on the association between religiosity and substance use behaviors is that it reveals the need to measure religiosity and the contextual level as well as the individual-level. While the theories that I put forward specifically mention contextual religiosity, there are no measures of contextual religiosity within Add health beyond Wave II, which prevents me from controlling for contextual religiosity in my analyses since that utilize data from Waves III and Wave IV. Beyond Add Health there are few studies

with measures of religiosity and the community-level. One major obstacle to obtaining religiosity data at the community level is that the U.S. census is not allowed to measure religiosity. As a result, any community-level religiosity data has to be obtained by non-governmental funds. One such effort is the U.S. Religion Census conducted by the Association of Statisticians of American Religious Bodies (ASARB). The ASARB collected data on data on the number of congregations and adherents for 236 religious groups in each county of the United States. They obtained the data by sending invitation to participate in the study was sent to every U.S. religious body listed in *the Yearbook of American and Canadian Churches* and having the offices the religious groups that are contacted to compile the data. Future studies exploring variation in the association between religiosity and substance use behaviors should attempt to link county-level religion data to uncover if it is in fact the proportion of co-religionists within a community that leads to variation in the association between religiosity and substance use behaviors.

Another major implication that this dissertation has for future research on the association between religiosity and substance use behaviors is that it elucidates the need to take into account life stage when interpreting results of studies exploring the relationship between religiosity and substance use behaviors—and possibly religion and health more generally. For example, if we wish to replicate findings from a study exploring the association between religion and substance use across samples, we must ensure that the samples are approximately the same age. If we do not, we cannot reliably interpret a lack of replication as evidence that our original finding was invalid. For future research, whenever possible, we should explore whether or not the association between religion and substance use—and religion and health in general—functions similarly at different stages of the life course. The finding also calls into question the use of samples which include individuals of vastly different ages.

A third implication that this dissertation has for future research exploring the association between religiosity and substance use behaviors is that it reveals the need to account for genetic factors

when we are trying to obtain the "true" estimate of the association between religiosity and substance use behaviors. This dissertation, along with a previous study by Kendler and Myers (2009), reveals that at least a portion of the covariance of religiosity and substance use is the result of common genetic factors. This means that any studies that do not account for genetic factors when estimating the association between religiosity and substance use behaviors are overestimating the actual association between these two phenomena.

One way to remedy this problem is to utilize sibling fixed-effect models that account for genetic and shared environmental influence on the association between religiosity and substance use behaviors of Genetic Risk Scores based on GWAS results. Sibling fixed-effects methods have long been used in in economics to control for unobserved variability in independent variables that is not otherwise accounted for in their model. The basic logic behind the method is that since siblings share many characteristics such as having the same parents, sharing many (or all) of the same genes, growing up in the same family, etc.; then using the differences in the values of the dependent variable, independent and covariates in the model will controls for many of the factors that could confound the estimates of the model. Twins in particular are useful for these types of analyses because they share the antenatal environment, are the same age and in the case of monozygotic twins share the same genes (Kohler, Behrman and Schnittker, 2011).

A genetic risk score (GRS) is the most straightforward way to adjust for genetic effects within sociological research. Genes found to be associated with variables of interest or covariates within a model can be included in a GRS to control for the possibility that a perceived relationship between those variables and the dependent variable is due to a spurious relationship caused by the pleiotropic (common genetic) effects. The simplest GRS's consist of summed scores of identified genetic variants which are weighted based on the effect size of the genetic variant on an outcome. Gene candidates

used in GRS's can be identified using GWAS or candidate gene studies. Generally, GRS scores are validated in different samples than they are generated in to avoid over gross fitting (Vrieze et. al. 2013). For example, Belsky and colleagues (2012) used 32 SNPs from an independent sample to generate a GRS for obesity in a separate sample. They found that individuals with higher GRS's were more likely to be chronically obese during adulthood. In addition, they found that the GRS were able to explain roughly 2% of the variance in BMI in their study. Similar studies can help researchers gain a deeper understanding of the ways in which genetic factors influence the association between religiosity and substance use behaviors.

Implications for Public Health. To date most research exploring the association between religiosity and substance use behaviors has treated the association as invariant across sub-populations of the U.S. and static across time. The results of this dissertation reveals that this treatment of the association between religiosity and substance use behaviors obscures the actual nature of the association. This dissertation has reveals that the association between religiosity and substance use behaviors varies across family status; varies between adolescence and early adulthood, and is partially driven by genetics.

First, at the macro-level if we do not gain a better understanding of the association between religiosity and substance use behavior then we will likely ignore non-associations and positive associations between religiosity and substance use behaviors across sub-populations of U.S. society and at different stages of the life course. For example, the CDC identifies tobacco-related disparities across racial/ethnic groups; among the LGBT community, and among people with low socio-economic status. Similarly, if there is a religious group where substance use behaviors are encouraged (e.g. marijuana use among Rastafarians) then then those groups can also be identified and policies can be put into place to mitigate the negative impact of substance use within those communities.

Second, because religion and spirituality continues to be a major part of the drug treatment programs such as Alcoholics Anonymous and Narcotics anonymous in the U.S. it is important to gauge the actual relationship between religiosity and substance use behaviors. If religiosity has positive association with substance use behaviors among some groups or at some stages of the life course, then the effectiveness of drug treatment programs may suffer as a result of the inclusion of religion. Future research should build on this dissertation and provide a more accurate view of the association between religiosity and substance use behaviors.

APPENDIX

Table 4.2: Comparison of Moderating Models for Full Model, Catholics Only Model and Conservative Protestant Only Model						
	Smoking Models			**Alcohol Use Models**		
	Catholic Only (N=2,280)	**Conservative Protestant Only (N=2,344)**	**Full Sample (N=9,322)**	**Catholic Only (N=2,280)**	**Conservative Protestant Only (N=2,344)**	**Full Sample (N=9,322)**
Religiosity, Wave IV	-0.393* [-0.750,-0.035]	-0.591*** [-0.850,-0.332]	-0.521*** [-0.711,-0.330]	-0.112 [-0.452,0.228]	-0.360*** [-0.555,-0.166]	-0.337*** [-0.485,-0.190]
Age	-0.155** [-0.247,-0.063]	-0.072 [-0.145,0.000]	-0.072** [-0.116,-0.028]	-0.160*** [-0.236,-0.083]	-0.146*** [-0.204,-0.088]	-0.116*** [-0.152,-0.081]
Male	0.382* [0.090,0.675]	0.124 [-0.147,0.396]	0.183* [0.041,0.324]	0.718*** [0.457,0.978]	0.441*** [0.239,0.644]	0.490*** [0.377,0.602]
Hispanic	-0.550*** [-0.866,-0.235]	0.016 [-0.744,0.776]	-0.496*** [-0.741,-0.252]	-0.344** [-0.573,-0.116]	-0.158 [-0.588,0.271]	-0.247** [-0.407,-0.087]
Black	0.241 [-0.253,0.735]	0.102 [-0.205,0.409]	-0.126 [-0.310,0.057]	-0.509 [-1.437,0.420]	0.024 [-0.275,0.323]	-0.309*** [-0.483,-0.136]
Asian	-0.049 [-0.511,0.412]	0.195 [-0.661,1.052]	-0.243 [-0.532,0.045]	-0.395* [-0.749,-0.041]	0.023 [-0.739,0.786]	-0.318* [-0.562,-0.075]
Other	0.107 [-0.438,0.652]	-0.131 [-0.630,0.368]	0.019 [-0.209,0.248]	-0.497 [-1.156,0.163]	-0.169 [-0.860,0.522]	-0.276 [-0.624,0.073]
Education, Wave III	-0.186** [-0.323,-0.049]	-0.373*** [-0.520,-0.226]	-0.315*** [-0.381,-0.250]	0.465*** [0.317,0.613]	0.324*** [0.157,0.491]	0.323*** [0.245,0.401]
Income, Wave III	-0.012 [-0.047,0.024]	-0.009 [-0.051,0.033]	-0.005 [-0.024,0.013]	0.019 [-0.020,0.058]	-0.005 [-0.034,0.023]	0.002 [-0.016,0.019]
Religiosity, Wave II	0.026 [-0.085,0.138]	0.091 [-0.027,0.209]	0.066* [0.006,0.126]	0.031 [-0.083,0.145]	0.093 [-0.016,0.203]	0.094** [0.027,0.161]
Smoking, Wave II	0.042*** [0.033,0.052]	0.046*** [0.037,0.055]	0.039*** [0.035,0.043]	-0.006 [-0.017,0.005]	0.002 [-0.010,0.014]	-0.001 [-0.007,0.004]
Alcohol Use, Wave II	0.070 [-0.013,0.153]	-0.001 [-0.074,0.073]	0.050* [0.009,0.091]	0.184*** [0.100,0.269]	0.169*** [0.077,0.262]	0.163*** [0.111,0.215]
Conservative Protestant, Wave III	---	---	0.113 [-0.038,0.265]	---	---	-0.243** [-0.387,-0.099]
Mainline Protestant, Wave III	---	---	-0.011 [-0.162,0.141]	---	---	0.066 [-0.066,0.198]
Catholic, Wave III	---	---	-0.022 [-0.186,0.143]	---	---	-0.037 [-0.199,0.125]
Other Protestant, Wave III	---	---	0.057 [-0.161,0.275]	---	---	-0.251** [-0.415,-0.086]
Non-Christian, Wave III	---	---	-0.068 [-0.245,0.109]	---	---	-0.007 [-0.194,0.180]
Delinquency, Wave III	0.019 [-0.031,0.068]	0.006 [-0.034,0.046]	0.039*** [0.017,0.061]	0.028 [-0.021,0.077]	-0.055* [-0.103,-0.007]	0.010 [-0.018,0.038]
Peer Substance Use, Wave III	0.272*** [0.161,0.383]	0.098 [-0.008,0.203]	0.131*** [0.081,0.181]	0.341*** [0.238,0.443]	0.396*** [0.301,0.491]	0.416*** [0.364,0.468]
Self-Control, Wave I	0.067 [-0.049,0.183]	0.035 [-0.064,0.133]	0.027 [-0.023,0.077]	0.126 [-0.016,0.267]	0.041 [-0.064,0.146]	0.058 [-0.001,0.118]
Parental Smoking	0.060 [-0.193,0.314]	0.146 [-0.151,0.444]	0.203*** [0.087,0.319]	-0.131 [-0.400,0.138]	-0.016 [-0.271,0.238]	-0.189** [-0.323,-0.055]
Parental Alcohol Use	-0.087 [-0.440,0.265]	0.112 [-0.140,0.364]	0.049 [-0.067,0.166]	-0.165 [-0.509,0.179]	0.072 [-0.232,0.376]	0.048 [-0.106,0.201]
Parental Religiosity	-0.063 [-0.189,0.064]	-0.157** [-0.261,-0.052]	-0.041 [-0.094,0.011]	0.034 [-0.106,0.175]	0.034 [-0.084,0.153]	0.001 [-0.067,0.069]
Family Status Change	-0.354** [-0.589,-0.119]	-0.341** [-0.564,-0.118]	-0.276*** [-0.392,-0.160]	-0.185 [-0.426,0.056]	-0.091 [-0.290,0.108]	-0.177** [-0.281,-0.073]
Married Non-Parent	-1.442*** [-2.132,-0.753]	-0.042 [-0.574,0.490]	-0.180 [-0.460,0.100]	0.101 [-0.455,0.657]	0.046 [-0.437,0.529]	-0.046 [-0.339,0.248]
Single Parent	0.621* [0.024,1.219]	-0.149 [-0.580,0.283]	0.109 [-0.142,0.361]	0.193 [-0.328,0.715]	-0.102 [-0.557,0.354]	0.116 [-0.178,0.410]
Single Non-Parent	-0.045	0.081	-0.048	0.302	0.047	0.309**

	[-0.499,0.409]	[-0.184,0.346]	[-0.213,0.116]	[-0.072,0.676]	[-0.333,0.428]	[0.095,0.524]
Cohabitating Parent	0.526 [-0.096,1.148]	0.221 [-0.248,0.690]	0.302* [0.021,0.582]	0.441 [-0.061,0.943]	-0.181 [-0.723,0.361]	0.174 [-0.134,0.482]
Cohabitating Non-Parent	0.457 [-0.051,0.966]	0.527** [0.135,0.918]	0.317** [0.080,0.554]	0.254 [-0.200,0.708]	0.341 [-0.285,0.966]	0.372* [0.088,0.657]
Religiosity*Married Non-Parent***	**-2.034*** [-2.935,-1.132]**	0.240 [-0.257,0.736]	0.123 [-0.173,0.418]	-0.438 [-0.918,0.041]	-0.181 [-0.520,0.159]	-0.195 [-0.437,0.048]
Religiosity*Single Parent	0.409 [-0.243,1.060]	**0.546** [0.183,0.910]**	**0.303* [0.025,0.581]**	-0.493 [-1.045,0.058]	-0.040 [-0.337,0.256]	0.063 [-0.178,0.304]
Religiosity*Single Non-Parent	-0.076 [-0.468,0.316]	0.112 [-0.194,0.418]	0.085 [-0.123,0.293]	-0.326 [-0.677,0.025]	-0.076 [-0.293,0.141]	-0.130 [-0.283,0.023]
Religiosity*Cohabitating Parent	-0.122 [-0.736,0.491]	**0.516** [0.144,0.887]**	**0.378* [0.071,0.686]**	0.397 [-0.040,0.834]	-0.058 [-0.516,0.399]	0.052 [-0.251,0.355]
Religiosity*Cohabitating Non-Parent	0.049 [-0.506,0.604]	**0.478* [0.058,0.898]**	**0.387** [0.127,0.647]**	0.387 [-0.115,0.889]	-0.283 [-0.712,0.146]	0.015 [-0.236,0.266]
Constant	4.767*** [2.989,6.545]	3.965*** [2.420,5.510]	3.695*** [2.739,4.650]			
Cut Point 1				-2.414** [-4.138,-0.690]	-2.374*** [-3.714,-1.033]	-1.865*** [-2.678,-1.052]
Cut Point 2				-1.839* [-3.568,-0.109]	-1.805** [-3.138,-0.471]	-1.263** [-2.072,-0.453]
Cut Point 3				-1.017 [-2.754,0.720]	-1.011 [-2.339,0.317]	-0.484 [-1.287,0.318]
Cut Point 4				-0.010 [-1.717,1.697]	-0.101 [-1.430,1.229]	0.398 [-0.396,1.193]
Cut Point 5				1.578 [-0.128,3.283]	1.303 [-0.078,2.684]	1.855*** [1.050,2.660]
Cut Point 6				3.992*** [2.225,5.759]	2.744*** [1.347,4.142]	3.515*** [2.680,4.351]
95% confidence intervals in brackets ** $p < 0.05$, **$p < 0.01$, *** $p < 0.001$ **Significant Interactions in Bold**						

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