2006

Relationships between Dimensions of Religiosity and Internalizing and Externalizing Psychiatric Disorders: A Twin Study

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Psychiatric Disorders: A Twin Study

A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy at Virginia Commonwealth University.

by

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M.S., Virginia Commonwealth University, 2005

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Virginia Commonwealth University
Richmond, Virginia
December, 2006

Acknowledgement

There are several people I would like to especially thank for their commitment to my development as a scientist and practitioner. First, thanks to my faculty advisor, Dace Svikis, for her support throughout my training at Virginia Commonwealth University. Thanks to Ken Kendler and Hermine Maes who graciously allowed me to use their data and were remarkably patient as I slowly became a student of behavior genetics. Thanks also to Ev Worthington, whose reputation first led me to VCU and who provided opportunities that will be part of my career for years to come. Finally, thanks to Jim McCullough, an exemplary supervisor who has been an inspiration to me in more ways than I can describe. I cannot repay each of you, but I will do my best to follow your examples and to pass it on.

This dissertation is dedicated to my wife Lisa and my children Miles and Ella. You make every day a good day. I love you.

Table of Contents

List of Tables

List of Figures

Abstract

RELATIONSHIPS BETWEEN DIMENSIONS OF RELIGIOSITY AND
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The present study estimated the genetic and environmental effects on different

dimensions of religiosity, explored how genetic and environmental effects covary across

different dimensions of religiosity, and decomposed the covariance of genetic and

environmental effects between different dimensions of religiosity and internalizing and

externalizing psychiatric disorders. Dimensions of religiosity were found to be largely

influenced by additive genetic and unique environmental effects, with little influence

observed from common environmental effects. Multidimensional analyses found that the

seven religiosity factors observed in the present study were influenced by one common

additive genetic factor, three common unique environmental factors, and unique environmental effects specific to each religiosity factor. Bivariate analyses of the seven religiosity factors and four psychiatric disorders found that the negative correlation between alcohol dependence and six of the seven religiosity factors could be accounted for by additive genetic effects. Similar results were obtained for nicotine dependence and one religiosity factor, "Social Religiosity" and for phobia and the religiosity factor "Unvengefulness" with shared genetic factors accounting for the observed correlation. For phobia and the religiosity factor "God as Judge", the correlation due to additive genetic factors was positive while that due to common environmental effects was negative. Analysis of a subset of religiosity items showed that for one religiosity factor, additive genetic effects increased over time while common environmental effects decreased. The results of the present study point to the complexity of the religiosity construct and suggest that various dimensions of religiosity are differentially related to various psychiatric disorders.

Introduction

We cannot fully understand human behavior without understanding individual differences in religiosity. In recent years, the medical and scientific community has shown a renewed interest in religiosity, especially as this trait relates to mental and physical health. However, this area of inquiry remains in its infancy and relatively little attention has been paid to the role of genetic and environmental effects on different dimensions of religiosity. Using a sample of 2,621 male and female adult twins from the Virginia Twin Registry, the present study estimated genetic and environmental effects on different dimensions of religiosity, explored how genetic and environmental effects covary across different dimensions of religiosity, and decomposed the covariance of genetic and environmental effects between different dimensions of religiosity and internalizing and externalizing psychiatric disorders. Additional longitudinal analyses were conducted on a subset of 10 items used in a previous study of female twins.

Literature Review

The Scientific Study of Religiosity, Historical Background and Renewed Interest

Religion is an integral part of human culture and it has been said that a scientific field such as Psychology cannot be complete until this construct is understood (Baumeister, 2002; Emmons, 1999; Pargament, 2002). Historically, psychologists and other social scientists, including figures such as Francis Galton, William James, and Gordon Allport, placed great emphasis on religion's role in the individual's experience (McCormick, 2004; James, 1902/1997; Emmons, 1999). However, during the course of

1

the 20th century, the medical and scientific communities largely ignored religion, often seeing it as a barrier to progress and potentially incompatible with mental and physical health (Astrow, Puchalski, & Sulmasy, 2001; Koenig, George, Blazer, Pritchett, & Meador, 1993; Shreve-Neiger & Edelstein, 2004). That view has begun to change, as renewed attention has been placed on research that examines religiosity as a psychological variable that plays various important roles in people's health and well being (Koenig, McGue, Krueger, & Bouchard, 2005; Mills, 2002).

To bolster arguments that religion is an important construct to study, American researchers often point to poll data collected over several decades showing that more than 90% of Americans say they believe in God (Powell, Shahabi, & Thoresen, 2003). Behaviorally, about 40% of Americans report that they attend religious services on a weekly basis and more than 90% of those surveyed report that they pray (Paloutzian, 1996; Powell, Shahabi, & Thoresen, 2003).

Recent studies have linked religious involvement to lower rates of coronary disease, emphysema, cirrhosis, and suicide; lower blood pressure; lower rates of myocardial infarction; reduced levels of pain; and improved physical functioning (Thoresen & Harris, 2002). All-cause mortality and cardiovascular disease have been found to be inversely related to religiosity (Powell, Shahabi, & Thoresen, 2002). Religiosity has also been found to be negatively related to antisocial behavior and positively related to prosocial behavior (Koenig et al., 2005). The positive role of religiosity in health behavior and outcomes has not been universally observed, however. For example, there is very

limited evidence to date for a protective role for religiosity and cancer progression, cancer

mortality, or coping with cancer (Stefanek, McDonald, & Hess, 2005).

It must be noted that the majority of the findings on the relationships between

religiosity (and related constructs) and various health-related outcomes are correlative and

the underlying reasons for the correlations have not been well studied (Clay, 2003).

Correlational findings do not imply causality. It remains largely unclear whether being

religious influences health outcomes, if certain health-related situations (e.g., a diagnosis

of terminal illness) lead persons to become more religious, or if a third set of factors (such

as genetic effects) is related to both religiosity and health (Smith, McCullough, & Poll,

2003).

While more and better research designs are needed, scholars have warned that

researchers should take care not to become too reductionist in their thinking about

religiosity and that research findings may explain religiosity without "explaining it away"

(Paloutzian, 1996; Pargament, 2002). Pargament (2002) has argued that beyond studying

religiosity as a resource for mental and physical health, researchers should be interested in

religiosity as a variable of interest in and of itself. Despite provocative findings and a

renewed interest in the scientific study of religiosity, the field remains in its infancy and

even basic issues such as measurement and definition of the religion construct are not fully

agreed upon.

Measurement and Definition of the Religiosity Construct

One of the limitations of research to date has been a lack of agreed upon measures and definitions of religiosity and related constructs (Cacioppo & Brandon, 2002; Kendler, Liu, Gardner, McCullough, Larson, & Prescott, 2003; Stefanek, McDonald, & Hess, 2004). Simplistic, single-variable measures of religiosity and spirituality have been a limitation of many previous studies (Fetzer Institute, 1999; Kendler et al., 2003). For example, past research has often attempted to measure religiosity by assessing a single item of religious affiliation, such as denominational preference, or by using face valid or easy-to-measure aspects of Euro-American religion, such as church attendance (Cacioppo & Brandon, 2002; Weaver, Kline, Samford, Lucas, Larson, & Gorsuch, 1998). Hill and Pargament (2003) argue that the use of such measures underestimates the complexity of the construct and leaves open the question of what is it about religiosity that accounts for its apparent relationships to mental and physical health.

A more basic issue is the challenge of defining the construct of religiosity. In describing the types of definitions of religiosity, Pargament (1997) distinguished between the substantive tradition (i.e., what *is* religion?) and the functional tradition (i.e., what is gained by being religious?). Greil and Bromley (2003) distinguished between exclusive (limiting definitions to practices and beliefs traditionally associated with being religious) and inclusive (expanding definitions to include behaviors that have common features associated with religion but may not necessarily be identified as such) definitions of religion. Critics of the inclusive approach have argued that by being too inclusive, the core meaning of the construct of religiosity is lost and subsequent scales may lead to results

that are confounded with measures of constructs other than religiosity (Moreira-Almeida & Koenig, 2006).

Gordon Allport was the first to conceptualize the difference between an intrinsic (religiosity for its own sake) and extrinsic (religiosity as a means to other ends) religiosity (Hackney & Sanders, 2003). The Intrinsic/Extrinsic (IE) religious typology, often called "religious orientation," is one of the most widely studied and theoretically integrated measures of religiosity. Despite its contributions to the study of religiosity, I/E measures are problematic, mostly because religious content (e.g., conservative religiosity vs. liberal religiosity) must be considered in order to fully understand what I/E measures are capturing in any given study. It has also been suggested that I/E measures are biased toward conservative religious beliefs (Paloutzian, 1996; D'Onofrio, Murrelle, Eaves, McCullough, Landis, & Maes, 1999).

Recent research has viewed religiosity as a multidimensional construct, with the assumption that all individuals can be located on continuous dimensions of religiosity and that the construct of religiosity cannot be defined strictly in terms of a specific set of beliefs or behaviors (Chatters, 2000; Fetzer Institute, 1999; Kendler, Gardner, & Prescott, 1997; Kendler, Liu, Gardner, McCullough, Larson, & Prescott, 2003; Miller & Thoresen, 2004; Seybold & Hill, 2001; Zinnbauer & Pargament, 2005). The multidimensional nature of this construct may include religious practices, behaviors, and beliefs (Flannelly, Koenig, Ellison, Galek, & Krause, 2006). While the idea of religiosity as a multidimensional construct is now firmly the majority opinion in the field, not all researchers agree that the

issue of whether religiosity and related constructs are indeed multidimensional has been settled (e.g., see Cook, 2004; Hackney & Sanders 2003).

In addition to religiosity, some researchers have asserted that "spirituality" is an important construct that is related to, but not necessarily part of, religion (D'Onofrio et al., 1999). A degree of overlap exists in the constructs and even some widely used scales, such as the Spiritual Well-Being Scale, reflect this overlap by including aspects of both religion and spirituality as part of what the scale attempts to measure (Moreira-Almeida & Koenig, 2006; Paloutzian, 1996; Tsuang, Williams, Simpson & Lyons, 2002). Although "religion" and "spirituality" have considerable overlap in behaviors and even attitudes associated with the constructs (e.g., the act of prayer or the attitude of forgiveness could be associated with either construct), religion can be seen to encompass both behaviors associated with formal, organizational relationships (e.g., going to church) and private, individual phenomena (e.g., spiritual experiences), while spirituality can be seen as encompassing experiences that may be had outside of any organizational structure (Hill & Pargament, 2003; Koenig, McCullough, & Larson, 2001). It is important to recognize that most study participants report being both spiritual and religious (Paloutzian & Park, 2005). Researchers have also noted that religiosity and spirituality may serve the same psychological purpose and that in this point in the field's development, breadth should be preferred to narrowness in defining these constructs (Paloutzian & Park, 2005; Zinnbauer & Pargament, 2005).

When a construct is not well-defined, one measurement approach is to saturate the ill-defined space thought to represent that construct, using multiple measures in an attempt

to maximize heterogeneity among items (Kendler et al., 2003; Little, Lindenberger, & Nesselroade, 2002). This was the approach taken by Kendler and colleagues (2003) in a previous study and this approach is used in the present study.

In the present study, the term "religiosity" is used broadly to encompass individual differences in religious behaviors, attitudes, beliefs, and related constructs, attitudes, and beliefs (e.g., spirituality, forgiveness, unvengefulness). Multivariate analysis of different dimensions of broadly defined religiosity is a major focus of the present study, along with examining how these dimensions relate to internalizing and externalizing psychiatric disorders. Key findings from past research about religiosity and the relationships between religiosity and internalizing and externalizing psychiatric disorders are summarized below.

Sex Differences in Religiosity

Mean scores on various measures of religiosity consistently show that women report being more religious and spiritual compared to men (e.g., Idler et al., 2003; Kendler et al., 2003). Shahabi, Powell and colleagues (2002) found that self-perceptions of being more spiritual (as opposed to being religious) were correlated with being younger, female, and better educated. In a Gallup poll, those who self identified as non-believers were nearly always men and more women than men fell into the group with the highest level of religious belief (Diener & Clifton, 2002). In addition, Ferraro and Kelley-Moore (2003) found that women are more likely than men to turn to religion for consolation when their health is threatened.

The phenomenon that women are more religious than men appears to hold across cultures and throughout history, in both the Christian and non-Christian world (Stark,

2002). The assumption has been that these differences are due to differences in socialization by gender. However, there has been little empirical support for this assumption (Miller & Stark, 2002). Sources such as Gallup polls, census data, and church records consistently reflect sex differences in regard to religiosity (Stark, 2002). In the United States, sex differences in church attendance, belief in life after death, frequency of prayer, and denominational loyalty have held steady over time, despite changes in attitudes toward gender roles over the past 30 years (Miller & Stark, 2002).

Religiosity and Depression

Relationships between religious affiliation and religious involvement and depression have been observed for many years, with associations between religious affiliation and depression reported as far back as the 1880s (Koenig, McCullough, & Larson, 2001). Smith, McCullough, and Poll (2003) conducted a meta-analysis of 147 studies with more than 98,000 subjects. The authors included studies that measured symptoms specific to depressive disorder as well as studies that diagnosed participants as having or not having clinical depression. The authors found a small but robust negative association between religiousness and symptoms of depression, with moderating effects observed for stressful life events (there were stronger religiousness-depression associations in people who were undergoing stress) and type of religiosity measures used (Smith, McCullough & Poll, 2003).

Kendler and colleagues (2003) found that lifetime risk for major depression in male and female twins was significantly and negatively associated with religiosity factors identified as "Social Religiosity" (12 items reflecting interaction with other religious

persons, frequency of church attendance, and attitudes about substance abuse),

"Unvengefulness" (eight items reflecting personal retaliation rather than forgiveness), and

"Thankfulness" (four items reflecting thankfulness versus anger toward God and life). In

an earlier study of female twins, Kendler, Gardner, and Prescott (1997) found that the

factor "Personal Devotion" was significantly and inversely related to lifetime risk for major

depression and to current depressive symptoms.

Religiosity and Phobia

Although phobias are among the most common psychiatric disorders, relatively

little has been written about religiosity and phobias. Several studies have examined

religiosity's relationship with broadly defined "anxiety," but few have studied clinically

defined anxiety disorders, and fewer still have examined phobias specifically (Koenig,

George, Blazer, Pritchett, & Meador, 1993; Shreve-Neiger & Edelstien, 2004). Results

from these studies have been mixed, with most finding negative relationships between

religiosity and anxiety, while some have found positive relationships or no relationship

between religiosity and anxiety.

A few studies have examined religiosity's relationship to phobias in particular. In a

study of adults 60 years and older, Koenig and colleagues (1993) found that the

significance of relationships between religiosity and phobias was lost when socio-

demographic and health variables were controlled for statistically. More recently, Flannelly

and colleagues (2006) reported that belief in an afterlife was inversely related to symptom

severity in phobic anxiety, while frequency of prayer was positively related with increased

symptom severity. Kendler and colleagues (2003) found that lifetime risk for phobia in

male and female twins was significantly and negatively associated with "Social

Religiosity," "Unvengefulness," and "Thankfulness." In a study of female twins, Kendler,

Gardner, and Prescott (1997) found that the associations between "Personal Devotion,"

"Personal Conservatism," and "Institutional Conservatism" were not statistically

significant for lifetime risk of phobia or for current symptoms of panic or phobia.

Religiosity and Alcohol Use

The relationship between religiosity and alcohol abuse has one of the longest

histories of any health-related research on religiosity. In 1902, William James wrote in his

famous book *The Varieties of Religious Experience*, "The sway of alcohol…is

unquestionably due to its power to stimulate the mystical faculties of human nature,

usually crushed to earth by the cold facts and dry criticisms of the sober hour. Sobriety

diminishes, discriminates, and says no; drunkenness expands, unites, and says yes…It

makes him for the moment one with truth. Not through mere perversity do men run after

it" (James, 1902/1997, pp. 304-305). The relationship between alcohol use and religiosity

has also had a long history of use in interventions to treat alcohol use problems.

Alcoholics Anonymous, which was founded in the 1930s, has helped millions of people in

their struggle with alcoholism, and is at its core, a spiritual program (Horstmann &

Tonigan, 2001).

Recent studies have found negative associations between religiosity and alcohol

use and abuse, with findings specific to the aspect of alcohol use measured and the

dimensions of religiosity measured. In a large, representative cross-sectional study of

almost 3,000 adults age 18-97 in the Piedmont region of North Carolina, Koenig and

colleagues (1999) found that recent (defined as "in the last six months") alcohol abuse and dependence was significantly lower among those who frequently engaged in prayer and scriptural study; recent and lifetime alcohol problems were lower among those who attended worship services; and those who attended religious services at least once a week had less than one-third the rate of alcohol abuse compared to those who attended less frequently.

In a study of adult female twins, Kendler, Gardner, and Prescott (1997) found that both current alcohol use, lifetime risk for problem drinking, and lifetime risk for alcoholism were significantly and negatively associated with the religiosity factors "Personal Devotion," "Personal Conservatism," and "Institutional Conservatism" (relative conservatism of organizational religious affiliation). In a study of male and female adult twins, Kendler and colleagues (2003) found that the religiosity factors "General Religiosity" (30 items reflecting concern and involvement with spiritual issues and active involvement with God), "Social Religiosity," "Involved God" (a deity who is actively involved in human affairs), "God as Judge" (six items reflecting a view of a judgmental and punitive deity), and "Thankfulness" were all significantly and negatively associated with lifetime risk for alcohol dependence, while the factors "Forgiveness" (seven items reflecting a caring, loving, and forgiving approach to the world) and "Unvengefulness" were not associated with lifetime risk for alcohol dependence.

Religiosity and Smoking

Studies have consistently found religiosity to be inversely associated with cigarette smoking. However, results depend on the population being studied and the specific aspects of smoking and religiosity being examined. For example, a study of older adults in North Carolina found that those who frequently studied the Bible, attended religious services, or prayed privately were much less likely to smoke, and if they did smoke, they smoked fewer cigarettes than their less religious peers (Koenig, 1999). Hestick and colleagues (2001) found that among African-American college students, those who regarded spirituality as important were less likely to have ever been lifetime regular smokers, but the importance of spirituality was not significantly related to having ever tried smoking.

In a study involving female twins, Kendler and colleagues (1997) found that "Personal Devotion" (including frequency of church attendance) and "Institutional Conservatism" (conservatism of self-reported denomination, rated highest to lowest, from fundamentalist Protestant to "other" or "unaffiliated") were inversely related to current smoking and to lifetime risk for nicotine dependence. In a study of male and female twins, Kendler and colleagues (2003) found an inverse relationship between some but not all religiosity factors and lifetime risk for nicotine dependence. The factors "General Religiosity," "Social Religiosity," "Involved God," "Forgiveness," and "Thankfulness" were inversely associated with lifetime risk for nicotine dependence while, the factors "God as Judge" and "Unvengefulness" were not significantly associated (Kendler, Gardner, & Prescott, 1997).

The present study seeks to add to what is known about these relationships between religiosity and psychiatric disorders, using a twin study design. Behavior genetics methodology and existing findings related to religiosity are summarized below.

Overview of Behavior Genetics and Twin Study Methodology

One of the major methods of the field of behavior genetics to examine the genetic and environmental contributions to individual differences in human characteristics and behaviors is twin studies (Bulik, Sullivan, Wade, & Kendler, 2000; D'Onofrio, et al., 1999; Loehlin, 1989; Neale & Cardon, 1992). Twin studies take advantage of the fact that monozygotic (MZ) twins share 100% of their genes, while dizygotic (DZ) twins share on average 50% of their segregating genes and are no more alike genetically than non-twin siblings. Therefore, differences in MZ twins provide evidence of environmental effects whereas differences in DZ twins can result from the effects of genes or the environment (Bulik, et al., 2000). A greater similarity in MZs than DZs for a particular trait is generally seen as evidence for a genetic contribution to the trait (D'Onofrio, et al., 1999).

Twin studies allow the variance of a trait to be partitioned into latent variables. Variance, first defined by Fisher (1918), refers to how much a trait varies from its mean value. Sources of variance identified in twin studies include additive genetic effects, non-additive genetic effects, common environmental effects, and unique environmental effects. Additive genetic effects (abbreviated "A") reflect the cumulative effect of many individual genes, each with small effects. Common environmental effects (abbreviated "C") are the environmental effects shared by twins and which make twins alike. Unique environmental effects (abbreviated "E") are those environmental effects that affect twins differently and

make twins different from one another (Bulik, et al., 2000; Loehlin, 1999; Scarr, 1997).

Estimates of unique environmental effects also include measurement error (Bulik, et al.,

2000). The total variance of a trait is scaled to one and the contributions of each source of

variance are represented as a^2, c^2, and e^2 (Neale, 2003; Bulik et al., 2000). There are other

sources of variation that explain individual differences, but these are not a focus of the

present study. These sources of variation include non-additive genetic effects such as

dominance (abbreviated "D"), epistasis, genotype-environment correlations, and

genotype-environment interactions (Scarr, 1997).

Many traits, such as height and weight, have a normal, continuous distribution,

with individual observations varying from the mean, or average value, of such traits.

Genetic and environmental factors lead to individual variation in these traits (Sham, 1998).

Partitioning the variance allows researchers to examine how much of the observed

variance is attributable to genetic and environmental effects. Covariance refers to how

much deviation from the mean is shared by two or more variables. Correlation is similar to

covariance (correlation is covariance divided by variance) and is scaled to be bound from -

1.0 to +1.0 (Neale & Cardon, 1992).

Until the 1970s, a popular method for partitioning the variance of traits in twin

studies was to obtain the correlation coefficients for MZs and DZs and to use algebraic

equations to solve for a^2, c^2, and e^2 (Neale, 2003). This method is still a good first step for

checking one's data to make sure parameter estimates obtained by this method typically

appear reasonable. However, there are serious limitations to using this method of

estimating parameters. These problems include obtaining non-sense estimates of

heritability, lack of precision, the inability to easily generalize to the multivariate case, and the inability to compare goodness-of-fit of different models (Neale, 2003).

Today, the technique of maximum likelihood is most often used to estimate parameters in behavior genetics studies. Maximum likelihood uses information on the slope and curvature of the likelihood for specific trial values of parameters to estimate the most likely values of parameters (Neale, 2003; Thomas, 2004). Maximum likelihood yields the most likely parameter estimates given the actual data and the specified parameters of a model. Computer programs such as Mx (Neale et al., 2005), which use maximum likelihood offer a great deal of flexibility and the ability to easily compare different models (Loehlin, 1999).

Structural equation modeling (SEM) is often used to analyze twin data. Structural equation modeling specifies two types of variables: observed variables, those variables being directly observed and measured, and latent variables, those factors not observed directly but which exist hypothetically (Neale, 2003). For example, in a study of depression, the Beck Depression Inventory would be an observed variable, while "depression" itself would be a latent variable, or in IQ testing, the latent variable general intelligence ("g") is indexed via observed scores on a range of different measures of "intelligence" (Bulik, et al., 2000). In twin studies, SEM can provide information regarding parameter estimates, confidence intervals, effect sizes, and model fitting to data. In addition to the full ACE model, sub-models such as AE, CE, and E can be fitted to the data and comparisons can be made to identify the best fitting model among these alternatives (Bulik et al., 2000). Structural equation modeling is also flexible, allowing for

multivariate extensions of modeling and examination of qualitative and quantitative sex differences. Quantitative sex differences refer to the magnitude of genetic and environmental effects on the same phenotype in males and females, while qualitative sex differences refers to whether the same or different sets of genes and environmental effects influence male and female phenotypes (Neale & Cardon, 1992; Neale & Maes, in preparation).

Different models are compared using goodness-of-fit statistics such as chi square difference tests and Akaike's Information Criterion (AIC). Saturated models estimate free variances and covariances, while univariate models can partition the variance into the latent variable components A, C, E, and D. The chi square difference test indicates how discrepant a given model (e.g., an AE model) is from the observed data or from other models (Loehlin, 1999). The degrees of freedom for the chi square are the difference between the number of observed values and the number of parameters solved for in each model. A statistically significant chi square indicates a significant mismatch between the model and the observed data, i.e., the model does not provide a good fit for the data (Loehlin, 1999). Akaike's Information Criterion is defined as $X^2 - 2(df)$ where X^2 is the goodness-of-fit likelihood ratio chi-square based on degrees of freedom (Truett, et al., 1992). The AIC is helpful when multiple models are fit, since it provides information relative to the number of parameters solved for in each model (Loehlin, 1999). When using AIC, the model with the lowest or most negative AIC value has the best balance between goodness-of-fit and parsimony (Kendler, Neale, Kessler, Heath, and Eaves, 1992). Simulation studies have shown the AIC generally does a good job at selecting the

true model (Williams & Holahan, 1994). However, caution should be used in determining best-fitting models based solely on the AIC, since the AIC may bias parameter estimates and associated confidence intervals, especially in the case of binary data with small samples sizes (Sullivan & Eaves, 2002).

Assumptions of Twin Studies

Twin study statistical methodology, like all statistical methods, depends on a number of assumptions. The first assumption is of having an accurate method of correct zygosity assignment. Misclassification of zygosity can bias twin study results. Reliable methods have been developed to determine zygosity. A second assumption is that twins must be similar to non-twins in regards to the trait being studied in order for results from a twin study to generalize to non-twins. A third assumption is that MZ and DZ twins are equally correlated for their exposure to the environmental effects relevant to the trait being studied. Violations of the equal environments assumption could upwardly bias the magnitude of estimated genetics effects and therefore threaten the validity of twin study findings (Bulik et al., 2000; Kendler & Gardner, 1998). However, for psychiatric and substance abuse disorders, empirical investigation of differential experiences by twins in childhood and adolescence has found little evidence to support substantial bias in twin studies of psychiatric and substance abuse disorders, with the possible exception of studies of initiation of substance use (Kendler & Gardner, 1998). Other important assumptions include the presence of additive genetic effects rather than non-additive genetic effects and random mating rather than assortative mating, i.e., the tendency for like to marry like and to therefore increase genetic and environmental similarity among siblings.

Other Considerations Regarding Twin Studies

There are several other important issues to consider when using twin study methodology. One is the issue of ascertainment of research participants. Clinically ascertained twin samples may produce inflated heritability estimates. In volunteer twin registries, MZ twins tend to be over-represented, and females are more likely to participate, as are those who are more invested in identifying as a twin. The optimal strategy for many purposes to minimize these concerns is to use population-based twin registries in which all twins are contacted for study participation (Bulik, et al., 2000).

There are also key points to consider with regard to parameter estimates (a^2, c^2, and e^2) in twin studies. Parameter estimates describe variation at the group level and have no immediate implication for the individual. Parameter estimates only apply to the group in which they were measured and may not generalize to groups with different genes or environments. Finally, parameter estimates must be considered in relation to their confidence intervals in order to have an idea of the precision of the parameter estimates (Bulik et al., 2000).

As with any methodology, findings from twin studies must be considered in light of what is known from past research and care must be taken to note the limitations of any particular study. However, advanced statistical modeling techniques for twin studies gives researchers flexibility to address many of the concerns that have been used to critique twin research in the past (Neale & Maes, in preparation). It is also important to consider that twin studies are observational and non-experimental in nature, and therefore require

constant vigilance about possible bias that may influence estimates of heritability (Kendler, 2005).

The Genetics of Religiosity

At first, it may seem that an attribute like religiosity would not be influenced by genes, and some behavior geneticists persist in neglecting the evidence for a genetic role in religiosity (e.g., see Plomin, 2004). However, behavior genetic studies have shown that nearly all individual psychological traits are moderately to substantially heritable (Bouchard & McGue, 2003). Genetic effects contribute to individual differences in social attitudes and personality (Eaves, Heath, Martin, Neale, Kendler, Kirk, & Corey, 1999; Olson, Vernon, Aitken Harris, & Jang, 2001) as well as vocational interests and IQ (Bouchard & McGue, 2003; D'Onofrio, Eaves, Murrelle, Maes, & Spilka, 1999).

D'Onofrio and colleagues (1999) suggested a number of questions that could be answered about religious attitudes and behaviors from a behavior genetics perspective. Among these questions are several that the present study attempts to address, including: Are genetic effects significant for religiosity? How large is the impact of genetic effects on religiosity? Do the same genetic factors that influence religiousness also contribute to variation in other traits or disorders? How important are environmental influences on religiosity? Are environmental influences on religiosity shared or unique?

Although behavior genetic studies of religiosity remain limited, extant studies have shown that certain aspects of religiosity do appear to be at least moderately heritable. Findings from these studies have been influenced by factors such as age, sex, and what

specific aspects of religiosity were measured. These findings are discussed below and a summary is given in Appendix A.

Age and Development

Development is an important issue in genetics research. Twin studies and other behavior genetics methodologies can help determine if the relative importance of genetic and environmental factors change over the lifespan (Kendler, 1995). Past studies of religiosity and associated attitudes have shown that additive genetic effects are generally greater in adulthood compared to childhood and adolescence. Boomsma and colleagues (1999) studied male and female Dutch adolescents and young adult twins, with an average age of 17.8 years. The authors found that additive genetic factors were non-significant for religious upbringing, religious affiliation, and participation in church activities. Common environmental factors had the greatest influence on phenotypic variance in these religion variables. However, the authors noted that these results may be specific to Dutch society, where people from different major religions go to separate schools and are somewhat segregated in larger society as well. The authors also noted that these findings may have been influenced by the measures of religiosity used and by the relatively young age of the study participants (Boomsma et al., 1999).

D'Onofrio and colleagues (1999) studied adolescent male and female twins with an average age of 14.6 years. Three factors emerged from the 21-item Religious Attitudes and Practices Inventory: "Theism" (beliefs about God), "Religious/Spiritual Practices," and "Peer Religiousness." Factor scores were estimated from these three factors and a fourth scale was added ("Drug Use as Sinful"). In females, common environmental effects

accounted for the largest share of the variance on all four measures of religiousness. Common environmental effects were also substantial for males for "Theism" and "Religious/Spiritual Practices." However, additive genetic effects accounted for 50% of the variance in "Peer Religiousness" in males.

Using a sample of Minnesota adult male twins who had been reared apart, Koenig, McGue, Krueger and Bouchard (2005) examined retrospective adolescent religiosity compared to current, adult religiosity. The authors found that additive genetic effects were weaker and common environmental effects stronger in adolescence, while the opposite was true in adulthood. The magnitude of unique environmental effects was similar in adolescence and adulthood.

Kirk, Eaves, and Martin (1999) examined spirituality in male and female Australian twins aged 50 and older. In univariate analysis of the variable "self-transcendence," which was used as an indicator of spirituality, additive genetic effects accounted for 48% of the variance in men and women. Unique environmental effects accounted for 52% of the variance in women and 48% of the variance in men, with a small age effect (4%) for men. The same study examined church attendance and found that in females, additive genetic effects accounted for 22% of the variance in church attendance, but no additive genetic effects were found for males in the best fitting univariate model. For both males and females, common environmental effects accounted for 43% of the variance in church attendance (Kirk, Eaves, & Martin, 1999).

Kirk and colleagues (1999) conducted the largest study on individual differences in church attendance, using samples of adult twins and their families from the United States

and Australia. In both the American and Australian twin cohorts there was evidence for additive genetic (15-35%), common environmental (7-14%), and unique environmental (35-48%) effects. Small effects were also detected for assortative mating, special twin environment, non-additive genetic effects, and cultural transmission (Kirk, Maes, Neale, Martin, & Eaves, 1999).

Measurement of Religiosity in Behavior Genetics Studies

As discussed above, findings in studies of religiosity depend on what aspect of religiosity is measured and lack of agreed upon measures and definitions of the construct have limited the ability to interpret findings from past research. The same has been the case in behavior genetics studies of religiosity. Religious affiliation (Protestant, Catholic, Jewish, etc.) and church attendance are two single-item measures of religiosity that have been examined. As has been noted in previous reviews (Bouchard and McGue, 2002; D'Onofrio et al., 1999) research shows almost no additive genetic effects for religious affiliation (e.g., whether one is Christian, Muslim, Jewish), although a small genetic contribution may be present in females (D'Onofrio et al., 1999; Eaves, Martin, & Heath, 1990). Church attendance and Sabbath observance, on the other hand, have been shown to be moderately influenced by additive genetic effects (Maes, et al., 1999; Martin, et al., 1986). As noted by Bouchard and McGue (2003), single-item measures are less reliable than scales with related, multiple items. A small number of behavior genetic studies have used multi-item scales to examine the religiosity construct and are summarized below.

Bouchard and colleagues (1999) studied intrinsic religiousness (IR) and extrinsic religiousness (ER) in male and female Minnesota twins reared apart. Additive genetic

effects accounted for 43% of the variance for IR and 39% of the variance in ER. Because the twins in the sample were reared apart, unique environmental effects accounted for the remainder of the observed variance.

Tsuang and colleagues (2002) examined spirituality in male twins, using the Spiritual Well-Being Scale and an Index of Spiritual Involvement. The authors found that additive genetic effects were similar in the religious well-being and existential well-being subscales, accounting for 37% and 36% of the variance, respectively. No common environmental effects were found for existential well being, but common environmental effects accounted for 10% of the variance in religious well being. Genetic effects accounted for 23% of the variance in spiritual involvement, with common environmental effects accounting for 45% of the variance.

Kendler, Gardner, and Prescott (1997) studied three factors – "Personal Devotion," "Personal "Conservatism," and "Institutional Conservatism" in adult female twins and found additive genetic effects for "Personal Devotion" (29%) and "Institutional Conservatism" (12%), but not for "Personal Conservatism." Common and unique environmental effects were observed on all three dimensions of religiosity.

Behavior Genetic Studies of Substance Abuse and Psychiatric Disorders

Behavior genetics studies have extensively examined substance abuse and psychiatric disorders. However, with some notable exceptions (see D'Onofrio et al., 1999; Maes et al., 1999; Kendler, Gardner & Prescott, 1997, and Tsuang et al., 2002) few behavior genetics studies have examined the relationships between religiosity and

substance abuse and psychiatric disorders. Brief summaries of behavior genetics research on smoking, alcohol use, depression, and phobias are given below.

Genetics and Major Depression

Past behavior genetics research has shown significant and consistent additive genetic and unique environmental effects on major depression (Sullivan, Neale, & Kendler, 2000). In a twin study using a sample from the Virginia Twin Registry, the heritability of major depression was identical in men and women, with additive genetic effects accounting for 39% of the variance and unique environmental effects accounting for the remaining 61% of the variance (Kendler & Prescott, 1999). A longitudinal study of female twins by Kendler and colleagues (1993) found that additive genetic effects on the liability for depression were stable over time, while environmental effects, which also play a significant role in liability for major depression, were occasion specific and transitory. A study of more than 42,000 twins from the Swedish Twin Registry found that additive genetic and unique environmental effects accounted for the variance in lifetime major depression, with significant differences in heritability in women compared to men (Kendler, Gatz, Gardner, and Pedersen, 2006).

Genetics and Phobia

Although phobias are among the most frequently occurring psychiatric problems, there have been relatively few behavior genetics studies of phobias. Kendler and colleagues (1992) reported a modest additive genetic contribution to phobias, ranging from 30% to 39% of the variance depending on the type of phobia, in a sample of adult female twins. With the same sample of female twins, Kendler, Karkowski, and Prescott

(1999) used a multiple threshold model, assuming that unreasonable fears and their associated phobias represented different points on a continuum of liability. Using this method, substantially higher contributions from additive genetic effects were observed, ranging from 43% to 59% of the variance, depending on the type of phobia. Kendler and colleagues (2001) used the same multiple-threshold method with a sample of adult male twins and found that additive genetic effects accounted 24% to 43% of the variance, depending on the type of phobia. Overall, findings to date indicate that additive genetic effects account for approximately one-third to two-thirds of individual differences in phobias, with unique environmental effects accounting for the remaining portions of the variance (Hettema, Neale, & Kendler, 2001; Kendler & Eaves, 2005; Kendler, Karkowski, & Prescott, 1999; Kendler, Myers, Prescott, & Neale, 2001; Kendler, Neale, Kessler, Heath, & Eaves, 1992).

Genetics and Alcohol Use

There are several distinct behaviors and stages of alcohol use (e.g., initiation of drinking, problem drinking, and alcohol dependence) that may be examined when estimating genetic and environmental effects on alcohol use. Regardless of the diagnostic system used (DSM vs. ICD) additive genetic effects have been found to play a significant role in liability for alcohol dependence (WHO, 2004). In a population-based study of adult male twins, Prescott and Kendler (1999) found that additive genetic effects accounted for 48% to 58% of the variation in liability for alcohol abuse or dependence using DSM-III and DSM-IV criteria. Sex differences have been observed in studies of the additive genetic effects on alcoholism. In a study of male and female adult twins, Prescott, Aggen, and

Kendler (1999) reported that additive genetic effects accounted for a substantial portion of the variation in liability for alcoholism in men and women, but rejected a model that genetic sources of liability completely overlap. It is less clear whether additive genetic effects have a strong influence on initiation of drinking and early alcohol use (Maes, Woodard, Murrelle, Meyer, Silberg, Hewitt, Rutter, Simonoff, Pickles, Carbonneau, Neale, & Eaves, 1999; Rose, Dick, Viken, Pulkkinen, & Kaprio, 2001; WHO, 2004).

Genetics and Smoking

There are many behavioral aspects of smoking and stages of smoking progression that may be considered when examining the genetic and environmental influences on smoking. Among these are the behaviors of trying smoking at least once, becoming a regular smoker, and developing nicotine dependence. Additive genetic effects have been found for each of these aspects of smoking (Maes, Sullivan, Bulik, Neale, Prescott, Eaves, & Kendler, 2004; WHO, 2004). Studies have found that there are different genetic contributions to different smoking behaviors and only partial overlap in the sets of genetic factors that contribute to these behaviors (Kendler, Neale, Sullivan, Corey, Gardner, & Prescott, 1999).

McGue, Elkins, and Iacono (2000) reported that additive genetic effects accounted for 56% of the variance in ever having used tobacco in a study of 17-year-old twins in Minnesota. In a study of Dutch adolescent and young adult twins with an average age of 17.7 years, Koopmans and colleagues (1999) found that additive genetic effects accounted for 39% of the variance in smoking initiation. In a study of Australian twins, Heath and colleagues (1999) reported that additive genetic effects accounted for 62% of the variance

in smoking initiation in a younger twin cohort (aged 30 years or less) and 51% of the variance in an older twin cohort (older than aged 30). In a meta-analysis of male and female adult twins, Li and colleagues (2003) found that additive genetic influences on smoking initiation were significantly larger in females (.55 ± .04) than in males (.37 ± .04). When males and females were combined in the same study, additive genetic effects accounted for 46-50%, common environmental effects accounted for 33-40%, and unique environmental effects accounted for 14-17% of the variance in smoking initiation (Li, Cheng, Ma, & Swan, 2003).

Additive genetic effects accounted for 41% of the variance in nicotine dependence in a study of 17-year-old Minnesota twins reported by McGue, Elkins, and Iacono (2000). In a study of adult male and female twins from the Virginia Twin Registry, Maes and colleagues (2004) found that additive genetic effects accounted for 62% of the variance in nicotine dependence while unique environmental effects accounted for the remaining 38% of the variance. In a meta-analysis of adult twins, Li and colleagues (2003) examined what they termed "smoking persistence" and included studies that measured current smoking and quantity of cigarettes smoked, which are highly correlated with nicotine dependence, as well as studies that measured nicotine dependence explicitly. The authors reported that additive genetic influences on smoking persistence were greater in males (.59 ± .02) than in females (.46 ± .12). When males and females were combined in the study, additive genetic effects accounted for 52-59%, common environmental effects

accounted for 13-14%, and unique environmental effects accounted for 35-38% of the

variance in smoking persistence (Li, et al., 2003).

Statement of the Problem

Researchers have shown renewed interest in the study of religiosity in recent years. However, the construct of religiosity is poorly understood and simplistic measures of religiosity have limited the ability to interpret results from past research. To date, several studies have examined the heritability of various aspects of religiosity, but little is known about how genetic and environmental effects on different dimensions of religiosity covary with one another. While the literature has shown inverse relationships with religiosity and the risk for various psychiatric disorders, there has been little research into the sources of covariance between dimensions of religiosity and risk for psychiatric disorders from a behavior genetics perspective.

The present study used 78 items measuring the multidimensional aspects of religiosity. This represents the most comprehensive set of religiosity measures known to be available for behavior genetics studies. A twin study design was used to examine the heritability of different dimensions of religiosity from a multivariate perspective and to examine how these phenotypes relate to internalizing and externalizing psychiatric disorders. Specifically, the study sought to answer the following research questions:

1) What are the magnitudes of the genetic and environmental effects on different dimensions of religiosity?

2) Are the same or different sets of genes and environmental effects involved in different dimensions of religiosity?

3)   What are the sources of covariation between different dimensions of

religiosity and risk for internalizing and externalizing psychiatric

disorders?

Method

Subjects

The sample for the present study comes from two related projects that recruited participants from the population-based Virginia Twin Registry. Female-female twin pairs born between 1934 and 1974 were initially interviewed beginning in 1988. Male-male and male-female twin pairs born between 1940 and 1974 were initially interviewed beginning in 1993. In 1999 prior participants in these two studies (N = 7,230) were mailed questionnaires that contained the religiosity measures included in the present study. Of those who were mailed the questionnaires, 2,621 were returned for a 36.3% response rate. Resources for follow up were limited. Data collection was approved by Virginia Commonwealth University's Institutional Review Board and informed consent was obtained prior to receiving the mailed questionnaires. Zygosity was determined by standardized techniques that have been shown to have an accuracy rate of >95% and were validated using molecular methods (Kendler, et al., 2003).

All participants in the present study were Caucasian and 58% were female. The average age of the participants was 43.06 years, SD=8.61, range=27-63 years. More than three quarters (77%) of the participants were Protestant (see Table 1) and the most common denominational preference was Baptist. Table 2 shows the ten most frequently endorsed denominations, which account for more than 88% of all responses.

Table 1

Religious Preference, N=2621

Religious Preference	%	N
Protestant	77.44	1988
No Preference	9.35	240
Catholic	9.23	237
Other	2.88	74
Jewish	1.09	28
Missing Data		54

Table 2

Protestant Denominational Preference, N=2621

Denominational Preference	%	N
Baptist	36.29	732
Methodist	21.02	424
Presbyterian	9.12	184
Episcopal, Anglican, Church of England	6.94	140
Pentecostal, Assemblies of God	3.47	70
Lutheran	3.27	66
Nondenominational Protestant	2.97	60
"Christian"	2.93	59
Church of God, Holiness	2.23	45
Other Protestant Denominations	11.76	237
Missing, No Preference, or Non-Protestant		604

Representativeness of the Sample

The sample in the present study was recruited from participants in two previous

studies. The GENMOD procedure in SAS was used to determine if any psychiatric

disorders predicted participation in the sample used in the present study (Kendler et al.,

2003). Logistic regression showed that of the four psychiatric disorders examined in the present study, only nicotine dependence was a significant predictor of participation. Although those who were nicotine dependent were significantly less likely to participate in this study, the overall size of this effect was quite modest (OR= .85, 95% CI = .74-.99, p = .0448).

Ten of the 78 religiosity items used in the present study were included in previous studies in which the present sample had participated. Of those 10 items, one item was a significant predictor of participation in the present sample. These patterns are not different from chance expectations (Feild & Armenakis, 1974). Increasing age predicted increasing religiosity scores; however, effect sizes were small and age effects were excluded from further analysis.

Other variables not directly of interest in the present study were significant predictors of participation. These included female sex, increasing education, and monozygosity (see Kendler et al., 2003). These predictors of participation are similar to those reported by others who have examined non-response in twin studies using questionnaires (e.g., Heath, Howells, Kirk, et al., 2001). Even with poor response rates, previous empirical studies of this problem have reported that response bias is minimal (Heath, et al., 2001; Vink, Willemsen, Stubbe, et al., 2004). If the phenotype of interest is not correlated with response to a study, there will be no effect of non-response and a low level of study response does not necessarily indicate non-response bias (Taylor, 2004).

Measures

    Religiosity. As discussed previously by Kendler and colleagues (2003), because the constructs of religiosity and spirituality are ill-defined, a broad selection of items measuring religiosity, spirituality, and related attitudes such as forgiveness and gratitude were selected for use in the present sample. As in the 2003 study, the present study takes an atheoretical approach toward the construct of religiosity and uses empirical methods, specifically phenotypic factor analysis to define dimensions of religiosity (Kendler et al., 2003). There were 78 items included in the questionnaires. See Appendix B for the wording of each item and the associated factors reported by Kendler and colleagues (2003). The items and their sources are described as follows:

    Religious Attitudes and Practices Inventory (RAPI). These measures were originally developed by D'Onofrio and colleagues (1999) to characterize adolescent religiousness. Twelve items from the RAPI were used in the present study: Seven designed to measure social support, three assessing religious views on drug use, and one item each assessing spirituality and theism.

    Multidimensional Measurement of Religiousness/Spirituality. These measures were developed by the Fetzer Institute and the National Institute on Aging Work Group (1999) specifically for use in health research. Items used in the present study include those from Pargament's Religious/Spiritual Coping Scale (Pargament, Smith, Koenig & Perez, 1998) and Underwood's Daily Spiritual Experiences Scale (Fetzer Institute/NIA Work Group, 1999; Underwood & Teresi, 2002).

Nature of God, forgiveness, revenge, gratitude. Items designed to assess the nature of God, loving and caring, forgiveness versus revenge, and gratitude versus ingratitude, which were developed by Kendler and colleagues (2003) and included in previous research with the present sample.

Parental influences on God images. Nine "God image" items were used in a 1982-83 study of more than 8,000 adolescents and their parents. Factor analysis of these items revealed two dimensions – "God as love" (6 items) and "God as authority" (3 items) (Hertel & Donohue, 1995). Following the work of Kendler and colleagues (2003), two "God as love" items and three "God as authority" items were used in the present study.

Internalizing psychiatric disorders. The common internalizing disorders of Major Depression and Phobia were used in the present study. Major Depression was assessed using an adaptation of the Structured Clinical Interview for DSM-III-R. Phobia was defined following DSM-III criteria as an irrational fear with objective behavioral impact on the respondent's behavior, as judged by a trained interviewer (Kendler et al., 2003).

Substance abuse disorders. Nicotine Dependence and Alcohol Dependence were examined in bivariate analyses. Nicotine Dependence was defined as a score of ≥ 7 on the Fagerstrom Tolerance Questionnaire (Fagerstrom and Schneider, 1989) as assessed during the heaviest period of lifetime use. Alcohol Dependence was assessed using an adaptation of the Structured Clinical Interview for DSM-III-R (Kendler et al., 2003).

Statistical Analyses

Factor Analysis of Religiosity Items. Kendler and colleagues (2003) performed an exploratory factor analysis with a VARIMAX rotation on the 78 religiosity items in the present twin sample. A scree plot and eigenvalues indicated seven important factors that explained 57.3% of the total variance (Kendler et al., 2003). See Appendix B. In the present study, the seven-factor structure reported by Kendler and colleagues (2003) was recovered via confirmatory factor analysis techniques using the computer program Mplus (Muthen & Muthen, 1998-2004). Correlated factor scores were estimated and compared to those factors found in the 2003 study.

Univariate Analysis. Genetic and environmental contributions to variance were estimated for religiosity factor scores for each factor found in the confirmatory factor analysis and for internalizing (major depression and phobia) and externalizing (alcohol and nicotine dependence) psychiatric disorders. Likelihood ratio tests, the chi square difference test, and Akaike's Information Criterion (AIC) were used to determine the best fitting models, with lower values of the AIC indicating models with a better balance of explanatory power and complexity (Kendler et al., 1993). Parameter estimates (a^2, c^2, and e^2) and 95% confidence intervals were estimated. Where appropriate, both full ACE models and best-fitting submodels were reported, along with 95% confidence intervals for each parameter in each model. See Appendix C for a graphic representation of univariate analysis. Qualitative and quantitative sex differences were also examined using the Mx program (Neale et al., 2005). Qualitative sex differences refer to different genetic and environmental effects influencing a trait in males and females, while quantitative sex

differences refers to different magnitudes of the same genetic and environmental factors acting in males and females.

Multivariate Analysis. Multivariate analysis estimates the contribution of genes and environment to the correlation between multiple variables. The present study was exploratory in nature and a combination of Cholesky decompositions and confirmatory independent pathway models were used to estimate the additive genetic and environmental factors shared by the seven religiosity factors. See Appendices D and E for simplified graphic representations of a Cholesky decomposition and independent pathway models.

Bivariate Analysis. The goal of bivariate analysis is to decompose the covariance between two traits of interest (Kendler et al., 1992). Bivariate analyses were conducted to decompose the covariance between different dimensions of religiosity and internalizing and externalizing psychiatric disorders into genetic and environmental effects. All univariate, multivariate, and bivariate analyses were conducted using the Mx program (Neale, Boker, Xie, & Maes, 2005).

Power. As with other methodologies, many factors act to influence statistical power in twin studies. The effect being examined (i.e., a^2, c^2, or e^2), the size of the effect in the population being studied, the number of subjects, the number of subjects within each zygosity group, the level of measurement used (e.g., continuous, categorical, ordinal), and parsimony of modeling all influence the ability to detect effects in twin studies (Martin, Eaves, Kearsey, & Davis, 1978; Neale, Eaves, Kendler, 1994).

In an effort to increase available power, the frequently occurring internalizing disorders of major depression and phobia were analyzed, as well as the common

externalizing disorders of nicotine dependence and alcohol dependence. When possible,

continuous data were used for analyses and males and females were combined.

Results

Factor Analysis and Factor Scores

The first goal of the present study was to replicate the factor structure reported in

a previous study by Kendler and colleagues (2003) and to obtain correlated factor scores

for the seven factors defined by the 78 religiosity items used in that study. Raw, ordinal-

level data collected on twins for the 78 religiosity items were entered into a confirmatory

factor analysis (CFA) using the Mplus program (Mplus Version 3.0, Muthen & Muthen,

1998-2004). A seven-factor model was specified based on the factor results reported in

2003 by Kendler and colleagues. A Weighted Least Square Means and Variance adjusted

estimator (WLSMV) was used to obtain estimates of factor loadings and inter-factor

correlations for this factor structure. The Weighted Least Square Means and Variance

estimator has been recommended as a robust estimator for ordinal-level data (Flora &

Curran, 2004). This estimation technique uses a matrix of polychoric correlations and the

diagonal elements of an asymptotic weight matrix to estimate the parameters of the

common factor model by weighted least squares. The full weight matrix is used to

compute standard errors and chi-square values.

Correlated factor scores were estimated in Mplus based on the results of the CFA

and using an iterative modal Bayesian posterior approach for ordinal data. Estimates of

person locations on the latent variables are optimized given the factor loading pattern and

item thresholds for items defining each factor. This Bayesian procedure results in the most

likely factor score on each factor for each person. This process results in correlated,

continuous-level factor scores with the assumption of an underlying normal distribution.

39

The accuracy of factor scores depends on how well the items define and differentiate the factor structure.

Factor loadings were generally high (see Appendix F). Correlations between the factor-derived composite scores used in the previous study (Kendler et al., 2003) and the factor scores used in the present study were also generally high, ranging from .98 - .77 (see Table 3). These correlated factor scores were used for further analysis of the religiosity factors in the present study. A comparison of univariate analyses of the religiosity factors was made using the previous, uncorrelated factor scores and the correlated factors scores used in the present study. Univariate results were similar for both sets of factor scores and results can be seen in Appendix G.

Table 3

Correlations between Correlated and Uncorrelated Factor Scores

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Correlation with previous factor scores	.98	.97	.87	.94	.82	.94	.77

Note: Previous factor scores from Kendler et al., 2003. All correlations significant at $p<.0001$

Univariate Analysis

Univariate analyses were conducted for each of the seven religiosity factors, using the Mx program (Neale et al., 2005) to estimate the genetic and environmental contributions to variance. A saturated model with free variances and covariances was first

estimated to yield expected means and covariance matrices. Next, the variance was partitioned into latent variables A, C, and E and submodels (e.g., AE, CE, and E) were fitted, with goodness-of-fit indices used to evaluate each submodel's fit compared to the full saturated model. Goodness-of-fit statistics include the difference chi-square and Akaike's Information Criterion, with lower values indicating better fitting models. The full ACE models and the best fitting models from the univariate analyses of the religiosity factors are shown in Table 4.

For five of the seven factors, an AE model provided the best fit, indicating variance in these factors could be accounted for by additive genetic and unique environmental effects. Two of the seven factors (Factor 2, "Social Religiosity" and Factor 5, "God as Judge") had modest contributions of variance from common environmental effects. In the strictest interpretation, the goodness-of-fit statistics show that an AE model represents the best fit for these two factors. However, in the presence of low power reduced models may bias parameter estimates for genetic effects upward. An ACE model may more accurately represent true parameter estimates, although this is less critical for continuous data than for categorical data because the former generally has more power (Sullivan & Eaves, 2002).

These results were compared to univariate analyses of the uncorrelated factor scores from Kendler and colleague's previous study (Kendler et al., 2003). Results were similar, with an AE model providing the best fit for five of the seven factors and estimates of variance very close in magnitude to those from the present study. See Appendix G for a comparison of the two sets of results of the factor scores.

Univariate analyses were also conducted on the four psychiatric disorders of interest in the present study. Using the Mx program (Neale et al., 2005), tetrachoric correlations for Major Depression, Phobia, Alcohol Dependence, and Nicotine Dependence were estimated for MZ and DZ twin pairs. The correlations were modeled as single liability thresholds (affected or not affected), assuming an underlying bivariate normal distribution. The Mx program was then used to partition the variance of the disorders attributed to the three latent factors A, C, and E and to compare goodness of fit in submodels. Results are shown in Table 5. An AE model provided the best fit for three of the four psychiatric disorders, with a modest contribution from common environmental effects noted for nicotine dependence.

Qualitative and quantitative sex differences were examined for the seven religiosity factors and the four psychiatric disorders. For the religiosity factors, no qualitative sex differences (different genetic and environmental factors influencing males and females) were found for any of the seven factors (see Table 6). Qualitative sex differences are determined using a one degree of freedom chi square difference test, to determine if the covariance between opposite sex DZ twin pairs can be equated to that between same sex DZ twins.

Testing for quantitative sex differences determines whether specific components of variance can be equated across the sexes (e.g., can a^2 in males be equated to a^2 in females?), using a one degree of freedom chi square difference test for each parameter tested. In the present example, a three degree of freedom test is used for ACE models and a two degree of freedom test is used for AE models. Quantitative sex differences were

found for factor 2, "Social Religiosity." (see Table 8). In subsequent bivariate analyses,

males and females were examined separately when analyzing Social Religiosity with the

four psychiatric disorders in the present study.

No evidence of qualitative or quantitative sex differences was found for any of the

four psychiatric disorders (see Tables 7 and 9). Because a modest contribution from

common environmental effects was observed for nicotine dependence, an ACE model and

an AE model were examined for nicotine dependence when analyzing for sex differences

(see Tables 7 and 9).

Table 4

Univariate Analysis of Religiosity Factors Best Fitting Models

Model	-2LL	df	a^2	c^2	e^2	$\Delta\chi^2$	AIC	p	$\chi^2 \Delta(df)$	p
Factor 1 Saturated	6788.75	2572								
ACE	6800.10	2584	.56	.09	.35	11.34	-12.66	.50		
			(.36-.70)	(0-.26)	(.30-.40)					
AE	6800.98	2585	.66	0	.34	12.22	-13.78	.51	.89 (1)	.35
			(.60-.70)	--	(.30-.40)					
Factor 2 Saturated	6624.28	2572								
ACE	6637.63	2584	.50	.17	.33	13.23	-10.77	.35		
			(.32-.70)	(0-.33)	(.28-.38)					
AE	6640.91	2585	.68	0	.32	16.51	-9.49	.22	3.28 (1)	.07
			(.63-.72)	--	(.28-.37)					
Factor 3 Saturated	6647.40	2572								
ACE	6661.05	2584	.60	.04	.36	13.64	-10.36	.32		
			(.39-.69)	(0-.22)	(.31-.42)					
AE	6661.27	2585	.64	0	.36	13.86	-12.13	.38	.22 (1)	.64
			(.59-.69)	--	(.31-41)					
Factor 4 Saturated	6825.69	2572								
ACE	6851.89	2584	.47	0	.53	26.20	2.20	.01		
			(.34-.54)	(0-.10)	(.46-.60)					
AE	6851.89	2585	.47	0	.53	26.20	.20	.02	0 (1)	1.00
			(.40-.54)	--	(.46-.60)					
Factor 5 Saturated	6350.67	2572								
ACE	6358.46	2584	.43	.17	.40	7.79	-16.21	.80		
			(.23-.63)	(0-.34)	(.35-.47)					
AE	6361.69	2585	.61	0	.39	11.02	-14.98	.61	3.23 (1)	.07
			(.55-.66)	--	(.34-.45)					
Factor 6 Saturated	6367.12	2572								
ACE	6388.08	2584	.20	0	.80	20.96	-3.04	.05		
			(0-.30)	--	(.70-.90)					
AE	6388.08	2585	.20	0	.80	20.96	-5.04	.07	0 (1)	1.00
			(.11-.30)	--	(.70-.89)					
Factor 7 Saturated	6373.41	2572								
ACE	6386.05	2584	.38	0	.62	12.64	-11.64	.40		
			(.24-.46)	--	(.54-.70)					
AE	6386.05	2585	.38	0	.62	12.64	-13.36	.48	0 (1)	incalc.
			(.30-.46)		(.54-.70)					

Note. Parameter estimates are standardized. Confidence intervals are for the 95th percentile. The first change statistic is compared to the saturated model and the final two are compared to the ACE model.

Table 5

Univariate Analysis of Psychiatric Disorders Best Fitting Models

	Model	-2LL	df	a^2	c^2	e^2	$\Delta\chi^2$	AIC	p	$\chi^2\Delta$(df)	p
MD	Saturated	3215.14	2500								
	ACE	3219.13	2503	.40	0	.60	3.99	-2.01	.26		
				(.15-.53)	(0-.18)	(.47-.75)					
	AE	3219.13	2504	.40	--	.60	3.99	-4.01	.41	0 (1)	incalc
				(.25-.53)		(.47-.75)					
Phob	Saturated	2911.86	2499								
	ACE	2913.74	2502	.33	0	.67	1.87	-4.13	.60		
				(0-.49)	(0-.25)	(.51-.84)					
	AE	2913.74	2503	.33	--	.67	1.87	-6.13	.76	0 (1)	incalc
				(.16-.49)		(51-.84)					
Alc D	Saturated	2128.60	2544								
	ACE	2132.26	2547	.52	0	.48	3.66	-2.34	.30		
				(.09-.70)	(0-.33)	(.30-.68)					
	AE	2132.26	2548	.52	--	.48	3.66	-4.34	.45	0 (1)	incalc
				(.32-.70)		(.30-.68)					
Nic D	Saturated	1915.15	2484								
	ACE	1915.91	2487	.64	.09	.27	.76	-5.24	.86		
				(.09-.85)	(0-.53)	(.15-.40)					
	AE	1916.03	2488	.74	--	.26	.88	-7.12	.93	.12 (1)	.73
				(.57-.85)		(.14-.43)					

Note. Parameter estimates are standardized. Confidence intervals are for the 95th percentile. The first change statistic is compared to the saturated model and the final two are compared to the ACE model. MD=Major Depression, Phob=Phobia, Alc D=Alcohol Dependence, Nic D=Nicotine Dependence.

Table 6

Qualitative Sex Differences, Seven Religiosity Factors

Factor	Model	-2LL Full model	-2LL Test	ΔX^2(df)	p
1	ACE	6795.26	6795.26	0 (1)	incalc
	AE	6797.65	6797.65	0 (1)	incalc
2	ACE	6627.84	6628.14	.30 (1)	.58
	AE	6631.33	6631.33	0 (1)	incalc
3	ACE	6654.86	6654.86	0 (1)	incalc
	AE	6656.80	6656.80	0 (1)	incalc
4	ACE	6848.21	6848.56	.35 (1)	.55
	AE	6849.01	6851.25	2.24 (1)	.13
5	ACE	6356.88	6356.99	.11 (1)	.74
	AE	6360.41	6360.41	0 (1)	1.00
6	ACE	6385.83	6385.87	.04 (1)	.84
	AE	6386.85	6388.07	1.23 (1)	.54
7	ACE	6383.62	6384.29	.67 (1)	.41
	AE	6385.57	6386.05	.48 (1)	.78

Table 7

Qualitative Sex Differences, Psychiatric Disorders

Disorder	Model	-2LL Full model	-2LL Test	ΔX^2(df)	p
MD	AE	3218.09	3218.18	.09 (1)	.77
Phob	AE	2913.37	2913.70	.33(1)	.57
Alc D	AE	2130.36	2132.22	1.86 (1)	.17
Nic D	ACE	1915.16	1915.91	.01 (1)	.92
	AE	1915.25	1915.25	0 (1)	incalc

Table 8

Quantitative Sex Differences, Seven Religiosity Factors

Factor	Model	-2LL Full model	-2LL Test	ΔX^2(df)	p	a_F	c_F	e_F	a_M	c_M	e_M
1	ACE	6795.26	6800.10	4.83 (3)	.18	.62 (.42-.72)	.06 (0-.24)	.32(.27-.39)	.24 (0-.66)	.36 (0-.62)	.40 (.32-.51)
	AE	6797.65	6800.98	3.32 (2)	.19	.68 (.62-.73)	--	.32 (.26-.38)	.61 (.51-.69)	--	.39 (.31-.49)
2	ACE	6628.14	6637.63	9.49 (3)	.02*	.57 (.28-.73)	.13 (0-.40)	.30 (.24-.36)	.31 (0-67)	.29 (0-.63)	.40 (.31-.51)
	AE	6631.33	6640.91	9.58 (2)	.01*	.71 (.64-.75)	--	.29 (.25-.35)	.62 (.52-.70)	--	.38 (.30-.48)
3	ACE	6654.86	6661.05	6.18 (3)	.10	.63 (.45-.72)	.04 (0-.21)	.33 (.27-.39)	.24 (0-.64)	.34 (0-.61)	.42 (.33-.53)
	AE	6656.80	6661.27	4.47 (2)	.11	.68 (.61-.73)	--	.32 (.27-.39)	.59 (.27-.39)	--	.41 (.33-.52)
4	ACE	6848.56	6851.89	3.32 (3)	.34	.29 (.01-.52)	.18 (0-.42)	.53 (.45-.63)	.47 (.28-.59)	.01 (0-.16)	.52 (.41-.66)
	AE	6851.25	6851.89	.64 (2)	.73	.47 (.38-.56)	--	.53 (.44-.62)	.47 (.32-.58)	--	.53 (.42-.67)
5	ACE	6356.99	6358.46	1.47 (3)	.69	.37 (.09-.63)	.22 (0-.46)	.41 (34-.49)	.50 (0-.66)	.10 (0-.60)	.40 (.32-.51)
	AE	6360.41	6361.69	1.28 (2)	.53	.61 (.53-.67)	--	.39 (.33-.47)	.61 (.50-.69)	--	.39 (.31-.49)
6	ACE	6385.87	6388.08	2.21 (3)	.53	.09 (0-.31)	.10 (0-.26)	.81 (.69-.93)	.21 (0-.38)	.01 (0-.30)	.78 (.62-.96)
	AE	6386.85	6388.08	1.23 (2)	.54	.20 (.10-.31)	--	.80 (.69-.92)	.21 (.03-.37)	--	.79 (.63-.97)
7	ACE	6384.29	6386.05	1.76 (3)	.62	.37 (.09-.49)	.03 (0-.27)	.60 (.50-.70)	.28 (0-.47)	.09 (0-.40)	.63 (.51-.78)
	AE	6385.57	6386.05	.48 (2)	.78	.40 (.29-.49)	--	.60 (.51-.71)	.36 (.21-.48)	--	.64 (.52-.79)

*=p<.05

Table 9

Quantitative Sex Differences, Psychiatric Disorders

Disorder	Model	-2LL Full model	-2LL Test	ΔX^2(df)	p	a_F	c_F	e_F	a_M	c_M	e_M
MD	AE	3218.18	3219.13	.95 (2)	.62	.35 (.16-.52)	--	.65 (.48-.84)	.51 (.23-.73)	--	.49 (.27-.77)
Phob	AE	2913.70	2913.73	.03 (2)	.98	.34 (.14-.52)	--	.66 (.48-.86)	.30 (0-.61)	--	.70 (.39-1.00)
Alc D	AE	2132.22	2132.26	.04 (2)	.98	.55 (.20-.80)	--	.45 (.20-.80)	.51 (.21-.73)	--	.49 (.27-.78)
Nic D	ACE	1915.16	1915.91	.75 (3)	.86	.74 (0-.92)	.05 (0-.66)	.21 (.08-.45)	.51 (0-.85)	.14 (0-.77)	.35 (.18-.65)
	AE	1915.25	1916.03	.78 (2)	.68	.79 (.58-.92)	--	.21 (.08-.42)	.66 (.37-.85)	--	.34 (.14-.63)

Note: MD=Major Depression, Phob=Phobia, Alc D=Alcohol Dependence, Nic D=Nicotine Dependence

Multivariate Analysis of Religiosity Factors

Multivariate analyses were conducted for the seven religiosity factors, using the Mx program (Neale et al., 2005). The present project is exploratory in nature. With no past studies to draw on and no strong *a priori* hypotheses about covariance between the factors, a two-step approach was used to determine the multivariate structure of the religiosity factors.

The first step was to submit the seven factors to a Cholesky or triangular decomposition, which uses a triangular matrix and its transpose to provide positive definite estimates of component covariance matrices. In a Cholesky decomposition, the number of common genetic factors, common shared environment factors, and common environmental factors are equal to the number of phenotypes, which in this case is seven. The first common factors load on each of the seven phenotypes, the second common factors load on six, the third on five, and so on as each subsequent factor load on one less phenotype. After the full Cholesky was fitted, factor loadings were examined and loadings approaching zero were tested to determine if removing these factors would result in a worse model fit.

The second step was to confirm the observed factor structure by fitting independent pathway models to the data. The independent pathway model allows multiple common factors for each phenotype as well as estimates of residual variance that are unique to each phenotype. The independent pathway model is flexible and assumes that genetic and environmental factors act independently, allowing for different patterns of

genetic versus environmental covariance (Hettema, Corey, & Kendler, 1999). An independent pathway model diagram is shown in Appendix E.

The initial Cholesky decomposition found that an AE model with all common environmental factors dropped did not result in a significantly worse fit compared to the full ACE Cholesky. Because retaining even one shared common environmental factor did not differ significantly from the full Cholesky, shared common environmental factors were dropped from further analysis. Models dropping common additive genetic factors and common unique environmental factors were also compared to the full Cholesky, with results showing that these factors could not be dropped without a significant loss of fit in the model. Therefore, additive genetic and unique environmental factors were retained for further analysis. See Table 10 for model comparisons.

An AE Cholesky model was then estimated and tests were conducted to determine if any common additive genetic factors could be dropped. Results showed that all but one additive genetic factor shared by the religiosity factors could be dropped without affecting model fit. See Table 11 for AE model and submodel comparisons.

Table 10

Comparisons of Cholesky ACE Model and Submodels

Model	-2 LL	ΔX^2 (df)	AIC	p
Full ACE	30234.29			
CE (Drop A)	30278.98	44.69 (28)	-11.30	.02
AC, E (Keep one E)	34156.10	3921.81 (21)	3879.81	0
AE (Drop C)	30235.79	1.50 (28)	-54.49	1.00
AE, 1 Cc (Keep one C)	30235.79	1.50 (7)	-12.49	.98

Table 11

Comparison of Cholesky AE Model and Submodels, Dropping Additive Genetic Factors

Model	-2 LL	ΔX^2 (df)	AIC	p
Full AE	30235.79			
Drop Factors 4-7	30235.79	0 (4)	-8.00	incalc
Drop Factors 3-7	30237.95	2.16 (5)	-7.84	.827
Drop Factors 2-7	30244.58	6.62 (6)	-5.38	.357
Drop A	30487.77	251.98 (28)	195.98	0

The next step in multivariate analysis was to confirm the results observed in Cholesky decompositions by fitting Independent Pathway models. A full seven by seven AE model was fit and factor loadings for additive genetic factors and unique environmental factors were examined. Factor loadings indicated that all but one common additive genetic factor could be dropped and the best fitting model included one common additive genetic factor, with one common unique environmental factor that loaded on all religiosity factors, and two other common unique environmental factors, one that loaded on religiosity factors 1-4 and another that loaded on factors 5, 6, and 7. See Table 12 for factor loadings from the best-fitting model. See Figure 1 for a graphic representation of the final multivariate structure.

Table 12

Factor Loadings, Best Fitting Independent Pathway Model, Seven Religiosity Factors

Religiosity Factor	Ac	Ec_1	Ec_2	Ec_3	Es
Factor 1	.51	.70	.31	--	.39
Factor 2	.54	.65	.09	--	.53
Factor 3	.61	.58	.32	--	.44
Factor 4	.44	.43	.49	--	.62
Factor 5	.80	--	.23	.25	.49
Factor 6	.45	--	.14	.46	.75
Factor 7	.68	--	.57	.35	.29

Note: Ec_1=1st common unique environment factor, Ec_2=2nd common unique environment factor, Ec_3=3rd common unique environment factor, Es=specific unique environment effect.
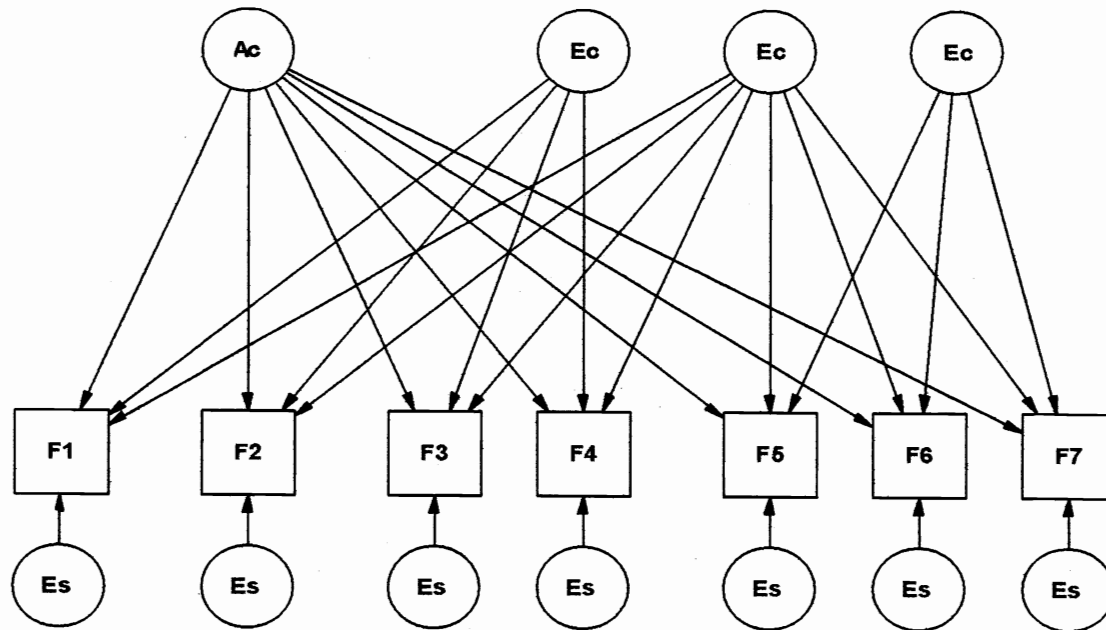
Figure 1. Multivariate structure, seven religiosity factors.

Bivariate Analysis

Bivariate analyses were conducted to estimate the covariance between the seven religiosity factors and two internalizing disorders, major depression and phobia, and two externalizing psychiatric disorders, alcohol and nicotine dependence. Factor scores for the religiosity variables were converted into deciles so that ordinal-level data could be used for analysis of both variables. Cholesky decompositions were used to estimate the covariance between the religiosity factors and the psychiatric disorders. For each factor and disorder, analysis began with a full Cholesky model including the latent variables A, C, and E. With one exception, results showed that the latent variable C (common environmental effects) was not significant and could be dropped from the models (see Table 13). Subsequent analyses included only an AE model for each religiosity factor and psychiatric disorder. The one exception to this finding was for the relationship between phobia and the religiosity factor "God as Judge." In this case, bivariate analyses were conducted with an ACE model.

Excessive computer run times made simultaneous, multivariate analysis of all seven religiosity factors and each psychiatric disorder untenable (Neale, 2003; Hettema, Neale, Myers, Prescott, & Kendler, 2006). Bivariate analyses made computer run times manageable and yielded results that were readily interpretable. A graphic representation of a bivariate Cholesky decomposition is shown in Figure 2.

Table 13

Comparison of Full ACE Model and AE Model, Bivariate Analysis of Seven

Religiosity Factors and Four Psychiatric Disorders

Factor	-2LL Full ACE Model	-2LL AE Submodel	ΔX^2 (df)	AIC	p
Factor 1					
MD	14998.8	14999.38	.58 (3)	-5.41	0.90
Phob	14681.84	14682.44	.60 (3)	-5.40	0.90
Alc D	13963.41	13963.41	0 (3)	-6.00	incalc
Nic D	13687.8	13687.8	0 (3)	-6.00	incalc
Factor 2					
MD	14971.04	14973.77	2.73 (3)	-3.27	0.43
Phob	14658.3	14660.24	1.94 (3)	-4.06	0.58
Alc D	13920.28	13921.9	1.62 (3)	-4.37	0.65
Nic D	13659.94	13661.56	1.62 (3)	-4.37	0.65
Factor 3					
MD	15020.58	15020.58	0 (3)	-6.00	1.00
Phob	14703.39	14703.39	0 (3)	-6.00	1.00
Alc D	13984.14	13984.14	0 (3)	-6.00	incalc
Nic D	13718.84	13718.84	0 (3)	-6.00	incalc
Factor 4					
MD	15118.32	15118.32	0 (3)	-6.00	incalc
Phob	14801.22	14801.32	.10 (3)	-5.90	0.99
Alc D	14107.39	14107.39	0 (3)	-6.00	incalc
Nic D	13817.59	13817.59	0 (3)	-6.00	incalc
Factor 5					
MD	15093.51	15101.11	7.59 (3)	1.59	0.06
Phob	14697.48	14708.91	11.43 (3)	5.43	0.01*
Alc D	14014.88	14019.67	4.79 (3)	-1.21	0.19
Nic D	13733.76	13738.97	5.21 (3)	-0.79	0.16
Factor 6					
MD	15207.98	15207.98	.001 (3)	-5.99	1.00
Phob	14886.36	14886.36	0 (3)	-6.00	incalc
Alc D	14208.76	14208.76	0 (3)	-6.00	incalc
Nic D	13921.53	13921.63	.10 (3)	-5.90	0.99
Factor 7					
MD	15116.93	15116.93	0 (3)	-6.00	incalc
Phob	14847.88	14847.88	0 (3)	-6.00	incalc
Alc D	14132.43	14132.43	0 (3)	-6.00	incalc
Nic D	13855.47	13855.47	0 (3)	-6.00	incalc

*=p<.05
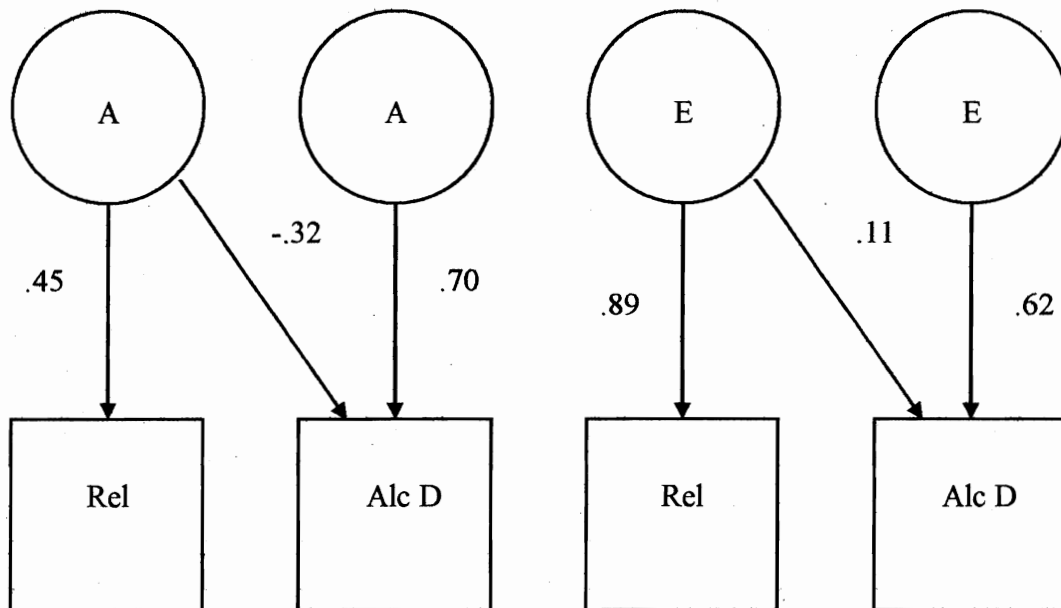
Figure 2. Bivariate Cholesky decomposition, "Unvengefulness" and alcohol dependence.

Bivariate analyses of the seven religiosity factors and internalizing and externalizing psychiatric disorders found significant negative correlations between alcohol dependence and six of the seven religiosity factors. These correlations could be accounted for by shared additive genetic factors. Similarly, additive genetic factors accounted for the significant negative correlation between nicotine dependence and one religiosity factor, "Social Religiosity" and between the religiosity factor "Unvengefulness" and phobia. Unique environmental effects were not a significant source of covariance for any of the religiosity factors and psychiatric disorders. There was no statistically significant

covariance due to additive genetic effects or unique environmental effects for major

depression and the seven religiosity factors. Correlations for additive genetic effects are

summarized in Table 14. Correlations for unique environmental effects are summarized in

Table 15.

Table 14

Additive Genetic Correlations, Religiosity Factors and Psychiatric Disorders

	MD	Phobia	Alc Dep	Nic Dep
Factor 1	0 (-.09 - .09)	.02 (-.08 - .12)	-.21† (-.25 - -.10)	-.10 (-.20 - .02)
Factor 2	-.06 (-.15 – 0)	-.02 (-.05 - .07)	-.27† (-.37 - -.24)	-.14* (-.24 - -.03)
Factor 3	-.04 (-.13 - .05)	.04 (.04 - .14)	-.19** (-.29 - -.18)	-.08 (-.20 - .03)
Factor 4	-.01 (-.03 - -.01)	-.01 (-.14 - .10)	-.18* (-.32 - -.04)	-.10 (-.23 - -.02)
Factor 5	0 (-.09 - .09)	.12* (.01 - .18)	-.11 (-.22 - 0)	-.02 (-.13 - -.02)
Factor 6	0 (-.19 - .20)	-.33** (-.59 - -.12)	-.32** (-.61 - -.09)	-.05 (-.30 - .19)
Factor 7	-.04 (-.17 - -.01)	-.04 (-.06 - .10)	-.31† (-.46 - -.15)	-.14 (-.28 - .02)

Note: MD=Major Depression, Alc Dep=Alcohol Dependence, Nic Dep=Nicotine Dependence
*=p<.05, **= p<.01, ***=p<.001, $\dagger$=p<.0001

Table 15

Unique Environmental Correlations, Religiosity Factors and Psychiatric Disorders

	MD	Phobia	Alc Dep	Nic Dep
Factor 1	.04 (-.07 - .15)	.01 (-.11 - .13)	-.03 (-.16 - .02)	-.11 (-.24 - .01)
Factor 2	-.02 (-.13 - .09)	-.03 (-.15 - .09)	0 (-.11 - .03)	-.09 (-.21 - .04)
Factor 3	.05 (-.06 - .16)	-.04 (-.16 - .08)	-.06 (-.19 - -.02)	-.06 (-.18 - .07)
Factor 4	.04 (-.03 - .07)	-.01 (-.12- -.01)	.04 (.01 - .13)	-.04 (-.16 - .05)
Factor 5	0 (-.11 - .11)	-.06 (-.18 - .06)	-.04 (-.12 - .04)	0 (-.04 - .12)
Factor 6	-.08 (-.18 - .02)	.10 (.01 - .20)	.11 (0 - .23)	-.02 (-.13 - .09)
Factor 7	0 (0 - .11)	-.03 (-.04 - .05)	.02 (-.10 - .13)	-.07 (-.17 - .04)

Note: MD=Major Depression, Alc Dep=Alcohol Dependence, Nic Dep=Nicotine Dependence
All covariances non-significant

Significant covariance between the religiosity factor "God as Judge" and phobia could be accounted for by common environmental effects. Model comparisons showed that the latent variable C (common environmental effects) could not be dropped without a significant loss in model fit (See Table 13). Submodels were tested to determine the significance of correlations due to additive genetic effects, common environmental effects, and unique environmental effects and 95% confidence intervals were estimated for each parameter. As shown in Table 16, both additive genetic effects and common environmental effects accounted significantly for the correlation. The correlation due to unique environmental effects was not statistically significant. Parameter estimates and 95% confidence intervals are given in Table 17 and the model is represented graphically in Figure 3.

Table 16

Model Comparisons, Bivariate Analysis of God as Judge and Phobia

	-2LL	x2 (df)	AIC	p
Full ACE Model	14697.48			
Drop COV$_A$	14707.60	10.12 (1)	8.12	.001**
Drop COV$_C$	14703.71	6.23 (1)	4.23	.01*
Drop COV$_E$	14700.04	2.56 (1)	.56	.11
Drop COV$_{A, C}$	14708.40	10.92 (2)	6.92	.004**

*=p<.05, **=p<.01

Table 17

Bivariate Analysis of God as Judge and Phobia

	God as Judge	Correlation	Phobia
Additive Genetic Effects	.60 (.43-.73)	.49** (.19-.63)	0 (-.61-.61)
Common Environmental Effects	.50 (.31-.58)	-.35* (-.49- -.10)	0 (-.41-.18)
Unique Environmental Effects	.62 (.57-.66)	-.10 (-.11-.02)	.79 (.69-.88)

*=p<.05, **=p<.01
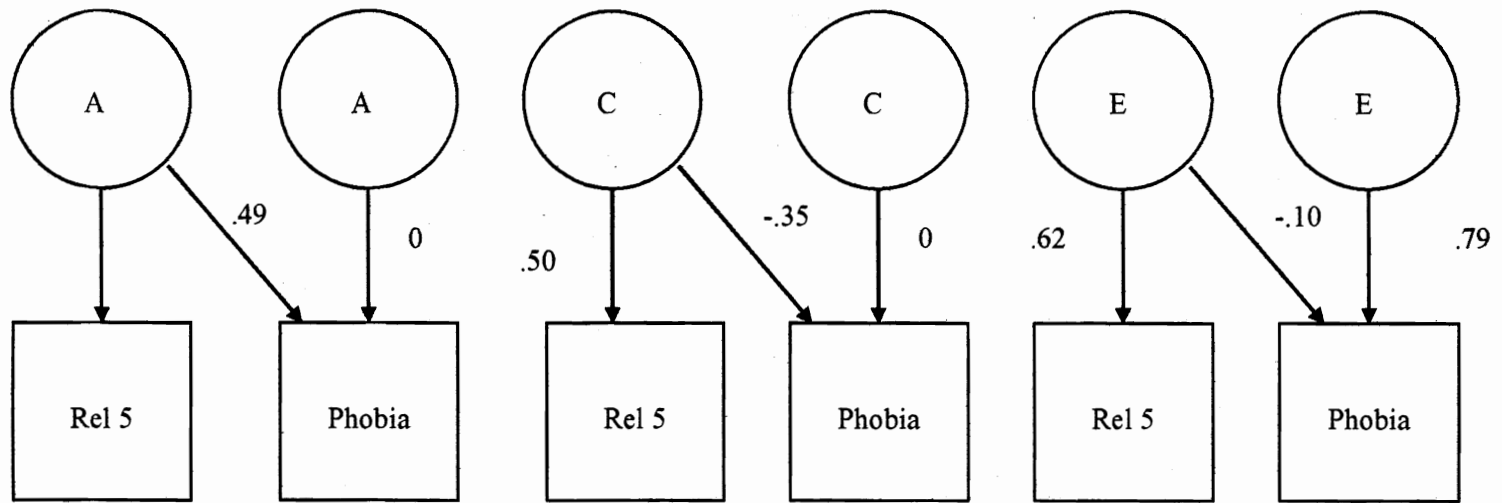
Figure 3. Bivariate relationships between "God as Judge" and phobia.

Because quantitative sex differences were found for Factor 2, "Social Religiosity," estimates of the variance shared by "Social Religiosity" and each of the four psychiatric diagnoses were estimated separately for males and females. Results are shown in Table 18. A low number of male twin pairs affected by phobia resulted in poor parameter estimates for the correlations between "Social Religiosity" and phobia in males.

Table 18

Bivariate Analysis of Social Religiosity and Four Psychiatric Disorders by Sex

Sex	Social Religiosity	Correlation	Disorder	Social Religiosity	Correlation	Disorder
	Social Religiosity A	Correlation A	MD A	Social Religiosity E	Correlation E	MD E
Male	.78 (.70-.84)	-.11 (-.29-.07)	.71 (.47-.85)	.63 (.55-.71)	-.02 (-.22-.17)	.69 (.51-.87)
Female	.84 (.80-.87)	-.04 (-.16-.07)	.59 (.40-.72)	.54 (.49-.60)	-.06 (-.70-.08)	.81 (.69-.91)
	Social Religiosity A	Correlation A	Phobia A	Social Religiosity E	Correlation E	Phobia E
Male	.78 (.70-.83)	0 (-.21-.20)	.57 (-.79-.79)	.63 (.55-.71)	.02 (-.21-.25)	.82 (.61-1.00)
Female	.84 (.80-.87)	-.10 (-.22-.20)	.59 (.39-.73)	.54 (.49-.59)	-.11 (-.26-.03)	.79 (.67-.91)
	Social Religiosity A	Correlation A	Alc Dep A	Social Religiosity E	Correlation E	Alc Dep E
Male	.78 (.69-.83)	-.23*(-.40- -.04)	.69 (.44-.78)	.63 (.55-.72)	-.07 (-.26-.13)	.69 (.51-.86)
Female	.84 (.80-.87)	-.26**(-.42 - -.09)	.74 (.47-.88)	.54 (.49-.59)	.11 (-.07-.30)	.61 (.39-.84)
	Social Religiosity A	Correlation A	Nic Dep A	Social Religiosity E	Correlation E	Nic Dep E
Male	.78 (.70-.83)	-.23* (-.43- -.03)	.77 (.52-.90)	.63 (.55-.72)	-.05 (-.26 -.16)	.59 (.39-.81)
Female	.84 (.80-.87)	-.10 (-.26-.07)	.90 (.78-.96)	.54 (.49-60)	-.10 (-.29-.08)	.40 (.24-.61)

$*=p<.05$, $**=p<.01$

Additional Analyses

The present study included 10 religiosity items that were used in a previous study of female twins (Kendler, Gardner, & Prescott, 1997). Of the 1,902 female twins who participated in the previous study, 1,021 (54%) completed the surveys used in the present study. The average age of participants in the previous study was 30.10 years (SD=7.60), while the average age of female twins who also participated in the present sample was 43.55 years (SD=7.64). Using the 10 items repeated in the present sample, an analysis of 1,021 female twins who participated in both studies was conducted to determine the stability of these measures over time.

The first step in the analysis was to recover the two factors from the 10 items reported previously (Kendler, Gardner, & Prescott, 1997). The 10 items were submitted to factor analyses and uncorrelated factor scores were obtained using a VARIMAX rotation in the SAS program (SAS Institute Inc., 2002-2003). Correlated factor scores were obtained using the Mplus program (Muthen & Muthen, 1998-2004). The two factors were labeled "Personal Devotion" and "Personal Conservatism." Correlation coefficients for uncorrelated factor scores at time one and at time two were estimated. The correlation for "Personal Devotion" was +0.71, while the correlation for "Personal Conservatism" was +0.55.

Univariate analyses of each factor at time two were conducted using the Mx program (Neale et al., 2005). For the factor "Personal Devotion," estimates of additive genetic, common environmental, and unique environmental effects were similar for both uncorrelated and correlated factor scores. Both methods showed a modest contribution

from common environmental effects in a full ACE model, with an AE model providing the best fit. Both methods showed additive genetic effects increasing and common environmental effects decreasing from time one to time two (see Table 19).

For the factor "Personal Conservatism," the two different methods of estimating factor scores produced somewhat different results. Using uncorrelated factor scores, a CE model provided the best fit and estimates of variance were very similar from time one to time two. When partitioning the variance using correlated factor scores, an AE model could not be rejected. The full ACE model provided the best fit, with common environmental factors accounting for 21% of the variance (see Table 19). Small sample size may have affected the ability to precisely estimate parameters. Confidence intervals were not reported in the previous study, therefore a comparison of the precision of parameter estimates from time one to time two was not possible.

Table 19

Longitudinal Comparison of Two Factors from 10 Religiosity Items

Factor	Method	Model	-2LL	a^2	c^2	e^2	ΔX^2(df)	AIC	p
Personal Devotion	Correlated	Saturated	2391.51						
		ACE	2394.45	.48	.10	.41	2.94 (3)	-3.10	.40
				(.20 - .66)	(0 - .35)	(.34 - .50)			
		AE	2395.00	.60	--	.40	3.50 (4)	-4.49	.48
				(.51 - .67)	--	(.33 - .49)			
Personal Devotion	Uncorrelated	Saturated	2771.41						
		ACE	2772.87	.43	.12	.44	1.46 (3)	-4.54	.69
				(.14-.63)	(0 - .38)	(.37-.53)			
		AE	2773.63	.56	--	.44	2.22 (4)	-5.78	.69
				(.48-.63)	--	(.37-.52)			
Personal Devotion	Uncorrelated (1997)			.29	.24	.47			
Personal Conservatism	Correlated	Saturated	2198.24						
		ACE	2204.68	.36	.21	.43	6.44 (3)	.44	.09
				(.08-.63)	(0 - .44)	(.35-.52)			
		AE	2207.15	.59	--	.41	8.91 (4)	.91	.06
				(.50 - .66)	--	(.34 - .49)			
Personal Conservatism	Uncorrelated	Saturated	2795.69						
		ACE	2800.82	.12	.34	.54	5.13 (3)	-0.87	.16
				(0-.42)	(.08-.50)	(.45-.64)			
		CE	2801.52	--	.43	.57	5.83 (4)	-2.17	.21
				--	(.35-.51)	(.43-.59)			
Personal Conservatism	Uncorrelated (1997)				.45	.55			

Discussion

The present study examined genetic and environmental effects on different dimensions of religiosity, estimated how genetic and environmental factors account for covariation between different dimensions of religiosity, and explored the role of genetic and environmental effects in accounting for the covariance between different dimensions of religiosity and internalizing and externalizing psychiatric disorders. Additional analyses were performed on longitudinal data for a subset of religiosity measures.

Univariate analyses found that the best fitting models for the seven religiosity factors included additive genetic and unique environment effects. Statistically significant common environmental effects were not found although a modest contribution from common environmental effects was observed for two religiosity factors. Multivariate analyses found that the seven religiosity factors were influenced by one common additive genetic factor, three common unique environmental factors, and unique environmental effects specific to each religiosity factor.

Bivariate analyses of the religiosity factors and psychiatric disorders showed that the covariation between various religiosity factors and alcohol dependence, nicotine dependence, and phobia could be accounted for by shared additive genetic effects. Common environmental effects accounted for significant covariance between the religiosity factor "God as Judge" and phobia.

Analysis of a subset of 10 religiosity items showed that common environmental effects may decrease over time for some dimensions of religiosity and that the ability to

detect common environmental effects may be influenced by specific items used to measure religiosity.

Univariate Findings

The univariate findings in the present study, in which additive genetic and unique environmental effects accounted for the variance in the best-fitting models for five of the seven religiosity factors, are somewhat in contrast to previous studies that have reported contributions to variance from common environmental effects. The variable religious affiliation has been used in previous studies to demonstrate that behavior genetics methodology, specifically twin studies, can measure traits that do not have a large portion of additive genetic effects contributing to the observed variance (Eaves, Martin, & Heath, 1990). Other religiosity measures have been used in twin studies, including church attendance, spiritual involvement, internal and external religiousness, personal devotion, personal conservatism, and religious well being. Many, but not all studies, have reported substantial amounts of variance accounted for by common environmental effects (Kendler et al., 1997; Kirk, Eaves, and Martin, 1999; Koenig et al., 2005; Truett et al., 1992; Tsuang et al., 2002). However, there have been exceptions. Kirk, Eaves, and Martin (1999) found no common environmental effects for the variable self transcendence in a study of older Australian twins. Tsuang and colleagues (2002) studied three spirituality measures and found no common environmental effects for existential well being in a study of Vietnam era males. Olson and colleagues (2002) reported no common environmental effects for attitude toward organized religion in a study of adult males and females. Additionally, Waller and colleagues (1990) reported that common environmental effects

for religious leisure time interests and religious occupational interests were non-significant in a sample of 1,642 male and female twins.

The present study used the most comprehensive set of religiosity measures known to exist for behavior genetics studies. The results presented here suggest that when a relatively ill-defined construct such as religiosity is saturated with items intended to create maximum heterogeneity and sophisticated measurement techniques (in this case, factor analysis) are applied, additive genetic effects and unique environmental effects account for most of the observed variance, with common environmental effects accounting for a smaller portion of the estimated variance. As others have noted, the predominance of additive genetic effects and unique environmental effects makes the expression of religiosity similar to other traits such as personality and temperament (Waller, Kojetin, Bouchard, Lykken, & Tellegen, 1990). Replication is needed to have confidence in the present study's findings.

Multivariate Findings

Multivariate analyses found that the seven religiosity factors were influenced by one common additive genetic factor, three common unique environmental factors, and unique environmental effects that were specific to each religiosity factor. Common environmental factors were not statistically significant and could be dropped without resulting in a worse model fit.

One interpretation of these results is that for the population represented by this sample, there is one common additive genetic factor that affects the predisposition to become religious, while unique environmental factors shape the specificity of how

religiosity phenotypes are expressed. In other words, the predisposition to become religious is due in part to additive genetic effects, while the manner in which that religiosity is expressed is shaped by unique environmental effects (e.g., the decision to become a fundamentalist or a pacifist, a preference for charismatic worship styles or contemplative spiritual experiences, etc.).

In the present sample, all seven religiosity factors were influenced by one unique environmental factor. The religiosity factors "General Religiosity," "Social Religiosity," "Involved God," and "Forgiveness/Love" were influenced by a second unique environmental factor. The three religiosity factors "God as Judge," "Unvengefulness," and "Thankfulness" were influenced by a third unique environmental factor. In other words, environmental experiences were identified that appear to uniquely influence these less traditional aspects of religiosity, while another set of environmental experiences appears to uniquely influence the more traditional aspects of religiosity. However, unique environmental experiences were also identified that appear to influence both the less traditional and more traditional aspects of the religiosity construct.

The present findings yield surprising insights into the nature of religiosity. The common (or "family") environment is often assumed to play a large role in determining mental well-being or mental illness (Kendler, 1995, Kendler, Myers, & Prescott; 2000; Kendler, 2005) and in passing on traits such as attitudes. However, twin studies have shown that the common environment has little or no detectable effect on most psychiatric disorders and personality and only modest contributions to other psychological differences such as social attitudes (Bouchard & McGue, 2003; Kendler, 2001; Kendler, 1995). Illicit

drug use/dependence is a typical exception where significant common environmental

effects are commonly found (Button, Rhee, Hewitt, Young, Corley, & Stallings, in press;

Tsuang, Lyons, Eisen, Goldberg, True, Lin, Meyer, Toomey, Faraone, & Eaves, 1996).

The present findings are another example of only modest, if any, effects from the common

or family environment. Past studies have shown substantial common or family

environmental effects on certain dimensions of religiosity such as religious affiliation

(Eaves, Martin, & Heath, 1990) and personal conservatism (Kendler, Gardner, & Prescott,

1997). However, the results of the present study add evidence that religiosity, when

operationalized as a broad, multidimensional construct, is similar to other individual

differences such as personality and social attitudes.

Before concluding that family environment has absolutely no impact on becoming

religious, it is important to consider that due to the limitations of classical twin studies, the

present findings do not completely diminish the importance of the family environment in

passing on religious values. To understand why, one must understand what exactly the

common or family environment tells us in twin studies. In twin studies, common or family

environment is defined as those environmental experiences that make twins similar.

Unique environmental effects are defined as those environmental experiences that make

members of the twin pair different. Two twins may experience the same "objective"

environmental event but respond differently to that event. This type of event would be

reflected in a twin study as a unique environmental effect, even though it was experienced

by both twins in the family environment (Kendler, 2001). Another consideration is that the

power limitations of classical twin studies require samples with tens of thousands of twin

pairs to detect relatively small common environmental effects. Studies that have been able

to address this methodological issue have shown that common or family environmental

effects do play a role in the development of traits and disorders, but the magnitude of the

effects is far below the power of most studies to detect (Kendler, 2001; Kendler, Myers, &

Prescott; 2000). Therefore, the results of the present study do not completely negate the

importance of the family environment in passing on religious values, and indeed, two twins

could be exposed to the same religious upbringing, but due to differences such as

temperament or other factors, one twin could become religious while the other does not

become religious.

Bivariate Findings

The bivariate results from the present study were in some ways consistent with

what would be expected from previous literature, in that inverse relationships were

observed between alcohol and nicotine dependence and several of the religiosity factors

(Kendler, Gardner, & Prescott, 1997; Kendler et al., 2003). For six of the seven

religiosity factors there were statistically significant negative correlations between

religiosity and alcohol dependence, accounted for by additive genetic factors. Similarly,

additive genetic factors accounted for the negative correlation between the factor "Social

Religiosity" and nicotine dependence. Unique environmental factors did not account

significantly for any of the relationships between alcohol and nicotine dependence and the

seven religiosity factors.

These results indicate that genetically, the predisposition to become religious is

inversely related to a predisposition toward alcohol dependence. The lack of any

significant environmental correlation suggests that in the present sample, relationships between religiosity and alcohol dependence are likely not due to environmental effects. In the most conservative interpretation, we can say that common factors, most likely additive genetic factors, account for the association between religiosity factors and alcohol dependence in the present study. More speculatively, it may be surprising that environmental effects do not account significantly for the association between religiosity and alcohol dependence, given widely held beliefs about the life-changing effects of becoming religious either through mystical religious experiences (James, 1902/1997) or through spiritually-oriented programmatic experiences such as Alcoholics Anonymous. (Royce & Scratchley, 1996).

The present results do not rule out gene-environment interactions, which occur when the environment alters genetic expression of a trait (Timberlake, Rhee, Haberstick, Hopfer, Ehringer, Lessem, Smolen, & Hewitt, 2006). Previous studies have shown that for individuals with a religious upbringing or who rate themselves as being religious, gene-environment interactions may attenuate the genetic influence on alcohol and smoking initiation, which in turn would influence the development of alcohol or nicotine dependence (Koopmans, Slutske, van Baal, & Boomsma, 1999; Timberlake et al., 2006). In other words, the environmental effects of a religious upbringing may attenuate the genetic effects on alcohol use or smoking initiation, so that an individual raised in such an environment does not later develop alcohol or nicotine dependence.

Somewhat surprisingly, no statistically significant relationships were observed in the covariance between major depression and the seven religiosity factors. Modest inverse

relationships between major depression and religiosity have been observed consistently in past studies (Kendler et al., 2003; Smith, McCullough, & Poll, 2003). In a previous study using the present sample, Kendler and colleagues (2003) found overall phenotypic associations between several religiosity factors and major depression. In the present study the correlations between religiosity factors and additive genetic and unique environmental effects for major depression were essentially zero, showing that while overall phenotypic associations may be significant, when the variance is decomposed into additive genetic, common environmental, and unique environmental effects, none are significant by themselves.

Interestingly, two of the religiosity factors had significant correlations with phobia. The correlation due to additive genetic effects between to the religiosity factor "Unvengefulness" and phobia was negative suggesting that the genes that predispose an individual not to seek revenge are also protective against developing phobia. The relationship between the religiosity factor "God as Judge" and phobia was the only bivariate relationship in which common environmental effects accounted significantly for the observed covariance. Previous literature has suggested that appraisals of a punishing God may have a negative affect on well-being (Miller, 1998; Pargament, 2002), but to our knowledge this finding has not been linked specifically to phobia. For "God as Judge," the covariance due to additive genetic effects and common environmental effects were in opposite directions. The covariance due to additive genetic effects was positive while the covariance due to common environmental effects was negative. This suggests that common environmental effects shared by this religiosity factor and phobia may attenuate

or cancel out shared additive genetic effects that predispose one to both believe in a punitive and judgmental deity and to develop phobia.

Separate bivariate analyses based on quantitative sex differences in "Social Religiosity" resulted in a contrast between males and females with regard to the correlation with nicotine dependence. Additive genetic effects accounted for the negative correlation between "Social Religiosity" and nicotine dependence in both males and females, but were only statistically significant for males. This suggests that more of the covariance is mediated by additive genetic effects in males than in females in the relationships between the social aspects of religiosity and nicotine dependence.

Overall, while statistically significant in several bivariate relationships, the estimates of covariance due to additive genetic effects were modest. Therefore, while there are statistically significant genetic effects that are shared by the religiosity factors and psychiatric disorders examined in the present study, there are many other variables that have stronger bivariate relationships with these psychiatric disorders (e.g., Kendler, Heath, Neale, Kessler, & Eaves, 1993). The present findings also support previous conclusions by authors who have noted that the relationships between religiosity and health are complex and modest (Thoresen & Harris, 2002).

While there is limited evidence for the efficacy of religious or spiritually-oriented interventions (Worthington & Sandage, 2001), the results of the present study should not preclude clinicians from incorporating religiosity into clinical practice when it is appropriate to do so (e.g., assessing the importance of religiosity to a patient, referring a patient to a chaplain, making referrals to explicitly religious treatment programs, etc.).

Religiosity is an important part of many individuals' value systems and is a significant source of meaning in people's lives (Paloutzian & Park, 2005; Shafranske, 2005). Further, for some religious patients, an acknowledgment of the importance of their religiosity may be expected in treatment (CASA, 2001; Worthington & Sandage, 2001). The importance of religiosity, quite apart from its efficacy as an intervention, has long been recognized. For example, Sir Francis Galton, the father of behavior genetics, observed that although his studies found that prayer does not protect individuals from harm, prayer nevertheless helps people cope with the trials of life (Galton, 1869/1978; Galton, 1876).

Additional Analyses

Using 10 items that had been included in a previous study by Kendler, Gardner, and Prescott (1997), an analysis of 1,021 female twins who participated in both studies was performed. These results, in combination with other results reported in the present study, suggest that for individual religiosity measures, substantial common environmental effects may be observed, but when these measures are incorporated into larger sets of related items in factor analysis, common environmental effects may be attenuated. As has been noted in previous research (Pearce, Little, & Perez, 2003), findings are affected by what aspect of religiosity is being measured.

For one of the two factors derived from these 10 items ("Personal Devotion"), additive genetic effects increased while common environmental effects decreased from time one to time two. According to correlation coefficients, "Personal Devotion" was a more stable trait over time compared to "Personal Conservatism." This indicates that the

extent to which twins are similar on the trait "Personal Conservatism" lessens over time. Replication is needed to confirm these findings.

Limitations and Directions for Future Research

In addition to the general limitations of twin studies that are discussed in the literature review section above, there are several limitations specific to the present study that must be considered. First, the twins in the Virginia Twin Registry are all Caucasian and findings from the present study may not generalize to other racial or ethnic groups. Self-report measures of religiosity and spirituality have been found to vary by race and ethnicity (Shahabi et al., 2002). Second, although population-based, this sample may not be fully representative of the twin population in Virginia. Questionnaires were sent out to 7,230 twins who had participated in previous studies and 2,621 questionnaires were returned. Limited resources prevented follow-up with non-responders (Kendler et al., 2003). Third, although the present study used the most comprehensive set of religiosity items known to exist for behavior genetics research, a relatively small sample size may have limited the ability to detect effects in bivariate analyses, due to the relatively low number of participants affected by each disorder studied. Finally, the present study was largely exploratory in nature and findings need to be replicated in future studies.

Despite these limitations, the present study represents a first of its kind in the field of behavior genetics. The present study used the most comprehensive set of religiosity measures known to be available for behavior genetics studies. The results of multivariate and bivariate analyses in the present study reinforce findings from previous research that

point toward the complexity of the religiosity construct, as well as the complexity of

religiosity's relationships with various psychiatric disorders.

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Appendix A
Summary of Estimates of Variance

Author/Variable	Sample	a^2	c^2	e^2
D'Onofrio et al., 1999	Adolescent Males			
Theism		—	75%	25%
Religious/Spiritual Practices		3%	74%	22%
Peer religiousness		50%	10%	40%
Drug use as sinful		9%	43%	48%
	Adolescent Females			
Theism		20%	53%	27%
Religious/Spiritual Practices		13%	62%	25%
Peer religiousness		1%	58%	40%
Drug use as sinful		12%	53%	35%
Truett, Eaves, et al., 1992	Adult Male and Female Twins			
	Females			
Religious Conservatism		37%	34%	29%
Church Attendance		21%	46%	33%
	Males			
Religious Conservatism		16%	47%	37%
Church Attendance		—	66%	34%
Kendler et al., 1997	Adult Females			
Personal Devotion		29%	24%	47%
Personal Conservatism		—	45%	55%
Institutional Conservatism		12%	51%	37%
Bouchard et al., 1999	Adult Twins Reared Apart			
Intrinsic Religiousness		43%	—	57%
Extrinsic Religiousness		39%	—	61%
Kirk, Eaves, & Martin, 1999	Adult Males and Females			
Self Transcendence				
Males		48%	—	48%
Females		48%	—	52%
Church Attendance				
Males		22%	43%	34%
Females		—	43%	56%
Olson et al., 2001	Adult Males and Females			
Attitude Organized Religion		45%	—	55%

Tsuang et al., 2002	Vietnam Era Males			
Spiritual Involvement		23%	45%	32%
Religious Well Being		37%	10%	53%
Existential Well Being		36%	--	64%
Koenig et al., 2005	Adult Males			
Retrospective Religiousness				
Internal		20%	44%	36%
External		8%	53%	39%
Current Religiousness				
Internal		34%	24%	42%
External		39%	18%	43%

Appendix B
Seven Factors from Kendler et al., 2003

Factor 1 - General Religiosity
I ask God to help me make important decisions.[1]
I feel that without God, there would be no purpose in life.[1]
Spiritual experiences are important to me.[1]
My faith in God helps me through hard times.[1]
I feel like I can always count on God.[1]
I try to live how God wants me to live.[1]
I consider myself to be a very spiritual person.[1]
My faith in God shapes how I think and act every day.[1]
I help others with their religious questions and struggles.[1]
Every day I see evidence that God is active in the world.[1]
I seek out opportunities to help me grow spiritually.[1]
I take time for periods of private prayer and meditation.[1]
I feel surrounded by God's love every day.[5]
In general, how important are your religious or spiritual beliefs in your daily life?[2]
To what extent are you conscious of some religious goal or purpose in life that serves to give you direction?[2]
When you have problems or difficulties in your family, work, or personal life, how often do you seek spiritual comfort?[2]
How satisfied are you with your spiritual life?[2]
Other than at mealtime, I pray to God privately.[2]
I feel God's presence.[3]
I find strength and comfort in my religion.[3]
I feel deep inner peace or harmony.[3]
I feel God's love for me, directly or through others.[3]
I am spiritually touched by the beauty of creation.[3]
I think about how my life is part of a larger spiritual force.[3]
I work together with God as partners to get through hard times.[3]
I look to God for strength, support, and guidance in crises.[3]
I try to find the lesson from God in crises.[3]
I try to make sense of the situation and decide what to do without relying on God.[3]
I confess my sins and ask for God's forgiveness.[3]
To what extent is your religion involved in understanding or dealing with stress situations in any way?[3]

Factor 2 - Social Religiosity
I know I can count on people from my church when I need help.[1]
Being with other people who share my religious views is important to me.[1]
My friends and I often talk about religious matters.[1]

Most of my best friends are religious.[1]
I like to worship and pray with others.[1]
I go to Sunday school often.[1]
Most of my best friends go to church.[1]
I often attend church activities such as Bible study and choir practice.[1]
How often in the last year did you attend religious services?[2]
I believe that smoking marijuana is a sin.[1]
I believe drinking alcohol is a sin.[1]
I believe that smoking cigarettes is a sin.[1]

Factor 3 - Involved God

I believe in God.[1]
I know that God loves me just as I am.[4]
I believe that God often responds to the individual prayers of men and women.[5]
I believe that God is very interested in the day-to-day lives of men and women.[5]
Do you believe in God or in a universal spirit?[2]
I question whether God really exists (scored negatively).[3]

Factor 4 - Forgiveness/Love

I try to live by the saying "love thy neighbor as thyself."[5]
I can forgive even if someone hurts me on purpose.[5]
I try to care for other people even if I don't really like them.[5]
I believe that you have to care about people regardless of how they treat you.[5]
Even when it is difficult, I try to forgive other people who have hurt or offended me.[5]
I try to be forgiving toward other people.[5]
I feel deep love for the world and all the creatures in it.[5]

Factor 5 - God as Judge

I believe that God has a lot of rules about how people should live their lives.[4]
I believe that God can be counted on to reward goodness and punish evil.[5]
I believe God is very strict.[4]
I believe God will punish me if I do something wrong.[4]
Do you believe that this God or universal spirit observes your actions and rewards or punishes you for them?[2]
I feel that stressful situations are God's way of punishing me for my sins or lack of spirituality.[3]
The Bible is the actual word of God and is to be taken literally word for word.[2]

Factor 6 - Unvengefulness (all scored negatively)

It is all right to get back at someone who hurts or offends you.[5]
I believe that if I do a lot of wrong things, God will stop loving me.[4]
The only person I have to thank for what I have received in life is me.[5]
When someone hurts me, I want to get whatever revenge I can.[5]

If people are not kind to me, I am not going to be kind to them.[5]
People tell me that I am not grateful enough for what I have in life.[5]
When someone hurts or offends me, I can only get over it when I have figured out how to get my revenge.[5]
When I look at the world, I don't see much to be grateful for.[5]

Factor 7 – Thankfulness

I feel thankful for what I have received in life.[5]
I feel grateful nearly every day.[5]
I express anger at God for letting terrible things happen (scored negatively).[3]
I wonder whether God has abandoned me (scored negatively).[3]
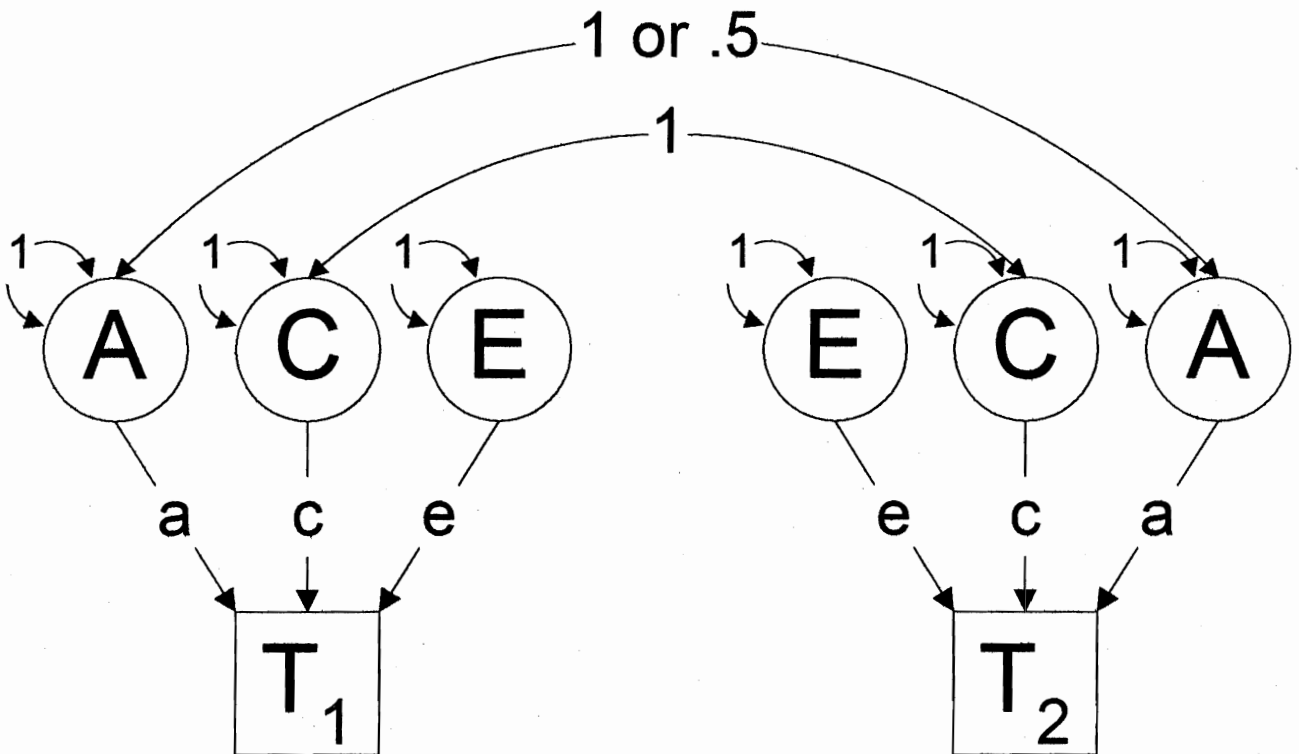
1=D'Onofrio et al. (1999)
2=Kendler, Gardner, & Prescott (1997)
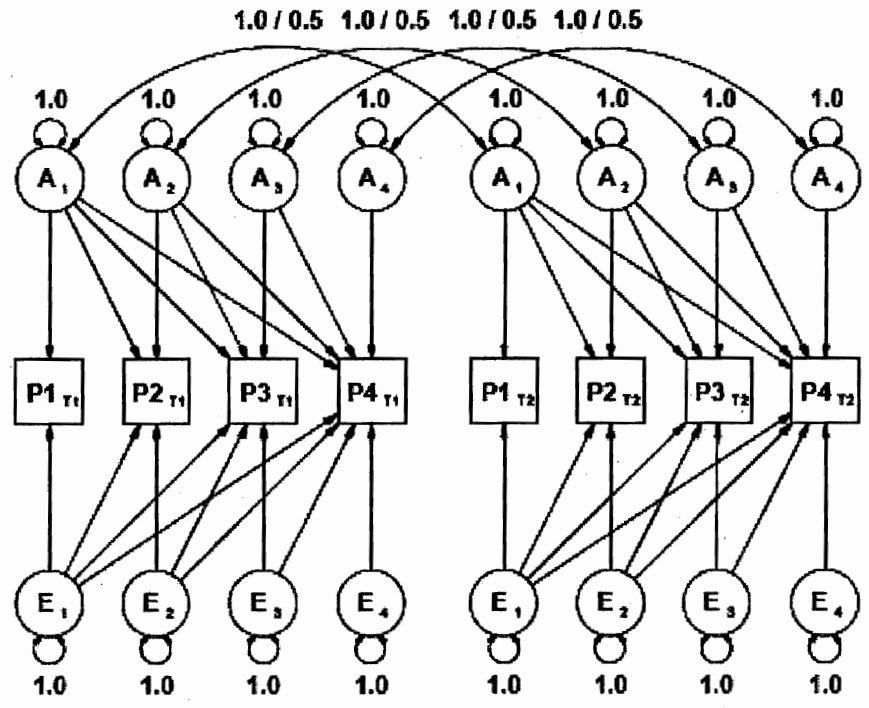3=Fetzer Institute (1999)
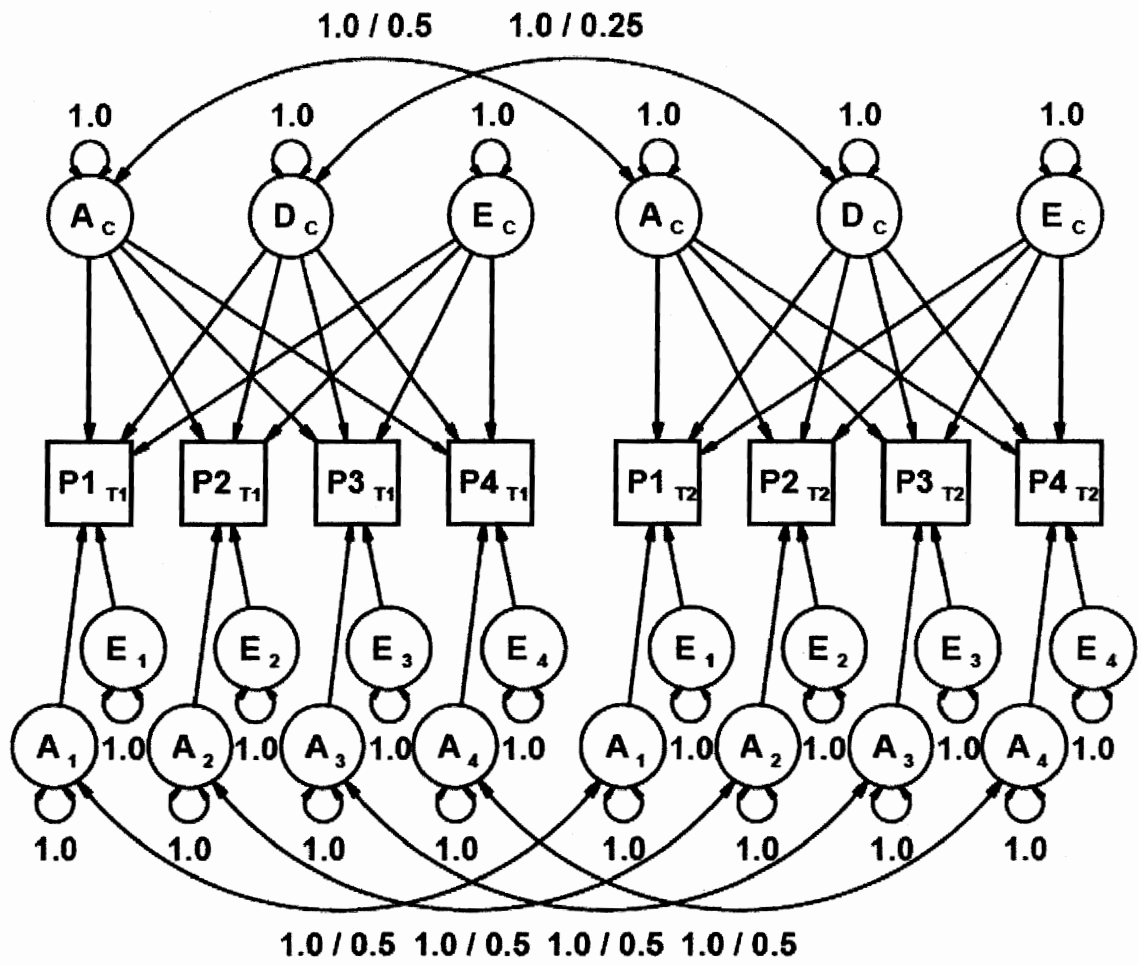4=Hertel & Donahue (1995)
5=Kendler et al. (2003)

Appendix C
Univariate ACE Model

Appendix D
Cholesky Decomposition

1.0 / 0.5 1.0 / 0.5 1.0 / 0.5 1.0 / 0.5

Appendix E
Independent Pathway Model

Appendix F
Factor Loadings
Correlated Factor Scores, Seven Religiosity Factors

Factor 1	Loading	SE
I ask God to help me make important decisions.	.904	.005
I feel that without God, there would be no purpose in life.	.873	.006
Spiritual experiences are important to me.	.880	.006
My faith in God helps me through hard times.	.951	.003
I feel like I can always count on God.	.944	.004
I try to live how God wants me to live.	.858	.007
I consider myself to be a very spiritual person.	.854	.006
My faith in God shapes how I think and act every day.	.922	.044
I help others with their religious questions and struggles.	.843	.007
Every day I see evidence that God is active in the world.	.883	.006
I seek out opportunities to help me grow spiritually.	.865	.006
I take time for periods of private prayer and meditation.	.843	.007
I feel surrounded by God's love every day.	.841	.007
In general, how important are your religious or spiritual beliefs in your daily life?	.929	.005
To what extent are you conscious of some religious goal or purpose in life that serves to give you direction?	.843	.007
When you have problems or difficulties in your family, work, or personal life, how often do you seek spiritual comfort?	.896	.006
How satisfied are you with your spiritual life?	.475	.015
Other than at mealtime, I pray to God privately.	.837	.007
I feel God's presence.	.912	.004
I find strength and comfort in my religion.	.738	.010
I feel deep inner peace or harmony.	.878	.005
I feel God's love for me, directly or through others.	.721	.010
I am spiritually touched by the beauty of creation.	.860	.006
I think about how my life is part of a larger spiritual force.	.648	.013
I work together with God as partners to get through hard times.	.898	.005
I look to God for strength, support, and guidance in crises.	.919	.004
I try to find the lesson from God in crises.	.749	.010
I try to make sense of the situation and decide what to do without relying on God.	.616	.015
I confess my sins and ask for God's forgiveness.	.832	.008
To what extent is your religion involved in understanding or	.856	.007

dealing with stress situations in any way?		
Factor 2		
I know I can count on people from my church when I need help.	.864	.009
Being with other people who share my religious views is important to me.	.924	.006
My friends and I often talk about religious matters.	.734	.013
Most of my best friends are religious.	.887	.008
I like to worship and pray with others.	.711	.013
I go to Sunday school often.	.858	.008
Most of my best friends go to church.	.702	.014
I often attend church activities such as Bible study and choir practice.	.930	.005
How often in the last year did you attend religious services?	.843	.009
I believe that smoking marijuana is a sin.	.796	.009
I believe drinking alcohol is a sin.	.879	.007
I believe that smoking cigarettes is a sin.	.813	.009
Factor 3		
I believe in God.	.924	.010
I know that God loves me just as I am.	.777	.012
I believe that God often responds to the individual prayers of men and women.	.933	.006
I believe that God is very interested in the day-to-day lives of men and women.	.885	.007
Do you believe in God or in a universal spirit?	.825	.022
I question whether God really exists (scored negatively).	.677	.020
Factor 4		
I try to live by the saying "love thy neighbor as thyself."	.764	.016
I can forgive even if someone hurts me on purpose.	.717	.014
I try to care for other people even if I don't really like them.	.738	.016
I believe that you have to care about people regardless of how they treat you.	.805	.013
Even when it is difficult, I try to forgive other people who have hurt or offended me.	.864	.011
I try to be forgiving toward other people.	.767	.014
I feel deep love for the world and all the creatures in it.	.613	.020
Factor 5		
I believe that God has a lot of rules about how people should	.587	.020

live their lives.		
I believe that God can be counted on to reward goodness and punish evil.	.856	.016
I believe God is very strict.	*.352*	*.025*
I believe God will punish me if I do something wrong.	*.291*	*.025*
Do you believe that this God or universal spirit observes your actions and rewards or punishes you for them?	.699	.022
I feel that stressful situations are God's way of punishing me for my sins or lack of spirituality.	.849	.022
The Bible is the actual word of God and is to be taken literally word for word.	*.161*	*.035*
Factor 6		
It is all right to get back at someone who hurts or offends you.	.731	.029
I believe that if I do a lot of wrong things, God will stop loving me.	.404	.030
The only person I have to thank for what I have received in life is me.	.569	.028
When someone hurts me, I want to get whatever revenge I can.	.770	.028
If people are not kind to me, I am not going to be kind to them.	.719	.023
People tell me that I am not grateful enough for what I have in life.	.406	.033
When someone hurts or offends me, I can only get over it when I have figured out how to get my revenge.	.525	.024
When I look at the world, I don't see much to be grateful for.	*.300*	*.031*
Factor 7		
I feel thankful for what I have received in life.	.787	.016
I feel grateful nearly every day.	.897	.015
I express anger at God for letting terrible things happen (scored negatively).	*.023*	*.035*
I wonder whether God has abandoned me (scored negatively).	*.174*	*.039*

Note: Factor loadings are highlighted if loadings were less than .40, the criteria used by Kendler and colleagues (2003).

Appendix G
Comparison of Univariate Analyses, Best Fitting Models

Factor	Model	-2LnL	AIC	df	ΔX^2	p value	a^2	c^2	e^2
Factor 1									
Previous Study	AE	7045.8	-13.18	2596	12.82	0.462	0.66	--	0.34
Present Study	AE	6800.98	-13.78	2585	12.224	0.509	0.66	--	0.34
Factor 2									
Previous Study	AE	7069.15	-11.16	2596	14.83	0.318	0.68	--	0.32
Present Study	AE	6640.91	-9.49	2585	16.507	0.223	0.68	--	0.32
Previous Study	ACE	7065.92	-12.39	2595	11.61	0.478	0.50	0.17	0.33
Present Study	ACE	6637.63	-10.65	2584	13.35	0.34	0.50	0.17	0.33
Factor 3									
Previous Study	AE	7183.88	15.50	2596	41.496	0	0.56	--	0.44
Present Study	AE	6661.27	-12.13	2585	13.865	0.383	0.64	--	0.36
Factor 4									
Previous Study	AE	7252.58	24.96	2596	50.946	0	0.45	--	0.55
Present Study	AE	6851.89	0.20	2585	26.196	0.016	0.47	--	0.53
Factor 5									
Previous Study	AE	7249.85	-15.88	2596	10.118	0.684	0.49	--	0.51
Present Study	AE	6361.69	-14.98	2585	11.023	0.609	0.61	--	0.39
Previous Study	ACE	7248.85	-15.85	2595	9.145	0.69	0.38	0.10	0.52
Present Study	ACE	6358.46	-16.21	2584	7.79	0.8	0.43	0.17	0.4
Factor 6									
Previous Study	AE	7339.3	18.27	2596	44.267	0	0.22	--	0.78
Present Study	AE	6388.08	-5.04	2585	20.957	0.074	0.20	--	0.80
Factor 7									
Previous Study	AE	7342.64	6.14	2596	32.141	0.002	0.32	--	0.68
Present Study	AE	6386.05	-13.36	2585	12.639	0.476	0.38	--	0.62

Curriculum Vitae

GILBERT T. "TODD" VANCE

<u>Office Address:</u>
Department of Psychology
Virginia Commonwealth University
806 West Franklin St.
Richmond, VA 23284-2018

EDUCATION

Ph.D., Clinical Psychology
Virginia Commonwealth University, Richmond, VA
Expected graduation: August 2007

Master of Science, Clinical Psychology
Virginia Commonwealth University, Richmond, VA
May 2005

Master of Public Administration
University of Georgia, Athens, GA
May 1991

Bachelor of Arts
Major: Political Science, Minor: English
Clemson University, Clemson, SC
May 1989

RESEARCH EXPERIENCE

Doctoral Dissertation   Proposed and Approved: January 18, 2006
"Relationships between Dimensions of Religiosity and Internalizing and Externalizing
Psychiatric Disorders: A Twin Study"
Virginia Commonwealth University, Richmond, VA
Advisors: Kenneth S. Kendler, M.D. and Dace S. Svikis, Ph.D.

Master's Thesis   Defended and Approved: Mar. 30, 2005
"Religion/Spirituality, Race, and Risk for Alcohol Use and Smoking: Relationships in
Pregnant Women Visiting an Urban OB/GYN Clinic"
Virginia Commonwealth University, Richmond, VA
Advisor: Dace S. Svikis, Ph.D.

- Study involved original data collection at VCU's Women's Health Clinics. Consult with Research Advisor on study design, methods, and data analysis.

Graduate Research Assistant   Aug. 2002 – May 2005
Promoting Healthy Pregnancies Research Team
Virginia Commonwealth University, Richmond, VA
Supervisor: Dace Svikis, Ph.D., L.C.P.
Research Coordinator: Diane M. Langhorst, Ph.D., L.C.S.W.

- Research with two primary populations: women seeking care at VCU Health Systems OB/GYN Clinics and women of childbearing age at substance abuse treatment facilities in the greater Richmond area. Write IRB protocols, coordinate research with clinical staff, conduct participant informed consent process, conduct intake assessments, coordinate data entry with undergraduate research assistants, conduct data analysis, assist in manuscript preparation.

Student Research Investigator   Sept. 2003 – Dec.
2003
"A Survey of Alcohol and Tobacco Use in College Students Visiting a University Health Clinic"
Virginia Commonwealth University, Richmond, VA
Supervisor: Dace Svikis, Ph.D.

- Lead Student Investigator (under supervision of Principal Investigator, Dr. Dace Svikis) for a survey of students visiting VCU's University Student Health Services clinics to examine prevalence rates of alcohol and tobacco use, number of female clinic visitors compared to men, and smokers' level of motivation to stop smoking. Purpose of the study was to collect descriptive data and to determine the feasibility of conducting smoking cessation research at the clinic.

Marriage Enrichment Consultant   Sept. 2002 – Dec. 2002
Virginia Commonwealth University, Richmond, VA
Supervisor: Everett Worthington, Jr., Ph.D.

- Conduct psycho-educational relationship skills enhancement training with newly married couples, using the FREE (Forgiveness and Reconciliation through Experiencing Empathy) protocol. Training was part of a longitudinal efficacy study supported by the John Templeton Foundation.

Research Assistant   Aug. 2001 – Feb. 2002
Georgia State University, Atlanta, GA
Supervisor: Eric Vanman, Ph.D.

- Analyze data and refine test instruments for Dr. Vanman's Social Neuroscience Lab at Georgia State University. Study measured prejudice of Whites toward Hispanics using the Implicit Association Test (IAT) in conjunction with physiological measures (EMG) and self-report data.

HONORS AND AWARDS

The Graduate School Dissertation Assistantship
College of Humanities and Sciences, Virginia Commonwealth University
Spring 2006 Recipient

Student Merit/Junior Investigator Award
Research Society on Alcoholism 2005 Scientific Meeting
June 25-29, Santa Barbara, CA

Corazzini Award for Therapeutic Group Work
2004 Recipient
Annual award given to VCU graduate student working in group therapy

Excellence in Research and Scholarship Student Award
Christian Association for Psychological Studies – Eastern Region
September 20, 2003

Student Merit/Junior Investigator Award
Research Society on Alcoholism 2003 Scientific Meeting
June 21-26, Ft. Lauderdale, FL

PUBLICATIONS AND PRESENTATIONS

Vance, T., Perry, B., Svikis, D. (2005) Psychometric Properties of the Daily Spiritual Experiences Scale in Female Populations. Alcoholism: Clinical and Experimental Research, 29 (5), p. 24A. Poster presented at Research Society on Alcoholism 2005 Scientific Meeting, June 25-30, Santa Barbara, CA.

Vance, T., Svikis, D., Schaefer, K., Burruss, K., Perry, B. (2003) Religion/Spirituality, Race, and Risk of Alcohol Use During Pregnancy. Alcoholism: Clinical and Experimental Research, 27 (5), p. 134A. Poster presented at Research Society on Alcoholism 2003 Scientific Meeting, June 21-26, Ft. Lauderdale, FL.

Penberthy, J.K., McCullough. J.P., Vance, T., Gray, D.G. (2005) CBASP Disciplined

Personal Involvement. Two CE credit workshop presented at the Virginia Psychological Association Spring 2005 Convention and Educational Conference, April 13-15, Williamsburg, VA.

Vance, T. & McCullough, J.P. (2005) Treating a Chronically Depressed Female Using the Cognitive Behavioral Analysis System of Psychotherapy and Assertiveness Training. Student paper presented at Virginia Psychological Association Spring Convention and Educational Conference, April 13-15, Williamsburg, VA.

Vance, T., Svikis, D.S., Perry, B.L. (2004) Religion/Spirituality, Race, and Risk of Alcohol Use During Pregnancy: Results from an Urban OB/GYN Clinic. Student paper presented at Christian Association for Psychological Studies East 2004 Regional Conference, November 12-14, Chambersburg, PA.

Vance, T., Svikis, D.S., Hancock, L. (2004) Clinical trials of smoking cessation in university student health clinics: A feasibility study. Poster presented at College on Problems of Drug Dependence 2004 Annual Scientific Meeting, June 12-17, San Juan, Puerto Rico.

Vance, T., Svikis, D.S., Perry, B.L. (2003) Religion/Spirituality, Race, and Risk of Alcohol Use During Pregnancy: Results from Two Studies. Paper selected for presentation at Christian Association for Psychological Studies East 2003 Regional Conference, September 19-21, Sandy Cove, MD.

CLINICAL EXPERIENCE

Psychology Intern   Aug. 2006 – present
APA-Approved Pre-Doctoral Internship
Minneapolis VA Medical Center
Minneapolis, MN

Psychology Technician   Sept. 2005 – June 2006
Clinical Practicum
Poly-Trauma Rehabilitation Center
Hunter Holmes McGuire VA Medical Center, Richmond, VA

- Neuropsychological Testing and Assessment
  Supervisor: Treven C. Pickett, Psy.D., L.C.P.

  Conduct initial and follow-up neuropsychological screenings, including GOAT, MOAT, O-Log, Coma Near Coma Scale and R-BANS, for patients admitted to Traumatic Brain Injury Unit. Write progress notes and treatment reports. Prior to

patient discharge, write assessment report and make rehabilitation recommendations based on neuropsychological assessment battery, including WRAT-3, CVLT-II, BVMT-R, WAIS-III, and PAI. Supervision including reviews of written reports and direct observation during assessment.

- Family and Individual Counseling
  Supervisor: Treven C. Pickett, Psy.D., L.C.P.

  Provide counseling and psycho-educational services for brain injured patients and their families. Discuss treatment process and outcomes. Supervision including direct observation during counseling.

Psychotherapist   May 2003 – May 2005
Clinical Practicum
Center for Psychological Services (CPSD)
Virginia Commonwealth University, Richmond, VA.

- *Chronic Depression*
  Supervisor: James P. McCullough, Jr., Ph.D., L.C.P.

  Conduct clinical intake interviews and functional assessments; make DSM-IV diagnoses; monitor weekly treatment progress using BDI and BAI; treat patients using CBASP, an empirically supported treatment specifically for the chronically depressed patient; attend weekly group and individual supervision, including videotape reviews, case conceptualization, and role plays; write intake reports, treatment plans, progress notes, and integrated psychological reports. Patients seen in CPSD, following an outpatient community mental health center model and including clients from a wide variety of cultural, ethnic, and socioeconomic backgrounds.

- *Assessment of Learning Disabilities*
  Supervisors: Robert S. Falk, Ph.D., L.C.P. and Scott Vrana, Ph.D., L.C.P

  Conduct multi-modal assessments to diagnose possible learning disabilities; administer and score standardized testing instruments including: intelligence tests (WAIS-III), cognitive abilities and achievement tests (Woodcock Johnson III), ADHD Symptoms Scales (Barkley & Murphy), Minnesota Multiphasic Personality Inventory-2 (MMPI-2), Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), and Comprehensive Test of Phonological Processing (CTOPP); write integrated assessment reports, conduct feedback sessions with clients, and submit reports to university counseling centers and offices of disability services for consideration of accommodations for the clients; attend individual supervision.

- *Anxiety Clinic*
  Supervisors: Scott Vrana, Ph.D., L.C.P. and Michael Southam-Gerow, Ph.D., L.C.P.

  Participate in weekly group supervision meetings; assist in case conceptualization; review use of empirically supported anxiety treatments; promote Anxiety Clinic services to the public.

Substance Abuse Treatment   Apr. 2003 – Mar. 2005
Promoting Healthy Pregnancies Research Team
Virginia Commonwealth University
Rubicon Women's Residential Drug Treatment Center, Richmond, VA

- *Be Aware Relapse Prevention and Aftercare Group*
  Supervisors: Dace Svikis, Ph.D., L.C.P. and Diane Langhorst, Ph.D., L.C.S.W.
  Develop group content; conduct weekly, Motivational Interviewing based relapse prevention and aftercare groups for women in residential drug treatment; supervision using MITI to assess group leaders' use of MI; assess group dynamics and process in post-group feedback sessions.

Open-Ended Interpersonal Process Group   Aug. 2004 – May 2005
University Counseling Services
Virginia Commonwealth University, Richmond, VA

- *Open-ended interpersonal process group*
  Supervisor: Claudia Carroll, Ph.D., L.C.P.
  Process observer and process notes writer for open-ended process group at VCU's University Counseling Services for the 2004-05 academic year; supervision including post-group processing and review of process notes; clients seen at university-based student counseling center, with students from a wide range of ages, racial/ethnic backgrounds, sexual orientations, and socioeconomic backgrounds.

SPECIALIZED CLINICAL TRAINING

SCID Workshop   Sept. 30 – Oct. 1, 2004
Leader: Michael First, M.D.

Addiction Severity Index (ASI) 5th Edition   Dec. 16 & 18, 2003
Leader: Dace Svikis, Ph.D.

Cognitive-Behavioral Analysis System of   June 2003 – May 2005
Psychotherapy (CBASP) Treatment for Chronic Depression

Leader: James P. McCullough, Jr., Ph. D.

Motivational Interviewing   May 20-21, 2003;
Leader: Chris Wagner, Ph.D.   April 22, 2004

CONFERENCES ATTENDED

Research Society on Alcoholism 2005 Scientific Meeting, June 25-30, Santa Barbara, CA

Virginia Psychological Association Spring 2005 Convention and Educational Conference, April 13-15, Williamsburg, VA

Christian Association for Psychological Studies East 2004 Regional Conference, Nov. 12-14, 2004, Chambersburg, PA

Science and Religion in Health, "Cultural Conflict and Healthcare: Bridging the Gap," Sept. 17, 2004, Richmond, VA.

Research Society on Alcoholism 2004 Scientific Meeting, June 27-30, Vancouver, BC

State-of-the-Art Mutual-Help Pre-Conference Satellite Session, RSA, June 26, 2004, Vancouver, BC

Getting the Buzz on College Student Drinking and Smoking, Brown University, Nov. 1, 2003, Providence, RI

Research Society on Alcoholism 2003 Scientific Meeting, June 21-26, Ft. Lauderdale, FL

TEACHING EXPERIENCE

CBASP National Training Program   June 6, 2006
Workshop Co-Leader
Richmond, VA

Understanding Depression   March 29, 2006
In-Service Leader
McGuire Veterans Administration Medical Center, Richmond, VA

Administration and Scoring of the Coma Near-Coma Scale March 27, 2006
Invited Presentation
McGuire Veterans Administration Medical Center, Richmond, VA

A Christian Response to Abuse   Jan 17 – Mar. 18, 2006

and Violence
Course Instructor
Eternity College of Ministry, Richmond, VA

Interventions for Victims of Abuse   Aug. 18-21 & Aug. 25-28, 2005
and Domestic Violence
Course Instructor
Bulgarian Evangelical Theological Institute, Sofia, Bulgaria

Psychology and Religious Experience (PSYC 333)   July 25 – Aug. 12, 2005
Course Instructor
Virginia Commonwealth University, Richmond, VA

Guest Lecture   October 5, 2005
"Teaching in Bulgaria"
Positive Psychology Research Team
Virginia Commonwealth University, Richmond, VA

Guest Lecture   July 27, 2005
"Religious Coping"
Stress and Its Management (PSYC 308)
Virginia Commonwealth University, Richmond, VA

Guest Lecture   March 30, 2005
"Religious Experience, Spirituality, and Substance Abuse"
Seminar on Issues in Substance Abuse
Virginia Commonwealth University, Richmond, VA

Guest Lecture   October 8, 2003
"Religious Experience, Spirituality, and Substance Abuse"
Seminar on Issues in Substance Abuse
Virginia Commonwealth University, Richmond, VA

Guest Lecture   June 9, 2003
"Health, Well-Being, and Religion/Spirituality"
Psychology and Religious Experience (Psych 333)
Virginia Commonwealth University, Richmond, VA

Guest Lecture   March 24, 2003
"Religion/Spirituality, Race, and Risk of Alcohol Use During Pregnancy"
Positive Psychology Research Team
Virginia Commonwealth University, Richmond, VA

SERVICE/VOLUNTEER ACTIVITIES

Positive Psychology Research Team   Sept. 2002 - Present
Virginia Commonwealth University, Richmond, VA
Participate in Positive Psychology Research Team, led by Dr. Ev Worthington, including team meetings, reviews of related research, independent projects, and guest lectures.

Eternity College of Ministry   June 2005 - Present
Steering Committee Member and Course Instructor
Eternity Church, Richmond, VA

Clinical Forum Speakers Committee   Fall 2002 – Fall 2003
Virginia Commonwealth University, Richmond, VA
Recruit speakers from throughout Virginia Commonwealth University and the Richmond area to present research and latest findings to Clinical Psychology faculty and students.

Homeless Shelter Volunteer/Counselor   Nov. 1997 – Apr. 1998
Central Presbyterian Homeless Shelter, Atlanta, GA
Volunteer worker and counselor at inner city shelter serving homeless men with substance abuse, mental illness, joblessness, and family issues.