

COLLEGE STUDENT RISK BEHAVIOR: IMPLICATIONS
OF RELIGIOSITY AND IMPULSIVITY

by

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ABSTRACT

COLLEGE STUDENT RISK BEHAVIOR: IMPLICATIONS OF RELIGIOSITY AND IMPULSIVITY

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College student risk-taking among 18 to 21 years olds includes smoking cigarettes, binge drinking, casual sex with multiple partners, automobile accidents due to risky driving or driving under the influence, and substance use. Among 10 to 24 year olds, 72% of all fatalities result from automobile accidents, unintended injuries, homicide, and suicide. Since not all college students participate in risk behaviors, protective factors such as religiosity may be a protective social or psychological buffer that supports positive relationships and moral order. Impulsivity, an inability to squelch inappropriate thoughts or actions, is associated with the later development (in the mid-twenties) of the prefrontal cortex.

The purpose of the cross-sectional correlational study is to determine the strength of associations between public and private religiosity, impulsivity, age, gender, fraternity/sorority membership (Greek affiliation), and risk-taking propensity among college students, 18 to 20 years old, who live away from home. All study participants (n = 110; mean age = 18.9 years) completed two behavioral measures, Tower of Hanoi (TOH) and Balloon Analogue Risk Task (BART) and four paper surveys (demographic information, Age Universal Religious Universal Orientation

Scale-12, Eysenck Impulsivity Subscale, and College Student Risk Behavior Measure). Adequate reliability was obtained for BART, private religiosity subscale, and Eysenck Impulsivity Subscale.

Results showed high mean private religiosity scores, low mean impulsivity scores, low average balloon inflations on BART, and two risk behaviors over the past 30 days. Only six sorority members participated in the study. Regression analysis explained that age, gender, private religiosity, and impulsivity accounted for only 4% of the variance in risk-taking propensity. The findings advocate for a broader investigation of the multi-dimensional influences that impact college student risk behavior. Lower impulsivity and BART scores suggest a link between environmental challenge, late adolescent neurobiology, and cognitive variables. BART proved to be an interactive educational strategy on inclination to take risks. Implications for nursing practice, education, and research describe links between adolescent neurodevelopment, reward-seeking or motivation, individually-planned prevention programs, as well as teaching and recruitment strategies.

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CHAPTER 1

INTRODUCTION

Adolescents are vulnerable to health-risk behaviors during this period of opposition, idealization, and personal discovery (Maggs, 1997; Simmonds, 2005). Adolescence has been described as “storm and stress,” “poignancy and unpredictability,” “turbulence and instability,” or “normal and healthy.” To adults, adolescent risk-taking behaviors are viewed as worrisome or dangerous. Risk behaviors, from an adolescent perspective, have positive and negative antecedents and consequences—described as the paradox of risk-taking (Maggs, Almeida, & Galambos, 1995; Maggs & Hurrelmann, 1996). While adults view binge drinking as harmful, adolescents may feel that saying “no” to drinking offers loneliness and alienation and saying “yes” offers a pathway to friendship and relaxation.

Risk factors, protective factors, and risk behaviors are distinct concepts in analyzing an adolescent’s propensity to take risks (Jessor, 1991). Since the processes of change and development are foremost in adolescence, understanding the dynamic factors of risk behavior on a developmental continuum is appropriate (Michaud, 2006). Literature supports neurobiological, psychosocial, and socio-emotional correlates to adolescent risk behavior; but as Steinberg (2008) observes, not all adolescents engage in risky behaviors. Effective prevention and intervention strategies for adolescent risk behavior should be based on developmentally appropriate knowledge of risk and protective factors.

Neuroimaging research has focused attention on the normative neurobiological imbalances in the adolescent brain, with estimated completion of brain maturation by the mid-twenties (Casey, Getz, & Galvan, 2008; Schepis, Adinoff, & Rao, 2008; Steinberg, 2008). Adolescents, in addition to neurodevelopment, are also affected by other biological, psychological, and social factors within the individual, family, school, peers, and community. Each of these factors has the potential to serve as a risk factor for or a protective factor against adolescent risk behavior (Catalano & Hawkins, 1996). Religiosity influences adolescent attitudes and behaviors in positive and constructive ways, mainly through parental influence (Wallace & Williams, 1997).

College students, legally viewed as adults when over 18 years of age, are considered late adolescents from a neurodevelopmental perspective. Sparse literature exists for college students (18 to 20 years) who are physically away from parental influence and considered late adolescents on: (1) the effects of religiosity on college students' attitudes and behaviors; (2) the degree of impulsivity and reward-seeking in late adolescence, based on neurobiological correlates; and (3) the interaction between the protective influence of religiosity and the degree of neurodevelopment.

Background and Significance

Among individuals aged 10 to 24 years in the United States, 72% of all deaths result from risky behaviors: automobile accidents (30%), unintended injuries (15%), homicide (15%), and suicide (12%). Conversely, for American adults over the age of 25, 59% of all deaths stem from cardiovascular disease and cancer (Eaton et al., 2008). The 2007 Youth Risk Behavior Survey of American high school students (9th through 12th grade) provides the following statistics of risk behavior engagement:

75% of high school students had ever drunk alcohol,...47.8% of students had ever had sexual intercourse, 35% of high school students were

currently sexually active, and 38.5% of currently sexually active high school students had not used a condom during last sexual intercourse,...20% had smoked cigarettes,...29.1% of high school students had ridden in a car or other vehicle driven by someone who had been drinking, 18% had carried a weapon,...11.1% had never or rarely worn a seat belt when riding in a car driven by someone else (Eaton et al., p.1).

Steinberg (2008) asserts that late adolescence, over 18 years but less than 25 years, is a time period of increased likelihood to “binge drink, smoke cigarettes, have casual sex partners, engage in violent and other criminal behaviors, and have fatal or serious automobile accidents, the majority of which are caused by risky driving or driving under the influence of alcohol” (p. 79). Public health experts are working to understand the mechanisms surrounding adolescent risk behavior as well as formulating and implementing public policies to reduce opportunities for adolescent risk-taking (Sunstein, 2008). To understand the contributory and inhibitory factors in adolescent risk behavior, three constructs were reviewed in the literature: adolescent neurobiology, religiosity, and adolescent risk behavior.

Neuroimaging research on normal adolescents has illuminated two separate developmental trajectories of the prefrontal cortex (PFC) and the subcortical limbic system. Figure 1 depicts the development of the PFC from adolescence to adulthood (in the mid-twenties), the mid-adolescent development of the limbic system, and the integration of both systems at adulthood (the dotted line arrow of the limbic system merging with the PFC). Even with delayed PFC maturity, the adolescent does have the cognitive ability to reason, weigh, and understand risks versus benefits of behaviors. The highly active and mature reward center of the subcortical limbic system, however,

will not inhibit inappropriate choices and actions (Reyna & Farley, 2006). Results from neuroimaging associate health-risk behavior correlates of impulsivity and reward-seeking with the PFC and subcortical limbic system, respectively (See Figure 1; Casey et al., 2008; Kuhner & Knutson, 2005; Matthews, Simmon, & Paulus, 2004; Schepis et al., 2008; Steinberg, 2008). With knowledge that executive cognitive function arises from a mature PFC, those working with adolescents can better understand problems with long-term planning, impulsive and risky decisions, sensation-seeking for short-term rewards, and a later development of formal operational thinking (McAnarney, 2008; Piaget, 1967).

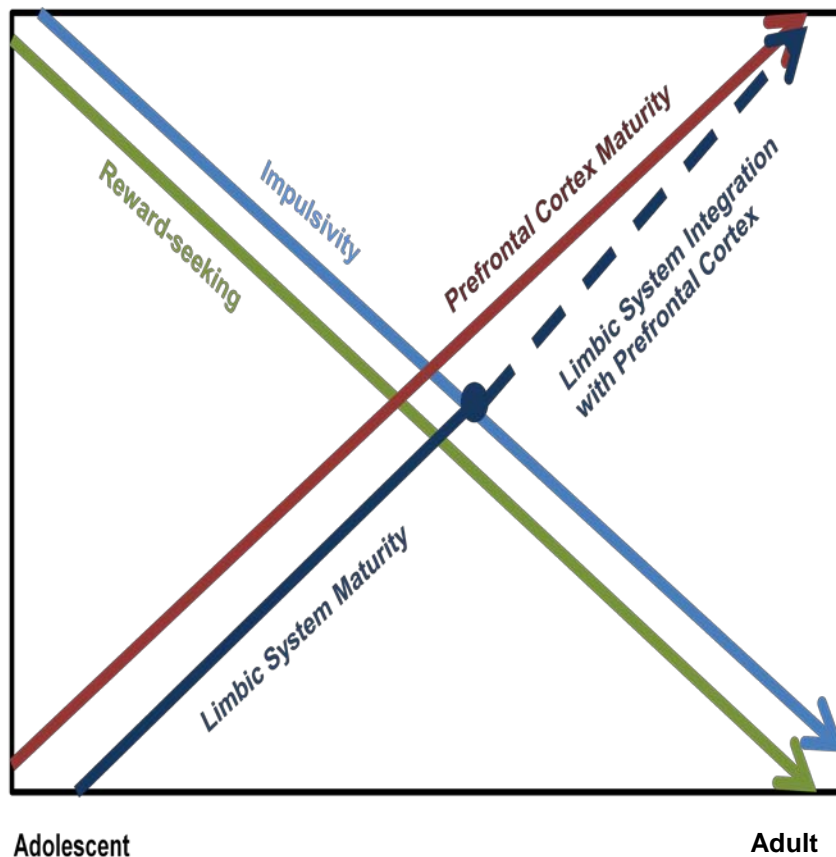


Figure 1. Evidence-Based Conceptual Framework of Adolescent Neurobiology

Steinberg (2008) emphasizes that despite the imbalances in the maturation trajectories of the PFC and limbic system, not all adolescents participate in risky behaviors. The prosocial belief system of religiosity, as a protective factor, has been identified as an inhibitor of health-risk behaviors (Resnick & Bearman, 1997). Linking neurobiology to risky adolescent decision-making, River, Reyna, and Mills (2008) purport that behavioral intentions are not as susceptible to the intense emotions from a mature limbic system when the adolescent has easily accessible and firmly held beliefs. The challenge in adolescent religiosity research is to develop clear, concise, and developmentally appropriate definitions of religiosity, with distinctions made from spirituality. Religiosity in early adolescence differs from religiosity in mid- or late-adolescence due to degrees of parental and environmental influences and is linked to the transition from concrete to formal operational thinking. Researchers have hypothesized that spirituality is possible with the adult development of PFC maturity and formal operational thought processes (Lau, 2006; Smithline, 2000). Another challenge in religiosity research is measuring religiosity as a uni-dimensional “add-on” variable rather than a primary variable measured by reliable and valid multi-dimensional instruments (Hancock, 2005; Wong, Rew, & Slaikeu, 2006).

The majority of adolescent risk behavior research is grounded in conceptual models or frameworks which identify psychological, contextual, developmental, and biological risks and protective factors. These frameworks guide the measurement of risk behavior based on presence or absence of risk or protective factors (Cicchetti & Dawson, 2002; Steinberg, 2008). Impulsivity and reward- or sensation-seeking are considered the two central domains of risk behavior (Krueger et al., 2002; Sher, Bartholow, & Wood, 2000; Tarter et al., 2003). Self-report tools that measure adolescent “real-world” risk taking are static measures that may suffer from response

inaccuracies or social desirability bias (Cleveland, Feinberg, Bontempo, & Greenberg, 2008). Behavioral measures such as Tower of Hanoi (TOH, impulsivity) and Balloon Analogue Risk Task (BART, risk-taking propensity) measure actual behaviors, complement self-report measures, and increase a study's robustness (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Lejuez, Aklin, Bornovalova, & Moolchan, 2005; Pleskac, Wallsten, Wang, & Lejuez, 2008; Simon, 1975; Waltz, Strickland, & Lenz, 2005).

This research study focused on college students who are frequently presumed to be adults when over 18 years old. Young college students are an under-researched population from the perspective of late adolescence. No reviewed research studies addressed or defined religiosity or components of risk behavior from a neuro-developmental continuum perspective. No research has previously examined the interaction between religiosity as a protective factor with the level of impulsivity (correlate of PFC maturity) and the relationship to risk-taking propensity. College students usually serve as adult controls in adolescent research or evaluation of measurement tools. Evidence supports increased college student vulnerability to risk behaviors due to a new physical environment and never-before-experienced situational opportunities (Cantor, 1994; Maggs et al., 1995; Maggs & Hurrelmann, 1996).

Framework

Three empirically-derived theoretical frameworks were synthesized to form the foundation for this study's conceptual framework and model: Cognitive-Motivational Theory, Social Development Model, and Fuzzy-Trace Theory (See Figure 2). Cognitive-Motivational Theory (CMT; Finn, 2002), a neuro-behavioral and psychosocial theory of decision-making and behavioral regulation links impulsivity, novelty-seeking, harm avoidance, and excitement-seeking. These concepts reflect the neurobiological,

cognitive, and socio-emotional correlates of risk behavior. CMT discusses the process of adolescent decision-making (looking at options and the probability of consequences) to discover why risky behaviors are chosen and purports that adolescents lean toward impulsive and risky behaviors when perceived positive consequences outweigh any negative consequences. The Social Development Model (SDM) includes parallel pathways to prosocial and antisocial behaviors and addresses behavioral patterns with specific risk and protective factors based on a developmental continuum (Catalano & Hawkins, 1996; Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996). SDM is grounded on the assumption that adolescents learn prosocial and antisocial behaviors from family, peers, school, and religious or other community organizations. Fuzzy-Trace Theory explains, on a developmental continuum, how choices are influenced by the positive or negative “valence” of a stimulus (Rivers et al., 2008). This theory depicts adolescents as lacking the adult reasoning process of “fuzzy intuition” where choices are quickly made based on the negative or positive value of stimulus, rather than on the “verbatim details” of the choice. The authors state that heightened emotional arousal to rewards and impulsive choices can be tempered by an accessible and firmly-held alternate belief system, such as religion that would clearly frame risky choices as negative.

All three theoretical frameworks contributed to this study’s conceptual framework (Figure 2). Impulsivity and risk-taking propensity were derived from CMT reflecting the correlates to the PFC and limbic system, respectively. In addition, Fuzzy-Trace Theory, reflecting the neurobiological basis to risk-taking, acknowledges that emotional arousal (limbic system) jeopardizes risk avoidance. Both SDM and Fuzzy-Trace Theory discuss the role of protective factors and strength of attitudes and beliefs in promoting prosocial behavioral choices.

The study's framework (Figure 2) included the concepts of impulsivity as it relates to the maturing PFC, risk-taking propensity as an indicator of risk behavior engagement, and two dimensions of religiosity (public and private). Public and private religiosity has been evidenced to be protective against the adolescent "vulnerability equation," [Impulsivity + Reward-seeking = Risk Behavior] (Jang, Bader, & Johnson, 2008, Smith, 2003). The model illustrates interactions between public religiosity and impulsivity, and private religiosity and impulsivity; based on research stressing the protective nature of firmly held religious beliefs and attitudes upon adolescent choices toward health-risk behaviors (Rew & Wong, 2006). Age, gender, and Greek affiliation

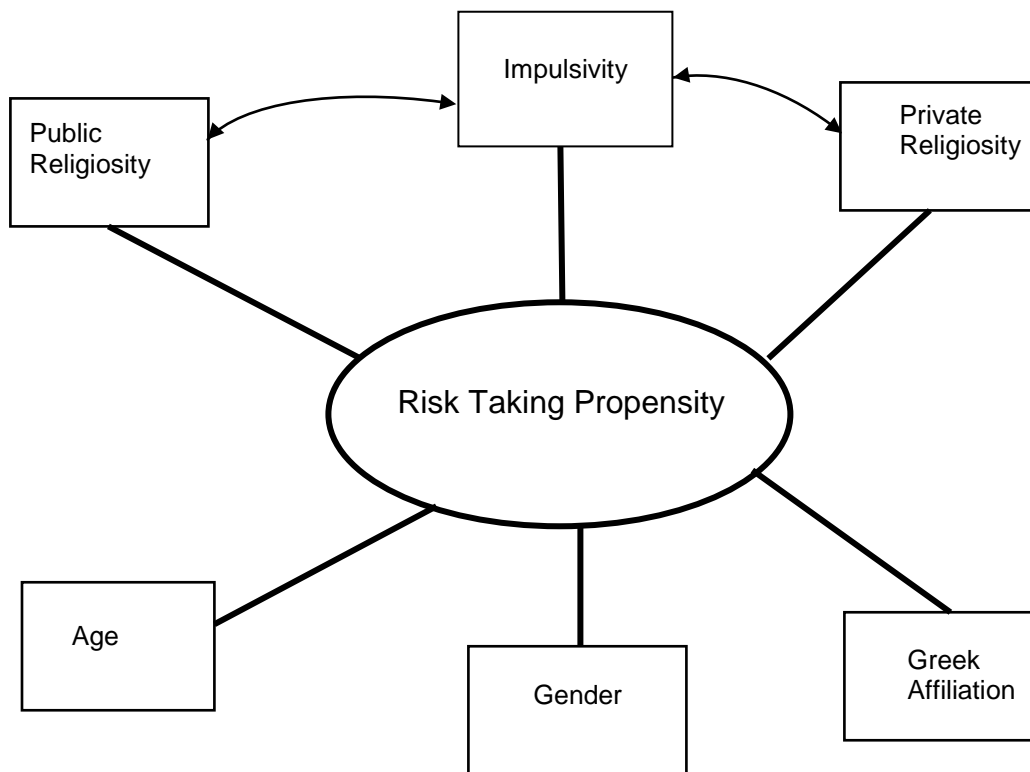


Figure 2. Conceptual Model of Study

are included as salient late-adolescent developmental considerations for college students. (See Table 1 for the conceptual definitions of all study concepts and variables).

Table 1. Conceptual Definitions

| Study Concept or Variable | Conceptual Definition |
|---------------------------|--|
| Adolescence | Adolescence is a transitional developmental period between childhood and adulthood when biological, psychological, and social role changes result in independence acquisition, separation from protection of family with increased opportunities for harmful consequences (Feldman & Elliott, 1990; Kelley, Schochet, & Landry, 2004). |
| Age | Age is defined as college students in late adolescence. |
| Impulsivity | Impulsivity is defined as the quick response to cues or entrance into situations with minimal planning or thought towards consequences (Eysenck, Pearson, Easting, & Allsopp, 1985; Pentz, Jasuja, Rohrbach, Sussman, & Bardo, 2006). |
| Risk-Taking Propensity | Risk-taking propensity is a natural inclination or preference to engage in potentially harmful behavior (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). |
| Religiosity | Religiosity is the representation of one's relationship with a Higher Power expressed as theological and moral attitudes, beliefs, and values that guide behaviors, decision-making, and opportunities for support networks (Benson et al., 2003; Rohrbaugh & Jessor, 1975; Wallace & Williams, 1997). |
| Private Religiosity | Private religiosity is the individualized expression of one's relationship with a Higher Power through personal devotion and practices (Benda & Corwyn, 2001; Berry, 2005). |
| Public Religiosity | Public religiosity is the extrinsic or outward expression of one's relationship with a Higher Power through group membership and identity, and public participation (Allport & Ross, 1967). |
| Gender | Gender is membership in a particular class, being male or female. |
| Greek Affiliation | Greek affiliation is membership in a Greek-letter sorority or fraternity. |

Propositional Statements

From review of the literature and the conceptual framework (Figure 3), the following propositional statements included:

1. The degree of impulsivity decreases with increased maturation of the PFC, not completed until the mid-twenties.
2. As an adolescent develops into an adult, religiosity matures into spirituality.
3. With increased PFC maturity and declines in impulsivity, risk-taking propensity decreases.
4. As religiosity develops toward spirituality, an adolescent displays less risk-taking propensity because development of spirituality and decrease in risk-taking propensity are dependent on prefrontal cortex maturity and the emergence of formal operational thinking.
5. Early, mid, and late adolescents do not experience the same levels of religiosity and impulsivity and thus, experience differing levels of risk-taking propensity.
6. Spirituality attainment parallels the completion of PFC maturity in adulthood.

Purpose

The purpose of this study was to determine the strength of associations between public religiosity, private religiosity, impulsivity, age, gender, Greek affiliation, and risk-taking propensity among college students in late adolescence (18 to 20 years). This study focused on a specific population that has previously been considered adults; now refuted by neuroimaging studies showing full cortical development is delayed until mid-twenties (Casey et al., 2008; Schepis et al., 2008; Steinberg, 2008). Religiosity was separated into public and private religiosity in order to capture both the extrinsic and intrinsic dimensions of religiosity described in the literature.

Research Questions

The following research questions were addressed in this study sampling college students, 18 to 20 years old who do not live with their parents:

1. Are private religiosity, public religiosity, impulsivity, age, gender, and Greek affiliation strongly and significantly associated with risk-taking propensity? Which variable(s) are the most strongly associated with risk-taking propensity?
2. Does the relationship of impulsivity to risk-taking propensity significantly strengthen or weaken when level of public religiosity changes?
3. Does the relationship of impulsivity to risk-taking propensity significantly strengthen or weaken when level of private religiosity changes?

Assumptions

The assumptions illustrated in Figure 3 were embedded within the neurobiological and developmental bases of the study's conceptual framework and the proposed study design (Burns & Grove, 2005). Assumptions are statements that are considered true, though not yet scientifically tested or lacking causal inferences (Silva, 1981).

Chapter Summary

Neurobiological evidence shows that adolescence is a critical period for brain maturation affecting cognitive, social, and emotional functions (Spear, 2000b). From developmental and social psychology, adolescence is "a general movement toward greater differentiation, integration, and complexity in ways that individuals think and behave" (Pascarella & Terenzini, 2005, p. 19). By integrating neurobiological, developmental, and psychosocial perspectives, this study focused on late adolescence, specifically college students (18 to 20 years) living away from home and the relationships between impulsivity, religiosity (both public and private), risk-taking propensity, age, gender, and Greek affiliation. The following comprehensive review of literature analyzes the major study variables from a developmental perspective throughout adolescence.

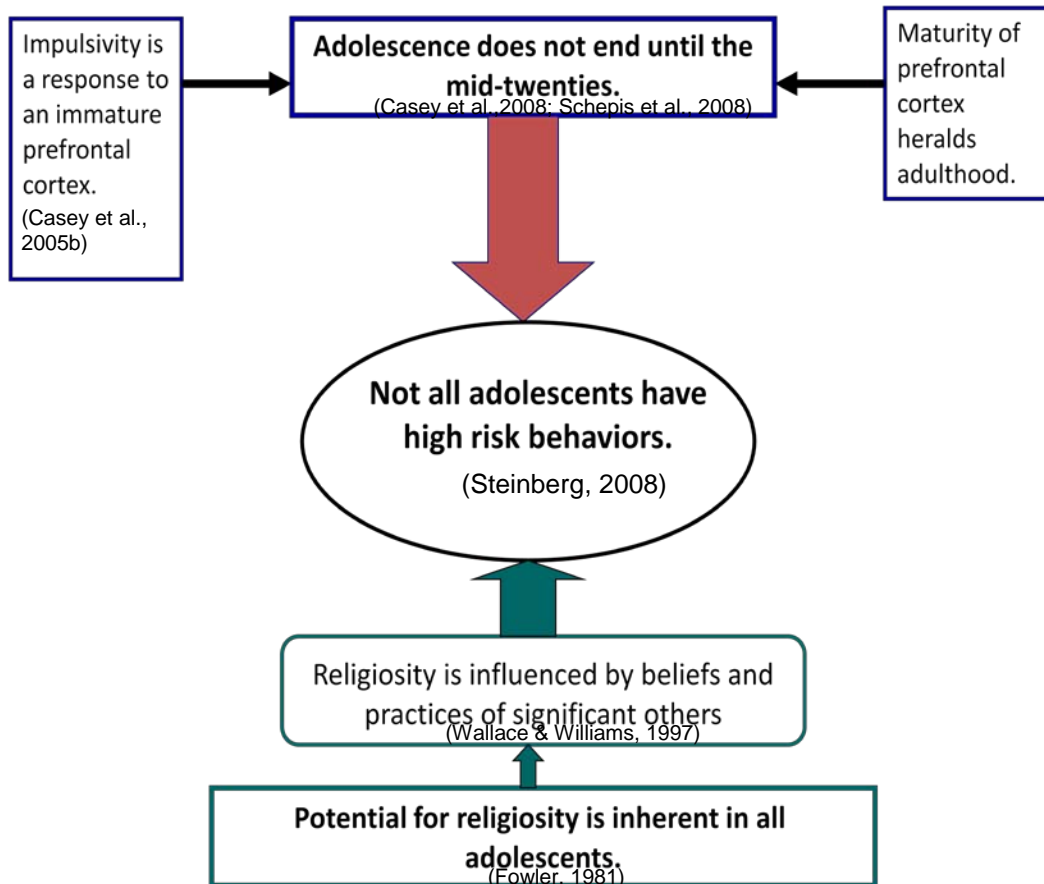


Figure 3. Study Assumptions

CHAPTER 2

REVIEW OF LITERATURE

Adolescence is characterized as a developmental “age period of intense ideological hunger, a striving for meaning and purpose, and desire for relationships” (King & Boyatzis, 2004, p.2). Unfortunately, adolescence, frequently romanticized, is the time when engagement in normative yet consequential risk behaviors is at its highest level (Arnett, 1992; Moffitt, 1993). In transitioning to adulthood, shifts from the safety net of and dependence on parents progress to more dominant peer networks and heightened stress as a new self-identity emerges (Spear, 2004; Steinberg, 2008).

In this section, three major concepts will be examined: adolescent neurobiology, religiosity, and adolescent risk behavior (Figure 4). The increased sophistication and use of neuroimaging technology on brains of normal adolescents have given researchers opportunities to examine structural and functional neurodevelopment. Because neuroimaging experts are able to scan the brains of normal adolescents while they are performing behavioral risk or impulsive tasks, new neurobiological information is being combined with previous understanding of adolescent risk-taking from psychosocial or cognitive perspectives. Knowledge of the interplay between various neural structures and regions can help increase understanding of the impacts of potential risk and protective factors. The role of religiosity, as a cognitive, inhibitory, or protective factor, and its relationship with adolescent risk behavior is examined. Finally, adolescent risk behavior is explained from within multiple conceptual and developmental frameworks in order to understand the factors and domains of impact or influence upon adolescent behavior. Each of the three concepts, adolescent neurobiology, religiosity, and risk behavior, is

explained on a developmental continuum from early to late adolescence; however, more emphasis has been placed on the older adolescent with special focus on college students.

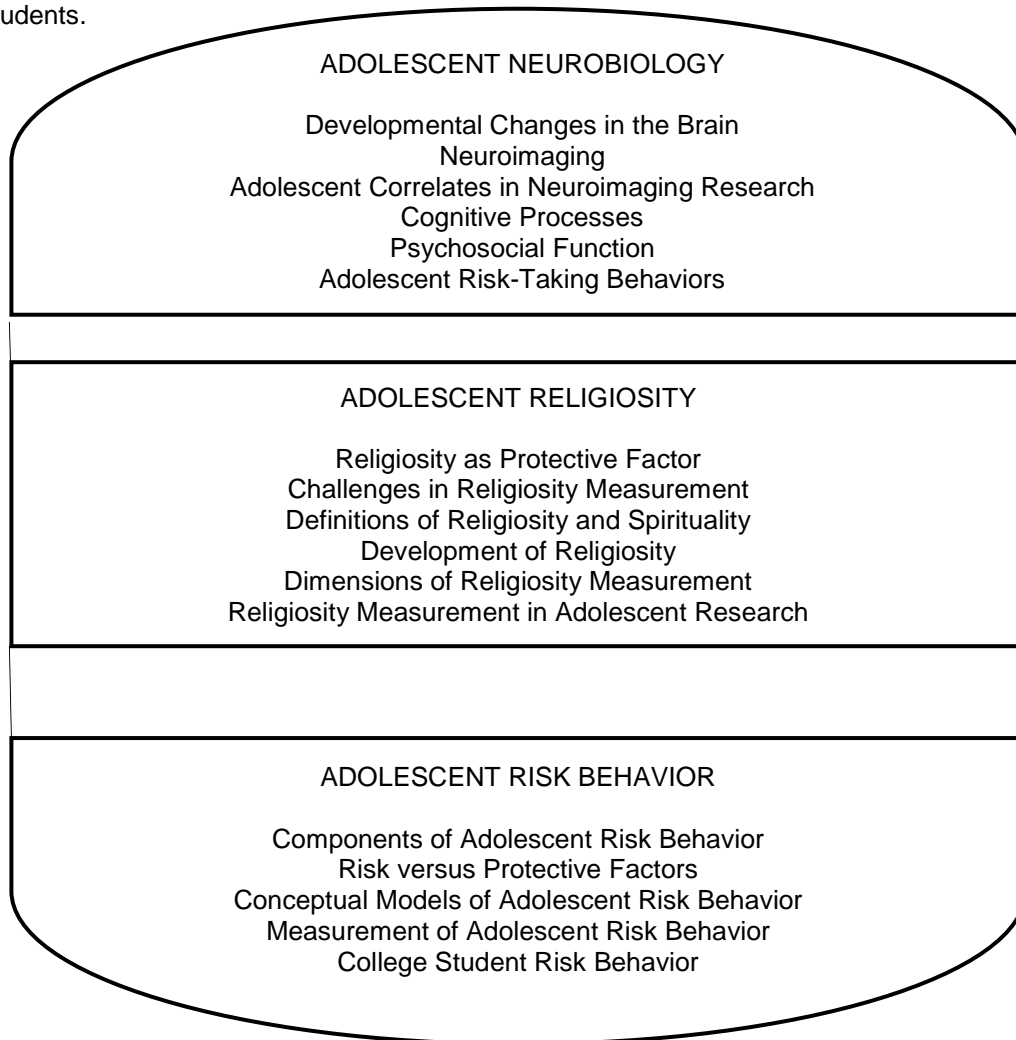


Figure 4. Review of Literature
Adolescent Neurobiology

Adolescence is a period of profound neural growth, change, and maturation influenced by neuroanatomical, neurophysiological, and neurochemical processes (Schepis et al., 2008; Weinberger, Elvevåg, & Giedd, 2005). Over the past five years with the improvement of brain imaging, researchers have discovered that the adolescent brain

undergoes major remodeling and demonstrates two different developmental trajectories (Powell, 2006; Rosser, Stevens, & Ruiz, 2005). Adolescents exhibit a normative rate of maturation imbalance between the subcortical/limbic stimulatory system and the slower, more protracted development of the prefrontal cortical suppressive mechanisms (Casey et al., 2008; Schepis et al.). Studies that incorporate imaging are beginning to associate reward-seeking, risk-taking, and impulsivity behaviors with the developing structures, functions, and neurotransmitter system of the adolescent brain (Steinberg, 2008). McAnarney (2008) labels the neurological imbalances as a “perfect storm” for the adolescent since full development of higher cognitive functioning (matched by completed prefrontal cortex maturity) may not be completed until the mid-twenties.

In this section, the neural structures and their developing functions within the adolescent brain will be discussed. Next, the history, goals, benefits, and types of neuroimaging are outlined as an important adolescent research methodology. Finally, research studies incorporating neuroimaging are presented to outline adolescent neurobiological correlates related to cognitive processes, psychosocial function, and risk behaviors.

Developmental Changes in the Adolescent Brain

Prefrontal Cortex

Comprising one-third of the volume of the human cortex, the prefrontal cortex (PFC) is larger and more sophisticated than other species (Larsen & Krubitzer, 2008; Wood, 2003). The current adolescent model of neurobiological development, characterized by the immaturity of the PFC and the earlier maturity of the subcortical system, was formulated from rodent models (Laviola, Adriani, Terranova, & Gerra, 1999; Spear, 2000b) and recent adolescent neuroimaging studies (Ernst et al., 2005, Galvan, Hare, Voss, Glover, & Casey, 2007; Galvan et al., 2006).

Though total brain volume is established by early elementary school years (Reiss, Abrams, Singer, Ross, & Denckla, 1996; Yurgelun-Todd, 2007), the remodeling and maturing of the PFC extends into early adulthood (Yurgelun-Todd, 2007). The human PFC is a system of neural circuitry divided into the dorsolateral and orbitofrontal regions. The neurons of the dorsolateral region connect to regions associated with motor control, performance monitoring, and sensory processing expected to monitor and control behaviors and reactions to environmental stimuli. The orbitofrontal cortex, the underside of the PFC, has connections to emotional and sensory processing and memory—groomed to integrate information about emotion, memory, and the environment (Wood, 2003).

The frontal cortex, especially the PFC, is the major contributor to executive cognitive functioning in an adolescent. Because mature executive cognitive functioning is dependent upon a mature PFC, an adolescent may have difficulties with the following behaviors: decision-making, impulse control, delay of gratification, self-monitoring, regulation of emotions, attention, organization, or long-range planning (Ellis, 2005; Giedd, 2008; Rosenberg, Grigsby, Dreisenbach, Busenbark, & Grigsby, 2002; Rosser et al., 2005; Schepis et al., 2008).

Using functional magnetic resonance imaging (fMRI), Galvan et al. (2006) examined 37 participants, ages 7 to 29 years, for reward-related neural responses and their influence on behavior such as impulsivity. While performing a delayed response two-choice task, the child and adolescent immature PFC manifested as diffuse or scattered PFC neuronal recruitment while more focal PFC neuronal recruitment was noted in adults (23 – 29 years). The maturing of the PFC, defined as more focal neuronal recruitment over time, has been previously replicated (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002; Casey et al., 1997; Durston et al., 2006; Moses et al., 2002). In

addition, the subcortical system (nucleus accumbens [NA_c]) of adolescent (13 -17 years) participants exhibited disproportionately high activation compared to children and adults, while the diffuse adolescent PFC activity looked similar to the child (7 – 11 years) participants (Galvan et al., 2006). Adults had the same NA_c activity as adolescents but exhibited focal neuronal recruitment of the PFC. Previous research has linked elevated NA_c activity to immediate reward seeking (McClure, Laibson, Loewenstein, & Cohen, 2004) with subsequent risk-taking (Kuhnen & Knutson, 2005). Galvan et al. (2006) assert that their study was one of the first to show that behavior can be influenced by reward-related neural responses and that there are really two different developmental trajectories: impulsivity is associated with an immature PFC and reward-seeking behavior is related to an overactive NA_c. Missing in this study were subjects between the ages of 18 to 22 years. Previous research studies have suggested that prefrontal control over emotional processing develops throughout adolescence and into early adulthood (Durstun et al., 2006; Tamm, Menon, & Reiss, 2002). Few studies have correlated age-related brain tissue changes to behavioral indices, therefore, inclusion of late adolescent and early adult participants would assist in timeline development of PFC maturity (Yurgelun-Todd, 2007).

Subcortical/Limbic System

The word “limbic” means “border.” The subcortical or limbic system includes the interconnected basal neural structures that control emotional behavior, memory, and related motivational drives. The key components of the limbic system are: the nucleus accumbens (NA_c), amygdala, hippocampus, and basal ganglia (Guyton & Hall, 2006; Schepis et al., 2008).

Nucleus Accumbens

Casey et al. (2008) question the hypothesis that adolescent “suboptimal choice behavior” is solely based on an immature PFC. The authors suggest if this were so, then children would act as impulsive as adolescents; yet they do not. The NA_c, the subcortical reward center, matures by mid-adolescence compared to the later maturation of the PFC control region (Galvan et al., 2006). Reyna and Farley (2006) assert that adolescents have the ability to reason and comprehend the risks of behaviors; however, the NA_c, especially when highly active, will not inhibit inappropriate choices and actions.

Galvan et al. (2007), in an fMRI study expanding on their 2006 study, found two separate developmental timelines for the PFC and the NA_c. The activity level of the earlier developing NA_c had a positive association with the likelihood of engaging in risky behaviors. Impulsivity ratings were negatively correlated with age and PFC development, not with the NA_c. In their previous study, Galvan et al. (2006) found increased NA_c activity on fMRIs of adolescents who were given medium or large rewards. A small reward actually decreased the response of the adolescents’ NA_c compared to the children or adult participants’ responses. A small response was perceived as no reward at all and did not lead to increased NA_c activity. Again as noted previously, late adolescents and early adults (18 – 23 years) were not part of the sample.

Ernst et al. (2005) studied 18 adolescents (9 – 17 years) and 16 adults (20 - 40 years) for their responses on Wheel of Fortune Tasks which differed based on probability and magnitude of monetary reward. In this study, two subcortical structures were examined with fMRIs: the NA_c and the amygdala (associated with harm avoidance behavior). The researchers found that adolescents demonstrate higher NA_c activity (approach behavior) and weaker involvement of the amygdala (avoidance behavior) than adults when there was a probability of increased monetary reward. Ernst et al. admit

caution with findings since the sample size was small, the study was statistically underpowered, older adolescents (18 – 19 years) were not included, and that the PFC was not considered as an “inhibitory” or “avoidance” variable in this study. Other fMRI studies, however, do support increased NA_c activity in adolescents compared to adults when given tasks related to reward-seeking (Baird et al., 1999; Killgore & Yurgelun-Todd, 2007).

Amygdala

Adolescence is characterized by an imbalance between three behavioral control systems: (1) the approach behavioral system (NA_c), (2) an avoidance behavioral system (amygdala), and (3) the supervisory or regulatory system (PFC). In this triadic model, Ernst, Pine, and Hardin (2006) hypothesize that an adolescent’s behavior is weighted heavily by NA_c activation and consciously experienced as sensation-seeking or risk-taking. In addition, the amygdala’s avoidance circuits are the least powerful during adolescence when compared to adults. The amygdala operates within the subcortical system at a semi-conscious level assessing the importance to survival of incoming environmental stimuli (Giedd, 2008). Amygdalar stimulation, however, can be consciously experienced as involuntary movements, changes in blood pressure, heart rate, even piloerection (Guyton & Hall, 2005).

fMRI studies assessing emotional reactivity in adults and adolescents revealed differing areas of neural activation (Baird et al., 1998; Hare et al., 2008). When adolescents and adults were shown faces expressing a range of emotions, the teens first activated their amygdala (region involved in fear assessment), responding to the stimuli with “gut emotion.” The adults, seeing the same faces with the same emotions, engaged the PFC first, asked questions while responding with reason and logic (Baird et al., 1999). In a recent fMRI study (Hare et al., 2008), children, adolescents, and adults (N = 60;

between 7 – 32 years) completed six runs of go-nogo tasks with fearful, happy, and calm facial expressions. For this study, the go-nogo tasks involved a continually presented series of happy, fearful, or calm faces on a computer screen. The participants were asked to respond as rapidly and click onto happy faces (“go” cues) only; but avoid responding to fearful faces (“nogo” cues). Adolescents (13-18 years) showed initial elevated amygdalar activity with fearful faces, but individual adolescent differences were explained based on the strength of neuronal integration between the PFC and amygdala. Adults were able to adapt and diminish amygdalar response because of their dominant PFC cognitive control. Hare et al. (2008) surmised that the high initial levels of amygdalar reactivity “might explain why poor decisions might be made in the heat of the moment even though adolescents know better” (p. 932). Steinberg (2008) concurs with these findings that adolescents act on “gut feelings” without thinking; characterizing adolescence as “lack of coordination of affect and thinking, rather than the dominance of affect over thinking” (p. 97).

Hippocampus

One end of the hippocampus is adjacent to the amygdala in the subcortical system—both with different functions. The hippocampus is implicated in memory storage and retrieval and can translate short-term memory into long-term memory (Guyton & Hall, 2005; Giedd, 2008). It is the interconnectivity between the amygdala and the hippocampus that consolidates memory for stimuli of high importance or strong emotional value (McGaugh, McIntyre, & Power, 2002; Poldrack & Packard, 2003).

In a cross-sectional sample of adolescents from the National Institute for Mental Health (NIMH) Child Psychiatric Branch Longitudinal Brain Imaging Project, the hippocampal volume significantly increased for adolescent females during puberty while the volume of amygdala for pubescent males significantly increased (Giedd et al., 1996).

Nonhuman primate findings suggest that high numbers of estrogen receptors in the female hippocampus may correlate with increased volume while higher numbers of androgen receptors in the male amygdala relate to larger volumes (Morse, Scheff, & DeKosky, 1986). The hippocampus, amygdala, and the caudate nucleus (from the basal ganglia) are important to visualize during fMRIs because of their association with impulse control and judgment (Weinberger et al., 2005).

Basal Ganglia

The basal ganglia are a collection of subcortical circuitry involved in mediating movement, attention, emotional or affective states, and for integrating higher cognitive functions in the PFC such as executive cognitive functioning (Giedd, 2008; Guyton & Hall, 2005). The most reliable fMRI techniques have been established for only one component of the basal ganglia—the caudate nucleus. The caudate nucleus is a “relay station” for all sensory and motor information that requires PFC processing. In adolescence, with an immature PFC, the caudate circuitry may be in place but without adult cognitive functions, the adolescent may lack the subconscious instinctive knowledge from integration of the subcortical system and PFC, may think too long, and may lack the ability to respond quickly or appropriately (Guyton & Hall, 2005). Liston et al. (2006), scanning 21 participants (7 -13 years) using Diffusion Tensor Imaging (DTI), discovered that connectivity of circuitry tracts between the basal ganglia and the PFC are negatively correlated with impulse control while tested on a go-nogo task. In this study, go-nogo tasks were used to measure response inhibition. The participants were to respond as rapidly to presented “go” cues (a specific letter or word) on the computer and not respond to “nogo” cues. The frequency of “go” cues was $\geq 75\%$.

A previous fMRI study by Casey et al. (1997) consisted of nine children (7 – 12 years) and nine young adults (21 – 24 years) performing a response inhibition task. The

location of PFC activation showed no differences between children and adults. The basal ganglia circuitry, however, showed significantly greater activity for children than adults. Because this task involved both the working memory and response inhibition, the subcortical structures of the NA_c and the hippocampus needed the extra support from the basal ganglia connections in communicating with a child's immature PFC.

Synaptic Pruning

The staging of adolescent brain maturity is marked by both expansive and retractive changes. In utero, the human brain starts with an overproduction of synapses followed by a selective and competitive elimination of the overage (Giedd, 2008; Rosser et al., 2005). Further elimination or synaptic pruning starts in early adolescence and is completed by mid-adolescence (Casey, Tottenham, Liston, & Durston, 2005a; Rapoport et al., 2001). Synaptic pruning is the process of removing excess connections (synapses) between neurons (Powell, 2006; Schepis et al., 2008). Synaptic connections that are used more frequently are retained and strengthened while synaptic pruning creates a more dedicated and focused system of neural networking as noted by thinning of gray matter (Luna & Sweeney, 2004).

In studies on the nonhuman primate adolescent brain, Rakic, Bourgeois, and Goldman-Rakic (1994) discovered that nearly 30,000 synaptic connections are eliminated per second during adolescence. The researchers further predict that during adolescence almost 50% of the cortical synapses existing before adolescence may be pruned. Giedd (2008) describes adolescence as a "use it or lose it" time in the development of efficient cognitive processing. If the adolescent experiences decreased environmental input, uncontrolled or exaggerated pruning could occur.

Myelination

In addition to synaptic pruning, another important change in adolescent brain structure is myelination or the increase in white matter in the PFC (Steinberg, 2008). From neuroimaging, brain maturation can be calculated based on the ratio of gray and white matter in the PFC (Ernst & Mueller, 2008). Myelination, the wrapping of oligodendrocytes around axons, creates electrical insulation or fatty myelin sheathes around the nerve fibers resulting in increased speed of neural transmissions (Giedd, 2008; Schepis et al., 2008; Steinberg, 2008). Fields and Stevens-Graham (2002) stress that myelination not only increases neural processing but also mediates the synchrony and timing of the neuronal impulse patterns, demonstrated by more focused neural patterns.

In childhood, PFC gray matter thickens, however, from the ages of four to twenty years old, MRI longitudinal studies portray a linear increase in white matter (Giedd, 2004; Paus et al., 1999). As gray matter thins, white matter is gained, beginning the steep upward curve of adolescent myelination which matures in females earlier than males (Powell, 2006). In an MRI study of men (19 – 76 years), Bartzokis et al., (2001) discovered that the peak male PFC myelination occurred at 44 years of age. Bennett and Baird (2005) followed the MRIs of 19 first-year undergraduates (mean age 18.6 years) and found that five brain regions, including the PFC, had significant increases in white matter six months from baseline; showing a dynamic brain maturation process even when an adolescent is transitioning into early adulthood.

Integration of PFC and Limbic System

Earlier adolescent imaging studies have concluded that the two different developmental trajectories of the PFC and the subcortical system (NA_c) are responsible for the imbalance between adolescent cognition and affect (Chambers, Taylor, &

Potenza, 2003; Galvan et al., 2006; Steinberg, 2008). Similarly, Bechara (2005) states that the impulsive limbic system “hijacks” the PFC so that future consequences are not considered in adolescent decision-making. Yurgelun-Todd (2007) correlated age with PFC functional activity when investigating adolescent emotional processing capacity.

The improved neural connections among cortical regions as well as between the PFC and the limbic system can now be visualized through Diffusion Tensor Imaging (DTI). Casey et al. (2008) discuss DTI as a tool for investigating the networks of myelinated nerve fiber tracts across and among cortical and subcortical regions. Liston et al. (2005) discovered that the networking of myelinated tracts between the PFC and the basal ganglia, associated with impulse control, do not fully develop until adulthood. Earlier, Luna and Sweeney (2004) concluded that the immature neural integration across the PFC and among the PFC and the subcortical regions in adolescence are important neurobiological risk factors leading to an inability to inhibit responses and to cognitively control motivations and emotions. Using literary metaphors to describe maturation as an adolescent neural integration process, Giedd (2008) explains that “maturation would not be the addition of new letters but of combining earlier formed letters into words, and then words into sentences, and then sentences into paragraphs” (p. 340).

Neurotransmitter/Hormone Balance

Adolescence also involves alterations in many neurotransmitters and hormones. Many of these relevant substrates impose stimulatory or suppressive effects upon the adolescent’s affect, cognition, or behavior (Schepis et al., 2008). Current human and animal research targeting neural transmitter systems are focusing on potential targets for pharmaceutical agents (Lee et al., 2001). With more knowledge of adolescent neurotransmitter/hormonal systems, research can better target the neurobiological correlates of adolescent disorders such as depression, aggression, and impulsive

behaviors (Kaufman, Martin, King, & Charney, 2001). The following neurotransmitters or hormones will be discussed in relation to the period of adolescence: dopamine, serotonin, gamma-aminobutyric acid (GABA), pubertal hormones, oxytocin, and cortisol.

Dopamine

Dopamine, a major brain neurotransmitter with profound effects on the brain reward system, is bestowed “celebrity status” by Marsden (2006) although dopamine neurons account for no more than 1% of total brain neuronal population. Marsden points out that current research is focusing on “the complex interaction between dopamine function in cortical areas, the prefrontal cortex in particular and subcortical dopaminergic systems” (p. S137).

Steinberg (2008) correlates increased risk-taking and reward-seeking with the imbalance in the amount of dopamine receptors within the PFC and the NA_c and the impressive remodeling of the dopaminergic system during adolescence. One theory, “reward deficiency syndrome,” describes a functional dopamine deficit in the PFC and NA_c of an adolescent. In this case, adolescents receive less “reward impact” from stimuli with low to moderate incentives and actively seek stronger appetitive rewards through behaviors involving drugs, risks, or sensation-seeking (Spears, 2000b). Current studies have contradicted this hypothesis by finding elevated dopaminergic activity in the adolescent NA_c during reward-related performance tasks (Ernst et al, 2005; Galvan et al., 2006).

An alternate hypothesis speculates that adolescents seek higher levels of reward because of the loss of dopamine autoreceptors in the PFC. These autoreceptors, in childhood, wield a negative feedback role that inhibit excess dopamine release. Research on prepubertal rats has shown that the large reserve of dopamine autoreceptors in the PFC contribute to no euphoric dopamine-driven responses from cocaine or

methamphetamines. Without this “buffering capacity” stemming from the loss of dopamine autoreceptor reserves throughout adolescence, the adolescent has higher levels of dopamine in an immature PFC creating a stage of vulnerability toward risky decisions and behaviors. The loss of dopamine autoreceptors in the PFC continue into adulthood, but integration of a mature PFC with subcortical system in adulthood decreases their risk vulnerability (Dumont, Andersen, Thompson, & Teicher, 2004). Concurring, Rosenberg & Lewis (1995) found increased dopaminergic innervation in the PFC among adolescent nonhuman primates; although the PFC had reduced dopamine receptor density.

Animal researchers Pezze, Dalley, and Robbins (2007) examined adolescent mice and discovered that premature “impulsive responding” to cue-mediated rewards (food pellets) were dependent on dopamine release within the NA_c. In a summary of animal research on dopamine and its links to drug abuse, DiChiara (2002) concludes that with increased dopamine in the NA_c from drug ingestion, drug-seeking behaviors are repeated which strengthens the learned association that led to the rewards. These same limbic (NA_c) pathways are activated by substances of abuse as well as naturally occurring rewards (Marsden, 2006). Little is known about how or when the dopaminergic mesolimbic circuitry mature from adolescence into adulthood, but the Tseng and O’Donnell (2007) study correlated cognitive function, working memory, and attention with an optimal level of dopamine receptor stimulation in the PFC.

Serotonin

Serotonin can be classified as a suppressive neurotransmitter (Schepis et al., 2008). Serotonin pathways directly link the PFC with the amygdala, the emotion-control center, in the limbic system. The aggressive and impulsive behaviors related to dopamine are directly opposed and inhibited by serotonergic activity (Frankle et al., 2005; Goveas,

Csernansky, & Coccaro, 2004). In adolescent rhesus monkeys, input of dopamine to the PFC is three times greater than serotonin input (Lambe, Krimer, & Goldman-Rakic, 2000). In rats, more synaptic pruning occurs for serotonin than dopamine in early adolescence (Dinopoulos, Dori, & Parnavelas, 1997).

In humans, Passamonti et al. (2006) found genetic variations that affect reuptake or catabolism of serotonin in the PFC among 24 healthy males (18 – 40 years). The researchers found that men who possessed the low-activity allelic variant of the Monoamine Oxidase-A (MAO-A) coding gene demonstrated greater serotonin availability and were better able to process conflicting and stimulatory information. Degradation of serotonin was correlated with high-activity allelic variant carriers of the MAO-A coding gene. People with active serotonin synapses report feeling content and calm while anxiety and depression are commonly seen with individuals who possess slower serotonin synapses (Kalus, Asnis, & Van Praag, 1989). The link between serotonin and criminality has been researched in psychopaths (Kiehl et al. 2001), in unusually impulsive crimes, in conduct disorders, and in antisocial personality disorders (Coccaro, Kavoussi, Cooper, & Hauger, 1997; Dolan, Deakin, Roberts, & Anderson, 2002).

GABA

The nature of gamma aminobutyric acid (GABA) system alterations are not well established in adolescents. Research on treatments for alcohol and cocaine dependence has shown that GABA has an inhibitory effect upon the NA_c (Johnson, 2005). Two researchers have discovered that the input of GABA to the PFC diminishes dramatically throughout adolescence in humans (Lewis, 1997; Spear, 2000a). Schepis et al. (2008) hypothesize that the pruning and remodeling of the cortical and limbic dopamine systems may be modulated by the GABAergic system during adolescence.

Pubertal Hormones

Puberty is one of the most important events occurring in adolescence. Ernst and Mueller (2008) acknowledge that little is known about the type or range of adrenal or gonadic hormonal-related cortical changes during adolescence since a paucity of fMRI data exist regarding puberty. Still unknown is the role of puberty in shaping the brain function or structure of an adolescent.

Evidence, however, exists that early maturing boys and girls experience higher incidences of delinquency and other problem behaviors such as alcohol, drug use, or unprotected sex (Deardorff, Bonzaes, Christopher, Roosa, & Millsap, 2005). Steinberg (2008) speculates that early maturers are at increased risk because these adolescents experience a longer time span between the start of the “stimulatory” dopaminergic system and the completed PFC maturation. In addition, pubertal hormones can strongly influence memory for social bonding; a factor that leads to the importance of peers and could result in risky behaviors (Nelson, Leibenluft, McClure, & Pine, 2005).

Ellis (2005) proposes the Evolutionary Neuroandrogenic Theory (ENA) to explain the higher incidence of male offenders responsible for aggressive criminal behaviors termed “competitive/victimizing behaviors.” First, androgens are thought to lower one’s sensitivity to negative consequences and potentially, reward-seeking and risk-taking behaviors could be pursued. Second, the combination of androgens, immature PFC, and mature NA_c could create sudden fits of rage which trigger forceful oppositional actions. Third, androgens can cause less cortical functioning from the left hemisphere (Reite, Cullum, Stocker, Teale, & Kozora, 1993) where “empathy-based moral reasoning” is located (Moll et al., 2002). Ellis accepts that not all adolescent males exhibit criminal behavior and further delineates genetic and environmental vulnerabilities, as well as

twelve biological correlates of crime that may predispose adolescent males to “competitive/victimizing behaviors.”

Oxytocin

Oxytocin, known best for its role in maternal bonding behavior, is a hormone that functions as a neurotransmitter. With pubertal hormones, oxytocin receptors proliferate in the amygdala and the NA_c resulting in more acute attentiveness to social stimuli (Nelson et al., 2005). Oxytocin moderates social stimuli memory and social bonding (Insel & Fernald, 2004; Winslow & Insel, 2004). Steinberg (2008) hypothesizes that increased oxytocin levels can indirectly affect adolescent risk behavior. Oxytocin influences adolescents who have friends engaging in risky behaviors, to be more likely to engage in similar behaviors. In a study where adolescents were randomly assigned to a video driving game either alone or with two friends, risk taking doubled among adolescents who had two friends in their “car,” with more males taking risks (Gardner & Steinberg, 2005). The same researchers collected fMRI data on two of the subjects from the previous study. When peers were present during the driving game, the same neural circuitry especially responsive to rewards (NA_c and medial frontal cortex) were activated.

Cortisol

The hypothalamic-pituitary-adrenocortical (HPA) axis, a neuroendocrine system, plays an important role during times of stress, especially controlling the secretion of cortisol (Lovallo, 2006; Schepis et al., 2008). Elevated cortisol levels in adults have been correlated with depression (Sadock & Sadock, 2003) and ingestion of alcohol (Lovallo). Integrated communication between the limbic system (amygdala, NA_c, and hippocampus) and the PFC triggers the HPA axis to secrete cortisol during episodes of acute psychological distress (Lovallo).

Normally, cortisol secretion peaks in the morning upon awakening, gradually decreases throughout the waking hours until the daily minimum is obtained during the first half of the sleep cycle (Czeisler et al., 1976). Two studies investigating cortisol levels of depressed children and adolescents found increased nighttime cortisol levels rather than the typical morning burst of cortisol (Goodyer et al., 1996; Kutcher et al., 1991). A third study of depressed and suicidal adolescents found increased cortisol levels with sleep but no difference in the overall 24-hour cortisol secretion from normal controls (Dahl et al., 1991). Soloff, Lynch, and Moss (2000) measured cortisol levels of 36 adolescents (16 – 21 years) with co-occurring alcohol use disorder (AUD) and conduct disorder (CD) as well as adolescents with AUD alone. The researchers found significantly higher cortisol levels in adolescents with AUD and CD than those with AUD alone; suggesting a relationship more with the aggressiveness and impulsivity of CD than with alcohol use alone.

In addition, research with adolescent criminal offenders has revealed HPA hypoactivity, demonstrated by blunted cortisol responses to stressor. When adolescents or young adults presented with a parental history of alcoholism, cortisol levels were lower than normal at baseline with a further decline after experiencing a mild anxiety-provoking stressor (application of scalp electrodes with attachment to a complex machine). Diminished cortisol responses in prepubertal boys were associated with later use of cigarettes and marijuana during adolescence (Moss, Vanyukov, Yao, & Kirillova, 1999). Ellis (2005) asserts that low cortisol levels, even in the presence of acute stressors, indicate suboptimal arousal which can lead to criminal behavioral tendencies. The author suggests that individuals with low cortisol demonstrate suboptimal arousal by being less intimidated by threatening environmental aspects, having a lowered sensitivity to pain, seeking higher levels of sensory stimulation in forms of risk-taking criminal behaviors,

and having the physiological indicators of suboptimal arousal—lower average resting heart and pulse rates. Four studies investigating male adult habitual offenders, violent substance- and alcohol-using criminals, and male suicidal alcoholics found consistently low cortisol levels in the offenders compared to healthy control participants (Bergman & Brismar, 1994; King, Jones, Scheuer, Curtis, & Zarcone, 1990; Lindman, Aromaki, & Erickson, 1997; Virkkunen, 1985). More adolescent research is needed to assess the impact of the earlier maturing limbic system and the later developing PFC upon the activation of the HPA axis during times of psychological stress (Lovallo, 2006).

Neuroimaging

Introduction to Neuroimaging

Over the past two decades, an eruption of neuroimaging research has focused on functional brain mapping of adults. This use of functional neuroimaging tools has led to experimental standards as well as expertise in both methodology and interpretation of imaging findings (Ernst & Mueller, 2008). Initial neuroimaging researchers have linked impulsivity, aggression, poor control of emotions, and missing awareness of future consequences to PFC function and structure in adults with orbital and medial PFC lesions (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Davidson, Putnam, & Larson, 2000; Fuster, 1998; Grafman et al., 1996).

Yurgelun-Todd (2007) recognizes that developing adolescent behaviors such as intense emotional expression, impulsivity, and risk-taking parallel behaviors noted from adults with PFC lesions. Most research on neurodevelopment has been completed on healthy children and adolescents. Research studies and imagery techniques are mandated to be of minimal risk to children and adolescents who are considered vulnerable populations (<http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm#subpartd>). Prior to the past decade, available functional neuroimaging tools were

from nuclear medicine involving exposure to radiation (Ernst & Mueller, 2008). Because radiation represents an increase over minimal risk, the nuclear medicine techniques of ionizing radiation positron emission tomography (PET) and single photon emission computed tomography (SPECT) seriously limit repeated measures, necessary for developmental studies of children and adolescents (Arnold, Zametkin, Caravella, & Korbly, 2000; Munson, Eshel, & Ernst, 2006). PET and SPECT, requiring radioactive compounds, measure radioligands that offer valid and reliable radioactive counts of the “in vivo behavior of biological molecules of interest” (Ernst & Mueller, p. 730).

Beginning with the last decade, most of neurodevelopmental research with children and adolescents uses magnetic resonance imaging [MRI] (Ernst & Mueller, 2008). MRIs measure electromagnetic field distortions that are proportional to any changes in the concentration of deoxyhemoglobin measured by Blood Oxygen Level Dependent signal (BOLD) (Eden & Zeffiro, 2000). Especially important in developmental research on adolescent brains, MRIs also measure water-to-fat content of brain tissue. This is especially important in determining gray to white matter ratios, since gray matter is water-filled nerve cell bodies and white matter is fatty myelin (Powell, 2006). When compared to other imaging techniques, MRIs are superior in defining gray-white matter distinctions and in differentiating white matter changes (Renshaw, 2002).

MRIs require children and adolescents to be isolated in an electromagnetic scanner room and to remain still in the scanner in order to prevent motion artifacts; both actions that can affect participant anxiety levels (Poldrak, Pare-Blagoev, & Grant, 2002; Thomas et al., 1999). Rosenberg et al. (1997) describe the use of mock scanner practice sessions to reduce anxiety, acclimate child or adolescent to scanner and room, and practice immobility. Though MRIs are radiation free, those using MRI must follow specific

precaution guidelines especially banning all ferromagnetic material from the scanner and scanner room or results can be fatal (Ernst & Mueller, 2008).

For children and adolescents, longitudinal MRI studies are the “gold standard” for researching neurobiological development. At present, however, most neuroimaging has been limited to cross-sectional studies comparing different age groups because longitudinal studies increase research costs and can cause reliability issues with repeated measures since instrumentation rapidly changes (Ernst & Mueller, 2008).

Types of Neuroimaging

A science of the mind must reduce...complexities (of behavior) to their elements. A science of the brain must point out the functions of its elements. A science of the relations of mind and brain must show how the elementary ingredients of the former correspond to the elementary functions of the latter (Williams James, *The Principles of Psychology*, 1890, as cited in Giedd, 2008, p. 335).

James' vision from the 19th century describes linking behavior to the structural and functional components of the brain. By combining radio waves, strong magnetic fields, and state-of-the-art computer technology, MRIs can analyze both structural and functional developmental trajectories of adolescent brains. Giedd (2008) states that “an important consideration in linking form and function in the brain is that differences in the trajectories of development may in some cases be more informative than the final adult differences” (p. 340).

Four different types of MRIs will be described as well as examples of their utility in adolescent neurobiology research: functional MRI (fMRI), structural MRI (sMRI), diffusion tensor imaging (DTI), and magnetization transfer imaging (MTI). These four types can be performed on the same MRI scanner utilizing different software (Giedd,

2008). Whether a technique is used solely or in combination with others, inter-individual variations can now be investigated from cellular to macroscopic levels, with an ability to link genes, brain, and behavior (Giedd, 2008).

Structural MRI (sMRI)

sMRIs are utilized to examine any associations between structural brain alterations occurring during adolescence and behavioral and/or cognitive measures (Yurgelun-Todd, 2007). More specifically, sMRI measures size and shape of neural structures.

Casey et al. (1997) concluded from their sMRI research that measures of cognitive control (response inhibition) correlate with PFC and basal ganglia regional volumes. Giedd (2004) discovered that full volume of the dorsolateral PFC is achieved in the early twenties and correlated with better ability to control or inhibit behavioral responses (Casey et al., 1997). With growth mapping techniques, sMRI was used to demonstrate the slower maturation process of the PFC compared to other regional brain structures (Casey, Galvan, & Hare, 2005b; Gogtay et al., 2004). Another sMRI study related higher IQ scores to greater volume of the whole cerebrum as well as cortical gray matter of children and adolescents (Reiss et al., 1996). Sowell et al. (2004) associated PFC maturation, measured by cortical gray matter thinning, with improved verbal memory test performance in children and adolescents (7 – 16 years).

Functional MRI (fMRI)

fMRIs are used to evaluate and measure brain activity within neuroanatomical structures. Casey et al. (2008) explain that fMRIs offer the most direct approach to investigate structure-function associations by simultaneously measuring changes in both the brain and resulting behaviors. Providing cognitive or emotional challenge paradigms while applying fMRI offers an effective method to assess region-specific brain changes

(Yurgelun-Todd, 2007). A subtraction rule algorithm is offered to assess or “score” neural processing (Owen, Epstein, & Johnsrude, 2001). As an example, the neuro-activation map of a decision-making task with monetary rewards is subtracted from the activation map of the exact task without reward. The remaining information would add input to the neural processing of rewards (Ernst & Mueller, 2008). In addition, fMRI clearly identifies the changes in cerebral hemodynamics that occur during thought processing or mood changes (Yurgelun-Todd). The fMRI can capture the different magnetic properties of oxygenated versus deoxygenated hemoglobin in the brain. Increased cerebral blood flow is triggered by greater metabolic need during a task (Giedd, 2008). Passamonti et al. (2006) utilized blood oxygenation level dependent (BOLD) fMRI to assess for activation of cortical regions involved in inhibitory control or impulsivity among 24 healthy men (18 – 40 years).

Researchers have used fMRIs to examine patterns of PFC activity in children and adults during the performance of working memory tasks (Nelson et al., 2000; Casey et al., 1995), response inhibition tasks (Casey et al., 1997; Luna et al., 2001), verbal fluency tasks (Gaillard et al., 2000), and executive function tasks (Bunge et al., 2002; Rubia et al., 2000; Schlagger et al., 2002; Thomas et al., 1999). fMRIs illuminate the shifts in balance between competing cognitive and emotional neuronal networks (Giedd, 2008). When 37 participants (ages 7 – 29 years) were assessed for reward-seeking response, this fMRI study found the adolescent NA_c functions equal to an adult’s NA_c, however, the adolescent’s PFC (cognitive control) was closer to the level of a child (Galvan et al., 2006). Casey et al. (2008) summarizes current fMRI interest:

Tracking subcortical (e.g. accumbens) and cortical (e.g. prefrontal) development of decision-making across childhood through adulthood, provides additional constraints on whether changes reported in

adolescence are specific to this period of development, or reflect maturation that is steadily occurring in a somewhat linear pattern from childhood to adulthood. (p. 68).

Giedd (2008) discusses future targets for fMRI study. Since puberty occurs with adolescence, fMRIs will address puberty-specific versus puberty-independent changes in adolescent neurodevelopment. Giedd suggests examining pre- and post-pubertal adolescents of same age to better compare cognitive and emotional systems during behavioral performance tasks.

Diffusion tensor imaging (DTI)

DTI evaluates the directional diffusion of free water (component of gray matter) and contributes information on white matter tract directionality and connectivity. Because of increasing knowledge of adolescent neural circuitry integration, DTI better characterizes the direction of white matter axons and measures the nonrandomness of free water diffusion (anisotropy) within the brains of children and adolescents (Cascio, Gerig, & Piven, 2007; Casey et al, 2008). High anisotropy conveys “coherently bundled myelinated axons” and linear axonal pruning resulting in neuronal communication efficiency (Suzuki, Matsuzawa, Kwee, & Nakada, 2003). DTI offers the greatest potential to examine the role of white matter tracts in adolescent brain development and behavior (Casey et al., 2008).

In a DTI study analyzing alterations in white matter microstructure, less myelination of frontal white matter was found in children than adults (Klingberg, Vaidya, Gabrieli, Moseley, & Hedehus, 1999). Silveri et al. (2006) investigated a correlation between impulse control (both boys and girls) and white matter organization. Twenty-one adolescents (mean age 12.3 years) completed self-report behavioral and cognitive measures of impulse control and were scanned using DTI. Males had a significant

relationship between white matter integrity and their self-report scores of impulse control (behavioral measure) while female adolescents' DTI findings of white matter significantly correlated with cognitive measures of impulse control. Using DTI, Liston et al. (2005) found that the white matter tracts between the PFC and basal ganglia correlate with impulse control while Nagy, Westerberg, & Klingberg (2004) correlated cognitive control with development of prefrontal-parietal fiber tracts.

Magnetization transfer imaging (MTI)

Differing from sMRI and DTI, MTI characterizes the microstructure of brain tissue by assigning a magnetization transfer ratio of the number of bound protons to unbound protons of macromolecules (Rovaris et al., 2003). Current research studies using MTI are focusing on myelinated neuronal tracts of persons with multiple sclerosis [MS] (Oda, Udaka, & Nippon, 2008; Cercignani & Barker, 2008) or investigating age-related brain tissue changes (Rovaris et al.). Though no literature was found using MTI with adolescents, researcher are utilizing this technique to evaluate cognitive impairment, an early and frequent finding of MS, by looking at both macroscopic and microscopic tissue damage in the corpus callosum (Lin, Tench, Morgan, & Constantinescu, 2008). In addition, poor performance by MS patients on attention tests were associated with lower magnetization transfer ratios in the microstructures of normal-appearing white matter (Summers et al., 2008). Since cognitive function and attention are important and shown to be associated with PFC cortex maturation and myelination for adolescents, future research may utilize MTI in combination with other neuroimaging modalities.

Adolescent Correlates in Neuroimaging Research

Neuroimaging has the ability to quantify and measure structural and functional changes in the developing adolescent brain. Currently, magnetic resonance imaging

(MRI) has the potential to link neural findings to adolescent cognitive processes, psychosocial functioning, and risk behaviors (Casey et al., 2008).

Cognitive Processes

Neuroimaging of adolescents has assisted researchers in correlating the developmental trajectories between cognitive and neural processes (Casey et al., 2008). In this section, adolescent neurobiology research associating four cognitive processes will be discussed: (1) intellectual ability, (2) memory/attention, (3) basic information processing, and (4) response inhibition/impulsivity.

Intellectual Ability

Prior to MRI technology, any knowledge of early brain development was acquired from autopsy studies of children (Reiss et al., 1996). Neuroimaging research studies have examined the neuroanatomical correlates of child and adolescent general intelligence. Intellectual ability, or general intelligence, is defined as an aptitude for reading, writing, arithmetic, and reasoning (Shaw et al., 2006). Generally, an age-appropriate version of the Wechsler Intelligence Scale is administered (Wechsler, 2003) to children and adolescents to measure intelligence quotient (IQ). The Wechsler Intelligence Scale yields three composite scores: verbal, performance, and full-scale (Canivez, Neitzel, & Martin, 2005). A Swedish MRI study (Ullén, Forsman, Blom, Karabanov, & Madison, 2008) measured intelligence of older adolescents and adults (19 – 49 years) using the Raven's Progressive Matrices (Styles, Raven, & Raven, 1998). Raven's Progressive Matrices is a nonverbal measure with an ability to measure intelligence over the age of six years old. With increasing difficulty, the task to find the missing part within each pattern correlated with skills of "perception, construction of wholes, memory, relations of right and left, and speed of perception" (Rimoldi, 1948, pp.

350-351). Rimoldi stresses that this measure is independent of the educational level of the participant.

In a cross-sectional MRI study of 85 normal children and adolescents (5 – 17 years), Reiss et al. (1996) investigated correlations between cerebral brain volume, IQ, gender, and age. This study was one of the earliest to image normal children and adolescents for the purpose of describing quantitative brain development in vivo. Reiss et al. discovered a significant modest and positive correlation between IQ and cerebral brain volume, based on cortical gray matter. At baseline, full-scale IQ scores from the Wechsler Intelligence Scale did not differ between gender and age. Though the range of ages for participants was 5 to 17 years of age, the mean ages (10.6 ± 2.9 years for girls and 10.7 ± 2.8 years for boys) represented a more homogeneous group of children rather than adolescents. Thus, age was not significantly associated with total cortical volume and IQ. Of the three components that comprise cerebral volume (gray matter, white matter, and cerebrospinal fluid), only the gray matter volume predicted a significant variance ($R^2 = 0.156$; $p < .001$) in IQ. In children, larger volumes of gray matter predicted higher IQ scores.

Based on gender, Reiss et al. (1996) found that, in males, gray matter contributes more to total cerebral volume than white matter. The MRIs showed increased cortical neuronal density (less gray matter volume) among girls while boys had more gray matter (less neuronal density). Because of the similar ages of the participants, the presence of age-related changes in gray and white matter volumes was not discussed. Subsequent studies have shown linear age-related white matter increases (Giedd, 2004; Paus et al., 1999). Researchers in a recent cross-sectional DTI study of children and adolescents (5 – 18 years) found not only age-related white matter increases, but were

able to differentiate gender-specific development of white matter microstructure; hypothesizing potential linkages to intelligence (Schmithorst, Holland, Dardzinski, 2008).

Shaw et al. (2006) presented clear finding of relationships between intellectual ability and specific cortical development in their longitudinal study (N = 307) of children and adolescents. Participants were divided into groups based on age (early [4 – 8 years] or late [9 – 12 years] childhood, adolescent [12 – 17 years], and early adult [17 – 29 years]) and also on IQ scores of average, high, or superior intelligence. Using sMRI, the researchers found significant interactions between cortical thickness of the PFC and IQ that varies with age groups but not with gender. From this study, Shaw et al. were able to describe the different developmental trajectories of cortical thickness based on each of the three IQ groupings. The superior intelligence group started with a thinner PFC followed by a dramatic increase in cortical gray matter thickness—peaking at 11 years. This group, in early adolescence, exhibited the most rapid rate of gray matter thinning. In comparison, the average and high intelligent groups presented with a brief onset of initial cortical thickness (peaking by 8 years); followed by a slower thinning process starting in late childhood. Shaw et al. also found that the intelligence groups based on differing rates of gray matter thinning differed significantly in socio-economic status [SES] ($p < 0.01$); SES negatively correlated with IQ ($r = -0.35$; $p < 0.01$). This study extended previous knowledge of association between gray matter and intelligence by describing the dynamic properties of cortical maturation. In an earlier imaging study, Sowell et al. (2004) linked cortical gray matter thickness in specific brain regions with variations in cognitive ability in 45 children (ages 5 – 11 years) over a two-year period of time.

Recently, 34 older adolescents and adults (19 – 49 years) were enrolled in a Swedish sMRI study correlating higher intelligence with increased prefrontal white matter volume (Ullén et al., 2008). Myelination, the process which increases white matter

volume in the PFC, is assumed to reflect increased corticocortical connections. In addition, the researchers found positive correlations between the scores from Raven's Progressive Matrices, a cognitive marker, and regional cortical gray matter volumes. A limitation of MRIs is that cellular events such as cell packing, myelination, or synaptic density cannot be visualized or explained (Sowell et al., 2004). At present, intelligence levels have been shown to be related to cortical growth during childhood and adolescence. No studies to date have investigated links between IQ, white or gray matter volume, and risk-taking or impulsive behavior during adolescence.

Memory/Attention

Steinberg (2008) advises the use of caution in attributing changes in brain structures or function to simple accounts of adolescent cognition such as memory or attention. He believes that without hard data demonstrating how brain influences cognition, causal linkages cannot be assumed.

Working memory, as both immediate and recent memory, is the ability to retain and store information for several seconds while corresponding cognitive processes take place on the retrieved information (Sadock & Sadock, 2003). The same authors assert that attention is strengthened by an intact right frontal lobe and is operationalized as persistence and maintenance of a coherent line of thought.

One imaging study found that male and female adolescents recruit different regions of the brain when performing a spatial working memory task (Schweinsburg, Nagel, & Tapert, 2005). In a later BOLD fMRI study, Schweinsburg et al. (2008) compared 15 marijuana(MJ)-using adolescents (16 – 18 years) with a demographically similar non-user control group (16 – 18 years) on brain responses to a working memory task. Without specifying gender, the control group activated the bilateral PFC and postparietal networks during the task. After 28 days of MJ abstinence, the experimental

group exhibited lower activity in the right PFC and more activity in the right postparietal cortex—paralleling usual response patterns of younger adolescents. This study was one of the first to look at long-term neurocognitive effects of MJ use in adolescents.

Ernst and Mueller (2008) state that normative developmental studies of attention in adolescents are sparse. One fMRI study compared 16 children (8 – 12 years) with an older control group (N = 16; 20 – 34 years). Differing from adults, the children had reduced neural activity in frontal, temporal, and parietal areas. Because of the need for PFC activity in adult attention tasks, children, with an underdeveloped PFC, activate areas in the occipital cortex, outside the usual expected PFC neural networks in order to perform attention tasks (Konrad et al., 2005).

Information Processing

One of the milestones of adolescence is to demonstrate deliberative thinking through the coordination of affect (correlate of limbic system) and cognition (correlate of PFC). In a recent review, Steinberg (2008) discusses maturation of PFC and improved neural networks among cortical and between cortical and limbic areas as main facilitators of adult-like information processing. It is the combination of intellectual ability (cognition) and psychosocial maturity (affect) found by Steinberg to occur around or after 25 years of age.

Another fMRI study asked adults and adolescents if some risky activities such as swimming with sharks or setting one's hair on fire were "good ideas." Adolescents deliberated longer before responding and activated diffuse scattered regions of the immature PFC. Adults were able to answer the questions promptly with narrow neural activation mainly in the dorsolateral PFC (Baird, Fugelsong, & Bennett, 2005, as cited in Steinberg, 2008). When activities were not dangerous (eating a salad or taking a walk), both adults and adolescents showed similar patterns of cortical activation. Steinberg

explains that adolescents possess a lack of coordination between affect and cognition, rather than only dominance of affect over thinking, due to the undeveloped integration between the PFC and the limbic system.

Impulsivity

Impulsivity is defined as an inability to squelch inappropriate thoughts and actions even in the presence of irresistible incentives. Impulsivity is associated with the lengthy protracted maturation of the PFC (Casey et al., 2005b) and should not be confused with reward-seeking which via imagery is associated with increased activity in the NA_c (Kuhnen & Knutson, 2005; Matthews et al., 2004). With PFC maturation, the intended outcome is response inhibition, to choose goal-oriented thoughts and actions (Casey et al., 2005a).

Claimed as the first fMRI study to assert a primary regulatory role of the PFC over subcortical regions, Rubia et al. (2000) found that inhibitory processing and executive function normally develop over the age-range of adolescence and adulthood in tandem with functional PFC activation. Using DTI, Liston et al. (2005) examined myelination of PFC axons and axonal pruning in 21 subjects (7 – 31 years) while performing a go-nogo response inhibition task. The researchers demonstrated a positive correlation between an ability to inhibit responses and “coherently bundled” white matter axons in the frontostriatal area of the PFC. Similarly, Steinberg (2008) associates improved intra-PFC neuronal integration with higher order executive functions such as inhibition of responses, foresight to plan ahead, balancing risks and rewards, and ability to consider multi-sources of information.

Because of strong neuroimaging results correlating PFC immaturity with impulsivity and PFC maturity with response inhibition, Rosser et al. (2005) used a psychological indicator, Tower of Hanoi (TOH), to assess PFC functioning related to

impulsivity and response inhibition. The behavioral markers of PFC function are the impulsive patterns of errors made on the Tower of Hanoi. The TOH has three disks (smallest at top, largest on bottom) stacked on the most left post and also includes two empty posts to the right. The disks must be moved from their post to the last post on the right and be stacked exactly as before. Only one disk can be moved per move and a larger disk can never be on top of a smaller disk. Scores are based on number of moves, time to solving, and total time/total moves. The test “times out” at 5 minutes. In the Rosser et al. study, 35 substance and criminally involved (SCI) adolescents and 50 “resilient” Air Force high school ROTC adolescents completed the TOH problem. Though the SCIs were older (mean age 17.7 years) than the control group (mean age 15.6 years), the already high risk youth exhibited little response inhibition and scores labeled them “impulsive.” Forty percent of the control ROTC group solved the TOH correctly, correlating with baseline PFC function for 15+ year olds. The researchers question if drug use leads to neurochemical brain changes with more prolonged PFC immaturity in criminally-involved adolescents who use substances.

Psychosocial Function

Steinberg (2008) argues that studying the social and emotional factors in adolescence in tandem with neurodevelopment may lead to prevention programs or interventions aimed at the minimization of adolescent risk-taking. Steinberg postulates that in situations of emotional arousal or peer presence, an adolescent’s emotional-social neural network (NA_c) is strongly activated. This network usurps the regulatory effectiveness of the maturing PFC as cognitive control agent.

Social Processes

Steinberg (2008) emphasizes that basic intellectual ability reaches adult capacity by 16 years of age but psychosocial maturation extends well into mid-twenties. The

author further notes that resistance to peer influence is facilitated with improved integration and communication between cortical and subcortical areas.

Both Steinberg (2008) and Grosbas et al. (2007) discovered that children and adolescents when exposed to angry hand or facial expressions (proxies for emotionally arousing social information) activated regions such as right dorsal premotor cortex and reported low scores on a measure of resistance to peer influence. Higher scores, indicating ability to resist peer pressure, were associated with fMRI findings of networking of the right dorsal premotor cortex with decision-making regions (dorsolateral PFC). Grosbas et al. also observed no brain region differences among individuals when participants viewed emotionally-neutral videos.

Future directions for adolescent research have been generated from a model of neural networking of social processing (Nelson, Leibenluft, McClure, & Pine, 2005). Nelson et al. found that pubertal gonadal steroids cause limbic system changes that affect emotional reactions to social stimuli. It is the gradual maturation of the PFC that enables inhibited and controlled responses to socio-emotional information. The authors advise further research on adolescent onset of mood and anxiety disorders related to speculation of the involvement of social processing dysregulation. Ernst and Mueller (2008) discuss current fMRI adolescent research on social processing involving new task paradigms of economic exchange affiliations, fairness, and trust.

Emotion

Though much neuroimaging research has focused on the study of emotion, researchers purposely evaluate behavioral performance and physiological or neurobiological reactions as proxy measures for emotion because of the unclear distinction between perceiving and producing emotion in children and adolescents

(Davidson & Slagter, 2000). Most affective neuroscience research involves the study of evoked responses to fearful face stimuli (Ernst & Mueller, 2008).

Claimed to be the largest MRI study of emotion development among children and adolescents, Guyer et al. (2008) compared the responses of 31 healthy children/adolescents (9 – 17 years) with a control group of 30 healthy adults (21 – 40 years) on an emotional face viewing task. When viewing fearful versus neutral faces, adolescents greatly activated the amygdala while adults demonstrated functional maturity of amygdalar/hippocampal connectivity leading to increased memory formation for the faces. The strong amygdala/hippocampal integration reflects maturation in memory retrieval (hippocampus) of facial expressions. The hyperactive amygdala in children and adolescents as a response to fearful faces was hypothesized by Guyer et al. to increase adolescent vulnerability to affective disorders. This study duplicated conclusions from previous MRI studies on fearful face responses (Killgore & Yurgelun-Todd, 2004; Kilpatrick & Cahill, 2003; Monk et al., 2003).

Adolescent Risk-Taking Behaviors

At present, Casey et al. (2008) admit that relatively little is known about adolescent neural changes simultaneously occurring with reward-seeking risky behaviors since few longitudinal studies are attempted. Most imaging research studies of children and adolescents are cross-sectional; reporting a specific period of neurodevelopment coinciding with particular behaviors.

Motivational behavior such as reward-seeking is the outcome of information processing ability and has been associated with activation of motivational or reward-seeking neural circuitry (Schepis et al., 2008). In addition, the behaviors related to decision-making have conceptualized adolescence as a period of suboptimal decisions and actions leading to high risk behaviors (Casey et al., 2008).

Risk-Taking

Adolescents are characterized as both impulsive and risky. Imaging literature discusses separate developmental trajectories and separate neurobiological systems (Casey et al., 2005a; Steinberg, 2004, 2007). While impulsivity is associated with PFC immaturity and diminishes from childhood to adulthood (Casey et al., 2005b), risk-taking is associated with increased limbic activity (NA_c), more exaggerated during adolescence than any other time between childhood and adulthood (Kuhnen & Knutson, 2005; Matthews et al., 2004).

From a species-evolutionary perspective, adolescent behaviors of novelty- or sensation-seeking and risk-taking are viewed as important behaviors. The risks taken to leave the protective nest are significant yet necessary to facilitate genetic diversity and avoid genetic inbreeding. Human adolescents must also achieve reproductive maturity and acquire independence through socially competent behaviors (Ernst & Mueller, 2008).

Though currently emphasizing the neurobiology of risk-taking in adolescents, Steinberg (2008) also views risk-taking on multiple levels: (1) psychological—based on the emotional reactivity affecting risky decision-making; (2) contextual—based on influential interpersonal processes of risk taking; and (3) biological—based on quantitative endocrinology, neurobiology, or genetics of risky novelty-seeking. However, Steinberg acknowledges that understanding first the biological perspective of all aspects of adolescent behavior will enhance and possibly correct the psychological and contextual theories of adolescent risk-taking.

Current research dispels the stereotype that adolescents are irrational, unaware, and unconcerned with potential consequences to their risky behavior. Reyna and Farley (2006) presented comparable logical-reasoning abilities between 15-year old adolescents and adults; both groups similarly estimated risk vulnerability. Supporting these results,

two earlier studies found few differences between adolescents and adults in: (1) judging the gravity of consequences stemming from risky behavior; (2) evaluating risks inherent with increasing danger level; and (3) weighing the costs and benefits of a risky behavior (Beyth-Marom, Austin, Fischhoff, Palmgren, & Jacobs-Quadrel, 1993; Millstein & Halpern-Felsher, 2002). However, risk taking is more common during adolescence (Steinberg, 2004).

Adolescent risk taking is explained as the product of competitive interplay between a more assertive socioemotional neural network (NA_c) and a slower-to-develop cognitive-control network [PFC] (Drevets & Raichle, 1998) Steinberg (2004) concludes that adolescent risk taking is inevitable—being both normative and biologically driven.

Reward Circuitry

Reward-related processes create the motivation behind high-risk behaviors (Ernst & Mueller, 2008). Termed a motivational learning system, reward circuitry and specific neurotransmitters are divided into stimulatory and suppressive systems. The PFC, serotonin, and GABA comprise the suppressive influence while the limbic system, dopamine, and glutamate are stimulatory. Normal adolescent neurodevelopment presents with greater expression of the stimulatory system (Chambers, Taylor, & Potenza, 2003).

Galvan et al. (2006) suggest that risky adolescent behavior is influenced by reward-related neural responses. In their fMRI study, 13 children, 12 adolescents, and 12 adults were provided a chance to win as much as \$25 playing a “pirates and treasure chest” video game. With correct responses, the screen would display a small, medium, or large payoff. Adolescents’ fMRIs revealed a two-fold increase in NA_c activity with a large pay-off compared to children and adults. These fMRI results were previously replicated by May et al. (2004) and Ernst et al. (2005).

The adolescent's NA_c and associated limbic structures connect with dopamine-rich areas—spawning emotion and motivation to obtain the largest reward. The understanding of the structure and functional connectivity of reward circuitry is furthering the neurobiological bases of adolescent-onset addiction fueled by increased reward-seeking (Galvan et al., 2006).

Decision-Making

Casey et al. (2008) depicts adolescence as “a developmental period characterized by suboptimal decisions and actions that give rise to an increased incidence of unintentional injuries and violence, alcohol and drug abuse, unintended pregnancy, and sexually transmitted diseases” (p. 62). Current neuroimaging studies focusing on “reward neuroscience” include both components of decision-making and reward-seeking as independent variables when investigating risky behaviors (Ernst et al., 2008).

To solely examine the decision-making process and its associated neurobiology, Bechara, Tranel, and Damasio (2000) recruited eight patients with bilateral lesions of the ventromedial PFC (18 – 63 years) and 17 normal control participants (21- 63 years). The Iowa gambling task, used to measure decision-making, asks the person to select cards from four decks; each deck associated with varying levels of reward (winning money) and punishment (losing money). Two decks have high monetary gains with unpredictable higher losses; the other two decks have low immediate gains with smaller future losses. Though the decks with smaller rewards brought more future gain, those with PFC lesions preferred the decks with high immediate reward and low immediate punishment.

Wood (2003) extrapolated the results from the Bechara et al. (2000) study to social decision-making in adolescents. The author asserts that both the ventromedial PFC and the amygdala are both significant in adolescent decision-making. Again, the

results suggest the assertiveness of the limbic system (amygdala) in assessing the emotional significance of the reward and the weaker PFC as the cognitive-control network (Drevets & Raichle, 1998).

Conclusion

Rather than considering an adolescent brain as a flawed adult brain, the adolescent brain undergoes tremendous structural and functional neurobiological changes as well as behavioral changes. Giedd (2008) presents a global view of adolescent neurobiology as:

The adaptive potential of the overproduction/selective elimination process, increased connectivity and integration of disparate brain functions, changing reward systems and frontal/limbic balance and the accompanying behaviors of separation from family of origin, increased risk taking, and increased sensation seeking...(p. 341).

Weinberger et al. (2005) suggest that adolescent neurobiology be considered as one part of an adolescent's "wider universe of factors." Increased knowledge of adolescent brain-behavior mechanisms provides insights into risk factors leading to morbidity and mortality (McAnarney, 2008). Because the inhibitory or suppressive PFC is not fully developed until the mid-twenties, protective factors that provide the needed structure and guidance must be identified as potential "brakes" for risky and reckless behaviors. From the National Longitudinal Study on Adolescent Health, factors such as parent-family and school connectedness, belief systems, and self-esteem have been identified as positive factors protecting emotional health of adolescents (Resnick & Bearman, 1997).

Future uses of neuroimaging in adolescent populations can stimulate neuroanatomically-driven models describing cognitive and socioemotional processes of

adolescent behaviors. In addition, understanding normative adolescent neurodevelopment and any supportive roles by gender and puberty, will help identify and ultimately assist in understanding developmental vulnerability factors of adolescence (Ernst & Mueller, 2008).

Adolescent Religiosity

Neurobiology is but one factor in the adolescent vulnerability equation (Weinberger et al., 2005). Since not all adolescents participate in risk behaviors, protective factors such as pro-social belief systems have been identified as essential structures and scaffoldings needed to inhibit health-risk behaviors (Resnick & Bearman, 1997). "There is an urgent need to discover young people's own values and beliefs surrounding risky behavior, including their concepts of right or wrong, legal or illegal, safe or dangerous" (Abbott-Chapman & Denholm, 2001). In this section, religiosity, as a social and psychological buffer, will be examined. First, the protective effects of religiosity are explored. The challenges in defining religiosity versus spirituality are outlined with multiple examples of literature-derived definitions. Next, the function of religiosity along the developmental continuum from childhood to adolescence is presented. The multiple dimensions of religiosity utilized in measurement tools are discussed and defined. Theoretical models of adolescent religiosity are next revealed before research studies of adolescent religiosity and their relationships to risk and non-risk behaviors are examined.

Religiosity as Protective Factor

In 1992, statistics obtained from American adolescents included: (1) 95% believed in God, (2) 42% prayed alone, and (3) 27% perceived their religious faith and religious service attendance as stronger than their parents (Gallup & Bezilla, 1992). From data collected in 1994 through 1995 as part of the National Longitudinal Study of Adolescent Health (Add Health), almost 88% of adolescents, grades 7 through 12,

reported having a religious affiliation (Resnick et al., 1997). From the National Study of Youth and Religion, Smith and Faris (2002) report that over 31% of 12th graders attend weekly religious services and 40% have been involved in church youth groups for more than two years. Over 60% of 12th graders claim their religion is “very” or “pretty” important.

From a recent systematic review of adolescent religiosity literature, 84% of the studies demonstrated that measures of religiosity or spirituality had positive relationships with adolescent health behaviors (Rew & Wong, 2006). Though evidence supports the protective effects of religiosity, understanding of the mechanisms of its effects remains unclear (Wills, Gibbons, Gerrard, Murry, & Brody, 2003). Protective factors are presumed to exert countering, balancing, moderating, or insulating effects on adolescent risk behaviors (Jessor, 1987). Describing the uniqueness of religiosity’s influence upon adolescent motivation toward action, Smith (2003) characterizes these protective pro-social dimensions as moral order, learned competencies, and social and organizational ties. Moral order is described as the moral directives or normative ideas of good/bad, right/wrong, just/unjust, or worthy/unworthy. Learned competencies of enhanced decision-making and coping skills stem from alternative group opportunities beyond family, school, and media. Social and organizational ties provide important ongoing networking opportunities that are cross-generational reinforcing positive experiences and events. “Religion exerts pro-social influences in the lives of youth not by happenstance or generic social process, but precisely as an outcome of American religions’ particular theological, moral, and spiritual commitments” (Smith, p. 20). To summarize, the role of religiosity is to promote pro-social outcomes such as parental attachment and school commitment, while inhibiting negative outcomes such as deviant peer associations leading to risk behaviors (Jang et al., 2008).

Wallace and Williams (1997) postulate that religiosity acts both independently and interdependently with other intra- and extra-adolescent influences impacting health outcomes. In measurements of religiosity, the Fetzer Institute (2003) has investigated causal pathways from behavioral, social, psychological, and physiological perspectives. "Given the pervasive social and personal nature of religiosity and spirituality (RS), there are likely very few unmediated relationships between RS factors and health (Berry, 2005, p. 644). Described as complex and multidimensional, religiosity includes interactions between behavioral, affective, and volitional dimensions (Berry; Hill & Pargament, 2003). Religiosity, as a protective buffer in areas of adolescent mental, emotional and physical well-being, has been described as a combination of learned general life skills, experiential or intrinsic aspects, strength of the subjective importance of one's religion, and social or extrinsic nature of the religious community (Beckwith, 2006). When assessing the protective nature of religiosity, assertions have been made that it may be wiser to examine actual behaviors related to religiosity rather than attitudes (Jensen, Newell, & Holman, 1990).

Goals of adolescent research are to determine influences of factors that lead adolescents through a successful transition into adulthood (Wilson 2004). "To ignore the influence of religion and spirituality in youth is to neglect a significant component of adolescent development" (Kerestes, Youniss, & Metz, 2004, p. 45). Religiosity during later adolescence may provide increased benefits because measurements may reflect more individual choices than sets of parent-imposed guidelines, values, and expectations (Wagener, Furrow, King, Leffert, & Benson, 2003). Older adolescents in college experience fewer constraining social influences such as parents. Religious values during college, therefore, may be re-examined, refined, and incorporated into personal belief

systems quite different from earlier stages of adolescence (Cherry et al., 2001; Wallace & Williams, 1997).

Religiosity versus Spirituality

Challenges in Religiosity Measurement

A review of religiosity literature suggests that challenges of measuring religiosity stem from: (1) unclear theoretical frameworks of religiosity; (2) unclear, confusing, or interchangeable definitions between religiosity and spirituality; and (3) problems with research design and methodology in the measurement of religiosity. Kerestes et al. (2004) present problems with static religiosity definitions applied to the dynamic developmental stage of adolescence. To prevent research problems in religiosity measurement, Berry (2005) suggests “conceptual clarity, deliberate design, and appropriate analysis” (p. 628).

Theoretical Challenges

Rostosky, Danner, and Riggle (2008) lament the lack of theoretical grounding in studies focusing on adolescent religiosity. The authors reviewed adolescent literature and found different religious constructs defined without any guiding conceptual or theoretical framework. Hancock (2005) discovered several adolescent studies on religiosity and its relationship to risk behaviors grounded in various theoretical explanations: social learning, social control, moral communities, decision theory, hellfire hypothesis, arousal theory, and problem behavior theory. Though no consensus has been reached, the author notes that documenting a theoretical framework would lead to a consistent and specific definition of religiosity. Abbott-Chapman and Denholm (2001) discuss an urgency of developing a theoretical framework concerning adolescent value and belief systems surrounding risk behaviors. Achieving this would avoid subjecting adolescents to an “adult-centric” perspective.

Bahr (1994) surmises that three theoretical relationships exist between religiosity and adolescent deviant behavior: (1) social control—formal and informal sanctions of religion (McGuire, 1987); (2) social support—adults provide emotional support to adolescents (Thomas & Carver, 1990); and (3) social learning—religious values taught through role modeling, instruction, and reinforcement through peers and adults (Fitzpatrick, 1997; Mason & Windle, 2001). These theories have been deemed “reductionistic” because reducing religiosity to nonreligious explanations denigrates the roles of sacred beliefs or relationships (Nonnemaker, McNeely, & Blum, 2006; Smith, 2003).

Definition Challenges

Interchangeable uses of terms such as religiosity, religiousness, religious involvement, and spirituality pose challenges in defining and measuring this phenomenon (Rew & Wong, 2006). Hancock (2005) asserts that the definition of religiosity is not interchangeable with spirituality. Poorly and inconsistently defined, religiosity has suffered from narrow conceptualization, specific focus on a doctrine or group, and simplistic religious measures (Berry, 2005; Hill & Pargament, 2003). In a systematic review of adolescent religiosity research, Wong, Rew, and Slaikeu (2006) discovered that religiosity was defined as a unidimensional construct. Concurring, Spangler (2004) noted that religiosity is defined by what it measures, namely variables of convenience such as religious affiliation or frequency of religious attendance.

Also identified as a complex and multidimensional construct, religiosity has been defined by its cognitive, emotional, behavioral, interpersonal, and physiological dimensions (Hill & Pargament, 2003; Rew & Wong, 2006). Criticism of the incongruence between definition and measurement focuses on the minimal representation of a multidimensional concept (Spangler, 2004). The challenge stems from recognizing the

complexity of religiosity but operationalizing the concept simplistically by one behavior (Litchfield, Thomas, & Li, 1997).

Methodological and Design Challenges

Upon examination, challenges to quality of religiosity research study designs include: (1) reliance on cross-sectional data with narrow populations; (2) threats to internal validity due to confounding variables; (3) small sample sizes neither randomly selected nor generalizable; (4) inappropriate study conclusions from a poorly measured and defined religiosity construct; and (5) use of religiosity as an “add-on variable” in the context of a larger research agenda (Berry, 2005; Hill & Pargament, 2003; Rew & Wong, 2006; Smith, Faris, Denton, & Regnerus, 2003). Hill and Hood (1999) discuss reliability and validity challenges in religiosity measurements. Due to the variability of religiosity definitions, construct and convergent validity is difficult to establish. For reliability assessments, no religiosity measures have been identified as parallel forms and test-retest reliability strategies are uncommon. The one basic reliability measure documented for religiosity instruments is the Cronbach’s alpha, a measure of internal consistency.

Definitions of Religiosity and Spirituality

Table 2 represents the multiple definitions of religiosity and spirituality used in adolescent research. Though similarities among the two concepts are noted, many differences and nuances of definitions exist; confusing readers and reviewers of distinctions between religiosity and spirituality. Koenig et al. (2001) expose the American phenomenon of the polarization of religiosity and spirituality where spirituality is viewed as positive, freeing, and expressive and religiosity is viewed negatively as institutional, doctrinal, and authoritarian. Differing, Hill et al. (2000) represent religiosity and spirituality as related rather than independent concepts—that the search for the sacred and transcendent occurs within a larger religious context. Pargament (1999) integrates the

individualism of spirituality operating within the social context of the religious institution. In fact, researchers have discovered that persons achieve spirituality (their searching for the sacred) through and within their religious practices (Hill & Pargament, 2003). Dyer (2006) introduces a developmental continuum beginning with childhood religiosity transitioning toward spirituality in young adulthood.

Table 2. Conceptual Definitions of Religiosity and Spirituality from Adolescent Literature

| Religiosity | Spirituality |
|--|---|
| 1. System of worship and doctrine shared within group to foster and nourish spiritual life (Fetzer Institute, 2003). | 1. Addresses ultimate questions about the meaning of life, concern for the transcendent—called beyond self to care for others (Fetzer Institute, 2003). |
| 2. Adherence to lived here and now within the context of the future; extending beyond religious affiliation or church attendance (Litchfield et al., 1997). | 2. Degree of commitment to living one's beliefs about self, others and life when following God's will (Acheampong & Bahr, 1986). |
| 3. Relationship with Higher Power often expressed as religious beliefs, commitment, and participation (Rohrbaugh & Jessor, 1975). | 3. All varieties of personal experiences and public expressions inclusive of religion (Miller & Thoresen, 2003). |
| 4. Formalized doctrine and dogma occurring in a public venue (King & Boyatzis, 2004; Miller & Thoresen, 2003). | 4. Connecting to and attaining a sense that one's personal existence is but one small part of a larger universe (Dyer, 2006). |
| 5. Attitudes, beliefs, values, and behaviors relating to all things spiritual (Wallace & Williams, 1997). | 5. Related to religiosity, includes search and discovery of what is sacred in one's life (Pargament, 1999). |
| 6. Centrality of individual relationship with God, commitment to live according to religious beliefs, and means to belonging, coping, support, and esteem building (Fiala, Bjorck, & Gorsuch, 2002). | 6. Quest for personal understanding of life's questions, meanings, and relationships to sacred (Koenig et al., 2001). |
| 7. Loyalty to specific system of faith and worship consisting of a formal theological structure unlike spirituality (Davis, Kerr, & Robinson Kurpius, 2003; Walker & Dixon, 2003). | 7. Capacity for self-transcendence which motivates search for meaning, connection, and new perspective (Benson, Roehlkepartain, & Rude, 2003; Chiu, Emblen, Van Hofwegen, Sawatzky, & Meyerhoff, 2004). |
| 8. Overarching framework that provides motivation and directions for living such as self-control and personal virtue (Pargament, 1999; Smith, 2003). | 8. "Makes you feel, helps you accomplish things" (Wilson, 2004, p. 5). |

Table 2 - continued

| Religiosity | Spirituality |
|--|--|
| 9. Organized beliefs and outward practices which facilitate a close relationship with God and nurture one's responsibility to community (Koenig et al., 2001). | 9. Includes religiosity extending to faith-derived peace, comfort, and well-being (Hill & Pargament, 2003). |
| 10. Multidimensional construct including behaviors, beliefs, attitudes, personal experiences, and emotional phenomena (Benson et al., 2003). | 10. Subjective commitments that motivate one's moral choices and life practices (Smith, 2003). |
| 11. Source of developmental assets for youth (Wegener et al., 2003). | 11. Within the realm of a transcendent entity, a private configuration of feelings and actions (King & Boyatzis, 2004). |
| 12. Social phenomena usually practiced in the company of other people (Regnerus, Smith, & Smith, 2004). | 12. Deep meaningful relationship with God possessing a belief system that guides daily behavior practiced in personal way (Walker & Dixon, 2002). |
| 13. "World-maintaining function that accommodates difficult situations into sacred frames of references (Uecker, 2008). | 13. Personal beliefs and practices that may be unconnected to an organized religion (French, Eisenberg, Vaughan, Purwono, & Suryanti, 2008). |
| 14. Opportunities to follow the practices of participative religious communities (French, Eisenberg, Vaughan, Purwono, & Suryanti, 2008). | 14. Key resource for emotion-coping and facilitator of the development of a new, more favorable personal identity (Giordano, Longmore, Schroeder, & Sefrin, 2008). |
| 15. Pathway to solidify one's position with prosocial others; catalyst for "making good" (Giordano, Longmore, Schroeder, & Sefrin, 2008). | |

Development of Religiosity

Childhood Religious Development

Deemed the least understood dimension of child or adolescent development, Benson et al. (2003) propose that development of religiosity or spirituality "can be enriched or thwarted within an ecological context of family, peers, community, and, in many cases, a religious tradition and community" (p. 208). Family remains a child's primary socialization influence especially in their religious and faith development (Wallace & Williams, 1997). Religious development can also be described as growth along a

continuum involving cognitive, social, emotional, and moral domains (King & Boyatzis, 2004).

From the channeling hypothesis of religious development, parents acclimate their children religiously by “channeling” them into groups or settings that offer experiences reinforcing parents’ religious beliefs and actions. This indirect approach has shown significant effect on subsequent religiosity from childhood to adolescence (Martin, White, & Perlman, 2003). An earlier study found that parents strongly influence a child’s church attendance but quality relationships with youth leaders and clergy directly impact a child’s religious attitude (Hoge & Petrillo, 1978). In a study of 15 male and 29 female early adolescents (12-18 years) of Mormon faith, Weigert and Thomas (1972) discovered that supportive parental interaction are an important determinant of youth religious attitudes and behaviors.

Using longitudinal data from The National Survey of Children (NSC), three waves of data were collected in 1976 (N = 2,301), 1981 (N = 1,423), and 1987 (N = 1,147) to assess the effect of parental religious upbringing in childhood (7 to 12 years) on religiosity and deviant behaviors in mid-adolescence (11 to 16 years) and late-adolescence (17 to 22 years). In analyzing this data, Jang et al. (2008) used the concept of cumulative continuity as the study framework. Positive circumstances result in cumulative advantages that build upon each other during human development. Jang et al. discovered that a child raised in a religious home, over time, remains religious into young adulthood. In addition, childhood religiosity “both strengthens the protective factors and weakens the risk factors that promote deviant behavior and drug use” into young adulthood (p. 787). Francis and Gibson (1993) studied 3,414 Scottish early and mid-adolescents and discovered that adolescent religiosity is shaped by early parental

influences. Maternal church attendance was more predictive of future adolescent church attendance.

Religious development has been described as a process that unfolds from childhood through adolescence and into adulthood involving cognitive, social, emotional, and moral dimensions. “If conversion has not occurred before twenty, the chances are small that it will ever be experienced” (Starbuck, 1899, as cited in Hancock, 2005, p.3). Adolescence up to young adulthood is the seminal life stage when religious conversion is most likely to occur (Smith et al., 2003). Potvin and Sloane (1985) discuss the differing motivations toward church membership in younger and older adolescents. In childhood and early adolescence, their “life center” is family and parental authority. Their bases of good and bad, and their religious practice are compatible with their parents. Fowler (1981), in discussing the Mythic-Literal stage of faith development, stresses that children (7-12 years) look at both God and parents similarly—as decision makers knowing what is best. With their concrete thinking, beliefs and moral rules are literally interpreted. Older adolescents do not blindly accept parental authority and beliefs; rather they begin the process of co-construction and internalization of their own beliefs (Potvin & Sloane).

Adolescent Religious Development

Adolescence, in the United States, is described as a transitional phase marked by experimentation and questioning of authority prompted by a culture accentuating individualism, pluralism, and choice (Smith, 2003). Contributing to the formation of personal identity and value system, an adolescent may have several “spheres of influence” such as peers, school, media, and a religious community (Dyer, 2006; Fowler, 1981). Religion is not so much an individual-level psychosocial constraint against adolescent risk behavior as a group or contextual suppression (Wallace & Williams, 1997). Favorable personal relationships among these “spheres” positively impact firm

identity formation. In early to mid-adolescence, God is viewed as a significant other who externally “resides in the interpersonally available ‘they’” (Fowler, p. 154). At this early stage, there is compatibility between parents controlling religious expressions and the young adolescent accepting this authority (Potvin & Sloane, 1985; Regnerus et al., 2004). The critical developmental task of late adolescence is achievement attained through formulation of future goals, ideas, and concepts of right and wrong (Hendricks-Ferguson, 2006). In later adolescence, the experience of leaving home, physically or emotionally, can ignite new interpretations of authority and previous value systems (Fowler). Faith is not just conforming to convention; their individual beliefs are now self-chosen, influenced by peer groups not parents, based on critical reflections (Coleman, 1971; Lau, 2006; Wilson, 2004).

Because adolescents struggle with who they are, these individuals, in tandem with physical, cognitive, psychosocial, and emotional changes, develop their religious orientation and identity on a continuum (Litchfield et al., 1997; Smith et al., 2003). “To ignore the influence of religion and spirituality in youth is to neglect a significant component of adolescent development” (Kerestes et al., 2004, p. 45). Lau (2006) describes explicit distinctions between religiosity and spirituality based on the context of an adolescent’s connectedness with a higher order being, their personal beliefs and value system, as well as level of answers to meaning of life. From Piaget’s theory of cognitive development, adolescence is a time of the emergence of formal operational thinking when adolescents progress to contemplating the future, analyzing meanings, and expressing their thinking into personal beliefs and values (Piaget, 1967). Lau stresses that adolescent spiritual development, as an important life task, should be examined in the context of cognitive development. Kapogiannis et al. (2009), in their functional MRI studies, discovered that components of religious beliefs are mediated by

specific neural networks, particularly those involved in cognitive and social cognition processes. In their fMRI study of Western religious and nonreligious adults (N = 26), adopting or rejecting religious beliefs was associated with the emotional-cognitive integration between the PFC and the subcortical system. Rejection of religious beliefs was associated with greater activation of the emotional subcortical system. The researchers have preliminarily suggested a link between developmental, psychological, and neuroanatomical frameworks in the processing of religious beliefs.

A necessary prelude to growth and development toward adulthood is the spiritual struggle of doubting, searching, and questioning what adolescents previously held as sacred and true (Batson, Schoenrade, & Ventis, 1993). Figure 5 depicts Lau's hypothesis of adolescent spirituality development. Smithline (2000) also discovered developmental components of spirituality during focus groups of early and late adolescents. Religious beliefs were strongly influenced by parents in early adolescence (11 to 14 years). By 16 to 18 years old, their beliefs were derived less from the religious institution, were generated as uniquely personal, yet were conceptually different than previously held parent-influenced religious beliefs.

Among college students, spiritual development may not be a linear process. Fowler (1981) discusses that the Kohlberg theory of moral development identifies a "regression" of moral judgment during the college years. This regression or backward slide occurs when older adolescents leave home for the first time and experience conflicting values. In a study of college students (18-22 years) from ADD Health data, researchers have discovered that religious socialization or network of like-minded peers may foster self-discipline; however, they caution there are potentially other nonrational variables affecting risk behaviors such as underage drinking (Ellison, Bradshaw, Rote, Storch, & Trevino, 2008). Though not outrightly rejecting their religious values, college

students retool and reinterpret earlier beliefs into a more personalized and internalized set (Cherry DeBerg, & Porterfield, 2001). Achieved by age 25, the marks of achieving moral orientation (spirituality) are “the experience of sustained responsibility for the welfare of others and the experience of making and living with irreversible moral choices” (Fowler, p. 82).

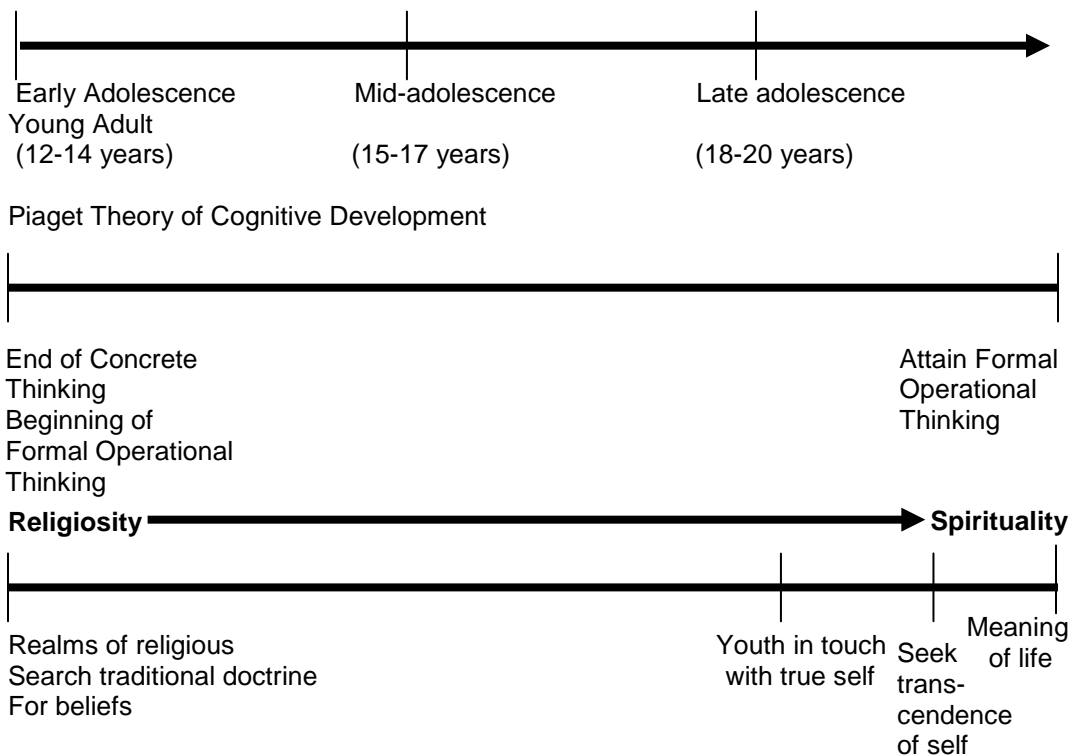


Figure 5. Continuum of Adolescent Spirituality Development (Lau, 2006)

Dimensions of Religiosity Measurement

Though religiosity is widely recognized as a multi-dimensional construct, no standardized conceptual definition or measurement of religiosity exists (Chitwood, Weiss, & Leukefeld, 2008; Fetzer Institute, 2003). Following a methodological review of religiosity research, Berry (2005) concludes that variability of measurement across differing dimensions of religiosity pose grave measurement validity challenges. This

author discovered that the four most common dimensions of religiosity measured were: public participation and attendance at formal religious activities, religious affiliation, private religious practices (prayer or feelings of religious attachment), and religious coping (use of religious behaviors to cope with stress). Hill and Pargament (2003) argue that religiosity is a complex variable composed of cognitive, emotional, behavioral, and interpersonal dimensions (See Table 3 for overview of religiosity dimensions). Berry contends that a “universalistic approach” to religiosity measurement would offer cost-effectiveness, relevance to many groups, and comparisons across groups. Dimensions of substance (intrinsic belief system) and function (behavior or responses) need to be addressed simultaneously (Berry).

Table 3. Dimensions of Religiosity in the Literature

| Author | Dimensions |
|--|---|
| Chitwood et al. (2008) [systematic literature review] | <ol style="list-style-type: none"> 1. Organizational religiosity—participation and attendance at formal activities 2. Religious affiliation—identity with group 3. Subjective religiosity—importance of religion in their lives 4. Religious beliefs—cognitive dimension 5. Nonorganizational religiosity—praying 6. Religious coping—religious behaviors to cope with stress 7. Spirituality—personal quest for understanding |
| Hackney & Sanders (2003) [meta-analysis] | <ol style="list-style-type: none"> 1. Institutional—social/behavioral aspects 2. Ideological—beliefs and attitudes 3. Personal devotion—private practices/intrinsic religious orientation 4. Existential—concepts of spirituality |
| Benda & Corwyn (2001) [research study] | <ol style="list-style-type: none"> 1. Public—church attendance/youth groups 2. Private—prayer, religious identity and attachment |
| Smart (2000) [religious philosopher] | <ol style="list-style-type: none"> 1. Doctrinal/philosophical—religious truths 2. Mythic/narrative—religious origin stories 3. Ethical/legal—moral code/commandments 4. Ritual/practical—prayer, worship 5. Experiential/emotional—religious feelings and attitudes 6. Social/institutional—community aspect |
| Allport & Ross (1967) [developers of Intrinsic-] | <ol style="list-style-type: none"> 1. Extrinsic orientation—how religion is used 2. Intrinsic—how religion is lived |

Table 3 - continued

| Author | Dimensions |
|---|--|
| Extrinsic Religious Orientation Scale] | |
| Glock (1962) [sociologist of religion] | 1. Ideological—content and importance of beliefs 2. Ritualistic—public and private practice 3. Experiential—religious sentiment 4. Intellectual—religious knowledge and attitudes 5. Consequential—implications of beliefs to daily life |

Problems with religiosity measurement in adolescents derive from limited operational definitions. Religiosity dimensions most measured are public attendance at church or religious affiliation (Table 4). These two variables may not actually reflect the choice of the adolescent; rather they may represent socially desirable answers based on family values or behaviors (Abbott-Chapman & Denholm, 2001; Wallace & Williams, 1997). Bahr (1994) asserts that tapping only the public dimension of adolescent religiosity offers inconsistent results; intrinsic or private dimensions should be added. Previous research has shown that individuals who score low on public displays of religiosity (church attendance or religious affiliation), pray frequently and consider their religion important to them (Taylor, 1988). Hill and Pargament (2003) note that religiosity measures, as paper/pencil self-report tools, can be limited by poor reading comprehension, social desirability response bias, or difficulty to engage the interest of the adolescent.

Religiosity Measurement in Adolescent Research Studies

This section focuses on the most common dimensions of religiosity that have been measured in selected adolescent research studies. The conceptual definition, if available, and measurement tool(s) for each study will be presented within Table 4. “To make progress in the area of construct measurement, researchers should consistently

and clearly define variables at the conceptual and operational levels in every publication”
 (Berry, 2005, p. 637).

Table 4. Conceptual Definitions and Measurement Tools in Adolescent Religiosity Research

| Research Study | Conceptual Definition | Measurement Tool | Multi-Dimensional | Single Dimension |
|---|--|---|-------------------|-----------------------------|
| Adamczyk (2008) Add Health data (7-12 graders) | None given | 1. 2-item private religiosity scale— frequency of prayer and importance of religion 2. 2-item public religiosity scale— church attendance and youth group activities 3. Religious affiliation | | X X X |
| Ellison et al. (2008) 967 American Midwestern undergraduates | Formal teaching, religious traditions, and personal religious beliefs | Newly created measure of religious involvement and religious salience: -affiliation organizational/ nonorganizational involvement -doctrinal beliefs -religious salience in lives and behavior | X | |
| Rostosky et al. (2008) Add Health data (12-20 years) | Distal religiosity— behavioral/ attitudinal components tied to formal religious institution Proximal religiosity— Personal belief or meaning system (Cotton, Zebracki, Rosenthal, Tsevat, & Drotar, | 1. 3-item distal religiosity index 2. 3-item proximal religiosity index | | X X |

Table 4 - continued

| Research Study | Conceptual Definition | Measurement Tool | Multi-Dimensional | Single Dimension |
|---|--|--|-------------------|------------------|
| | 2006) | | | |
| Beckwith (2006) 396 college students (18-22 years) | Extrinsic religious behaviors/values used as means to an end and an intrinsic motivation or personal satisfaction used as an end in itself | 1. 14-item Intrinsic/Extrinsic Religious Orientation Scale (2 subscales; Gorsuch & McPherson, 1989) 2. 1-item—interest in religion 3. 1-item frequency of church attendance | X | X X |
| Nasim, Utsey, Corona, & Belgrave (2006) 435 urban and rural African-Americans (12-25 years) | Provides one with social and psychological support; increasing one's resiliency and ability to resist temptation | 1. 7-item God support subscale of Religious Support Scale (Fiala, Bjorck, & Gorsuch, 2002) -private religiosity 2. 2 items from Personal Religiousness Scale (Cochran, 1993) -attendance and involvement (public religiosity) | | X X |
| Kerestes et al. (2004) 4-year longitudinal study of 545 adolescents (14-18 years) | System of values, meaning, and identity development for youth | 1. 1-item importance of religion 2. 1-item frequency of attendance 3. 6-item Religious Perspective Scale -Relationship with God -Relationship with others -Actions -Identity | X | X X |

Table 4 - continued

| Research Study | Conceptual Definition | Measurement Tool | Multi-Dimensional | Single Dimension |
|--|--|--|-------------------|------------------------------|
| Piko & Fitzpatrick (2004) 1240 Hungarian middle school and high school students | Religious membership, personal devotion, and commitment to community | 1. 1-item religious denomination 2. 1-item prayer frequency 3. 1-item attendance at religious service | | X X X |
| Probst (2003) Dissertation 792 ethnically diverse American 9-12 th graders | Exhibited by public behavior and private attitude of religion | 1. 1-item religious affiliation 2. 1-item frequency of church attendance 3. 1-item importance of religion 4. 1-item attitude towards religion | | X X X X |
| Spangler (2003) Dissertation 290 ethnically and religiously diverse college students | Organized system of beliefs, practices that support closeness to a sacred power, and understanding of one's responsibility to others (Koenig et al., 2001) | 1. 20-item Age Universal Religious Orientation Scale (Gorsuch & McPherson, 1989) 2. Brief Multi-dimensional Measurement of Religiousness/Spirituality | X X | |
| Wills et al. (2003) 297 African American adolescents (Mean age-13 years) | None given | 1-item importance of religion | | X |
| Walker & Dixon (2002) 83 African American college | Religiosity as formal church affiliation and participation; individual belief | 16-item Spirituality Scale with 2 subscales -Spiritual Beliefs -Religious | X | |

Table 4 - continued

| Research Study | Conceptual Definition | Measurement Tool | Multi-Dimensional | Single Dimension |
|---|--|--|-------------------|---------------------|
| students | system defined as spirituality | Participation | | |
| Abbott-Chapman & Denholm (2001) 954 Tasmanian students (15-19 years) | Religious values and commitment | 3-item Index of Religiosity -level of religious belief -frequency of church attendance -religious affiliation | X | |
| Joseph & Diduca (2001) 492 British students (13-18 years) | None given | 24-item Francis Scale of Attitude towards Christianity (Francis & Stubbs, 1987) -affect only | | X |
| Crozier & Joseph (1997) 143 British students (16-18 years) | None given | 24-item Francis Scale of Attitude towards Christianity (Francis & Stubbs, 1987) -affect only | | X |
| Wright, Frost, & Wisecarver (1993) 451 Texas public high school students | None given | 1. 2 items from Extrinsic-Intrinsic Religious Orientation Scale (Allport & Ross, 1967) -meaning only 2. 1-item on church attendance | | X X |
| Potvin & Sloane (1985) National sample of 1121 Christian adolescents in 1975 | Dimensions of religious practice, personal-experiential, and religious beliefs | 1. 3-item Religious Practice Scale -church attendance -church studies -youth group participation 2. 3-item Personal-Experiential Scale -God and prayer 3. 3-item Religious Belief Scale -traditional beliefs of Bible and God | | X X X |

Issues in Measuring Adolescent Religious Affiliation

As noted in Table 4, several of the researchers measured religious affiliation or denomination as an independent variable. Resulting from a systematic review of 45 studies between 1998 and 2003, Rew and Wong (2006) discovered that religious affiliation was a poor indicator of religiosity. The authors conjectured that this measure may not reflect an adolescent's religious commitment; religious affiliation may only reflect parental choices. Piko and Fitzpatrick (2004) found that religious denomination does not significantly predict smoking or drinking among adolescents; prayer and religious attendance were stronger factors. Similarly, other researchers have discussed the transmission of religious affiliation as nongenetic and culturally-driven; also suggesting that other components of religiosity may have biological or genetic roots (D'Onofrio, Eaves, Murrelle, Maes, & Spilka, 1999). In their "Virginia 30,000" study, D'Onofrio et al. looked at the strength of genetic and environmental factors on religious attitudes and practices among 14,781 twin pairs and their family members. The stronger monozygotic twin correlations versus dizygotic twin correlations to religious attitudes and church attendance have provided new evidence that religious attitudes and behaviors are influenced by degrees of genetic inheritability beyond shared family environments.

In a four-year longitudinal study, Kerestes et al. (2004) also found that "affiliation failed to differentiate individuals in terms of attendance, importance of religion, religious perspective, or self-reported risk taking" (p. 44). The authors concluded that adolescents do not need to identify any specific religious affiliation in order to be religious. This finding concurs with Bahr's (1994) summary that measuring only the "public sphere" of religiosity (church attendance or affiliation), without an intrinsic dimension, jeopardizes valid concept measurement.

Religiosity and Risk Behavior in Adolescent Research

In a systematic review of adolescent health behavior and attitude literature, 84% of the studies suggested an association between religiosity and health behaviors. Since most studies are cross-sectional rather than longitudinal, direct cause-effect relationships are limited (Rew & Wong, 2006). This section outlines a variety of adolescent risk behavior research that utilizes religiosity as a primary independent variable rather than an “add-on” concept.

Longitudinal Studies

In a rare longitudinal study, Kerestes et al. (2004) collected data over four years on 545 public high school students (14 – 18 years). The purpose of the study was to examine associations between levels of religious development, involvement in school or community activities, and drug or alcohol use. Viewed from a developmental perspective, religious development parallels identity development, the primary task of adolescence (Erickson, 1968). The researchers hypothesized that adolescents with high level religiosity tend to be involved in pro-social activities and avoid risk behaviors of drug and alcohol use. Religiosity was conceptualized as a multi-dimensional concept of other-worldly personal expressions and this-worldly socially-oriented expression. Newly developed for this study, the 6-item Religious Perspective measure, with a Cronbach’s alpha of 0.85, was denomination-neutral since youth religious affiliations were diverse. With added questions about the importance of their religion and frequency of church attendance, the Religious Perspective measure focused on facets such as justice, fairness, God, faith, and religious beliefs. The students were also questioned about their civic and extracurricular activities as well as marijuana and alcohol use. Religious Perspective scores were inversely associated with alcohol and marijuana use. Over four years, adolescents who maintained high religiosity levels participated more in civic and

volunteer activities and avoided drugs and alcohol. Students who started the study with high religiosity scores but ended with low scores were disengaged from extracurricular activities and exhibited the highest usage of marijuana and alcohol ($p = .001$). This study stressed the need to measure religiosity on multiple levels. Church attendance decreased over the four-year period for all groups though religious importance stayed strong. The authors surmised that risk behavior prevention hinges on the maintenance of strong religious beliefs and attitudes during adolescence which lead to participation in pro-social civic, school, or volunteer activities.

Examining religiosity as a social and psychological buffer, Rostosky et al. (2008) focused on sexual minority adolescents and young adults from Waves 1 and 3 Add Health data. The authors analyzed a large sampling of data ($N = 15,170$) providing an opportunity to study, over a six-year span, "...the developmental trajectory of religiosity from adolescence to young adulthood for sexual minority adolescents who later identified as gay, lesbian, or bisexual in young adulthood" (Rostosky et al., p. 555). The researchers chose to utilize the Cotton et al. (2006) Proximal-Distal religiosity framework for their study. The Distal Religiosity Index, tied to formal behavioral and attitudinal components of the religious institution, measured adolescent and young adult church and youth group attendance as well as importance of religion. The Proximal Religiosity Index, used only with young adult data, measured personal religious beliefs and meanings. Cronbach's alpha for each index averaged 0.80. The goals of this study were to describe religiosity among sexual minority youth and assess for any protective effects upon alcohol use. For sexual minority adolescents and young adults (gay, lesbian, or bisexual), religiosity dramatically decreases from adolescence and offers no protective effect against alcohol abuse. Rostosky et al. surmise that religiosity may be a complicating

factor in the development of a sexual minority identity; rejecting religion may be viewed as a necessary coping strategy.

Cross-sectional Studies

Abbott-Chapman and Denholm (2001) investigated the impact of religiosity on a range of risk-taking behaviors among 954 Tasmanian high school students (15 – 19 years). In this mixed methods study, focus groups data constructed the five risk hierarchy groups based on perceived risk of activity and level of participation ranging from sharing needles or injecting heroin to “sunbaking, no sunscreen” or watching R/X-rated movies. The adolescents completed a risk-taking inventory and a religiosity index. This index of religiosity measured levels of religious conviction, religious beliefs, church attendance, and affiliation. Since the sample of students included equal percentages from secular and denominational schools, the authors found that beliefs and church-going were highly associated to type of school. From their previous research, the authors’ guiding framework identified social values, religious beliefs, and commitment as either inhibitory factors of unsafe behaviors or mediators between knowledge and risk behaviors (Abbott-Chapman & Denholm, 1997). The results from the religiosity measure reinforced findings from the focus groups: religiosity is inversely correlated with all categories of risk-taking behavior except eating disorders or “sunbaking” without sunscreen which have no perceived moral consequences. Supporting the multi-dimensional measurement of religiosity, the authors emphasize that the level of social belonging, support, and commitment to a church offer more structure to adolescents than intrinsic religious beliefs alone.

The importance of measurement tool choice becomes evident in a study examining adolescent spirituality associations with depression and risky behaviors (Cotton, Larkin, Hoopes, Cromer, & Rosenthal, 2005). In this study, 183 high school

students (14 – 18 years) were asked to complete an adapted 10-item version of the Spiritual Well-Being Scale (SWBS) which includes two subscales: religious well-being and existential well-being (Ellison, 1983). Of the 183 questionnaires, 49 were dropped from data analysis because answers on the SWBS were left blank or incomplete. As noted in Figure 5, high school adolescents (14 -18 years) are still developing formal operational thought processes necessary for higher order “meaning of life” thinking (Lau, 2006; Piaget, 1967). In the Cotton et al. (2005) study, the questions answered blank or “does not apply to me” include: (1) “I don’t know who I am, where I came from, or where I’m going;” (2) “My relationship to a Higher Power contributes to my sense of well-being;” and (3) “I believe that a Higher Power loves and cares about me” (p. 529.e9). In this study, no specific definitions of or relationships between religiosity or spirituality were given; though religiosity was measured as single items: importance of religion and belief in Higher Power. Importance of religion was positively associated with symptoms of depression. Though longitudinal research is needed, the researchers hypothesize that as adolescents experience depression, they may turn to religion for meaning or support.

Results from a Hungarian study highlighted differing gender effects of religiosity upon substance use (Piko & Fitzpatrick, 2004). The authors looked at potential protective factors (religiosity, group membership, or school) and their relationship with cigarette smoking, binge drinking, and marijuana use among 1240 Hungarian middle and high school students. The guiding study framework is based on the unique socio-political atmosphere of post-Socialist Hungary. Because outward religious practice was banned up to a decade ago, the authors believe that Christians, even without outward practice, possess an internal moral code that can prevent participation in negative behaviors. Religiosity was measured as denomination, praying, and attendance at religious services. Adolescent girls reported religiosity variables more frequently than boys but none of the

variables were correlated with smoking or binge drinking. Girls, who felt most happy in school, used less marijuana. For boys, the relationship between religiosity and substance use was stronger. Praying correlated with lower odds of smoking and binge drinking. Religious affiliation was associated with less marijuana use among boys.

In a different approach, Nasim et al. (2006) investigated whether refusal efficacy (one's ability to refuse drugs) mediates the relationship between religiosity and substance use in 435 African-American adolescents and young adults (12 – 25 years) from rural and urban areas. The authors purport that religiosity's effect on substance use is strengthened by the alternate pathway of drug refusal efficacy. Both public and private religiosity were measured on separate tools and analyzed separately for its effects on substance use. Refusal efficacy significantly mediated the relationship of public religiosity (religious involvement) with alcohol use. Alone, public religiosity was inversely correlated with illicit drug use. Without the mediating effect of refusal efficacy, private religiosity had a diminished association with substance use. The researchers concluded that private religiosity's association with risky substance use "is largely attributable to the refusal efficacy skills of African-Americans (Nasim et al., p. 42). One limitation noted is that the different developmental periods of adolescence were not analyzed separately to determine if refusal efficacy, as a counter to impulsivity, had differing mediator effects.

Conclusion

The goal of adolescent research is to identify factors that assist an adolescent's healthy passage into adulthood. With rare exceptions, positive associations have been demonstrated between adolescent religiosity and well-being (Wilson, 2004). Religiosity was found to have direct negative effects on adolescent deviant behavior partly due to condemnation of delinquent acts and higher percentage of positive peer connections (Johnson, Jang, Larson, & De Li, 2001). In theorizing the rationale for religiosity's direct

positive effects on adolescent health behaviors, Smith (2003) lists nine key factors: “moral directives, spiritual experiences, role models, community and leadership skills, coping skills, cultural capital, social capital, network closure, and extra-community links” (p. 19). These factors are interdependent and mutually reinforcing social processes that researchers can operationalize and measure as independent variables. Conversely, Smith postulates that religiosity may have no significant effects when: (1) religious groups offer few of the nine supporting factors; (2) adolescents choose to remain uninvolved or detached from the religious community; (3) disruptive events, family upheavals, or personal tragedies cannot be countered by positive religious influences; or (4) strong competing influences overwhelm the moral code shaped by religious involvement.

Despite this knowledge of the widespread significant effects of religiosity on adolescent health behaviors, religiosity research has been labeled “untidy, inconclusive, and incomplete” (Francis, James, & Jones, 1993). Empirical knowledge about religiosity in adolescence is limited by the lack of nationally representative sampling, rare longitudinal study designs, and measurement by a single dimension (Smith et al., 2003). In addition, scientific investigation neglects the meaning of religiosity, its causes, and consequences in adolescent health behaviors (Nonnemaker et al., 2006; Wallace & Williams, 1997). Wallace and Williams bemoan the lack of communication and collaboration between those who research religiosity, scholars who study adolescents, and scientists who research health or health behaviors. Responsible adolescent religiosity research includes investigating religiosity as a primary variable of interest, using reliable and valid multi-dimensional religiosity tools (Hancock, 2005; Wong et al., 2006), and examining other “multiple layers of influence on adolescent behaviors” (Nonnemaker et al., p. 3094).

Adolescent Risk Behavior

Identified as the “*Drosophila*” (laboratory-species fruit fly) of risk behavior research, adolescents deliver “a normative sample of people for whom risk-taking is a preoccupation of daily life” (Reyna & Rivera, 2008, p.2). From a developmental perspective, adolescence is a time-limited period of exploration fulfilling needs to master new sensations, conditions, and situations that potentially undermine health or impose risks (Michaud, 2006). Risk behaviors such as alcohol and substance use, smoking, and criminal activity provide challenges in the arenas of law, education, clinical psychology, public health, and public policy (Abbott-Chapman & Denholm, 2001; Eaton et al., 2008; Reyna & Farley, 2006). Among 10 to 24 year olds, 72% of all fatalities result from motor-vehicle accidents, unintended injuries, homicide, and suicide (Eaton et al.). The Centers for Disease Control and Prevention (2006) report that risk behavior prevalence among adolescents remains high. Correlated with peak but normative neurobiological imbalances, mid-adolescence is a period of heightened vulnerability to risk behavior. Rates of risk taking, however, remain high for those between 18 to 21 years old; previously labeled as young adults (Steinberg, 2008).

Assumptions of adolescent irrationality, ignorance, beliefs of invulnerability, or information processing deficiencies have been empirically debunked (Millstein & Halpern-Felsher, 2002; Reyna & Farley, 2006; Steinberg & Cauffman, 1996; Rivers et al., 2008). Research reports that adolescents are “at least, as knowledgeable, logical, reality-based, and accurate as their elders—but engage in higher rates of risky behavior than adults...” (Steinberg, 2008, p. 80). With less focus on adolescent cognition, researchers argue for a multilevel approach toward the identification of socio-emotional factors of adolescent risk behavior through the “cross-fertilization” of psychological, contextual, and biological perspectives (Cicchetti & Dawson, 2002; Steinberg, 2008). Deemed “terminology

mischief,” Jessor (1991) clarifies the distinctions between adolescent risk behavior and risk-taking behavior. When describing the larger subclass of normative adolescent behavior, *risk behavior* characterizes the functional developmental goals of peer acceptance and respect, autonomy from parents, rejection of conventional norms and values, and transition out of childhood. *Risk-taking behavior* describes a more consciously perverse, psychopathic, and deliberative seeking of thrill or danger (Jessor, 1991).

In this section, literature focuses on the normative developmental perspectives of adolescent risk behavior. Described as a paradox with both positive and negative antecedents and consequences (Maggs et al., 1995; Maggs & Hurrelmann, 1996), risk behavior is examined by its components of impulsivity and reward- or sensation-seeking, as well as its risk and protective factors. Next, empirically-driven conceptual frameworks or theories of adolescent risk behavior are described. Linking theory to research, self-report and behavioral measurement methods of adolescent risk behavior are described. Finally, research with a focus on college student risk behavior is examined.

Components of Adolescent Risk Behavior

Functional MRIs of adolescent brains, with emphases on prefrontal cortex and subcortical regions concurrently measure resulting behaviors from simulated risk-taking task paradigms (Casey et al., 2008; Yurgelun-Todd, 2007). From this research, two clear components of risk behaviors emerge: impulsivity and reward- or sensation-seeking. Research indicates that these two concepts together generate significant vulnerability to risk behaviors (Krueger et al., 2002; Sher et al., 2000; Tarter et al., 2003). Though Finn (2002) defines impulsivity and sensation-seeking as a single dimension in his cognitive motivational theory of alcoholism, the majority of the literature describes, defines, and measures these concepts separately. In a 2002 study sampling 76 inner-city drug users

in a treatment center, a nonsignificant correlation was obtained between scores on impulsivity and sensation-seeking subscales (Hopko et al., 2006).

Impulsivity

Impulsivity is defined as a propensity to quickly respond to cues or enter into situations with perceived potential rewards, with minimal planning, or thought towards possible consequences (Eysenck et al., 1985; Pentz et al., 2006). The developmental trajectory from immature to mature prefrontal cortex correlates with the similar path from impulsivity in adolescence to executive function in adulthood. As the antithesis of impulsivity, executive function includes “response inhibition, planning ahead, weighing risks and rewards, and the simultaneous consideration of multiple sources of information (Steinberg, 2008, p. 94). Piaget’s (1967) work on the emergence of formal operational thought processes at the onset of adolescence “dovetails nicely” with the developmental trajectory of executive function and prefrontal cortex maturity into the mid-twenties (Emick & Welsh, 2005). Formal operational thought emerges around 12 years of age and ultimately develops into the ability to construct abstract and long-term hypotheses and to act upon these hypothetical representations using well-planned means-end problem solving skill sets (Shute & Huertas, 1990; Welsh & Huizinga, 2001).

Reward-Seeking

Also labeled sensation- or novelty-seeking, reward-seeking involves different neural and cognitive processes than impulsivity. The adolescent nucleus acumbens is greatly activated, in the presence of an immature prefrontal cortex, during reward-seeking behavioral tasks (Casey et al., 2008; Galvan et al., 2007). Reward-seeking, as a time-limited neurobiological, developmental, and behavioral trait reaches its peak later in adolescence but declines with age (Bardo, Donohew, & Harrington, 1996; Zuckerman, 1994). Zuckerman (1979) defines reward-seeking as “the need for varied, novel, and

complex sensations and experiences and the willingness to take physical and social risks for the sake of such experiences” (p. 10). One study correlated high sensation-seeking in adolescents (12 to 18 years, N = 5,049), friends’ drug use, and low parental monitoring with ecstasy use. The researchers concluded that high sensation-seeking predicted a willingness and inclination to take risks as well as future drug use (Martins, Storr, Alexander, & Chilcoat, 2008). Finn (2002) describes both emotional and cognitive aspects of novelty-seeking as increased consideration of reward cues, inability to delay gratification, and greater emotional reactions to reward and frustration. Reward-seeking has also been defined as a conscious need for thrills, unpredictable situations, novelty, and risks for excitement (Pentz et al., 2006). This definition correlates more with Jessor’s (1991) depiction of the more harmful and dangerous risk-taking behavior rather than the transitive, time-limited period of adolescent risk behavior. Spear (2000a) posits that reward- or sensation-seeking is a normative process of broad exploration, outside the familiar home environment, of new behaviors essential for a successful adult role.

Risk versus Protective Factors

Steinberg (2000) emphasizes that not all adolescents, even with normative increases in impulsivity and reward-seeking, participate in risky behaviors. Michaud (2006) warns professionals against assuming that adolescents are “automatically risk behavior participants” when risk factors are identified. Believing that risk or problem behaviors are not random occurrences, Kazdin (1995) stresses the complex interactions between risk and protective factors directing the likelihood of risk behavior. The etiology of adolescent risk behavior is multifactorial across diverse domains of risk and protective influences with genetic, psychological, and social determinants (Cleveland et al., 2008; Hawkins, Catalano, & Miller, 1992). These domains of influences include individual or personality, family, peers, school, and community factors (Cleveland et al.).

Risk Factors

Risk factors are defined as any conditions within one's biology, physical and social environment, or behavior that lead to compromises in health, safety, quality of life, or even life itself (Jessor, 1991). From a legal perspective, adolescents participate in unjustified risk behavior due to neurobiological risk factors—the weakness of their analytic systems leaving their dominant impulsivity unchecked (Sunstein, 2008). Agreeing with these biologically-based risk factors, Steinberg and Scott (2003) also insert psychosocial risk factors such as susceptibility to peer pressure (peaking at age 14), and less risk-averse attitudes. With more time spent with peers, Steinberg (2008) postulates that adolescents are propelled toward risk behavior because presence of peers rouses the “reward-seeking” neural circuitry.

In a cross-sectional survey of over 3400 African-American and Caucasian adolescents (14-18 years), Reininger et al. (2005) identified three ecological levels of risk factors that predict engagement in risk behaviors: individual, interpersonal, and community levels. On the individual level, age was a significant risk factor for both males and females. Males until the age of 17 and females until age 15 demonstrated higher risk scores. Females with low parental presence or low perceived support by parents of other primary adults, scored higher on risk. Individual beliefs and values that were supportive of risk behaviors predicted risk engagement. On the interpersonal level, the strength of peer values and actions toward risk behavior involvement significantly correlated to male and female risk scores. On the community level, perceived or actual school support and teacher concern were strong predictors of risk behavior engagement. In similar research, Hawkins et al. (1992) uncovered an increased likelihood of risk behaviors in the presence of peer pressure, poor family cohesion, and poor school performance.

Risk factors that contribute to the sensation-seeking of risk behaviors include: maturational timing where earlier onset of puberty places the individual at greater risk; degree of parental monitoring; ease of accessibility of alcohol, tobacco, and other drugs; and temperamental predispositions such as levels of anxiety or degree of fearlessness (Steinberg, 2008). Researchers have discovered that risk factors exert more influence on risk behaviors and specific adolescent outcomes than protective factors (Kliewer & Murrelle, 2007; Ostaszewski & Zimmerman, 2006). In a cross-sectional survey of over 91,000 sixth through twelfth graders, individual, peer, and family risk factors rather than the protective factors of family, school, and community were significantly more predictive of higher levels of lifetime use of cigarettes, alcohol, and marijuana across all grades (Cleveland et al., 2008).

Protective Factors

Protective factors, when present and active, counteract, buffer, and weaken the impact of risk factors upon adolescent health behavior, and development (Garmezy, 1985; Jessor, 1991; Rutter, 1990). Jessor (1991) identifies several conceptual domains within which protective factors function:

In the social environment, a cohesive family, a neighborhood with informal resources, a caring adult; in the perceived environment, peer models for conventional behavior, and strict social controls; in the personality domain, high value on academic achievement and on health, and high intolerance of deviance; and, in the behavior domain, involvement in conventional behavior, such as church attendance and participation in school activities (p. 603).

The author asserts that the presence of protective factors plays a role in thwarting or diminishing involvement in risk behaviors.

In a five-year longitudinal study of 806 adolescents in Minnesota, researchers examined potential protective effects of family meal patterns on initiation of substance use from middle school to high school (Eisenberg, Neumark-Sztainer, Fulkerson, & Story, 2008). Unexpectedly, only females experiencing regular family meals had protective long-term effects from substance use development over five years. Fulkerson et al. (2006) previously completed a cross-sectional study surveying 99,000 sixth through twelfth graders on family dinner frequency and risk behaviors. Similarly, a significant inverse relationship between family dining frequency and substance use, violence, and eating problems were found. Both sets of research teams explained the protective benefits of family meal times as exposure to values and expectations of parents, more quality time with family versus friends, and ongoing anticipated and structured family rituals (Eisenberg et al.; Fulkerson et al.).

Cleveland et al. (2008) uncovered differences in the domains of protective factors among adolescents in younger and older grades. In their cross-sectional survey of over 90,000 Pennsylvania middle and high schoolers, family and community protective factors such as family cohesion and neighborhood attachment significantly correlated with less lifetime alcohol and marijuana use in middle school. In high school, protective peers (greater influence by prosocial vs. deviant friends) and school factors (school commitment) were strongly correlated with recent (30-day) substance use in high school.

Jessor (1991) purports that two adolescents with similar risk factors may exhibit varying degrees of actual risk behavior dependent on the magnitude and impact of protective factors in their life. Catalano and Hawkins (1996) state that clear theoretical

frameworks are needed to specify the mechanisms by which interactions between and ratios of risk and protective factors lead to risk behavior.

Conceptual Models of Adolescent Risk Behavior

Empirically-driven conceptual models and theoretical frameworks of adolescent risk behavior serve three important functions: (1) promotes understanding of the mechanisms and interactions between risk and protective factors (Catalano & Hawkins, 1996); (2) directs research questions and study designs for the investigation of risk behavior (Cleveland et al., 2008); and (3) provides the basis for prevention and intervention of adolescent risk behavior (Lonczak et al., 2001). A majority of adolescent risk behavior research has been grounded in theories and conceptual frameworks within the domains of sociology and psychology (Abbott-Chapman & Denholm, 2001). Steinberg (2008), however, cautions researchers that sociological and psychological theories should be consistent with what is known about adolescent neurobiology. The following theories or conceptual models offer multi-dimensional perspectives of adolescent risk behavior: Social Development Model, socio-ecological theories, cognitive theories, Prototype-Willingness Model, Developmental Assets Framework, Problem-Behavior Theory, and Fuzzy Trace Theory.

Social Development Model

Grounded in criminological theory with the inclusion of empirical predictors of adolescent antisocial behavior (delinquency and drug use), the Social Development Model (SDM) incorporates parallel pathways to prosocial and antisocial behaviors along a developmental continuum (Catalano & Hawkins, 1996; Catalano et al., 1996; Lonczak, 2001). The main goals of SDM are to predict and understand the general processes of prosocial and antisocial behaviors. The developers of SDM, Catalano and Hawkins, proposed four “submodels” to encompass specific developmental periods in childhood

(preschool and elementary years) and adolescence (middle and high school years) with specific risk and protective factors (Catalano et al., 1996). SDM is based on the assumption that children and adolescents learn prosocial and antisocial behavior patterns from family, peers, school, and religious or other community institutions. Social bonds, whether prosocial or antisocial, develop between the individual and a socializing unit when there are: (1) opportunities for involvement, (2) high degrees of involvement and interaction, (3) skills that facilitate participation, and (4) perceived reinforcements from involvements (Catalano & Hawkins, 1996).

Prosocial bonds are designed to inhibit antisocial behavior. Protective factors fuel prosocial bonds by enhancing resilience in those who are directly affected by high levels of risk for drug abuse and delinquent behavior. SDM hypothesizes that protective factors mediate or moderate risk factor effects; they do not directly negate effects of risk factors (Hawkins et al, 1992; Rutter,1990). Table 5 lists proposed SDM protective and risk factors influencing social bond outcomes.

Table 5. Protective and Risk Factors of the Social Development Model

| Domains of Influence | Protective Factors | Risk Factors |
|---|---|---|
| Individual | -Resilient temperament -Intelligence -Positive social orientation | -Academic failure -Early onset of drug use -Alienation -Rebelliousness |
| Family | -Family cohesion -Warmth and bonding in childhood | -Parental permissiveness -Family history of drug abuse or crime -Low family bonding -Poor family management -Family conflict |
| External Social Supports: School Peer Groups Community | -Reinforcement of individual competencies -Commitment to provide prosocial belief system | -Neighborhood disorganization -Extreme economic deprivation -Associations with drug-using peers -Peer rejection in elementary grades |

Table 5 - continued

| Domains of Influence | Protective Factors | Risk Factors |
|----------------------|--------------------|---|
| | | -Community norms favorable to drug use or criminal behavior |

(Garmezy, 1985; Hawkins et al., 1992; Radke-Yarrow & Sherman, 1990)

In addition to risk factor influences, SDM theorizes other reasons for antisocial behavior. Antisocial behavior results from lack of opportunities to experience prosocial activities, low levels of prosocial bonding, and failed environmental reinforcements of prosocial behaviors. Even with prosocial bonding, deviant behavior is chosen when the potential cost to the individual is low and perceived benefit is high. Antisocial bonding to family, peers, school, and community domains which embrace drug-using or criminal beliefs and values are clear pathways to antisocial behavior (Catalano & Hawkins, 1996).

To examine the power of the prosocial and antisocial constructs of SDM in predicting adolescent substance use, Catalano et al. (1996) performed structural equation modeling (SEM) on data obtained from a longitudinal (1985 through 1993), theory-driven study. The Seattle Social Development Project (SSDP) examined 590 youth at 3 time periods—at 9 to 10 years, 13 to 14 years, and 17 to 18 years. The results of self-reported substance use at age 17 and 18 were dependent measures. All constructs from SDM provided an acceptable fit when predicting drug use as an older adolescent. This study also verified that the constructs of opportunities, involvements, and reinforcements are significant across all three time frames from childhood to later adolescence. The researchers asserted that interventions should start early to interrupt causal processes and should offer multiple approaches to address constructs from both prosocial and antisocial pathways. Using the same SSDP data from 1985, Lonczak et al. (2001) utilized SEM to investigate the predictive value of SDM on effects of alcohol use at 14 years to alcohol misuse at age 16 years (N = 807). The constructs of SDM provided a significant explanation for alcohol misuse at 16 and verified the importance of assessing

SDM constructs using elementary, middle school, high school, and young adult submodels. Lonczak et al. suggested prevention or interventions that addressed increasing prosocial or decreasing antisocial opportunities, involvements, and rewards. In a cross-sectional survey of 91,778 middle and high schoolers, Cleveland et al. (2008) utilized SDM to create their instruments measuring individual risk index, peer risk, family risk domain, family cohesion, school cohesion, and community cohesion. The purpose of the study was to compare the influence of protective and risk factors on adolescent substance use. Cleveland et al. reported that individual and peer risk factors such as low perceived risk, rebelliousness, and high reward sensitivity, are most closely associated with adolescent drug use. The strongest protection against substance use was from the school and community domains. The authors recognized their cross-sectional study design as a limitation since SDM constructs are best examined at different periods of adolescent development.

Social Ecological Perspective

Examining the social ecology of adolescent life provides opportunities to explain the origins or sources of organized risk behavior patterns. Jessor (1991) describes social ecology of adolescence as "...an ecology that provides socially organized opportunities to learn risk behaviors together and normative expectations that they be performed together" (p. 600). As an example, substance use and early sexual activity can provide a path toward autonomy and independence from parents (Jessor). Similar to the Social Development Model, an ecological approach to interventions includes multiple levels of an adolescent's environment: individual, interpersonal, organizational community, and policy (McLeroy, Bibeau, Steckler, & Glanz, 1988). Reiningger et al. (2005) suggest that intervention strategies specifically target parents, peers, schools, and neighborhoods. In their study of 343 adolescents (14-18 years), self values reflective of peer values,

perceived school support, and empathetic relationships with parents/adults were most predictive of involvement in health risk behaviors.

Bronfenbrenner (1986) presents three different environmental systems that influence human development within a family structure: (1) mesosystem, (2) exosystem, and (3) chronosystem models. The mesosystem model assumes that human development takes place in several settings, not independent of each other, though family is the primary context. The exosystem model is more concerned with the outside environments that offer limited access to the child or adolescent—the social network or work-world of parents. The assumption is that child development is affected by other settings where parents spend time. The chronosystem model assigns an important developmental role to life transitions rather than chronological age. The life transitions can be distinguished as normative (school entry, puberty, marriage, etc.) or non-normative (divorce, moving, death in family, etc.). In 1983, Bronfenbrenner and Crouter were beginning their research to identify developmental outcomes from influences of the “new demography”—day care, working mothers, stay-at-home fathers, remarriage, blended families, and single parents. Macoby (1951) investigated the effects of television on pattern of family interaction and found that “the nature of family social life during a program could be described as ‘parallel’ rather than interactive, and the set does seem quite clearly to dominate family life when it is on” (p. 428). Concurring, Bronfenbrenner (1974) found that family interaction was prevented in a “TV environment.” The author proposed that television prevented learning developmental behaviors stemming from talks, games, family time, even arguments.

Currently, this generation of adolescents has access to social networking sites (MySpace, Facebook) online. This new technological environment is presenting challenges to parents, law enforcement, educators, health professionals, and policy

makers due to on-line profiles referencing risk behavior information (Mitchell & Ybarra, 2009). In a cross-analysis of over 500 Web profiles of 18-year-olds from MySpace, 54% of the profiles contained risk behavior content: 24% discussed their sexual activity, 41% talked about substance use, and 14% referenced violent activities (Moreno, Parks, Zimmerman, Brito, & Christakis, 2009a). The researchers, however, did find that less risk behavior information was reported when Web profiles included content on religious involvement or sport or hobby participation. In a randomized controlled intervention trial with self-described “at-risk” 18 to 20 year olds (N = 190) on MySpace, a single physician email on healthy behaviors was sent to half of the sample to assess the effect on postings referencing sex and substance use (Moreno et al., 2009b). The researchers reported three protective changes from the single physician email administered to the intervention group: (1) Zero references to sex online were 13.7% compared to 5.3% in the control group ($p = .05$); (2) Zero references for substance use were 26% vs. 22% for controls ($p = .61$); and (3) 10.5% set their profiles to “private” compared to 7.4% of control group ($p = .45$). The authors propose future study on this Internet environment and the effects of different risk behavior disclosures.

Cognitive Theories

To attempt to understand the mechanisms associated with personality vulnerability to alcoholism, Cognitive-Motivational Theory (CMT) proposes three dimensions: impulsivity/novelty-seeking, harm avoidance, and excitement seeking (Finn, 2002). The assumption of CMT is that inadequate regulation of behavior fundamentally leads to alcohol use disorders. Impulsivity/novelty-seeking, used interchangeably as one concept, reflects poor control over the inhibitory motivational system, more attention to reward cues, and increased emotional reaction to rewards and obstacles. Harm avoidance relates to differences in fearlessness, regard for danger, enjoyment of risky

activities, and avoiding vs. seeking out risk situations. Excitement seeking infers a preference for very pleasurable activities in less predictable environments. Though CMT is a psychosocial theory on decision-making and behavioral regulation, its concepts parallel current neurobiological correlates to risk behavior. (See Table 6). Finn does acknowledge that impulsive/novelty-seeking persons' behaviors may reflect neurophysiological processes within a strong behavioral facilitation system.

Table 6. Comparisons of Cognitive-Motivational Theory (CMT) Constructs and Neurobiological Correlates to Risk Behavior

| CMT | Adolescent Neurobiology |
|-----------------------------------|---|
| Impulsivity/Novelty-Seeking | Prefrontal Cortex <ul style="list-style-type: none"> • Impulse control • Regulation of emotions • Delay of gratification • Self-monitoring |
| Harm Avoidance | Amygdala <ul style="list-style-type: none"> • Avoidance behavioral system |
| Excitement Seeking | Nucleus accumbens (limbic system) Dopamine levels in Prefrontal Cortex Glutamate <ul style="list-style-type: none"> • Reward circuitry imbalances • More stimulating influences |
| Working Memory Capacity | Hippocampus <ul style="list-style-type: none"> • Memory storage and retrieval • Translate short-term into long-term memory |
| Dynamic Decision-Making Processes | Prefrontal Cortex <ul style="list-style-type: none"> • Major contributor to executive cognitive function |

(Chambers et al., 2003; Ellis, 2005; Finn, 2002; Giedd, 2008; Rosenberg et al., 2002; Rosser, et al., 2005; Schepis et al., 2008).

Finn (2002) hypothesizes that increased working memory capacity and dynamic decision-making processes moderate and temper the harmful association between the three personality dimensions and poor behavioral regulation resulting in alcohol misuse. Beyth-Marom and Fischhoff (1997) utilize the components of working memory capacity and dynamic decision-making into their adolescent-specific decision-making model to

uncover why adolescents choose particular risks. Their decision-making model includes three components: possible options, possible consequences, and the attractiveness and probability of consequences. Adolescents, with low working memory capacity, lean toward impulsive behaviors when more perceived positive consequences are envisioned without negative consequences (Beyth-Marom & Fischhoff; Finn, 2002). The “Just Say No!” [to drugs] campaign from the 1980s ignored alternative options and their consequences from which to make a decision. The formal operational stage of cognitive development (Piaget, 1967) is the final stage where mastery of effective decision-making skills is achieved: (1) integration of complex components into a decision, (2) ability to imagine abstract future possibilities, (3) generation of solutions to problems, and (4) ability to recognize other perspectives (Keating, 1980). Keating declares that approximately 50 to 60% of older adolescents (18 to 20 years) use formal operation thinking. With these impressive statistics, Beyth-Marom and Fischhoff acknowledge that adolescent decision makers may lack structural protections or resources when in an unfamiliar environment, when stakes are high, or when consequences may be irreversible.

From a decision-making or cognitive theoretical perspective, education strategies to improve adolescent decisions would be communication of current beliefs worth knowing and teaching of higher-order thinking skills (Beyth-Marom & Fischhoff, 1997). Contradicting these preventive strategies, Steinberg (2008), from a neurobehavioral perspective, emphasizes that prevention should not focus on adolescents’ means of thinking or what they do not understand; rather, preventions should focus on impeding or narrowing the opportunities for immature judgments.

Prototype-Willingness Model

The Prototype-Willingness Model of adolescent risk behavior describes the dual processes of a “reasoned path” of analytic processing and a “social reaction path” to explain unintended behavior (Gerrard et al., 2008). This model was initially developed from the theories of reasoned action and planned behavior (Fishbein & Ajzen, 1975; Ajzen, 1985). These theories include beliefs, values, “perceptions of control, social norms, and self-efficacy in determining behavioral intentions which are then used to predict behavior” (Reyna & Rivera, 2008, p. 3). Gerrard et al. (2008) modified the Prototype-Willingness Model to address volitional adolescent risk behavior that is unintentional based on empirical evidence that behavioral intentions commonly explain only 30 to 40% of the variance in health-promoting behaviors (Armitage & Connor, 2001).

This prototype model is based on two assumptions: (1) An adolescent chooses to participate in a risk behavior, but often it is unplanned and unintentional; and (2) All adolescents have clear social images (prototypes) of the typical person in their age group who participates in specific risk or deviant behaviors (Gerrard et al., 2008). Two new constructs were added to this model—risk prototypes and behavioral willingness. Risk prototypes offer favorable social images resulting in an increased willingness to “prototype-match,” follow others in risk behaviors, and accept any social consequences. This image-based “social reaction path” helps to explain unintended risk participation. The adolescent may find prototypes of risk among family, peers, media, and the environment (Gerrard et al., 2008). To test the strength of prototypes of risk avoidance, Gerrard et al. (2002) compared images of drinkers, non-drinkers, and the self to 16 year olds. The researchers concluded that non-risk images create more positive impact on an adolescent, especially on one who has not yet experimented with alcohol. Behavioral willingness is “an openness to engage in a behavior, or curiosity about a behavior that is

internal rather than a reaction to social pressure (Gerrard et al., 2008, p. 40). Higher willingness is predictive of risk behavior engagement for two reasons: adolescents have an “optimistic bias” and they tend to focus on the immediate possibilities of gains while processing their decisions superficially (Weinstein, 1984; Loewenstein, Weber, Hsee, & Welch, 2001).

Based on the Prototype-Willingness Model, Sunstein (2008) asserts that prevention efforts must focus on the social meaning of adolescent risk behavior. Changing the social meaning and favorable images of risk prototypes is a collective action problem within society rather than within an adolescent. Willingness is closely linked to risk behavior in an environment of accessible substances and temptations (Reyna & Rivera, 2008). In a college student population, interventions using photographic images of sun damage to skin resulted in reduced favorability of sunbathing or tanning beds leading to decreased willingness to tan (Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005).

Developmental Assets Framework

The Developmental Assets Framework, empirically grounded in child and adolescent development studies, conceptualizes the core components of human development that contribute to health promotion and well-being (Leffert et al., 1998). The framework specifically highlights factors (assets) of prevention, resiliency, and protection in the lives of adolescents from middle to high school. The 40 assets are separated into two domains, external and internal; each domain consists of four categories (Table 7). External assets are environmental features that promote health while internal assets are defined as individual values, personal commitments, and age-appropriate competencies. The 40 developmental assets, compared to a “set of building blocks,” serve as benchmarks for healthy child and adolescent development.

Table 7. 40 Developmental Assets

| Asset Type | Asset |
|---|---|
| <p>External</p> <ul style="list-style-type: none"> • Support • Empowerment • Boundaries and Expectations • Constructive Use of Time | <ol style="list-style-type: none"> 1. Family support 2. Positive family communication 3. Other adult relationships 4. Caring neighborhood 5. Caring school climate 6. Parent involvement in schooling 7. Community values youth 8. Youth as resources 9. Service to others 10. Safety 11. Family boundaries 12. School boundaries 13. Neighborhood boundaries 14. Adult role models 15. Positive peer influence 16. High expectations 17. Creative activities 18. Youth programs 19. Religious community 20. Time at home |
| <p>Internal</p> <ul style="list-style-type: none"> • Commitment to Learning • Positive Values • Social Competencies • Positive Identity | <ol style="list-style-type: none"> 21. Achievement motivation 22. School engagement 23. Homework 24. Bonding to school 25. Reading for pleasure 26. Caring 27. Equality and social justice 28. Integrity 29. Honesty 30. Responsibility 31. Restraint 32. Planning and decision-making 33. Interpersonal competence 34. Cultural competence 35. Resistance skills 36. Peaceful conflict resolution 37. Personal power 38. Self-esteem 39. Sense of purpose 40. Positive view of personal future |

(Leffert et al., 1998, p. 212)

To test the hypothesis that adolescents who possess a greater number of developmental assets exhibit fewer risk behaviors, Leffert et al. (1998) surveyed 99,462 sixth through twelfth graders across 213 American cities. Developed by Leffert et al., at The Search Institute, the Profiles of Student Life: Attitudes and Behaviors (PSL-AB) tool is a 156-item self-report survey measuring all 40 developmental assets plus developmental deficits, thriving indicators, and high-risk behaviors (alcohol, tobacco, and other drugs). The sample included comparable numbers of boys and girls, 40% in middle school, 60% in high school, and 86% Caucasian. The dependent variables of risk behavior were operationalized as recent patterns of drinking alcohol, smoking cigarettes, using other drugs, and the Overall Risk Behavior Index. Acknowledging that their sample was not representative of the American adolescent population, Leffert et al. discovered that the assets of positive peer influence and restraint were the predictors most associated with the lowest alcohol and substance use. In fact, positive peer influence (41% variance) and restraining (11% variance) were the most important predictors of The Overall Risk Behavior Index. The overall model of risk behavior also includes peaceful conflict resolution (3% variance), time at home (1% variance), school engagement (1% variance), and resistance skills (1% variance) to explain almost 60% of the variance in the risk behavior index.

Like the Social Development Model (SDM) and its multiple layers of influence on an adolescent, The Developmental Assets Framework promotes multiple interventions on asset development—either in risk reduction or healthy development. Leffert et al. (1998) suggest “that it is more developmentally advantageous to err on the side of raising youth who have many assets, rather than focus on just a few assets” (p. 227). Similar to SDM, The Developmental Assets Framework focuses on supportive caring relationships and consistent messages across the many contexts where adolescents interact. The

involvement of multiple community groups plays a powerful protective role across the external and internal domains of adolescent health.

Problem-Behavior Theory

To help explain the nature and development of adolescent risk or problem behaviors, Problem-Behavior Theory (PBT) focuses on systems of psychosocial influence: Personality System, Perceived Environment System, and Behavior System (Jessor, 1987). Each of the systems has its own explanatory variables of instigation or proneness to problem behaviors and the controls against it (See Table 8). Similar to Spear’s (2000a) definition of normative vs. maladaptive adolescent risk behavior, problem behavior “is defined as behavior that departs from norms—both social and legal—of the larger society; it is behavior that is socially disapproved by the institutions of authority and that tends to elicit some form of social control response whether mild reproof, social rejection, or even incarceration (Jessor, 1987, p. 332). The premise of PBT is that all behavior results from the interaction between person and environment.

Table 8. Systems of Psychosocial Influences on Problem Behavior

| Personality System | Perceived Environment System | Behavior System |
|---|--|---|
| Motivational Instigation <ul style="list-style-type: none"> • Value on academic achievement • Value on independence • Value on affection • Independence-achievement value discrepancy • Expectation for academic achievement • Expectations for independence • Expectation for affection | Distal Structure <ul style="list-style-type: none"> • Parental support • Parental controls • Friends support • Friends control • Parent-friends compatibility • Parent-friends influence | Problem-Behavior Structure <ul style="list-style-type: none"> • Marijuana use • Sexual intercourse • Activist protest • Drinking • Problem drinking • General deviant behavior • Multiple problem-behavior index |
| Personal Belief Structure | Proximal Structure | Conventional Behavior |

Table 8 - continued

| Personality System | Perceived Environment System | Behavior System |
|--|--|---|
| <ul style="list-style-type: none"> • Social criticism • Alienation • Self-esteem • Internal-external locus of control | <ul style="list-style-type: none"> • Parent approval of problem behavior • Friends approval of problem behavior • Friend models of problem behavior | Structure <ul style="list-style-type: none"> • Church attendance • Academic performance |
| Personal Control Structure <ul style="list-style-type: none"> • Attitudinal tolerance of deviance • Religiosity • Positive-negative functions discrepancy | | |

(Adapted from Jessor, 1987, p. 333)

Reflecting the development of adolescent socio-cognition, the Personality System includes the social meanings, values, beliefs, and attitudes toward self and others that control or incite problem behaviors. Proneness to problem behaviors from the Personality System are: low value on and expectations of achieving independence and academic achievement, low self-esteem, low religious involvement, and more externalized locus of control. Jessor (1987) purports that low religiosity “suggests an absence of internalization of the moral perspectives of the main conventional institution in society” (p. 334). The adolescent becomes more vulnerable to problem behavior with more personality instigation and control variables. The Perceived Environment System offers socio-organizational dimensions of support, influence, control, and modeling. Proneness in the Perceived Environment System includes: increased friends vs. parental influence, lower parental disapproval and higher friend approval of problem behaviors, low parental support and control, and incompatibility between friends and parents. The Behavior System structures personal identity and goal attainment. Problem behavior, as a transition-marker of a “mature status,” disavows conventional norms, gains status among peers, signifies independence from parents, and attains blocked goals (Jessor,

1987). The lower the involvement in conventional behaviors such as religious attendance and academic achievement, there is increased proneness to problem behaviors.

In research using longitudinal data from ADD Health, Bartlett, Holditch-Davis, Belyea, Halpern, and Beeber (2006), selected variables from PBT's personality domain (low self-esteem), the environment domain (maternal/paternal support and friends supporting conventional behavior), and the behavior domain (clusters of normal, problem, and deviant behaviors). Normal behavior clusters included alcohol use, public rowdiness, and lying to parents. Problem behaviors also added unprotected sex or multiple sex partners. Deviant behavior clusters were selling drugs, using weapons and sex under the influence of substances. In addition, the investigators examined ADHD or learning disabilities from the biology/genetics domain. Reflecting the systems of Jessor's (1987) PBT, results confirmed that high levels of paternal support protect against problem behaviors, offering a life-stabilizing force in adolescents' lives. Positive self-esteem provided a protective mechanism against changing to a group with problem behaviors; however, girls had the lowest self-esteem. With the combination of low paternal support and minimal or no friends, adolescents seek more problem- or deviant-oriented groups. Adolescents with ADHD or learning disabilities are most at risk for problem and deviant behaviors (Bartlett et al.). Alternately, when adolescents exhibit clusters of problem behaviors, parental support decreases. Michaud (2006) cautions against examining risk behavior as "clusters." Stressed as not the norm, the suggestions of a developmental "risk behavior syndrome" may be related more to specific cultural factors than only adolescent status (Jessor, 1991).

Bartlett et al. (2006) propose multiple domains of prevention or intervention in adolescent problem behaviors. Self-esteem enhancement, especially for girls, was identified to decrease membership in groups supporting problem behaviors. Parents'

need for information on the importance of their multiple roles of support, control, and awareness of their child's peers in the prevention of adolescent risk behaviors were discussed. The use of community-initiated programs in schools and cities, in order to address the above interventions, has been termed "problematic." Leffert et al. (1998) explain that as intervention or prevention programs become "institutionalized," the sustainability, especially with shifting priorities for funding, becomes tenuous.

Fuzzy-Trace Theory

Fuzzy-Trace Theory explicates what constitutes risky decision-making in children and adolescents vs. adults (Rivers, Reyna, & Mills, 2008). The authors introduce the concept of "gist-based thinking," developed in late adolescence and young adulthood. As an advanced reasoning process, gist is a "fuzzy process of intuition" with choices influenced more by the "valence," positive or negative value of a stimulus, than by the meaning of verbatim details about the stimulus (Rivers et al.; Sunstein, 2008). In 1997, Beyth-Marom and Fischhoff purported that the apparent "rational" decision-making processes in adolescents actually produce more deviant results related to the valuing of consequences. Acknowledging the neurobiological basis of adolescent risk-taking decisions, emotional arousal can jeopardize efforts to engage in "gist-thinking" resulting in self-regulation and risk avoidance. Rivers et al. place the development of gist-reasoning on a developmental continuum (Figure 6). Beginning in early to middle adolescence, distinctions are made among levels of risk using a verbatim analysis of amount of risks against quantity of rewards (Reyna & Farley, 2006). Successful gist-based reasoning in late adolescence and young adulthood ignores the fine-grained details and categorizes or "lumps together" all options and conflicting information, assigns valence or meaning to choices, and does not take the risk.

The development of gist relies on life experiences since behaviors never before confronted may be labeled as “fun” rather than a negative social meaning (Figure 6). Valence is “the simple evaluation of a stimulus [e.g. as good/bad, positive/negative, or approach/avoid]” (Rivers et al., 2008, p. 122). In Slovic (2001), young smokers attributed a positive meaning to cigarette smoking and interpreted the experience as fun, peer-driven, and exciting. The awareness of the negative consequences of smoking has not occurred and thus, smoking is sustained.

Rivers et al. (2008), based on Fuzzy-Trace Theory, outline intervention approaches to gist-reasoning attainment and decreased risk behaviors. First, manipulate

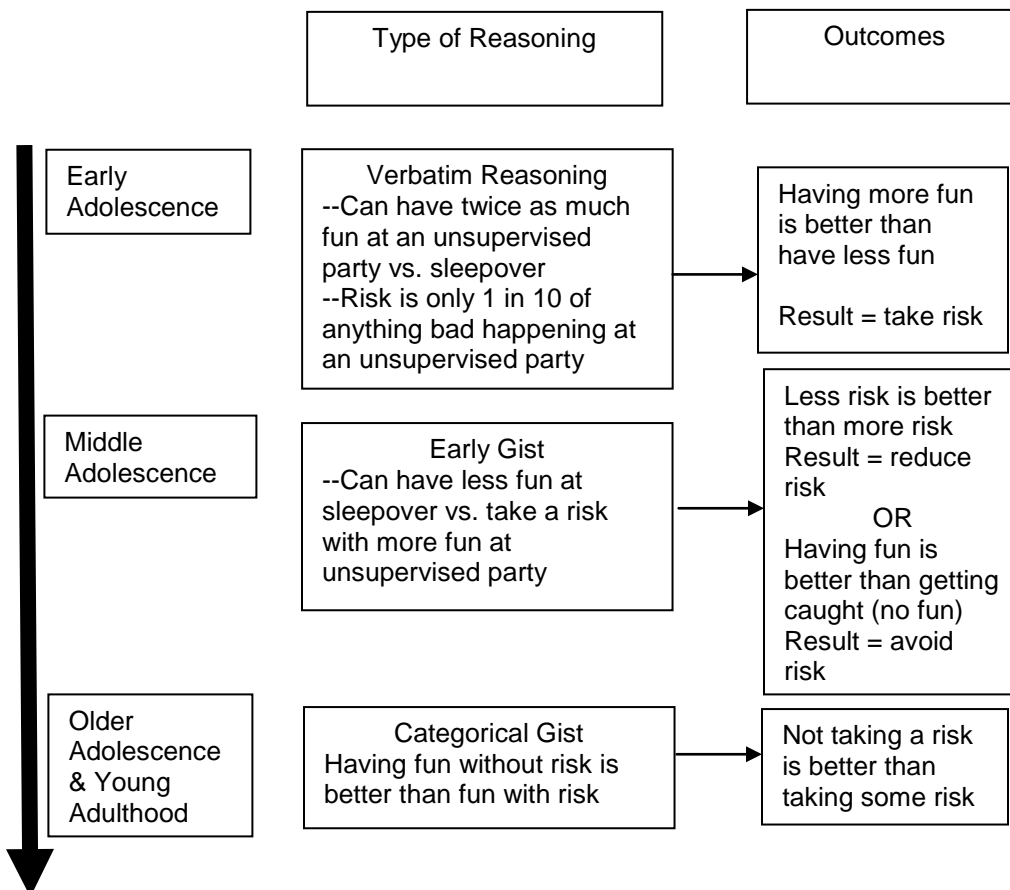


Figure 6. Development of Gist-Based Thinking [Sleepover vs. Unsupervised Party] (Adapted from Rivers et al., 2008, p. 118).

gist, at a beginner's level, by clearly framing the positive or negative valences of stimuli in concrete terms such as frequencies, numbers, stories, and labels (good/bad) rather than the more abstract measure of probabilities (Peter et al., 2006; Reyna & Brainerd, 1994; Slovic, Peters, Finucane, & MacGregor, 2005). Second, identifying, for adolescents, strongly held alternate belief systems that are easily accessible and less susceptible to the influence of incidental emotional states (Rivers et al.). Third, a pre-emptive limiting access-to-risk approach is necessary in order to temper the heightened emotional arousal to rewards resulting in impulsive verbatim processing of stimuli (Rivers et al.; Steinberg, 2008).

Measurement of Adolescent Risk Behavior

The two methods most used to measure adolescent risk behavior are self-report and behavioral instruments. All of the risk behavior conceptual frameworks discuss multiple domains, dimensions, risk factors, and protective factors. Cleveland et al. (2008) pinpoint problems in adolescent research when combined indicators or predictors (communities, school, family, peers, impulsivity or sensation-seeking) are combined into a single cross-domain factor. In addition, other self-report measures of crucial behaviors or attitudes of risk behaviors may omit critical factors needed to assess the full spectrum of co-occurring risk factors. For example, several investigators have noted that when sexual activity is measured; other critical questions are missing: condom use, drug use, history of sexually transmitted diseases, or sexual abuse history (Klitzner, Schwartz, Gruenewald, & Blasinsky, 1987; Vaughan et al., 1996). Conversely, other researchers criticize self-report measures or screening tools of risk behavior as being too lengthy (Lescano et al., 2007). The Youth Behaviors Survey takes more than 40 minutes to complete (Brenner et al., 2002). The ADD Health longitudinal data was obtained from a comprehensive 135 page survey (Lescano et al.).

Aklin et al. (2005) purport that the unimethod assessment approach of self-report measures is insufficient to capture the full spectrum of adolescent risk behavior. Social desirability bias may affect results from self-report measures when participants are concerned about perceived negative consequences from their answers, worried about breaches in confidentiality, and lacking in insight or cognitive ability to complete the measure completely and accurately (Aklin et al.). Behavioral assessments identify impulsivity or a propensity to take risks—through a controlled assessment method. This section delineates the most frequently used self-report and behavioral measures of risk behavior utilized to assess impulsivity, sensation-seeking, or factors of risk behavior.

Self-Report Measures

Since “change” is the defining component in adolescent development (Holmbeck, 2002), measurement of the dynamic and complex interplay between genetic and psychosocial determinants is necessary in adolescent research (Cleveland et al., 2008). In addition to methodological pitfalls of social desirability response bias among adolescents with paper-and-pencil self-report measures, issues of reliability and validity are of concern in adolescent research. “Reliability is a necessary prerequisite for validity...not, however, a sufficient condition for validity (Waltz et al., 2005, p. 18). Thus, an instrument can consistently measure a phenomenon such as risk behavior; but reliability does not ensure that risk behavior is actually being measured as the phenomenon of interest (validity). The quandary of adolescent researchers is what tools best address the components of adolescent risk behavior. Will only impulsivity measures, only sensation-seeking, or factors of risk behavior measurement be sufficient to measure the phenomenon of adolescent risk behavior? Administering three separate measures of each concept may be necessary to validate the total realm of risk behavior; however, internal validity may be jeopardized if subject burden is too high (Waltz, et al.).

The self-report tools most frequently used in the measurement of adolescent impulsivity, sensation-seeking, and risk behaviors are displayed in Tables 9, 10, and 11, respectively. Though alpha coefficients of total test score reliability hover at or near an acceptable reliability rating of .80; the internal consistency of subscales are low ranging from .32 to .73). For subscales, a low alpha coefficient means that one's performance on any one item on a subscale is not a good indicator of performance on another item within the same subscale (Waltz et al., 2005). As can be noted in the Development/History sections in Tables 9, 10, and 11, several of the original tools have spawned subsequent revised versions in search of improved psychometric values and shorter tools for the adolescent population (Arnett, 1994; Barratt, 1985; Leffert et al., 1998; Parsons, Siegel, & Cousins, 1997; Stephenson, Hoyle, Palmgreen, & Slater, 2003; Zuckerman, Eysenck, & Eysenck, 1978). Usually, factor analysis was performed to increase construct validity or modify an existing tool.

Martins et al. (2008) emphasize the concerns of adolescent self-report measures used within cross-sectional study designs. Because of the developmentally time-limited factor of adolescent risk behavior, using self-reports lays the groundwork, but offers only a description of this particular "snippet" in time, limiting any opportunity to make causal inferences along a continuum (Eisenberg et al., 2008; Martins et al.).

Behavioral Measures

Behavioral measures offer controlled assessments of cognition or actual risk behaviors through games or simulated scenarios resulting in the identification of executive function capacity or risk-taking propensity (Aklin et al., 2005; Simon, 1975). Because self-report measures with adolescents can lead to inaccuracies and recall bias, using a behavioral instrument with adolescent samples measures actual behavior. Adding a behavioral measure with a self-report measure creates a preferred multi-trait,

multi-method framework (Lejuez et al., 2005; Pleskac et al., 2008). This type of design framework with multiple measures contributes more reliability and validity data; further increasing the study's robustness and potential for generalizability of results (Waltz et al., 2005). In addition to uses of behavioral measures in descriptive or correlational research studies, researchers have proposed other uses, especially in the assessment of risk-taking propensity:

could help to assess brain function while making those risk-related decisions (imaging studies), genetic contributions to such decisions (twin studies), acute effects of intoxication or withdrawal on the decisions, likelihood of future risky behaviors, and youths' responses to risk-targeted treatments (Crowley, Raymond, Mikulch-Gilbertson, Thompson, & Lejuez, 2006, p. 176).

Tower of Hanoi

Just as Reyna and Rivera (2008) have labeled the adolescent as the "*Drosophila*" of risk behavior research, Simon (1975) has termed the Tower of Hanoi (TOH) task the "*Drosophila*" of cognition. The TOH is the signature task of problem solving with applications to prefrontal lobe function and to two main characteristics of executive function—planning and response inhibition or impulsivity (Varma, 2006). Planning is defined "as the evaluation of moves in advance of their selection in an attempt to discover a sequence of one or more moves that optimizes the route from start-state to goal-state" (Ormerod, 2005, p.1). Simon stresses that a successful TOH strategy involves an ability to think abstractly in order to problem solve. Emick and Welsh (2005) also uncovered an association between TOH performance scores (measure of executive function) and scores on the Logical Reasoning Test (indicator of formal operational

Table 9. Self-Report Measures of Adolescent Impulsivity

| Measure | Description | Development/History | Reliability | Validity |
|---|---|---|---|---|
| 1. Impulsivity Subscale from the Eysenck Impulsivity-Venturesomeness Test (Eysenck & Eysenck, 1978; Eysenck, Pearson, Easting, & Allsopp, 1985) | <ul style="list-style-type: none"> • 19 forced-choice (yes/no) items • High score = high impulsivity • Rated as psychometrically sound • Impulsivity defined as risk-taking and nonplanning | <ul style="list-style-type: none"> • Majority of studies on older adolescents, undergraduates, prison inmates • Developed as Personality Scale for empathy, venturesomeness, and impulsivity • Has revised versions: EIQ—Eysenck Impulsivity Questionnaire IVE-I—Impulsivity, Venturesomeness, and Empathy Inventory | <ul style="list-style-type: none"> • Internal consistency ($\alpha = .84$) • $\alpha = .78$; in study of 5th- 12th graders (Lejuez, Aklin, Bornovalova, & Moolchan, 2005) | <ul style="list-style-type: none"> • Convergent validity with Barratt Impulsivity Scale (BIS) ($\alpha = .70$) |
| 2. Barratt Impulsivity Scale (BIS) (Barratt, 1985) | <ul style="list-style-type: none"> • 30-item scale, no subscales, reports only total scores • Measures motor, cognitive, and nonplanning impulsivity • Rated as psychometrically sound | <ul style="list-style-type: none"> • Tested on university undergraduate students, African American patients, psychiatric patients, and prisoners • Translated into French, German, Italian, Japanese, Korean, & Spanish | <ul style="list-style-type: none"> • Internal consistency coefficient ($\alpha = .79$ to $.83$) • Internal consistency coefficient in adolescent sample ($\alpha = .62$) | <ul style="list-style-type: none"> • Convergent validity with Eysenck Impulsivity Scale ($\alpha = .70$) • Construct validity via 2 factor analyses (led to BIS-10 & BIS-11) |

Table 9 - continued

| Measure | Description | Development/History | Reliability | Validity |
|---------|--|---------------------|-------------|----------|
| | <ul style="list-style-type: none"> • Most widely used self-report measure of impulsive personality traits | | | |

Table 10. Self-Report Measures of Sensation-Seeking

| Measure | Description | Development/History | Reliability | Validity |
|--|---|--|---|---|
| 1. Sensation-Seeking Form-V (SSS-V) (Zuckerman, Eysenck, & Eysenck, 1978) | <ul style="list-style-type: none"> • 40-item test with 4 subscales • Dichotomous forced-answer response • Scores range from 0 to 40 • High scores = high sensation-seeking • Assesses 4 domains: <ul style="list-style-type: none"> ○ Thrill and adventure seeking ○ Experience seeking ○ Disinhibition ○ Boredom | <ul style="list-style-type: none"> • Primarily used with adults • Has been used with adolescents | <ul style="list-style-type: none"> • Internal consistency ($\alpha = .83$ to $.86$) • Test-retest reliability at 3 weeks ($\alpha = .94$) • Subscale internal consistencies ($\alpha = .56$ to $.82$) | <ul style="list-style-type: none"> • Reported construct validity • Reported concurrent validity between males and females • Factor analyses resulted in later forms: <ul style="list-style-type: none"> ○ Brief Sensation Seeking Scale (BSSS) ○ BSSS-4 |
| 2. Brief Sensation-Seeking Scale-4 (BSSS-4) (Stephenson, Hoyle, Palmgreen, & Slater, 2003) | <ul style="list-style-type: none"> • 4-item scale • 1 question per domain: <ul style="list-style-type: none"> ○ Thrill and adventure seeking ○ Experience seeking ○ Disinhibition ○ Boredom | <ul style="list-style-type: none"> • Tested on 12 to 17 year olds | <ul style="list-style-type: none"> • Internal consistency ($\alpha = .78$) • Less reliable with African-American youth | <ul style="list-style-type: none"> • Convergent validity with BSSS ($\alpha = .94$) • Reported construct validity |
| 3. Arnett Inventory | <ul style="list-style-type: none"> • 20-items with 2 subscales: | <ul style="list-style-type: none"> • Arnett felt that | <ul style="list-style-type: none"> • Reported low | <ul style="list-style-type: none"> • Convergent validity |

Table 10 - continued

| Measure | Description | Development/History | Reliability | Validity |
|--|---|---|--|---|
| of Sensation Seeking (AISS) (Arnett, 1994) | <ul style="list-style-type: none"> ○ Intensity ○ Novelty-seeking • Scoring based on total and 2 subscale scores • 6 items worded negatively to avoid affirmation bias | <ul style="list-style-type: none"> • SSS-V was too multi-dimensional • Scale theoretically grounded in role of socialization in biological propensity to seek sensation • Has been developed on 18 to 77 year olds • Has been translated in to French | <ul style="list-style-type: none"> • scale reliability • Subscale internal consistencies ($\alpha = .56$ to $.59$) • Test-retest reliability after 6 months ($\alpha = .48$ to $.51$) | <ul style="list-style-type: none"> • with SSS-V ($\alpha = .39$ to $.65$) • Higher predictive validity than SSS-V • Low correlation between impulsivity and AISS |

Table 11. Self-Report Measures of Risk Behavior

| Measure | Description | Development/History | Reliability | Validity |
|--|--|--|---|--|
| 1. Profiles of Student Life: Attitudes and Behaviors (PSL-AB) (Leffert et al., 1998) | <ul style="list-style-type: none"> • 156-item survey • Measure 40 developmental assets plus: <ul style="list-style-type: none"> ○ Developmental deficits ○ Thriving indicators ○ High-risk behaviors | <ul style="list-style-type: none"> • Developed in 1989 by Search Institute • Designed for 6th to 12th graders • Since 1994, more than 600 communities have used survey • 300 communities | <ul style="list-style-type: none"> • Cronbach's alpha by categories of subscales: <ul style="list-style-type: none"> ○ Support (.65) ○ Empowerment (.32) ○ Boundaries and expectations (.56) ○ Constructive use of time ○ Commitment to learning (.55) | <ul style="list-style-type: none"> • Content validity based on literature support • Construct validity by exploratory factor analysis • 89 of 156 items |

Table 11 - continued

| Measure | Description | Development/History | Reliability | Validity |
|---|--|--|---|--|
| | | <ul style="list-style-type: none"> have used results to launch community-wide initiatives • Revised in 1996 based on new child-adolescent research | <ul style="list-style-type: none"> ○ Positive values (.73) ○ Social competencies (.62) ○ Personal identity (.70) | <ul style="list-style-type: none"> accounted for ~50% of variance |
| <p>2. Personal Lifestyle Questionnaire (PLQ) for Adolescents Mahon, Yarcheski, & Yarcheski, 2002)</p> | <ul style="list-style-type: none"> • 24 statements with 6 subscales: <ul style="list-style-type: none"> ○ Nutrition ○ Exercise ○ Relaxation ○ Safety ○ Substance use ○ Health promotion • Each subscale contains 3 to 5 items | <ul style="list-style-type: none"> • Developed in 1983 by Muhlenkamp and Brown • Widespread appeal in research • Initial psychometrics developed on adult samples • Has been used on adolescents | <ul style="list-style-type: none"> • Subscale coefficient alphas: <ul style="list-style-type: none"> ○ .41 to .62 for middle adolescents ○ .43 to .68 for late adolescents • Coefficient alpha for PLQ ($\alpha = .72$ to $.80$) | <ul style="list-style-type: none"> • Construct validity: Not established as valid tool for substance use assessment • Valid for general health promotion • Last published validity data in 1983 |
| <p>3. Adolescent Risk Inventory (ARI) (Lescano et al., 2007)</p> | <ul style="list-style-type: none"> • Majority of items with yes/no response • Assess risk behaviors and attitudes • Items specific to: <ul style="list-style-type: none"> ○ Sexual risk ○ Sexual and physical abuse | <ul style="list-style-type: none"> • Developed specifically to assess risk behaviors in youth (12 to 19 years) in psychiatric treatment | <ul style="list-style-type: none"> • Internally reliable • Subscale coefficient alphas ($\alpha = .53$ to $.80$) | <ul style="list-style-type: none"> • Unable to establish convergent validity • Used exploratory factor analysis to |

Table 11 - continued

| Measure | Description | Development/History | Reliability | Validity |
|---|---|--|---|---|
| | <ul style="list-style-type: none"> ○ Suicidal behavior ○ Aggressive behaviors ○ Weight management ○ Substance abuse • 4 attitude scales: <ul style="list-style-type: none"> ○ HIV anxiety ○ HIV prevention self efficacy ○ General distress ○ General risk • 3 behavior scales: <ul style="list-style-type: none"> ○ Sex Risk ○ Abuse/self harm ○ Acting out | <ul style="list-style-type: none"> • Created by extracting items considered to be major constructs of risk behavior • Items evaluated by qualitative structured interviews | | <ul style="list-style-type: none"> • establish construct validity |
| 4. Reckless Behavior Questionnaire (Arnett, 1996) | <ul style="list-style-type: none"> • Consists of 16 items on 5 point scale of responses based on frequency of engaging in given behavior • Evaluates adoption of 16 reckless behaviors • Items clustered into 4 groups: <ul style="list-style-type: none"> ○ Alcohol and drug use ○ Risky sexual behavior ○ Reckless driving ○ Theft and vandalism | <ul style="list-style-type: none"> • Developed for use with high school and college students < 22 years old | <ul style="list-style-type: none"> • Test-retest reliability for college sample after 3 months ($\alpha = .80$) • Alpha coefficient for high schoolers ($\alpha = .80$) • Test-retest reliability for individual items ($\alpha = .51$ to $.82$) | <ul style="list-style-type: none"> • Evidence of construct validity |
| 4. Risk Involvement and Perception Scale (RIPS) | <ul style="list-style-type: none"> • Addresses 19 risk-taking behaviors in six topic areas: <ul style="list-style-type: none"> ○ Alcohol ○ Illegal drugs | <ul style="list-style-type: none"> • Intended audience is late adolescents | <ul style="list-style-type: none"> • Cronbach's alpha coefficients of internal consistency: <ul style="list-style-type: none"> ○ Risk involvement | <ul style="list-style-type: none"> • Factor analysis resulted in development |

Table 11 - continued

| Measure | Description | Development/History | Reliability | Validity |
|---|--|---------------------|---|-----------------------------|
| (Parsons, Siegel, & Cousins, 1997; Siegel et al., 1994) | <ul style="list-style-type: none"> ○ Sex ○ Stereotypic male behaviors ○ Socially acceptable behaviors ○ Imprudent behaviors • 3 subscales: <ul style="list-style-type: none"> ○ Risk involvement ○ Perceived risks ○ Perceived benefits | | <ul style="list-style-type: none"> ($\alpha = .72$) ○ Perceived risks ($\alpha = .87$) ○ Perceived benefits ($\alpha = .77$) • Test-retest reliability coefficients at 2 weeks (Pearson product-moment correlation): <ul style="list-style-type: none"> ○ Risk involvement ($r = .59$ to $.97$) ○ Perceived risks ($r = .42$ to $.81$) ○ Perceived benefits ($r = .45$ to $.84$) | of revised version (RIPS-R) |

thought processes), noting parallels between the development of operational reasoning and executive functioning.

The TOH, a peg-and-disk puzzle invented by Édouard Lucas, a French mathematician in 1883, consists of three vertical pegs and at least three disks of differing radii with holes in the center so they can be stacked on the pegs (See Figure 7; Stockmeyer & Lunnon, 2008). Prior to contemporary use as a behavioral measure of

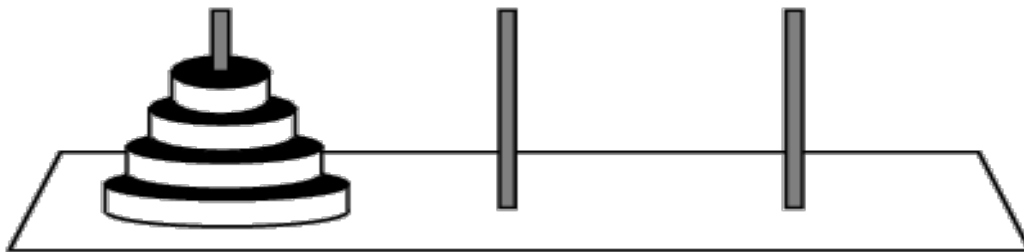


Figure 7. Tower of Hanoi (Weisstein, 2009)

planning ability or impulsivity, the TOH was well known to students in the fields of discrete mathematics and computer science. At the outset of the TOH task, all disks are arranged on one peg in a pyramid fashion, largest disk on bottom. The task goal is to move all disks from peg A across to peg C. Any quantity of disks, starting at three, may be used, but minimum number of moves for successful completion is $2^n - 1$; n equals the number of disks (Simon, 1975).

Rosser et al. (2005), in their study examining the differences in impulsivity and response inhibition between high school students in a Junior ROTC program and criminally involved adolescents, issued the following instructions for the use of TOH:

On the leftmost post, we have three disks, arranged from largest on the bottom to smallest on top. The goal of this task is to move all the disks from the leftmost post over to the rightmost post so that they are stacked

up exactly as they are here, from largest on the bottom to smallest on top. However, there are two rules: (1) You can only move one disk at a time...and (2) A large disk cannot sit on top of a smaller disk (p.88).

Performance on the TOH task can be scored in three ways: (1) number of moves, (2) amount of time to solution, and (3) total time/total moves. The latter score, an average index of time/move, is a measure of impulsivity; while the first two scores characterize planning ability (Bishop, Aamodt-Leeper, Creswell, McGurk, & Skuse, 2001). Goel, Pullara, and Grafman (2001) discuss the necessary strategies to solve TOH efficiently: subjects must look several moves ahead and plan the move in their heads before actually moving any of the disks. "Efficient performance on the TOH task may depend on the ability to withhold immediate responding and to plan ahead" (Wright, Hardie, & Rodway, 2004, p. 137).

Psychometric statistics have been reported for the TOH. The reliability of TOH tasks, measured as an index of internal consistency, is .90 (Humes, Welsh, Retzlaff, & Cookson, 1997). The TOH has documented poor test-retest reliability on children, adolescents, and elderly ($r = .26$ to $.72$) with intervals from 25 minutes to one week (Aman, Roberts, & Pennington, 1998; Gnys & Willis, 1991; Lowe & Rabbitt, 1998). Speculation for these low correlations relate to the task novelty of TOH; thus, poor reliability is anticipated when subjects show dramatic improvement on the retest as they develop task strategies (Burgess, 1997). In a study designed to assess the reliability of TOH scores, test-retest reliability was low from the first to second performance with a two-month interval, but greatly improved and stabilized after the third or more assessments. The subjects needed at least three performances to learn the TOH and stabilize scores at a consistently high level—termed the ceiling effect (Ahonnisha, Ahonen, Aro, Tolvanen, & Lyytinen, 2000). Content validity of TOH was initially indexed

by research on people with frontal lobe lesions; observing inability to plan ahead and problems with response inhibition. Goel and Grafman (1995) surmised that TOH task difficulties for people with frontal lobe lesions stemmed from problems recognizing long-term goals in the face of “an immediate subgoal.”

Research Studies Using the TOH

Using the TOH to examine executive function performance in 85 college students (mean age = 18.84 years, SD = 1), the investigators also administered tasks of working memory and response inhibition measures (Zook, Davalos, DeLosh, & Davis, 2004). Four trials of the five-ring TOH computerized task were administered to each participant. The minimum number of moves with a five-ring TOH is 31. Each trial ended with a successful resolution or a maximum of 100 moves. The dependent variable was average number of excess moves, minus 31 per trial, across the four trials. Using regression analyses, the most significant predictors of TOH performance, based on average number of excess moves, were working memory and response inhibition. General intelligence also contributed a significant amount of variance to TOH performance (Zook et al.).

Tower of Hanoi can be administered via a computerized version or as a table-top wooden model. Two different studies examined the mode of administration of TOH. Noyes and Garland (2003) hypothesized that the wooden model would benefit performance and lead to more efficient problem solving. Undergraduate students in England (mean age = 19.47 years, SD = .99) were given 15 minutes to complete a five-disk TOH task via three different modes: computer, wooden version, and mental. In the mental mode, the TOH was described and the individual had to state the moves in a “think-out-loud” process. Unexpectedly, without any visual aids, the participants made the least moves in the mental mode, suggesting “that problem-solving ‘in the head’ is more efficient than a computer” (Noyes & Garland, p. 586). Next, the computer presentation of

TOH provided less moves than the wooden model—more participants failed to complete the TOH physical model. Individuals were faster using the computer version, especially in moves per second, probably related to ease of disk movement with the mouse. However, the computer TOH version led to the greatest number of moves in the shortest times—a measure of impulsivity. In a slightly older undergraduate population (mean age = 22.5 years; SD = 4.9), Mataix-Cols and Bartrés-Faz (2002) found no significant performance differences between the 4-disk 3-D wooden version and the 2-D computer version. The investigators uncovered gender differences across both TOH versions. The female participants took more time and made more moves before successful completion of the TOH task.

Using a three-disk version of the TOH, Wright et al. (2004) examined the effects of handedness on TOH performance among 90 university students and staff. Stronger left-hand preferences were significantly associated with fewer moves while right-hand preferences were significantly associated with the highest number moves. Time-to-task-completion and hand preference were not correlated. The researchers suggest that left-handers are more cautious, have a better ability to plan ahead, and demonstrate behavioral inhibition.

Two recent studies have examined the role of affect and mood on the TOH performance. Swiss high school students ($n = 64$, mean age = 18, SD = 1.58), split randomly into experimental conditions of positive or negative mood induction, were then asked to complete three- and four-disk TOH tasks. Positive or negative moods were induced by student recall of either a happy or sad event and writing about it for 15 minutes (Brand & Opwis, 2007). Pe, Tan, and Heller (2008) administered a paper-and-pencil version of TOH to 109 students (17-20 years) in Singapore. Self-reports of positive and negative moods were also measured. Both studies similarly reported that a positive

mood was associated with reduced problem solving time of the TOH. Brand and Opwis suggest that positive moods speed up knowledge transfer; while Pe et al. propose that a positive mood breeds task interest and therefore, leads to a successful TOH performance.

Exploring the use of TOH as a cognitive marker for the impulsivity component of risk behavior, Rosser et al. (2005) examined the differences in a three-disk TOH performance among substance-using adolescents (n = 35, mean age = 17.7 years) and 50 “resilient” high school students involved in an Air Force Junior ROTC program (mean age = 15.6 years). The dependent variable was total time/total moves; each participant was given five minutes to complete the three-disk task. Among the ROTC group, 40% were able to solve the TOH task, while only 28.5% of the at-risk youth solved TOH within five minutes. The substance-using youth took less time per move and made more moves than did the ROTC group. The researchers proposed to correlate scores on TOH with executive function contributed by level of prefrontal cortex maturity. The response styles of substance-using youth were labeled “impulsive” as evidenced by little thought placed on each move and little response inhibition.

Balloon Analogue Risk Task

Developed in 2002 by Dr. C. W. Lejuez from the Department of Psychology at the University of Maryland, the Balloon Analogue Risk Task (BART) provides a simulated context in which actual risk behavior performance can be assessed (Lejuez et al., 2002). Currently, BART is the most broadly used and tested risk task behavioral tool (Pleskac et al., 2008). BART has been administered to a broad range of populations and has been correlated to “real-world” risk taking (Aklin et al., 2005; Crowley et al., 2006; Lejuez et al., 2002, 2005). College students were recruited in early developmental studies with BART; mainly to assess risk taking propensity as vulnerability to substance use and other risk

behaviors, to avoid any chronic confounding factors, and to develop initial psychometric data on a narrow sample before enlarging to clinical samples (Pleskac et al., Tull, Patterson, Bornovalova, Hopko, and Lejuez, 2008). As rationale for their focus on adolescents, Lejuez et al. (2005) state that “it is crucial to examine whether levels of disinhibition are related to engagement in risk behavior in adolescence, before the influence of chronic engagement in adulthood” (p. 72). In addition, recent studies have discovered preliminary indications of neurobiological correlates of risk behavior (Fecteau et al., 2007; Fein & Chang, 2008). The developer asserts that BART “is an easy-to-use, adolescent-appropriate, behavioral task to index risk-taking propensity” (Lejuez et al., 2005, p. 72).

BART consists of a set of computer-simulated balloon pumping trials (See Figure 8). Increasing balloon inflation is associated with greater reward (5¢/pump), but each balloon can potentially explode at any point, causing any accumulated reward for that balloon to disappear. The average breaking point for the balloons is 64 pumps (Lejuez et al., 2002). Decisions on balloon inflation must balance potential gains against any potential risk of losing the accrued rewards. At any time during each balloon trial, the individual can stop pumping and collect the accumulated amount into a permanent bank. Lejuez et al. (2002), in the first BART study, provided very detailed instructions to their 86 participants (18 to 25 years of age):

Throughout the task, you will be presented with 90 balloons, one at a time. For each balloon you can click on the button labeled “Press This Button to Pump Up the Balloon” to increase the size of the balloon. You will accumulate 5 cents in a temporary bank for each pump. You will not be shown the amount you have accumulated in your temporary bank. At any point, you can stop pumping up the balloon and click on the button

labeled “Collect \$\$\$.” Clicking this button will start you on the next balloon and will transfer the accumulated money from your temporary bank to your permanent bank labeled “Total Earned.” The amount you earned on the previous balloon is shown in the box labeled “Last Balloon.” It is your choice to determine how much to pump up the balloon, but be aware that at some point the balloon will explode. The explosion point varies across balloons, ranging from the first pump to enough pumps to make the balloon fill the entire computer screen. If the balloon explodes before you click on “Collect \$\$\$,” then you move on to the next balloon and all money in your temporary bank is lost. Exploded balloons do not affect the money accumulated in your permanent bank. At the end of the task, you will receive gift certificates in the amount earned in your permanent bank (p. 79).

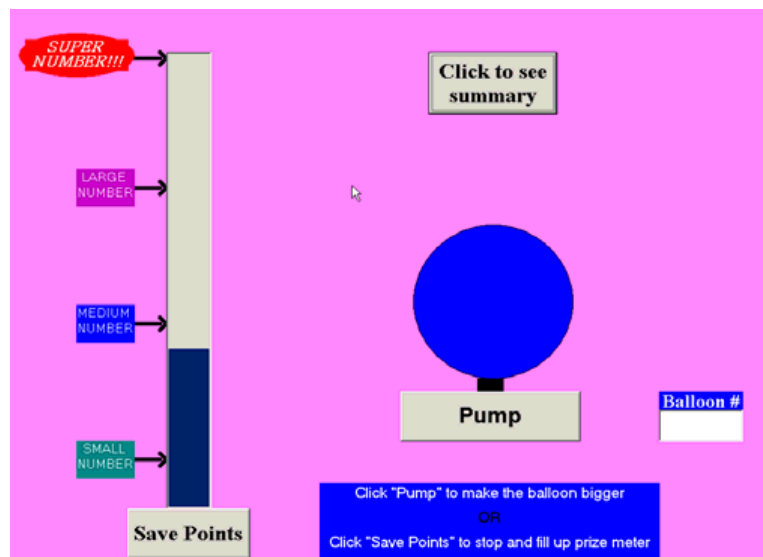


Figure 8. Balloon Analogue Risk Task (BART)
(Study of Early Child Care and Youth Development, 2006).

Scoring on BART is based on an adjusted value. Rather than using an absolute average number of pumps across all balloon trials, Lejuez et al., (2002) define BART scores for risk taking propensity as the average number of pumps excluding exploded balloons.

Since its creation in 2002, BART has accrued strong reliability and validity data. To assess the internal consistency of BART, Lejuez et al. (2002) assess BART scores across the first set of 10 pumps, second 10 and final 10 balloon trials and found a high correlation ($r = .82$). Research replication performed in 2003 attained an internal consistency correlation of .86 (Lejuez, Aklin, Zvolensky, & Pedulla, 2003a). Aklin et al. (2005) also used 30-balloon trials and attained .61 internal consistency correlation. In a 60-balloon trial, volunteers (18-35 years) were administered BART twice at two-week intervals. Test-retest reliability was strong ($r = .77$) over two weeks, did not exhibit any gender differences, nor did previous experience with BART alter scores (White, Lejuez, & deWit, 2008). Convergent validity of BART is evidenced by significant correlations (.28 to .35) between adjusted BART scores and frequent measures of risk constructs: Barratt Impulsiveness total score, Eysenck Impulsivity subscale scores, and Sensation Seeking total score (Lejuez et al., 2002, 2003a). In their study assessing risk-taking propensity among smoking or non-smoking African-American high school students, Lejuez et al. (2005) found that high BART and impulsivity/sensation-seeking scores were associated with greater probability of being a smoker. However, Aklin et al. (2005) found nonsignificant correlations (though approaching significance, $p < .1$) between BART scores and both the Eysenck Impulsivity subscale and the Sensation Seeking scale scores. In Hopko et al.'s (2006) study of inner-city ecstasy users, BART scores were not related to impulsivity subscale or sensation seeking total scores. Construct validity was evidenced via factor analysis demonstrating that BART risk scores accounted for significant variance within composites of self-reported risk behaviors (Lejuez et al., 2002),

such as ecstasy use (Hopko et al.), antisocial behavior (Hunt, Hopko, Bare, Lejuez, & Robinson, 2005), and smoking (Lejuez et al., 2005). Lejuez et al. (2002), based on strong psychometric evidence, support using BART “in combination with paper-and-pencil measures of risk-related constructs to improve the assessment of a broad range of real-world risk behaviors” (p. 82). But, the same authors caution that identifying an overall risk propensity is not the same as predicting the likelihood of involvement in a specific type of risk behavior.

Research Studies Using BART

Though the first study utilizing BART was purely for tool evaluation (Lejuez et al., 2002), the second BART study investigated 60 undergraduate students between 18 and 30 years old for any evidence of differences in risk-taking propensity (BART scores) between smokers and non-smokers (Lejuez et al., 2003b). The participants also completed the Eysenck Impulsivity subscale and the Sensation Seeking scale. Results demonstrated, using regression analysis that only sensation seeking and especially BART scores accounted for significant variance in smoking. Useful in differentiating smokers from nonsmokers, BART “represents a distinct form of behavioral inhibition/undercontrol and, therefore, taps unique aspects of why individuals choose to smoke” (Lejuez et al., 2002, p.31). Though smokers performed a higher average of balloon pumps than nonsmokers, the researchers discovered no participant ever reached the optimal number of 64 pumps to maximize earnings; smokers pumped an average of 44.3/balloon and nonsmokers averaged 36.4 pumps/balloon.

Research by Aklin et al. (2005) was the first study to examine adolescents younger than 18 years of age. In addition to 30 balloon trials of BART, the 51 adolescents (9th through 12th grade, mean age = 14.8, SD = 1.5) also completed the Eysenck Impulsivity subscale, the Sensation Seeking scale, and a self-report measure of their

actual engagement in risk behaviors. Obtained data demonstrated a positive correlation between BART scores and engagement in substance use, delinquency, and safety risk behaviors. Though Jessor (1991) posits that male adolescents have greater involvement in risk behaviors; no gender differences were found in this study, though Aklin et al. admit the small sample size may have been a limitation in interpreting these results.

In another adolescent research study, Lejuez et al. (2005) again revisited the risk behavior of smoking, this time among 125 African-American inner city youth (mean age = 15.1 years, SD = 1.5). The purpose of this study was to determine if minority inner-city youth who smoke cigarettes have higher BART scores (increased risk propensity) than never-smokers. A self-report measure on smoking (smoking = even one puff ever), Sensation Seeking Scale, Eysenck Impulsivity subscale, and BART were administered. As anticipated, ever-smokers had the higher scores on BART than never-smokers. Similar to Aklin et al.'s (2005) study results, no gender differences were found in this mid-adolescent group. However, previous studies did find that among older adolescents and young adults, males scored higher on BART than females (Lejuez et al., 2002, 2003b). In planning future direction for research, Lejuez et al. (2005) discussed the role of BART in adolescent risk prevention programs. The authors suggest knowledge of an adolescent's risk propensity, before smoking ever begins, could assist in "culturally sensitive individualized prevention programs."

In the first study utilizing BART on clinical samples, Crowley et al. (2006) examined 20 adolescents with serious conduct and substance problems (CSP) and 20 adolescent controls—all between 14 and 18 years of age. The CSP youth differed significantly in socioeconomic status (SES) from controls; but both groups were similar in age, gender distribution, race/ethnicity, and IQ. This study's findings advanced BART's content validity since BART scores quantified the anticipated and literature-driven

differences between adolescents with CSP and controls. The youth with CSP exploded more balloons, made more total presses, and earned more money than controls. Consistent with previous studies (Lejuez et al., 2002, 2003b), all adolescents were more restrained in their number of pumps compared to the optimal 64 pumps/balloon to earn the maximum amount of reward. Youth with CSP pumped an average of 39 times per balloon compared to the controls' 24 pumps/balloon. This study verified the investigators initial hypothesis that with higher scores on BART, adolescent with CSP would "expose themselves to greater loss probabilities and loss/reward ratios than do controls" (Crowley et al., p. 180).

College Student Risk Behavior

Rates of risk behavior involvement are high among 18 to 21 year olds when compared to adults over 25 years old. Risk-taking in this age group, including college students, consists of smoking cigarettes, binge drinking, casual sex with multiple partners, automobile accidents due to risky driving or driving under the influence, and substance use (Ellison et al., 2008; Steinberg, 2008). Both Greek affiliation and living in fraternity or sorority houses were strong predictors of binge drinking—even if involved in college sports (Wechsler, Davenport, Dowdall, Grossman, & Zanakos, 1997). Pascarella and Terenzini (2005) report that between 24% and 44% of college students binge drink regularly; male students drinking more than females. Binge drinking is defined as five or more consecutive alcoholic drinks on one occasion for men, four drinks in a row for women. However, data indicate that the probability of alcohol abuse or binge drinking decreased after the completion of two years of college, though..."what influences drinking behavior during college may have implications for alcohol consumption in later life" (Pascarella & Terenzini, pp. 562-563).

Going to college slows one's passage and transition to adulthood. During college years, the older adolescent can begin to explore and experiment, in a safe haven, with various adult behaviors, attitudes, and values. Sherrod, Haggerty, and Featherman (1993) label college days as "a developmental moratorium." Formal operational thought processes, a hallmark of adulthood, parallels the development of executive cognitive function. However, only 50% to 60% of 18 to 20 year olds demonstrate formal operational thought (Emick & Welsh, 2005; Keating, 1980). Shute and Huertas (1990), in the study of 58 undergraduates, found that performance on executive function measures significantly contributed to formal operational thought. From neuroimaging studies, Steinberg (2008) asserts that the prefrontal cortex, responsible for executive function, does not completely mature until the mid-twenties.

Factors such as undeveloped executive function and formal operational thought processes increase a college student's vulnerability to risk behaviors. Moving away from parents and home contributes to new situational opportunities never before experienced (Cantor, 1994). While binge drinking is considered harmful, older adolescents, especially college students in a new physical environment, may consider drinking a constructive and positive method to de-stress, make new friends, and act adult-like (Maggs et al., 1995; Maggs & Hurrelmann, 1996). Finn (2002) describes the role of impulsivity and the novel college environment in the following scenario: "...a young college student faced with a decision either to go out drinking with his friends or to spend time studying alone for an upcoming test" (p. 188). In an ideal adult-like situation, Finn purports that the student would consider each option (party and drink with friends or study alone), weigh his preferences for each behavior, and factor in the outcome and consequence of each option. In reality, with shorter deliberation times, and a heightened positive emotional and excitement about one option; the momentum shifts toward the immediate gratification of

drinking with friends. Yanovitzky (2006), similarly, presents the mediating effects of peer influence upon alcohol use in college students. However, from a developmental viewpoint, Larson and Richards (1994) stress that peer-directed social interactions guide and ease the transition from the home environment toward independence.

Maggs (1997) examined 344 first-year university students in Canada living in dorms (mean age = 18.7 years) and to what extent self-image and peer acceptance can predict degree of drinking behavior. The results presented drinking as both positive and negative adolescent actions. For instance, peer acceptance and self-image were strongly correlated to drinking. The greater the peer acceptance and pervasive negative self-esteem, the more likely the student would binge drink. Positively perceived peer acceptance predicts more drinking while less drinking occurs with a strong positive self-esteem. Drinking fulfilled the positive role of increased interpersonal competence and confidence. Academic, health, and social goals did not differentiate between intention to drink and actual drinking behavior (Maggs, 1997).

Looking at intention and willingness among college students, Gerrard et al., (2008) examined their influences upon the "risk" behavior of skipping class. When the student expresses a positive attitude towards a risk behavior, intention and willingness occur. Intentions were better predictors of class-skipping for students well-experienced with this behavior; however, willingness was a more important predictor for those with no or minimal experience.

The interplay of willingness and intention can lead an adolescent to harm. Maggs (1997) proposes health promotion and harm avoidance strategies since professionals acknowledge college students will not give up opportunities to drink with their peers without equally appealing alternatives serving the same function. Maggs suggests rigid enforcement of public anti-alcohol policies on campus. Conversely, the author suggests

that since drinking is a foregone conclusion in college, to offer and encourage responsible drinking in a regulated environment with oversight, such as adult supervision and the use of designated drivers.

Conclusion

Adolescent risk behaviors, from a developmental perspective, “are functional, purposive, instrumental, and goal-directed and that these goals are often central to normal adolescent development” (Jessor, 1991, p. 598). In order to establish independence from parents, gain acceptance and respect from peers, and affirm maturity, adolescents will smoke, drink, use substances, drive dangerously, or engage in unprotected sexual activity (Jessor, 1991). Michaud (2006) suggests adopting a risk paradigm change and utilize expressions such as “exploratory” or “experimental” for the common behaviors seen during adolescence that are not health-compromising. Rather than labeling behaviors as “risky,” health professionals can learn to understand the role, meanings, motivations, and consequences behind these adolescent behaviors.

All of the conceptual frameworks on risk behaviors or decision-making explain the complexity and multi-dimensionality of adolescents and their behaviors. Bartlett et al. (2006) describe three facets of successful adolescent prevention/intervention programs: (1) comprehensive, including family, school, and community contexts continuing over time; (2) coherent, developmentally appropriate, and of sufficient length; and (3) integrated with family, school, and community across the span of adolescence. Michaud (2006) suggests that health professionals should reduce both risks and promote protective factors as well as explore the degree of adolescent resources, rather than only targeting the problem behaviors. Without only focusing on risk eradication, Abbott-Chapman and Denholm (2001) propose harm minimization and development of personal resilience. Concurring, Jessor (1991) stresses that “risk is embedded in the larger social

context of adolescent life and that reduction in risk requires social change as well” (p. 604). Because positive features are cumulative and protective, adolescents are in need of supportive caring relationships across the many domains of interaction such as peers, family, school, and community (Leffert et al., 1998).

Chapter Summary

Existing Knowledge Base

The comprehensive review of literature on adolescent neurobiology, religiosity, and risk behavior supports the importance and relevance of the research problem: Despite immature neurobiology, not all adolescents engage in risky behaviors, suggesting that there are protective or inhibitory factors deterring adolescent risk behaviors. Each concept was examined in the literature separately; however, the common thread of a developmental trajectory emerged within adolescent neurobiology, religiosity, and risk behavior.

Confronting the assumption that 18-year-olds are adults, neurobiologists have discovered, via imaging studies, two separate developmental trajectories in the adolescent brain’s transition to adulthood (Ernst et al., 2005; Ernst & Mueller, 2008; Galvan et al., 2006, 2007; Schweinsburg et al., 2008; Sowell et al., 2004). The limbic stimulatory system, especially the nucleus accumbens (NA_c), fully developed by mid-adolescence, controls emotions, memory, and motivational drives. The prefrontal cortex (PFC), with completed maturity projected by the mid-twenties, monitors, controls, and inhibits behaviors and emotional reactions to environmental stimuli. In adolescence, the increasing activity of the earlier developing limbic system leads to more reward-seeking and from the immature PFC, impulsivity and poor response inhibition contribute to potential participation in risk behavior. Though adolescents and adults have similar logical-reasoning abilities, adolescents are more vulnerable to risk taking because of the

interrelationships between a more assertive socioemotional neural network (NA_c) and a slowly emerging cognitive-control (PFC) network (Drevets & Raichle, 1998; Reyna & Farley, 2006).

Adolescent neurobiology alone impacts proneness to risk behaviors; but is only one factor in the “adolescent vulnerability equation” (Weinberger et al., 2005). Religiosity was examined and supported by the literature as a protective factor and psychological buffer against risk behavior. Countering risky behavior, religiosity offers protective pro-social influences such as moral structure, learned competencies, and social or organizational ties (Smith, 2003). Reviews of adolescent religiosity literature support the assertion that religiosity has positive relationships with adolescent health behaviors (Rew & Wong, 2006). The literature provided evidence, though not explicitly stated, that the development from parent-driven religiosity culminating in adult spirituality, parallels the Piaget (1967) Theory of Cognitive Development, further supported by the protracted maturity of the PFC (Batson et al., 1993; Lau, 2006; Smithline, 2000).

Adolescent risk behavior, in the literature, is considered a developmental product of the time-limited period of exploration (Michaud, 2006). Because adolescent neurobiology links impulsivity and reward-seeking to the outcome of risk behaviors, the interaction between risk and protective factors direct the likelihood of participation (Kazdin, 1995). Grounded in sociology and psychology, the literature supplies multiple perspectives and measures of adolescent risk behavior. Currently, a few researchers have linked adolescent neurobiology as the rationale and conceptual framework of their adolescent studies (Finn, 2002; Rivers et al., 2008).

Knowledge Gaps

To date, no adolescent research has examined the interactive effects between a neurobiological correlate (impulsivity), a protective factor (religiosity), and their effects,

separately and together, in risk-taking propensity of college students as older adolescents. Risk-taking propensity assesses vulnerability to “real-world” risk taking (Aklin et al., 2005; Crowley et al., 2006; Lejuez et al., 2002, 2005). Most neuroimaging studies are cross-sectional and focus only on the performance of an in-lab behavioral task related to impulsivity or sensation-seeking; moreover, they do not include any other supporting measures of “real-world” risk behaviors (Ernst & Mueller, 2008). In addition, few neuro-imaging studies have focused on older adolescents (18-20 years old) and some have used them as controls; thus less evidence is available for this age group (Ernst et al., 2005; Ernst & Mueller, 2008; Galvan et al., 2006, 2007; Schweinsburg et al., 2008; Sowell et al., 2004).

Gaps in religiosity stem from conceptual confusion, unclear definitions, and limited single-dimension measurements of the concepts of religiosity and spirituality (See Tables 2 & 4). Synthesis of literature promoted a developmentally-appropriate perspective on the growth from religiosity to spirituality (See Figure 5); but has not been utilized in research except by Lau, 2006). College students were frequently recruited for evaluation studies on religiosity tool development; only a few studies measured levels of religiosity in college-age study participants (Beckwith, 2006; Ellison et al., 2008; Nasim et al., 2006; Spangler, 2003; Walker & Dixon, 2003). Even the Balloon Analogue Risk Task (BART) was initially evaluated on college students, but planned focus for BART was on early to mid-adolescents and clinical samples (Crowley et al., 2006; Lejuez et al., 2002).

Using data from ADD Health obtained from adolescents in the 1990s may offer out-dated correlations between religiosity and risk behavior, not necessarily relevant with 21st century adolescents (Adamczyk, 2008; Bartlett et al., 2006; Rostosky et al., 2008). Using self-report measures with adolescents for religiosity and risk behavior may provide inaccuracies or biased data (Aklin et al., 2005). This research study addressed these

gaps by investigating a less studied population in late adolescence, by providing multiple methods of variable measurement (self-reports and behavioral instruments), by defining all concepts clearly using a developmentally-appropriate perspective, and by including the literature-driven roles of the prefrontal cortex in adolescent risk behavior propensity or vulnerability.

CHAPTER 3

METHODS AND PROCEDURES

This chapter is focused on the methods and procedures that were used to address the relationships between the independent variables of public religiosity, private religiosity, age, gender, Greek affiliation, and impulsivity, and the dependent variable of college student risk-taking propensity. Sampling was described as the target population of college students, the sample size, and the method used to obtain the study population. The design of this study (Figure 8) guided all decisions related to measurement methods and data analyses. In addition, ethical considerations and study delimitations are discussed.

Research Design

A quantitative cross-sectional descriptive correlational design was used because no research studies have examined the relationships between public and private religiosity, impulsivity as a neurobiological correlate, and risk-taking propensity of college students (Figure 9). Based on adolescent research, age, gender, and Greek affiliation of the college student participants were also examined for their relationships to risk-taking propensity. The basic purpose of a descriptive correlational design is to describe the relationships between two or more variables for one given group within an identified situation (Burns & Grove, 2005; Simon & Francis, 2001). Unlike experimental and quasi-experimental study designs, no manipulation of independent variables occurs and thus, causality between variables cannot be established (Simon & Francis).

The proposed model (Figure 9) depicted potential multivariate associations with risk-taking propensity. This design guided statistical analyses using multiple regression to

assess the strengths and significance of relationships of the six independent variables with the one dependent variable (Vincent, 2005). In addition, the model presented two

Study Design as Regression Equation:

$$Y = a \text{ (constant)} + \beta_1 (X_1) + \beta_2 (X_2) + \beta_3 (X_3) + \beta_4 (X_4) + \beta_5 (X_5) + \beta_6 (X_6) + \beta_7 (X_1X_2) + \beta_8 (X_2X_3) \text{ (Interaction)}$$

Legend

- | |
|---|
| <p>Y = Risk Taking Propensity X₁ = Public Religiosity X₂ = Impulsivity X₃ = Private Religiosity X₄ = Age X₅ = Gender X₆ = Greek Affiliation</p> |
|---|

Figure 9. Representation of Correlational Multivariate Study Design Using Multiple Regression Equation

interaction variables between public religiosity and impulsivity and between private religiosity and impulsivity that were examined during data analyses. In multiple regression, the regression equation is used to assess the predictive association of independent variables with the dependent variable. Interaction effects test the multiplicative combination of two independent variables and its relationship upon the dependent variable (Burns & Grove, 2005). The literature strongly suggests that development of the prefrontal cortex (PFC; impulsivity relates to immature PFC) is strongly associated with the development from religiosity to spirituality (Kerestes et al., 2004; Lau, 2006; Smithline, 2000; Steinberg, 2008).

The literature review on impulsivity, religiosity, and adolescent risk behavior suggests relational rather than causal inferences between variables. The strengths of a cross-sectional descriptive correlational design for this study are: (1) co-relationships among variables, positive or negative, can be examined based on initial assumptions

(Filipovitch, 2005); (2) characteristics of college students can be investigated as to the extent of their variances; (3) the relationships among variables can be examined in a natural environment without researcher-imposed treatments (Simon & Francis, 2001); and (4) results from this type of study design can produce hypotheses for future studies (Burn & Grove, 2005). The cross-sectional correlational study design lacks experimental manipulation of variables, thus no causal directions or inferences can be demonstrated among variables (Simon & Francis). Filipovitch (2005) asserts that correlational studies demonstrate weaker effects because unlike experimental designs, many uncontrolled variables are blended into each individual circumstance, thus relatively larger sample sizes are indicated.

Sample

The target population was college students between the ages of 18 and 20 years old who do not live with their parents; rather they live away from home in apartments or on- or off-campus housing facilities. The selection of college students was grounded in the study assumptions (Figure 4). Based on neurobiology and psychology research, college students, 18 to 20 years of age, are considered late adolescents, have not completed PFC maturity, may demonstrate or report religiosity without parental influence, and are vulnerable to risk behaviors (Cantor, 1994; Lau, 2006; Maggs et al. 1995; Maggs & Hurrelmann, 1996; Pascarella & Terenzini, 2005; Steinberg, 2008).

Burns and Grove (2005) emphasize that sample size determination for correlational studies is based on power. "Power is the capacity of the study to detect differences or relationships that actually exist in the population" (Burns & Grove, p. 354). Unfortunately, in a recent systematic review of literature from 1997 to 2006 on adolescent religiosity and the risk behavior of substance use, Chitwood et al. (2008) reported that components of power analysis, especially effect size were lacking. They explained that

researchers "...refer to the presence of statistically significant effects, but do not inform on the magnitude of the effects..." (Chitwood et al., p. 676). Sample size determination, for correlational research using multiple regression statistical analysis, requires four parameters in the power analysis: (1) the probability (alpha) level, (2) number of predictors, (3) anticipated R square (R^2), and (4) desired statistical power level (Soper, 2009a). Table 12 outlines the appropriate parameters used to determine a-priori sample size. It was anticipated that this study's predictors/independent variables will together

Table 12. Power Analysis to Determine Sample Size

| Parameter | Value | Sample Size |
|--|------------------------|-------------|
| Probability Level | .05 | |
| Number of Predictors/Independent Variables | 8 | |
| Anticipated Effect Size .02 small R square .15 medium R square .35 large R square | .15 medium R square | |
| Power Level | .80 | |
| Minimum Sample Size | | 108 |

Calculations via Soper (2009b)

explain at least 15% of the variance (R^2) in the measure of risk-taking propensity. To address inherent weaknesses in correlational study designs, a larger sample size was needed to achieve a conservatively moderate R^2 of .15. For this study, 110 eligible participants were recruited.

The sampling method for this study was a representative convenience sampling of undergraduate college students in the researcher's setting. Burns and Grove (2005) describe convenience samples as an accessible, inexpensive, and efficient means of acquiring information in areas previously unknown, especially useful in descriptive and association studies. Recruitment of college students (18 to 20 years old) occurred via face-to-face contact or printed flyer in the dormitories, campus apartments,

fraternity/sorority houses, and in classrooms likely to have age-eligible students. Peer-to-peer recruitment also occurred via Facebook, the social networking site (See Appendix A for Participant Recruitment Script and Flyer).

Because convenience sampling can introduce biases (Burns & Grove, 2005), minimal but stringent participant eligibility criteria were identified—college students, 18 to 20 years old, who do not live with their parents. The inclusion criteria addressed the study assumptions and current research in neurobiology and psychology. For this study, college students who live with their parents were excluded because of the assumption that parental influence still contributes to or biases an adolescent's religiosity. In addition, students younger than 18 years and 21 years of age or older were excluded from this study. Students younger than 18 years of age, in adolescent literature, are a well studied population for risk behavior; while college students 18 years of age or older have traditionally been considered adults and studied as adults. Those over 21 years of age were excluded because drinking is legally sanctioned and binge drinking is evidenced to be a strong risk behavior in college students younger than 21.

Also, students having a current medical diagnosis of Attention-Deficit-Hyperactivity-Disorder/Attention-Deficit Disorder (ADHD/ADD) and not currently taking medications for ADHD/ADD were excluded; since the impulsivity from unmedicated ADHD/ADD could confound the impulsivity of a still-developing prefrontal cortex. Though usually diagnosed before the age of seven, ADHD or ADD persists into adolescence and adulthood in at least 80% of affected children. With increasing age, hyperactivity decreases though inattention and impulsivity becomes more prominent (Behrman, Kliegman, & Jenson, 2004). Student participants having a diagnosis of ADHD/ADD with current use of appropriate medications were eligible to participate in the study. In order to identify and describe other important and potentially confounding attributes of

participants, the following demographic variables, based on literature review, were obtained: age, gender, Greek affiliation, handedness, level in school, race/ethnicity, and grade point average (GPA).

Each of the demographic variables (Appendix B) was carefully selected from the literature to attain representativeness of the sample and to prevent confounding of study results related to convenience sampling. Demographic data were obtained from a 7-item self-report paper-and-pencil measure administered after the informed consent was signed. The study participants were asked to place a check mark by the appropriate answer. Prior to the informed consent, the researcher asked the participant if they are a college student, 18, 19 or 20 years of age, live away from home, and if diagnosed with ADHD/ADD, do they currently take meds. Aklin et al. (2005) discusses social desirability response bias when respondents are concerned with confidentiality or perceived negative consequences. The question regarding GPA may be perceived as sensitive by the participant, but the researcher encouraged full completion of the demographic information by ensuring confidentiality such that answers are not traced back to the individual.

Age (18 to 20 years) was selected because all three study variables (religiosity, impulsivity, and risk-taking propensity) have been discussed on developmental continuums. Several researchers have uncovered the mid-twenties as the estimated time of PFC maturity (Casey et al., 2008; Schepis et al., 2008; Yurgelun-Todd, 2007) and thus the emergence of formal operational thinking, executive cognitive function, and the integration of the cognitive and socio-emotional neural systems. Previous research studies have examined college students (18 to 20 years old) as adults or as control groups (Ernst et al., 2005; Galvan et al., 2006), but this study analyzed 18 to 20-year olds as late adolescents. Because of the prevalence of age-related associations in adolescent literature, age was included as one of the independent variables.

Gender was selected because differences between males and females were found in effects of pubertal hormones on the hippocampus and amygdala (Giedd et al., 1996), on differing peak rates of PFC myelination (Bennett & Baird, 2005), in potential genetic variabilities of serotonin (Passamonti et al., 2006), and in correlations between impulse control and either gray or white matter organization (Reiss et al., 1996; Silveri et al., 2006). To examine the strength of the relationship of gender with risk-taking propensity, gender was an independent variable. Wechsler et al. (1997) report sorority/fraternity membership as a strong predictor of binge drinking, the most common risk behavior among college students. Greek affiliation was included in the study design as an independent variable in order to assess the strength of its relationship with risk-taking propensity.

Handedness was selected not only to alert the researcher of use of right-or left-hand mouse during the two computer measures; but research from Wright et al. (2004) suggested that left-handers make fewer moves on the Tower of Hanoi and exhibit more caution and less impulsivity. Handedness was used to describe the sample and could be used for future analysis. Level in school was selected because Fowler (1981) identified a backslide in moral judgment and religiosity during the earliest years of college. Finn (2002) discussed effects of a novel college environment on risk vulnerability. Completion of the first two years of college was associated with less alcohol abuse and binge drinking (Pascarella & Terenzini, 2005). Descriptive data of level in school was obtained to assess for heterogeneity or homogeneity of sample on this data point. Race/ethnicity is an important demographic variable in order to assess if the makeup of the study sample reflected the diversity of university student population.

GPA was included because of the strong correlations between IQ and test scores on gray matter thinning, PFC myelination, and increased white matter volume (Reiss et

al.; Sowell et al., 2002; Ullén et al., 2008). In a longitudinal study following high school students (15 to 17 years of age; N = 110) through college (up to 24 years of age), Coyle and Pillow (2008) discovered that performance on cognitive tests to measure IQ were moderately correlated with GPA in college undergraduate students. Performance on standardized, norm-referenced, and individually administered IQ tests predicted college student GPAs (Murray & Wren, 2003). Hardert and Dowd (1994) found that low GPAs were associated with a moderate increase in the odds of alcohol use and marijuana use in college. Zern (1989) also uncovered a slightly positive relationship between measures of religiosity and undergraduate GPA. Self-reported GPAs were used to describe the sample and could be used in future analysis. Addressing the issue of self-report response bias regarding college student GPAs, Coyle and Pillow found a strong correlation ($r = .88$) between official school records of GPAs and college student GPA self-reports.

Setting

The research study was conducted at the University of Texas at Arlington, a public university in the southwestern United States with a total Fall 2009 enrollment of slightly over 28,000 students. Undergraduate student enrollment is approximately 19,000. Students at this university are from across the United States and 130 foreign countries. The following statistics explain the diversity of the student population: 47% White, 15.2% Hispanic, 13.8% African American, 10.6% Asian, 10.6% International, and 0.5% American Indian. Approximately 4% of the undergraduate student population belongs to Greek-letter organizations.

Measurement Methods

Four study variables were operationalized in this study using a variety of self-report and behavioral measures (Table 13). In this correlational study, the independent variables, not previously defined as demographic variables (age, gender, and Greek

affiliation), were private religiosity, public religiosity, and impulsivity; and the dependent variable was risk-taking propensity. The literature on religiosity clearly supports measuring this variable as two-dimensional such as private and public, intrinsic and extrinsic, or proximal and distal (Berry, 2005; Hill & Pargament, 2003). For the adolescent population, researchers have discussed the challenges of instrument reliability and validity when using self-report measures, the effects of social desirability response bias, and concluded that concurrent behavioral measures, when available, may be necessary to conceptually and operationally measure a study variable (Aclin et al., 2005; Eisenberg et al., 2008; Martins et al., 2008). Careful evaluation of each of the paper-and-pencil measures involved assessing the developmental history of the tool, its psychometric indicators, and its initial and subsequent uses on targeted populations of interest to this study. To operationalize impulsivity and risk-taking propensity, the behavioral measures of TOH and BART respectively, were added because these tools have been established to measure actual behavior (Lejuez et al., 2002; Simon, 1975). The benefits from using both self-report and behavioral instruments to measure one variable arise from its contribution to the psychometric evaluation (reliability and validity) of the tools (Waltz et al., 2005).

Table 13. Conceptual and Operational Definitions of Study Variables

| Study Variable | Conceptual Definition | Operational Definition |
|---------------------|--|--|
| Religiosity | Religiosity is the representation of one's relationship with a Higher Power expressed as theological and moral attitudes, beliefs, and values that guide behaviors, decision-making, and opportunities for support networks (Benson et al., 2003; Rohrbaugh & Jessor, 1975; Wallace & Williams, 1997). | Subscale scores on: Age Universal Religious Orientation Scale-12 (AUROS-12) (Maltby & Lewis, 1996) 2 subscales: Intrinsic and Extrinsic |
| Private Religiosity | Private religiosity is the | Score on: |

Table 13 - continued

| Study Variable | Conceptual Definition | Operational Definition |
|------------------------|---|--|
| | individualized expression of one's relationship with a Higher Power through personal devotion and practices (Benda & Corwyn, 2001; Berry, 2005). | AUROS-12 Intrinsic Subscale (6 items) |
| Public Religiosity | Public religiosity is the extrinsic or outward expression of one's relationship with a Higher Power through group membership and identity, and public participation (Allport & Ross, 1967). | Score on: AUROS -12 Extrinsic Subscale (6 items) |
| Impulsivity | Impulsivity is defined as the quick response to cues or entrance into situations with minimal planning or thought towards consequences (Eysenck, Pearson, Easting, & Allsopp, 1985; Pentz, Jasuja, Rohrbach, Sussman, & Bardo, 2006). | Scores on : 3-disk Tower of Hanoi measure with 5-minute time limit (Simon, 1975)—behavioral measure Impulsivity Subscale from the Eysenck Impulsivity-Venturesomeness Test—self-report paper-and-pencil tool (Eysenck & Eysenck, 1978; Eysenck et al., 1985) |
| Risk-Taking Propensity | Risk-taking propensity is a natural inclination or preference to engage in potentially harmful behavior (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). | Scores on: Balloon Analogue Risk Task (BART) 8-item self-report measure of risk behavior |
| Age | Age is defined as college students in late adolescence. | Response on Participant Demographic Form as 18 or 19 or 20 years of age |
| Gender | Gender is membership in a particular class, being male or female. | Response on Participant Demographic Form as Male or Female |
| Greek Affiliation | Greek affiliation is membership in a Greek-letter sorority or fraternity. | Response on Participant Demographic Form as Yes or No to question asking Greek membership |

Religiosity

Both private and public religiosity were measured by the Age Universal Religious Orientation Scale-12 (AUROS-12; See Appendix C). In the public domain, this paper-

and-pencil measurement tool was originally developed by Allport and Ross (1967), revised by Gorsuch and Venable (1983), and amended by Maltby and Lewis in 1996. The original Religious Orientation Scale was a 20-item measure that included two subscales: 11 items on the extrinsic subscale and 9 items on the intrinsic subscale (Allport & Ross). Because the original tool was designed for and only tested on adults, Gorsuch and Venable simplified the language of each item on both subscales, maintained 20 items, and facilitated measurement of religiosity among children up through adults.. Assessing that the revised tool restricted measurement solely to religious persons, Maltby and Lewis (1996) found that previous versions of the AUROS could not be completed by non-religious persons (do not identify with any particular denomination) or less committed religious persons. The authors changed the response format, altered the instructions, examined the internal structure of the tool, and shortened the form to 12 questions (six intrinsic items and six extrinsic items).

The two previous versions of AUROS-12 used five-point response formats ranging from "I strongly disagree" to "I strongly agree" (Maltby, 1999; Maltby & Lewis, 1996). The amended response format is on a three-point scale with "Yes," "Not Certain," and "No." The AUROS-12, used in this study, instructed the participant to "think about each item carefully. Does the attitude or behavior described in the statement apply to me?" (Maltby & Lewis). Interval/ratio data is obtained from scores on the AUROS-12, with three points for a "Yes" response, two points for a "Not Certain" response, and one point for a "No" response for each item. Private religiosity was operationally defined as scores ranging from 6 to 18 on the intrinsic orientation subscale and similarly; public religiosity was defined as scores ranging from 6 to 18 on the extrinsic orientation subscale (Lewis, Maltby, & Day, 2005). For each of the subscales, higher scores signify higher levels of either intrinsic or extrinsic orientation.

Psychometric evaluation (reliability and validity) of this amended AUROS-12 has been utilized on over 4,100 participants ranging in age from 12 to 82 years old (mean age = 29.89, SD = 9.87), on both self-reported religious and non-religious samples, on samples from United States, England, and Ireland, and most frequently on White (n = 3,380, 81.3%), single (n = 1,941, 46.7%), and employed (n = 2,585, 62.1%) samples (Maltby, 2002). Alpha coefficients, as an index of internal consistency reliability for both subscales, ranged from 0.83 to 0.88 on the intrinsic subscale and from 0.81 to 0.89 on the extrinsic subscale (Maltby & Lewis, 1996). Though no evidence of test-retest or parallel-form reliability was reported, internal consistency represents the consistency of performance that participants demonstrate across the items of each subscale (Waltz et al., 2005). Construct validity was assessed by computing Pearson product moment correlation coefficients between intrinsic and extrinsic subscales. As seen in Table 14, weak or low correlations between subscales were reported among geographically diverse Christian and non-religious samples—supporting the two bipolar dimensions of religiosity. These findings support measuring the variable of religiosity as private and public religiosity on intrinsic and extrinsic subscales, respectively. In addition, construct validity was further evaluated using confirmatory factor analysis (Maltby, 2002). The findings confirmed the construct uniqueness of each subscale through the separate loadings of intrinsic and extrinsic items. The author found that the extrinsic subscale measured both personal and social attributes which parallels with the conceptual definition of public religiosity (Table 13). As part of the study before data analyses, calculations of the subscales' internal consistency reliability and construct validity (Pearson r) between subscales were performed for this study sample.

Maltby and Lewis (1996) discuss the use of this instrument for both religious and non-religious populations and do not discuss this tool for use with Christians only. Dr.

Maltby suggests changing “church” to “place of worship” and “God” to “my God” to address use with non-Christians. In addition, to reflect religious diversity, the author added an instruction change to address the potential ethnic and religiosity diversity of this study sample: I “appreciate as a researcher that people have different words for similar concepts across religions and have tried to make allowances for that” (personal electronic communication, Dr. John Maltby, March 19, 2009; See Appendix C).

Table 14. Pearson r Correlations Between Intrinsic(I) and Extrinsic(E) Subscale Scores on AUROS-12

| Sample | Pearson r between I and E subscale scores |
|---|---|
| Adults from North Carolina (n = 156, 18 to 62 years) Protestant—85% Catholic—4% No religious denomination—11% | r = -0.51, <i>p</i> < 0.01 |
| Adults from Northern Ireland (n = 189, 17-57 years) Catholic—54% Protestant—44% No religious denomination—2% | r = -0.43, <i>p</i> < 0.01 |
| Adults from Republic Ireland (n = 167, 19-54 years) Catholic—98% Protestant—2% | r = -0.35, <i>p</i> < 0.01 |
| University students from Ohio (n = 144, 19-55 years) Protestant—59% Catholic—32% No religious denomination—9% | r = -0.13, <i>p</i> > 0.05 |
| Adults from England (n = 149, 18- 82 years) Church of England—70% Free Church—11% Catholic—9% No religious denomination—10% | r = 0.04, <i>p</i> > 0.05 |
| Schoolchildren from England (n = 135, 17- 18 years) Church of England—70% Free Church—11% Catholic—9% No religious denomination—10% | r = 0.02, <i>p</i> > 0.05 |

(Maltby & Lewis, 1996)

Impulsivity

Impulsivity was operationally defined as the scores obtained on a three-disk Tower of Hanoi (TOH) task (Simon, 1975) when given a five-minute time limit, a behavioral measure (Table 13). In addition, to evaluate the psychometric properties of the TOH and to contribute to its reliability and validity data, all participants completed a paper-and-pencil self-report measure, The Impulsivity Subscale from the Eysenck Impulsivity-Venturesomeness Test (Eysenck & Eysenck, 1978; Eysenck et al., 1985).

Tower of Hanoi

An on-line computerized version of the TOH task was administered and obtained from <http://www.novelgames.com/flashgames/games.php?id=31>. The TOH was originally created by a French mathematician for students studying discrete mathematics (Stockmeyer & Lunnon, 2008). For this study, three disks were pre-arranged on the left most peg, like a pyramid, largest disk on the bottom. The participant was instructed as to the object and rules of this task (Appendix D) and the time limit of five minutes. This behavioral tool is currently used to measure response inhibition, planning ability, or impulsivity.

The TOH produces interval/ratio data for higher-order statistics. For this study, impulsivity was scored as the ratio of the total time divided by total moves (or mean time/move). With a three-disk TOH task, seven moves are the least moves possible to successfully complete this test. To set the criterion or cut score for a TOH performance based on achieved adult prefrontal cortex maturity, 13 TOH-naïve adults (twelve females and one male) between the ages of 40 and 60 years of age completed one trial of TOH after being given the same instructions for TOH that the college student participants will receive (Appendix D). All participants had completed either an undergraduate, master, or doctoral degree. Two participants' scores were dropped after one revealed that she was

familiar with the TOH and the other restarted after failing to finish the first trial. Data for 11 subjects were collected on total moves, total time, and ratio scores of total time/total moves. Mean time/move ratios ranged from 2.54 seconds to 8.64 seconds (obtained by the male subject). The criterion score for this study is 4.69 seconds (mean time/move; see Table 15). In Rosser et al.'s (2005) study, participants were characterized as "impulsive" when they "made more moves, took less time to finish, and spent less time per move taken" (p. 91). For this study, all three data points were collected; but impulsivity was categorized as less mean time per move than the set criterion score. Greater mean time per move than set criterion score may indicate an inability to plan ahead exhibited as longer deliberative reasoning processes—another sign of an immature prefrontal cortex (Baird et al., 2005, as cited in Steinberg, 2008). All participants completed the TOH task within the 5 minute time frame.

Table 15. Impulsivity Criterion Cut Score Development for TOH

| Participant # | # of Moves | Total Time (sec) | Mean Time/Move | Criterion Cut Score* |
|----------------------|------------|------------------|------------------------------|----------------------|
| 1 | 13 | 33 | 2.54 | |
| 2 | 13 | 37 | 2.85 | |
| 3 | 19 | 63 | 3.32 | |
| 4 | 12 | 43 | 3.58 | |
| 5 | 7 | 45 | 6.42 | |
| 6 | 15 | 63 | 4.20 | |
| 7 | 17 | 84 | 4.94 | |
| 8 | 25 | 169 | 6.76 | |
| 9 | 13 | 61 | 4.69 | |
| 10 | 17 | 62 | 3.65 | |
| 11 | 11 | 95 | 8.64 | |
| Criterion Cut Score* | | | Sum of scores/11 51.59/11 | 4.69 sec |

*Criterion cut score is average of all mean times/moves from all 11 participants.

Reliability of TOH tasks has been established through evidence of an internal consistency of .90 (Humes et al., 1997). TOH has been tested on children, adolescents, university students, adults, and elderly; but test-retest reliability indices are low (.26 to

.72) between first and second performances with intervals between 25 minutes up to one week (Aman et al., 1998; Gnys & Willis, 1991; Lowe & Rabbitt, 198). Burgess (1997) states that researchers should anticipate poor reliability between the first and second performances because retests demonstrate dramatic improvements as task strategies are developed and working memory is engaged. This study had no retest provision since the impulsivity measure was based on the first performance from a TOH-naïve participant. Content validity for TOH was established based on research results of individuals with frontal lobe lesions and scores correlating with problems of response inhibition and inability to plan moves ahead (Goel & Grafman, 1995).

The Eysenck Impulsivity Subscale

Measuring impulsivity, the Eysenck Impulsivity Subscale is a paper-and-pencil self-report tool that contains 19 items using a forced-choice (yes or no) response format (Eysenck et al., 1985; Appendix D). Those individuals who complete this measure answer each item by agreeing or disagreeing with each “impulsivity-related” question (Lejuez et al., 2003a). The developers of this tool defined impulsivity as acting on the spur of the moment with no apparent regard for or thought of potential consequences (Eysenck et al.). This subscale provides interval/ratio data and the data will be used to analyze if convergent validity exists between the TOH and the Eysenck Impulsivity Subscale.

Rated as psychometrically sound, the Eysenck Impulsivity Subscale has been tested mainly on older adolescents, undergraduates, and prison inmates. This subscale was originally part of the Personality Scale measuring empathy, venturesomeness, and impulsivity (Eysenck & Eysenck, 1978; Eysenck et al., 1985). After revisions, the Impulsivity subscale forms half of the Eysenck Impulsivity-Venturesomeness Test.

In scoring the Eysenck Impulsivity Subscale, it is important to recognize that three of the questions are reverse-scored (See Appendix D). The 16 “Yes” responses and the three “reverse-scored No” responses are added up to form a subscale total score ranging from 0 to 19. The higher scores express higher impulsivity levels (Lejuez et al., 2003a). This subscale has established internal consistency reliability with an alpha coefficient of 0.84. In a 2005 study by Lejuez et al., the alpha coefficient was 0.78. Convergent validity has also been confirmed with the Barratt Impulsivity Scale (BIS; Barratt, 1985) with an alpha coefficient of 0.70.

Risk-Taking Propensity

Risk-taking propensity was operationally defined as scores on the computer-generated Balloon Analogue Risk Task (BART; Table 13). BART was developed in 2002 by Dr. C. W. Lejuez from the University of Maryland Department of Psychology. Accessible and downloadable from <http://www.addiction.umd.edu/research.htm>, BART is currently the most broadly used and tested risk task behavioral tool and has been administered to a wide range of populations, especially college students and adolescents (Aklin et al., 2005; Crowley et al., 2006; Lejuez et al., 2002, 2005; Pleskac et al., 2008). College students were also used in BART’s development phase to develop initial psychometric data.

Balloon Analogue Risk Task (BART)

As a behavioral measure, BART consists of a set of computer-simulated balloon pumping trials (Figure 7). Increasing inflation of each balloon is associated with greater reward and the participant can stop pumping at any time and transfer the accumulated amount into their “permanent bank.” If the balloon explodes, the accumulated money for that balloon disappears. For this study, each participant completed 30 balloon trials. All participants were given a copy of the instructions to begin BART (Appendix E). Data from

all 30 balloon trials were automatically transferred to a BART database—easily accessible after the trials were completed. In this database, interval/ratio data for each participant was recorded. Scoring on BART was based on an adjusted value. Rather than obtaining scores based on absolute average numbers of balloon pumps across all 30 trials, scoring was based on the average number of pumps excluding exploded balloons. Though not shared with participants, the average breaking point for the balloons is 64 pumps (Lejuez et al., 2002).

BART has accumulated strong reliability and validity data since its inception. Developmental evaluations of BART and subsequent studies using BART have obtained strong alpha coefficients (0.82 to 0.86) as measures of internal consistency reliability (Lejuez et al., 2002, 2003a). This is done by correlating adjusted BART scores across the first ten pumps, second ten, and final ten trials. Test-retest reliability ($r = .77$) was strong at two week intervals and performance was not affected by gender or previous experience (White et al., 2008). In a 2005 study, Lejuez et al. discovered that high BART scores with high impulsivity scores from paper-and-pencil measures predicted greater probability of being a smoker. Convergent validity (0.28 to 0.35) was evidenced between adjusted BART scores and Sensation Seeking total score (Lejuez et al., 2002, 2003a). Construct validity, via factor analysis, was evidenced when BART scores accounted for significant amount of variance within composites of self-report risk behaviors (Lejuez et al., 2002) such as ecstasy use (Hopko et al., 2006), antisocial behavior (Hunt et al., 2005), and smoking (Lejuez et al., 2005).

To strengthen the measurement of the concept of risk-taking propensity during this study, internal consistency reliability correlations were obtained between the first, second, and third sets of 10 balloon trials. In addition, Dr. Lejuez, as developer, suggests using BART “in combination with a paper-and-pencil measure of risk-related constructs to

improve the assessment of a broad range of real-world risk behaviors” (Lejuez et al., 2002, p. 82). Convergent and concurrent validity correlational statistics were obtained between BART scores and the scores from the risk self-report measure.

Self-Report College Student Risk Behavior Measure

Because the creators of BART (Lejuez et al., 2002) caution against using its overall risk-taking propensity scores to *predict* the likelihood of specific risk behavior participation, a modified 8-item paper-and-pencil self-report risk behavior measure was included to provide concurrent validity data for BART in measuring risk-taking propensity. In this situation, concurrent validity correlations between BART and each item from the self-report risk behavior measure were obtained to address the extent to which the risk-taking propensity scores on BART can be used to assess or predict “real-world” risk-taking. Preliminary concurrent validity does exist for BART on adolescents, specifically in high school. In African-American inner city adolescents, Lejuez et al. (2003b, 2005) found that BART scores significantly accounted for smoker versus nonsmoker or never-smoker differentiation. Using similar populations, Aklin et al. (2005) found significant positive relationships between BART scores and engagement in substance use, delinquency, and safety risk behaviors. In addition, this measure was utilized to obtain descriptive data on risk behaviors from the college student sample for this study.

In this study, the modified self-report risk behavior measure, based originally on the Centers for Disease Control (CDC) Youth Risk Behavior Surveillance System (YRBSS) questionnaire, reflected the literature review of college student risk behaviors and current risk-taking statistics of this group (Brener et al., 2004; Eaton et al., 2008; Ellison et al., 2008; Steinberg, 2008). In college students, the most prevalent risk behaviors are: smoking cigarettes, binge drinking, casual unprotected sex, automobile accidents due to risky driving or driving under the influence, and substance use. This 8-

item measure represented an index of engagement in “real-world” or daily life risk behaviors (Appendix E).

Providing interval/ratio data, this 8-item measure specifically asked the participants to answer “Yes” or “No” to involvement over the past 30 days in the listed behavioral statements (See Appendix E). Scoring equaled the sum of all “Yes” responses to obtain a total risk behavior index score—ranging from 0 to 8, with higher scores inferring higher risk behaviors.

This 8-item measure was adapted for college students from a previously modified 10-item measure based on the original 87-item CDC YRBSS questionnaire (Brener et al., 2004; Lejuez et al., 2003a). Concurrent validity statistics were reported between each item of this self-report tool and BART. The items for this risk behavior index were based on literature review and currently reported United States statistics; thus construct validity was preliminarily addressed. To develop content validity, two content experts were utilized to judge scale relevance for a college student sample and to judge if the items adequately represent the risk behaviors in the domain of interest (college student risk behavior; See Appendix F). The content experts included one doctorally-prepared social worker and one pediatric clinical nurse specialist—both currently working in the adolescent addiction field. Content validity index (CVI) was calculated to quantify the extent of agreement between experts (Waltz et al, 2005; Table 16). To obtain evidence of content validity based on the Waltz et al. standards for two reviewers, the content experts were given a list of behavioral objectives that led to the tool construction, a definition of the terms, and a separate list of the eight items to be individually rated on a four-point scale according to the relevancy of each item to the objectives [(1) not relevant, (2) somewhat relevant, (3) quite relevant, and (4) very relevant] (Appendix F). The obtained CVI of .88 affirms that adequate content validity was obtained for the modified 8-item

college student risk behavior measure from the proportion of items given a rating of 3 or 4 by both content experts (Table 16).

Table 16. Content Validity Index of Modified 8-item Risk Behavior Self-Report Measure (Judges Ratings of 8 items)

| Judge 2 | Judge 1 | | Total |
|------------------------------|------------------------------|----------------------------|------------|
| | 1 or 2 not/somewhat relevant | 3 or 4 quite/very relevant | |
| 1 or 2 not/somewhat relevant | 2 | 0 | 2 |
| 3 or 4 quite/very relevant | 6 | 8 | 14 |
| Total | 8 | 8 | 16 |
| Content Validity Index | 14/16 = .875 | | .88 |

The CDC has reported test-retest reliability and validity data on their YRBSS questionnaire (Brener et al., 2004) of adolescent risk behaviors. The authors discovered that test-retest reliability (Kappa = 61% to 100%) increased starting with students in the eighth grade and beyond. No reports of internal consistency reliability were reported. To assess validity, experts reviewed existing literature to determine if any cognitive or situational factors affected the validity of behavioral self-reporting by adolescents (Brener, Billy, & Grady, 2003). The authors found that comprehension and retrieval processes as cognitive factors may affect self-report validity when questionnaires include retrieval of behaviors based on frequency rather than whether that behavior has occurred over a specified time period. Situational or external environmental factors include perceived level of privacy or confidentiality, if responses are made in the presence of others, and if there is a need for attention or status attainment. Brener et al. (2003) discovered adolescent over-reporting of "status" behaviors such as alcohol use, drug use, and sexual behavior but found under-reporting of illegal or stigmatized behaviors such as violent acts or carrying a weapon due to fear of reprisal.

Procedure

Sampling Procedure

The goal of sampling for this study was to obtain a convenient sampling of 110 college students, 18 to 20 years old, who do not live with their parents, and if have ADHD/ADD, are currently taking medications. Having very broad sampling criteria increased the probability of accessing a more heterogeneous sample. Burns and Grove (2005) suggest that “in descriptive or correlational studies, the sampling criteria may be defined to ensure a heterogeneous population with a broad range of values for the variables being studied” (p. 342). After notification of approval by the university Institutional Review Board (IRB), access to the college student population occurred through contacts with the Resident Advisors at the university dorms, with university sorority/fraternity organization leaders and chapter presidents, with campus apartment staff, and with university faculty. Initially, appointments or informal meetings with each group were made to explain the purpose of the study (Appendix A) and the reasons necessary to access this population. With university IRB approval, flyers with recruitment and contact information were also posted in university-approved locations (Appendix A). In addition, because recruitment occurred during the summer when dorms are less occupied, the sample was sought from summer class-time recruitment with previous permission obtained from undergraduate course instructors who teach 18 to 20 year old students. Recruitment and assignment of study times were avoided during “dead week,” the week before finals as well as finals week. This was done to avoid any external influences on participant responses such as fatigue, duress, stress, preoccupation, anxiety, and any other distracters or extraneous variables that may affect participant responses on the measurement tools (Burns & Grove, 2005).

During recruitment meetings, phone contacts, or emails, each participant received the following information: (1) importance of the study [to increase understanding of factors that lead to college student healthy or unhealthy behaviors]; (2) what the student will be asked to do [give informed consent, complete four short paper-and-pencil forms and perform two computer games]; (3) time involvement [approximately 30 minutes]; (4) conditions of participation [confidentiality and ability to withdraw from study at any time without penalty]; (5) compensation upon completion of study participation [\$10 gift card]; and (6) reminder of participant eligibility criteria [18 to 20 years of age, in college, living away from parents, and currently takes meds if has diagnosis of ADHD/ADD]. Once eligible students were recruited for the study, specific date, time, place, and directions to research setting were given.

Informed Consent

When the study participant arrived at the designated study room on the second floor of the nursing school building, the individual signed in, was assigned a code number (from 101-210), and was given the informed consent form by the Principal Investigator to read. The informed consent was administered in person in front of the researcher and the participant was asked if there were any questions; any questions were answered before, during, and after reading of the consent; and the participant was instructed to read all of the pages carefully in the consent form, initialing at the bottom of each page and signing their name and date on the last page.

Process of Data Collection

Figure 10 depicts the flow chart of the data collection process for this research study. The data collection process began with successful recruitment of eligible study participants and ended when all data was obtained from 110 study participants. This study utilized only one data collector; the same researcher recruited the sample and

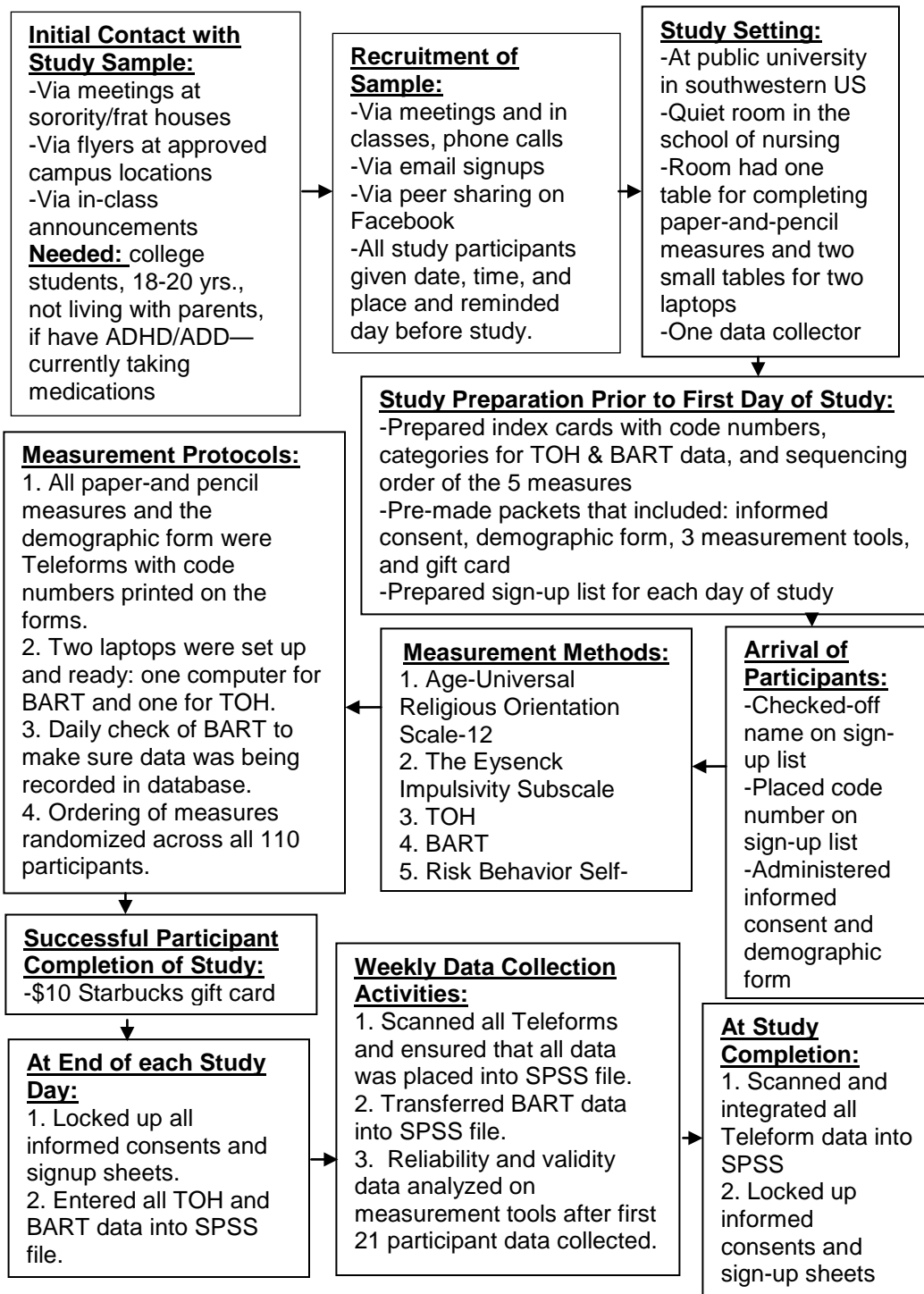


Figure 10. Flow Chart of Data Collection

collected data on all participants. As noted under Measurement Protocols in Figure 10, the ordering of the five measures was randomized using an online list randomizer accessed at <http://www.random.org.lists/>. One hundred-ten randomized orderings of the five measures were obtained—one for each study participant (See Appendix G). In research, order effects arise from the serial ordering of procedures or measurements and can introduce extraneous or confounding variables such as fatigue that lead to faulty interpretation of results. Order effects are controlled by the randomization of the order of the administration of the measures (Colman, 2001; Maxwell & Delaney, 2004).

Ethical Considerations

Review Process

Prior to recruitment and data collection, review and approval of this research proposal was obtained from the Institutional Review Board at the University of Texas at Arlington where the college student sampling occurred.

Risk/Benefit Ratio

For this study, the goal was to maximize benefits to individual participants and society while minimizing any known or potential risks to the participants (Burns & Grove, 2005). The participants in this study could potentially benefit by gaining experience in the research process and were offered an opportunity to receive an overview of the findings upon completion of the dissertation research. Society may potentially benefit from the results of this study through expansion of knowledge of college student health and risk behaviors and the contributions of religiosity and impulsivity to those behaviors. This research could potentially offer foundational knowledge for prevention/intervention programs within the university or college environment. This research could also generate important psychometric data on the chosen measurement tools used in this study and

could offer increased evidence for use-generalizability among older adolescents (See Appendix H for Informed Consent).

Plans to minimize any potential risks to participants included actions to decrease or prevent any physical or emotional impact upon the participants. The study participant could have experienced mild frustration during one or both behavioral measures, especially if they encountered any difficulties during task performances of 30 trials of BART or up to five minutes of TOH. To minimize the potential risk of frustration, the researcher did reinforce each participant's understanding of each task's written instructions as well as offer a brief respite, if needed, between tasks if the participant received the randomized ordering of TOH and BART back-to-back. No brief respites were needed with any of the participants. Also, a left-hand mouse, when needed, could be utilized during performances of TOH and BART to prevent frustration from using a right-hand mouse with a left-handed participant. In this study, six participants were left-handed; however, all used the right-hand mouse, stating this as their normal habit. The individual could also experience mild fatigue with the battery and variety of measurement tools: demographic form, AUROS-12, The Eysenck Impulsivity Subscale, Risk Behavior Measure, TOH, and BART. To minimize the risk of mild fatigue, random ordering of all measures was included in the study protocol. There were no complaints of fatigue from any of the participants related to subject burden. In addition, no data collection occurred one week before or during finals week at the university (See Appendix H for Informed Consent).

Maintenance of privacy and confidentiality was addressed during recruitment, informed consent process, and during data collection. During recruitment, potential participants were aware that they would be alone in the study room with the researcher and that no personal identifiers would be included on any items except the sign-up list

which was stored and locked after each day. The sign-up list was shredded upon completion of data collection. The informed consent included information on confidentiality of study results and that all data and consents would be stored and locked for three years. During data collection, each participant was identified by a code number (101-210) and no identifying information was placed on the computer or on the paper-and-pencil measures.

Data Analyses

Data Preparation

The use of Teleforms for the paper-and-pencil measures (demographic form, AUROS-12, The Eysenck Impulsivity Subscale, and the Risk Behavior Measure) simplified data preparation since the forms were scanned into a computer equipped with Cardiff Teleform software and which directly placed the data into an SPSS file (SPSS 17.0). All TOH data was obtained from each study participant's index card where the two data points were documented—total moves and total time in seconds. This data was hand-entered into the study SPSS file and calculations of total time/total moves were performed to create a new variable of mean time/move (sec). This variable operationally defined impulsivity. For the second behavioral measure, BART, a back-up database automatically recorded each participant's performance. However, the only data-point needed to operationally define risk-taking propensity was the adjusted value of mean number of balloon pumps in unexploded balloons. Each individual's adjusted score was placed into the study SPSS file.

Statistical Analyses of Sample

The study sample was college students between 18 and 20 years of age who do not live at home, and if they have an ADHD/ADD diagnosis, currently take medications (n = 110). To describe the sample, descriptive statistics were obtained on all 7 categories

from the Study Participant Demographic Form (Appendix B). These descriptive statistics included frequencies and percentages. Mean and standard deviation were obtained for age of study participants. In addition, description of the demographic variables based on age and gender was completed with Chi Square calculations to assess for significant differences between groups.

Psychometric Analyses of Study Measures

As discussed under Measurement Methods, all paper-and-pencil self-report measures/scales (except for the College Student Risk Behavior Measure) and behavioral task measures used in this study were analyzed for reliability and validity. The College Student Risk Behavior Measure was analyzed for concurrent validity with BART. Initial analyses of measures were performed after data had been collected on the first 21 participants in order to address, early on, the psychometric strength of the measures used. Reporting measurement reliability and validity information provides sound scientific evidence for this study's proposed score interpretations and for use in parametric statistical analyses (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999).

Statistical Analyses of Study Results

To answer the research questions, multiple regression analyses were performed to assess the strength of associations between the independent variables and the dependent variable of risk-taking propensity (Figure 8). Alpha was set at .05 for this study. Post hoc power analysis was performed at the end of the study.

Exploratory Data

The range of scores, means, standard deviations, and skewness statistics of the primary study variables (AUROS-12 subscales, TOH, BART, Eysenck Impulsivity Subscale, and Risk Behavior Measure) were calculated for the proposed sample of

college students ($n = 110$). In addition, descriptive statistics of the measures were obtained based on age and gender. The remaining independent variables (age, gender, and Greek affiliation) were also analyzed for degree of skewness prior to entry into regression analysis. Normality or normal distribution of data is demonstrated by the characteristic bell-shaped curve which signifies that the mean, mode, and median fall at or near the same value (Howell, 2004; Vincent, 2005). Assessment of the level of skewness and the results from the Shapiro-Wilk's W Test assisted in decisions toward the valid use of parametric statistical analyses which are based on assumptions of normal distribution (Burns & Grove, 2005).

Next, Pearson product moment coefficients (r) for all study variables were calculated as exploratory data to assess if this data avoided multicollinearity ($p < .05$). Multicollinearity is defined as "a condition where two or more independent variables in multiple regression are highly correlated ($r \geq .80$) with each other" (Vincent, p. 295). The main problem of multicollinearity is the inflation of the values of the standard errors of the β s, the standardized regression coefficient, causing greater variability and instability in the regression equation (Norman & Streiner, 2000). With high correlations among the independent variables, the size of the multiple R (correlation between the observed values of Y and the predicted value of Y) will be limited since the independent variables are going after some of the same variance on Y . With multicollinearity, it is difficult to determine which independent variable contributes most to the variance of the dependent variable.

Homoscedasticity is a "condition where the variance of the residuals of each of the independent variables in multiple regression is equal or nearly so" (Vincent, 2005, p. 294). Residuals are the "leftovers" of the regression equation, the difference between the predicted Y values and the observed Y values (Cipher, 2001). The sizes of the

standardized residuals were evaluated for homoscedasticity from the output during data analyses and displayed as a scatterplot. A test of normality, as the skewness ratio, was calculated on the standardized residuals

Delimitations

Decisions on three delimitations were imposed for this study and the college student population regarding language spoken by participants, age of participants, and religious affiliation. Locke, Spirduso, and Silverman (2007) explain that “delimitations describe the populations to which generalizations may be safely made” (p. 16). The decision was made to not limit inclusion criteria to English-only or English-as-first-language participants nor to exclude English-as-second-language (ESL) college students from the study sample. The university where the study was performed has universal admission standards for undergraduate ESL or international students: acceptable and current Test of English as a Foreign Language (TOEFL) scores of at least 550 or Test of Spoken English (TSE-A) scores of at least 45. In addition, an analysis of readability levels based on Flesch-Kincaid Grade Level was completed on all written forms and instructions that each participant encountered during the study (Table 17). As noted readability levels ranged from 5.3 to 7.6 grade level with a mean grade level of 6.6.

Table 17. Readability Levels of Study Measures and Instructions

| Measure/Instruction | Readability Grade Level | Mean Grade Level |
|-----------------------|-------------------------|------------------|
| Demographics Form | 7.2 | |
| AUROS-12 | 5.3 | |
| TOH Instructions | 7.5 | |
| Eysenck Subscale | 5.5 | |
| BART Instructions | 6.7 | |
| Risk Behavior Measure | 7.6 | |
| Mean Grade Level | | |

The age of the college students was limited to between the ages of 18 and 20 years because 21 years of age is the legally sanctioned age to drink and binge drinking,

as one college student risk behavior, is well documented in this age group (Ellison et al., 2008; Steinberg, 2008). In addition, Pascarella and Terenzini (2005) present data indicating that completion of two years of college correlates with a decreased probability of alcohol abuse or binge drinking. Finn (2002) further describes being in novel or new physical or situational environments as increasing a college student's vulnerability to risk behaviors.

Finally, religious affiliation was not included in demographic information as a descriptive of adolescent religiosity. In a large systematic review of adolescent religiosity research, Rew and Wong (2006) found that religious affiliation was a poor indicator for adolescent religiosity. Kerestes et al. (2004), in their four-year longitudinal study, concluded that adolescents do not feel the need to identify any specific religious affiliation in order to be religious. Religious affiliation may reflect parental choices rather than an adolescent's religious commitment and may be more culturally, biologically, or genetically influenced (D'Onofrio et al., 1999; Rew & Wong). For college students, religious affiliation may be less important as they reinterpret former beliefs into a more personalized belief system (Cherry et al., 2001).

Chapter Summary

This study utilized a quantitative cross-sectional descriptive correlational design to investigate the relationships between public and private religiosity, impulsivity, age, gender, Greek affiliation, and risk-taking propensity by college students between the ages of 18 and 20 years of age. The convenience sampling method for this study was appropriate for correlational studies and a pre-study power analysis revealed a needed sample size of at least 108 participants. Identified minimal participant eligibility criteria included: college student, 18 to 20 years old who do not live with parents, and currently

take medications if they have an ADHD/ADD diagnosis. Rationale for sample demographics and delimitations were offered.

Measurement methods, both self-report paper-and-pencil forms as well as behavioral measures operationally defined the study variables of private religiosity, public religiosity, impulsivity, and risk-taking propensity. Private and public religiosity were measured by AUROS-12 intrinsic and extrinsic subscales, respectively. Impulsivity was measured by scores on the TOH and the Eysenck Impulsivity Subscale. Risk-taking propensity was measured by scores on the BART and the Risk Behavior measure. Prior to their uses, criterion cut scores on the TOH was established based on adult performances on the measure. Content validity of the Risk Behavior Measure was established prior to its use.

Prior to data collection, sampling procedure via face-to-face recruitment and posted flyers were discussed. Informed consent and ethical considerations were reviewed for this study with very minimal assessed risk noted for study participants; though proactive anticipatory plans were outlined for any physical or emotional impact upon participants.

The study design graphic in Figure 8 depicts six independent variables and risk-taking propensity, the dependent variable. The choice of multiple regression analyses was appropriate for this study design as no causal inferences can be obtained from this cross-sectional descriptive correlational study design. In addition, statistical analyses of the psychometric properties of all study measures were explained to enhance the reliability and validity of score interpretations and study results.

In this Methods and Procedures chapter, the identified research design was closely linked to the conceptual framework of the study, to the purpose, and the research questions. The design also guided the implementation plans for the actual sampling

method, procedures for data collection, statistical analyses, and interpretation of study results.

CHAPTER 4

FINDINGS

Data collection commenced June 1, 2009, at the start of the university Summer semester, and ended September 15, 2009, approximately four weeks into the Fall semester. During the Summer semester, data from 41 students (37% of sample), primarily 19 or 20 years old, were collected. Once the Fall semester resumed, the remaining 69 participants were recruited, mainly 18 year old college freshmen. In all, 123 college students were recruited; data were collected on 110 students with 13 students who did not come to their appointment time. The majority of freshmen college students were recruited from classrooms, either from in-person presentations or flyer handouts in class. The majority of older college students (19 or 20 year olds) were recruited from posted study flyers across campus, word-of-mouth, or student posts on Facebook, a social networking site.

Results

Description of Sample

Study participant eligibility included: 18, 19, or 20 year old college students who lived away from their parents. All students were asked if they had ever received a medical diagnosis of ADD/ADHD—no study participants reported past histories of these medical diagnoses. In addition to age, students were asked about their gender, handedness, level in school, race/ethnicity, Greek affiliation, and GPA. As noted in Table 18, the study sample included more 18 year old college students ($n = 48$) than 19 year old ($n = 27$) or 20 year old ($n = 35$) college students. More female college students ($n = 86$) participated in the study than males. The majority (92.7%) of participants were right-

handed. Though asked if they preferred to use a left-handed mouse, all left-handed students wanted to use the right-handed mouse during the study. More college freshmen (45.5%) participated in the study than sophomore (29%) and junior (22.7%) college students. Three participants identified themselves as college seniors. The race/ethnicity of the study sample was reflective of the culturally diverse university undergraduate student population. Eleven students designated “Other” as a choice for mixed race.

Table 18. Descriptive Sample Statistics

| Demographic Variable | Frequency | Percentages* (%) |
|--------------------------------|-----------|------------------|
| Age: | | |
| 18 years | 48 | 43.6 |
| Mean 18.9 (.87) | 27 | 24.5 |
| 20 years | 35 | 31.8 |
| Total | 110 | 99.9 |
| Gender: | | |
| Male | 24 | 21.8 |
| Female | 86 | 78.2 |
| Total | 110 | 100.0 |
| Handedness: | | |
| Right-handed | 102 | 92.7 |
| Left-handed | 8 | 7.3 |
| Total | 110 | 100.0 |
| Level in School: | | |
| Freshman | 50 | 45.5 |
| Sophomore | 32 | 29.1 |
| Junior | 25 | 22.7 |
| Senior | 3 | 2.7 |
| Total | 110 | 100.0 |
| Race/Ethnicity: | | |
| White/Cauc | 38 | 34.5 |
| Hispanic | 18 | 16.4 |
| African-Amer | 21 | 19.1 |
| Asian | 19 | 17.3 |
| International | 3 | 2.7 |
| Other | 11 | 10.0 |
| Total | 110 | 100.0 |
| Member of fraternity/sorority: | | |
| Yes | 6 | 5.5 |
| No | 104 | 94.5 |
| Total | 110 | 100.0 |
| GPA: | | |
| <2.0 | 1 | 0.9 |
| 2.0-2.5 | 3 | 2.7 |
| >2.5-3.0 | 6 | 5.5 |
| >3.0-3.5 | 52 | 47.3 |
| >3.5-4.0 | 48 | 43.6 |
| Total | 110 | 100.0 |

* Totals may not equal 100% due to rounding

Though efforts to recruit students from sororities/fraternities involved emails to 32 chapter presidents and two Panhellenic directors, face-to-face meetings, and flyer handouts, only six sorority members participated in this study. As noted in Table 19, when cross-tabulations were performed, all Greek members were female and four of the six students were 20 years old. Of the 32 chapter presidents contacted via email, eight responded. Four chapter presidents stated that their members were over 20 years old and four others offered to contact their members. At 5.5% of the study sample, six Greek members are representative of the university's percentage (4%) of Greek-affiliated students among the general undergraduate population. The majority of students (>90%) who participated in this study reported GPAs between >3.0 and 4.0; freshmen reporting their last high school GPA.

Since the selection of demographic variables was based on the review of adolescent and college student literature, separate statistical cross-tabulations and Chi squares were performed between gender and demographic variables (Table 19) as well as between age and demographic variables (Table 20). Gender and age variables support the developmental focus of the study's conceptual framework. No significant differences were found between male and female study participants on age, level in school, race/ethnicity, Greek affiliation, and GPA. The only significant difference was between gender and handedness ($p = .004$). Approximately 97% of the 86 female participants ($n = 83$) were right-handed while almost 80% of the 24 total male participants were right-handed. Though not statistically significant but approaching significance ($p = .07$), more females than males described their race/ethnicity as White/Caucasian or Other (mixed).

Table 19. Sample Description Based on Gender

| | Male Frequency | Female Frequency | Chi Square |
|-----------------------------------|-------------------|---------------------|------------------------------------|
| Age: | | | |
| 18 years | 12 | 36 | 1.1; <i>df</i> =2; <i>p</i> =.58 |
| 19 years | 4 | 23 | |
| 20 years | 8 | 27 | |
| Total | 24 | 86 | |
| Handedness: | | | |
| Right-handed | 19 | 83 | 8.4; <i>df</i> =1; <i>p</i> =.004* |
| Left-handed | 5 | 3 | |
| Total | 24 | 86 | |
| Level in School: | | | |
| Freshman | 11 | 39 | .92; <i>df</i> =3; <i>p</i> = .82 |
| Sophomore | 8 | 24 | |
| Junior | 4 | 21 | |
| Senior | 1 | 2 | |
| Total | 24 | 86 | |
| Race/Ethnicity: | | | |
| White/Cauc | 5 | 33 | 10.1; <i>df</i> =5; <i>p</i> =.07 |
| Hispanic | 6 | 12 | |
| African-Amer | 6 | 15 | |
| Asian | 7 | 12 | |
| International | 0 | 3 | |
| Other | 0 | 11 | |
| Total | 24 | 86 | Total = 110 |
| Member of fraternity/sorority: | | | |
| Yes | 0 | 6 | 1.8; <i>df</i> =1; <i>p</i> =.18 |
| No | 24 | 80 | |
| Total | 24 | 86 | |
| GPA: | | | |
| < 2.0 | 1 | 0 | 7.5; <i>df</i> =4; <i>p</i> =.11 |
| 2.0-2.5 | 0 | 3 | |
| >2.5-3.0 | 3 | 3 | |
| >3.0-3.5 | 11 | 41 | |
| >3.5-4.0 | 9 | 39 | |
| Total | 24 | 86 | |

* Significant differences between male and females ($p < .05$)

No statistically significant differences in demographic variables were found among college students who were either 18, 19, or 20 years old, except for level in school which obviously related to the age of the student ($p = .00$; Table 20). Since data collection occurred early in their first semester of college, most of the 18 year old study participants reported their last high school GPA. To compare the study sample with the

general undergraduate student population at the large public university which served as the recruitment site, the general student population averages 25 years old, has 50% of all freshmen living on campus with 18% of all undergraduates living on campus, consists of 52% female vs. 48% male students, and is racially and ethnically diverse (48% Caucasian with remainder equally spread between Hispanics, Asians, and African-Americans).

Table 20. Sample Description Based on Age

| | 18 years old Frequency | 19 years old Frequency | 20 years old Frequency | Chi Square |
|-----------------------------------|---------------------------|---------------------------|---------------------------|--|
| Handedness: | | | | |
| Right-handed | 42 | 26 | 34 | 3.5; <i>df</i> =2; <i>p</i> =.18 |
| Left-handed | 6 | 1 | 1 | |
| Total | 48 | 27 | 35 | |
| Level in School: | | | | |
| Freshman | 44 | 5 | 1 | 107.6; <i>df</i> =6; <i>p</i> =.00* |
| Sophomore | 4 | 19 | 9 | |
| Junior | 0 | 3 | 22 | |
| Senior | 0 | 0 | 3 | |
| Total | 48 | 27 | 35 | |
| | | | | Total = 110 |
| Race/Ethnicity: | | | | |
| White/Cauc | 20 | 6 | 12 | 11.5; <i>df</i> =10; <i>p</i> =.32 |
| Hispanic | 11 | 3 | 4 | |
| African-Amer | 9 | 7 | 5 | |
| Asian | 5 | 6 | 8 | |
| International | 0 | 1 | 2 | |
| Other | 3 | 4 | 4 | |
| Total | 48 | 27 | 35 | |
| | | | | Total = 110 |
| Member of fraternity/sorority: | | | | |
| Yes | 1 | 1 | 4 | 3.6; <i>df</i> =2; <i>p</i> =.16 |
| No | 47 | 26 | 31 | |
| Total | 48 | 27 | 35 | |
| GPA: | | | | |
| < 2.0 | 1 | 0 | 0 | 6.5; <i>df</i> =8; <i>p</i> =.59 |
| 2.0-2.5 | 1 | 2 | 0 | |
| >2.5-3.0 | 2 | 2 | 2 | |
| >3.0-3.5 | 20 | 14 | 18 | |
| >3.5-4.0 | 24 | 9 | 15 | |
| Total | 48 | 27 | 35 | |
| | | | | Total = 110 |

* Significant differences between 18, 19, and 20 year olds ($p < .05$)

Psychometric Analyses of Study Measures

Psychometric analyses of reliability and/or validity were performed on all study measures, three paper-and-pencil measures and two behavioral measures, early in the study (after the first 21 participants) and upon completion of all 110 participants. Only the measures that achieved reliability coefficients of $\geq .70$ or higher were included in the multiple regression analysis. Results of the reliability and validity from each of the time periods will be reported for each of the study instruments.

Age Universal Religious Orientation Scale-12 (AUROS-12)

Intrinsic subscale (private religiosity). As a measure of internal consistency reliability for the six-item Intrinsic subscale after the first 21 participants, the Cronbach's Alpha was .754. When all 110 study participants completed the Intrinsic subscale, the Cronbach's Alpha increased to .872. Strong reliability of this subscale was achieved for this study sample and private religiosity was included in the regression analysis.

To attempt to support the bipolar dimensions of religiosity and construct validity of the AUROS-12, a Pearson product moment correlation coefficient (r) was computed between total scores on the Intrinsic and Extrinsic subscales of the AUROS-12. The Pearson r was .383 ($p = .01$). The Pearson r of .383 describes a statistically significant positive but weak correlation between the subscales of the AUROS-12 indicating that scores on the Intrinsic subscale are only weakly related to scores on the Extrinsic subscale. Construct validity was established for the AUROS-12 in this study. This correlation coefficient was only calculated at the end of the study on subscale scores from all 110 participants.

Extrinsic subscale (public religiosity). After the first 21 participants completed the AUROS-12 six-item Extrinsic subscale, a measure of internal consistency reliability was

performed. The Cronbach's Alpha was .288, denoting an unreliable subscale for this initial sample of 18, 19, and 20 year old college students. Upon completion of data collection on 110 participants, the Cronbach's Alpha was .597. Because the reliability or consistency of the Extrinsic subscale was poor for this study, public religiosity, as an independent variable, was removed from the regression equation. Research Question #2 was not addressed in this study because of an unreliable AUROS-12 Extrinsic subscale.

Tower of Hanoi (TOH)

The computerized version of the TOH was performed as a one-time measure and three scores were obtained: total number of moves, total time, and ratio of time per move. The TOH was administered and scored following the same procedures as the Rosser et al. (2005) study where Air Force Junior ROTC high schoolers and substance and criminally involved adolescents completed a one-time three-disk version. The TOH has an established internal consistency reliability of .90 (Humes et al., 1997). This reliability was established, not through a one-time measure, but through 11 different trials of TOH at different disk starting states and all ending in a tower configuration (M. C. Welsh, personal communication, August 13, 2009). For this study, Dr. Welsh states that "reliability for a single-item task does pose a problem." No reliability statistic was reported for the use of TOH in this study and the initially proposed variable for impulsivity, ratio of time/move, was not entered into the regression analysis.

Eysenck Impulsivity Subscale

Internal consistency reliability calculations were performed after the first 21 participants and upon completion of the study for 108 participants. Data from two participants were excluded because seven answers on the back side of the Teleform were not completed. Both of the Cronbach's Alphas were reliable: .718 for the first 21 participants and .728 on 108 participants. Because of its established reliability for this

study, the Eysenck Impulsivity Subscale scores were included in the regression analysis as the Impulsivity variable, since reliability could not be established for the Tower of Hanoi.

To examine convergent validity between total scores on the Eysenck Impulsivity Subscale and scores of time per move from the TOH, correlations were calculated between the measures. The Pearson r of .101 indicates a weak positive correlation between total scores on the Eysenck Impulsivity Subscale and ratio of time/move from the one-time performance of the TOH; supporting discriminant validity (Waltz et al., 2005). The scores from the one-time performance of TOH and the 19-item Eysenck Impulsivity Subscale may measure different constructs. No other reviewed studies have looked at convergent validity between the TOH and the Eysenck Impulsivity Subscale.

Balloon Analogue Risk Task (BART)

For BART, internal consistency reliability was calculated by correlating adjusted BART scores (number of balloon inflations excluding exploded balloons) across the first ten pumps, second ten, and third ten balloon trials. The Cronbach's Alpha on BART, for the first 21 participants, was .852 and slightly decreased to .780 when scores from all 110 participants were obtained. The developers of BART (Lejuez et al., 2002, 2003a) reported internal consistency reliability alpha coefficients between .82 and .86 on middle school and high school adolescent populations. Because BART obtained adequate reliability in this study, scores from BART, as a measure of risk-taking propensity, was entered into regression analysis as the dependent variable.

College Student Risk Behavior Measure

The College Student Risk Behavior Measure was modified from the original 87-item CDC YRBSS questionnaire. Content validity was established from two content experts and a CVI of .88 was obtained prior to the use of the Risk Behavior measure.

Since reliability is necessary but not sufficient in establishing validity, concurrent (predictive) validity was examined between BART scores and each of the eight items on the Risk Behavior measure (Table 21). No significant correlations were found between scores on BART and any item on the Risk Behavior Measure. In this study, BART scores did not correlate significantly with participation in any of the risk behaviors. In a study by Lejuez et al. (2005), scores on BART were significantly associated with the probability of being a smoker among inner city African-American high school students.

Table 21. Correlations between BART scores and Individual Item Scores on the Risk Behavior Measure

| College Student Risk Behavior Measure Items | BART Scores Pearson r |
|---|--------------------------|
| 1. I smoked a cigarette (even a puff). | -.009 |
| 2. I drank alcohol (even a drink). | .028 |
| 3. I used an illegal drug (even once). | .093 |
| 4. I had sexual intercourse without a condom. | .178 |
| 5. I rode in a car without wearing my seatbelt (even once). | -.040 |
| 6. I drove a car without wearing my seatbelt (even once). | -.021 |
| 7. I rode in a car with a person driving under the influence (even once). | .153 |
| 8. I drove a car while under the influence (even once). | .177 |

Statistical Analyses of Study Results

Statistical Measures

Descriptives of study measures. All descriptive statistics (range, mean, standard deviation, and skewness) are listed in Table 22 for each study measure. For public religiosity, the mean score was 11 out of a maximum of 18 points. For private religiosity, the study participants achieved a high mean score of 14 out of a maximum of 18 points. The 18, 19, and 20 year old students had a mean TOH ratio (time/move) of 3.42 seconds. On average, the study participants performed the TOH in less time per move than adults—pre-study adult criterion score for TOH time/move was 4.69 seconds. Scores on the Eysenck Impulsivity Subscale averaged 6.2 points out of a maximum of 19 points. Though the average balloon breaking point averages at 64 inflations for BART,

study participants averaged only 29 inflations per balloon, though one student's adjusted average of balloon inflations was 67. The college students in this study reported an average of two risk behaviors over the past 30 days.

Table 22. Study Measures: Range of Scores, Means, Standard Deviation, and Skewness (n = 110)

| Study Measures | Range of Scores | | Mean Score | Standard Deviation | Skewness Ratio |
|---|-----------------|------|------------|--------------------|----------------|
| | Min | Max | | | |
| Public Religiosity | 6 | 18 | 11.0 | 2.7 | .543 |
| Private Religiosity | 6 | 18 | 14.0 | 3.9 | -3.20 |
| Impulsivity (TOH; time/move) | 1.43 | 7.13 | 3.42 | 1.4 | 3.95 |
| Impulsivity (Eysenck Impulsivity Subscale) | 0 | 14 | 6.20 | 3.6 | 1.48 |
| Risk-Taking Propensity (BART; adjusted average pumps) | 5 | 67 | 28.9 | 10.6 | 1.94 |
| College Student Risk Behavior Measure | 0 | 8 | 1.93 | 1.6 | 4.32 |

Table 23 displays the frequencies and percentages of all eight items of the College Student Risk Behavior Measure. The most frequent risk behaviors reported were drinking alcohol and riding in a car without seat belts. The risk behaviors with the lowest frequencies were using illegal drugs and driving a car under the influence. Descriptive statistics and Chi Square calculations were performed on all study measures and items of the Risk Behavior Measure based on age and gender of study participants (Tables 24 & 25). Based on age, no significant differences in scores on study measures or Risk Behavior items were found. On item #2 of the Risk Behavior Measure, scores for alcohol use approached significance [$\chi^2(2) = 5.1, p = .08$], with 20 year old students reporting this behavior more frequently. When gender differences were examined, scores between males and females differed significantly on the Eysenck Impulsivity Subscale [$\chi^2(14) = 26.64, p = .02$]; males were more impulsive than females. More than 70% of females and

46% of males scored between 0 and 7 points (out of 19 total points). The higher range of Impulsivity scores (between 8 and 14) included 50% of males and only 27% of females. No other significant differences between males and females were found among the study measures.

Table 23. Descriptives of College Student Risk Behavior Measure Items (n = 110)

| Items | Frequency | | Percentage (%) [*] | |
|---|-----------|-----|-----------------------------|----|
| | Yes | No | Yes | No |
| 1. I smoked a cigarette (even a puff). | 21 | 89 | 19 | 81 |
| 2. I drank alcohol (even a drink). | 50 | 60 | 55 | 46 |
| 3. I used an illegal drug (even once). | 4 | 106 | 4 | 96 |
| 4. I had sexual intercourse without a condom. | 29 | 81 | 26 | 74 |
| 5. I rode in a car without wearing my seatbelt (even once). | 59 | 51 | 54 | 46 |
| 6. I drove a car without wearing my seatbelt (even once). | 21 | 89 | 19 | 81 |
| 7. I rode in a car with a person driving under the influence (even once). | 20 | 90 | 18 | 82 |
| 8. I drove a car while under the influence (even once). | 8 | 102 | 7 | 93 |

* Totals may not equal 100% due to rounding

Table 24. Study Measure Descriptives Based on Age

| | 18 years old Mean | 19 years old Mean | 20 years old Mean | Chi Square |
|---|------------------------|------------------------|------------------------|--------------------------------------|
| Public Religiosity | 11.0 (2.6) | 10.3 (2.7) | 11.5 (2.7) | 29.0; <i>df</i> =22; <i>p</i> =.14 |
| Private Religiosity | 13.9 (4.0) | 13.3 (4.1) | 14.5 (3.6) | 31.7; <i>df</i> =24; <i>p</i> =.13 |
| Impulsivity (TOH; time/move) | 3.1 (1.3) | 3.6 (1.3) | 3.8 (1.5) | 168.7; <i>df</i> =160; <i>p</i> =.30 |
| Impulsivity (Eysenck Impulsivity Subscale) | 5.7 (3.3) | 6.6 (3.8) | 6.6 (3.7) | 18.6; <i>df</i> =28; <i>p</i> =.91 |
| Risk-Taking Propensity (BART; adjusted average pumps) | 28.5 (12.0) | 28.6 (9.1) | 29.7 (10.7) | 207.3; <i>df</i> =210; <i>p</i> =.54 |
| College Student Risk Behavior Measure | 1.7 (1.8) | 2.3 (1.7) | 1.9 (1.2) | 19.3; <i>df</i> =16; <i>p</i> =.25 |
| | 18 years old n = 48 | 19 years old n = 27 | 20 years old n = 35 | |

Table 24 - continued

| | 18 years old Mean | | 19 years old Mean | | 20 years old Mean | | Chi Square |
|---|--|-------------|--|----|--|----|------------------|
| | Frequency (%) | | Frequency (%) | | Frequency (%) | | |
| | Yes | No | Yes | No | Yes | No | |
| 1. I smoked a cigarette (even a puff). | 6 (13%) | 42 (87%) | 7 (26%) (74%) | 20 | 8 (23%) (77%) | 27 | 2.5; df=2; p=.29 |
| 2. I drank alcohol (even a drink). | 16 (33%) | 32 (67%) | 15 (56%) (44%) | 12 | 19 (54%) (46%) | 16 | 5.1; df=2; p=.08 |
| 3. I used an illegal drug (even once). | 3 (6%) | 45 (94%) | 1 (4%) (96%) | 26 | 0 (100%) | 35 | 2.3; df=2; p=.32 |
| 4. I had sexual intercourse without a condom. | 10 (21%) | 38 (79%) | 10 (37%) (63%) | 17 | 9 (26%) (74%) | 26 | 2.3; df=2; p=.31 |
| | 18 years old n = 48 Frequency (%) | | 19 years old n = 27 Frequency (%) | | 20 years old n = 35 Frequency (%) | | Chi Square |
| | Yes | No | Yes | No | Yes | No | |
| 5. I rode in a car without wearing my seatbelt (even once). | 27 (56%) | 21 (44%) | 13 (48%) (52%) | 14 | 19 (54%) (46%) | 16 | .47; df=2; p=.79 |
| 6. I drove a car without wearing my seatbelt (even once). | 8 (17%) | 40 (83%) | 7 (26%) (74%) | 20 | 6 (17%) (83%) | 29 | 1.1; df=2; p=.58 |
| 7. I rode in a car with a person driving under the influence (even once). | 9 (19%) | 39 (81%) | 6 (22%) (78%) | 21 | 5 (14%) (86%) | 30 | .66; df=2; p=.72 |
| 8. I drove a car while under the influence (even once). | 4 (8%) | 44 (92%) | 2 (7%) (93%) | 25 | 2 (6%) (94%) | 33 | .21; df=2; p=.90 |

Table 25. Study Measure Descriptives Based on Gender

| | Male Mean (SD) | | Female Mean (SD) | | Chi Square |
|--|---|-------------|---|-------------|--------------------------------------|
| Public Religiosity | 10.4 (2.9) | | 11.2 (2.6) | | 14.2; <i>df</i> =11; <i>p</i> =.22 |
| Private Religiosity | 13.5 (4.3) | | 14.1 (3.8) | | 16.6; <i>df</i> =12; <i>p</i> =.17 |
| Impulsivity (TOH; time/move) | 2.7 (1.0) | | 3.6 sec (1.4) | | 76.1; <i>df</i> =80; <i>p</i> =.60 |
| Impulsivity (Eysenck Impulsivity Subscale) | 7.6 (3.5) | | 5.8 (3.5) | | 26.6; <i>df</i> =14; <i>p</i> =.02* |
| Risk-Taking Propensity (BART; adjusted average pumps) | 32.4 (11.4) | | 27.9 (10.5) | | 104.1; <i>df</i> =105; <i>p</i> =.51 |
| College Student Risk Behavior Measure | 2.1 (1.6) | | 1.9 (1.6) | | 5.7; <i>df</i> =8; <i>p</i> =.68 |
| | Male <i>n</i> = 24 Frequency (%) | | Female <i>n</i> = 86 Frequency (%) | | |
| | Yes | No | Yes | No | |
| 1. I smoked a cigarette (even a puff). | 6 (25%) | 18 (75%) | 15 (17%) | 71 (83%) | .69; <i>df</i> =1; <i>p</i> = .41 |
| | Male <i>n</i> = 24 Frequency (%) | | Female <i>n</i> = 86 Frequency (%) | | |
| | Yes | No | Yes | No | |
| 2. I drank alcohol (even a drink). | 10 (42%) | 14 (58%) | 40 (47%) | 46 (53%) | .18; <i>df</i> =1; <i>p</i> =.67 |
| 3. I used an illegal drug (even once). | 1 (4%) | 23 (96%) | 3 (4%) (96%) | 83 | .03; <i>df</i> =1; <i>p</i> =.88 |
| 4. I had sexual intercourse without a condom. | 5 (21%) | 19 (79%) | 24 (28%) | 62 (72%) | .48; <i>df</i> =1; <i>p</i> =.49 |
| 5. I rode in a car without wearing my seatbelt (even once). | 15 (63%) | 9 (37%) | 44 (51%) | 42 (49%) | .97; <i>df</i> =1; <i>p</i> =.33 |
| 6. I drove a car without wearing my seatbelt (even | 5 (21%) | 19 (79%) | 16 (19%) | 70 (81%) | .06; <i>df</i> =1; <i>p</i> =.81 |

Table 25 - continued

| | Male Mean (SD) | | Female Mean (SD) | | Chi Square |
|---|-------------------|-------------|---------------------|-------------|----------------------------------|
| once). | | | | | |
| 7. I rode in a car with a person driving under the influence (even once). | 6 (25%) | 18 (75%) | 14 (16%) | 72 (84%) | .96; <i>df</i> =1; <i>p</i> =.33 |
| 8. I drove a car while under the influence (even once). | 2 (8%) | 22 (92%) | 6 (7%) | 80 (93%) | .05; <i>df</i> =1; <i>p</i> =.82 |

* Significant differences between male and females ($p < .05$)

Regression Assumptions

Normal distribution. The determination of skewness (skewness ratio $\geq \pm 2.0$) of all study measures, was calculated by dividing the skewness statistic by its standard error value (Table 22). Though the distribution of scores is not skewed, the measure of public religiosity (Extrinsic subscale) cannot be entered into the regression equation due to its poor reliability. Tabachnick and Fidell (2007) stress that regression analysis assumes error-free measurement of all independent variables; one way to minimize measurement error is to enter only reliable variables into the equation. The measure of private religiosity is negatively skewed (-3.2) due to the high mean scores; though the Intrinsic subscale was psychometrically sound. With both logarithmic and square root transformations of the private religiosity variable, skewness remained unchanged, -5.1 and -4.1, respectively. Private religiosity, untransformed, was included in the regression analysis.

The TOH time/move scores and the College Student Risk Behavior Measure exhibit significant skewness, but these measures cannot be entered into the regression equation because of poor reliability statistics. Scores from the Eysenck Impulsivity Subscale and BART (adjusted average pumps) are not skewed and both measures have proven reliability. In addition, to answer the research questions through regression

analyses, the remaining three independent variables (age, gender, and Greek affiliation) were analyzed for skewness (Table 26). Age, as an independent variable, is not skewed. Both gender and Greek affiliation are nominal variables and via “dummy coding” were converted into analyzable variables for parametric analysis. Gender was coded as 1 for male and 0 for female; Greek affiliation was coded as 1 for Yes and 0 for No. Both of these values are positively skewed since there were more females than males and more non-Greek affiliated college students in the study sample. Though positively skewed (6.0), gender, as an untransformed nominal variable, was added into the regression equation. Because of the very small percentage of Greek member representation and high degree of skewness, Greek affiliation was not added into regression equation. To assess the impact of skewed variables into the regression analysis, standardized residuals were examined for skewness, linearity, and homoscedasticity.

In addition, Shapiro-Wilk *W* tests were performed on all study variables, since this test is described as the most reliable test for non-normality in studies with small to medium-sized samples (StatsDirect Limited, 2009; Table 27). A significant *p* value provides evidence for a non-normal distribution. As noted in Table 27, scores on BART, the dependent variable, obtained nonsignificance on the Shapiro-Wilk’s *W* test—suggesting normally distributed scores. The four independent study variables achieved significant *p* values and are described as having non-normal distributions. Thus, the private religiosity variable, untransformed and transformed, is skewed with a significant *W*. The variables, age and impulsivity, are not skewed but obtained significant *W*s. Gender is skewed with a significant *W*. Decisions were made to include the four independent variables (age, gender, private religiosity, Eysenck Impulsivity Subscale scores as impulsivity) into regression analysis because Dawson and Trapp (2004) state

that “regression is a robust procedure and may be used in many situations in which the assumptions are not met, as long as the measurements are fairly reliable” (p.206).

Table 26. Skewness Measures of Age, Gender, and Greek Affiliation
N = 110

| | Skewness Ratio |
|-------------------|----------------|
| Age | 1.0 |
| Gender | 6.0 |
| Greek Affiliation | 17.3 |

Table 27. Shapiro-Wilk's W Test of Normality on Study Measures

| | Statistic | df | Significance (<i>p</i>) |
|-------------------------------------|-----------|-----|---------------------------|
| Age | .762 | 110 | .000 |
| Gender | .513 | 110 | .000 |
| Greek Affiliation | .240 | 110 | .000 |
| Private Religiosity (untransformed) | .877 | 110 | .000 |
| Transformed via log | .187 | 110 | .000 |
| Transformed via sqrt | .180 | 110 | .000 |
| Public Religiosity | .965 | 110 | .006 |
| Eysenck (Impulsivity) | .959 | 108 | .002 |
| TOH (Impulsivity) | .921 | 110 | .000 |
| Risk Behavior Measure | .899 | 110 | .000 |
| BART | .986 | 110 | .344 |

Multicollinearity. Pearson product moment coefficients (*r*) were calculated for all independent variables (Table 28). These variables avoid multicollinearity, are not interrelated, and meet the assumption for regression analysis. All correlations are weak, although the correlation between gender and impulsivity is significant ($p = .05$). Multicollinearity is considered a threat in multiple regression analysis when $r \geq .80$.

Table 28. Correlations between Independent Study Variables

| Study Variable | 1 | 2 | 3 | 4 | 5 |
|--------------------------|---|-------|-------|-------|-------|
| 1. Age | - | -.030 | .173 | .056 | .112 |
| 2. Gender | | - | -.127 | -.067 | .208* |
| 3. Greek Affiliation | | | - | .107 | .043 |
| 4. Private Religiosity | | | | - | -.032 |
| 5. Impulsivity (Eysenck) | | | | | - |

* $p = .05$

Study Results

Research Question #1 (revised): Are private religiosity, impulsivity, age, and gender, strongly and significantly associated with risk-taking propensity? Which variable(s) are the most strongly associated with risk-taking propensity?

For this question, a standard simultaneous variable entry multiple regression was performed with the following predictors/independent variables: age, gender, private religiosity, and impulsivity. Risk-taking propensity was entered as the dependent variable. The multiple linear regression statistics are presented in Table 29. Multiple regression analyses revealed no significant predictors of risk-taking propensity. The model R^2 was .04, indicating that age, gender, private religiosity, and impulsivity accounted for 4% of the variance in risk-taking propensity.

Table 29. Research Question #1 Multiple Regression Statistics

| Model 1 | <i>b</i> | SE | β | <i>p</i> | R | R^2 | SEE |
|---------------------------|----------|-------|---------|----------|-----|-------|-------|
| Constant (Y intercept) | 19.29 | 23.35 | | .41 | | | |
| Age | .47 | 1.24 | .04 | .71 | | | |
| Gender | 3.95 | 2.59 | .15 | .13 | | | |
| Private Religiosity | -.12 | .27 | -.04 | .66 | | | |
| Impulsivity | .27 | .31 | .09 | .87 | | | |
| | | | | | .20 | .04 | 10.93 |

b = Unstandardized regression coefficient beta

SE = Standard error of unstandardized regression coefficient beta

β = Standardized regression coefficient

p = Significance level

R = Correlation between X and (Y) risk-taking propensity

R^2 = R square

SEE = Standard Error of the Estimate

Post-regression analyses of standardized residuals were performed for normality, linearity, and homoscedasticity. The standardized residuals were normally distributed, evidenced by obtained skewness ratio of 2.1. As seen in Figure 11, the residuals have a straight-line (linear) relationship with the dependent variable. Even with the skewed

values ($> \pm 2.0$) for gender and private religiosity, the assumption of homoscedasticity was met as noted by the approximately equal spread of the residuals at almost all values of the dependent variable, risk-taking propensity.

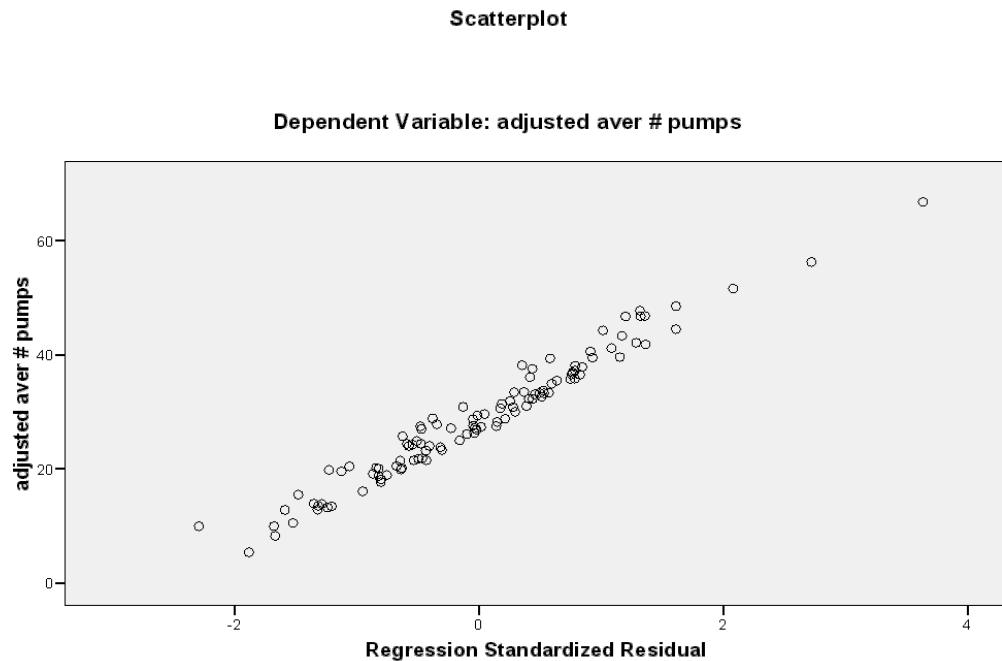


Figure 11. Evaluation of Standardized Residuals for Normality, Linearity, and Homoscedasticity

Research Question #3: Does the relationship of impulsivity to risk-taking propensity significantly strengthen or weaken when level of private religiosity changes?

To evaluate a potential interaction between private religiosity and impulsivity, multiple regression was used to analyze and interpret a two-way interaction between private religiosity and impulsivity. In this regression equation: Y (Risk-Taking Propensity) = a (constant) + $\beta_1(X_1 \text{ Private Religiosity}) + \beta_2(X_2 \text{ Impulsivity}) + \beta_3(X_1 \text{ Private Religiosity} * X_2 \text{ Impulsivity})$, the interaction is written as the product of the first two betas (β). β_3 is interpreted as the

amount of change in the slope of the regression of Y (Risk-Taking Propensity) on X₂ (Impulsivity) when X₁ (Private Religiosity) changes. An interaction variable is significant when the association between Impulsivity and Risk-Taking Propensity changes whenever Private Religiosity changes.

To set up this interaction variable, the variables of Private Religiosity and Impulsivity were centered by subtracting the mean from each variable and obtaining deviation scores. The interaction variable was created by multiplying the centered Private Religiosity variable with the centered Impulsivity variable. To assess for normal distribution of the independent variables, the skewness ratios (Table 30; skewness statistic/standard error) and Shapiro-Wilk W tests were calculated. The centered Impulsivity and interaction variables were not skewed, but the centered Private Religiosity variable was slightly negatively skewed. All three centered and interaction variables obtained nonsignificant Ws, indicating normal distribution. Multicollinearity was avoided

Table 30. Skewness of Centered and Interaction Variables

| Variable | Skewness |
|---|----------|
| Centered Private Religiosity | -3.13 |
| Centered Impulsivity | 1.45 |
| Centered Private Religiosity* Centered Impulsivity | .20 |

since all independent variables (centered and interaction) were poorly correlated with each other (Table 31). Then, the two centered and one interaction variables were entered

Table 31. Correlations Between Centered and Interaction Variables

| | Centered Private Religiosity | Centered Impulsivity | Centered Private Religiosity * Centered Impulsivity |
|------------------------------|------------------------------|----------------------|---|
| Centered Private Religiosity | | -.036 | -.109 |
| Centered Impulsivity | | | -.149 |

into multiple regression and results were analyzed for significance (Table 32). The interaction variable was not significant, indicating that the association of impulsivity on risk-taking propensity did not significantly change whenever levels of private religiosity changed.

Table 32. Multiple Regression of Interaction Between Private Religiosity and Impulsivity

| Model 1 | <i>b</i> | SE | β | <i>p</i> | R | R ² | SEE |
|--|----------|------|---------|----------|------|----------------|-------|
| 1 Constant (Y intercept) | 28.93 | 1.06 | | .00 | | | |
| Centered Private Religiosity (X ₁) | -.12 | .28 | -.04 | .67 | | | |
| Centered Impulsivity (X ₂) | .40 | .30 | .13 | .19 | | | |
| Interaction (X ₁ *X ₁) | .04 | .08 | .05 | .59 | | | |
| | | | | | .141 | .02 | 10.99 |

b = Unstandardized regression coefficient beta
 SE = Standard error of unstandardized regression coefficient beta
 β = Standardized regression coefficient
 R = Correlation between X and (Y) risk-taking propensity
 R² = R square
 SEE = Standard Error of the Estimate
p = Significance level

Post-hoc power analysis. The study sample size of 110 participants was based on an a priori power analysis of: (1) a probability level of .05, (2) 8 predictors, (3) medium R square of .15, and (4) a power level of .8 (Table 12). Post-hoc power analysis, with a probability level of .05, 4 predictors, 110 participants, and an observed model R square of .04, resulted in an observed power of .36 (Soper, 2009c). Based on the post-hoc power analysis, 301 participants would be needed to achieve adequate power and a chance of producing statistically significant relationships between variables, if they existed (Tabachnick & Fidell, 2007; Soper 2009b). For this study, however, even if significance were found, the four predictors would still only explain 4% of the variance in risk-taking propensity.

Chapter Summary

Study sample characteristics include: (1) a greater percentage of 18 year old participants (44%) than 19 or 20 year olds; (2) predominantly more female participants (78%) than males; (3) more right-handed participants (93%); (4) more students in their freshman year (46%); (5) racially and ethnically diverse study sample; (6) very few Greek-affiliated members; and (7) most students (90%) with reported GPAs between 3.0 and 4.0. Greek affiliation was removed as an independent variable due to very low numbers of participants ($n = 6$; all female) who were members of fraternities or sororities. Age (18, 19, or 20 years old) and gender (male or female) were included as independent variables in regression analysis.

Psychometric analyses of study measures were performed on all study measures. The Intrinsic subscale of the AUROS-12 as the measure for private religiosity, the Eysenck Impulsivity Subscale, and the BART, as the risk-taking propensity dependent variable, obtained strong internal consistency reliability alphas. The Extrinsic subscale of the AUROS-12, the measure for public religiosity did not achieve reliability. Public religiosity, as an independent variable, was removed from the regression equation for both Research Questions #1 and #2. The one-time TOH performance, used as a behavioral measure of impulsivity, was not entered into the regression analysis because reliability of this measure could not be established for this study. The reported Cronbach's Alpha for TOH is .90 (Humes et al., 1997); however, this was calculated based on 11 serial performances on the TOH and each performance was dichotomously scored as one item.

Statistically significant construct validity was obtained between the Intrinsic (private religiosity) and Extrinsic (public religiosity) subscales of the AUROS-12, denoting that the two subscales do measure different constructs of religiosity. Convergent validity

was not established between scores on the Eysenck Impulsivity Subscale and the time/move ratios of the TOH. Concurrent (predictive) validity was not demonstrated between scores on BART and individual items on the Risk Behavior Measure.

Based on study measure scores, the study participants exhibited: (1) high mean scores on private religiosity, (2) less time per move on the TOH than adults, (3) low mean scores on the Eysenck Impulsivity Subscale, (4) low average balloon inflations on the BART, and (5) an average of two risk behaviors over the past 30 days. The most frequent reported risk behaviors were drinking alcohol and riding in a car without seat belts. Male students reported significantly higher impulsivity scores than females and 20 year old students reported the highest alcohol use.

Evaluations of all reliable study variables were performed for normal distribution, multicollinearity, and homoscedasticity. Except for reported non-normal distributions based on the Shapiro-Wilk W test, no other study assumptions were violated and no variables were transformed prior to entry into regression analysis. Multiple regression analysis was used to answer Research Question #1. Private religiosity, impulsivity, age, and gender were entered into regression as independent variables with risk-taking propensity as the dependent variable. No significant predictors of risk-taking propensity were found. These four variables accounted for only 4% of the total variance in risk-taking propensity. Research Question #2 was not answered because the public religiosity measure, the Extrinsic subscale of the AUROS-12, was found unreliable for this study. Research Question #3 addressed the potential interaction between private religiosity and impulsivity. Multiple regression using centered and interaction variables showed no significant interaction between the two variables. Based on a post hoc power analysis, even if statistical significance was achieved, the four independent study variables would still have accounted for only a very small percentage of risk-taking propensity.

CHAPTER 5

DISCUSSION

The study results obtained from the statistical analyses, sample descriptives, and psychometric analyses are further discussed in a broader perspective. All major findings from the study are interpreted in light of current research and publications. Limitations of the study are presented with their meanings for the interpretation of study results. The study's conclusion statements answer the question of "so what?" for current or future researchers of adolescents. The implications of working with, teaching to, or researching about older adolescents such as college students, are discussed within a professional nursing context. Finally, specific recommendations are provided for additional research on college students.

Interpretation of Major Findings

Research Question #1 (revised): Are private religiosity, impulsivity, age, and gender strongly and significantly associated with risk-taking propensity? Which variable(s) are the most strongly associated with risk-taking propensity?

From this study's findings, private religiosity, impulsivity, age, and gender were shown to minimally contribute to the comprehensive view of college student risk-taking propensity. The results from the study measures describe an average college student living away from home who is female and approximately 19 years old with high private religiosity, low impulsivity, and moderate risk-taking propensity. Over 50% of the participants, regardless of age and gender, reported drinking alcohol and riding in a car without seatbelts.

The results suggest that private religiosity, for male or female college students (18 to 20 years old), is not as strong a protective factor on late adolescent risk-taking as literature describes. In a systematic review of adolescent religiosity literature by Rew and Wong (2006), evidence supports the protective effects of religiosity on adolescent health behaviors; but Wills et al. (2003) caution that the mechanism of its effects are unclear. The weak relationship, in this study, between private religiosity and risk-taking propensity may be explained by Smith (2003) who hypothesizes that adolescent religiosity may not significantly buffer or protect an adolescent when strong competing influences overwhelm the moral code that was shaped by their religious involvement. In this study, “competing influences” could include being a college student and living away from home. Galen and Rogers (2004) obtained different results in their study of mainly female 19 year old college students. In their study, private religiosity attained a strong inverse relationship with alcohol consumption. The researchers purport that private religiosity promotes the “instillation” of negative beliefs and expectations of alcohol use, especially if drinking alcohol is not proscribed by their religious affiliation (Galen & Rogers).

More females (n =86) participated in this study than male college students (n = 24); but males had significantly higher impulsivity scores on The Eysenck Impulsivity Subscale [$\chi^2(14) = 26.64, p = .02$]. While most females (70%) scored between 0 and 7 (out of 19 total points), 50% of the male college students scored between 8 and 14 points. The study results regarding gender and impulsivity are supported by neuroimaging findings that the steep upward curve of prefrontal cortex (PFC) myelination occurs earlier in females than males (Giedd, 2004; Paus et al., 1999; Powell, 2006). Myelination, as increased PFC white matter, speeds neural processing in a more focused pattern demonstrated behaviorally as lower impulsivity and improved planning and response inhibition (Fields & Stevens-Graham, 2002). Impulsivity, as an independent

variable entered into this study's regression analysis, however, reflected more the female college students' lower scores in its contribution to risk-taking propensity.

Considering that an average of 64 balloon pumps is needed to maximize monetary earnings on the Balloon Analogue Risk Task (TASK), this study's college student participants pumped an average of almost 30 (28.9, SD 10.6) pumps. Only one student exceeded 64 balloon pumps; while one averaged only five balloon pumps. Though not statistically significant, males and 20 year old college students had higher risk propensity scores than females and 18 or 19 years old college students. These scores closely reflect the scores obtained on undergraduate students (18 to 25 years old) who participated in the initial administration of BART (Lejuez et al., 2002). In this first evaluation of BART, male college students scored higher (30.5, SD 10.1) than female undergraduates (25.0, SD 9.6). In a study with college age smokers and nonsmokers, Lejuez et al. (2003b) reported average BART scores of 33.0 (SD 14.7).

In this study, the two most frequently reported risk behaviors were drinking alcohol and riding in a car without seat belts. The students were all below the legally sanctioned age of 21 to drink; but over 55% of all respondent answered "yes" to drinking alcohol in the last 30 days. Males and females, both equally drank, but a higher percentage of 19 and 20 year old college students than 18 years olds drank alcohol. A possible reason for the lower "yes" responses to alcohol use by 18 year olds may be the timing of the study—within the first month of their first college semester and living away from home. Asked about their alcohol use in the past 30 days, 33% of the 18 year old college freshmen responded positively. This percentage exceeds previous research findings stating that approximately 20% of all college freshmen begin drinking during their freshman year (Lindsay, 2006). It is unknown, in this study sample, if positive responses

were over-reported, if these students drank alcohol prior to entering college, or if they were heavy or binge drinkers.

In this study, 54% of all participants acknowledged that they rode in a car without wearing seat belts in the last 30 days. Though not significantly different between age and gender, more males (63% vs. 51% females) reported not wearing seat belts. Thirty percent of all deaths among 10 to 24 year old Americans result from automobile accidents (Eaton et al., 2008). In a State of Rhode Island study on high school and college students, the primary reason to not use seat belts is when travelling a short distance. Reasons given to increase seat belt usage included knowledge of someone involved in a crash and fear of getting a ticket (Berman, 2005). A study on college students by Raynor and Levine (2009) may explain the low rates of seat belt use in this study sample. The researchers have linked the personality trait of conscientiousness with increased incidence of seat belt use and decreased incidence of smoking cigarettes, alcohol consumption, and binge drinking. Conscientiousness is defined as thorough decision-making, delayed immediate gratification, and long-term planning of health goals (Raynor & Levine). This definition presupposes prefrontal maturity and the strength of executive cognitive functions. College students, still in late adolescence, may not exhibit conscientiousness until completed myelination of the PFC. The larger percentage of males not wearing seat belts may be explained by the later male brain myelination of the PFC, even into the fourth decade of life (Bartzokis et al., 2001; Powell, 2006).

These findings suggest a broader focus on and measurement of more factors that are associated with college student vulnerability or propensity to risk behaviors. The National Longitudinal Study on Adolescent Health (Add Health), with its initial 1994 to 1995 sample size of 90,000 adolescents in grades seven through twelve, included numerous measures of family and school contexts, and individual characteristics

(Resnick et al., 1997). Add Health researchers surveyed social, economic, psychological, and physical variables, and collected health data on family, neighborhood, community, school, friendships, peer groups, and romantic relationships. The conceptual framework for this study, a synthesis of the Cognitive-Motivational Theory, Social Development Model, and the Fuzzy-Trace Theory, grounded the selection of variables in the neurobiological, cognitive, and socio-emotional correlates of risk behavior. As the answer to this research question suggests, late adolescent or college student risk-taking propensity is associated with more than PFC immaturity (impulsivity), a strong pro-social belief system (private religiosity), age, or gender. Concurring, Cleveland et al. (2008) assert that adolescent risk behavior, or tendencies toward risk, should be explained as diverse domains of risk and protective influences. These influences not only stem from genetic, psychological, and social determinants; rather domains of influences must be examined through individual, family, peers, school, and community factors.

Research Question #2: Does the relationship of impulsivity to risk-taking propensity significantly strengthen or weaken when level of public religiosity changes?

Research Question #2 could not be addressed because of the unreliability of the six-item extrinsic subscale of the Age Universal Religious Orientation Scale-12 (AUROS-12) for this study sample of college students. This subscale did not achieve an acceptable reliability coefficient of greater than .70 and was removed from Research Questions #1 and #2. Internal consistency reliability represents “the consistency of performance of one group of individuals across the items on a single measure” (Waltz et al., 2005, p. 140). In a 2000 study of 230 first-year undergraduate students, Zaleski and Schiaffino also obtained a low internal consistency reliability of .61 (this study’s alpha was .597) for the extrinsic public religiosity subscale. One hypothesis for the poor reliability of this subscale is that the items referred to church involvement, religious activity

participation, and other externalized behaviors. The extrinsic subscale of the AUROS-12 mainly elicits responses about the perceived benefits derived from going to church: (1) helps me make friends, (2) gain relief and protection, (3) comfort in times of trouble and sorrow, (4) peace and happiness, (5) spend time with friends, and (6) enjoy seeing people I know there (Appendix C). Fowler (1981) states that late adolescence is a period when religious beliefs, even religious affiliations, initially regress during the early years of college when they are in a new unconstrained a-parental environment. For this study's sample, the low reliability of the subscale may reflect the transitioning nature of students' moral development from a more public form of religiosity into a more personalized and internalized set of religious values (private religiosity).

Another hypothesis for the low reliability statistic is the small number (6) of items in this subscale. Waltz et al. (2005) state that reliability of a measure increases when more items are added. The original Religious Orientation Scale, prior to revisions by Gorsuch and Venable (1983) and Maltby and Lewis (1996), was a 20-item subscale with 11 items on the extrinsic subscale and nine items of the intrinsic subscale.

Research Questions #2 was included in the study design to describe a potential interaction between impulsivity and public religiosity based on a 2009 neuroimaging study by Kapogiannis et al. The researchers discovered that adoption or rejection of religious beliefs is correlated with the level of cognitive interaction between the PFC and subcortical system. Though the interaction between public religiosity and impulsivity could not be addressed, the college students did report public religiosity with scores ranging from 6 to the maximum of 18 (mean of 11, SD 2.7). Though not significant, 18 and 20 year olds scored similarly on public religiosity; while 19 year olds scored slightly lower. The 18-year old college students had just been away from home for one month, possibly not enough time to show the "regression" from their parent-influenced public

religiosity that the lower scores may suggest in 19 year old college students in their second year of studies. To explain the higher public religiosity scores among this study's 20 year old and more experienced college students, Cherry et al. (2001) state that though religious affiliation, identity, and attendance may be minimized during the early years of college, they are not rejected. Females also scored slightly higher than males but the difference was nonsignificant. Confirming this study's gender findings, Resnick et al. (1997) found that adolescent girls reported public religiosity variables (denomination and attendance at religious services) more frequently than boys; however, there was no correlation with the risk behaviors of smoking or binge drinking.

Research Question #3: Does the relationship of impulsivity to risk-taking propensity significantly strengthen or weaken when level of private religiosity changes?

In this study, religiosity was measured as two unrelated dimensions, public and private. The intrinsic (private religiosity) subscale of the AUROS-12 attained strong internal consistency reliability for this study population. This research question was asked because Wallace and Williams (1997) hypothesize that religiosity acts independently and interdependently with inner and outer adolescent influences impacting health, with impulsivity as an inner influence. With this study sample, the interaction between impulsivity and private religiosity was not significant, meaning there was no significant relationship between impulsivity and risk-taking propensity whenever the level of private religiosity changes. This finding differs from the findings of other researchers who purport that in late adolescence, as the prefrontal cortex matures and cognition is approaching formal operational thinking, private religiosity increases as adolescents are becoming attuned to their true selves (Cherry et al., 2001; Lau; Smithline, 2000).

On the intrinsic subscale of the AUROS-12, the college student participants reported high religiosity, a mean of 14 points out of a possible 18 total points. Though no

significant differences between age and gender were obtained, it is interesting to note that the highest average private religiosity scores were among 20 year olds. This supports the premise of the Continuum of Adolescent Spirituality Development (Figure 5; Lau, 2006): as an adolescent proceeds toward adulthood, religious beliefs are derived less from the religious institution, less from parent-influenced religious beliefs, and more from uniquely individual-generated beliefs.

Unanticipated Findings

The administration of BART to the college students prompted some unexpected findings. Upon completion of all study measures, a majority of students remained in the study room and inquired about the meaning of their performance on BART. During each BART performance, the researcher remained in the room, hidden from view of the participant, but able to listen to the audio of the measure. BART has specific sounds: (1) “clicking” for each balloon inflation, (2) “explosion” sound when balloon pops, (3) “slot machine jingle” each time money is transferred to the permanent bank, and (4) “applause” at the end of the game. Since the same researcher remained in the study room during all 110 performances, specific patterns of behavior were noted. For instance, some students, once a random balloon popped, would decrease the amount of inflations for the next few balloons; while others were not influenced by the balloon explosions and would continue the pace of balloon inflations. Some students would audibly voice fear or physically startle with a balloon explosion. Most students understood that BART tested their willingness to take chances, but wanted to understand what this meant to them personally. For those interested, the researcher explained that BART measured their natural inclination to take risks—whether they were more responsive to rewards (earning more money) or to the consequences (punishment of balloon popping and loss of money).

Though BART has been developed as a behavioral tool measuring risk-taking propensity, this study has demonstrated BART's potential as an individualized prevention/intervention mechanism for college students. Alluding to this type of use, Lejuez et al. (2005) states that "BART is precisely the type of measure that may support movement from one-size-fits-all prevention efforts toward culturally sensitive individualized prevention programs" (p. 78). The "one-size-fits-all" programs are grounded on the belief that knowledge of the dangers and consequences of risky behaviors will be adequate to inhibit risk taking (Evans, 1983; Parsons et al., 1997). Even with well-informed adolescents cognizant of health-promoting behaviors, they will exhibit risk behaviors (Greene, Krmar, Walters, Rubin, & Hale, 2000).

The college students' personal inquisitiveness about BART, its individual meaning about them, and its potential use in risk behavior prevention may be explained by the emergence of "egocentrism" during the transition from concrete thinking to formal operational thought processes (Elkind, 1967). Egocentrism, in adolescents, is defined as the belief that your own thoughts are different than others or that others are probably preoccupied with you just as much as you are preoccupied with yourself. In a study examining risk-taking behaviors of 187 college students (17 to 20 years old), Parsons et al. (1997) found that perceived personal benefits were significantly predictive of behavioral intentions—the ability to think rationally and make well-informed decisions; behavioral intentions were predictive of future risk-taking behavior. In a related study, McElwee and Dunning (2005) found that images of the self in future situations, "the possible self" ("me as risky," "me as wealthy," etc.) explains their social judgments which reflect their belief about themselves. If this is the case, then BART, as an individualized prevention strategy, could alert the student's "possible self" of the level of their own natural risk-taking propensity. Future research on the use of BART as a risk prevention

strategy is warranted since Omori and Ingersoll (2005) state that egocentrism is responsible for risky behaviors and targeting egocentrism could prevent the development of risk behavior engagement.

Second, based on the adolescent vulnerability equation of *reward-seeking* (overactive nucleus accumbens [NA_c] + *impulsivity* (immature prefrontal cortex [PFC]) = *risk-taking propensity*, it was expected that college students younger than the mid-twenties, as older adolescents, would exhibit higher BART scores on risk-taking propensity than scores obtained in this study. The lower scores of this sampling of college students, however, may be explained by “regionally specific” neural changes found to occur during the first year of college. Bennett and Baird (2006) scanned the brains of 19 first-year college students (mean 18.6 years) twice at six-month intervals. From baseline to six months, significant myelination, increased white matter, was found in five brain regions inclusive of the prefrontal cortex. Increased myelination is associated with faster neural processing, better coordination and integration of neural pathways across brain regions, and improved functional maturity of cognitive and behavioral processes (Bennett & Baird). Though no comparison group of non-college students were scanned, the researchers have hypothesized that the increased white matter and neural connectivity in college students may be the result of “environmental provocation,” suggesting a dynamic and environmentally sensitive brain structure. “The transition from adolescence to adulthood is rife with social and emotional challenges that require cognitive skills to interpret and respond to increasingly complex environmental demands” (Bennett & Baird, p. 774). Attending college, living away from home, and adjusting to a new environment may contribute to the increased neural changes (increased PFC myelination) associated with emotional integration and behavioral regulation. Future

neuroimaging research on non-college older adolescents is needed to assess differences in myelination and risk-taking propensity.

Third, one possible hypothesis for the surprising very weak correlation between the TOH and the Eysenck Impulsivity Subscale is that the TOH behaviorally may measure more executive cognitive functions than the self-report impulsivity questionnaire. Executive cognitive functions consist of decision-making, planning ability, attention control, response inhibition, delayed gratification, and emotional regulation (Steinberg, 2008; Welsh & Huizinga, 2001). The 19 items from the Eysenck Impulsivity Subscale refer mainly to impulsivity or the inability to plan ahead such as : (1) thinking carefully before doing, (2) doing without thinking, (3) speaking without thinking, (4) use of self-control, (5) work quickly without checking, and (5) make up mind quickly, as some examples (Appendix D). TOH may be a more global behavioral measure of executive cognitive functions and impulsivity, or response inhibition, is but one part of the TOH (Welsh & Huizinga). Examining only one PFC correlate of executive cognitive function, impulsivity, may also explain the low mean scores on the self-report impulsivity questionnaire in this current study. PFC maturity levels are expressed as more than impulsivity, including decision-making, planning, emotional control, working memory, and attention control. In addition, following Bennett and Baird's (2006) proposition of "environmental provocation," the college students' experiences of living away from home and/or attending college may have stimulated increased PFC myelination, thus, less reported impulsivity.

Limitations

First, the correlational cross-sectional research design limited the generalizability and interpretation of the study's findings. This was not an experimental design and no causal inferences can be proven from relationships among the variables (Simon &

Francis, 2001). Data on all of the study variables were collected at a single point in time, representing a “snippet of time” in college students (18, 19, or 20 years old) who live away from home. One hazard of cross-sectional correlational study designs is that uncontrolled variables could possibly blend into each individual participant’s circumstances (Filopovitch, 2005). To more fully examine the importance of age, gender, religiosity, impulsivity, and Greek affiliation to college student risk-taking propensity, a longitudinal research design should be considered. Because of the proposed environmental impact of college on PFC maturity, a longitudinal study following freshmen students through the ensuing college years would be most appropriate in order to study risk-taking propensity.

Second, the timing of data collection for the 18 year old college students may have been a limitation. After IRB approval was obtained, data collection began in the summer when 19 and 20 year olds were either attending summer school or continuing to live off-campus. When the Fall semester began, 18 year old freshmen students were recruited; but these study participants experienced only one to four weeks of college life away from home. Thus, scores on the behavioral or self-report measures may have reflected their experiences more at home than a college student in a novel environment. In future studies, researchers should be cognizant of how much time students have been involved in college experiences.

Third, though it is illegal to drink alcohol before the age of 21, it may have been just as important to measure the level of binge drinking in underage college students (more than four drinks on one occasion for females and more than five drinks at one time for males). Drinking alcohol (even a sip) was the most frequent reported risk behavior across all three age groups in this study sample. The National Institute on Alcohol Abuse and Alcoholism (NIAAA) reported that from 1998 until 2005, engagement in binge

drinking among 18 to 24 year old college students increased from 42% to 45% (Mitka, 2009). Future research should include questions on binge drinking for all ages of college students.

Fourth, though the study population was racially and ethnically diverse, the geographic region of the public university study site might have affected the obtained scores on the AUROS-12 subscales of public and private religiosity. This part of the southwestern United States is commonly labeled as “The Bible Belt.” Geographic region might have influenced religiosity scores. Future research on college student religiosity should be conducted in different regions of the United States to discern any existence of differences in geographic influences.

Fifth, the use of self-report measures is a well-documented limitation in adolescent research due to social desirability bias and over- or under-reporting of behaviors whether for the religiosity, impulsivity, or risk behavior measures (Aklin et al., 2005). This may have contributed to the weak concurrent validity between individual item scores on the risk behavior measure and BART scores. This limitation relates to the concerns of Aklin et al. that adolescents may worry about confidentiality or perceived personal negative consequences—though all study participants read in the Informed Consent and were each personally told that all answers are confidential and not traced back to them. In addition, Brener et al. (2003) surmised that adolescents may consider the status of certain risk behaviors and over-report alcohol or drug use, sexual behaviors, and perceived less risky behaviors, like seat belt use, as safe to report. Though behavioral measures are most desirable, researchers must ensure that behavioral measures actually define operationally the desired study variable.

Sixth, in this study, results from the Tower of Hanoi (TOH) as a behavioral measure, could not be used as the impulsivity variable due to methodological difficulties.

The protocol to use the TOH, as a one-time performance measure, was based on a 2005 research study examining cognitive markers of adolescent risk-taking in comparison groups of adolescent substance abusers in residential programs and Air Force Junior ROTC high schoolers (Rosser et al., 2005). No reliability data was reported for the Rosser et al. study. The TOH, however, has established internal consistency reliability of .91 (Humes et al., 1997); a later TOH-Revised measure achieved a Cronbach's alpha of .77 (Welsh & Huizinga, 2001). None of these reliability coefficients were based on a one-time performance of the TOH (M. C. Welsh, personal communication, August 13, 2009). Humes et al. required participants to complete 11 different scenarios of different starting disk states—all ending in a tower. Welsh and Huizinga redesigned the TOH and created 22 different scenarios—not all with tower-ending states. Reliability was obtained from correct or incorrect scores on each scenario item. In addition, prior to the beginning of data collection, a criterion cut score mean time/move was obtained from eleven middle-aged adults for comparison with college student ratios of time/move on the TOH. The ratio of mean time/move was established as an operational definition of impulsivity—faster time than the adult criterion score. Dr. Marilyn C. Welsh, involved in the development of TOH's reliability statistics, states that:

a faster move per time might just be faster speed of processing (a good thing, and clearly college students do have faster speed of processing), rather than impulsivity...Fast move times would be more likely to reflect impulsivity if they were the wrong moves, but if they were fast and accurate, wouldn't this reflect faster speed of processing (M. C. Welsh, personal communication, August 13, 2009)?

Welsh and Huizinga (2001) propose that the TOH measures a range of PFC-related executive cognitive functions: planning ability, working memory, and response inhibition.

This may be one reason why the correlation between the TOH time/move scores and scores from the Eysenck Impulsivity Subscale was so weak—they do not measure the same concepts.

The seventh study limitation relates to this study's inability to measure religiosity as a multi-dimensional variable. Only private religiosity was analyzed in its contribution to college student risk-taking propensity because of the poor internal consistency reliability of the public religiosity subscale of the AUROS-12. Unreliability may be related to the small number of items on the subscale or the possible insignificance of the public religiosity dimension in the neurocognitive development of college students as late adolescents. More effort is needed to examine other religiosity measurement tools and even consider administering instruments measuring "spirituality" to college students to assess their growth toward the development of spirituality.

The final study limitation was the very minimal recruitment of college students from sororities and fraternities. Timing of the study may have been a factor in low recruitment; since members may not have lived on campus during the summer or the beginning of the Fall semester may have been too early for Chapter Presidents to meet with their members for study recruitment. Four of the Chapter Presidents stated that all of their members were over the age of 21. In systematic literature review of 33 articles published from 1984 to 2003, the researchers found that:

Compared with their non-Greek peers, findings suggest that fraternity and sorority members are a subgroup of college-aged individuals who consume alcohol in greater quantities, underscore and misperceive the risk associated with their alcohol abuse, and emulate a social environment and culture in which drinking alcohol is a key part of life (Barry, 2007, p. 312).

Thus, inclusion of sorority and fraternity members is vital to studies on college student risk-taking, particularly alcohol consumption. In this study, it is unknown whether timing of recruitment and data collection was a factor or if there were some hesitancy or sensitivity to participation in research concerned with health promoting behaviors. Barry emphasizes that Greek members are a notably different subculture.

Conclusion

In analyzing factors that contribute to college student risk-taking propensity, study results support a broader focus on identification and measurement of meaningful predictors beyond age, gender, religiosity, and impulsivity. The study supports the need to examine Greek-affiliation among college students, executive cognitive functions (in addition to impulsivity), and types of residences whether living away or at home. The lower scores on BART by the study sample and recent neuroimaging research on college student brains propose a link between a positive environmental neural challenge and increasing myelination in the PFCs of college students, correlated to the development of executive cognitive functions. The role of BART as a potential individualized prevention intervention was an unexpected result from the use of BART as a behavioral measure during data collection.

Implications for Nursing

Nursing Practice

From the findings of this study, the most important point for practicing nurses to know is that the older adolescent brain is still developing, described by Herrman (2005) as a “work in progress.” Though college students are physically mature and legally considered adults at age 18, the adolescent college student remains a concrete thinker though progressing toward abstract or formal operational thinking parallels the development of the PFC and its associated executive cognitive functions. When planning

care, treatments, or interventions, the nurse needs to be aware of the competitive and dynamic interplay between an assertive limbic system (a reward-seeking socioemotional neural network) and the immature PFC, the cognitive control network (Drevets & Raichle, 1998). College students do have the ability to cognitively weigh the risks and benefits of risk behaviors; but choices are based on emotions and immediate social consequences (Beyth-Marom et al., 1993; Millstein & Halpern-Felsher, 2002). Reward-seeking may be evidenced by: (1) going with friends rather than returning for a follow-up clinic appointment, (2) not refilling a prescription and using the money to go out with friends, or (3) noncompliance with medications or treatments because they feel different than their school friends.

Registered nurses and nurse practitioners in all health care settings accessed by college students are the obvious first-responders for prevention or intervention needs. Nurses are in key positions to communicate appropriately with students by applying neurobiological developmental theory and encouraging their positive strengths (Herrman, 2005).

From this study, college students were found to be extremely interested in what the study results said about them personally. Rather than offering programs on the cognitive only level (knowledge or information), nurses can be innovative in individual-focused care plans that attend to the adolescent's own needs and emotional cues. In addition, peers that offer pro-social influences such as peer mentors, may re-direct reward-seeking into health-promoting activities (Catalano et al., 1996). It is especially important for nurses to be patient and caring, as well as to role model "confrontations as learning experiences rather than power struggles" (Herrman, 2005, p. 147).

Nursing Education

From this study and the literature review, college students are motivated to learn, not by passive information transfer, but through innovative active teaching/learning strategies. Motivation can be defined as a powerful force within individuals that drive people to satisfy their perceived needs and personal goals (Cole, 1993; Mullins, 1996). Reward-seeking, a neurobiological correlate of the adolescent limbic system, fuels the motivation behind behavior (Ernst & Mueller, 1996). Therefore, nurse educators must utilize active and motivational strategies that positively employ the natural inclination of reward-seeking among traditional nursing students in college. For instance, faculty could occasionally substitute small group work among peers or presentations of case studies for lecture. These learning activities begin with concrete facts and employ faculty-modeled examples of inductive critical thinking. In clinical settings, pre- and post-conference gatherings could be “dens of critical thinking,” where students, feeling very vulnerable with their level of critical thinking, could feel safe and comfortable to practice higher level thinking skills (Murphy, 2006). Bennett and Baird (2006) found that increased PFC white matter and neural interconnectivity is promoted by the “environmental provocation” caused by challenging college experiences. Nurse educators are encouraged to become “provocateurs” of PFC development by innovative active learning and promotion of repetitive critical thinking opportunities starting from concrete to the “big picture.”

Nurse educators are also on the front-line of assessing their students’ risk behaviors. Alcohol consumption was the most frequent risk behavior reported in this study. Nursing faculty should be aware of referral resources at the university or within the local community for any nursing students who are identified with alcohol problems (Marion, Fuller, Johnson, Michels, & Diniz, 1996). In addition, concepts of adolescent

neurobiology and the developmental trajectories of the cortical and subcortical systems could be integrated into the pediatric nursing curriculum. Discussing adolescent vulnerabilities to risk behaviors could fulfill two goals: (1) the students will better understand the adolescent population and (2) traditional nursing students can gain personalized information about their own vulnerabilities.

Nursing Research

One important lesson learned in this study was the issue of college student recruitment. Of the 123 students recruited for the study, 13 did not show for their appointment time. It is curious that these 13 students were recruited in face-to-face contacts with the researcher. One hypothesis is that the students did not feel comfortable to say “no” in front of the “adult” researcher; but really meant “no” and chose not to come. Knowles (1980) states that older adolescents, in their transition to adulthood, may experience difficulty in asserting a self-directed personal identity in front of an adult. Other reasons may be that face-to-face recruitment could appear too forceful and coercive, since no trust or social relationship had previously been initiated or possibly another more attractive activity came along at the same time. Successful recruitment, however, came from classroom recruitment, posted flyers, and word-of-mouth between peers. Because peer influence is an important motivator of adolescent behavior, a couple of students who completed the study, posted the study flier on their Facebook page, a social networking site. Future researchers may want to include in their IRB proposals, college student recruitment via Facebook. When one student posted the study flyer on Facebook, ten students responded and completed the study. Facebook may be an alternative method of recruitment; since the Pew Internet study reports that 75% of college students have Facebook accounts (Richardson, 2007).

All college students who participated in this study received a \$10 gift card upon completion of the study. The researcher received several calls and emails from students who wanted to participate in the study because of the gift card. A \$10 gift card was an attractive motivator for college students and some financial compensation should be considered for college student study participation.

Recommendations for Additional Research

Based on the findings from the study, the following research studies are recommended:

1. Replication of this current study examining the risk-taking propensity among college students who live at home with their parents; as well as on older college students (23 to 25 years old) living away or at home.
2. Longitudinal study of college students, from freshman year onward, with a larger sample size, to examine the multiple factors relating to individual, family, peers, school, and community.
3. Psychometric analysis study of the TOH using the Welsh and Huizinga's (2001) multiple performance guidelines.
4. Neuroimaging research on college students who live at home or away from home to assess difference in PFC myelination rates and risk-taking propensity.
5. Qualitative research study of adolescents who complete 30 BART balloon trials and receive individualized results of their performance; evaluate the effectiveness of BART as an individualized risk behavior prevention strategy and assess what college students perceive as risky behaviors.
6. Intervention study using BART as a teaching strategy against binge drinking in college targeting the "egocentric" characteristics of college students.

7. A replication of this research study of college students from different geographical regions of the United States who both live away and at home.
8. Comparison study with samples of non-college students matched by age and living accommodations with college student sample.
9. Add a male and female binge drinking question to the College Student Risk Behavior Measure.
10. Employ stronger recruitment efforts to include more Greek-affiliated college students in future research.

Chapter Summary

The findings from this study on college student risk-taking propensity clearly advocate for a broader investigation of contributors to risk behaviors of late adolescents.

Their reasoning and decision-making processes are therefore not only a simple reflection of their cognitive abilities, but also their emotional, social, and physical situation. Importantly, adolescence needs to be viewed as another step on the road to executive mastery, rather than the end point of executive development (De Luca & Leventer, 2008, p. 36).

The findings from this study demonstrated that single stand-alone variables such as age, gender, private religiosity, and impulsivity nominally contribute, in a small way, to college student risk-taking. Ford and Coleman (1999) purport that the unique developmental period of adolescence is characterized by an “interplay of neuropsychological maturation, environmental stimulation, environmental responsiveness, and constant cognitive reorganization” (p. 72).

Though nonsignificant, males and 20 year old college students had higher risk propensity scores on BART; suggesting a connection between gender, age, and risk propensity. The use of BART among college students introduced a potential interactive

educational prevention strategy. This study's college students (18, 19, or 20 years old) did report drinking alcohol and riding in a car without seat belts as the most frequent risk behaviors. In this study, age (being 19 or 20 years old), not gender, described alcohol use in the past 30 days. Regarding the use of seat belts when riding in a car, gender (males) was linked to the least use of seat belts.

Based on adolescent moral development, it was not surprising that the public religiosity subscale was unreliable for this study sample. College students tend to stray away from traditional religious institutional involvement (Fowler, 1981). Females did score higher on public religiosity, as well as 18 and 20 year olds. The higher scores on private religiosity by 20 year olds support the developmental neurocognitive links between attaining formal operational thinking and transitioning from inner religiosity to spirituality (Lau, 2006).

Though scores on the TOH were not entered into regression analyses to answer each research question, important lessons were learned for future use of the behavioral tool: (1) protocol to use the TOH will be linked to the methods used to establish TOH's reliability, and (2) need identified to re-expand the conceptual definition of what the TOH measures from solely impulsivity to a broader range of executive cognitive functions. Males scored significantly higher on The Eysenck Impulsivity Subscale. This confirmed previous neuroimaging research that females had a faster rate of PFC myelination than males (Bartzokis et al., 2001; Powell, 2006).

Study limitations include the correlational cross-sectional research design, the timing of the data collection, the missing item of binge drinking on the College Student Risk Behavior Measure, and the specific geographic study setting. Other study limitations reflected the difficulties found in using self-report and behavioral measures in the older

adolescent population and the minimal recruitment of Greek-affiliated college students despite strong recruitment efforts.

Implications for nursing practice, education, and research were delineated with the common theme of understanding the links between adolescent neurodevelopment, the reward-seeking component of adolescent motivation, and their related behaviors. It is essential for nurses, educators, and researchers to understand the importance of personalized individually-planned prevention/intervention programs, teaching strategies, as well as recruitment strategies or compensation plans for research.

Several recommendations were offered for future research on college students including indications for study replication on college students living at home, longitudinal studies, further psychometric analyses on behavioral measures, neuroimaging research, qualitative research, and intervention research studies using BART. In addition, suggestions were made to strengthen items of the College Student Risk Behavior Measure, as well as recruitment efforts for Greek-affiliated college students.

APPENDIX A
PARTICIPANT RECRUITMENT SCRIPT AND FLYER

My name is Mary Cazzell. I am a nurse and a doctoral student in the School of Nursing here at the University. I have been a Pediatric Nurse for almost 30 years and have worked with premature infants up through adolescents. I am currently recruiting participants for my dissertation research study. I am interested in college students, ages 18 to 20 years of age, who live away from home, in dorms, apartments, rental houses, or sorority or fraternity houses—not with their parents. Also, if you have been diagnosed with ADHD/ADD and are currently taking medications for this, you are eligible to participate in this study.

I am examining the roles of a college student's normal brain development and their belief system and how these are associated with health-related tendencies. If you agree to participate in this study, you can expect to complete an informed consent form explaining the study and your participation, four brief paper-and-pencil forms, and two computer games. Your total time investment is approximately 30 minutes. Complete confidentiality will be assured—no identifying information will be on the forms. Upon completion of your participation, you will receive a \$10 gift card from local merchant. Please sign up on the form and you will receive further details via telephone or email.

Doctoral Dissertation Study

Who: Looking for College Students between the ages of 18 to 20 years old who live away from home—not with your parents. [Will discuss inclusionary criteria of current medication use with ADHD/ADD diagnosis during first phone or email recruitment contact.]

What: Researching the relationships between college student's normal brain development, belief systems, and health-related tendencies

Time requirement: Approximately 30 minutes to complete an informed consent form, 4 brief paper-and-pencil forms, and 2 computer games.

All participants will receive a \$10 gift card from local merchant upon completion of study participation

Please email Mary Cazzell at mary.cazzell@mavs.uta.edu or call at 972-998-3559 for more information or to sign-up.

APPENDIX B

DEMOGRAPHIC VARIABLE FORM

Please answer each item completely as it relates to you.

1. Age 18 19 20

2. Gender M F

3. Handedness Right-handed Left-handed

4. Level in School Freshman Sophomore Junior Senior

5. Race/Ethnicity White/Caucasian Hispanic African American Asian
 International American Indian Other

6. Are you a member of a fraternity or sorority on campus? Yes No

7. GPA < 2.0 2.0 – 2.5 > 2.5 – 3.0 > 3.0 – 3.5 > 3.5 - 4.0

APPENDIX C
RELIGIOSITY MEASURES

Age-Universal Religious Orientation Scale-12

Think about each item carefully. Does the attitude or behavior described in the statement apply to me?
 I appreciate as a researcher that people have different words for similar concepts across religions and I have tried to make allowances for that.

| | No (1) | Not Certain (2) | Yes (3) |
|---|--------------------------|--------------------------|--------------------------|
| 1. I enjoy reading about my religion..... (Intrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. I go to church (place of worship) because it helps me make friends..... (Extrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. It is important to me to spend time in private thought and prayers..... (Intrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. I have often had a strong sense of (my) God's presence..... (Intrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. I pray mainly to gain relief and protection.. (Extrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I try hard to live all my life according to my religious beliefs..... (Intrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. What religion offers me most is comfort in times of trouble and sorrow..... (Extrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. My religion is important because it answers many questions about the meaning of life... (Intrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Prayer is for peace and happiness..... (Extrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. I go to church (place of worship) mostly to spend time with my friends..... (Extrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. My whole approach to life is based on my religion..... (Intrinsic) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. I go to church (place of worship) mainly because I enjoy seeing people | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

I know there (Extrinsic).....

Letter from Author

RE: Further questions regarding AUROS-12

Hi sorry Mary

This is always a difficult problem. I have no direct advice.

I would change the word's Church to place of worship and God, to my God's. I usually also then in the introduction give some general guidance that you appreciate as a researcher that people have different words for similar concepts across religions and you have tried to make allowances for that.

John

From: Cazzell, Mary A [mary.cazzell@mavs.uta.edu]
Sent: 19 March 2009 15:57
To: Maltby, Dr J.
Subject: RE: Further questions regarding AUROS-12

Dr. Maltby,

I had sent the email below last night, but I received a blank email from your email address and will try once more to see if it arrives and if you will have an opportunity to address my questions about your measure.

Thank you for your continued assistance in my research endeavors.

Sincerely,
Mary Cazzell

Hello Dr. Maltby (again!),

I am proceeding along and will defend my dissertation proposal soon. However, one of my committee members was concerned about the use of AUROS-12 in non-Christians since our university has students from many diverse nations and faiths. Have you administered this tool in populations other than Christians? My committee member was concerned that the term "church" in a few of the items was "Christ-centric." I have read that your tool (AUROS-12) can be administered to religious and non-religious; but does this also mean Christians and non-Christians (Hindu, Buddhists, Muslims, Jewish, etc.)? I would be so appreciative of your guidance or direction in this matter,

Mary Cazzell, RN, BSN, PhD Student
University of Texas at Arlington School of Nursing

RE: Permission to use Age Universal I-E scale-12

Maltby, Dr J. [jm148@leicester.ac.uk]

Sent: Wednesday, February 25, 2009 2:25 PM

To: Cazzell, Mary A

Hi Mary

There scale is in the public domain so no reason to ask for permission. the scale is on this page <http://www.le.ac.uk/pc/jm148/>
Good luck with the research

John

From: Cazzell, Mary A [mary.cazzell@mavs.uta.edu]
Sent: 25 February 2009 04:46
To: jm148@le.ac.uk
Subject: Re: Permission to use Age Universal I-E scale-12

Dear Dr. Maltby,

My name is Mary Cazzell, a doctoral student in nursing at the University of Texas at Arlington (United States) and I am currently in dissertation phase writing my chapter on Methodology and Procedure and after much literature review, would like to use the revised Age-Universal I-E scale-12 for one of my measures. I am seeking your permission to use your tool and would like a copy of the measure along with clear directions of which questions are Intrinsic and Extrinsic and for scoring. I have found psychometric data on this tool in the literature.

My study investigates college students (ages 18-20) who live away from parents and I am looking for relationships between public (extrinsic) and private (intrinsic) religiosity and impulsivity (as a neurobiological correlate of prefrontal cortex) on risk taking propensity. I am examining levels of public and private religiosity as protective factors of risk-taking propensity and using impulsivity as a mediating variable looking for the interaction between the religiosity and impulsivity and looking for the variances that account for risk-taking propensity. I have conceptualized religiosity on a developmental continuum that culminates in spirituality in adulthood. My definition of adulthood is when the prefrontal cortex is mature (~mid-twenties), when formal operational thought is apparent, and when the individual is able to achieve spirituality.

I am seeking your permission to use this tool for my dissertation research. I also would like to obtain this measure from you to use or if you could direct me to where I could find it. I appreciate all of the diverse research you have carried out in your career. Thank you for your time and attention to my request,
Mary Cazzell, RN, BSN, PhD Student
University of Texas at Arlington School of Nursing
Arlington, TX, USA

APPENDIX D
IMPULSIVITY MEASURES

Tower of Hanoi Instructions for Participants

The object of this game is to move all of the rings from the first column (peg) to the third column (peg). **The rings can only be moved one by one and a larger ring cannot be placed on top of a smaller ring,** You must click once to grab the ring and you also must click once on the ring to release it onto another peg. You will have 5 minutes to complete this game. When you are ready, please click on OK, the timer will start, and you can begin the game.

The Eysenck Impulsivity Subscale

Directions: Please answer each question by putting a circle around the “YES” or the “NO” following the question. There are no right or wrong answers, and no trick questions. Work quickly and do not think too long about the exact meaning of the question (Miksza, 2007).

PLEASE REMEMBER TO ANSWER EACH QUESTION

- | | | |
|--|-----|----|
| 1. Do you often buy things on impulse? | YES | NO |
| 2. Do you generally do and say things without stopping to think? | YES | NO |
| 3. Do you often run into problems because you do things without thinking? | YES | NO |
| 4. Are you an impulsive person? | YES | NO |
| 5. Do you usually think carefully before doing anything? **Reverse scored** | YES | NO |
| 6. Do you often do things on the spur of the moment? | YES | NO |
| 7. Do you mostly speak without thinking things out? | YES | NO |
| 8. Do you often get involved in things you later wish you could get out of? | YES | NO |
| 9. Do you get so ‘carried away’ by new and exciting ideas that you never think of possible problems? | YES | NO |
| 10. Do you need to use a lot of self-control to keep yourself out of trouble? | YES | NO |
| 11. Would you agree that almost everything enjoyable is illegal or immoral? | YES | NO |
| 12. Are you often surprised at people’s reactions to what you do or say? | YES | NO |
| 13. Do you think an evening out is more successful if it is unplanned or arranged at the last moment rather than planned in advance? | YES | NO |
| 14. Do you usually work quickly without bothering to check? | YES | NO |
| 15. Do you often change your interests? | YES | NO |
| 16. Before making up your mind, do you consider all the advantages and disadvantages? | YES | NO |

****Reverse scored****

- | | | |
|---|-----|----|
| 17. Do you prefer to 'sleep on it' before making large decisions? | YES | NO |
| ***Reverse scored** | | |
| 18. When people shout at you, do you shout back? | YES | NO |
| 19. Do you usually make up your mind quickly? | YES | NO |

APPENDIX E
RISK BEHAVIOR MEASURES

Instructions for Balloon Analogue Risk Task

On the screen you will see a blue balloon. You can click on the button labeled "Click this Button to Pump Up the Balloon" to increase the size of the balloon. You will accumulate money in a temporary bank for each pump. You will get 5 cents for each pump. You will not be shown the amount of money accumulated in your temporary bank. At any point, you can stop pumping up the balloon and click on the button labeled "Collect \$ \$ \$." Clicking this button will start you on the next balloon and will move all the money from the temporary bank to your permanent bank labeled "Total Earned." It is your choice to determine how much to pump up the balloon, but be aware that at some point the balloon will explode. You never know when the balloon will explode, but it could occur on the first pump ranging to enough pumps to make the balloon fill the entire computer screen. If the balloon explodes before you click on "Collect \$ \$ \$," then you move on to the next balloon and all the money in your temporary bank is lost. Exploded balloons do not affect the money in your permanent bank. In total there will be 30 balloons. Good luck! (Hopko et al., 2006, pp.97-98).

Self-Report College Student Risk Behavior Measure

Please circle YES or NO based on your participation in these behaviors over the **past 30 days**.

- | | | |
|---|-----|----|
| 1. I smoked a cigarette (even a puff)..... | YES | NO |
| 2. I drank alcohol (even one drink)..... | YES | NO |
| 3. I used an illegal drug (even once)..... | YES | NO |
| 4. I had sexual intercourse without a condom (even once)..... | YES | NO |
| 5. I rode in a car without wearing my seatbelt (even once)..... | YES | NO |
| 6. I drove a car without wearing my seatbelt (even once)..... | YES | NO |
| 7. I rode in a car with a person driving under the influence (even once)... | YES | NO |
| 8. I drove a car while under the influence (even once)..... | YES | NO |

APPENDIX F
FORMS GIVEN TO CONTENT SPECIALISTS

Behavioral Objectives Guiding Construction of 8-Item Self-Report College Student Risk Behavior Measure

1. The measure applies findings from literature review that late adolescence, over 18 years but less than 25 years, is a time period of increased likelihood to “binge drink, smoke cigarettes, have casual sex partners, engage in violent and other criminal behaviors, and have fatal or serious automobile accidents, the majority of which are caused by risky driving or driving under the influence of alcohol” (Steinberg, 2008, p. 79).

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review, 28*, 78-106.

2. The measure identifies morbidity statistical information of risk behavior engagement from the 2007 Youth Risk Behavior Survey (9th through 12th graders):

75% of high school students had ever drunk alcohol,...47.8% of students had ever had sexual intercourse, 35% of high school students were currently sexually active, and 38.5% of currently sexually active high school students had not used a condom during last sexual intercourse,...20% had smoked cigarettes,...29.1% of high school students had ridden in a car or other vehicle driven by someone who had been drinking, 18% had carried a weapon,...11.1% had never or rarely worn a seat belt when riding in a car driven by someone else (Eaton et al., 2008, p.1).

Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., Hawkins, J. et al. (2008). Youth Risk Behavior Surveillance—United States, 2007. *Morbidity & Mortality Weekly Report, 57*(SS-4), 1-131.

3. This measure, modified from the Youth Risk Behavior Surveillance System measure (Brener et al., 2004) which determines health-risk behaviors among high schoolers, applies current knowledge of college student (18 to 21 years old) risk behaviors: smoking cigarettes, binge drinking, casual sex with multiple partners, automobile accidents due to risky driving or driving under the influence, and substance use (Ellison, Bradshaw, Rote, Storch, & Trevino, 2008; Pascarella & Terenzini, 2005).

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: Evidence from the scientific literature. *Journal of Adolescent Health, 33*, 436-457.

Ellison, C. G., Bradshaw, M., Rote, S., Storch, J., & Trevino, M. (2008). Religion and alcohol use among college students: Exploring the role of domain-specific religious salience. *The Journal of Drug Issues, 38*(3), 821-846.

Pascarella, E. T. & Terenzini, P. T. (2005). *How college affects students: A third decade of research* (Vol. 2). San Francisco: Jossey-Bass.

4. This measure utilizes the same risk behavior consideration used by other researchers (Lejuez et al., 2003; Lejuez, Aklin, Bornovalova, & Moolchan, 2005)—the identification of risk behavior is a differentiation between ever- and never-engagement.

Lejuez, C. W., Aklin, W. M., Jones, H. A., Richards, J. B., Strong, D. R., Kahler, C. W. et al. (2003). The Balloon Analogue Risk Task (BART) differentiates smokers and nonsmokers. *Experimental and Clinical Psychopharmacology, 11*(1), 26-33.

Lejuez, C. W., Aklin, W. M., Bornovalova, M. A., & Moolchan, E. T. (2005). Differences in risk-taking propensity across inner-city adolescent every-and never-smokers. *Nicotine & Tobacco Research, 7*(1), 71-79.

Definition of Terms

1. Adolescence--Adolescence is a transitional developmental period between childhood and adulthood when biological, psychological, and social role changes result in independence acquisition, separation from protection of family with increased opportunities for harmful consequences (Feldman & Elliott, 1990; Kelley, Schochet, & Landry, 2004).

Feldman, S. S. & Elliott, G. R. (1990). *At the threshold: The developing adolescent*. Cambridge, MA: Harvard University Press.

Kelley, A. E., Schochet, T., & Landry, C. (2004). Risk-taking and novelty-seeking in adolescence: Introduction to Part I. *Annals of the New York Academy of Sciences, 1021*, 27-32.

2. Risk Behavior—The functional developmental goals of peer acceptance and respect, autonomy from parents, rejection of conventional norms and values, and transition out of childhood (Jessor, 1991)

Jessor, R. (1991). Risk behavior in adolescence: A psychosocial framework for understanding and action. *Journal of Adolescent Health, 12*, 597-605.

3. Under the influence—After drinking alcohol or using an illegal drug.

Item-Relevancy Rating Scale for the Self-Report College Student Risk Behavior Measure

Instructions:

Please rate the relevance of each item separately to the objectives of the Self-Report College Student Risk Behavior Measure. Each item is to be rated using the 4-point rating scale from “not relevant,” “somewhat relevant,” “quite relevant,” or “very relevant.”

Please place an X in one box only. You will need to double click inside appropriate box to place X.

| | Not Relevant | Somewhat Relevant | Quite Relevant | Very Relevant |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. I smoked a cigarette (even a puff) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. I drank alcohol (even one drink) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. I used an illegal drug (even once) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. I had sexual intercourse without a condom (even once) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. I rode in a car without wearing my seatbelt (even once) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I drove a car without wearing my seatbelt (even once) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. I rode in a car with a person driving under the influence (even once) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. I drove a car while under the influence (even once) Comments: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

APPENDIX G
RANDOMIZED ORDERING OF THE STUDY MEASURES FOR ALL STUDY
PARTICIPANTS

Randomized Ordering of the Study Measures for All Study Participants

| Legend |
|---|
| 1. Age-Universal Religious Orientation Scale-12 |
| 2. The Eysenck Impulsivity Subscale |
| 3. Tower of Hanoi |
| 4. Balloon Analogue Risk Task |
| 5. Risk Behavior Self-Report Measure |

| Participant # | Random Ordering | Participant # | Random Ordering |
|---------------|-----------------|---------------|-----------------|
| 1 | 1 5 4 2 3 | 41 | 4 1 2 5 3 |
| 2 | 4 5 2 3 1 | 42 | 4 3 1 5 2 |
| 3 | 2 1 5 4 3 | 43 | 4 5 3 2 1 |
| 4 | 4 2 1 5 3 | 44 | 1 5 2 3 4 |
| 5 | 3 4 2 5 1 | 45 | 1 5 3 4 2 |
| 6 | 3 2 4 1 5 | 46 | 3 4 5 1 2 |
| 7 | 2 5 4 3 1 | 47 | 4 5 1 3 2 |
| 8 | 5 1 3 4 2 | 48 | 4 5 3 2 1 |
| 9 | 5 2 3 4 1 | 49 | 5 1 3 2 4 |
| 10 | 3 5 1 2 4 | 50 | 2 4 3 5 1 |
| 11 | 5 3 1 2 4 | 51 | 4 2 1 3 5 |
| 12 | 1 2 4 3 5 | 52 | 3 2 4 1 5 |
| 13 | 1 5 2 3 4 | 53 | 4 1 2 3 5 |
| 14 | 2 1 5 3 4 | 54 | 1 2 4 5 3 |
| 15 | 4 2 5 3 1 | 55 | 4 2 1 5 3 |
| 16 | 3 2 1 4 5 | 56 | 5 3 4 1 2 |
| 17 | 3 2 5 4 1 | 57 | 1 5 4 2 3 |
| 18 | 1 4 2 5 3 | 58 | 4 3 2 5 1 |
| 19 | 2 4 3 1 5 | 59 | 2 3 1 4 5 |
| 20 | 4 1 2 5 3 | 60 | 2 3 1 4 5 |
| 21 | 2 4 3 5 1 | 61 | 3 2 5 4 1 |
| 22 | 1 5 2 4 3 | 62 | 5 1 2 4 3 |
| 23 | 4 5 1 3 2 | 63 | 4 3 5 1 2 |
| 24 | 3 5 2 4 1 | 64 | 5 2 1 3 4 |
| 25 | 4 1 5 2 3 | 65 | 3 4 5 2 1 |
| 26 | 3 5 1 4 2 | 66 | 4 2 3 5 1 |
| 27 | 2 3 1 5 4 | 67 | 5 1 3 4 2 |
| 28 | 1 4 2 3 5 | 68 | 1 5 4 3 2 |
| 29 | 5 2 1 3 4 | 69 | 1 4 3 2 5 |
| 30 | 1 4 2 5 3 | 70 | 2 3 5 1 4 |
| 31 | 3 1 5 4 2 | 71 | 1 2 5 3 4 |
| 32 | 1 3 2 5 4 | 72 | 5 2 1 4 3 |
| 33 | 5 2 3 1 4 | 73 | 1 2 3 4 5 |
| 34 | 5 4 3 2 1 | 74 | 3 4 2 1 5 |
| 35 | 1 4 5 2 3 | 75 | 2 4 3 5 1 |
| 36 | 5 3 2 4 1 | 76 | 4 3 1 2 5 |
| 37 | 1 3 5 4 2 | 77 | 4 3 2 5 1 |

| | | | |
|---------------|-----------------|---------------|-----------------|
| 38 | 2 4 3 1 5 | 78 | 5 3 1 4 2 |
| 39 | 5 4 3 2 1 | 79 | 1 3 5 4 2 |
| 40 | 2 4 1 3 5 | 80 | 2 3 5 1 4 |
| Participant # | Random Ordering | Participant # | Random Ordering |
| 81 | 5 4 3 2 1 | 101 | 2 1 4 3 5 |
| 82 | 3 1 5 4 2 | 102 | 3 5 2 4 1 |
| 83 | 2 4 3 5 1 | 103 | 5 1 2 4 3 |
| 84 | 4 3 1 5 2 | 104 | 5 1 2 4 3 |
| 85 | 4 2 5 1 3 | 105 | 4 2 1 5 3 |
| 86 | 2 4 5 1 3 | 106 | 4 3 1 5 2 |
| 87 | 2 5 4 1 3 | 107 | 2 5 1 4 3 |
| 88 | 4 5 1 3 2 | 108 | 5 2 4 3 1 |
| 89 | 2 1 3 5 4 | 109 | 1 3 2 5 4 |
| 90 | 1 5 3 4 2 | 110 | 3 2 1 4 5 |
| 91 | 2 1 5 3 4 | | |
| 92 | 2 4 5 3 1 | | |
| 93 | 1 5 3 4 2 | | |
| 94 | 1 2 3 4 5 | | |
| 95 | 5 2 3 4 1 | | |
| 96 | 3 1 5 4 2 | | |
| 97 | 2 5 3 4 1 | | |
| 98 | 3 4 2 1 5 | | |
| 99 | 5 2 3 4 1 | | |
| 100 | 3 2 5 4 1 | | |

APPENDIX H
INFORMED CONSENT FORM



INFORMED CONSENT

PRINCIPAL INVESTIGATOR: Mary Cazzell, RN, BSN, PhD Candidate

TITLE OF PROJECT: College Student Risk Behavior: Implications of Religiosity and Impulsivity

INTRODUCTION:

This Informed Consent will explain about being a research participant in a research study. It is important that you read this material carefully and then decide if you wish to be a volunteer. Please ask questions if there is anything you do not understand.

PURPOSE:

The purpose of this research study is to examine the strength of relationships between two types of religiosity (public and private), impulsivity, and risk behaviors among college students. Understanding how strong the roles of a protective factor (religiosity) and a risk factor (impulsivity) play in college student risk behavior may add new insights into activities that could increase healthy behavior choices among college students.

DURATION:

You can expect to spend approximately thirty (30) minutes at the study site to complete your participation in the study.

PROCEDURES:

The procedures, which will involve you as a research participant, include: (1) completion of this informed consent form, (2) completion of a demographic (background) information form, (3) completion of a brief religiosity questionnaire, (4) completion of an impulsivity questionnaire, (5) completion of a brief risk behavior measure, and (5) performances on two (2) computerized task games. The order that you will perform the tests is randomized for each research subject.

POSSIBLE RISKS/DISCOMFORTS:

The possible risks and/or discomforts of your involvement include: mild fatigue or frustration related to the variety of forms, questionnaires, instructions, and

computer activities required for each research participant to complete this study. The researcher will ask the participant if a brief break is needed between study procedures. There will also be a left-hand mouse available to prevent any difficulties for left-handers.

PRINCIPAL INVESTIGATOR: Mary Cazzell, RN, BSN, PhD Candidate

TITLE OF PROJECT: College Student Risk Behavior: Implications of Impulsivity and Religiosity

POSSIBLE BENEFITS:

The possible benefits of your participation are: (1) gaining experience in the research process, (2) having an opportunity to receive the results from this study upon completion, and (3) adding new knowledge and insights into the study of college student health behaviors.

COMPENSATION:

Each study participant will receive a \$10 gift card from local merchants for their time and effort upon completion of their study participation.

ALTERNATIVE PROCEDURES / TREATMENTS:

There are no alternative procedures or treatments if you choose not to participate in this study.

WITHDRAWAL FROM THE STUDY:

You may discontinue participation at any time without penalty or loss of benefits, to which you are otherwise entitled.

NUMBER OF PARTICIPANTS:

We expect 110 participants to enroll in this study.

CONFIDENTIALITY:

Every attempt will be made to see that your study results are kept confidential. A copy of the records from this study will be stored in the Center for Nursing Scholarship & Technology for at least three (3) years after the end of this research. The results of this study may be published and/or presented at meetings without naming you as a subject. The data resulting from your participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data

will contain no identifying information that could associate you with it, or with your participation in any study. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the UTA IRB, and personnel particular to this research (Mary Cazzell) have access to the study records. Your student records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as noted above.

PRINCIPAL INVESTIGATOR: Mary Cazzell, RN, BSN, PhD Candidate

TITLE OF PROJECT: College Student Risk Behavior: Implications of Impulsivity and Religiosity

CONTACT FOR QUESTIONS:

If you have any questions, problems or research-related medical problems at any time, you may call Mary Cazzell at 972-998-3559, or Dr. Diane Snow at 817-272-2776. You may call the Chairman of the Institutional Review Board at 817-272-1235 for any questions you may have about your rights as a research subject.

VOLUNTARY PARTICIPATION:

Participation in this research study is voluntary. You may refuse to participate or quit at any time. If you quit or refuse to participate, the benefits to which you are otherwise entitled will not be affected. You may quit by calling Mary Cazzell, whose phone number is 972-998-3559.

PRINCIPAL INVESTIGATOR: Mary Cazzell, RN, BSN, PhD Candidate

TITLE OF PROJECT: College Student Risk Behavior: Implications of Impulsivity and Religiosity

By signing below, you confirm that you have read or had this document read to you. You will be given a signed copy of this informed consent document. You have been and will continue to be given the chance to ask questions and to discuss your participation with the investigator.

You freely and voluntarily choose to be in this research project.

PRINCIPAL INVESTIGATOR:

DATE

SIGNATURE OF VOLUNTEER DATE

SIGNATURE OF PATIENT/LEGAL GUARDIAN (if applicable) DATE

SIGNATURE OF WITNESS (if applicable)

REFERENCES

- Abbott-Chapman, J. & Denholm, C. J. (1997). Adolescent risk taking and the romantic ethic—HIV/AIDS awareness among year 11 and 12 students. *Australian and New Zealand Journal of Sociology, 33*, 306-321.
- Abbott-Chapman, J. & Denholm, C. (2001). Adolescents' risk activities, risk hierarchies, and the influence of religiosity. *Journal of Youth Studies, 4*(3), 279-297.
- Acheampong, Y. A. & Bahr, J. B. (1986). Religion, family, and adolescent drug use. *Sociological Perspectives, 29*(1), 53-76.
- Adamczyk, A. (2008). The effects of religious contextual norms, structural constraints, and personal religiosity on abortion decisions. *Social Science Research, 37*, 657-672.
- Ahonniska, J., Ahonen, T., Aro, T., Tolvanen, A., & Lyytinen, H. (2000). Repeated assessment of the Tower of Hanoi test: Reliability and age effects. *Assessment, 7*, 297-310.
- Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckman (Eds.), *Action control from cognition to behavior*. Heidelberg: Springer.
- Aklin, W. M., Lejuez, C. W., Zvolensky, M. J., Kahler, C. W., & Gwadz, M. (2005). Evaluation of behavioral measures of risk taking propensity with inner city adolescents. *Behavior Research and Therapy, 43*, 215-228.
- Allport, G. W. & Ross, J. M. (1967). Personal religious orientation and prejudice. *Journal of Personality and Social Psychology, 5*(4), 432-443.
- Aman, C. J., Roberts, R. J., Jr., & Pennington, B. F. (1998). A neuropsychological examination of the underlying deficit in attention deficit hyperactivity disorder: Frontal lobe versus right parietal lobe theories. *Developmental Psychology, 34*, 956-969.

- American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (1999). *Standards for Educational and Psychological Testing*. Washington DC: American Educational Research Association.
- Ames, S. L. & McBride, C. (2006). Translating genetics, cognitive science, and other basic science research findings into applications for prevention. *Evaluation & the Health Professions, 29*(3), 277-301.
- Anderson, P. J. (2008). Toward a developmental model of executive function. In V. Anderson, R. Jacobs, & P. J. Anderson (Eds.), *Executive functions and the frontal lobes: A lifespan perspective* (pp. 3-21). New York: Psychology Press.
- Anderson, S. W., Bechara, A., Damasio, H., Tranel, D. & Damasio, A. R. (1999). Impairment of social and moral behavior related to early damage in human prefrontal cortex. *Nature Neuroscience, 99*(2), 1032-1037.
- Armitage, C. J. & Connor, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*, 471-499.
- Arnett, J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review, 12*, 339-373.
- Arnett, J. (1994). Sensation-seeking: A new conceptualization and a new scale. *Personality and Individual Differences, 16*, 289-296.
- Arnett, J. (1996). Sensation seeking, aggressiveness, and adolescent reckless behavior. *Personality and Individual Differences, 20*(6), 693-702.
- Arnold, L. E., Zametkin, A., Caravella, L., & Korbly, N. (2000). Ethical issues in neuroimaging research with children. In M. Ernst & J. M. Rumsey (Eds., pp. 99-109), *Functional neuroimaging in child psychiatry*. Cambridge, UK: Cambridge University Press.

- Bahr, S. J. (1994). Religion and adolescent drug use: A comparison of Mormons and other religions. In M. Cornwall, T. B. Heaton, & L. A. Young (Eds.), *Contemporary Mormonism: Social science perspectives* (pp. 118-137). Chicago: University of Illinois Press.
- Baird, A., Fugelsong, J., & Bennett, C. (2005, April). "What were you thinking"? An fMRI study of adolescent decision-making. Poster presented at the 12th Annual Cognitive Neuroscience Society (CNS) Meeting, New York.
- Baird, A., Gruber, S., Fein, D., Maas, L., Steingard, R., Renshaw, P. et al. (1999). Functional magnetic resonance imaging of facial affect recognition in children and adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry*, 38, 195-199.
- Bardo, M. T., Donohew, R. L., & Harrington, N. G. (1996). Psychobiology of novelty seeking and drug seeking behavior. *Behavioural Brain Research*, 77(1-2), 23-43.
- Barratt, E. S. (1985). Impulsiveness defined within a systems model of personality. In C. D. Spielberger & J. N. Butcher (Eds.). *Advances in personality assessment* (Vol. 5, pp. 113-132). Hillsdale, NJ: Lawrence Erlbaum.
- Barry, A. E. (2007). Using theory-based constructs to explore the impact of Greek membership of alcohol-related beliefs and behaviors: A systematic literature review. *Journal of American College Health*, 56(3), 307-315.
- Bartlett, R., Holditch-Davis, D., Belyea, M., Halpern, C. T., & Beeber, L. (2006). Risk and protection in the development of problem behaviors in adolescents. *Research in Nursing & Health*, 29, 607-621.
- Bartzokis, G., Beckson, M., Lu, P. H., Nuechterlein, K. H., Edwards, N. & Mintz, J. (2001). Age-related changes in frontal and temporal lobe volumes in men: A magnetic resonance imaging study. *Archives of General Psychiatry*, 58, 461-465.
- Batson, C. D., Schoenrade, P., & Ventis, W. L. (1993). *Religion and the individual: A social-psychological perspective*. New York: Oxford University Press.

- Bechara, A. (2005). Decision-making, impulse control and loss of willpower to resist drugs: A neurocognitive perspective. *Nature Neuroscience*, 8, 1458-1463.
- Bechara, A., Tranel, D., & Damasio, H. (2000). Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. *Brain*, 123, 2189-2202.
- Beckwith, H. D. (2006). Risky behavior in college students: The influence of religiosity and spirituality. Psy.D. dissertation, Virginia Consortium for Professional Psychology (Old Dominion University), United States-Virginia. Retrieved July 27, 2008 from *Dissertations & Theses: Full Text database*. (Publication No. AAT3238923).
- Behrman, R. E., Kliegman, R. M., Jenson, H. B. (2004). *Nelson textbook of pediatrics* (17th ed.). Philadelphia: Saunders.
- Benda, B. B. & Corwyn, R. F. (2001). Are the effects of religion on crime mediated, moderated, and misrepresented by inappropriate measures? *Journal of Social Science Research*, 27(3), 57-86.
- Bennett, C. M. & Baird, A. A. (2006). Anatomical changes in the emerging adult brain: A voxel-based morphometry study. *Human Brain Mapping*, 27, 766-777.
- Benson, P. L., Roehlkepartain, E. C., & Rude, S. P. (2003). Spiritual development in childhood and adolescence: Toward a field of inquiry. *Applied Developmental Science*, 7(3), 205-213.
- Bergman, B. & Brismar, B. (1994). Hormone levels and personality traits in abusive and suicidal male alcoholics. *Alcoholism: Clinical and Experimental Research*, 18, 311-316.
- Berman, D. (2005). Motivating teens to buckle up. *Public Roads*, 69(1), 26-30.
- Berry, D. (2005). Methodological pitfalls in the study of religiosity and spirituality. *Western Journal of Nursing Research*, 27(5), 628-647.

- Beyth-Marom, R., Austin, L., Fischhoff, B., Palmgren, C., & Jacobs-Quadrel, M. (1993). Perceived consequences of risky behaviors: Adults and adolescents. *Developmental Psychology*, 29, 549-563.
- Beyth-Marom, R., & Fischhoff, B. (1997). Adolescents' decisions about risks: A cognitive perspective. In J. Schulenberg, J. L. Maggs, & K. Hurrelmann (Eds.), *Health risks and developmental transitions during adolescence* (pp.110-135). New York: Cambridge University Press.
- Bishop, D. V. M., Aamodt-Leeper, G., Creswell, C., McGurk, R., & Skuse, D. H. (2001). Individual differences in cognitive planning on the Tower of Hanoi task: Neuropsychological maturity or measurement error? *Journal of Child Psychology & Psychiatry*, 42(4), 551-556.
- Brand, S. & Opwis, K. (2007). Effects of mood and problem solving in dyads on transfer. *Swiss Journal of Psychology*, 66(1), 51-65.
- Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: Evidence from the scientific literature. *Journal of Adolescent Health*, 33, 436-457.
- Brener, N. D., Kann, L., Kinchen, S. A., Grunbaum, J. A., Whalen, L., Eaton, D. et al. (2004). Methodology of the Youth Risk Behavior Surveillance System. *Morbidity & Mortality Weekly Report*, 53(RR12), 1-13.
- Brener, N. D., Kann, L., McManus, T., Kinchen, S. A., Sundberg, E. C., & Ross, J. G. (2002). Reliability of the 1999 youth risk behavior survey questionnaire. *Journal of Adolescent Health*, 31(4), 336-342.
- Bronfenbrenner, U. (1974). Developmental research and public policy. In J. Romanshyn (Ed.), *Social science and social welfare* (pp. 159-182). New York: Council on Social Work Education.

- Bronfenbrenner, U. (1986). Ecology of the family as a context of human development: Research perspectives. *Developmental Psychology, 22*(6), 723-742.
- Bronfenbrenner, U. & Crouter, A. C. (1983). The evolution of environmental models in developmental research. In W. Kessen (Ed.), *History, theory, and methods*, Volume 1 of P. H. Mussen (Ed.), *Handbook of child psychology* (4th ed., pp. 357-414). New York: Wiley.
- Bunge, S., Dudukovic, N. M., Thomason, M. E., Vaidya, C. J., & Gabrieli, J. D. (2002). Immature frontal lobe contributions to cognitive control in children: Evidence from fMRI. *Neuron, 33*,301-311.
- Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 81-116). Hove, UK: Psychology Press.
- Burns, N. & Grove, S. K. (2005). *The practice of nursing research: Conduct, critique, and utilization* (5th ed.). St. Louis: Elsevier.
- Canivez, G. L., Neitzel, R., & Martin, B. E. (2005). Construct validity of the Kaufman Brief Intelligence Test, Wechsler Intelligence Scale for Children-Third Edition and Adjustment Scales for Children and Adolescents. *Journal of Psychoeducational Assessment, 23*, 15-34.
- Cantor, N. (1994). Life task problem solving: Situational affordances and personal needs. *Personality and Social Psychology Bulletin, 20*, 235-243.
- Cascio, C. J., Gerig, G., & Piven, J. (2007). Diffusion tensor imaging: Application to the study of the developing brain. *Journal of the American Academy of Child & Adolescent Psychiatry, 46*, 213-223.
- Casey, B. J., Castellanos, F. X., Giedd, J. N., Marsh, W. L., Hamburger, S. D., Schubert, A. B. et al. (1997). Implication of right frontostriatal circuitry in response inhibition and attention-

- deficit/hyperactivity disorder. *Journal of American Academy of Child and Adolescent Psychiatry*, 36, 374-383.
- Casey, B. J., Cohen, J. D., Jezzard, P., Turner, R., Noll, D. C., Trainor, R. J. et al. (1995). Activation of prefrontal cortex in children during a nonspatial working memory task with functional MRI. *NeuroImage*, 2, 221-229.
- Casey, B. J., Galvan, A., & Hare, T. A. (2005b). Changes in cerebral functional organization during cognitive development. *Current Opinion in Neurobiology*, 15, 239-244.
- Casey, B. J., Getz, S., & Galvan, A. (2008). The adolescent brain. *Developmental Review*, 28, 62-77.
- Casey, B. J., Tottenham, N., Liston, C., & Durston, S. (2005a). Imaging the developing brain: What have we learned about cognitive development? *Trends in Cognitive Science*, 9, 104-110.
- Casey, B. J., Trainor, R., Orendi, J., Schubert, A., Nystrom, L. E., Giedd, J. N. et al. (1997). A developmental functional MRI study of prefrontal activation, during performance of a Go-No-Go task. *Journal of Cognitive Neuroscience*, 9(6), 835-847.
- Catalano, R. F. & Hawkins, J. D. (1996). The Social Development Model: A theory of antisocial behavior. In J. D. Hawkins (Ed.), *Delinquency and crime: Current theories* (pp. 149-197). New York: Cambridge University Press.
- Catalano, R. F., Kosterman, R., Hawkins, J. D., Newcomb, M. D., & Abbott, R. D. (1996). Modeling the etiology of adolescent substance use: A test of the Social Development Model. *Journal of Drug Issues*, 26(2), 429-455.
- Centers for Disease Control and Prevention. (2006). Youth Risk Behavior Surveillance—United States, 2005. *Morbidity & Mortality Weekly Report*, 55, (SS-5), 1-108.

- Cercignani, M. & Barker, G. J. (2008). A comparison between equations describing in vivo MT: The effects of noise and sequence parameters. *Journal of Magnetic Resonance*, 191(2), 171-183.
- Chambers, R. A., Taylor, J. R., & Potenza, M. N. (2003). Developmental neurocircuitry of motivation in adolescence: A critical period of addiction vulnerability. *American Journal of Psychiatry*, 160, 1041-1052.
- Cherry, C., DeBerg, G., & Porterfield, A. (2001). *Religion on campus*. Chapel Hill, NC: University of North Carolina Press.
- Chitwood, D. D., Weiss, M. L., & Leukefeld, C. G. (2008). A systematic review of recent literature on religiosity and substance use. *Journal of Drug Issues*, 38(3), 653-688.
- Chiu, L., Emblen, J. D., Van Hofwegen, L., Sawatzky, R., & Meyerhoff, H. (2004). An integrative review of the concept of spirituality in the health sciences. *Western Journal of Nursing Research*, 26(4), 405-428.
- Cicchetti, D. & Dawson, G. (2002). Multiple levels of analysis. *Development and Psychopathology*, 14, 417-420.
- Cipher, D. (2001). *Multiple regression*. Retrieved March 20, 2009 from <http://home.earthlink.net/~dcipher>.
- Cleveland, M. J., Feinberg, M. E., Bontempo, D. E., & Greenberg, M. T. (2008). The role of risk and protective factors in substance use across adolescence. *Journal of Adolescent Health*, 43(2), 157-164.
- Coccaro, E. F., Kavoussi, R. J., Cooper, T. B., & Hauger, R. L. (1997). Central serotonin activity and aggression: Inverse relationship with prolactin response to d-fenfluramine, but not CSF 5-HIAA concentration in human subjects. *American Journal of Psychiatry*, 154, 1430-1435.

- Cochran, J. K. (1993). The variable effects of religiosity and denomination on adolescent self-reported alcohol use by beverage type. *Journal of Drug Issues, 23*, 479-492.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.
- Cole, G. (1993). *Management, theory, and practice* (5th ed.). London: Letts Educational.
- Coleman, J. S. (1971). *The adolescent society*. New York: Free Press.
- Colman, A. M. (2001). "order effect." *A dictionary of psychology*. Retrieved February 26, 2009 from Encyclopedia.com at <http://www.encyclopedia.com/doc/1087-ordereffect.html>.
- Cotton, S., Larkin, E., Hoopes, A., Cromer, B. A., & Rosenthal, S. L. (2005). The impact of adolescent spirituality on depressive symptoms and health risk behaviors. *Journal of Adolescent Health, 36*, 529.e7-529.e14.
- Cotton, S., Zebracki, K., Rosenthal, S. L., Tsevat, J., & Drotar, D. (2006). Religion/spirituality and adolescent health outcomes: A review. *Journal of Adolescent Health, 38*, 472-480.
- Coyle, T. R. & Pillow, D. R. (2008). SAT and ACT predict college student GPA after removing g. *Intelligence, 36*(6), 719-729.
- Crowley, T. J., Raymond, K. M., Mikulch-Gilbertson, S. K., Thompson, L. L., & Lejuez, C. W. (2006). A risk-taking "set" in a novel task among adolescents with serious conduct and substance problems. *Journal of the American Academy of Child & Adolescent Psychiatry, 45*(2), 175-183.
- Crozier, S. & Joseph, S. (1997). Religiosity and sphere-specific just world beliefs in 16- to 18-year olds. *The Journal of Social Psychology, 137*(4) 510-513.
- Czeisler, C. A., Ede, M. C., Regestein, Q. R., Kisch, E. S., Fang, V. S., Ehrlich, E. N. (1976). Episodic 24-hour cortisol secretory patterns in patients awaiting elective cardiac surgery. *Journal of Clinical Endocrinology & Metabolism, 42*, 273-283.

- Dahl, R. E., Ryan, N. D., Puig-Antioch, J., Nguyen, N. A., al-Shabbout, M., Meyer, V. A., et al. (1991). 24-hour cortisol measures in adolescents with major depression: A controlled study. *Biological Psychiatry*, 30(1), 25-36.
- Davidson, R. J., Putnam, K. M., & Larson, C. I. (2000). Dysfunction in the neural circuitry of emotion regulation: A possible prelude to violence. *Science*, 289(5479), 591-594.
- Davidson, R. J. & Slagter, H. A. (2000). Probing emotion in the developing brain: Functional neuroimaging in the assessment of the neural substrates of emotion in normal and disordered children and adolescents. *Mental Retardation & Developmental Disability Research Review*, 6, 166-170.
- Davis, T. L., Kerr, B. A., & Robinson Kurpius, S. E. (2003). Meaning, purpose, and religiosity in at-risk youth: The relationship between anxiety and spirituality. *Journal of Psychology and Theology*, 31(4), 356-365.
- Dawson, B. & Trapp, R. G. (2004). *Basic & clinical biostatistics* (4th ed.). New York: Lange Medical Books/ McGraw-Hill.
- Deardorff, J., Bonzales, N. A., Christopher, F. S., Roosa, M. W., & Millsap, R. E. (2005). Early puberty and adolescent pregnancy: The influence of alcohol use. *Pediatrics*, 116, 1451-1456.
- De Luca, C. R. & Leventer, R. J. (2008). Developmental trajectories of executive functions across the lifespan. In V. Anderson, R. Jacobs, & P. J. Anderson (Eds.), *Executive functions and the frontal lobes: A lifespan perspective* (pp. 23-56). New York: Psychology Press.
- DiChiara, G. (2002). Nucleus accumbens shell and core dopamine: Differential role in behavior and addiction. *Behavioral Brain Research*, 137, 74-114.
- Dinopoulos, A., Dori, I., & Parnavilas, J. G. (1997). The serotonin innervation of the basal forebrain shows a transient phase during development. *Brain Research: Developmental Brain Research*, 99, 38-52.

- Dolan, M., Deakin, W. J. F., Roberts, N., & Anderson, I. (2002). Serotonergic and cognitive impairment in impulsive aggressive personality disordered offenders: Are there implications for treatment? *Psychological Medicine*, *32*, 105-117.
- D'Onofrio, B. M., Eaves, L. J., Murrelle, L., Maes, H. H., & Spilka, B. (1999). Understanding biological and social influences on religious affiliation, attitudes, and behaviors: A behavior genetic perspective. *Journal of Personality*, *67*, 953-983.
- Drevets, W. C. & Raichle, M. E. (1998). Reciprocal suppression of regional cerebral blood flow during emotional versus higher cognitive processes: Implications for interactions between emotion and cognition. *Cognition and Emotion*, *12*, 353-385.
- Dumont, N., Andersen, S., Thompson, A., & Teicher, M. (2004). Transient dopaminergic synthesis modulation in prefrontal cortex: In vitro studies. *Developmental Brain Research*, *150*, 163-166.
- Durston, S., Davidson, M. C., Tottenham, N., Galvan, A., Spicer, J. Fossella, J. A. et al. (2006). A shift from diffuse to focal cortical activity with development. *Developmental Science*, *9*, 1-18.
- Dyer, F.J. (2006). The spiritual journey for youth: Spiritual themes can take on real-world focus for adolescents. *Addiction Professional*, *4*(3), 17-19.
- Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., Hawkins, J. et al. (2008). Youth Risk Behavior Surveillance—United States, 2007. *Morbidity & Mortality Weekly Report*, *57*(SS-4), 1-131.
- Eden, G. F. & Zeffiro, T. A. (2000). Functional magnetic resonance imaging. In M. Ernst & J. M. Rumsey (Eds., pp. 45-58). *Functional neuroimaging in child psychiatry*. Cambridge, UK: Cambridge University Press.

- Eisenberg, M. E., Neumark-Sztainer, D., Fulkerson, J. A., & Story, M. (2008). Family meals and substance use: Is there a long-term protective association? *Journal of Adolescent Health, 43*, 151-156.
- Elkind, D. (1967). Egocentrism in adolescence. *Child Development, 38*, 1025-1034.
- Ellis, L. (2005). A theory explaining biological correlates of criminality. *European Journal of Criminology, 2*(3), 287-315.
- Ellison, C. G., Bradshaw, M., Rote, S., Storch, J., & Trevino, M. (2008). Religion and alcohol use among college students: Exploring the role of domain-specific religious salience. *The Journal of Drug Issues, 38*(3), 821-846.
- Ellison, C. W. (1983). Spiritual well-being: Conceptualization and measurement. *Journal of Psychology and Theology, 11*, 330-340.
- Emick, J. & Welsh, M. (2005). Association between formal operational thought and executive function as measured by the Tower of Hanoi-Revised. *Learning and Individual Differences, 15*, 177-188.
- Erickson, E. H. (1968). *Identity, youth, and crisis*. New York: W. W. Norton.
- Ernst, M. & Mueller, S. C. (2008). The adolescent brain: Insights for functional neuroimaging research. *Developmental Neurobiology, 68*, 729-743.
- Ernst, M., Nelson, E. E., Jazbec, S., McClure, E. B., Monk, C. S., Leinbenluft, E. et al. (2005). Amygdala and nucleus accumbens in responses to receipt and omission of gains in adults and adolescents. *NeuroImage, 25*, 1279-1291.
- Ernst, M., Pine, D. S., & Hardin, M. (2006). Triadic model of the neurobiology of motivated behavior in adolescence. *Psychological Medicine, 36*, 299-312.
- Evans, R. (1983). Deterring smoking in adolescents: Evolution of a research program in applied psychology. *International Review of Applied Psychology, 32*, 71-83.

- Eysenck, S. B. G. & Eysenck, H. J. (1978). Impulsiveness and venturesomeness: Their position in a dimensional system of personality description. *Psychological Reports*, 43, 1247-1255.
- Eysenck, S. B. G., Pearson, P. R., Easting, G., & Allsopp, J. F. (1985). Age norms for impulsiveness, venturesomeness, and empathy in adults. *Personality and Individual Differences*, 6, 613-619.
- Fecteau, S., Pascual-Leone, A., Zald, D. H., Liguori, P., Theoret, H., Boggio, S. et al. (2007). Activation of prefrontal cortex by transcranial direct current stimulation reduces appetite for risk during ambiguous decision making. *The Journal of Neuroscience*, 27, 6212-6218.
- Fein, G. & Chang, M. (2008). Smaller feedback ERN amplitudes during the BART are associated with a greater family history density of alcohol problems in treatment-naïve alcoholics. *Drug and Alcohol Dependence*, 92, 141-148.
- Feldman, S. S. & Elliott, G. R. (1990). *At the threshold: The developing adolescent*. Cambridge, MA: Harvard University Press.
- Fetzer Institute. (2003). *Multidimensional measurement of religiousness/spirituality for use in health research: A report of the Fetzer Institute/National Institute on Aging Working Group*. Kalamazoo, MI: Fetzer Institute.
- Fiala, W. E., Bjorck, J. P., & Gorsuch, R. (2002). The religious support scale: Construction, validation, and cross-validation. *American Journal of Community Psychology*, 30, 761-787.
- Fields, R. D. & Stevens-Graham, B. (2002). New insights into neuron-glia communication. *Science*, 298, 556-562.
- Filopovitch, A. J. (2005). *The design of experiments: Correlational & observational design*. Retrieved February 21, 2009 from <http://krypton.mnsu.edu/~tony/courses/609/Design/Design4.html>.

- Finn, P. (2002). Motivation, working memory, and decision-making: A cognitive-motivational theory of personality vulnerability to alcoholism. *Behavioral and Cognitive Neuroscience Review*, 1(3), 183-205.
- Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Fitzpatrick, K. M. (1997). Fighting among America's youth: A risk and protective factors approach. *Journal of Health & Social Behaviors*, 38(2), 131-148.
- Ford, C. A. & Coleman, W. L. (1999). Adolescent development and behavior: Implications for the primary care physician. In M. D. Levine, W. B. Carey, & A. C. Crocker (Eds.), *Developmental behavioral pediatrics* (3rd ed., pp. 69-79). Philadelphia: Saunders.
- Francis, L. J. & Gibson, H. M. (1993). Parental influence and adolescent religiosity: A study of church attendance and attitude toward Christianity among adolescents 11 to 12 and 15 to 16 years old. *The International Journal for the Psychology of Religion*, 3(4), 241-253.
- Francis, L. J., James, D. J., & Jones, M. (1993). Attitudes towards Christianity during childhood and adolescence: Assembling the jigsaw. *Journal of Beliefs & Values: Studies in Religion & Education*, 14(2), 4-6.
- Francis, L. J. & Stubbs, M. T. (1987). Measuring attitudes towards Christianity: From childhood to adulthood. *Personality and Individual Differences*, 8, 741-743.
- Frankle, W. G., Lombardo, I., New, A. S., Goodman, M., Talbot, P. S., Huang, Y. et al. (2005). Brain serotonin transporter distribution in subjects with impulsive aggressivity: A positron emission study with [¹¹C]McN 5652. *American Journal of Psychiatry*, 162, 915-923.
- French, D. C., Eisenberg, N., Vaughan, J., Purwono, U. & Suryanti, T. A. (2008). Religious involvement and the social competence and adjustment of Indonesian Muslim adolescents. *Developmental Psychology*, 44(2), 597-611.

- Fulkerson, J. A., Story, M., Mellin, A., Leffert, N., Neumark-Sztainer, D., & French, S. A. (2006). Family dinner meal frequency and adolescent development: Relationships with developmental assets and high-risk behaviors. *Journal of Adolescent Health, 39*, 337-345.
- Fuster, J. M. (1998). *The prefrontal cortex: Anatomy, physiology and neuropsychology of frontal lobe*. Philadelphia: Lippincott.
- Gaillard, W. D., Hertz-Pannier, L., Mott, S. H., Barnett, A. S., LeBehan, D., & Theodore, W. H. (2000). Functional anatomy of cognitive development: fMRI of verbal fluency in children and adults. *Neurology, 54*, 180-185.
- Galen, G. W. & Rogers, W. M. (2004). Religiosity, alcohol expectancies, drinking motives and their interaction in the prediction of drinking among college students. *Journal of Studies on Alcohol, 65*(4), 469-476.
- Gallup, G. & Bezilla, R. (1992). *The religious life of young Americans*. Princeton, NJ: The George Gallup International Institute.
- Galvan, A., Hare, T., Parra, C. E., Penn, J., Voss, H., Glover, G. et al. (2006). Earlier development of the accumbens relative to orbitofrontal cortex might underlie risk-taking behavior in adolescents. *Journal of Neuroscience, 26*, 6885-6892.
- Galvan, A., Hare, T., Voss, H., Glover, G., & Casey, B. J. (2007). Risk-taking and the adolescent brain: Who is at risk? *Developmental Science, 10*, F8-F14.
- Gardner, M. & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology, 41*, 625-635.
- Garnezy, N. (1985). Stress resistant children: The search for protective factors. In J. Stevenson (Ed.), *Recent research in developmental psychopathology* (pp. 213-233). Oxford, UK: Pergamon Press.

- Gerrard, M., Gibbons, F. X., Houlihan, A. E., Stock, M. L., & Pomery, E. A. (2008). A dual-process approach to health risk decision making: The prototype willingness model. *Developmental Review, 28*, 29-61.
- Gerrard, M., Gibbons, F. X., Reis-Bergan, M., Trudeau, L., Vande Lune, L. S., & Buunk, B. (2002). Inhibitory effects of drinker and nondrinking prototypes on adolescent alcohol consumption. *Health Psychology, 21*, 601-609.
- Gibbons, F. X., Gerrard, M., Lane, D., Mahler, H. I. M., & Kulik, J. A. (2005). Using UV photography to reduce use of tanning booths: A test of cognitive mediation. *Health Psychology, 24*, 358-363.
- Giedd, J. N. (2004). Structural magnetic resonance imaging of the adolescent brain. *Annals of the New York Academy of Science, 1021*, 77-85.
- Giedd, J. N. (2008). The teen brain: Insights from neuroimaging. *Journal of Adolescent Health, 42*, 335-343.
- Giedd, J. N., Vaituzis, A. C., Hamburger, S. D., Lange, N., Rajapakse, J. C. & Kaysen, D. (1996). Quantitative MRI of the temporal lobe, amygdala, and hippocampus in normal human development: Ages 4 – 18 years. *The Journal of Comparative Neurology, 366*, 223-230.
- Giordano, P. C., Longmore, M. A., Schroeder, R. D., & Sefrin, P. M. (2008). A life-course perspective on spirituality and desistance from crime. *Criminology, 46*(1), 99-132.
- Glock, C. Y. (1962). On the study of religious commitment. *Religious Education, 57*(4, Res. Suppl.), 98-110.
- Gnays, J. A. & Willis, W. G. (1991). Validation of executive function tasks with young children. *Developmental Neuropsychology, 7*, 487-501.
- Goel, V. & Grafman, J. (1995). Are the frontal lobes implicated in “planning” functions? Interpreting data from the Tower of Hanoi. *Neuropsychologia, 33*, 623-642.

- Goel, V., Pullara, S. D., & Grafman, J. (2001). A computational model of frontal lobe dysfunction: Working memory and the Tower of Hanoi task. *Cognitive Science*, 25, 287-313.
- Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C. et al. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, 101, 8174-8179.
- Goodyer, I. M., Herbert, J., Altham, P. M., Pearson, J., Secker, S. M., Shiers, H. M. (1996). Adrenal secretion during major depression in 8-to-16-year-olds. Altered diurnal rhythms in salivary cortisol and dehydroepiandrosterone (DHEA) at presentation. *Psychological Medicine*, 26, 245-256.
- Gorsuch, R. L. & McPherson, S. E. (1989). Intrinsic/extrinsic measurement: I/E-revised and single item scales. *Journal for the Scientific Study of Religion*, 28(3), 348-354.
- Gorsuch, R. L. & Venable, G. D. (1983). Development of an 'Age Universal' I-E scale. *Journal of the Scientific Study of Religion*, 12, 181-197.
- Goveas, J. S., Csernansky, J. G., & Coccaro, E. F. (2004). Platelet serotonin content correlates inversely with life history of aggression in personality-disordered subjects. *Psychiatry Research*, 126, 23-32.
- Grafman, J., Schwab, K., Warden, D., Pridgen, A., Brown, H. R., & Salazar, A. M. (1996). Frontal lobe injuries, violence, and aggression: A report of the Vietnam Head Injury Study. *Neurology*, 46(5), 1231-1238.
- Greene, K., Krcmar, M., Walters, L. H., Rubin, D. L., & Hale, J. L. (2000). Targeting adolescent risk-taking behaviors: The contributions of egocentrism and sensation-seeking. *Journal of Adolescence*, 23, 439-461.

- Grosbas, M., Jansen, M., Leonard, G., McIntosh, A., Osswald, K., Poulsen, C. et al. (2007). Neural mechanisms of resistance to peer influence in early adolescence. *Journal of Neuroscience*, 27, 8040-8045.
- Guyer, A. E., Monk, C. S., McClure, E. B., Nelson, E. E., Roberson-Nay, R., Adler, A. et al. (2008). Developmental differences in amygdala response to fearful facial expressions. *Journal of Cognitive Neuroscience*, 20(9), 1565-1582.
- Guyton, A. C. & Hall, J. E. (2006). *Textbook of medical physiology* (11th ed.). Philadelphia: Elsevier.
- Hackney, C. H. & Sanders, G. S. (2003). Religiosity and mental health: A meta-analysis of recent studies. *Journal for the Scientific Study of Religion*, 42(1), 43-55.
- Hancock, M. D. (2005). Forms of religiosity and levels of risky/health-endangering behaviors among adolescents: A meta-analysis. Ph.D. dissertation, Indiana University, United States—Indiana. Retrieved July 27, 2008 from *Dissertations & Theses: Full Text database*. (Publication No. AAT 3183474).
- Hardert, R. A. & Dowd, T. J. (1994). Alcohol and marijuana use among high school and college students in Phoenix, Arizona: A test of Kandel's socialization theory. *International Journal of the Addictions*, 29(7), 887-912.
- Hare, T. A., Tottenham, N., Galvan, A., Voss, H. U., Glover, G. H., & Casey, B. J. (2008). Biological substrates of emotional reactivity and regulation in adolescence during an emotional Go-Nogo Task. *Biological Psychiatry*, 63, 927-934.
- Hawkins, J. D., Catalano, R. F., & Miller, J. Y. (1992). Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance abuse prevention. *Psychological Bulletin*, 112, 64-105.
- Hendricks-Ferguson, V. (2006). Relationships of age and gender to hope and spiritual well-being among adolescents with cancer. *Journal of Pediatric Oncology Nursing*, 23(4), 189-199.

- Herrman, J. W. (2005). The teen brain as a work in progress: Implications for pediatric nurses. *Pediatric Nursing, 31*(2), 144-148.
- Hill, P. C. & Pargament, K. I. (2003). Advances in the conceptualization and measurement of religion and spirituality. *American Psychologist, 58*(1), 64-74.
- Hill, P. C., Pargament, K. I., Hood, R. W., Jr., McCullough, M. E., Swyers, J. P., Larson, D. B. et al. (2000). Conceptualizing religion and spirituality: Points of commonality, points of departure. *Journal for the Theory of Social Behaviour, 30*, 51-77.
- Hoge, D. R. & Petrillo, G. H. (1978). Determinants of church participation and attitudes among high school youth. *Journal for the Scientific Study of Religion, 17*, 359-379.
- Holmbeck, G. N. (2002). A developmental perspective on adolescent health and illness: An introduction to the special issues. *Journal of Pediatric Psychology, 27*(5), 409-415.
- Hopko, D. R., Lejuez, C. W., Daughters, S. B., Aclin, W. M., Osborne, A., Simmons, B. L. et al. (2006). Construct validity of the Balloon Analogue Risk Task (BART): Relationship with MDMA use by inner-city drug users in residential treatment. *Journal of Psychopathology and Behavioral Assessment, 28*(2), 95-101.
- Howell, D., C. (2004). *Fundamental statistics for the behavioral sciences* (5th ed.). Belmont, CA: Brooks/Cole—Thomson Learning.
- Humes, G. E., Welsh, M. C., Retzlaff, P., & Cookson, N. (1997). Tower of Hanoi and London: Reliability of two executive function tasks. *Assessment, 4*, 249-257.
- Hunt, M. K., Hopko, D. R., Bare, R., Lejuez, C. W., & Robinson, E. V. (2005). Construct validity of the Balloon Analog Risk Task (BART): Associations with psychopathy and impulsivity. *Assessment, 12*, 416-428.
- Insel, T. & Fernald, R. (2004). How the brain processes social information: Searching for the social brain. *Annual Review of Neuroscience, 27*, 697-722.

- Jang, S. J., Bader, C. D., & Johnson, B. R. (2008). The cumulative advantage of religiosity in preventive drug use. *Journal of Drug Issues, 38*(3), 771-798.
- Jensen, L., Newell, R. J., & Holman, T. (1990). Sexual behavior, church attendance, and permissive beliefs among unmarried young men and women. *Journal for the Scientific Study of Religion, 29*, 113-117.
- Jessor, R. (1987). Problem-behavior theory, psychosocial development, and adolescent problem drinking. *British Journal of Addictions, 82*(4), 331-342.
- Jessor, R. (1991). Risk behavior in adolescence: A psychosocial framework for understanding and action. *Journal of Adolescent Health, 12*, 597-605.
- Johnson, B. A. (2005). Recent advances in the development of treatments for alcohol and cocaine dependence: Focus on topiramate and other modulators of GABA or glutamate function. *CNS Drugs, 19*, 873-896.
- Johnson, B. R., Jang, S. J., Larson, D. B., & De Li, S. (2001). Does adolescent religious commitment matter? A reexamination of the effects of religiosity in delinquency. *The Journal of Research in Crime and Delinquency, 38*(1), 22-44.
- Joseph, S. & Diduca, D. (2001). Schizotypy and religiosity in 13 – 18 year old school pupils. *Mental Health, Religion, & Culture, 4*(1), 63-69.
- Kalus, O., Asmis, G. M., & Van Praag, H. M. (1989). The role of serotonin in depression. *Psychiatric Annals, 19*, 348-353.
- Kapogiannis, D., Barbey, A. K., Su, M., Zamboni, G., Krueger, F., & Grafman, J. (2009). Cognitive and neural foundations of religious belief. *Proceedings of the National Academy of Sciences*. Retrieved March 18, 2009 from www.pnas.org/cgi/doi/10.1073/pnas.0811717106.
- Kaufman, J., Martin, A., King, R. A., & Charney, D. (2001). Are child-, adolescent-, and adult-onset depression one and the same disorder? *Biological Psychiatry, 49*, 980-1001.

- Kazdin, A. E. (1995). *Conduct disorders in childhood and adolescence* (2nd ed.). Thousand Oaks, CA: Sage.
- Keating, D. P. (1980). Thinking processes in adolescence. In J. Adelson (Ed.), *Handbook of adolescent psychology* (pp. 211-246). New York: Wiley.
- Kelley, A. E., Schochet, T., & Landry, C. (2004). Risk-taking and novelty-seeking in adolescence: Introduction to Part I. *Annals of the New York Academy of Sciences*, 1021, 27-32.
- Kerestes, M., Youniss, J., & Metz, E. (2004). Longitudinal patterns of religious perspective and civic integration. *Applied Developmental Science*, 8(1), 39-46.
- Kiehl, K. A., Smith, A. M., Hare, R. D., Mendrek, A., Forster, B. B., Brenk, J. et al. (2001). Limbic abnormalities in affective processing by criminal psychopaths as revealed by functional magnetic resonance imaging. *Biological Psychiatry*, 50, 677-684.
- Killgore, W. & Yurgelun-Todd, D. (2007). Unconscious processing of facial affect in children and adolescents. *Social Neuroscience*, 2, 28-47.
- Killgore, W. D. & Yurgelun-Todd, D. A. (2004). Activation of the amygdala and anterior cingulate during non-conscious processing of sad versus happy faces. *NeuroImage*, 21, 1215-1223.
- Kilpatrick, L. & Cahill, L. (2003). Amygdala modulation of parahippocampal and frontal regions during emotionally influences memory storage. *NeuroImage*, 20, 2091-2099.
- King, P. E. & Boyatzis, C. J. (2004). Exploring adolescent spiritual and religious development: Current and future theoretical empirical perspectives. *Applied Developmental Science*, 8(1), 2-6.
- King, R. J., Jones, J., Scheurer, J. W., Curtis, D., & Zarcone, V. P. (1990). Plasma cortisol correlates of impulsivity and substance abuse. *Personality and Individual Differences*, 11, 287-291.

- Kliewer, W. & Murrelle, L. (2007). Risk and protective factors for adolescent substance use: Findings from a study in selected Central American countries. *Journal of Adolescent Health, 40*, 448-455.
- Klingberg, T., Vaidya, C. J., Gabrieli, J. D., Moseley, M. E., & Hedehus, M. (1999). Myelination and organization of the frontal white matter in children: A diffusion tensor MRI study. *Neuroreport, 10*, 2817-2821.
- Klitzner, M., Schwartz, R. H., Gruenewald, P., & Blasinsky, M. (1987). Screening for risk factors for adolescent alcohol and drug use. *Archives of Pediatric & Adolescent Medicine, 141*(1), 45-49.
- Knowles, M. S. (1980). *The modern practice of adult education*. Chicago: Association Press.
- Koenig, H. G., McCullough, M. E., & Larson, D. B. (2001). *Handbook of religion and health*. New York: Oxford University Press.
- Konrad, K., Neufang, S., Thiel, C. M., Specht, K., Hanisch, C., Fan, J. et al. (2005). Development of attentional networks: An fMRI study with children and adults. *NeuroImage, 28*, 429-439.
- Krueger, R. F., Hicks, B. M., Patrick, C. J., Carlson, S. R., Lacono, W. G., & McGue, M. (2002). Etiologic connections among substance dependence, antisocial behavior, and personality: Modeling the externalizing spectrum. *Journal of Abnormal Psychology, 111*, 411-424.
- Kuhnen, C. M. & Knutson, B. (2005). The neural basis of financial risk-taking. *Neuron, 47*, 763-770.
- Kutcher, S., Malkin, D., Silverberg, J., Marton, P., Williamson, P., Malkin, A. et al. (1991). Nocturnal cortisol, thyroid stimulating hormone and growth hormone secretory profiles in depressed adolescents. *Journal of American Academy of Child & Adolescent Psychiatry, 30*(3), 407-414.

- Lambe, E. K., Krimer, L. S., & Goldman-Rakic, P. S. (2000). Differential postnatal development of catecholamine and serotonin inputs to identified neurons in prefrontal cortex of rhesus monkey. *Journal of Neuroscience*, *20*, 8780-8787.
- Larsen, D. D. & Krubitzer, L. (2008). Genetic and epigenetic contributions to the cortical phenotype in mammals. *Brain Research Bulletin*, *75*, 391-397.
- Larson, R. & Richards, M. H. (1994). *Divergent realities: The emotional lives of mothers, fathers, and adolescents*. New York: Basic Books.
- Lau, P.S. Y. (2006). Spirituality as a positive youth development construct: Conceptual bases and implications for curriculum development. *International Journal of Adolescent Medical Health*, *18*(3), 363-370.
- Laviola, G., Adriani, W., Terranova, M. L., & Gerra, P. (1999). Psychobiological risk factors for vulnerability to psychostimulants in human adolescents and animal models. *Neuroscience and Biobehavioral Reviews*, *23*, 993-1010.
- Lee, D. K., George, S. R., Cheng, R., Nguyen, T., Liu, Y, Brown, M. et al. (2001). Identification of four novel human G protein-coupled receptors expressed in the brain. *Molecular Brain Research*, *86*, 13-22.
- Leffert, N., Benson, P. L., Scales, P. C., Sharma A. R., Drake, D. R., & Blyth, D. A. (1998). Developmental assets: Measurement and prediction of risk behaviors among adolescents. *Applied Developmental Science*, *2*(4), 209-230.
- Lejuez, C. W., Aklin, W. M. Bornovalova, M. A., & Moolchan, E. T. (2005). Differences in risk-taking propensity across inner-city adolescent every-and never-smokers. *Nicotine & Tobacco Research*, *7*(1), 71-79.
- Lejuez, C. W., Aklin, W. M., Jones, H. A., Richards, J. B., Strong, D. R., Kahler, C. W. et al. (2003b). The Balloon Analogue Risk Task (BART) differentiates smokers and nonsmokers. *Experimental and Clinical Psychopharmacology*, *11*(1), 26-33.

- Lejuez, C. W., Aklin, W. M., Zvolensky, M. J., & Pedulla, C. M. (2003a). Evaluations of the Balloon Analogue Risk Task (BART) as a predictor of adolescent real-world risk taking behaviors. *Journal of Adolescence*, *26*, 475-479.
- Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L. et al. (2002). Evaluation of a behavioral measure of risk taking: The Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied*, *8*(2), 75-84.
- Lescano, C. M., Hadley, W. S., Beausoleil, N. I., Brown, L. K., D'eraimo, D., & Zimskind, A. (2007). A brief screening measure of adolescent risk behavior. *Child Psychiatry & Human Development*, *37*, 325-336.
- Lewis, C. A., Maltby, J., & Day, L. (2005). Religious orientation, religious coping, and happiness among UK adults. *Personality and Individual Differences*, *38*, 1193-1202.
- Lewis, D. A. (1997). Development of the prefrontal cortex during adolescence: Insights into vulnerable neural circuits in schizophrenia. *Neuropsychopharmacology*, *16*, 385-398.
- Lin, X., Tench, C. H., Morgan, P. S., & Constantinescu, C. S. (2008). Use of combined conventional and quantitative MRI to quantify pathology related to cognitive impairment in multiple sclerosis. *Journal of Neurology, Neurosurgery, & Psychiatry*, *79*(4), 437, 441.
- Lindman, R. E., Aromaki, A. S., & Eriksson, C. J. (1997). Sober-state cortisol as a predictor of drunken violence. *Alcohol and Alcoholism*, *32*, 621-626.
- Lindsay, V. (2006). Factors that predict freshmen college student's preference to drink alcohol. *Journal of Alcohol & Drug Education*, *50*, 7-19.
- Liston, C., Watts, R., Tottenham, N., Davidson, M. C., Niogi, S., Ulug, A. M. et al. (2005). Frontostriatal microstructure modulates efficient recruitment of cognitive control. *Cerebral Cortex*, *16*, 553-560.

- Litchfield, A. W., Thomas, D. L., & Li, B. D. (1997). Dimensions of religiosity as mediators of the relations between parenting and adolescent behavior. *Journal of Adolescent Research*, 12(2), 199-226.
- Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2007). *Proposals that work: A guide for planning dissertations and grant proposals* (5th ed.). Thousand Oaks, CA: Sage Publications.
- Loewenstein, G. F., Weber, E. U. Hsee, C. K., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin*, 127, 267-286.
- Lonczak, H. S., Huang, B., Catalano, R. F., Hawkins, J. D., Hill, K. G., Abbott, R. D. (2001). The social predictors of adolescent alcohol misuse: A test of the Social Development Model. *Journal of Studies on Alcohol*, 62(2), 179-189.
- Lovallo, W. R. (2006). Cortisol secretion patterns in addiction and addiction risk. *International Journal of Psychophysiology*, 59, 195-202.
- Lowe, C & Rabbitt, P. (1998). Test/retest reliability of the CANTAB and ISPOCD neuropsychological batteries: Theoretical and practical issues. *Neuropsychologia*, 36, 915-923.
- Luna, B. & Sweeney, J. A. (2004). The emergence of collaborative brain function. fMRI studies of the development of response inhibition. *Annals of the New York Academy of Science*, 1021, 296-309.
- Luna, B., Thulborn, K. R., Munoz, D. P., Merriam, E. P., Garner, K. E., Minshaw, N. J. et al. (2001). Maturation of widely distributed brain function subserves cognitive development. *NeuroImage*, 13,786-793.
- Macoby, E. E. (1951). Television: Its impact on school children. *Public Opinion Quarterly*, 15, 421-444.

- Maggs, J. L. (1997). Alcohol use and binge drinking as goal-directed action during the transition to postsecondary education. In J. Schulenberg, J. L. Maggs, & K. Hurrelmann (Eds.), *Health risks and developmental transitions during adolescence* (pp. 345-371). New York: Cambridge University Press.
- Maggs, J. L., Almeida, D. M., & Galambos, N. L. (1995). Risky business: The paradoxical meaning of problem behavior for young adolescents. *Journal of Early Adolescence, 15*, 339-357.
- Maggs, J. L. & Hurrelmann, K. (1996). Do substance use and delinquency have differential associations with adolescents' peer relations? *International Journal of Behavioral Development, 22*(2), 367-388.
- Mahon, N. E., Yarcheski, A., & Yarcheski, T. J. (2002). Psychometric evaluation of personal lifestyle questionnaire for adolescents. *Research in Nursing & Health, 25*, 68-75.
- Maltby, J. (1999). The internal structure of a derived, revised, and amended measure of The Religious Orientation Scale: The 'Age-Universal' I-E Scale-12. *Social Behavior and Personality, 27*(4), 407-412.
- Maltby, J. (2002). The Age Universal I-E Scale-12 and orientation toward religion: Confirmatory factor analysis. *The Journal of the Scientific Study of Religion, 12*, 181-197.
- Maltby, J. & Lewis, C. A. (1996). Measuring intrinsic and extrinsic orientation toward religion: Amendments for its use among religious and non-religious samples. *Personality and Individual Differences, 21*(6), 937-946.
- Marcia, J. E. (1980). Identity in adolescence. In J. Adelson (Ed.), *Handbook of adolescent psychology*, New York: Wiley.
- Marion, L. N., Fuller, S. G., Johnson, N. P., Michels, P. J., & Diniz, C. (1996). Drinking problems of nursing students. *Journal of Nursing Education, 35*(5), 196-203.

- Marsden, C. A. (2006). Dopamine: The rewarding years. *British Journal of Pharmacology*, *147*, S136-S144.
- Martin, T. P., White, J. M., & Perlman, D. (2003). Religious socialization: A test of the channeling hypothesis of parental influence on adolescent faith maturity. *Journal of Adolescent Research*, *18*, 169-187.
- Martins, S. S., Storr, C. L., Alexandre, P. K., & Chilcoat, H. D. (2008). Adolescent ecstasy and other drug use in the National Survey of Parents and Youth: The role of sensation-seeking, parental monitoring and peer's drug use. *Addictive Behaviors*, *33*, 919-933.
- Mason, W. A. & Windle, M. (2001). Family, religious, school, and peer influences on adolescent alcohol use: A longitudinal study. *Journal of Studies on Alcohol*, *62*(1), 44-53.
- Mataix-Cols, D. & Bartrés-Faz, D. (2002). Is the use of the wooden and computerized versions of the Tower of Hanoi equivalent? *Applied Neuropsychology*, *9*(2), 117-120.
- Matthews, S. C., Simmon, A. N., & Paulus, M. P. (2004). Selective activation of the nucleus accumbens during risk-taking decision making. *Neuroreport*, *15*, 2123-2127.
- Maxwell, S. E. & Delaney, H. D. (2004). *Designing experiments and analyzing data: A model comparison perspective* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.
- May, J. C., Delgado, M. R., Dahl, R. E., Stenger, V. A., Ryan, N. D., Fiez, J. A. et al. (2004). Event-related functional magnetic resonance imaging of reward-related brain circuitry in children and adolescents. *Biological Psychiatry*, *55*, 359-366.
- McAnarney, E. R. (2008). Adolescent brain development: Forging new links. *Journal of Adolescent Health*, *42*, 321-323.
- McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science*, *306*, 503-507.
- McElwee, R. O. & Dunning, D. (2005). A broader view of "self" in egocentric social judgment: Current and possible selves. *Self and Identity*, *4*, 113-130.

- McGaugh, J. L., McIntyre, C. R., & Power, A. E. (2002). Amygdala modulation of memory consolidation: Interaction with other brain systems. *Neurobiology of Learning and Memory, 78*, 539-552.
- McGuire, M. B. (1987). *Religion: The social context*. Belmont, CA: Wadsworth.
- McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly, 15*(4), 351-377.
- Michaud, P. A. (2006). Adolescents and risks: Why not change our paradigm? *Journal of Adolescent Health, 38*, 481-483.
- Miksza, P. (2007). Relationships among impulsivity, achievement goal motivation, practice behavior, and the performance achievement of high school wind players. Ph.D. dissertation, Indiana University, United States—Indiana. Retrieved February 10, 2009 from *Dissertations & Theses: Full Text database*. (Publication No. AAT 3274248).
- Miller, W. R. & Thoresen, C. E. (2003). Spirituality, religion, and health: An emerging research field. *American Psychologist, 58*, 24-35.
- Millstein, S. G. & Halpern-Felsher, B. L. (2002). Perceptions of risk and vulnerability. *Journal of Adolescent Health, 31S*, 10-27.
- Mitchell, K. J. & Ybarra, M. (2009). Social networking sites: Finding a balance between their risks and benefits. *Archives of Pediatric and Adolescent Medicine, 163*(1), 87-89.
- Moffitt, T. E. (1993). Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review, 100*, 674-701.
- Moll, J., Oliveira-Souza, R., Eslinger, P. J., Bramanti, B. E., Mourao-Miranda, J., Andreiulo, P. A. et al. (2002). The neural correlates of moral sensitivity: A functional magnetic resonance imaging investigation of basic and moral emotions. *Journal of Neuroscience, 22*, 2730-2736.

- Monk, C. S., McClure, E. B., Nelson, E. E., Zarahn, E., Bilder, R. M., Leibenluft, E. et al. (2003). Adolescent immaturity in attention-related brain engagement to emotional facial expressions. *NeuroImage*, 20, 420-428.
- Moreno, M. A., Parks, M. R., Zimmerman, F. J., Brito, T. E., & Christakis, D. A. (2009a). Display of health risk behaviors on MySpace by adolescents. *Archives of Pediatric and Adolescent Medicine*, 163(1), 27-34.
- Moreno, M. A., VanderStoep, A., Parks, M. R., Zimmerman, F. J., Kurth, A., & Christakis, D. A. (2009b). Reducing at-risk adolescents' display of risk behavior on a social networking web site. *Archives of Pediatric and Adolescent Medicine*, 163,(1), 35-41.
- Morse, J. K., Scheff, S. W., & DeKosky, S. T. (1986). Gonadal steroids influence axonal sprouting in the hippocampus dentate gyrus: A sexually dimorphic response. *Exploratory Neurology*, 94, 649-658.
- Moses, P. Roe, K., Buxton, R. B., Wong, E. C., Frank, L. R., & Stiles, J. (2002). Functional MRI of global and local processing in children. *NeuroImage*, 16, 415-424.
- Moss, H. B., Vanyukov, M., Yao, J. K., Kirillova, G. P. (1999). Salivary cortisol responses in prepubertal boys: The effects of parental substance abuse and association with drug use behavior during adolescence. *Biological Psychiatry*, 45, 1293-1299.
- Mullins, L. (1996). *Management and organizational behaviour* (4th ed.). London: Pitman Publishing.
- Munson, S., Eshel, N., & Ernst, M. (2006). Ethics of PET research in children. In M. Charron (Ed., pp. 72-91), *Pediatric PET imaging*. New York: Springer.
- Murphy, F. (2006). Motivation in nurse education practice: A case study approach. *British Journal of Nursing*, 15(20), 1132-1135.

- Murray, C. & Wren, C. T. (2003). Cognitive, academic, and attitudinal predictions of the grade point average of college students with learning disabilities. *Journal of Learning Disabilities, 36*(5), 407-415.
- Nagy, Z., Westerberg, H., & Klingberg, T. (2004). Maturation of white matter is associated with the development of cognitive function during childhood. *Journal of Cognitive Neuroscience, 16*, 1227-1233.
- Nasim, A., Utsey, S. O., Corona, R., & Belgrave, F. Z. (2006). Religiosity, refusal efficacy, and substance use among African-American adolescents and young adults. *Journal of Ethnicity in Substance Abuse, 5*(3), 29-49.
- National Center for Chronic Disease Prevention and Health Promotion. (2009). *Healthy Youth! 2009 questionnaire and item rationale*. Retrieved October 9, 2009 for <http://www.cdc.gov/HealthYouth/yrbs/pdf/questionnaire/2009HighSchool.pdf>.
- Nelson, C. A., Monk, C. S., Lin, J., Carver, L. J., Thomas K. M., & Truwit, C. L. (2000). Functional neuroanatomy of spatial working memory in children. *Developmental Psychology, 36*, 109-116.
- Nelson, E. E., Leibenluft, E., McClure, E. B., & Pine, D. S. (2005). The social re-orientation of adolescence: A neuroscience perspective on the process and its relation to psychopathology. *Psychological Medicine, 35*(2), 163-174.
- Nonnemaker, J., McNeely, C. A., & Blum, R. W. (2006). Public and private domains of religiosity and adolescent smoking transitions. *Social Science and Medicine, 62*, 3084-3095.
- Norman, G. R. & Streiner, D. L. (2000). *Biostatistics: The bare essentials* (2nd ed.). Hamilton, Ontario: BC Decker, Inc.
- Noyes, J. M. & Garland, K. J. (2003). Solving the Tower of Hanoi: Does mode of presentation matter? *Computers in Human Behavior, 19*, 579-592.

- Oda, M., Udaka, F., & Nippon, R. (2008). Magnetic resonance imaging in multiple sclerosis. *Japanese Journal of Clinical Medicine*, 66(6), 1098-1102.
- Omori, M. & Ingersoll, G. M. (2005). Health-endangering behaviours among Japanese college students: A test of psychosocial model of risk-taking behaviours. *Journal of Adolescence*, 28, 17-33.
- Oreland, L. (2004). Platelet monoamine oxidase, personality and alcoholism: The rise, fall, and resurrection. *Neurotoxicology*, 25(1/2), 79-89.
- Ormerod, T. C. (2005). Planning and ill-defined problems: In R. Morris & G. Ward (Eds.), *The cognitive psychology of planning* (pp.1-32). London: Psychology Press. Retrieved January 19, 2009 from <http://www.psych.lancs.ac.uk/people/Tom-Ormerod.html>.
- Ostszewski, K. & Zimmerman, M. A. (2006). The effects of cumulative risks and promotive factors on urban adolescent alcohol and other drug use: A longitudinal study of resiliency. *American Journal of Community Psychology*, 38, 237-249.
- Owen, A. M., Epstein, R., & Johnsrude, I. S. (2001). fMRI: Applications to cognitive neuroscience, In P. Jezzard, P. M. Matthews, & S. M. Smith (Eds., pp. 311-327). *Functional MRI*. New York: Oxford University Press.
- Pargament, K. I. (1999). The psychology of religion and spirituality? Yes and no. *The International Journal for the Psychology of Religion*, 9, 3-16.
- Parsons, J. T., Siegel, A. W., & Cousins, J. H. (1997). Late adolescent risk-taking: Effects of perceived benefits and perceived risks on behavioral intentions and behavioral change. *Journal of Adolescence*, 20, 381-392.
- Pascarella, E. T. & Terenzini, P. T. (2005). *How college affects students: A third decade of research* (Vol. 2). San Francisco: Jossey-Bass.
- Passamonti, L., Fera, F., Magariello, A., Cerasa, A., Gioia, M. C., Muglia, M. et al. (2006). Monoamine oxidase-A genetic variations influence brain activity associated with inhibitory

- control: New insight into the neural correlates of impulsivity. *Biological Psychiatry*, 59, 334-340.
- Paus, T., Zijdenbos, A., Worsley, K., Collins, D. L., Blumenthal, J., Giedd, J. N. et al. (1999). Structural maturation of neural pathways in children and adolescents: In vivo study. *Science*, 283, 1908-1911.
- Pe, M. L., Tan. A.-G., & Heller, K. A. (2008). Affect and successful performance: A study on the Tower of Hanoi and Nine-Dot. *The Korean Journal of Thinking and Problem Solving*, 18(1), 93-103.
- Pentz, M. A., Jasuja, G. K., Rohrbach, L. A., Sussman, S., & Bardo, M. T. (2006). Translation in tobacco and drug abuse prevention research. *Evaluation & The Health Professions*, 29(2), 246-271.
- Peters, E., Romer, D., Slovic, P., Jamieson, K. H., Wharfield, L., Mertz, C. K. et al. (2007). The impact and acceptability of Canadian-style cigarette warning labels among U. S. smokers and nonsmokers. *Nicotine & Tobacco Research*, 9, 473-481.
- Pezze, M. A., Dalley, J. W., & Robbins, T. W. (2007). Differential roles of Dopamine D1 and D2 receptors in the nucleus accumbens in attentional performance on the five-choice serial reaction time task. *Neuropsychopharmacology*, 32(2), 273-283.
- Piaget, J. (1967). *Six psychological studies*. New York: Random House.
- Piko, B. F. & Fitzgerald, K. M. (2004). Substance use, religiosity, and other protective factors among Hungarian adolescents. *Addiction Behaviors*, 29, 1095-1107.
- Pleskac, T. J., Wallsten, T. S., Wang, P., & Lejuez, C. W. (2008). Development of an automatic response mode to improve the clinical utility of sequential risk-taking tasks. *Experimental and Clinical Psychopharmacology*, 16(6), 555-564.

- Poldrack, R. A. & Packard, M.G. (2003). Competition among multiple memory systems: Converging evidence from animal and human brain studies. *Neuropsychologia*, 41, 245-251.
- Poldrack, R. A., Pare-Blagoev, E. J., Grant, P. E. (2002). Pediatric functional magnetic resonance imaging: Progress and challenges. *Topics in Magnetic Resonance Imaging*, 13, 61-70.
- Potvin, R. H. & Sloane, D. M. (1985). Parental control, age and religious practice. *Review of Religious Research*, 27(1), 3-14.
- Powell, K. (2006). How does the teenage brain work? *Nature*, 442(24), 865-867.
- Probst, D. C. (2003). Parental attachment and adolescents: Religiosity and antisocial behavior. Ph.D dissertation, University of Houston, United States-Texas. Retrieved July 27, 2008 from *Dissertations and Theses: Full text database*. (Publication No. AAT 3094014).
- Radke-Yarrow, M. & Sherman, T. (1990). Children born at medial risk: Factors affecting vulnerability and resilience. In J. Rolf, A. S. Masten, D. Cicchetti, K. H. Nüchterlein, & S. Weintraub (Eds.), *Risk and protective factors in the development of psychopathology* (pp. 120-140). Cambridge, UK: Cambridge University Press.
- Rakic, P., Bourgeois, J. P., Goldman-Rakic, P. S. (1994). Synaptic development of the cerebral cortex: Implications for learning, memory, and mental illness. *Progress in Brain Research*, 102, 227-243.
- Rapoport, J. L., Castellanos, F. X., Gogate, N., Janson, K., Kohler, S., & Nelson, P. (2001). Imaging normal and abnormal brain development: New perspectives for child psychiatry. *Australian and New Zealand Journal of Psychiatry*, 35, 272-281.
- Regnerus, M. D., Smith, C., & Smith, B. (2004). Social context in the development of adolescent religiosity. *Applied Developmental Science*, 8(1), 2-6.

- Raynor, D. A. & Levine, H. (2009). Association between the five-factor model of personality and health behaviors among college students. *Journal of American College Health, 58*(1), 73-81.
- Reininger, B. M., Evans, A. E., Griffin, S. F., Sanderson, M., Vincent, M. L., Valois, R. F. et al. (2005). Predicting adolescent risk behaviors on an ecological framework and assets. *American Journal of Health Behavior, 29*(2), 150-161.
- Reiss, A. L., Abrams, M. T., Singer, H. S., Ross, J. L., & Denckla, M. B. (1996). Brain development, gender, and IQ in children. A volumetric imaging study. *Brain, 119*, 1763-1744.
- Reite, M., Cullum, C. M., Stocker, J., Teale, P., & Kozora, E. (1993). Neuropsychological test performance and MEG-based brain lateralization: Sex differences. *Brain Research Bulletin, 32*, 325-328.
- Renshaw, P. (2002). Psychiatric disease. In S. W. Atlas (Ed.), *Magnetic resonance imaging of the brain and spine* (3rd ed., pp. 1993-2019). Baltimore: Lippincott, Williams & Wilkins.
- Resnick, M. S. & Bearman, P. S. (1997). Protecting adolescents from harm: Findings from the National Longitudinal Study on Adolescent Health. *Journal of the American Medical Association, 278*(10), 823-831.
- Rew, L. & Wong, Y. J. (2006). A systematic review of associations among religiosity/spirituality and adolescent health attitudes and behaviors. *Journal of Adolescent Health, 38*, 433-442.
- Reyna, V. F. & Brainerd, C. J. (1994). The origins of probability judgment: A review of data and theories. In G. Wright and P. Ayton (Eds.), *Subjective probability* (pp. 239-272). Oxford: John Wiley & Sons.

- Reyna, V. F. & Farley, F. (2006). Risk and rationality in adolescent decision-making: Implications for theory, practice, and public policy. *Psychological Science in the Public Interest*, 7, 1-44.
- Reyna, V. F. & Rivera, S. E. (2008). Current theories of risk and rational decision-making. *Developmental Review*, 28, 1-11.
- Richardson, W. (2008). Social tools in schools taking root. *District Administration*, 43(11), 68.
- Rimoldi, H. J. A. (1948). A note on Raven's Progressive Matrices test. *Educational and Psychological Measurement*, 8, 347-352.
- Rivers, S., Reyna, V., & Mills, B. (2008). Risk taking under the influence: A fuzzy-trace theory of emotion in adolescence. *Developmental Review*, 28, 107-144.
- Rohrbaugh, J. & Jessor, R. (1975). Religiosity in youth: A personal control against deviant behavior? *Journal of Personality*, 43(1), 136-155.
- Rosenberg, D. & Lewis, D. (1995). Postnatal maturation of the dopaminergic innervation of monkey prefrontal and motor cortices: A tyrosine hydroxylase immunohistochemical analysis. *Journal of Comparative Neurology*, 358, 383-400.
- Rosenberg, D. R., Sweeney, J. A., Gillen, J. S., Kim, J., Varanelli, M. J., O'Hearn, K. M. et al. (1997). Magnetic resonance imaging of children without sedation: Preparation with simulation. *Journal of American Academy of Child and Adolescent Psychiatry*, 36, 853-859.
- Rosenberg, N. L., Grigsby, J., Dreisbach, J., Busenbark, D., & Grigsby, P. (2002). Neuropsychologic impairment and MRI abnormalities with chronic solvent abuse. *Clinical Toxicology*, 40(1), 21-34
- Rosser, R., Stevens, S., & Ruiz, B. (2005). Cognitive markers of adolescent risk-taking: A correlate of drug abuse in at-risk individuals. *The Prison Journal*, 85, 83-96.

- Rostosky, S. S., Danner, F., & Riggle, E. D. B. (2008). Religiosity and alcohol use in sexual minority and heterosexual youth and young adults. *Journal of Youth and Adolescence*, 37, 552-563.
- Rovaris, M., Ianucci, G., Cercignani, M., Sormani, M. P., DeStefano, N., Gerevini, S. et al. (2003). Age-related changes in conventional, magnetization transfer, and diffusion-tensor MR imaging findings: Study with whole-brain tissue histogram analysis. *Radiology*, 227(3), 731-738.
- Rubia, K., Overmeyer, S., Taylor, E., Brammer, M., Williams, S. C., Simmons, A. et al. (2000). Functional frontalization with age: Mapping neurodevelopmental trajectories with fMRI. *Neuroscience and Biobehavioral Reviews*, 24, 13-19.
- Rutter, M. (1990). Psychosocial resilience and protective mechanisms. In J. Roff, A. S. Masten, D. Cicchetti, K. H. Nüchterlein, & S. Weintraub (Eds.), *Risk and protective factors in the development of psychopathology* (pp. 181-214). Cambridge, UK: Cambridge University Press.
- Sadock, B. J. & Sadock, V. A. (2003). *Kaplan & Sadock's synopsis of psychiatry: Behavioral sciences/clinical psychiatry* (9th ed.). Philadelphia: Lippincott, Williams, & Wilkins.
- Schepis, T. S., Adinoff, B., & Rao, U. (2008). Neurobiological processes in adolescent addictive disorders. *The American Journal on Addictions*, 17, 6-23.
- Schlagger, B. L., Brown, T. T., Lugar, H. M., Visscher, K. M., Miezen, F. M., Petersen, S. E. et al. (2002). Functional neuroanatomical differences between adults and school-age children in the processing of single words. *Science*, 296, 1476-1479.
- Schmithorst, V. J., Holland, S. K., & Dardzinski, B. J. (2008). Developmental differences in white matter architecture between boys and girls. *Human Brain Mapping*, 29(6), 696-710.

- Schweinsburg, A. D., Nagel, B. J., Schweinsburg, B. C., Park, A., Theilmann, R. J., & Tapert, S. F. (2008). Abstinent adolescent marijuana users show altered fMRI response during spatial working memory. *Psychiatry Research: Neuroimaging*, *163*, 40-51.
- Schweinsburg, A. D., Nagel, B. J., & Tapert, S. F. (2005). fMRI reveals alteration of spatial working memory networks across adolescence. *Journal of the International Neuropsychology Society*, *11*, 631-644.
- Shaw, P., Greenstein, D., Leich, J., Clasen, L., Lenroot, R., & Gogtay, N. (2006). Intellectual ability and cortical development in children and adolescents. *Nature*, *440*(30), 676-679.
- Sher, K. J., Bartholow, B. D., & Wood, M. D. (2000). Personality and substance use disorders: A prospective study. *Journal of Counseling and Clinical Psychology*, *68*, 818-829.
- Sherrod, L. R., Haggerty, R. J., & Featherman, D. L. (1993). Introduction: Late adolescence and the transitions to adulthood. *Journal of Research on Adolescence*, *3*, 217-226.
- Shute, G. E. & Huertas, V. (1990). Developmental variability in frontal lobe function. *Developmental Neuropsychology*, *6*, 1-12.
- Siegel, A. W., Cousins, J. H., Rubovits, D., Parsons, J. T., Lavery, B., & Crowley, C. (1994). Adolescents perception of the benefits and risks of their own risk-taking. *Journal of Emotional and Behavioral Disorders*, *2*, 89-98.
- Silva, M C. (1981). Selection of a theoretical framework. In S. D. Krampitz and N. Pavlovich (Eds.), *Readings for nursing research* (pp. 17-28). St. Louis: C. V. Mosby.
- Silveri, M. M., Rohan, M. L., Pimental, P. J., Gruber, S. A., Rosso, I. M., & Yurgelun-Todd, D. A. (2006). Sex differences in the relationship between white matter microstructure and impulsivity in adolescents. *Magnetic Resonance Imaging*, *24*, 833-841.
- Simmonds, J. G. (2005). Other than "the set pattern": Developing one's own thoughts about spirituality and religion. *Mental Health, Religion, & Culture*, *8*(4), 239-251.

- Simon, M. K. & Francis, J. B. (2001). *The dissertation and research cookbook from soup to nuts: A practical guide to help you start and complete your dissertation or research project* (3rd ed.). Dubuque, IA: Kendall/Hunt Publishing Company.
- Simon, H. A. (1975). The functional equivalence of problem solving skills. *Cognitive Psychology*, 7, 268-288.
- Slovic, P. (2001). Cigarette smokers: Rational actors or rational fools? In P. Slovic (Ed.), *Smoking: Risk perception and policy* (pp. 97-124). Thousand Oaks, CA: Sage Publications, Inc.
- Slovic, P., Peters, E., Finucane, M. L., & MacGregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology*, 24, 535-540.
- Smart, N. (2000). *Worldviews: Crosscultural exploration of human beliefs*. New Jersey: Prentice Hall.
- Smith, C. (2003). Theorizing religious effects among American adolescents. *Journal for the Scientific Study of Religion*, 42(1), 17-30.
- Smith, C. & Faris, R. (2002). *Religion and American adolescent delinquency, risk behaviors, and constructive social activities*. Chapel Hill, NC: National Study of Youth and Religion. Accessed November 14, 2008 from www.youthandreligion.org.
- Smith, C., Faris, R., Denton, M. L., & Regnerus, M. (2003). Mapping American adolescent subjective religiosity and attitudes of alienation toward religion: A research report. *Sociology of Religion*, 64(1), 111-133.
- Smithline, C. W. (2001). Spirituality as protective factor against adolescent substance abuse. Ph.D. dissertation, California School of Professional Psychology—Berkeley/Alameda, United States—California. Retrieved November 21, 2008 from *Dissertations & Theses: Full Text database*. (Publication No. AAT 9973859).

- Soloff, P. H., Lynch, K. G., & Moss, H. B. (2000). Serotonin, impulsivity, and alcohol use disorders in the older adolescent: A psychobiological study. *Alcoholism: Clinical and Experimental Research, 24*(11), 1609-1619.
- Soper, D. (2009b). *A-priori sample size calculator for multiple regression*. Retrieved February 21, 2009 from <http://www.danielsoper.com/statcalc/calc01.aspx>.
- Soper, D. (2009a). *A-priori sample size for multiple regression*. Retrieved February 21, 2009 from <http://www.danielsoper.com/statkb/topic01.aspx>.
- Soper, D. (2009c). *Post-hoc statistical power calculator for multiple regression*. Retrieved September 21, 2009 from <http://www.danielsoper.com/statcalc/calc09.aspx>.
- Sowell, E. R., Thompson, P. M., Leonard, C. M., Welcome, S. E., Kan, E., & Toga, A. W. (2004). Longitudinal mapping of cortical thickness and brain growth in children. *The Journal of Neuroscience, 24*(38), 8223-8231.
- Spangler, D. J. C. (2004). The role of religion in moderating the impact of stress on negative health outcomes. Ph.D. dissertation, Pacific Graduate School of Psychology, United States—California. Retrieved August 3, 2008, from *Dissertations & Theses: Full Text database*. (Publication No. AAT 3106438).
- Spear, L. P. (2000a). Neurobehavioral changes in adolescence. *Current Directions in Psychological Science, 9*, 111-114.
- Spear, L. P. (2000b). The adolescent brain and age-related behavioral manifestations. *Neuroscience and Biobehavioral Reviews, 24*, 417-463.
- Spear, L. P. (2004). Adolescent brain development and animal models. *Annals of the New York Academy of Sciences, 1021*, 23-26.
- Starbuck, E. D. (1899). *The psychology of religion: An empirical study of the growth of religious consciousness*. New York: Scribner.

- StatsDirect Limited. (2009). *Shapiro-Wilk W test*. Retrieved October 16, 2009 from http://www.statsdirect.com/help/parametric_methods/swt.htm.
- Steinberg, L. (2004). Risk-taking in adolescence: What changes, and why? *Annals of the New York Academy of Sciences*, 1021, 51-58.
- Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. *Current Directions in Psychological Science*, 16, 55-60.
- Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, 28, 78-106.
- Steinberg, L. & Cauffman, E. (1996). Maturity of judgment in adolescence: Psychosocial factors in adolescent decision making. *Law and Human Behavior*, 20, 249-272.
- Steinberg, L. & Scott, E. S. (2003). Less guilty by reason of adolescence: Developmental immaturity, diminished responsibility, and the juvenile death penalty. *American Psychologist*, 58(12), 1009-1018.
- Stephenson, M. T., Hoyle, R. H., Palmgreen, P., & Slater, M. D. (2003). Brief measures of sensation for screening and large-scale surveys. *Drug and Alcohol Dependence*, 72(3), 279-286.
- Stockmeyer, P. K. & Lunnon, F. (2008). *New variations on the Tower of Hanoi*. Thirteenth International Conference on Fibonacci Numbers and Their Applications, July 7-11, 2008, Patras, Greece. Retrieved January 19, 2008 from http://www.cs.wm.edu/~pkstoc/h_papers.html.
- Study of Early Child Care and Youth Development [SECCYD]. (2006). *Procedures for administering the age 15 Balloon Analogy Risk Task (B.A.R.T.)*. Phase IV data from SECCYD (Chapter 91, Section 8, p. 1-8). Bethesda, MD: National Institute of Child Health and Human Development.

- Styles, I., Raven, M., & Raven, J. C. (1998). *Raven's Progressive Matrices. SPM plus sets A-E*. Oxford: Oxford Psychologists.
- Summers, M. M., Fisniku, L. K., Anderson, V. M., Miller, D. H., Cipelotti, L., & Ron, M. A. (2008). Cognitive impairment in relapsing-Remitting multiple sclerosis can be predicted by imaging performed several years earlier. *Multiple Sclerosis, 14*(2), 197-204.
- Sunstein, C. R. (2008). Adolescent risk-taking and social meaning: A commentary. *Developmental Review, 28*, 145-152.
- Suzuki, Y., Matsuzawa, H., Kwees, I. L., & Nakade, T. (2003). Absolute Eigenvalue diffusion tensor analysis for human brain maturation. *NMR in Biomedicine, 16*, 257-260.
- Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, Pearson Education, Inc.
- Tamm, L., Menon, V., & Reiss, A. L. (2002). Maturation of brain function associated with response inhibition. *Journal of the Academy of Child and Adolescent Psychiatry, 41*, 1231-1238.
- Tarter, R. E., Kirisci, L., Mezzick, A., Cornelius, J. R., Pajer, K., Vanyukov, M. et al. (2003). Neurobehavioral disinhibition in childhood predicts early age at onset of substance use disorder. *American Journal of Psychiatry, 160*, 1078-1085.
- Taylor, R. J. (1988). Correlates of religious non-involvement among Black Americans. *Review of Religious Research, 29*, 126-139.
- Thomas, D. L. & Carver, C. (1990). Religion and adolescent social competency. In T. P. Gullotta, G. R. Adams, & R. Montemayor (Eds.), *Advances in adolescent development* (Vol. 3, pp. 195-219). Newbury Park, CA: Sage.
- Thomas, K. M., King, S. W., Franzen, P. L., Welsh, T. F., Berkowitz, A. L., & Noll, D. C. (1999). A developmental functional MRI study of spatial working memory. *NeuroImage, 10*, 327-338.

- Tseng, K. Y. & O'Donnell, P. E. (2007). Dopamine modulation of prefrontal cortical interneurons changes during adolescence. *Cerebral Cortex*, *17*(5), 1235-1240.
- Tull, M. T., Patterson, R., Bornovalova, M. B., Hopko, D. R., & Lejuez, C. W. (2008). Analogue research methods. In D. McKay (Eds.), *Handbook of research methods in abnormal and clinical psychology*. Thousand Oaks, CA: Sage.
- Uecker, J. E. (2008). Religious and spiritual responses to 9/11: Evidence from the ADD Health Study. *Sociological Spectrum*, *28*, 477-509.
- Ullén, F., Forsman, L., Blom, O., Karabanov, A., & Madison, G. (2008). Intelligence and variability in a simple timing task share neural substrates in prefrontal white matter. *The Journal of Neuroscience*, *28*(16), 4238-4243.
- Varma, S. (2006). A computational model of Tower of Hanoi problem solving. Ph.D. Dissertation, Vanderbilt University, United States—Tennessee. Retrieved November 3, 2008 from *Dissertations & Theses: Full text database*. (Publication No. AAT 3230587).
- Vaughan, R. D., McCarthy, J. F., Walther, H. J., Resnicow, K., Waterman, P. D., Armstrong, B. et al. (1996). The development, reliability, and validity of a risk factor screening survey for urban minority junior high school students. *Journal of Adolescent Health*, *19*(3), 171-178.
- Vincent, W. J. (2005). *Statistics in kinesiology* (3rd ed.). Champaign, IL: Human Kinetics.
- Virkkunen, M. (1985). Urinary free cortisol excretion in habitually violent offenders. *Acta Psychiatrica Scandinavica*, *72*, 40-44.
- Walker, K. L. & Dixon, V. (2002). Spirituality and academic performance among African-American college students. *Journal of Black Psychology*, *28*(2), 107-121.
- Wallace, Jr., J. M. & Williams, D. R. (1997). Religion and adolescent health compromising behavior. In J. Schulenberg, J. L. Maggs, & K. Hurrelmann (Eds.), *Health risks and developmental transitions during adolescence* (pp. 444-468). Cambridge, UK: Cambridge University Press.

- Waltz, C. F., Strickland, O. L., & Lenz, E. R. (2005). *Measurement in nursing and health research* (3rd ed.). New York: Springer Publishing Company.
- Wechsler, D. (2003). *Manual for the Wechsler Intelligence Scale for Children—Fourth edition*. San Antonio, TX: The Psychological Corporation.
- Wechsler, H., Davenport, A., Dowdall, G., Grossman, S., & Zanakos, S. (1997). Binge drinking, tobacco, and illicit drug use and involvement in college athletics. *Journal of American College Health, 45*, 195-200.
- Wegener, L. M., Furrows, J. L., King, P. E., Leffert, N., & Benson, P. (2003). Religious involvement and developmental resources in youth. *Review of Religious Research, 44*(3), 271-284.
- Weigert, A. J. & Thomas, D. L. (1972). Parental support, control, and adolescent religiosity: An extension of previous research. *Journal for the Scientific Study of Religion, 11*(4), 389-393.
- Weinberger, D. R., Elvevåg, B., & Giedd, J. N. (2005). *The adolescent brain: A work in progress*. Washington DC: The National Campaign to Prevent Teen Pregnancy.
- Weinstein, N. D. (1984). Why it won't happen to me: Perceptions of risk factors and susceptibility. *Health Psychology, 3*, 431-457.
- Weisstein, E. (2009). *Tower of Hanoi*. Graphic retrieved February 3, 2009 from <http://mathworld.wolfram.com/TowerofHanoi.html>.
- Welsh, M. & Huizinga, M. (2001). The development and preliminary validation of the Tower of Hanoi-Revised. *Assessment, 8*(2), 167-176.
- White, H. R., Fleming, C. B., Kim, M. J., Catalano, R. F., & McMorris, B. J. (2008). Identifying two potential mechanisms for changes in alcohol use among college-attending and non-college-attending emerging adults. *Developmental Psychology, 44*(6), 1625-1639.

- White, T. L., Lejuez, C. W., & deWit, H. (2008). Test-retest characteristics of the Balloon Analogue Risk Task (BART). *Experimental and Clinical Psychopharmacology*, *16*(6), 565-570.
- Wills, T. A., Gibbons, F. X., Gerrard, M., Murry, V. M., & Brody, G. H. (2003). Family communication and religiosity related to substance use and sexual behavior in early adolescence: A test for pathways through self-control and prototype perceptions. *Psychology of Addictive Behaviors*, *17*(4), 312-323.
- Wilson, M. (2004). *A part of you so deep: What vulnerable adolescents have to say about spirituality*. Burlington, VT: New England Network for Child, Youth, & Family Services.
- Winslow, J. & Insel, T. (2004). Neuroendocrine basis of social recognition. *Current Opinion in Neurobiology*, *14*, 248-253.
- Wong, Y. J., Rew, L., Slaikeu, K. D. (2006). A systematic review of recent research on adolescent religiosity/spirituality and mental health. *Issues in Mental Health Nursing*, *27*, 161-183.
- Wood, J. N. (2003). Social cognition and the prefrontal cortex. *Behavioral and Cognitive Neuroscience Reviews*, *2*(2), 97-114.
- Wright, L., Hardie, S. M., & Rodway, P. (2004). Pause before you respond: Handedness influences response style on the Tower of Hanoi task. *Laterality*, *9*(2), 133-147.
- Wright, L. S., Frost, C. J., & Wisecarver, S. J. (1993). Church attendance, meaningfulness of religion, and depressive symptomatology among adolescents. *Journal of Youth and Adolescence*, *22*(5), 559-568.
- Yanovitzky, I. (2006). Sensation seeking and alcohol use by college students: Examining multiple pathways of effects. *Journal of Health Communication*, *11*(3), 269-280.
- Yurgelun-Todd, D. (2007). Emotional and cognitive changes during adolescence. *Current Opinion in Neurobiology*, *17*, 251-257.

- Zaleski, E. H. & Schiaffino, K. M. (2000). Religiosity and sexual risk-taking behavior during the transition to college. *Journal of Adolescence, 23*, 223-227.
- Zern, D. S. (1989). Some connections between increasing religiousness and academic accomplishment in a college population. *Adolescence, 24*(93), 141-154.
- Zook, N. A., Davalos, D. B., De Losh, E. L., & Davis, H. P. (2004). Working memory, inhibition, and fluid intelligence as predictors of performance on Tower of Hanoi and London tasks. *Brain and Cognition, 56*, 286-292.
- Zuckerman, M. (1979). *Sensation seeking: Beyond the optimal level of arousal*. Hillsdale, NJ: Erlbaum.
- Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking*. New York: Cambridge University Press.
- Zuckerman, M., Eysenck, S., & Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology, 46*, 139-149.

BIOGRAPHICAL INFORMATION

Mary Cazzell has been a pediatric nurse since graduating in 1978 from Marquette University, Milwaukee, Wisconsin, with a Bachelors of Science Degree in Nursing. In December, 2009, she will graduate with a doctorate in nursing from the BSN-to-PhD program at the University of Texas at Arlington School of Nursing (UTASON). Research interests include: adolescent vulnerability to risk behaviors, behavioral measures of executive cognitive functions, and adolescent neurobiology. Involvement in research projects while a Graduate Research Assistant include: (1) cardiopulmonary resuscitation (CPR) studies on CPR training, compression effectiveness, and feedback device; and (2) elder risk behavior and psychometric evaluation of behavioral measures of executive cognitive function and risk-taking propensity. Future plans include a post-doctoral fellowship with a focus on executive cognitive function behavioral measurement, collaboration with neurobiologists to increase knowledge of neuroimaging and to enhance opportunities for research, employment as an Assistant Clinical Professor/Lead Teacher of the undergraduate pediatric program at UTASON beginning the Spring of 2010, and tenure track beginning the Fall of 2010.