APPLICATION OF THE BIOECOLOGICAL MODEL AND HEALTH BELIEF MODEL TO SELF-REPORTED HEALTH RISK BEHAVIORS OF ADOLESCENTS IN THE UNITED STATES

A Thesis

by

SASHA A. FLEARY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2008

Major Subject: Psychology

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Approved by:

Co-Chairs of Committee,	Robert W. Heffer
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ABSTRACT

Application of the Bioecological Model and Health Belief Model to Self-Reported Health Risk Behaviors of Adolescents in the United States. (December 2008)

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Health risk behaviors are responsible for the majority of morbidity and mortality among adolescents. Researchers have identified three sources of risk-taking in adolescents – dispositional, ecological and biological. The Bioecological Model incorporates these three sources of risk-taking, however it lacks explanatory power. For this reason, this thesis focused on explaining risk perception of health risk behaviors (smoking cigarette, alcohol and marijuana use), and health risk behaviors by integrating the Bioecological Model with a more specific Health Belief Model. The relationship between risk perception and health risk behavior was also investigated as a first step in understanding adolescent decision-making using the Health Belief Model.

Adolescents from a suburban Indiana area were asked to complete the Adolescent Health Risk Behavior Survey which assessed egocentrism, self-esteem, social norms, risk perceptions, and the incidence and prevalence of health endangering behaviors. Hierarchical linear regression was used to determine the ability of the systems in the Bioecological Model and their specific variables to explain risk perception of health risk behaviors. Hierarchical logistic regression was used to determine the ability of the systems in the Bioecological Model and their specific

variables to explain health risk behaviors and to moderate the relationships between risk perception and health risk behaviors.

Based on the results, it was confirmed that the Bioecological Model is important in understanding adolescent's risk perception of health risk behaviors, and their self-reported health risk behaviors. It is also important in understanding the relationship between risk perception and health risk behaviors. Adolescent Variables, Microsystem, and Mesosystem were significant in predicting adolescent risk perception of all health risk behaviors examined, and self-reported smoking cigarette behavior and marijuana use. Adolescent variables and Microsystem were the only systems to predict adolescent self-reported alcohol use. The relationship between risk perception and reported smoking cigarette behavior was moderated by Adolescent Variables, Microsystem and Mesosystem, however for alcohol use the path was moderated by Adolescent Variables and for marijuana use the path was moderated by the Mesosytem. Results of this thesis imply the importance of considering the contribution of Bioecological Model variables when implementing prevention intervention programs specific to adolescent health risk behaviors.

DEDICATION

To my niece and nephews

NOMENCLATURE

AHRB	Adolescent Health Risk Behavior
BIT	Behavioral Intervention Theory
CDT	Cognitive Developmental Theory
CFA	Confirmatory factor Analysis
CFI	Comparative Fit Index
RMSEA	Root Mean Square Error of Approximation
SLT	Social Learning Theory

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INTRODUCTION

Health endangering behaviors in adolescence is not uncommon and is responsible for the majority of morbidity and mortality among this group (Irwin and Millstein, 1992). The *Division of Adolescents and School Health, National Center for Chronic Disease Prevention and Health Promotion* identifies six priority categories of health risk behaviors among the young; alcohol use, other drug use, risky sexual behaviors, tobacco use, unhealthy dietary behavior and lack of physical activity (Grunbaum et al., 2004). Millstein (1989) identified accidents, homicide and suicide as the leading cause of mortality during adolescence in the United States and 14 years later this is still true. According to Grunbaum et al. (2004), 70.8% of deaths among individuals aged 10-24 years were due to the same causes in Millstein (1989). Sullivan and Terry (1998) identified adolescence as a period of increased risk taking behavior, which poses a danger to their health and concerns child and adolescent health psychologists.

Irwin et al. (1997) identified three sources of risk taking – dispositional, ecological and biological. The dispositional basis of risk-taking behavior assumes that engaging in risky behaviors is due to individual differences that include self-esteem, depression and a general propensity to be deviant. According to Irwin et al. (1997), certain dispositions may be reflective of underlying differences among individuals such as levels of sensation seeking. The ecological basis of risk taking behavior emphasizes the importance of the social and environmental context in which the individual is embedded, more specifically, the relationship of these contextual variables to perceived social norms and opportunities for and reinforcement of risky behaviors. The contextual variables include economic status, culture, and social environment. The biological basis of risk taking behavior take into account the role of genetics and neuroendocrine processes, such as hormonal influences and the timing of pubertal events. Genetics and

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This thesis follows the style of *Journal of Pediatric Psychology*.

neuroendocrine processes are believed to have direct effects on adolescence risk taking behavior and the onset of puberty has indirect effects. Irwin et al. (1997) argued that changes in family interactions, peer expectations and parental feelings usually occur at the onset of puberty.

This proposal will focus on the ecological context of substance use (specifically smoking cigarette, marijuana use and alcohol use) and incorporate dispositional and biological variables using the Bioecological Model proposed by Bronfenbrenner and Morris (2006). In addition, I will explore how these variables affect the relationship between risk perception and health risk behavior using the Health Belief Model proposed by Becker et al. (1977).

The Bioecological Model

The Bioecological Model, as shown in Figure 1, previously known as the Socioecological Model, was first introduced by Bronfenbrenner (1979) to highlight the importance of the ecological context in the development of the individual. Researchers have continued to emphasize the importance of social ecology in child health and well being, hence providing the premise for using Bronfenbrenner (1979) and Bronfenbrenner and Morris' (2006) Bioecological Model in studying health risk behaviors among adolescents. According to Bronfenbrenner and Morris (2006), the Bioecological Model consists of four major underlying properties: process, person, context, and time.

Process, also called Proximal Processes, is recognized as the foundation of the model and, because it is defined as the interaction between the individual and the environment that occurs over time, it has significant influence in human development. Proximal Processes do not operate independently; they are influenced by the characteristics and traits of the individual, the immediate environment and the time period in which they evolve. For Proximal Processes to be influential, their interactions

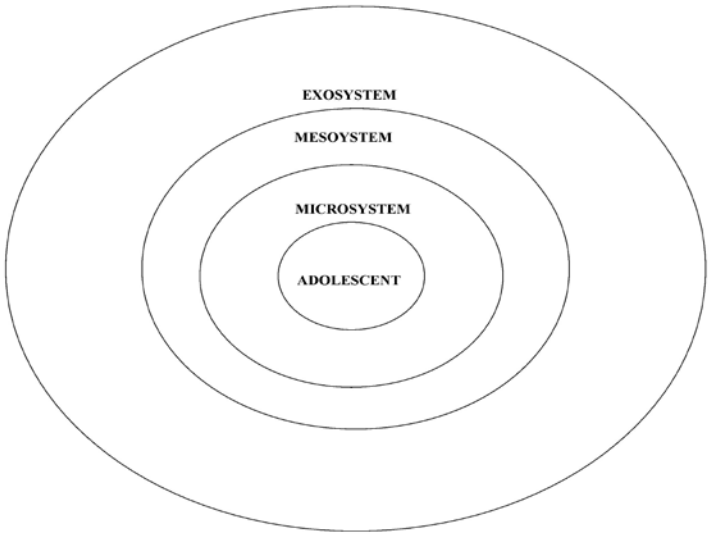

Figure 1. The Bioecological Model

among the person and environment must transpire regularly over extended periods of time.

Person comprises of the characteristics of the individual being assessed in the model as well as characteristics that compose the Microsystem (e.g. parents, close friends, and relatives), Bronfenbrenner and Morris (2006) highlighted three types of Person characteristics as being most influential in Proximal Processes. One such characteristic, Dispositions or Person Forces, is responsible for initiating Proximal Processes during a developmental level, and for maintaining their operation. Person Forces are further divided into Developmentally Generative and Developmentally Disruptive characteristics. Developmentally Generative characteristics represent an individual's propensity to be curious, initiate and engage in activity alone, and defer immediate gratification to pursue long term goals. Developmentally Disruptive characteristics include impulsiveness, explosiveness, feelings of insecurity and a general problem controlling emotions and behavior. The second Person characteristic is Sources, which, is the bioecological resources of ability, experience, knowledge, and skill needed for the successful functioning of proximal processes at any developmental level. Demand Characteristics, the final Person characteristic elaborated by Bronfenbrenner and Morris (2006), encourages or discourages responses from the social environment that can be beneficial or detrimental to the management of Proximal Processes. Person characteristics emerge in two aspects of the Bioecological Model: first as one of the influences on Proximal Processes, then as Developmental Outcomes, which are the product of the interaction of the four components of the model.

Context as defined in the Bioecological Model is the environment in which the Proximal Processes unfold, more specifically the interaction of the Proximal Processes with Symbols and Objects. Context includes features of the environment that promote or interfere with Proximal Processes.

The last defining property of the Bioecological Model, Time, is divided into Microtime, Mesotime and Macrotime. Microtime is the stability versus instability of continuing episodes of Proximal Processes and Mesotime is the period of the episode across expansive time intervals. Macrotime is the shifting expectations and events of the society both intergenerationally and intragenerationally as they influence and are influenced by processes and products of human development throughout the life course. Bronfenbrenner and Morris (2006) concluded that the Bioecological Model should be concerned with the role of developmental processes and outcomes in generating changes over time in the individual and in the society and how those changes affect the future of society.

As shown in Figure 1, the Bioecological Model identifies the child or adolescent at the heart of a progression of concentric circles, which represent systems that influence a given child or adolescent. It is at this point Person characteristics described by Bronfenbrenner and Morris (2006) should be examined. The first system surrounding the child in the Bioecological Model is the Microsystem. The Microsystem is best defined as the most immediate influences on the child. Kazak et al. (2003) identified the family and its subsystems, that is, parents, siblings, marital relationships, as being most representative of the Microsystem. A substantial amount of research examining health risk behaviors have found family type, parent influence and peer influence to be the most salient influences on adolescents' decision to engage or not engage in health risk behaviors (Deleire & Kalil, 2002; Hundleby & Mercer, 1987; Avry et al., 1999). To be consistent with research findings, peer influence will be identified as a Microsystem variable in this proposal.

The second system surrounding the adolescent is the Mesosystem. Researchers define the Mesosystem as the interaction of two or more Microsystems; however, diagrams of the Bioecological Model identify variables that are considered more distal than those in the Microsystem as comprising the Mesosystem (e.g. Kazak et al., 2003, p.

161; Spirito & Kazak, 2006, p. 38). For this proposal, the Mesosystem will be defined as the interaction of two or more Microsystems and adolescent variables and statistical analyses will reflect this distinction.

The most distal system in the Bioecological Model is the Exosystem. The Exosystem is all environmental contexts that contribute to culture, subculture and general belief patterns of the child or adolescent and includes socioeconomic status, religion, law and cultures (Kazak et al., 2003). According to Bronfenbrenner (1993), these environmental contexts should lead to indirect influences on the immediate setting in which the person resides. Systems in the Bioecological Model have considerable overlap and are very interactive. Because health risk behavior researchers tend to study a combination of the variables across these systems simultaneously, it is difficult to discuss the systems separately; however evidence for the variables in the systems would be distinguished as much as possible in this proposal. In the case of variables such as age, ethnicity, gender and socioeconomic status, however, clear separation is not possible since these variables are hardly ever discussed by themselves and are often discussed in the context of interaction with other variables.

Adolescent Person Variables. Although other models of adolescent risk behavior, such as Irwin and Millstein's (1986) Biopsychosocial Model, have stressed the importance of personality characteristics and developmental level in predicting behavior, the Bioecological Model has a history of placing relatively less emphasis on dispositions and development. This proposal will not only examine adolescents' Developmentally Disruptive dispositions, but also other Person specific variables such as age, and gender, because according to Bronfenbrenner and Morris (2006) these two variables along with ethnicity "place that person in a particular environmental niche that defines his or her position and role in society" (p. 814). Developmentally Disruptive dispositions are important to examine because researchers have argued that sensation seeking, egocentrism, self concept, impulse control, and other individual dispositions may

exaggerate developmental characteristics that increase the likelihood of adolescents engaging in reckless behavior (Jessor & Jessor, 1977; Arnett, 1992; Omori & Ingersoll, 2005).

Arnett (1995) identified three developmental predispositions as being central to adolescent health risk behavior: sensation-seeking, egocentrism, and aggressiveness. Sensation seeking is the tendency to seek out new and extreme experiences, and tends to be higher in adolescents than in adults. For adolescents some of these experiences include trying illegal drugs, driving recklessly, and engaging in sexual activity. Egocentrism is best described as adolescents' use of their newly acquired imaginative capacity to imagine themselves as having a grandiose life and having a special existence. Elkind (1967) referred to this as "personal fable" and part of it is that adolescents ignore or fail to recognize the possibility of their future being disrupted by injury, death, legal prosecution or any other negative consequence of their actions. Arnett (1995) pointed out that adolescents are able to recognize these consequences as being a possibility for others, but not for themselves and for this reason they are more likely to engage in health risk behaviors. Arnett (1995) identified the role of testosterone in puberty as being responsible for aggressiveness in adolescents, because higher levels of testosterone are associated with higher levels of aggressiveness. He argued that higher levels of testosterone are present in boys and girls at the end of puberty and declines by individuals' mid-twenties. Risky driving and criminal behavior are both highly correlated with aggressiveness, and as previously mentioned, automobile accidents are a leading cause of deaths among adolescents. Arnett (1995) argued the importance of studying these variables in the cultural socialization environment, since all adolescents undergo the same hormonal changes, but prevalence rates of health risk behaviors differ across cultures.

In their review of studies on adolescent smoking, Conrad et al. (1992) confirmed Arnett's (1995) argument for smoking tobacco, a more specific health risk behavior.

Conrad et al. (1992) recognized that 77% of the studies that included intrapersonal variables were able to pinpoint it as a significant predictor of adolescent smoking. Intrapersonal variables included locus of control, tolerance of deviance, curiosity, independence, rebelliousness/risk taking, intelligence, constructiveness, submissiveness, aggressiveness, social helplessness, self esteem, personal efficacy, emotional well-being, social expectancy, short time orientation, distress/stress, and refusal skills. Of the intrapersonal variables identified, rebelliousness/risk taking, and self esteem were established as the most significant predictors of adolescent smoking.

Similarly, Shedler and Block (1990) argued for underlying psychological differences in people who choose to use illicit drugs frequently, experimentally or not at all and that their choice to use drugs is a symptom of their psychological and social maladjustment as opposed to a cause. In there longitudinal study that followed children from preschool up to 18 years of age, Shedler and Block (1990) observed that frequent users of marijuana at age 18 years tended to have poor impulse control and to be alienated and distressed compared to experimenter users. In contrast, abstainers tended to have poor social skills and to be emotionally constricted, and anxious compared to experimenter users. These differences between the three groups at age 18 years were noticeable in assessments at ages 7 and 11 years, as was poor maternal parenting in frequent users and experimenter users. Shedler and Block (1990) concluded that quality of interpersonal relations (warm interpersonal relationships, alienation, distrust), subjective distress (self devaluation, emotional distress, sense of personal well being), and ego control (impulse control, impetuousness, conformity) were relevant personality variables in understanding adolescent marijuana use. Although quality of interpersonal relations and subjective distress showed a U-shaped relationship to marijuana use, ego control produced a more linear relationship, with frequent users having poorest impulse control. No environmental variables were assessed, which is an important limitation to the study.

Kaplan et al. (1984) studied pathways to adolescent substance use (alcohol, marijuana) and highlighted self-derogation as one of four variables that provided explanations for adolescent substance use. The premise for self-derogation is that an individual has little sense of self and negative self attitudes due to rejection from valued others, Kaplan et al. (1984) explained that this rejection, will likely lead to the individual associating these experiences with failure to attain self accepting attitudes. Kaplan et al. (1984) hypothesized that this association of negative experiences contribute to adolescent drug use in two ways. Individuals with a derogated sense of self lack motivation to conform to normative culture but acquire motivation to deviate and they are also motivated to develop deviant patterns so they can achieve self acceptance. Kaplan et al. (1984) showed that after rejection from others, adolescents lost motivation to conform to their social group. They then formed deviant associations and developed deviant behavior patterns, more specifically they engaged in drug use. They also determined that early self-derogation predicted later self derogation which in turn predicted drug use.

Conrad et al. (1992) and Shedler and Block (1990) both provide evidence for considering impulse control when studying adolescent risk behavior and Arnett (1995) stressed the importance of sensation seeking in adolescence. Sensation seeking paired with poor impulse control could possibly be more predictive of adolescents' inclination to engage in health risk behaviors. For example, someone who is a high sensation seeker with poor impulse control may be more likely to seek out the most thrill rewarding activities and engage in them without thinking about consequences. Not considered, however, in this scenario are opportunities for engaging in these activities. Ecological variables become important, therefore, in predicting behavior and in developing prevention interventions. Similarly, Conrad et al. (1992), Shedler and Block (1990) and Kaplan et al. (1984) all recognized self esteem, specifically negative self concept to be a

significant predictor in adolescent drug use, but as mentioned before these studies failed to assess the environmental context.

I propose that the predictive capabilities of impulse control, body and self image, and mastery of external world be assessed in a model that includes the environmental context of the individual such as the Bioecological Model. Because these variables are personal characteristics they should be conceptualized in the most inner circle of the model along with age and gender. The studies cited also failed to include adolescents' own belief about their risk vulnerability as predictors of substance use, which is important because adolescents tend to perceive themselves as being invulnerable (Elkind, 1967; Arnett, 1995) to harm. Based on the Health Belief Model, which will be discussed later, I propose that there is a direct path between risk perception and substance use and this path would be moderated by impulse control, body and self image, and mastery of the external world. I also hypothesize that impulse control, body and self image, and mastery of the external world will be predictive of risk perception of substance use and reported substance use.

Microsystem and Mesosystem Variables. As mentioned previously, the Microsystem is the immediate environment of the adolescent and consists primarily of the family and its functioning. Arnett (1992) in his article on socialization and adolescent reckless behavior introduced the concepts of broad and narrow socialization. Broad socialization is a culture in which people's individuality is valued over conformity and there are no set mores and belief systems on what constitutes acceptable behavior. Narrow socialization, on the other hand, is a culture in which children are socialized to follow an ideology with set mores for acceptable behavior and where conformity to society's standards is demanded and disobedience punished. He argued that the way in which families socialize their children could determine their propensity for engaging in risk behaviors. In families where children receive broad socialization, low supervision of adolescents' whereabouts occurs, and parents encourage their children to be

independent. In contrast, in families where there is narrow socialization more restrictions on behavior occur. Arnett (1992) reasoned that in families where there is narrow socialization, the likelihood of adolescents engaging in health risk behavior is considerably lower since parents can influence how adolescents' egocentrism and sensation seeking is manifested. He did mention that although control is important, research shows that control without warmth is unsuccessful in preventing adolescents from engaging in health risk behaviors (Patterson et al., 1992).

Avry et al. (1999) attempted to test the generalizability of Patterson et al. (1992) model of development of antisocial behavior in children to an older sample and to other adolescent heath risk behaviors, specifically substance use. The Patterson et al. (1992) model of development of antisocial behavior suggested that antisocial behavior is a variable of family and peer influence. They believe that if the child behaves inappropriately and the parent engage in harsh and inconsistent discipline then it would result in more aggressive behavior by the child. Then, the child becomes more coercive and parents react more inconsistently to avoid this until aggressive behavior becomes more established. When the behavior pattern is carried into the school, the child faces rejection from peers and forms friendships with other rejected peers who are just as aggressive and who shape and reinforce aggressive behavior. As a result, the child is at high risk for developing antisocial behavior. Avry et al. (1999) found that this model was applicable to adolescents and was indicative of general problem behavior syndrome, specifically substance use, academic failure, high-risk sexual behavior, and antisocial behavior in mid to late-adolescence. They concluded that despite the insurmountable evidence of peer influence on adolescent behavior, parent influence continues throughout adolescence to be a moderator for adolescent risk behaviors. Further evidence for family influence was put forward by Conrad et al. (1992), in their review of longitudinal studies of adolescent cigarette smoking. They identified social bonding as one of the predictors of adolescent smoking. One aspect of social bonding was family

bonding which included attachment to parents and parenting styles. They found that family bonding was supported in 60% of the studies that examined it. Similarly, Hundleby and Mercer (1987) examined family and friends' characteristics and relationship to adolescents as predictors of adolescents' alcohol, cigarette, and marijuana use. They measured family characteristics by examining parental style of control and interaction, parents' drug use and parents' norms on drug use. Hundleby and Mercer (1987) were able to attribute 10 -22 % of the variance in adolescent drug and alcohol use to family characteristics, with a majority of the variance being explained by the inclusion of drug and alcohol use items of family members. Hundleby and Mercer (1987) found parental affection to be a significant predictor of adolescent drug and alcohol use and parents' alcohol use to be more predictive of girls' behavior, especially girls' cigarette and alcohol use.

Family structure is another important variable in the Microsystem. Studies have shown that the size of the household and number of parents in the household are good predictors of adolescent substance use, general problem behavior, and psychological distress. Deleire and Kalil (2002) focused on family structure by measuring family structure when adolescents were in the 8^{th} grade and development outcomes when they were in 12^{th} grade, with self report of substance use (cigarettes, alcohol) being among these outcomes. They distinguished 10 family structures: never married single mother multigenerational, divorced single mother multigenerational, two biological cohabiting parents, step families, never married single mothers, divorced single mothers, single mothers with male cohabiters, single father families, grandparent headed with no parents households, and married parents. Deleire and Kalil (2002) found that adolescents belonging to all non-married parent family structures, with the exception of two, had poorer outcomes than those in married parent families. They found that adolescents in never married single mother multigenerational families were less likely to smoke and drink than those in married parent families. In contrast, adolescents in divorced single

mother multigenerational households were no more likely to smoke and drink than those in married parent families. Adolescents in never married single multigenerational families were also less likely to use substances than those in never married single parent families and cohabiting families. No significant differences were found for adolescents in divorced single parent multigenerational families and divorced single mother families or cohabiting families. In addition, adolescents in cohabiting and stepparent families had higher smoking and drinking rates than those in married parent families. Deleire and Kalil (2002) did not find support for demographic characteristics and income explaining the differences in substance use, furthermore despite their influence on youth outcomes, parental behavior, home and school characteristics, did not mediate the family structure effects.

Blum et al. (2000) studied the effects of race, ethnicity, income, and family structure on adolescents' engagement in health risk behavior. They used Problem Behavior Theory to examine how individual, behavioral, biological, and personality variables interact with perceived and actual social environments and how all these variables act as risk or protective variables for adolescents health risk behaviors. They identified adolescents of single parent families as being more likely to engage in cigarette smoking and alcohol use independent of income and race/ethnicity, with younger adolescents of single parent families having a stronger tendency to engage in alcohol use. They also found that White adolescents were more likely to smoke cigarettes than Blacks and Hispanics even after controlling for family structure and income. Whites were also 50% more likely to drink alcohol in the past year than Blacks and significantly more likely to drink alcohol than Hispanics. Blum et al. (2000) found that for younger adolescents as income increased the prevalence of cigarette smoking decreased, but in high school students the pattern was reversed. In addition, higher family income in high school adolescents was associated with higher alcohol use regardless of family structure and income.

According to Kandel (1980) "[The] extent of perceived drug use in the peer group, self-reported drug use by peers, and perceived tolerance for use are all strong predictors of a youth's subsequent initiation into use of alcohol, marijuana, or other illicit drugs" (p. 269). Arnett (1992) described broad socialization in peers associated with adolescent risk behavior as providing a group setting that promotes and rewards reckless behavior and also encouraging reckless behavior that an individual may be unwilling to do alone. He argued that reckless behaviors such as vandalism are rarely done alone and sometimes these behaviors may increase friendship bonds. In narrow socialization, friends who are unlikely to engage in risk behaviors may form bonds to encourage and strengthen that unwillingness in each other. Arnett (1992) stated that it is important to recognize that these peer relationships may not cause individuals to choose whether to engage in substance use. Rather, individuals may become friends with each other because of their initial propensity to engage in risk behaviors and their tendency to want to be around others who share their interests.

Similar to Arnett (1992), Kaplan et al. (1984) described peer influence as important because if individuals associate themselves with peers who view activities (e.g. illicit drug use) that are unacceptable in society as favorable then they are likely to take part in those activities. Peer subculture may encourage or require individuals to engage in illicit drug use such that individuals seeking acceptance and approval from the group may not only feel compelled to oblige but also judge their behavior by the group's standards. Peer subculture groups may also serve as more direct environmental forces by providing access to drugs and social settings for use. Kaplan et al. (1984) examined the direct path between belonging to a drug using peer network and adolescent drug use at three different time points over a 3-year period and found that adolescents who were part of a drug using peer network at Time 1, and Time 2 were users at Time 2 and Time 3, respectively. They also observed that early drug use was associated with increased involvement with drug using friends at follow up times.

Conrad et al. (1992) also looked at peer bonding as a feature of social bonding in their review of adolescent cigarette smoking, with peer bonding including number of friends someone has, social life, antisocial activities, and attachment. Peer bonding was supported in 73% of the studies that examined it. Hundleby and Mercer (1987) examined peer influence as predictors of adolescents substance use and assessed peer delinquent behavior, joint activities, achievement orientedness, subgroup conformity and alienation, divisiveness, interpersonal enjoyment, friends drug and alcohol use, and friends pressure toward drug and alcohol use. They found that 25 -39% of the variance could be explained by friend characteristics, and the majority of the variance was explained by the inclusion of drug and alcohol use items of others.

Hundleby and Mercer (1987) observed that although friend drug and alcohol use accounted for almost all the predictive power in friendship characteristics, delinquent behavior of friends was also a significant predictor of adolescent drug and alcohol use suggesting the possibility of drug and alcohol use belonging to a larger grouping of delinquent behavior. Friends' lack of achievement orientation was also a good predictor of adolescent drug use. Hundleby and Mercer (1987) did not find a relationship between family and friend characteristics. Prinstein et al. (2001) also studied the variables that altered or enhanced peer influence on adolescents health risk behaviors and found peers' substance use (cigarette, alcohol, marijuana) to be a significant predictor of adolescents' substance use and cigarette use to be negatively related to friends prosocial behavior. Peers deviant behaviors were also significant predictors of adolescent binge drinking and marijuana use. Adolescents' substance use was associated with physical fighting. In contrast to Hundleby and Mercer (1987), Prinstein et al. (2001) determined that high levels of family dysfunction coupled with high levels of friends health risk behaviors were predictive of highest levels of adolescents health risk behaviors, followed by the combination of high levels of friends behaviors and low family dysfunction, then low levels of friends behaviors and high levels of family dysfunction. The lowest level of

adolescent health risk behaviors was predicted by low levels of friends' behaviors and low levels of family dysfunction.

Ianotti et al.'s (1996) 4-year longitudinal study of 4th and 5th grade students on the extent to which perception of peer behaviors was associated with students' substance use compared to actual peer behaviors is another example of the importance of peers influence on adolescent substance use. They found that students' beliefs about peer use were more predictive of students prior substance use than their friends' actual use and the influence of perceptions of friends' use was positively correlated with age. They also examined the likelihood of friends' actual substance use being a stronger predictor of students' substance use than classmates substance use and found the opposite to be true. Ianotti et al. (1996) investigated whether preadolescents' substance use was more strongly correlated to classmates' attitudes compared to their actual behavior and found it to not be as significant a predictor as classroom use. They examined the effect of perceived family use on adolescents' substance use and found this to be the second best predictor of substance use, with perception of peer use being the most significant contributor.

As previously stated Mesosystem variables are interactions between two or more Microsystem and although some Mesosystem variables were examined in the previous studies, Tinsley et al. (1995) provided a good example of the importance of the Mesosystem in studying adolescent substance use. Tinsley et al. (1995) considered developmental status and gender when they examined how children engaged in health related decision making. They used a behavioral decision making approach to determine how the source of influence on health decision making changes at different ages and the impact of gender on these decisions. Three categories of sources of influence were proposed. The first one was social influences (i.e. mother, father, teacher, friends and information sources), the second was positive influence (i.e. habit and enjoyment), and the last source of influence was negative influence (i.e. health value and worry). Tinsley

et al. (1995) found that high school students were more likely than elementary school students to be influenced by all three sources of influence when deciding to exercise, but when deciding to use cigarette or alcohol only social influence and negative influence affected their decisions. They also determined that the grade by gender interaction and grade by influence interaction was predictive of cigarette and alcohol use. Specifically, they found that cigarette and alcohol use was higher with each grade level and that girls engage in these behaviors slightly more than boys. Tinsley et al. (1995) confirmed that social influences and negative influences were negatively associated with risky behavior and positively associated with preventive behaviors, suggesting that personal concerns and others influences were considered in the decision making process of whether to engage in certain behaviors. They also found that positive influences were predictive of all behaviors except alcohol use, with it being most predictive of older students' cigarette and seat belt use. Elementary school students reported more positive health habits toward risky behaviors but negative health habits to preventive health behaviors.

Summary of Microsystem and Mesosystem Variables. In summarizing the predictive capabilities of the Microsystem variables to predict substance use in adolescents, multiple parent and peer variables seem to be important. Hundleby and Mercer (1987) provided evidence for the importance of parent use and Ianotti et al. (1996), stressed the importance of perceived family use in predicting adolescent substance use. Deleire and Kalil (2002) and Blum et al. (2000) highlighted the importance of family structure. The former found coming from a multigenerational single parent household was a protective variable and the latter found living in a single parent household was a risk variable for adolescent substance use. Conrad et al. (1992), Hundleby and Mercer (1987), and Avry et al. (1999) determined that family bonding was also a significant predictor of substance use. The importance of peer use was also stressed by Kaplan et al. (1984), Hundleby and Mercer (1987), and Prinstein et al. (2001). Ianotti et al. (1996) argued that an adolescent's perception of friends use was

more significant than their friends' actual use. Peer prosocial behavior and peer delinquent behavior were supported by numerous studies as being significant predictors of adolescents' substance use (Kaplan et al., 1984; Hundleby and Mercer, 1987; Conrad et al., 1992 & Prinstein et al., 2001). The last peer variable proven to be a good predictor of substance use in adolescents is peer norms (Avry et al., 1999; Arnett, 1992; Kaplan et al., 1984). Most of these studies included Mesosystem variables by studying the interactions of Microsystem variables. Mesosystem variables was also prominent in Tinsley et al (1995), with age and gender, the two variables most salient to development, being highlighted as having the most influence on other Microsystem variables.

Similar to the studies focusing on the intrapersonal variables of adolescence and substance use, these studies fail to consider the likelihood of adolescents' risk perception being a predictor of their substance use. In addition, although some of these studies assessed intrapersonal variables, no one study assessed all the intrapersonal and Microsystems variables highlighted here. The proposal for including intrapersonal variables in a Bioecological Model would not make sense unless social and ecological factors were added. Therefore, I propose that the Microsystem variables investigated in the study include parent use, parent norm, family type, peer norm, peer delinquent behavior, peer prosocial behavior, and peer use. Further, I hypothesize that these Microsystem variables will predict both adolescent substance use and risk perception above and beyond the intrapersonal variables and will moderate the path between adolescent risk perception and substance use. Because of the developmental nature of this study and previous literature emphasizing the importance of parent and peer influences, I also propose that Mesosystem variables include two way interactions of age x gender, age x parent norm, age x peer norm, gender x peer norm, and gender x parent norm. I hypothesize that these Mesosystem variables will predict adolescent substance use and adolescent risk perception above and beyond the intrapersonal variables and the

Microsystem variables and will moderate the path between adolescent risk perception and substance use.

Exosystem Variables. The Exosystem is the most distal system in the Bioecological Model, but its importance should not be underestimated. In studying adolescent substance use, one has to ask themselves "how do adolescents find out about illicit substances and how do they get access to them?" Exosystem variables may help answer these questions because they include the actual living environment of the adolescent, where protective variables may be less individually tailored. In studying adolescent substance use, the school is viewed as an Exosystem variable because it has its own culture and may provide opportunities for the child to gain access to substances. Arnett (1992) also conceptualized schools into broad and narrow socialization. Schools with broad socialization are more likely to be less structured, place little emphasis on discipline, poorly monitor attendance, and not have uniforms or dress codes. In contrast, schools with narrow socializations would demonstrate inverse characteristics. Arnett (1992) argued that students in schools with narrow socialization are less likely to partake in reckless behaviors and these schools are most likely to be private – religious or non-religious schools.

Allison et al. (1999) conducted a study examining the influence of the school and neighborhood context in adolescent drug use and their ability to predict use above and beyond peer and parent influence, thus examining variables in the Microsystem and the Exosystem. They pointed out that students' perception of drug use in the school and among peers were good predictors of their own drug use. They highlighted the important role schools play in students' drug use by providing social norms for use and access and availability for drugs. Ianotti et al. (1996) also argued the importance of student's perception of drug use in the school, concluding that this may be a reflection of social and environmental conditions (e.g., neighborhood availability of drugs, neighborhood values concerning substance use) that promote or deter drug use.

The importance of socioeconomic status (SES) has been addressed throughout this proposal. In addition to findings previously mentioned, Conrad et al. (1992) found lower SES to be predictive of adolescent smoking in 76% of the studies in which it was measured. Hundleby and Mercer (1987) found SES to be negatively related to substance use in boys but no relationship was found with girls' substance use. SES and school cultures are Exosystem variables in this study. As in the other Bioecological systems, the likelihood of these variables predicting risk perception has not been addressed, nor have these variables been included with all the other variables in the proposed Bioecological Model to predict substance use. I propose that these Exosystem variables be added in the outer most circle of the proposed Bioecological Model. I hypothesize that Exosystem variables will predict risk perception and substance use above and beyond variables in the intrapersonal domain, the Microsystem and the Mesosystem and that these variables will also moderate the path between adolescent risk perception and substance use.

The Health Belief Model

Bronfenbrenner and Morris (2006) argued that the purpose of a research design using the Bioecological Model is not to test for significance but to develop hypotheses with adequate explanatory power and precision that would justify empirical testing. They explained that the goal should be discovery instead of verification and for this reason theory is critical.

One of the limitations of using the Bioecological Model in research design is that it lacks specificity and predictive power. Bronfenbrenner and Morris (2006) suggested that researchers apply a generative process to research design to address this problem. A generative process entails incorporating into the research design different variables that are more precise than those already included in the existing theoretical model and testing

for scientific soundness. This process is repeated until one is able to formulate hypotheses that are theory driven and can be scientifically verified.

The Bioecological Model consists of variables that are important to consider when studying child and adolescent populations. However, given its limitations and the suggestions made by Bronfenbrenner and Morris (2006), it is practical to test adolescent health risk behavior within a more specific theory that has predictive power and is more specific within the context of the Bioecological Model, thus employing a generative process.

The Health Belief Model, as shown in Figure 2, is a predictive theoretical model. The Health Belief Model assumes that individuals will not seek out health care or screening unless they have some level of knowledge and motivation, see themselves as being vulnerable to a condition, perceive the condition as threatening, believe interventions to be beneficial, and identify few difficulties in implementing the intervention. The Health Belief Model was first introduced by Rosenstock (1966; 1974) and its main dimensions and pathways were developed from established behavioral and psychological theories, particularly the work of Lewin et al. (1944). The Health Belief Model is similar to decision making theories in that it focuses on a goal, personal motivation, and probability of attaining that goal. Becker et al. (1977) stressed the applicability of the model to non-preventive health actions such as explaining illness, sick role behaviors, and cigarette smoking behaviors.

One element of the Health Belief Model (see Figure 2) is perceived susceptibility and severity. Perceived susceptibility is one's belief about how likely she is to contract a disease and severity is ones belief about how harmful the disease is to her. Another element is perceived benefits versus perceived barriers, which refers to one's opinion on how likely the intervention is to reduce severity and susceptibility in relation to the perceived costs associated with partaking in the intervention. The final element, a cue to

action, is the internal or external stimulus that encourages the individual to engage in the appropriate health behavior.

Bush and Ianotti (1990) argued that the Health Belief Model was created for adults and failed to include developmental variables, therefore, it was not specific to children and should be modified. They identified three conceptual models as being relevant when studying the health of children: social learning theory (SLT), cognitive development theory (CDT), and behavioral intervention theory (BIT), with SLT being the most dominant. SLT proposed by Bandura (1972) deduces that behaviors are modified and learned due to negative and positive influences in the child's social and physical environment. CDT focuses on children's cognitive capacity to understand social and physical events based on their developmental level. The child's perception of the environment is more important than the actual environment (Inhelder and Piaget, 1958). BIT includes reference group norms and highlights behavioral intentions as the best predictors of behavior (Fishbein and Ajzen, 1975). Bush and Ianotti's (1990) Child Health Belief Model, shown in Figure 3, includes ideas from these three conceptual models so as to better understand a child's behavior, intentions, and reasoning. Although this model was created for children suffering with chronic illnesses, it explains some of the developmentally specific variables that influence adolescents' decisions to engage in health risk behaviors (e.g., parent variables) otherwise unexplained by the Health Belief Model, especially since egocentrism or "personal fable" is synonymous with perceived susceptibility or risk.

The Child Health Belief Model was created to explain preadolescents' medical adherence and as a result, the developmental variables they identified as most salient were caretakers' motivations. In studying adolescents' health risk behaviors however, parents attitudes and behaviors are important but other developmental variables, specifically those included in the proposed Bioecological Model may be just as influential thus providing the need to further modify the Child Health Belief Model to

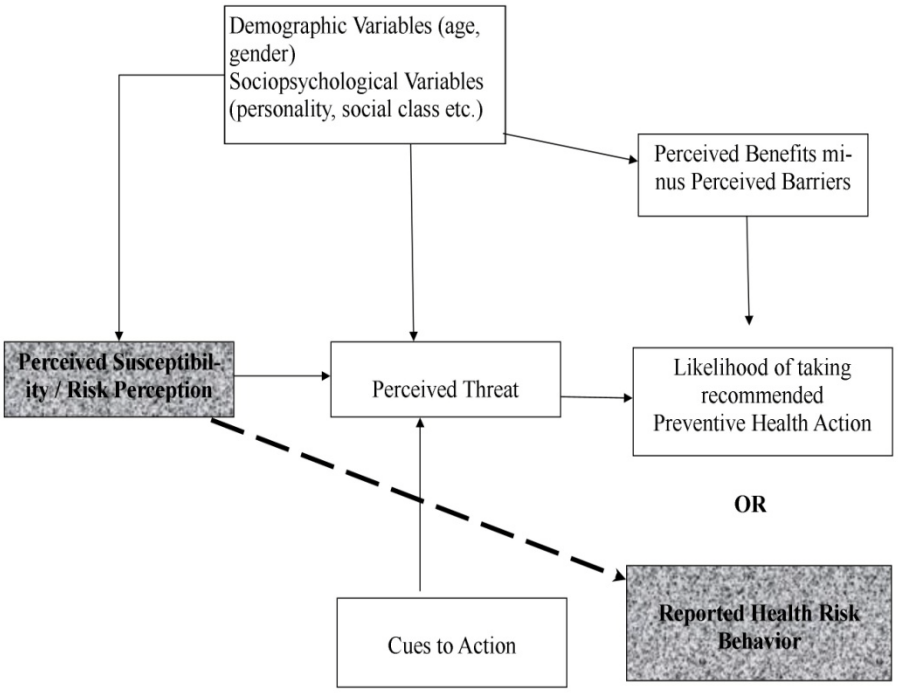

Figure 2. The Health Belief Model (adapted from Becker et al., 1977)

address this. I propose that the results of this thesis will further inform the adaptation of the Health Belief Model and the Child Health Belief Model into the Adolescent Health Belief Model by exploring the developmental variables specific to adolescence. The Health Belief Model and the Child Health Belief Model were both conceptualized to explain preventive behavior and behavioral change. For this proposal, however, the Health Belief Model will be used to explain risk behavior. As shown in Figure 4, the direct path between risk perception and reported health risk behavior will be explored.

Risk Perception. Perceived susceptibility and severity, also called risk perception, in adolescents have been argued to be one of the contributing variables of their high involvement in health risk behaviors. It is believed that adolescents perceive themselves to be invincible to injury or death due to them imagining themselves as having a special existence and purpose (i.e., believing a *personal fable*; Elkind, 1967). Cohn et al. (1995) explored the differences between adolescent and adults in their risk perception of health risk behaviors and unrealistic optimism associated with engaging in health risk behaviors. They measured parents' and adolescents' (13-18 years) risk perception for 14 health risk behaviors, including skateboarding, pigging out, drinking alcohol, using diet pills, smoking cigarettes, not using seat belts, getting drunk, sniffing glue, driving home after a few beers, drag racing, using steroids, smoking marijuana, using cocaine, and driving intoxicated. Participants were required to rate the risk associated with these behaviors and frequency of engaging in them (i.e., done "experimentally", "occasionally", or "frequently"). Cohn et al. (1995) found small but significant differences in male and female adolescents' ratings of risk perception with males risk perceptions being rated lower. No age difference or sex by age difference was found. In all three categories of use frequency, adolescents perceived risks

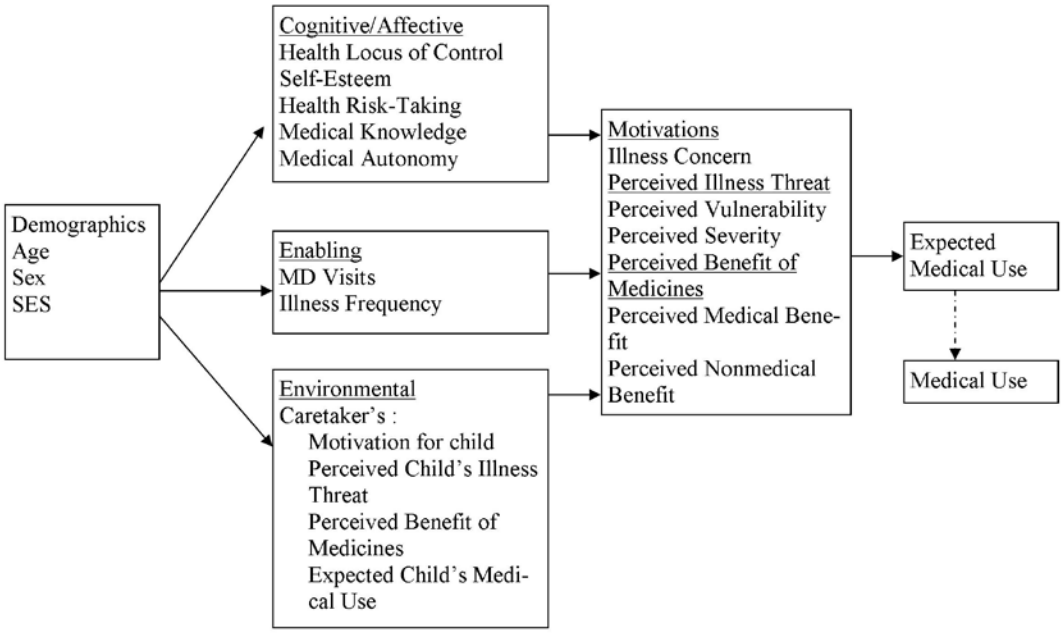

Figure 3. The Child Health Belief Model (adapted from Bush and Ianotti, 1990)

significantly lower than their parents, although the gap between adolescent and parent risk perception was largest for experimental use and smallest for frequent use. The largest parent-adolescent differences were found in the ratings of sniffing glue experimentally and not using seat belts experimentally. Parents also rated nine health risk behaviors (i.e., smoking cigarettes, getting drunk, driving after drinking, smoking marijuana, drinking alcohol, drag racing, using diet pills, not wearing seatbelts)as being significantly more harmful to their children than to themselves. Parents were also asked to rate the risk associated with their teenager engaging in a health risk behavior, Cohn et al. (1995) identified large discrepancies of adolescents' risk ratings and parents' ratings for experimental alcohol use and found that adolescents rated themselves as less likely to be at risk for negative events if they engaged in health risk behaviors compared to peers of similar age. However, adolescents who engaged in health risk behaviors frequently were less likely to report unrealistic optimism than adolescents who engaged in them experimentally or occasionally.

These findings contradict predictions of the Health Belief Model, which assumes that individuals who perceive health risk and threat as high are less likely to engage in health risk behaviors. One possible explanation for this contradiction might be that adolescents' perceptions change as they move from experimental to frequent use. However, because of the possibility of addiction and abuse associated with the health risk behavior, perceived threat is not sufficient to deter or stop the behavior. One limitation of Cohn et al. (1995) is that they failed to examine the psychosocial and ecological variables associated with individuals risk perception and reported health risk behaviors. In addition, although they examined the relationship between unrealistic optimism, which is a variable of risk perception, and reported health risk behavior, they did not explore the relationship between reported risk perception itself and reported health risk behavior. These two limitations will be addressed in this proposal for three

of the health risk behaviors examined by Cohn et al. (1995), alcohol use, smoking cigarettes, and marijuana use.

Integration of the Bioecological Model and the Health Belief Model

Combining the Bioecological Model and the Health Belief Model provides the unique opportunity of assessing adolescents' decisions to engage in health risk behaviors. By superimposing the Bioecological Model on risk perception, reported substance use and the path between risk perception and substance use (see Figure 4), I propose to better understand how bioecological variables influence adolescents' decisions and variables affecting those decisions. Risk perception has been pinpointed as important to adolescents' decision to engage in health risk behavior, but little research has emerged to understand why some adolescents engage in health risk behaviors in spite of having the same risk perception as adolescents who refrain from health risk behaviors. As mentioned previously, Bronfenbrenner and Morris (2006) proposed that the Bioecological Model should be part of a generative process that is integrated with specific prediction theory. The Health Belief Model provides the theory that risk perception is negatively related to health risk behavior, and the Child Health Belief Model provides some developmentally focused variables, but they both lack bioecological variables that are key players in adolescents' decision making. The variables in the proposed Bioecological Model provide a starting point for understanding the decision making that occurs and the difference in the path between risk perception and health risk behaviors adolescents at different ages choose.

The Bioecological Model proposed in this study will assess intrapersonal and environmental variables proven by researchers to be important to understanding adolescent substance use. Intrapersonal variables proven to be important include age,

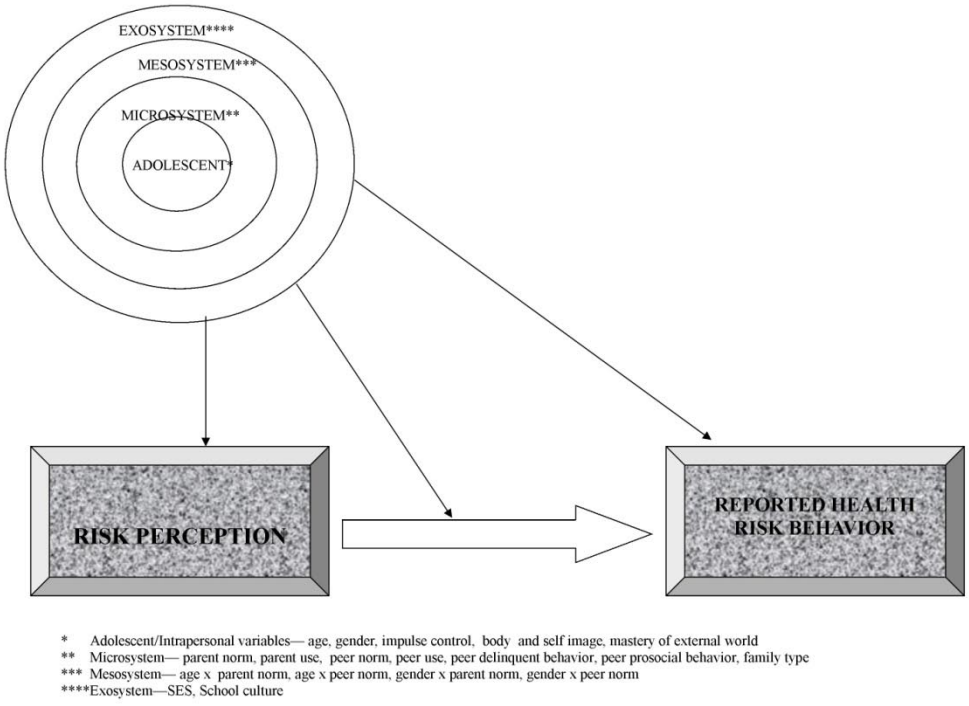

Figure 4. The Integration of the Bioecological Model and One Path in the Health Belief Model

gender, impulse control, body and self image, and mastery of external world (Bronfenbrenner & Morris, 2006; Conrad et al., 1992; Shedler & Block, 1990). Important Microsystem variables include parent use, parent norm, family type, peer norm, peer delinquent behavior, peer prosocial behavior, and peer use (Hundleby and Mercer, 1987; Ianotti et al., 1996; Deleire and Kalil, 2002; Avry et al., 1999; Prinstein et al., 2001). Because of the developmental emphasis of the study, important Mesosystem variables will include the interaction of age and gender with Microsystem variables (Tinsley et al., 1995). Exosystem variables include SES and school culture (Conrad et al., 1992; Allison et al., 1999). Knowledge of how these variables interact with risk perception to predict substance use may be helpful when planning prevention interventions and also when treating adolescents with substance abuse problems. For this reason, I will examine the predictive power of the bioecological variables in predicting risk perception and substance use, and also the ability of the bioecological variables to moderate the path between risk perception and reported substance use.

Hypotheses

Hypothesis I. I hypothesize that the variables in the Bioecological Model will significantly predict risk perception of smoking cigarettes, marijuana use and alcohol use. Based on the Bronfenbrenner and Morris' (2006) argument of more nested variables being more influential on the adolescent, I hypothesize that intrapersonal variables will be more predictive than the other variables in the model, Microsystem variables will be more predictive than Mesosystem and Exosystem variables, Mesosystem variables will be more predictive than Exosystem variables, and Exosystem variables will be least predictive of risk perception of substance use than the other bioecological variables. See Appendix I for specific exploratory hypotheses within the model.

Hypothesis II. I hypothesize that the variables in the Bioecological Model will significantly predict reported substance use (i.e., tobacco, marijuana, alcohol). I hypothesize that intrapersonal variables will be more predictive than the other variables in the model, Microsystem variables will be more predictive than Mesosystem and Exosystem variables, Mesosystem variables will be more predictive than Exosystem variables, and Exosystem variables will be least predictive of reported substance use than the other bioecological variables. See Appendix II for more specific exploratory hypotheses within the model.

Hypothesis III. I hypothesize that the variables in the Bioecological Model will moderate the path between risk perception and each reported health risk behavior (i.e., tobacco, marijuana, alcohol). I hypothesize that the most nested variables in the model will moderate the path more significantly than the outer variables. See Appendix III for more specific hypotheses.

METHOD

Procedures

This study is based on an archival dataset. The data was collected as part of a project entitled "Impacts of Social and Environmental Factors in the Formation of Adolescent Health-Endangering Behaviors." The data was gathered using the Adolescent Health Risk Behavior Survey (AHRB) developed by Omori and McKyer in 2005, modified from one developed by Omori and Ingersoll (2005) [personal communication, McKyer, 2008]. Participants for the study were recruited from public and private schools (elementary, middle and high schools) in Indiana. Schools were invited to have their students from grades 7 through 12 participate in the study and the schools were given $300 toward their alcohol, tobacco and other drug use prevention programs after receipt of surveys by the researchers. Passive consent by parents was used. Adolescents without parental consent were not given surveys and those with parental consent who did not wish to participate were not forced to participate. The surveys were distributed in the classrooms, and each classroom was provided with a large manila envelope to hold the completed surveys. The teachers or administrators distributed the blank surveys and the students placed their completed survey in the manila envelope without revealing their answers to the teacher or administrator. The teacher or administrator sealed the manila envelope containing all the completed surveys and mailed it to the Principal Investigator. The teacher or administrator was not allowed to view the completed surveys at any time. The survey was completely anonymous; students were not required to provide any identifying information and were instructed to complete the survey privately.

Participants

As shown in Table 1, participants included 1820 adolescents in grades 7 through 12 from a suburban Indiana area and their ages ranged from 10 to 19 years (M = 15.36 years, SD = 1.892). These participants were recruited from 16 public schools and 7 private schools. Of the public schools, ten were elementary schools, three were middle schools and three were high schools. Of the private schools, six were parochial and one was non-parochial, and four were elementary and middle school combined, two were Pre-K -12th grade and one was a high school. Participants were predominantly White and varied in socioeconomic status.

To identify the variable "Family Type," participants were asked to identify all the family members they lived with. This variable was originally divided into single parent homes, two parent homes, single multi-generational homes and two parent multi-generational homes but because only 2.5% of the sample reported belonging to multigenerational homes, it was subsequently divided into single parent (15.8%) and two parent homes (84.2%).

T-tests were computed to test for significance between age and school culture (t = -1.791, p = 0.073), and age and gender (t = 0.87, p = 0.382) and the results confirmed that age was comparable across school culture and gender. A significant t was found between age and family structure (t = -3.84, $p < 0.001$), and a significant χ^2 was found for school culture and family structure (χ^2 = 7.73, p = 0.005), therefore family structure coefficients should be interpreted with caution. The χ^2 for gender and school culture (χ^2 = 0.04, p = 0.847) and gender and family structure (χ^2 = 0.02, p = 0.879) was not significant.

Table 1. Demographic Information of Participants

	School Culture		
	Private N=824 (45.3%)	Public N=996 (54.7%)	Total N=1820 (100%)
Gender			
Male	366	438	804 (44.2%)
Female	396	465	861 (47.3%)
Missing	62	93	155 (8.5%)
Age			
10	0	1	1 (0.1%)
11	0	52	52 (2.9%)
12	64	20	84 (4.6%)
13	98	71	169 (9.3%)
14	118	156	274 (15.1%)
15	106	155	261 (14.3%)
16	129	165	294 (16.2%)
17	163	186	349 (19.2%)
18	85	146	231 (12.7%)
19	0	2	2 (0.1%)
Missing	61	42	103 (5.7%)
Family Type			
Single-parent Family	105	168	273 (15%)
Two-parent Family	694	764	1458 (80.1%)
Missing	25	64	89 (4.9%)

Table 1. Continued.

	School Culture		
	Private N=824 (45.3%)	Public N=996 (54.7%)	Total N=1820 (100%)
Father's Education			
Junior High School	10	25	35 (1.9%)
Senior High School	163	196	359 (19.7%)
College, Junior College	234	263	497 (27.3%)
Some Grad School/ Master's Degree	232	215	447 (24.6%)
Professional/Doctoral Degree	97	114	211 (11.6%)
Missing	88	183	271 (14.9%)
Mother's Education			
Junior High School	13	23	36 (2%)
Senior High School	141	199	340 (18.7%)
College, Junior College	317	338	655 (36%)
Some Grad School/ Master's Degree	226	216	442 (24.3%)
Professional/Doctoral Degree	62	63	125 (6.9%)
Missing	65	157	222 (12.2%)

Measures

Table 2. Mean, Standard Deviation and Range of Scaled Variables

Variable	Mean	Standard Deviation	Range
Impulse Control	3.36	0.74	0.86 - 5
Body and Self Image	3.51	0.89	0 – 5
Mastery of External World	3.88	0.76	0.2 - 5
Parent Norm			
Smoke Cigarettes	3.89	0.47	0 – 4
Alcohol	3.36	1.03	0 – 4
Illicit Drug	3.93	0.41	0 - 4
Peer Norm			
Smoke Cigarettes	3.54	0.85	0 – 4
Alcohol	2.58	1.33	0 – 4
Illicit Drug	3.67	0.78	0 - 4
Peer Use			
Smoke Cigarettes	0.77	1.18	0 – 5
Alcohol	1.22	1.51	0 – 5
Illicit Drug	0.45	0.97	0 - 5
Peer Prosocial Behavior	3.18	0.62	0 - 4
Peer Delinquent Behavior	0.32	0.70	0 - 4
Socioeconomic Status	0.0059	2.2	-5.56 – 9.15

Means, standard deviations, and ranges of scores for all variables used in analyses are provided in Table 2.

AHRB Survey. This survey was initially developed by Omori and Ingersoll (2005) and modified and revised by Omori and McKyer (personal communication, McKyer, 2008). The main changes made to the survey were the inclusion of items to assess incidence and prevalence of health risk behaviors such as alcohol, tobacco and other drug use and the exclusion of most of the questions assessing sexual behaviors and personal safety. The revised survey included 191 questions assessing egocentrism, self-esteem, social norms, risk perceptions, and the incidence and prevalence of health endangering behaviors with the emphasis on substance abuse. The survey also included items on demographics.

Impulse Control. To measure impulse control, Omori and Ingersoll (2005) adapted the impulse control subscale from the Offer Self-Image Questionnaire (OSIQ) created by Offer et al (1988) to measure domain-specific self image. The impulse control scale consists of seven items assessing adolescents' perception of their ability to exercise self control and to respond to unpleasant situations positively. Participants were asked to rate how well the items described them using a 6-point scale (1 = describes me very well, 2 = describes me well, 3 = describes me fairly well, 4 = does not quite describe me, 5 = does not describe me well, 6 = does not describe me at all).

Mean scores of the items were calculated for each participant and used in the analysis. The scale was reversed coded so that low scores indicated low impulse control. Confirmatory factor analysis (CFA) were calculated and produced factor loadings ranging from 0.3 – 0.63 and the scale's Cronbach's alpha was 0.64.

Body Image. Omori and Ingersoll (2005) also adopted the body and self image subscale from Offer et al (1988). Body image was measured using seven items including adolescents' perception of their body, their health and themselves in relation to

others. Participants were asked to rate how well the items described them using the same 6 point Likert scale used for impulse control.

Mean scores of the items were calculated for each participant and used in the analysis. The scale was reversed coded so that low scores indicate low body and self image. Confirmatory factor analysis (CFA) produced factor loadings ranging from 0.32 to 0.83 and the scale's Cronbach's alpha was 0.77.

Mastery of External World. The mastery of the external world subscale included five items that assessed adolescents' belief in their capabilities to accomplish tasks regardless of their level of difficulty. The 6-point Likert scale described above was also used for this subscale.

As was done for the impulse control and body and self image subscales, mean scores of the items were calculated for each participant and used in the analysis. This scale was also reversed coded so that low scores indicated low mastery of external world. Confirmatory factor analysis (CFA) produced factor loadings ranging from 0.33 to 0.71 and a Cronbach's alpha of 0.63.

Parent and Peer Norm. Parent and peer norm was measured by adolescents' rating how approving or disapproving they perceived their parent or close friend were about them engaging in each of the three behaviors: smoking cigarettes, alcohol use, and illicit drugs use. A 5-point Likert scale, ranging from Strongly Approve (0) to Strongly Disapprove (4), was used.

Parent Use. Parent use information was only available for smoking cigarettes. This information was gathered from adolescents' answer to the question if either mother or father or both parents smoke. No distinction between mother, father or both parents smoking was made in the analysis. This variable was dichotomized into "parents smoke" versus "parents do not smoke."

Peer Use. Information for all three substances was available. Participants were asked to identify what percentages of their friends engage in smoking cigarettes, drinking alcohol regularly and using illicit drugs. These percentages were recorded in 20% increments and this variable was treated as a continuous variable.

Peer Delinquent Behavior and Peer Prosocial Behavior. These variables were measured by asking participants to rate how much they would agree with eight statements about their friends. The statements included friends' belonging to gang, getting in trouble with police, disobedience to teacher, negative attitudes towards school, friends' positive attitude towards good grades, attitudes towards school and positive plans for the future. The ratings were on a 5-point scale ranging from Strongly Agree (0) to Strongly Disagree (4).

An exploratory factor analysis (EFA) resulted in two factors with two items not loading on any factors. Factor 1 included four items with factor loadings ranging from 0.58 to 0.66 and Cronbach's alpha of 0.75. The items assessed friends' positive attitudes towards school and positive plans for the future, this factor was labeled Peer Prosocial Behavior. Factor 2 included two items with factor loadings of 0.73 and 0.87 and Cronbach's alpha of 0.8. The items assessed friends' belonging to gang and getting in trouble with the police, this factor was labeled Peer Delinquent Behavior.

The mean scores for Peer Prosocial Behavior and Peer Delinquent Behavior were used in the analysis. The items were reverse coded so that high scores on Peer Prosocial Behavior indicated that peers display these behaviors and high scores on Peer Delinquent Behavior indicate that peers display these behaviors.

School Culture. This was based on whether the school was public or private and was based on Arnett's (1992) idea of narrow and broad socialization in schools.

SES. Socioeconomic status was measured by asking participants their parents' educational backgrounds and work status. Educational backgrounds included junior high school, senior high school, junior college/college work/college degree, some graduate work/master's degree, professional degree/doctoral degree (e.g., M.D., Ph.D.). Work status included if each parent worked full-time, part-time, or was not working. *Z* – scores were computed for both variables and added together to yield an SES estimate.

Risk Perception. Risk perception was measured by perceived personal risk, which is the extent to which the participant felt they would be at risk of getting sick or hurt if they engaged in any of the three behaviors. This was measured on a 7-point scale ranging from No Risk at all (0) to Very Much at Risk (7).

Reported Risk Behavior. Three questions were used to assess each of the three risk behaviors. Participants were asked if they ever engaged in the behavior, if they engaged in the behavior in the last year and if they engaged in the behavior in the last month. These responses were on a 5-point scale (0 = Never, 1 = 1-5 times, 2 = 6-19 times, 3 = 20-40 times and 4 = more than 40 times). An answer of 1 or higher to all three questions would classify the participant as a user while all others will be classified as non users. Alcohol use included drinking beer, wine, wine coolers and liquor and marijuana use included hashish or hash oil. Frequencies of Reported Health Risk Behaviors are shown in Table 3.

Table 3. Frequencies of Reported Health Risk Behaviors

Health Risk Behavior	Smoke Cigarettes (N = 1764)	Alcohol Use (N = 1651)	Marijuana Use (N= 1689)
Yes	210 (11.9%)	436 (26.4%)	116 (6.9%)
No	1592 (88.1%)	1215 (73.6%)	1573 (93.1%)

Statistical Analyses

Risk Perception and the Bioecological Model. Hierarchical linear regression was used to determine the ability of the variables in the Bioecological Model to predict risk perception. Hierarchical linear regression allows for the most salient variables to be entered into the equation first and other variables to be entered in subsequent steps. The theoretical framework of the Bioecological Model assumes that the most inner spheres of influence in adolescent behavior are most immediate; therefore these variables were inputted first. Intrapersonal variables (i.e., gender, age, impulse control, body and self image, mastery of external world) will be inputted in Step 1. Microsystem variables (i.e., parent use, parent norm, family type, peer norm, peer delinquent behavior, peer prosocial behavior, and peer use) were inputted in Step 2. Mesosystem variables (i.e., gender x age, gender x parent norm, gender x peer norm, age x parent norm, age x peer norm) were inputted in Step 3. Step 4 was comprised of Exosystem variables (SES, school culture). For each of the three health risk behaviors the corresponding risk perception for that behavior were predicted by inputting Bioecological variables in the order described above. The standardized coefficients were interpreted in the analyses.

Reported Risk Behavior and the Bioecological Model. Hierarchical logistic regression was used to determine the ability of the variables in the Bioecological Model to predict each reported risk behavior. Hierarchical logistic regression was used instead of hierarchical linear regression because reported risk behavior was dichotomized. The Bioecological variables were entered in the equation in the same steps entered in the equation for risk perception above. Logistic regression does not produce R^2, therefore Nagelkerke R^2 was interpreted in confirming the systems in the model ability to predict reported risk behavior. The exponential B (Exp[B]) produced in logistic regression is the odds ratio and was interpreted in the analysis.

Bioecological Model Moderating the Path between Risk Perception and Reported Risk Behavior. To test for moderation, interaction terms were computed for each of the variables in the Bioecological Model. This was done by multiplying the centered predictor scores by the centered risk perception scores. The systems in the Bioecological Model were entered in a hierarchical logistic regression with main effects for adolescent variables imputed in the first step, the interaction terms imputed in the second step, main effects for Microsystem variables imputed in the third step, the interaction terms were placed in the fourth step, main effect of Mesosystem variables in the fifth step and its interactions terms in the sixth step and finally the main effects of the Exosystem variables were imputed in the seventh step and its interaction terms in the eighth step. In so doing, all main effects were controlled for without removing a large amount of the variance at the start.

Centered Variables. Centering variables is particularly important for conducting the analysis in the third hypothesis, that is, that the Bioecological Model variables would moderate the path between risk perception and health risk behaviors. It is important for this hypothesis because if variables are centered, the interaction terms will be less correlated with other predictors and highly correlated predictors run the risk of producing peculiar coefficients and large standard errors that make interpretations complex. Another advantage of centering predictors is that the coefficients in the regression are comparable across the equation, given this advantage centered variables were used in the analysis of all three hypotheses. To center variables, the mean of each of the variables was subtracted from the individual scores. Categorical variables including gender, family structure, parent cigarette use, and school culture were not centered. Centering age was also unnecessary because it has a definite zero point.

RESULTS

Hypothesis I

Smoking Cigarettes. Results of the predictive ability of the Bioecological Model on adolescent risk perception of smoking cigarettes are shown in Table 4.

As hypothesized, adolescent variables entered into the first step of the hierarchical regression statistically significantly explained the variance in adolescent risk perception of smoking cigarettes ($\Delta R^2 = 0.05$, $F[5, 1230] = 13.03$, $p < 0.001$). As predicted, age was significantly negatively related to adolescent risk perception of smoking cigarettes ($\beta = -0.12$, $p < 0.001$), confirming that older adolescents had lower risk perception than younger adolescents. Also consistent with predictions, gender was a significant predictor of adolescent risk perception of smoking cigarettes ($\beta = 0.13$, $p < 0.001$). In addition, impulse control significantly predicted adolescent risk perception of smoking ($\beta = - 0.1$, $p = 0.005$), adolescents with high impulse control had higher risk perception. The other adolescent variables, body and self image and mastery of external world, did not significantly contribute to explaining the variance in adolescent risk perception of smoking.

Microsystem variables were entered into the second step of the hierarchical regression and after controlling for adolescent variables, this group of variables statistically significantly contributed to explaining the variance in adolescent risk perception of smoking cigarettes ($\Delta R^2 = 0.103$, $F [7, 1223] = 21.35$, $p < 0.001$). As hypothesized, parent norm was significantly associated with adolescent risk perception ($\beta = 0.07$, $p = 0.023$), adolescents whose parents were more disapproving of smoking cigarettes had higher risk perception than those whose parents were more tolerant. Peer use was also a significant predictor of adolescent risk perception for smoking ($\beta = -0.15$, $p < 0.001$), adolescents who had a greater percentage of peers who smoked cigarettes had lower risk perceptions about smoking cigarettes than others. Peer delinquent

Table 4. Results of Hierarchical Regression of Bioecological Model Variables on Adolescent Risk Perception of Smoking Cigarettes

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
1	**Adolescent**	**0.05*** **							
	Age		-0.12***						
	Gender		0.13***						
	Impulse Control		0.10**						
	Body and Self Image		0.04						
	Mastery of External World		0.06						
2	**Microsystem**			**0.103*** **					
	Age				-0.05				
	Gender				0.05				
	Impulse Control				0.06				
	Body and Self Image				0.01				
	Mastery of External World				0.003				
	Family Structure				-0.01				
	Parent Use				-0.05				
	Parent Norm				0.07*				
	Peer Use				-0.15***				
	Peer Norm				0.05				
	Peer Delinquent Behavior				-0.07*				
	Peer Prosocial Behavior				0.15***				
3	**Mesosystem**					**0.028*** **			
	Age						-0.14		
	Gender						-0.28		
	Impulse Control						0.06*		
	Body and Self Image						-0.02		

Table 4. Continued.

Model	Variables	ΔR²	β	ΔR²	β	ΔR²	β	ΔR²	β
	Mastery of External World						0.001		
	Family Structure						0.23		
	Parent Use						-0.06*		
	Parent Norm						0.17		
	Peer Use						-0.16***		
	Peer Norm						1.36***		
	Peer Delinquent Behavior						-0.03		
	Peer Prosocial Behavior						0.16		
	Age x Gender						0.34		
	Age x Parent Norm						[a]		
	Age x Peer Norm						-1.45***		
	Gender x Parent Norm						-0.11		
	Gender x Peer Norm						0.14		
4	**Exosystem**							**0.001**	
	Age								-0.13
	Gender								-0.26
	Impulse Control								0.64*
	Body and Self Image								-0.03
	Mastery of External World								0.001
	Family Structure								0.005
	Parent Use								-0.05
	Parent Norm								0.17
	Peer Use								-0.16***
	Peer Norm								1.36***
	Peer Delinquent Behavior								-0.03

Table 4. Continued.

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
	Peer Prosocial Behavior								0.15***
	Age x Gender								0.33
	Age x Parent Norm								[a]
	Age x Peer Norm								-1.46***
	Gender x Parent Norm								-0.11
	Gender x Peer Norm								0.15
	Socioeconomic Status								0.04
	School Culture								0.01

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$, [a] Could not be computed because of problems with Tolerance

behavior was negatively associated with adolescent risk perception (β = -0.07, p = 0.025), adolescents whose peers engaged in delinquent behaviors had a reduced risk perception of smoking cigarettes while peer prosocial behavior had an adverse effect (β = 0.15, $p < 0.001$), adolescents whose peers engaged in prosocial behaviors had a higher risk perception than others. Parent use was not a significant predictor of adolescent risk perception of smoking cigarettes but may be worth investigating again in future research (β = -0.2, $p < 0.060$). Other Microsystem variables, family type and peer norm, were not significant predictors of adolescent risk perception of smoking cigarettes.

Mesosystem variables were entered in the third step of the hierarchical regression, these variables were a select few of the interactions between the adolescent variables and the Microsystem variables. As hypothesized, after controlling for adolescent variables and Microsystem variables, this group of variables significantly contributed to the variance explained in adolescent risk perception of smoking cigarettes (ΔR^2 = 0.028, F[4, 1219] = 10.33, $p < 0.001$). In spite of the significant change in R^2, only the interaction of age and peer norm was significant in this group (β = -4.94, $p <$ 0.001), and as predicted the relationship between peer norm and risk perception was dependent on age such that the relationship was stronger for younger adolescents (see Figure 5). Specifically, younger adolescents' risk perception increased as their peers' disapproval of smoking cigarettes increased, while older adolescents' risk perception decreased as their peers' disapproval increased. The interaction of age and parent norm was originally included in the block but was subsequently excluded because of low tolerance (an indication of problem with multicollinearity).

Exosystem variables were entered in the final step of the hierarchical regression and this group of variables did not significantly contribute to the explained variance after controlling for the other systems in the Bioecological Model (ΔR^2 = 0.001, F[2, 1217] = 1.02, p = 0.362). No variable in this group reached statistical significance. When entered in the regression by itself, Exosystem variables significantly contributed to explaining

adolescent risk perception of smoking cigarettes, and of the variables in the system socioeconomic status was a significant predictor.

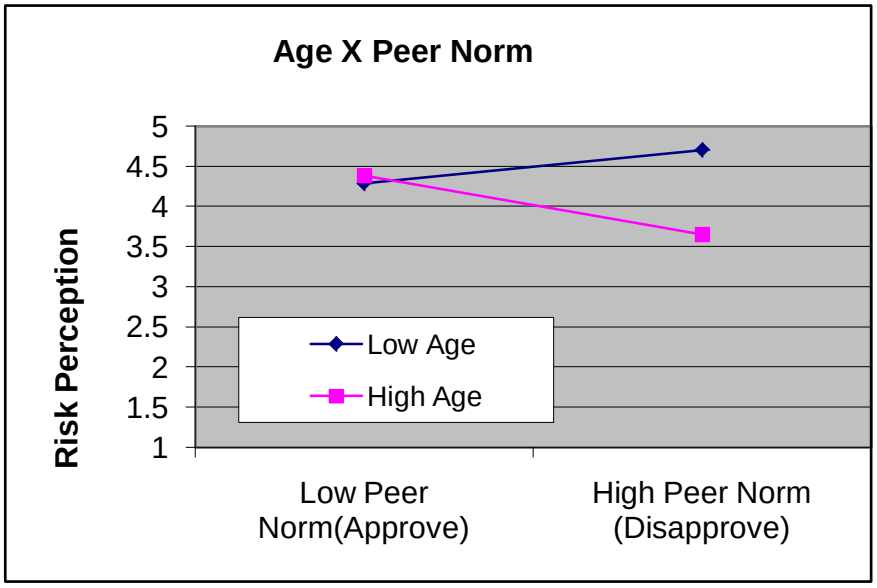

Figure 5. Graph Showing Interaction of Age and Peer Norm in Predicting Adolescent Risk Perception of Smoking Cigarettes

Alcohol Use. As shown in Table 5, the Bioecological Model was predictive of adolescents risk perception of alcohol use.

The first group of variables entered into the hierarchical regression, adolescent variables, significantly explained the variance in adolescents' risk perception of alcohol use ($\Delta R^2 = 0.09$, $F[5, 1286] = 27.68$, $p < 0.001$). As hypothesized, age was significantly negatively related to adolescent risk perception of alcohol use ($\beta = -.27$, $p < 0.001$), with older adolescents having lower risk perception than younger adolescents. Gender was also significantly related to adolescent risk perception ($\beta = 0.14$, $p < 0.001$) with female

adolescents having higher risk perception for alcohol use than male adolescents. Impulse control was significantly associated with adolescent risk perception of alcohol use ($\beta = 0.07$, $p = 0.046$), adolescents with low impulse control had higher risk perception. Body and self image, and mastery of external world were both insignificant predictors of adolescent risk perception of alcohol use.

With adolescent variables controlled for, the second group of variables entered into the hierarchical regression, Microsystem variables significantly explained the variance in adolescents' risk perception of alcohol use ($\Delta R^2 = 0.156$, $F[6, 1280] = 44.44$, $p < 0.001$). As hypothesized, parent norm was significantly positively related to adolescent risk perception ($\beta = 0.09$, $p = 0.002$), adolescents whose parents had higher parent norm scores (disapprove of alcohol use) had higher risk perception of alcohol. Similar, to parent norm, peer norm was also significantly positively related to adolescent risk perception ($\beta = 0.36$, $p < 0.001$), adolescents whose peers disapproved of alcohol use had higher risk perception of alcohol. Peer prosocial behavior was not a significant predictor of adolescent risk perception of alcohol use but indicated a trend in the hypothesized direction ($\beta = 0.05$, $p = 0.089$). None of the other variables (peer use, peer delinquent behavior, family type) in the Microsystem were significant predictors of adolescent risk perception of alcohol use.

The third group of variables entered in the hierarchical regression was the Mesosystem. This group of variables did not explain a significant amount of variance in adolescent risk perception of alcohol use after controlling for adolescent and Microsystem variables ($\Delta R^2 = 0.005$, $F[5, 1275] = 1.73$, $p = 0.125$). The age x gender interaction, however, was a significant predictor of adolescent risk perception ($\beta = -0.78$, $p = 0.004$), confirming the hypothesis that the relationship of age and risk perception of alcohol use was dependent on gender such that the relationship was stronger for female adolescents than for male adolescents (see Figure 6).

Table 5. Results of Hierarchical Regression of Bioecological Model Variables on Adolescent Risk Perception of Alcohol Use

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
1	**Adolescent**	**0.097*** **							
	Age		-0.27***						
	Gender		0.14***						
	Impulse Control		0.07*						
	Body and Self Image		0.04						
	Mastery of External World		-0.02						
2	**Microsystem**			**0.156*** **					
	Age				-0.13***				
	Gender				0.07**				
	Impulse Control				-0.01				
	Body and Self Image				-0.03				
	Mastery of External World				0.05				
	Family Structure				-0.01				
	Parent Norm				0.09**				
	Peer Use				-0.002				
	Peer Norm				0.36***				
	Peer Delinquent Behavior				0.017				
	Peer Prosocial Behavior				0.05				
3	**Mesosystem**					**0.005**			
	Age						0.11		
	Gender						0.81**		
	Impulse Control						0.02		
	Body and Self Image						0.03		

Table 5. Continued.

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
	Mastery of External World						-0.06		
	Family Structure						-0.02		
	Parent Norm						0.50		
	Peer Use						0.01		
	Peer Norm						-0.27		
	Peer Delinquent Behavior						-0.002		
	Peer Prosocial Behavior						0.05		
	Age x Gender						-0.78**		
	Age x Parent Norm						-0.37		
	Age x Peer Norm						0.61		
	Gender x Parent Norm						-0.04		
	Gender x Peer Norm						0.25		
4	**Exosystem**							**0.000**	
	Age								0.11
	Gender								0.80**
	Impulse Control								0.02
	Body and Self Image								0.03
	Mastery of External World								-0.06
	Family Structure								-0.02
	Parent Norm								0.50
	Peer Use								0.01
	Peer Norm								-0.27
	Peer Delinquent Behavior								-0.002
	Peer Prosocial Behavior								0.05

Table 5. Continued.

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
	Age x Gender								-0.78**
	Age x Parent Norm								-0.37
	Age x Peer Norm								0.60
	Gender x Parent Norm								-0.04
	Gender x Peer Norm								0.03
	Socioeconomic Status								0.01
	School Culture								-0.004

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

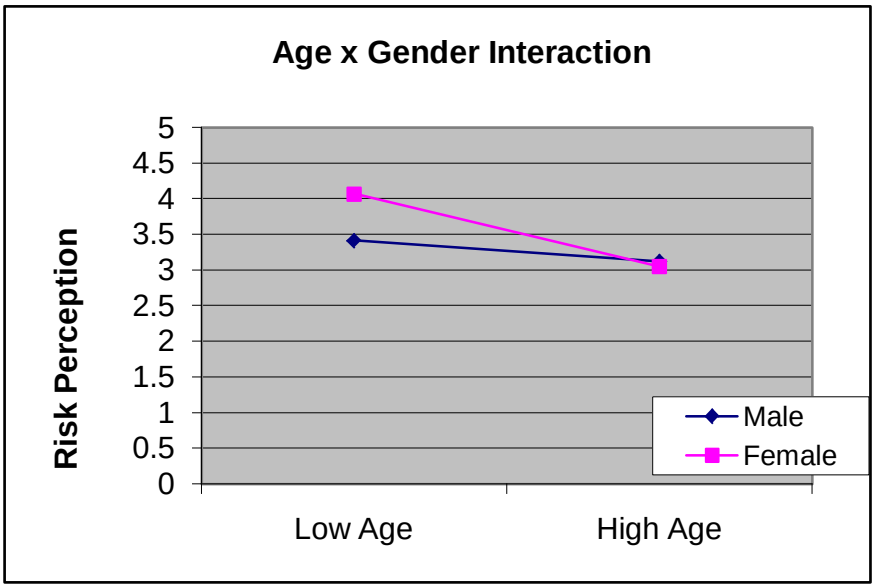

Figure 6. Graph Showing Interaction of Age and Gender in Predicting Adolescent Risk Perception of Alcohol Use

Similar to risk perception of smoking cigarettes, the Exosystem failed to explain significant variance in adolescent risk perception of alcohol use after controlling for all other systems in the Bioecological Model ($\Delta R^2 = 0.000$, $F[2, 1273] = 0.05$, $p = 0.955$). No Exosystem variable was significant. When entered in the regression by itself, the Exosystem significantly predicted risk perception of alcohol use, with both socioeconomic status and school culture significantly explaining adolescent risk perception.

Marijuana Use. As shown in Table 6, three of the systems in the Bioecological Model significantly predict adolescent risk perception of marijuana use.

Adolescent variables were entered in the hierarchical regression first and significantly increased the explained variance in adolescent risk perception of marijuana use ($\Delta R^2 = 0.058$, $F[5, 1313] = 16.24$, $p < 0.001$). Similar to smoking cigarettes and alcohol use, age was a significant predictor of adolescent risk perception of marijuana

use (β = -0.17, $p < 0.001$), confirming the hypothesis that older adolescents have lower risk perception than younger adolescents. Gender was another significant contributor to variance explained in adolescent risk perceptions of marijuana use ($\beta = 0.16$, $p < 0.001$), with girls having higher risk perceptions than boys. Although not a significant predictor, body and self image did approach significance in predicting adolescent risk perception. No other adolescent variables significantly contributed to explaining the variance in adolescent risk perception of marijuana use.

As hypothesized, after controlling for adolescent variables, Microsystem variables entered in the second step of the hierarchical regression resulted in a significant increase in the variance explained in adolescent risk perception of marijuana use ($\Delta R^2 = 0.169$, $F[6, 1307] = 47.52$, $p < 0.001$). Of the six Microsystem variables entered in the regression, parent norm was the only variable that was not a significant predictor of adolescent risk perception of marijuana use. As hypothesized, family type had a positive relationship with adolescent risk perception ($\beta = 0.08$, $p = 0.001$), meaning that adolescents who belonged to two-parent families were more likely to have a higher risk perception of marijuana use than those who belonged to single-parent families. Peer use (β = - 0.17, $p < 0.001$) and peer delinquent behavior (β = -0.06, $p = 0.023$) were both significantly negatively predictive of adolescent health risk perception of marijuana, therefore adolescents whose friends use marijuana or engaged in delinquent behavior were more likely to have a lower risk perception than other adolescents. Peer norm (β = 0.19, p <0.001) and peer prosocial behavior ($\beta = 0.13$, $p < 0.001$) significantly contributed to the explained variance in adolescent risk perception of marijuana use, with adolescents whose peers disapproved of marijuana use or engage in prosocial behavior having a higher risk perception of marijuana use than other adolescents.

Table 6. Results of Hierarchical Regression of Bioecological Model Variables on Adolescent Risk Perception of Marijuana Use

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
1	**Adolescent**	**0.058*** **							
	Age		-0.17***						
	Gender		0.16***						
	Impulse Control		0.001						
	Body and Self Image		0.06						
	Mastery of External World		0.04						
2	**Microsystem**			**0.169*** **					
	Age				-0.11***				
	Gender				0.05*				
	Impulse Control				-0.02				
	Body and Self Image				0.02				
	Mastery of External World				-0.04				
	Family Structure				0.08***				
	Parent Norm				0.03				
	Peer Use				-0.17***				
	Peer Norm				0.19***				
	Peer Delinquent Behavior				- 0.06*				
	Peer Prosocial Behavior				0.13***				
3	**Mesosystem**					**0.025*** **			
	Age						-0.14		
	Gender						-0.08		
	Impulse Control						-0.05		
	Body and Self Image						-0.01		

Table 6. Continued.

Model	Variables	ΔR²	β	ΔR²	β	ΔR²	β	ΔR²	β
	Mastery of External World						-0.01		
	Family Structure						0.09***		
	Parent Norm						-0.67***		
	Peer Use						-0.26***		
	Peer Norm						2.37***		
	Peer Delinquent Behavior						-0.06*		
	Peer Prosocial Behavior						0.13***		
	Age x Gender						0.13		
	Age x Parent Norm						[a]		
	Age x Peer Norm						-1.90***		
	Gender x Parent Norm						0.65***		
	Gender x Peer Norm						-0.29**		
4	**Exosystem**							**0.001**	
	Age								-0.16
	Gender								-0.12
	Impulse Control								-0.05
	Body and Self Image								-0.01
	Mastery of External World								-0.01
	Family Structure								0.09**
	Parent Norm								-0.67***
	Peer Use								-0.26***
	Peer Norm								2.31***
	Peer Delinquent Behavior								-0.06*
	Peer Prosocial Behavior								0.13***
	Age x Gender								0.17

Table 6. Continued.

Model	Variables	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
	Age x Parent Norm								[a]
	Age x Peer Norm								-1.84***
	Gender x Parent Norm								0.64***
	Gender x Peer Norm								-0.28**
	Socioeconomic Status								-0.02
	School Culture								-0.03

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$, [a] Could not be computed because of problems with Tolerance

The Mesosystem also significantly increased the variance explained in adolescent risk perception of marijuana use after controlling for adolescent and Microsystem variables ($\Delta R^2 = 0.025$, $F[4, 1303] = 10.97$, $p < 0.001$). As hypothesized, the interactions of gender and peer norm ($\beta = -0.29$, $p = 0.002$), and gender and parent norm ($\beta = 0.65$, $p < 0.001$) were significant. Contrary to what was predicted, the relationship of peer norm and risk perception was dependent on gender such that the relationship was positive and stronger for male adolescents (see Figure 7). Consistent to what was hypothesized, the relationship between parent norm and risk perception was dependent on gender such that the relationship was positive and stronger for female adolescents and for males, the relationship was negative (see Figure 8). The interaction of age and peer norm was also a significant predictor of adolescent risk perception of marijuana use ($\beta = -1.90$, $p < 0.001$) and as was predicted the relationship between peer norm and risk perception was positive and stronger for younger adolescents (see Figure 9). Similar to smoking cigarettes, the interaction of age and parent norm was originally added to this step in the regression but was subsequently deleted because of low tolerance. The age by gender interaction was not significant.

As seen on Table 6, the Exosystem was the only system in the Bioecological Model that failed to significantly contribute to explaining the variance in adolescent risk perception of marijuana use ($\Delta R^2 = 0.001$, $F[2, 1301] = 0.94$, $p = 0.389$) . None of the variables entered in this step of the regression were significant, however when entered in the regression by itself the Exosystem significantly predicted adolescent risk perception of marijuana use, and of the Exosystem variables, school culture was a significant predictor.

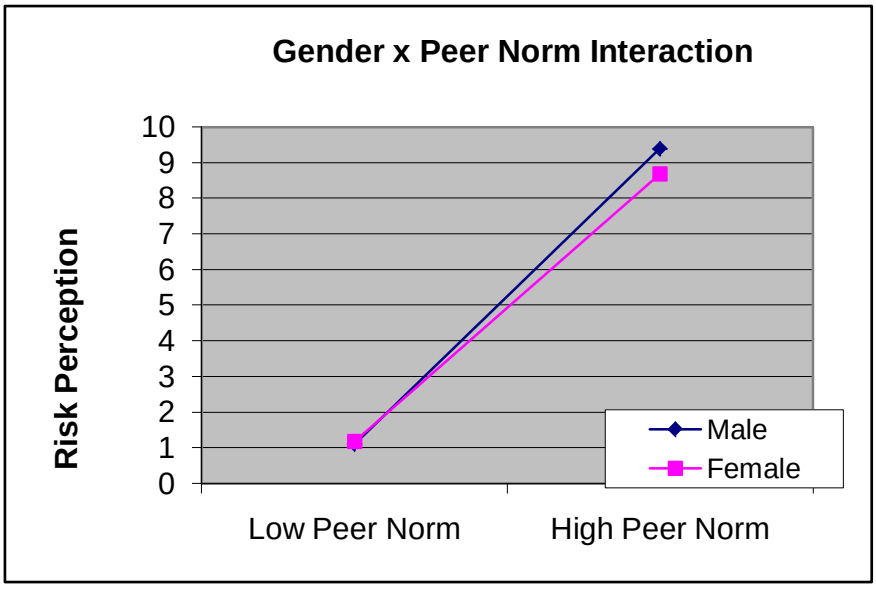

Figure 7. Graph Showing Interaction of Gender and Peer Norm in Predicting Adolescent Risk Perception of Marijuana Use

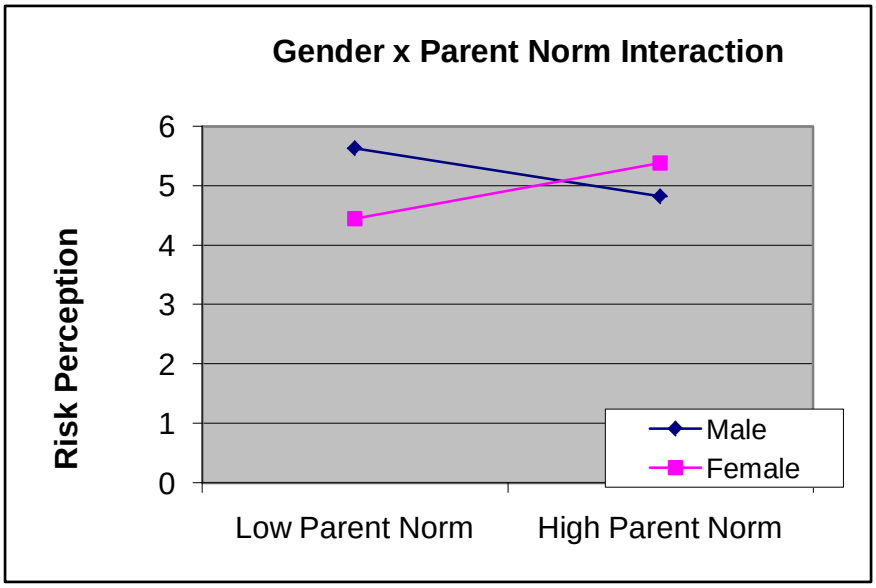

Figure 8. Graph Showing Interaction of Gender and Parent Norm in Predicting Adolescent Risk Perception of Marijuana Use

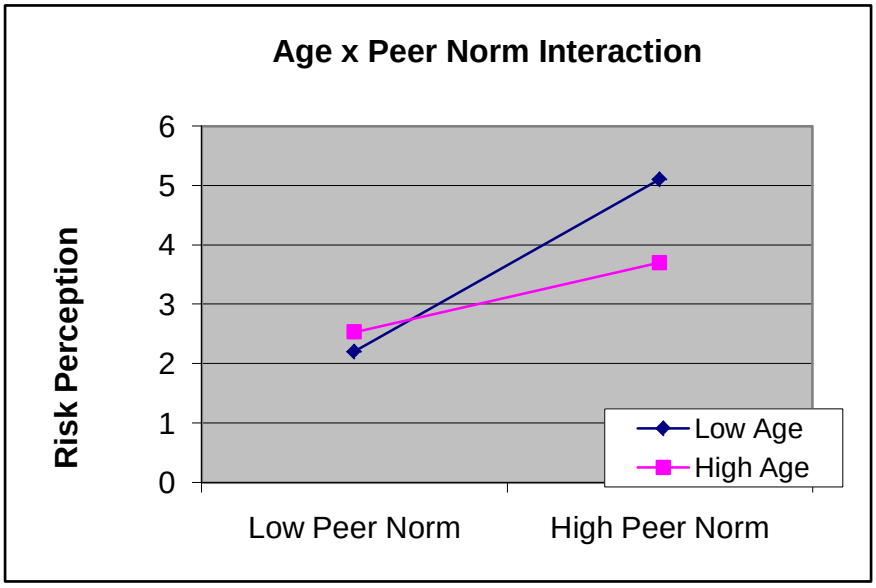

Figure 9. Graph Showing Interaction of Age and Peer Norm in Predicting Adolescent Risk Perception of Marijuana Use

Hypothesis II

Smoking Cigarettes. Results of the Bioecological Model in predicting adolescent reported smoking cigarettes behavior are reported in Table 7. Three of the systems in the Bioecological Model significantly predicted adolescent reported smoking cigarette behavior.

The first group of variables entered in the hierarchical logistic regression was adolescent variables and this group significantly contributed to predicting adolescent smoking behavior (Δ*Nagelkerke* $R^2 = 0.195$, χ^2[df =5] = 110.49, $p < 0.001$). Of these adolescent variables, age was the only significant predictor of adolescent smoking cigarette behavior ($b = 0.68$, *Exp(B)* = 1.98, $p < 0.001$). As hypothesized, a positive relationship between age and adolescent smoking behavior emerged. Specifically, for every one year increase in age, the probability that the adolescent smoked increased by 1.98 times. Two other variables in the model, gender ($b = -0.36$, *Exp (B)* = 0.70, $p =$

0.092) and impulse control (*b* = -0.32, *Exp (B)* = 0.73, *p* = 0.057) demonstrated trends in the hypothesized directions.

The second group of variables entered in the hierarchical logistic regression was Microsystem variables. As hypothesized, this group significantly increased the variance explained in adolescent smoking cigarette behavior after controlling for adolescent variables (Δ*Nagelkerke* R^2 = 0.344, χ^2 [df = 7] = 231.44, $p < 0.001$). As hypothesized, family structure was a significant predictor of adolescent smoking cigarettes behavior (*b* = -1.29, *Exp (B)* = 0.28, $p < 0.001$), adolescents in single-parent families were 0.28 times more likely to smoke cigarettes than those coming from two parent families. Also consistent with predictions, peer use significantly increased the variance explained in adolescent smoking cigarettes behavior (*b* = 1.18, *Exp (B)* = 3.26, $p < 0.001$), adolescents whose peers smoke cigarettes are 3.26 times more likely to smoke cigarettes. Adolescents whose peers engaged in prosocial behavior were significantly less likely or 0.61 times less likely to smoke (*b* = -0.50, *Exp (B)* = 0.61, *p* = 0.05). Contrary to what was hypothesized, peer delinquent behavior was significantly negatively predictive of adolescent smoking cigarettes behavior (*b* = -0.40, *Exp (B)* = 0.67, *p* = 0.48), adolescents whose peers engaged in delinquent behavior were 0.67 times less likely to smoke cigarettes. No other Microsystem variable achieved significance in explaining the variance in adolescent reported smoking cigarettes behavior.

Table 7. Results of Hierarchical Logistic Regression of Bioecological Model Variables on Adolescent Self–Reported Smoking Cigarettes Behavior

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
1	**Adolescent**	**0.195*** **							
	Age		1.98***						
	Gender		0.70						
	Impulse Control		0.73						
	Body and Self Image		0.83						
	Mastery of External World		0.86						
2	**Microsystem**			**0.344*** **					
	Age				1.71***				
	Gender				1.14				
	Impulse Control				0.95				
	Body and Self Image				0.98				
	Mastery of External World				0.84				
	Family Structure				0.28***				
	Parent Use				1.38				
	Parent Norm				0.89				
	Peer Use				3.26***				
	Peer Norm				0.84				
	Peer Delinquent Behavior				0.67*				
	Peer Prosocial Behavior				0.61*				
3	**Mesosystem**					**0.02****			

Table 7. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Age						1.42		
	Gender						0.13		
	Impulse Control						1.01		
	Body and Self Image						1.05		
	Mastery of External World						0.83		
	Family Structure						0.26***		
	Parent Use						1.37		
	Parent Norm						744.87		
	Peer Use						3.41***		
	Peer Norm						4.77		
	Peer Delinquent Behavior						0.75		
	Peer Prosocial Behavior						0.63		
	Age x Gender						1.12		
	Age x Parent Norm						0.63		
	Age x Peer Norm						0.98		
	Gender x Parent Norm						1.89		
	Gender x Peer Norm						0.35***		
4	**Exosystem**							**0.003**	
	Age								1.47
	Gender								0.22
	Impulse Control								0.99

Table 7. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Body and Self Image								1.05
	Mastery of External World								0.84
	Family Structure								0.26***
	Parent Use								1.29
	Parent Norm								574.58
	Peer Use								3.45***
	Peer Norm								5.25
	Peer Delinquent Behavior								0.73
	Peer Prosocial Behavior								0.62
	Age x Gender								1.09
	Age x Parent Norm								0.64
	Age x Peer Norm								0.98
	Gender x Parent Norm								1.09
	Gender x Peer Norm								0.35***
	Socioeconomic Status								0.92
	School Culture								0.90

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

The Mesosystem was also a significant predictor of adolescent smoking cigarettes behavior (Δ*Nagelkerke* R^2 = 0.02, χ^2 [df = 5] = 15.21, p = 0.01). Of the five Mesosystem variables entered in the hierarchical logistic regression, the gender by peer norm interaction was the only significant predictor of adolescent smoking behavior (b = -1.06, *Exp (B)* = 0.35, p = 0.001). As predicted, the relationship between peer norm and smoking cigarette behavior was dependent on peer norm, where the relationship was stronger for female adolescents (see Figure 10).

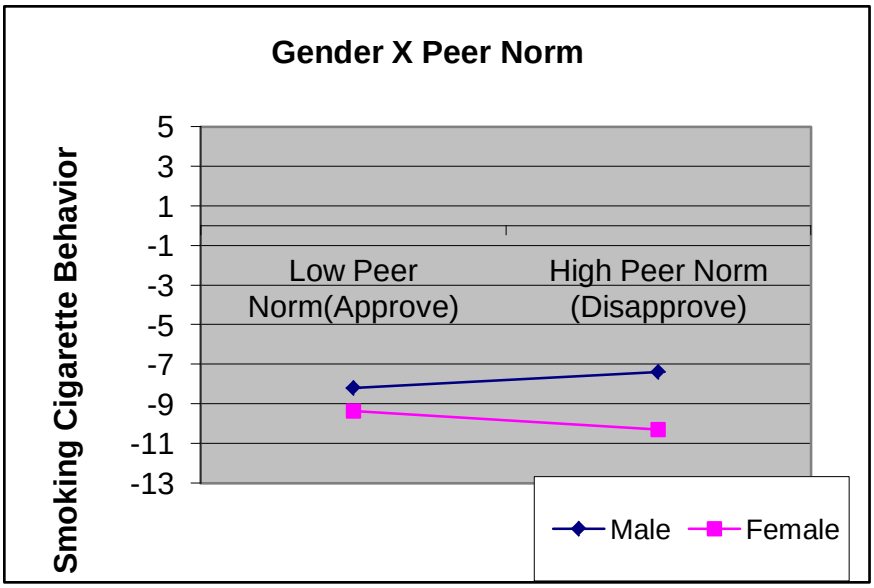

Figure 10. Graph Showing Interaction of Gender and Peer Norm in Predicting Adolescent Smoking Cigarette Behavior

The last Bioecological Model system added to the hierarchical logistic regression equation was the Exosystem, and this system was not a significant predictor adolescent smoking behavior (Δ*Nagelkerke* R^2 = 0.003, χ^2 [df = 2] = 2.06, p = 0.358). None of the individual variables in the system were significant. The Exosystem did significantly predict adolescent reported smoking cigarette behavior when entered in the regression by

itself, however only socioeconomic status significantly contributed to its predictive ability.

Alcohol Use. As shown in Table 8, two of the systems in the Bioecological Model significantly contributed to explaining variance in adolescent reported alcohol use.

Adolescent variables were entered in the first step in the regression, and this group of variables significantly contributed to the explained variance in adolescent alcohol use (Δ*Nagelkerke* $R^2 = 0.183$, χ^2 [df = 5] = 148.96, $p < 0.001$). Four of the five adolescent variables were significant in this step. As predicted, age was positively associated with adolescent alcohol use ($b = 0.51$, *Exp (B)* = 1.66, $p < 0.001$, for each additional year in age, adolescents were 1.66 times more likely to use alcohol. Adolescents' gender also significantly influenced their alcohol use ($b = -0.38$, *Exp (B)* = 0.68, $p = 0.012$), with males being 0.68 more likely to use alcohol than females. As hypothesized, impulse control was significantly negatively predictive of adolescent alcohol use ($b = -0.47$, *Exp (B)* = 0.62, $p < 0.001$), adolescents with poor impulse control were 0.62 times more likely to use alcohol. Thirdly, adolescents who had a high mastery of external world were 1.44 times more likely to engage in alcohol use ($b = 0.36$, *Exp (B)* = 1.44, $p < 0.001$).

The Microsystem significantly increased the variance explained in adolescent alcohol use (Δ*Nagelkerke* $R^2 = 0.273$, χ^2 [df = 6] = 268.81, $p < 0.001$). As hypothesized, family type was a significant predictor of adolescent alcohol use ($b = -0.59$, *Exp (B)* = 0.55, $p = 0.026$), with adolescents in single-parent families being 0.55 times more likely to use alcohol than those in two parent families. Adolescents whose peers engaged in alcohol use were significantly more likely (1.31 times) to use alcohol ($b = 0.27$, *Exp (B)*

= 1.31, $p < 0.001$). As hypothesized, adolescents whose peers had more positive attitudes toward alcohol use were 0.45 times more likely to engage in alcohol use (b = -0.79, *Exp (B)* = 0.45, $p < 0.001$). Contrary to what was hypothesized, peer delinquent behavior significantly negatively contributed to the variance explained in adolescent alcohol use (b = -0.39, *Exp (B)* = 0.68, $p = 0.004$), with adolescents whose peers engaged in delinquent behavior being 0.39 times less likely to use alcohol. No other Microsystem variables were significant, however, parent norm demonstrated trends in unexpected directions (b = -0.15, *Exp (B)* = 0.86, $p = 0.059$).

Mesosystem variables were entered in the third step of the hierarchical logistic regression and were not significant (Δ*Nagelkerke* $R^2 = 0.003$, χ^2 [df = 5] = 3.79, $p = 0.580$). Exosystem variables were entered in the fourth step of the regression and were also not significant (Δ*Nagelkerke* $R^2 = 0.001$, χ^2 [df = 2] = 0.79, $p = 0.675$). No Mesosystem or Exosystem variables entered in steps three or four were significant. Similar to risk perception, the Exosystem significantly predicted adolescent reported alcohol use when entered in the regression by itself and both variables in the system significantly contributed to explaining the behavior.

Table 8. Results of Hierarchical Logistic Regression of Bioecological Model Variables on Adolescent Self–Reported Alcohol Use

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
1	**Adolescent**	**0.183*** **							
	Age		1.66***						
	Gender		0.68*						
	Impulse Control		0.62***						
	Body and Self Image		0.87						
	Mastery of External World		1.44**						
2	**Microsystem**			**0.273*** **					
	Age				1.27***				
	Gender				1.03				
	Impulse Control				0.73*				
	Body and Self Image				0.80				
	Mastery of External World				1.82***				
	Family Structure				0.55*				
	Parent Norm				0.86				
	Peer Use				1.31***				
	Peer Norm				0.45***				
	Peer Delinquent Behavior				0.68**				
	Peer Prosocial Behavior				0.78				
3	**Mesosystem**					**0.003**			

Table 8. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Age						1.64**		
	Gender						14.57		
	Impulse Control						0.73*		
	Body and Self Image						0.79		
	Mastery of External World						1.82***		
	Family Structure						0.57*		
	Parent Norm						0.94		
	Peer Use						1.30***		
	Peer Norm						0.49		
	Peer Delinquent Behavior						0.68**		
	Peer Prosocial Behavior						0.77		
	Age x Gender						0.84		
	Age x Parent Norm						0.99		
	Age x Peer Norm						1.01		
	Gender x Parent Norm						0.95		
	Gender x Peer Norm						0.81		
4	**Exosystem**							**0.001**	
	Age								1.64**
	Gender								14.32
	Impulse Control								0.73*
	Body and Self Image								0.79

Table 8. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Mastery of External World								1.82***
	Family Structure								0.58*
	Parent Norm								0.94
	Peer Use								1.29***
	Peer Norm								0.50
	Peer Delinquent Behavior								0.68**
	Peer Prosocial Behavior								0.77
	Age x Gender								0.84
	Age x Parent Norm								0.99
	Age x Peer Norm								1.01
	Gender x Parent Norm								0.95
	Gender x Peer Norm								0.81
	Socioeconomic Status								1.01
	School Culture								1.16

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Marijuana Use. As shown in Table 9, three of the systems in the Bioecological Model significantly contributed to the variance explained in adolescent reported marijuana use.

Adolescent variables were entered in the first step of the hierarchical logistic regression and proved to explain a significant amount of variance in adolescent marijuana use (Δ*Nagelkerke* $R^2 = 0.086$, χ^2 [df = 5] = 39.75, $p < 0.001$). Of these adolescent variables, only two were significant; age ($b = 0.43$, *Exp (B)* = 1.54, $p < 0.001$) and impulse control ($b = -0.40$, *Exp (B)* = 0.67, $p = 0.047$). As hypothesized age was positively associated with adolescent marijuana use, for every additional year in age, adolescents were 1.54 times more likely to engage in marijuana use. Adolescents who had poor impulse control were also 0.67 times more likely to engage in marijuana use. Although not a statistically significant predictor of adolescent marijuana use, gender coefficients demonstrated trends in the direction predicted ($b = -0.45$, *Exp (B)* = 0.64, $p = 0.074$).

The group of Microsystem variables were placed in the second step of the hierarchical logistic regression and explained a significant proportion of the variance in adolescent reported marijuana use after adolescent variables were controlled for (Δ*Nagelkerke* $R^2 = 0.229$, χ^2 [df = 6] = 112.77, $p < 0.001$). As hypothesized, family structure explained a significant proportion of the variance in adolescent marijuana use ($b = -1.01$, *Exp (B)* = 0.36, $p = 0.005$), adolescents coming from single-parent households were 0.36 times more likely to engage in marijuana use. Peer marijuana use significantly positively contributed to the variance explained in adolescent marijuana use ($b = 0.76$, *Exp (B)* = 2.13, $p < 0.001$), and adolescents whose peers strongly approved with marijuana use were also more likely to engage in marijuana use themselves ($b = -0.46$, *Exp (B)* = 0.63, $p = 0.006$). No other Microsystem variables significantly contributed to explaining adolescent reported marijuana use.

Mesosystem variables were entered in the third step of the regression and this group of variables also significantly explained the variance in adolescent marijuana use

(Δ*Nagelkerke* R^2 = 0.021, χ^2 [df = 5] = 11.17, p = 0.048). Consistent to what was hypothesized, the relationship between age and marijuana use was significantly dependent on peer norm (b = -0.31, *Exp (B)* = 0.73, p = 0.01). Contrary to what was hypothesized, the relationship between peer norm and marijuana use was negative for older adolescents, and positive for younger adolescents (see Figure 11). The age by parent norm interaction was also significant, (b = 0.41, *Exp (B)* = 1.51, p = 0.04). Also contrary to what was hypothesized, the relationship between parent norm and marijuana use dependent on age was positive, more so for older adolescents than for younger adolescents (see Figure 12). The gender by parent norm interaction did approach significance in the hypothesized direction (b = -1.27, *Exp (B)* = 0.28, p = 0.064).

As seen in Table 9, the exosystem variables did not significantly contribute to explaining the variance in adolescent reported marijuana use (Δ*Nagelkerke* R^2 = 0.006, χ^2 [df = 2] = 3.13, p = 0.210). When entered in the regression by itself, the Exosystem significantly contributed to explaining adolescent reported marijuana use, and both variables in the system were significantly predicted the behavior.

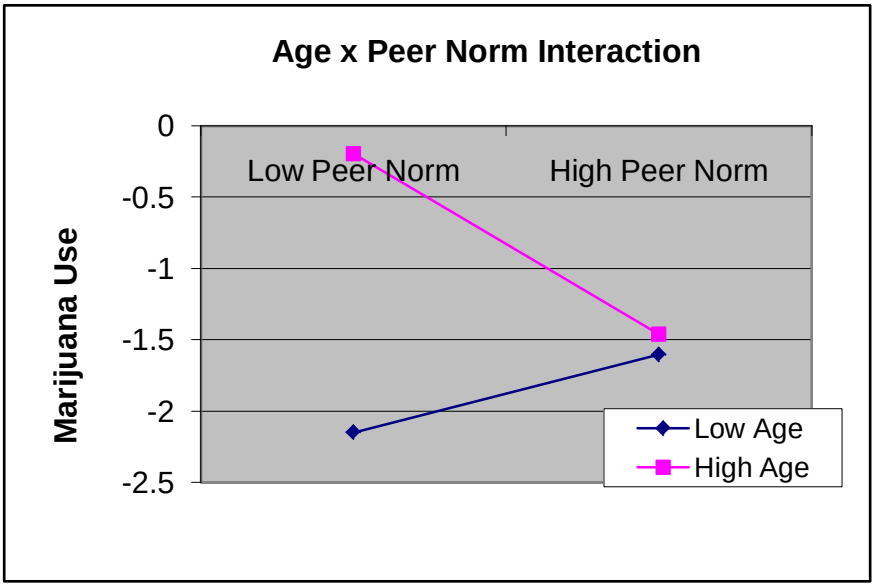

Figure 11. Graph Showing Interaction of Age and Peer Norm in Predicting Adolescent Marijuana Use

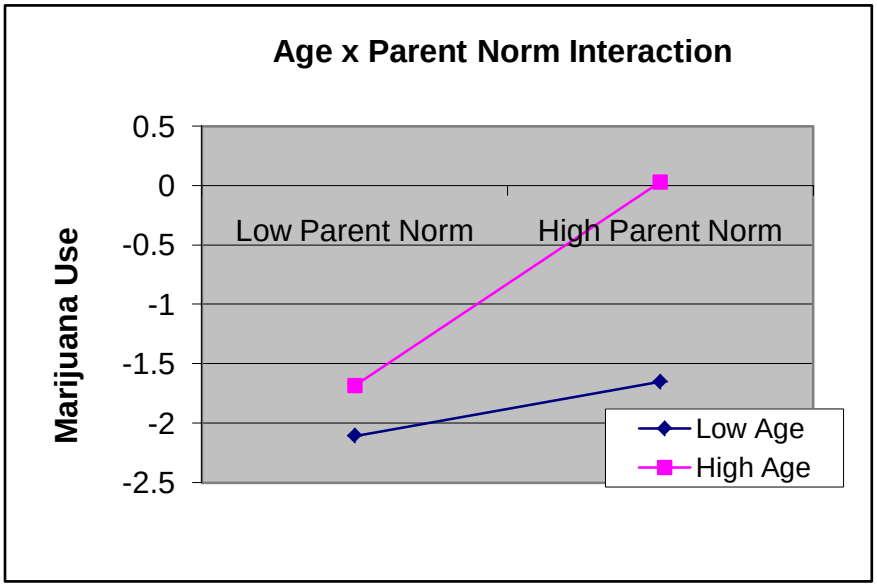

Figure 12. Graph Showing Interaction of Age and Parent Norm in Predicting Adolescent Marijuana Use

Table 9. Results of Hierarchical Logistic Regression of Bioecological Model Variables on Adolescent Self–Reported Marijuana Use

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
1	**Adolescent**	**0.086*** **							
	Age		1.54***						
	Gender		0.64						
	Impulse Control		0.67*						
	Body and Self Image		1.05						
	Mastery of External World		0.89						
2	**Microsystem**			**0.229*** **					
	Age				1.40***				
	Gender				1.16				
	Impulse Control				0.73				
	Body and Self Image				1.38				
	Mastery of External World				0.99				
	Family Structure				0.36**				
	Parent Norm				1.25				
	Peer Use				2.13***				
	Peer Norm				0.63**				
	Peer Delinquent Behavior				0.76				
	Peer Prosocial Behavior				0.94				
3	**Mesosystem**					**0.021***			

Table 9. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Age						1.32		
	Gender						0.85		
	Impulse Control						0.73		
	Body and Self Image						1.30		
	Mastery of External World						1.05		
	Family Structure						0.33**		
	Parent Norm						0.01		
	Peer Use						2.27***		
	Peer Norm						100.14*		
	Peer Delinquent Behavior						0.89		
	Peer Prosocial Behavior						0.97		
	Age x Gender						1.02		
	Age x Parent Norm						1.51*		
	Age x Peer Norm						0.73**		
	Gender x Parent Norm						0.28		
	Gender x Peer Norm						1.11		
4	**Exosystem**							**0.006**	
	Age								1.28
	Gender								0.78
	Impulse Control								0.72
	Body and Self Image								1.30

Table 9. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Mastery of External World								1.08
	Family Structure								0.35**
	Parent Norm								0.003
	Peer Use								2.30***
	Peer Norm								117.51*
	Peer Delinquent Behavior								0.86
	Peer Prosocial Behavior								1.00
	Age x Gender								1.03
	Age x Parent Norm								1.57
	Age x Peer Norm								0.72**
	Gender x Parent Norm								0.31
	Gender x Peer Norm								1.13
	Socioeconomic Status								0.91
	School Culture								1.36

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Hypothesis III

Smoking Cigarettes. Risk perception of smoking cigarettes significantly predicted adolescent smoking cigarette behavior, adolescents with low risk perception of smoking cigarettes were more likely to smoke cigarettes (b = -0.45, *Exp (B)* = 0.64, $p <$ 0.001).

As shown in Table 10, the group of adolescent variables were a significant moderator of the path between risk perception and adolescent reported smoking cigarette behavior after controlling for main effects (Δ*Nagelkerke* R^2 = 0.021, χ^2 [df = 5] = 13.75, p = 0.017). Of these adolescent variables, gender significantly moderated the path between risk perception and smoking cigarette behavior (b = -0.28, *Exp (B)* = 0.76, p = 0.041), confirming that the relationship between risk perception and smoking cigarette behavior was dependent on adolescents' gender, as was hypothesized, the relationship was stronger for females than for males (see Figure 13). Impulse control also moderated the relationship between risk perception and smoking cigarette behavior (b = -0.27, *Exp (B)* = 0.77, p = 0.005) with the relationship being stronger for adolescents with high impulse control, that is although smoking cigarettes decreased as risk perception decreased, it decreased at a more rapid rate for adolescents who had high impulse control (see Figure 14). Mastery of external world was also a significant moderator of risk perception and reported smoking cigarette behavior (b = 0.18, *Exp (B)* = 1.20, p = 0.052), the relationship was stronger for adolescents with low mastery of external world (see Figure 15).

Table 10. Bioecological Model Variables Moderating the Path Between Risk Perception and Adolescent Self-Reported Smoking Cigarettes Behavior

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
1	**Adolescent**	**0.021***							
	Age		2.09***						
	Gender		0.74						
	Impulse Control		0.62*						
	Body and Self Image		0.76						
	Mastery of External World		1.10						
	Risk Perception		0.25						
	Risk perception x Age		1.08						
	Risk perception x Gender		0.76*						
	Risk perception x Impulse Control		0.77**						
	Risk perception x Body and Self Image		0.89						
	Risk perception x Mastery of External World		1.20*						
2	**Microsystem**			**0.029****					
	Age				1.76***				
	Gender				1.38				
	Impulse Control				0.98				

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Body and Self Image				0.76				
	Mastery of External World				1.12				
	Risk Perception				0.22				
	Risk perception x Age				1.01				
	Risk perception x Gender				1.09				
	Risk perception x Impulse Control				0.86				
	Risk perception x Body and Self Image				0.86				
	Risk perception x Mastery of External World				1.14				
	Parent Use				1.62				
	Family Structure				0.31**				
	Parent Norm				0.34*				
	Peer Use				3.82***				
	Peer Norm				1.02				
	Peer Delinquent Behavior				0.83				
	Peer Prosocial Behavior				0.68				
	Risk Perception x Parent Use				1.30				

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Parent Norm				0.59**				
	Risk perception x Peer Use				1.16				
	Risk perception x Peer Norm				1.12				
	Risk perception x Peer Delinquent Behavior				0.89				
	Risk perception x Peer Prosocial Behavior				0.89				
3	**Mesosystem**					**0.021****			
	Age						1.32		
	Gender						0.06		
	Impulse Control						1.01		
	Body and Self Image						0.79		
	Mastery of External World						1.14		
	Risk Perception						3.17		
	Risk perception x Age						0.83		
	Risk perception x Gender						0.20		
	Risk perception x Impulse Control						0.80		

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Body and Self Image						0.86		
	Risk perception x Mastery of External World						1.22		
	Parent Use						1.72		
	Family Structure						0.27**		
	Parent Norm						0.00		
	Peer Use						4.26***		
	Peer Norm						5753.65**		
	Peer Delinquent Behavior						0.94		
	Peer Prosocial Behavior						0.63		
	Risk Perception x Parent Use						1.26		
	Risk perception x Parent Norm						0.01		
	Risk perception x Peer Use						1.18		
	Risk perception x Peer Norm						22.75*		
	Risk perception x Peer Delinquent Behavior						0.98		
	Risk perception x Peer Prosocial Behavior						0.87		

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Age x Gender						1.20		
	Age x Parent Norm						1.62		
	Age x Peer Norm						0.64*		
	Gender x Parent Norm						1.49		
	Gender x Peer Norm						0.45*		
	Risk perception x Age x Gender						1.12		
	Risk perception x Age x Parent Norm						1.36*		
	Risk perception x Age x Peer Norm						0.79**		
	Risk perception x Gender x Parent Norm						0.37*		
	Risk perception x Gender x Peer Norm						2.07**		
4	**Exosystem**							**0.000**	
	Age								1.36
	Gender								0.08
	Impulse Control								1.00
	Body and Self Image								0.80
	Mastery of External World								1.16
	Risk Perception								3.49
	Risk perception x Age								0.84

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Gender								0.20
	Risk perception x Impulse Control								0.79
	Risk perception x Body and Self Image								0.86
	Risk perception x Mastery of External World								1.23
	Parent Use								1.72
	Family Structure								0.26**
	Parent Norm								0.000
	Peer Use								4.32***
	Peer Norm								7021.22*
	Peer Delinquent Behavior								0.92
	Peer Prosocial Behavior								0.63
	Risk Perception x Parent Use								1.27
	Risk perception x Parent Norm								0.01
	Risk perception x Peer Use								1.19
	Risk perception x Peer Norm								24.17*

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Peer Delinquent Behavior								0.97
	Risk perception x Peer Prosocial Behavior								0.87
	Age x Gender								1.18
	Age x Parent Norm								1.69
	Age x Peer Norm								0.64
	Gender x Parent Norm								1.69
	Gender x Peer Norm								0.44*
	Risk perception x Age x Gender								1.12
	Risk perception x Age x Parent Norm								1.38
	Risk perception x Age x Peer Norm								0.79**
	Risk perception x Gender x Parent Norm								0.39*
	Risk perception x Gender x Peer Norm								2.04**
	Socioeconomic Status								0.95
	School Culture								0.82
	Risk perception x Socioeconomic Status								0.99

Table 10. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x School Culture								0.91

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

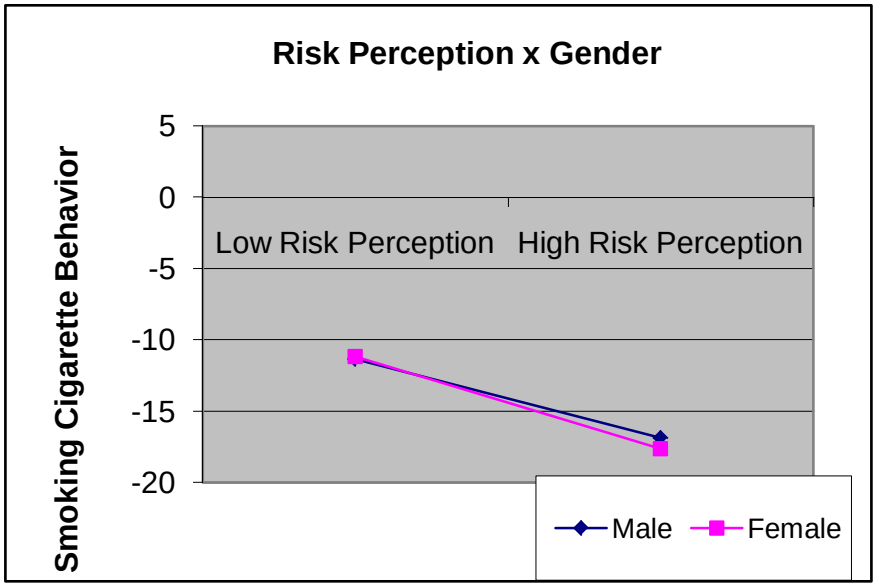

Figure 13. Graph Showing Gender Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior

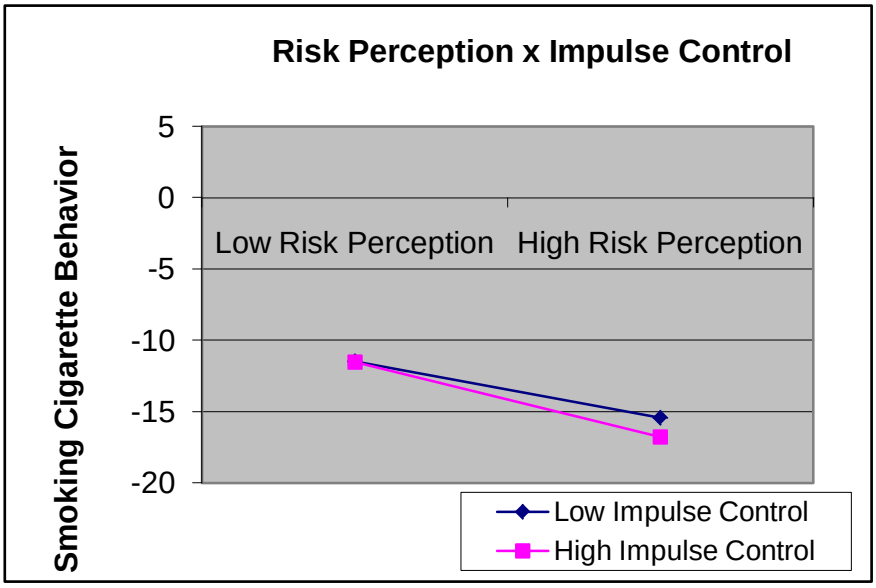

Figure 14. Graph Showing Impulse Control Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior

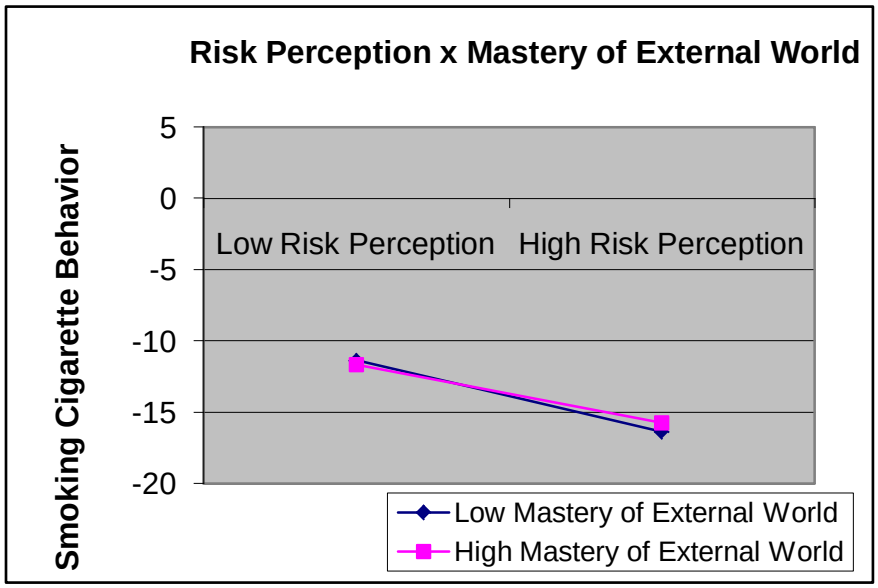

Figure 15. Graph Showing Mastery of External World Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior

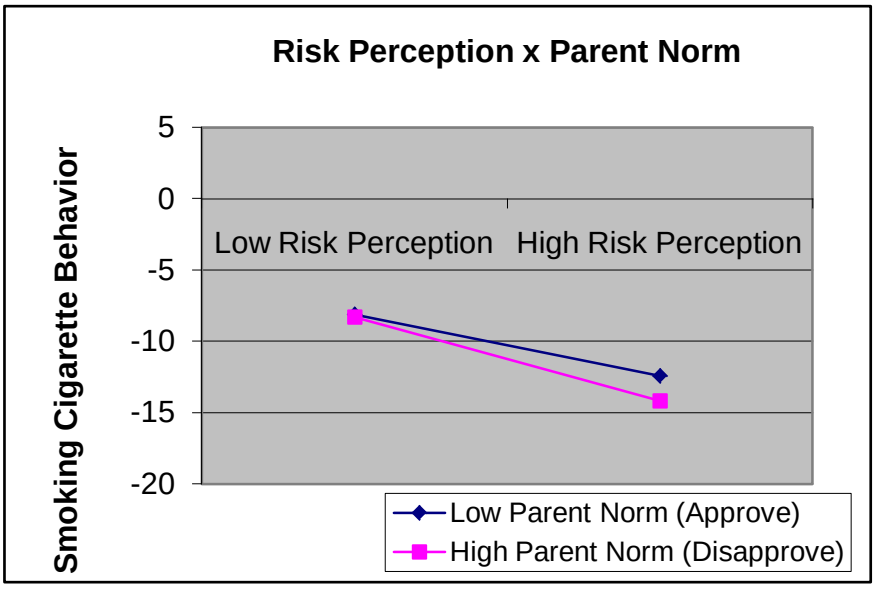

Figure 16. Graph Showing Parent Norm Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior

After controlling for adolescent variables, the Microsystem significantly moderated the path between adolescent risk perception of smoking cigarettes and their reported smoking cigarette behavior (Δ*Nagelkerke* $R^2 = 0.029$, χ^2 [df = 7] = 22.86, $p = 0.002$). Parent norm was the only Microsystem variable that significantly moderated the path between risk perception and reported smoking cigarette behavior in adolescents ($b = -0.54$, *Exp (B)* = 0.59, $p = 0.001$), as predicted the relationship was negative and stronger for adolescents whose parents disagreed with smoking cigarettes (see Figure 16).

As predicted, after controlling for both adolescent variables and the Microsystem variables, the Mesosystem significantly moderated the relationship between risk perception and smoking cigarette behavior (Δ*Nagelkerke* $R^2 = 0.021$, χ^2 [df = 5] = 16.93, $p = 0.005$). All the interactions (age by parent norm [$b = 0.31$, *Exp (B)* = 1.36, $p = 0.051$], age by peer norm [$b = -0.24$, *Exp (B)* = 0.79, $p = 0.10$], gender by parent norm [$b = -0.99$, *Exp (B)* = 0.37, $p = 0.30$], gender by peer norm [$b = 0.73$, *Exp (B)* = 2.07, $p = 0.004$]), with the exception of age by gender yielded moderation effects. As seen in Figures 17 and 18, the relationship between risk perception and smoking cigarette was dependent on age and parent norm such that among the adolescents whose parents approved (low parent norms) of smoking cigarettes, the relationship was stronger for older adolescents and among those whose parents disapproved of the behavior the relationship was stronger for the younger adolescents. The age by peer norm interaction moderated the path between risk perception and smoking cigarette behavior such that among adolescents whose peers approved (low peer norms), the relationship was stronger for older adolescents, and among those whose peers disapproved of the behavior the relationship was also stronger for older adolescents (see Figures 19 and 20). As previously mentioned, the relationship between risk perception and smoking cigarettes was also dependent on the interaction of gender and parent norm. For adolescents whose parents approved of smoking cigarettes (low parent norm), very little difference was detected between males and females, although females did have a slightly positive slope (see Figure 21). For adolescents whose parents disapproved of the

behavior, the relationship was stronger for males (see Figure 22). The gender by peer norm interaction was significant in moderating the path between risk perception and smoking cigarette behavior, however all slopes produced were positive. It is possible that its significance was due to it's coefficient being derived from a regression model that included multiple three way interactions and for this reason it will be treated as a non-significant interaction.

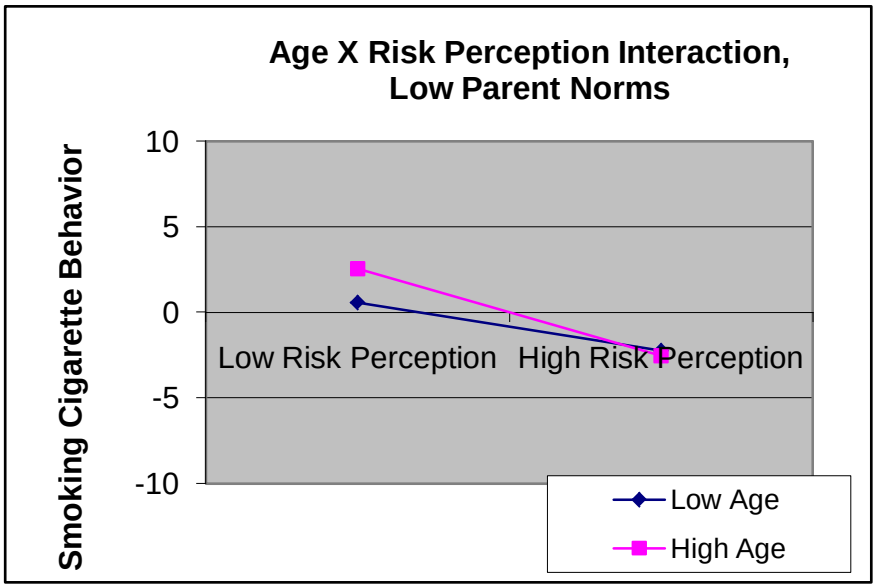

Figure 17. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior when Parents Approve of the Behavior

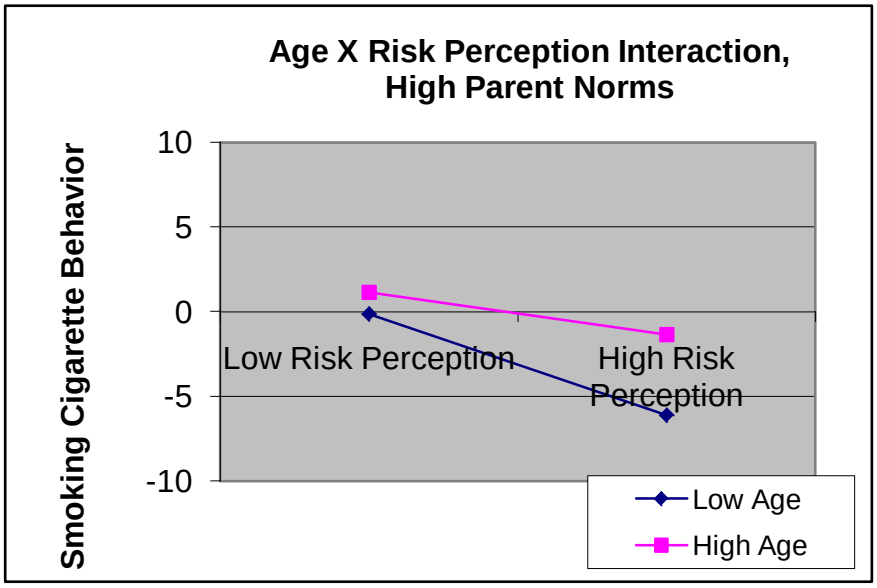

Figure 18. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior when Parents Disapprove of the Behavior

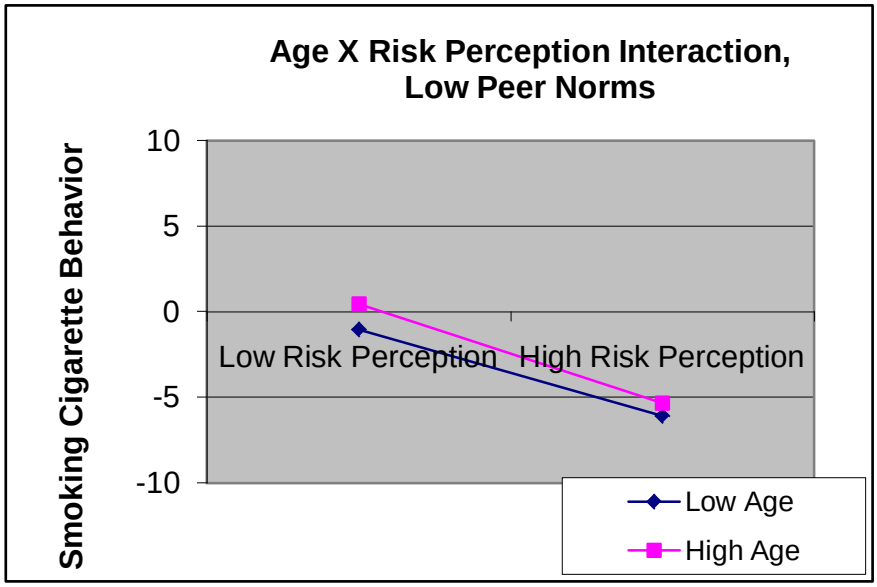

Figure 19. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior when Peers Approve of the Behavior

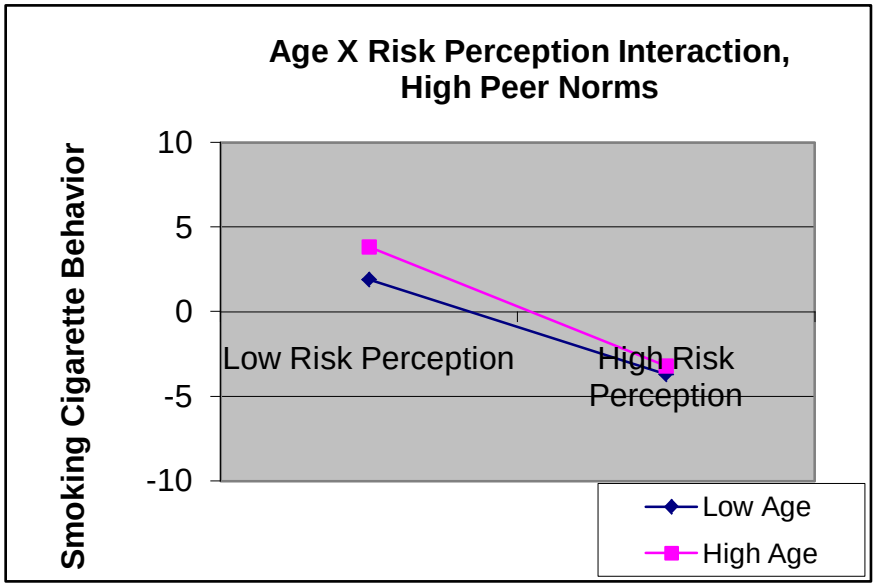

Figure 20. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior when Peers Disapprove of the Behavior

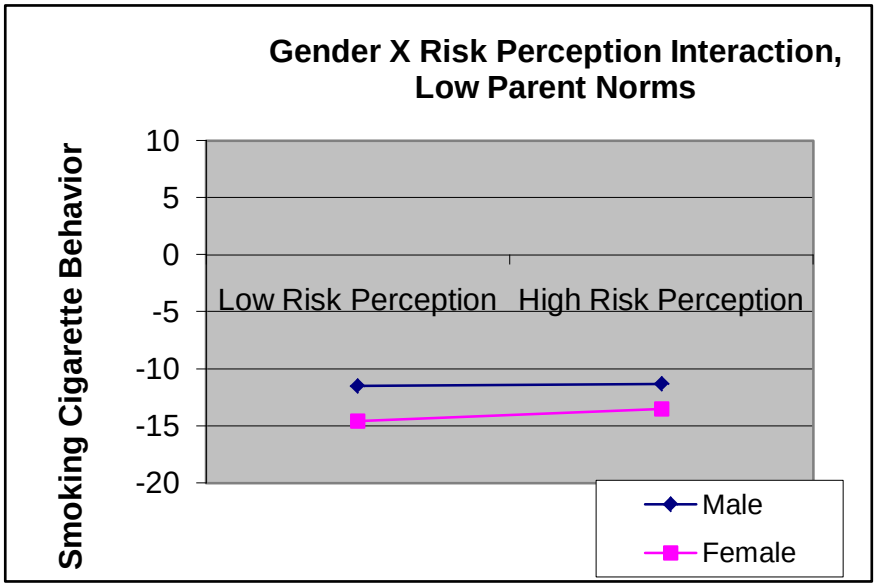

Figure 21. Graph Showing Gender Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior when Parents Approve of the Behavior

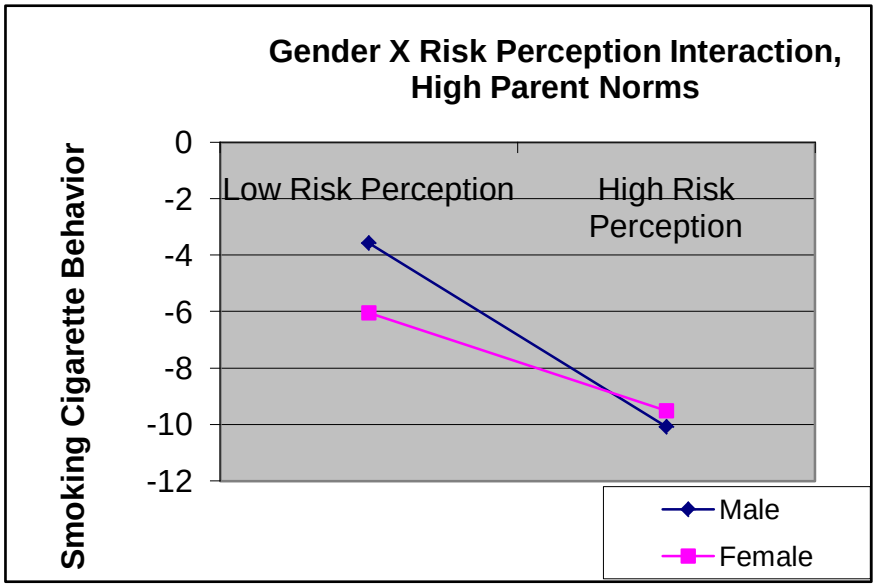

Figure 22. Graph Showing Gender Moderating the Path Between Adolescent Risk Perception of Smoking Cigarettes and Smoking Cigarette Behavior when Parents Disapprove of the Behavior

The Exosystem did not moderate the path between risk perception and adolescent reported smoking cigarette behavior (Δ*Nagelkerke* $R^2 = 0.001$, χ^2 [df = 2] = 0.46, $p = 0.79$) after all other Bioecological Model variables were controlled for. None of the individual variables were successful in moderating risk perception and adolescent smoking cigarette behavior. When entered in the regression equation by itself, the Exosystem significantly moderated the relationship between risk perception and smoking cigarette behavior, but no individual Exosystem variable significantly moderated this relationship.

Alcohol Use. Risk perception of alcohol use significantly predicted adolescent alcohol use, such that adolescents with low risk perception of alcohol use were more likely to use alcohol ($b = -0.40$, *Exp (B)* = 0.67, $p < 0.001$).

Table 11. Bioecological Model Variables Moderating the Path Between Risk Perception and Adolescent Self-Reported Alcohol Use

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
1	**Adolescent**	**0.02****							
	Age		1.45***						
	Gender		0.91						
	Impulse Control		0.69**						
	Body and Self Image		0.77*						
	Mastery of External World		1.56**						
	Risk Perception		1.42						
	Risk perception x Age		0.94*						
	Risk perception x Gender		1.11						
	Risk perception x Impulse Control		1.11						
	Risk perception x Body and Self Image		0.83**						
	Risk perception x Mastery of External World		1.16*						
2	**Microsystem**			**0.004**					
	Age				1.18*				
	Gender				1.16				
	Impulse Control				0.82				
	Body and Self Image				0.71*				

Table 11. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Mastery of External World				1.94***				
	Risk Perception				1.30				
	Risk perception x Age				0.94*				
	Risk perception x Gender				1.13				
	Risk perception x Impulse Control				1.19*				
	Risk perception x Body and Self Image				0.83*				
	Risk perception x Mastery of External World				1.13				
	Family Structure				0.61				
	Parent Norm				0.88				
	Peer Use				1.37***				
	Peer Norm				0.51**				
	Peer Delinquent Behavior				0.75				
	Peer Prosocial Behavior				0.87				
	Risk perception x Family Structure				1.18				
	Risk perception x Parent Norm				0.98				
	Risk perception x Peer Use				1.07				

Table 11. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Peer Norm				1.05				
	Risk perception x Peer Delinquent Behavior				0.97				
	Risk perception x Peer Prosocial Behavior				1.05				
3	**Mesosystem**					**0.006**			
	Age						1.32		
	Gender						4.56		
	Impulse Control						0.83		
	Body and Self Image						0.71*		
	Mastery of External World						1.96***		
	Risk Perception						9.72		
	Risk perception x Age						0.82		
	Risk perception x Gender						0.31		
	Risk perception x Impulse Control						1.22*		
	Risk perception x Body and Self Image						0.84*		

Table 11. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Mastery of External World						1.12		
	Family Structure						0.68		
	Parent Norm						0.80		
	Peer Use						1.38**		
	Peer Norm						0.24		
	Peer Delinquent Behavior						0.77		
	Peer Prosocial Behavior						0.84		
	Risk perception x Family Structure						1.29		
	Risk perception x Parent Norm						1.03		
	Risk perception x Peer Use						1.07		
	Risk perception x Peer Norm						0.80		
	Risk perception x Peer Delinquent Behavior						1.00		
	Risk perception x Peer Prosocial Behavior						1.07		
	Age x Gender						0.92		
	Age x Parent Norm						1.01		
	Age x Peer Norm						1.09		

Table 11. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Gender x Parent Norm						1.09		
	Gender x Peer Norm						0.99		
	Risk Perception x Age x Gender						0.004		
	Risk perception x Age x Parent Norm						0.99		
	Risk perception x Age x Peer Norm						1.03		
	Risk perception x Gender x Parent Norm						0.99		
	Risk perception x Gender x Peer Norm						0.88		
4	**Exosystem**							**0.000**	
	Age								1.31
	Gender								4.46
	Impulse Control								0.83
	Body and Self Image								0.71*
	Mastery of External World								1.96***
	Risk Perception								10.90
	Risk perception x Age								0.81
	Risk perception x Gender								0.30

Table 11. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Impulse Control								1.22*
	Risk perception x Body and Self Image								0.84*
	Risk perception x Mastery of External World								1.12
	Family Structure								0.69
	Parent Norm								0.81
	Peer Use								1.37***
	Peer Norm								0.24
	Peer Delinquent Behavior								0.76
	Peer Prosocial Behavior								0.85
	Risk perception x Family Structure								1.28
	Risk perception x Parent Norm								1.02
	Risk perception x Peer Use								1.07
	Risk perception x Peer Norm								0.81
	Risk perception x Peer Delinquent Behavior								1.004

Table 11. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Peer Prosocial Behavior								1.07
	Age x Gender								0.92
	Age x Parent Norm								1.01
	Age x Peer Norm								1.09
	Gender x Parent Norm								0.91
	Gender x Peer Norm								0.72
	Risk Perception x Age x Gender								1.09
	Risk perception x Age x Parent Norm								0.99
	Risk perception x Age x Peer Norm								1.03
	Risk perception x Gender x Parent Norm								0.98
	Risk perception x Gender x Peer Norm								0.88
	Socioeconomic Status								1.00
	School Culture								1.17
	Risk perception x Socioeconomic Status								0.99
	Risk perception x School Culture								0.97

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

As shown in Table 11, Adolescent variables significantly moderated the path between risk perception and adolescent reported alcohol use (Δ*Nagelkerke* $R^2 = 0.02$, χ^2 [df = 5] = 18.39, $p = 0.002$). Body and self image was the most significant moderator ($b = -0.19$, *Exp (B)* = 0.83, $p = 0.002$), while age ($b = -0.06$, *Exp (B)* = 0.94, $p = 0.033$) and mastery of the external world ($b = 0.15$, *Exp (B)* = 1.16, $p = 0.038$) also moderated the path between adolescent risk perception of alcohol use and reported alcohol use. As seen in Figure 23, the relationship between risk perception and alcohol use was dependent on age, with a stronger relationship for older adolescents. As seen in Figure 24, body and self image moderated the relationship between risk perception and alcohol use such that adolescents with lower body and self image had a stronger positive relationship. Similar to body and self image, mastery of external world moderated the path between risk perception and alcohol use such that the relationship was positive and stronger for adolescents with high mastery of external world (see Figure 25).

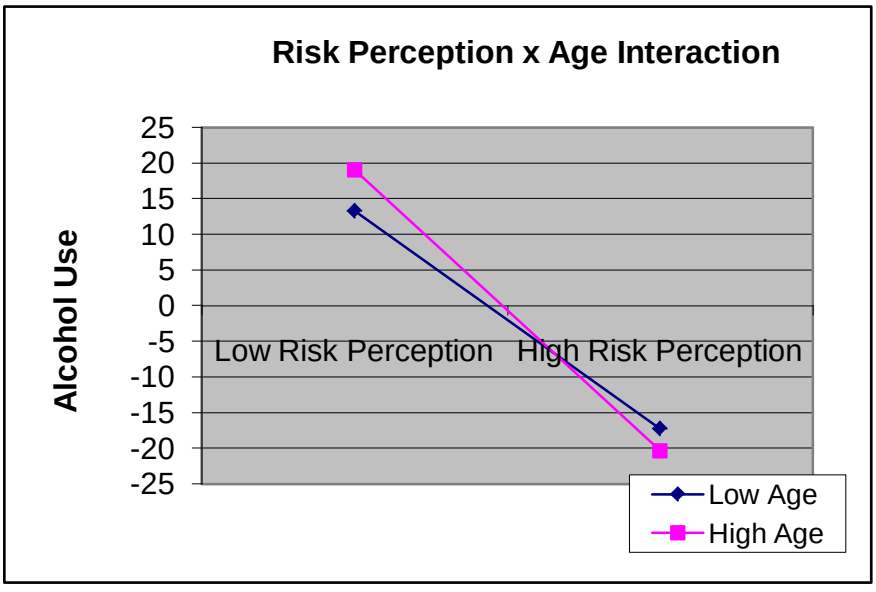

Figure 23. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Alcohol Use and Alcohol Use

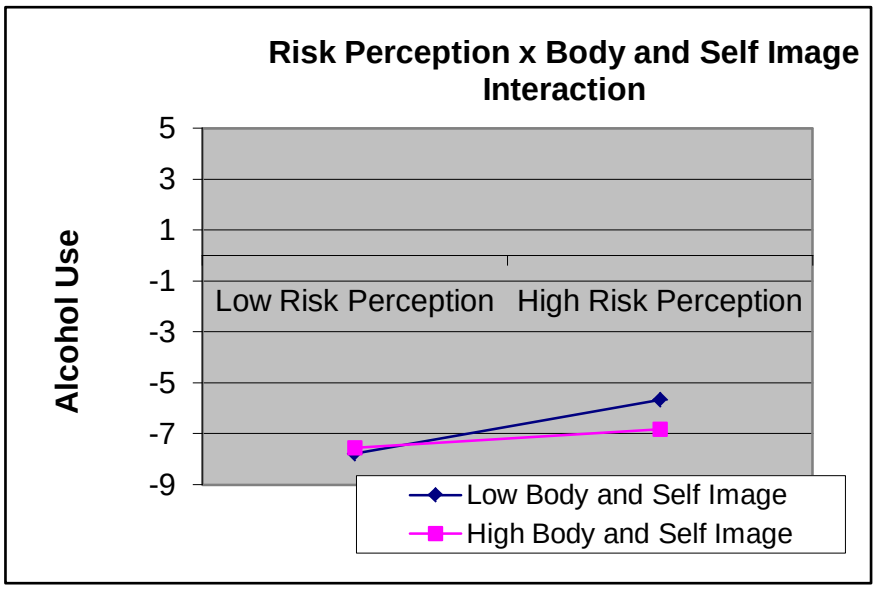

Figure 24. Graph Showing Body and Self Image Moderating the Path Between Adolescent Risk Perception of Alcohol Use and Alcohol Use

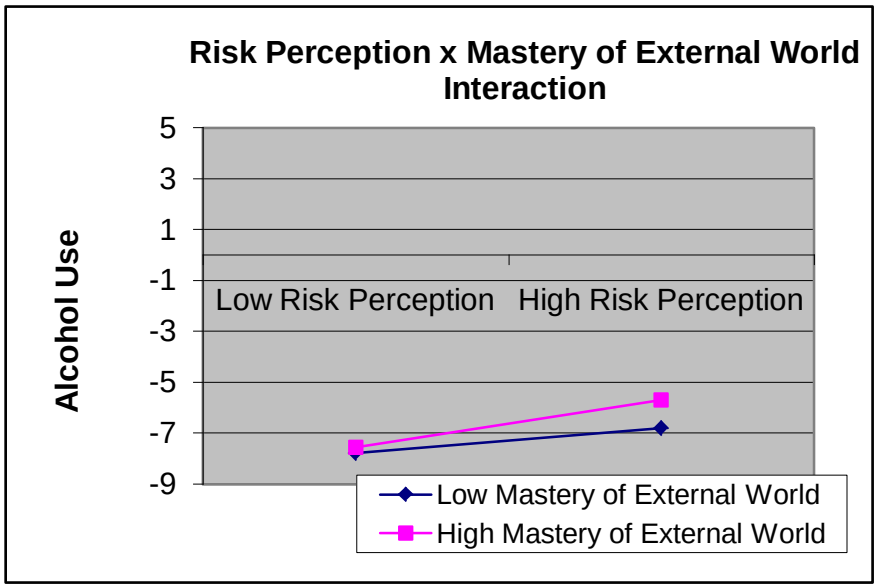

Figure 25. Graph Showing Mastery of External World Moderating the Path Between Adolescent Risk Perception of Alcohol Use and Alcohol Use

Contrary to what was hypothesized the Microsystem did not significantly moderate the path between adolescent risk perception of alcohol use and reported alcohol use after controlling for adolescent variables (Δ*Nagelkerke* $R^2 = 0.004$, χ^2 [df = 6] = 4.32, $p = 0.633$). No individual Microsystem variable was a significant moderator of the relationship between adolescent risk perception of alcohol use and alcohol use.

Similar to the Microsystem, the Mesosystem (Δ*Nagelkerke* $R^2 = 0.006$, χ^2 [df = 5] = 6.70, $p = 0.244$) and Exosystem (Δ*Nagelkerke* $R^2 = 0.000$, χ^2 [df = 2] = 0.13, $p = 0.938$) also failed to moderate the path between adolescent risk perception of alcohol use and reported alcohol use after controlling for other systems in the Bioecological Model. When entered in the regression equation by itself, the Exosystem significantly moderated the relationship between risk perception and alcohol use, but no individual Exosystem variable significantly moderated this relationship.

Marijuana Use. Risk perception of marijuana use significantly predicted adolescent marijuana use. Adolescents with low risk perception of marijuana use were more likely to use marijuana ($b = -0.79$, *Exp (B)* = 0.45, $p < 0.001$).

As shown in Table 12, Adolescent variables failed to moderate the path between adolescent risk perception of marijuana use and reported marijuana use (Δ*Nagelkerke* $R^2 = 0.001$, χ^2 [df = 5] = 5.37, $p = 0.372$). No individual adolescent variable was significant.

The Microsystem also failed to moderate the path between adolescent risk perception of marijuana use and reported marijuana use after controlling for adolescent variables (Δ*Nagelkerke* $R^2 = 0.015$, χ^2 [df = 6] = 8.22, $p = 0.222$). Parent norm was the only individual Microsystem variable that was a significant moderator of the path between risk perception of marijuana use and reported marijuana use ($b = -0.44$, *Exp (B)* = 0.65, $p = 0.013$), the relationship between risk perception and marijuana use was stronger for adolescents whose parents disapproved of marijuana use (see Figure 26).

Table 12. Bioecological Model Variables Moderating the Path Between Risk Perception and Adolescent Self-Reported Marijuana Use

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
1	**Adolescent**	**0.01**							
	Age		1.25						
	Gender		1.28						
	Impulse Control		1.07						
	Body and Self Image		1.20						
	Mastery of External World		0.61						
	Risk Perception		0.73						
	Risk perception x Age		0.96						
	Risk perception x Gender		1.11						
	Risk perception x Impulse Control		1.26						
	Risk perception x Body and Self Image		0.98						
	Risk perception x Mastery of External World		0.83						
2	**Microsystem**			**0.015**					
	Age				1.13				
	Gender				1.54				
	Impulse Control				1.25				

Table 12. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Body and Self Image				1.26				
	Mastery of External World				0.70				
	Risk Perception				0.58				
	Risk perception x Age				0.94				
	Risk perception x Gender				1.11				
	Risk perception x Impulse Control				1.36*				
	Risk perception x Body and Self Image				0.95				
	Risk perception x Mastery of External World				0.84				
	Family Structure				1.46				
	Parent Norm				0.30				
	Peer Use				2.37***				
	Peer Norm				1.23				
	Peer Delinquent Behavior				1.03				
	Peer Prosocial Behavior				1.35				
	Risk perception x Family Structure				1.42				
	Risk perception x Parent Norm				0.65*				

Table 12. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Peer Use				1.08				
	Risk perception x Peer Norm				1.18				
	Risk perception x Peer Delinquent Behavior				1.04				
	Risk perception x Peer Prosocial Behavior				0.97				
3	**Mesosystem**					**0.036*** **			
	Age						1.72		
	Gender						7.73		
	Impulse Control						1.07		
	Body and Self Image						1.42		
	Mastery of External World						0.70		
	Risk Perception						0.16		
	Risk perception x Age						1.02		
	Risk perception x Gender						0.84		
	Risk perception x Impulse Control						1.32*		
	Risk perception x Body and Self Image						1.01		

Table 12. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Mastery of External World						0.90		
	Family Structure						1.49		
	Parent Norm						5124829		
	Peer Use						2.53**		
	Peer Norm						5.80**		
	Peer Delinquent Behavior						1.16		
	Peer Prosocial Behavior						1.00		
	Risk perception x Family Structure						1.31		
	Risk perception x Parent Norm						1736.33		
	Risk perception x Peer Use						1.07		
	Risk perception x Peer Norm						241.07*		
	Risk perception x Peer Delinquent Behavior						0.95		
	Risk perception x Peer Prosocial Behavior						0.72		
	Age x Gender						0.92		
	Age x Parent Norm						0.50		
	Age x Peer Norm						0.23**		

Table 12. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Gender x Parent Norm						0.04		
	Gender x Peer Norm						0.92		
	Risk perception x Age x Gender						1.02		
	Risk perception x Age x Parent Norm						0.64		
	Risk perception x Age x Peer Norm						0.74*		
	Risk perception x Gender x Parent Norm						0.83		
	Risk perception x Gender x Peer Norm						0.83		
4	**Exosystem**							**0.002**	
	Age								1.63
	Gender								7.08
	Impulse Control								1.12
	Body and Self Image								1.45
	Mastery of External World								0.68
	Risk Perception								0.20
	Risk perception x Age								1.02
	Risk perception x Gender								0.83

Table 12. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Impulse Control								1.34*
	Risk perception x Body and Self Image								0.99
	Risk perception x Mastery of External World								0.89
	Family Structure								1.57
	Parent Norm								<105459
	Peer Use								2.69***
	Peer Norm								6.00**
	Peer Delinquent Behavior								0.97
	Peer Prosocial Behavior								0.90
	Risk perception x Family Structure								1.24
	Risk perception x Parent Norm								4426.7*
	Risk perception x Peer Use								1.09
	Risk perception x Peer Norm								275.09**
	Risk perception x Peer Delinquent Behavior								0.89

Table 12. Continued.

Model	Variables	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)	ΔNagelkerke R^2	Exp (B)
	Risk perception x Peer Prosocial Behavior								0.66
	Age x Gender								0.92
	Age x Parent Norm								0.49
	Age x Peer Norm								0.23**
	Gender x Parent Norm								0.04
	Gender x Peer Norm								1.20
	Risk Perception x Age x Gender								1.01
	Risk perception x Age x Parent Norm								0.60*
	Risk perception x Age x Peer Norm								0.73*
	Risk perception x Gender x Parent Norm								0.82
	Risk perception x Gender x Peer Norm								0.90
	Socioeconomic Status								0.89
	School Culture								1.25
	Risk perception x Socioeconomic Status								1.05
	Risk perception x School Culture								0.97

* $p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

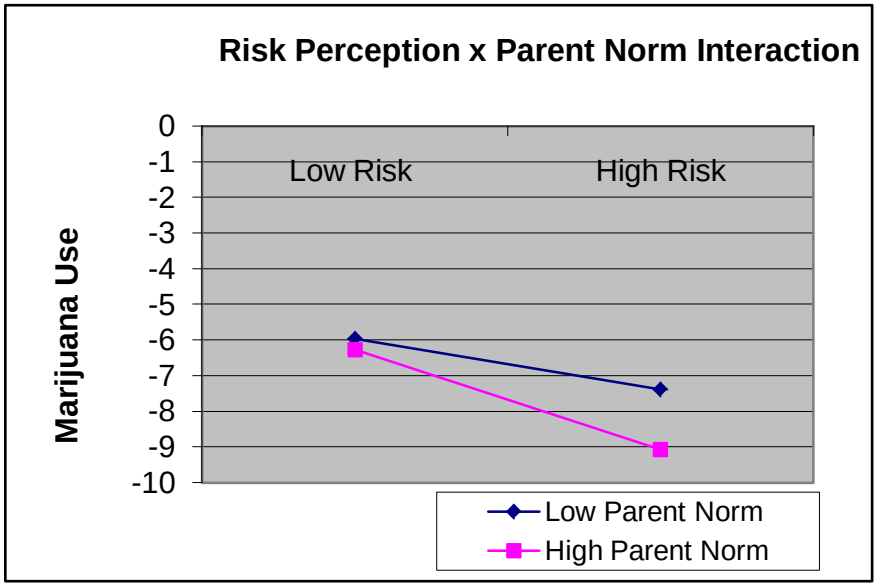

Figure 26. Graph Showing Parent Norm Moderating the Path Between Adolescent Risk Perception of Marijuana Use and Marijuana Use

As hypothesized, after controlling for adolescent variables and Microsystem variables, the Mesosystem significantly moderated the relationship between adolescent risk perception of marijuana use and reported marijuana use (Δ*Nagelkerke* $R^2 = 0.036$, χ^2 [df = 5] = 20.84, $p = 0.001$). Of the Mesosystem variables, age by peer norm was the only significant moderator of the relationship ($b = -0.30$, *Exp (B)* = 0.74, $p = 0.039$. The relationship between risk perception and marijuana use was dependent on age and peer norm such that among adolescents whose peers approved of marijuana use (low peer norms) the relationship was stronger slightly stronger for younger adolescents and among those whose peers disapproved of the behavior, the relationship was stronger for older adolescents (see Figure 27 and 28).

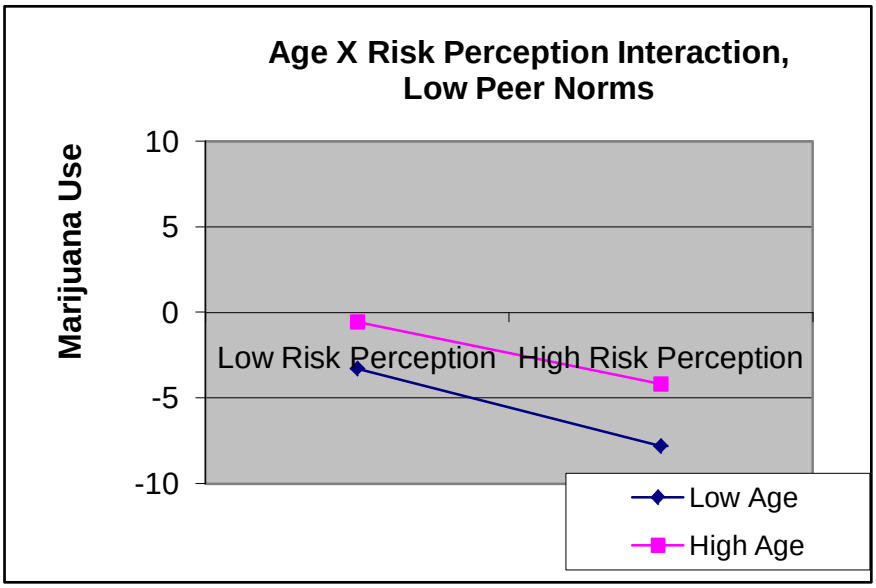

Figure 27. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Marijuana Use and Marijuana Use when Peers Approve of the Behavior

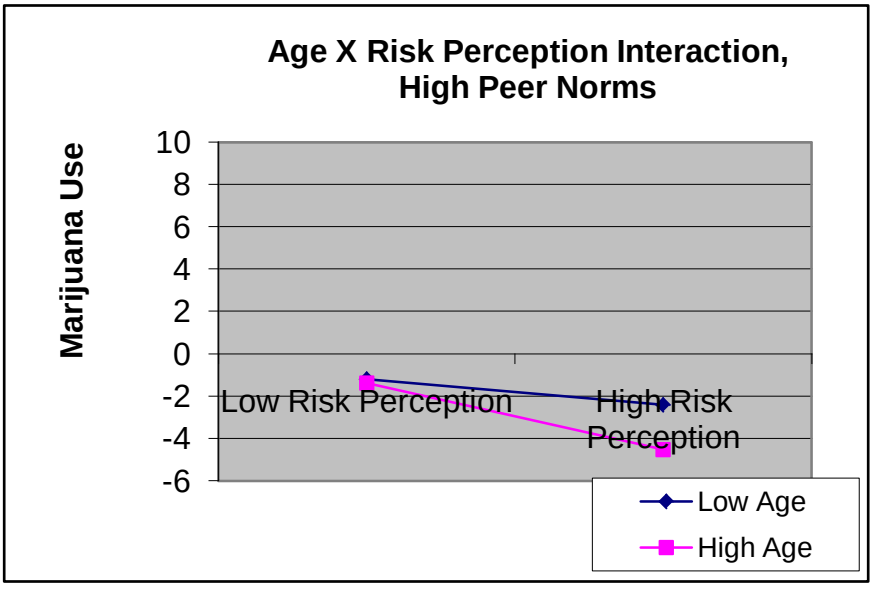

Figure 28. Graph Showing Age Moderating the Path Between Adolescent Risk Perception of Marijuana Use and Marijuana Use when Peers Disapprove of the Behavior

After controlling for adolescent variables, Microsystem variables and Exosystem variables, the Exosystem also failed to moderate the path between adolescent risk perception of marijuana use and reported marijuana use (Δ*Nagelkerke* $R^2 = 0.002$, χ^2 [df = 2] = 0.93, $p = 0.628$). No individual Exosystem variable was significant. When entered in the regression equation by itself, the Exosystem significantly moderated the relationship between risk perception and smoking cigarette behavior, but no individual Exosystem variable significantly moderated this relationship.

DISCUSSION AND CONCLUSIONS

The Bioecological Model and Risk Perception of Adolescent Health Risk Behaviors

Results of the regression in Hypothesis 1 provide support for the need to examine Bioecological Model variables when trying to assess or change adolescents' risk perception of health risk behaviors. Three of the systems in the model significantly explained risk perception in smoking cigarettes and marijuana use, while only two systems explained the variance in alcohol use. Noteworthy are the similar patterns of predicting risk perception of smoking cigarettes and marijuana use with almost identical changes in R squared reported at each system. The difference in the ability of the respective systems in the Bioecological Model to explain differing health risk behaviors is an important one, because it provides insight into prevention program planning, especially those programs that adopt a standardized program to address all health risk behaviors.

Irwin et al (1997) argued that there are three sources of risk taking, dispositional, ecological and biological. These results provide basis for these sources being also responsible for adolescent risk perception of health risk behaviors. Age and gender, both biological and developmental variables, were significant predictors for adolescent risk perception of all three risk behaviors, while impulse control, a dispositional variable was significant for risk perception of smoking cigarettes and alcohol use. The systems in the Bioecological Model as described by Bronfenbrenner and Morris (2006) are considered ecological, and each of the three health risk behaviors had at least one system that significantly contributed to adolescents' risk perceptions.

Adolescent variables being a significant predictor of risk perception of all three risk behaviors examined provides evidence that developmental trajectory is important when examining adolescents' risk perceptions of health risk behaviors. The developmental trajectory of adolescents is not limited to age and gender but also includes Developmentally Disruptive Dispositions as proposed by Bronfenbrenner and Morris (2006). Of the health risk behaviors examined, risk perception of alcohol use had

the highest amount of variance explained by adolescent variables followed by marijuana use. Of the adolescent variables age, gender and impulse control seem to be most salient in predicting risk perception. As mentioned, age and gender represent biological influences and impulse control represent dispositional influences. The combination of age, gender, and poor impulse control may influence a tendency to engage in sensation seeking as described by Arnett (1992), which may explain why these variables moderated the path between risk perception and health risk behavior as will be discussed later.

The Microsystem was a significant predictor of adolescent risk perception for all three health risk behaviors, this is consistent with Bronfenbrenner's (1979) idea that the most immediate influences on the child or adolescent is the Microsystem variables. Of the health risk behaviors explained, risk perception of marijuana use had the most amount of variance explained followed by alcohol use, although risk perception of smoking cigarettes was explained by more variables in the Microsystem than alcohol use. The illicit nature of marijuana (illegal to all individuals not just minors) means that external influences (peer pressure, parent concerns) have a strong impact on how adolescents are able to formulate their opinion about its risks. For smoking cigarette and alcohol use, however it is illegal for adolescents to access and use it but cigarettes and alcohol are not illegal, so external influences may impact their risk perception but not in the same way as marijuana. Noteworthy is the statistical trend seen in the results; peer use, peer delinquent behavior and peer prosocial behavior were significant predictors of risk perception for smoking cigarettes and marijuana use but not for alcohol use. One possible explanation for this might be that individuals in this sample perceive the risks associated with smoking cigarette and marijuana use to be similar because they classify both of the behaviors in a similar way, this is especially true if smoking cigarettes is used as a gateway to marijuana use. Adolescent risk perception of alcohol use was influenced only by parent and peer norm and this should be further explored. The overwhelming contribution of peer influence to explaining adolescent risk perception of smoking

cigarettes and marijuana use should be considered and be the target of health risk behavior prevention campaigns.

The Mesosystem was very important in understanding risk perception in smoking cigarette and marijuana use but less important in understanding that of alcohol use. Problems with multicollinearity resulted in no statistical information for risk perception for smoking cigarette and marijuana use and the age by parent norm, though the age by parent norm statistic was not significant for risk perception of alcohol use. Continuing with the trend seen in the Microsystem, adolescents' risk perceptions of smoking cigarettes and marijuana use were both influenced by the interaction of age by peer norm, however peer norm affected each of these risk perceptions differently. For smoking cigarettes older adolescents whose peers approved of the behavior still had higher risk perception than those whose peers disapproved, whereas for marijuana use older adolescents' risk perception increased as there peers disapproval increased. This may be reflective of the differences between cigarettes and marijuana described above. The relationship between gender and Microsystem variables proved to be significant in understanding adolescent risk perception of marijuana use. Noteworthy, for males peer norm significantly contributed to explaining risk perception, and for females parent norm was more instrumental in explaining risk perception. This suggests that male and female adolescents rely on different Microsystem sources to help them formulate their perceptions and opinions and this means in order to shape adolescents' opinion on health risk behaviors, different approaches may be needed for males and females. Additionally, based on the results, for males, risk perception was lower when parents disapproved and higher when parents approved, this is important because it demonstrates that parent interventions may encourage males to have negative perceptions. These results also reiterate the developmental characteristics of adolescence, that is, it is a period marked by rebelliousness, risk taking and sensation seeking. Rebelliousness may occur in varying situations and it may be more characteristic of males to rebel against their parents' perceptions of marijuana use, while for girls another health risk behavior not assessed in this paper may be the object of their rebellion.

Both Bronfenbrenner and Morris (2006) and Irwin et al (1997) stressed the importance of variables such as economic status and culture as being important ecological variables, however the results of this study did not mirror this idea. One possible reason for this is that school culture was measured by belonging to private versus public school, and although Arnett (1992) argued that there is a difference between these school groups because of narrow and broad socializations, there may be some within group differences specific to health risk behaviors that minimize the differences in how students are socialized, for example public schools may have more funding for drug prevention programs or more monitoring of student activity. Another reason for the Exosystem not being a significant predictor of adolescent risk perception of health risk behaviors may be that socioeconomic status was measured arbitrarily. Assumptions were made about people's socioeconomic status based on whether they were working and their education qualifications ignoring the idea that some people may choose not to work because of economic comfort, or that some blue collar jobs are just as highly paid as those requiring a higher education degree. Finally, the Bioecological Model identifies the Exosystem as the most distal system for the adolescent but the nature of Exosystem variables means they permeate throughout the Model; variables such as socioeconomic status and school culture influences who the adolescents peers are, and this will influence Microsystem variables. Based on the results derived when the Exosystem variables were the only variables entered in the system, I propose that future studies attempt to address this discrepancy by restructuring the Bioecological Model so that Exosystem variables are viewed and analyzed as more immediate influences.

The Bioecological Model and Reported Health Risk Behaviors

Based on the results of the hierarchical logistic regression in Hypothesis 2, it is apparent that the Bioecological Model is very influential in adolescent health risk behaviors. The predictive ability of the Bioecological Model is very similar to that seen in predicting risk perception of health risk behaviors. Knowing the impact of the Bioecological Model and health risk behaviors can help program planners develop

effective prevention programs as well as treatments and interventions to reduce the number of adolescents engaging in health risk behaviors.

Similar to risk perception, the adolescent variables in the Bioecological Model were responsible for a significant proportion of the variance explained in each of the three health risk behaviors. Of the three, it explained the most variance in smoking cigarette behavior. Adolescent variables influence access to substances (e.g. older adolescents might have more access to cigarettes because they could lie about their age), and adolescents' propensity to be deviant among other things and this is why these developmental and dispositional variables are relevant in explaining adolescents health risk behaviors. Contrary to what was predicted, mastery of external world was positively predictive of adolescent marijuana use, such that adolescents who have high mastery of external world are more likely to engage in alcohol use than others. One reason for this is that high mastery of external world is related to low risk perception since it contributes to "personal fable" or perceived invincibility, and as per the health belief model, low risk perception increases the chances of engaging in health risk behaviors.

As hypothesized, the Microsystem significantly predicted adolescent reported health risk behaviors after controlling for adolescent variables. The placement of the Microsystem as an immediate influence on adolescent health risk behavior in the Bioecological Model is a legitimate one, since in all three reported health risk behaviors the Microsystem accounted for the majority of the variance explained in the model. Of the three health risk behaviors, the Microsystem explained reported smoking cigarette behaviors most efficiently, followed by alcohol use and marijuana use respectively. This is the reverse of what was found in Hypothesis 1. One possible reason might be that parent and peer influences are more readily available to provide an environment that is conducive to engaging in smoking cigarettes or alcohol use, since these substances are more readily available than marijuana. Noteworthy among Microsystem variables are family structure and peer use, these variables, as was seen in previous studies (Blum et al., 2000; Kaplan et al., 1984), predicted all three health risk behaviors in adolescents.

Adolescents who belonged to single-parent families were more likely to engage in health risk behaviors and this may be because of lack or supervision, or as argued by Hundleby and Mercer (1987), lack of attachments to parents. Although peer use may be erroneous because it was measured by adolescent report, Ianotti et al (1996) pointed out that perception of peer behavior was just as important, if not more so than, actual peer behavior. Peer use provided a subgroup for adolescents to engage in health risk behaviors and probably a medium by which adolescents can access cigarettes, alcohol and marijuana (Conrad et al., 1992; Kaplan et al., 1984). Peer delinquent behavior was significant for both smoking cigarettes and marijuana use in directions opposite to what was predicted. One possible reason for this might be seeing the consequences of their friends' behavior functions as a deterrent. Another possible reason might be the prominent cigarette and marijuana advertisement campaigns nullify any influence peers' delinquent behavior might have on adolescents' own behavior, this reasoning is speculator and should be further explored. Other peer variables were also significant predictors for each of the three health risk behaviors respectively, solidifying the idea that targeting peers' influence is instrumental in prevention program planning. Parent variables had no impact on adolescent health risk behavior, and this might be explained by their developmental level; in adolescence, there is a tendency for adolescents to be rebellious especially toward parents and mainstream society (Kaplan et al., 1984; Arnett, 1995).

Similar to risk perception, the Mesosystem was very influential in predicting smoking cigarette behavior and marijuana use and less so alcohol use. This trend similar to that seen in the Microsystem and Mesosystem of risk perception, begs that one ask the question of why these two behaviors are so similarly explained. One hypothesis is that smoking cigarettes acts as a gateway drug for marijuana use, more so than alcohol use, and individuals who use marijuana may be identical to those who smoke cigarettes, since they are the cigarette smokers who started using marijuana. Specifically for marijuana use, the relationship between age and marijuana use was strongly influenced by parent and peer norms, reiterating the importance of the interaction of developmental variables

with environmental factors and the need to further explore Mesosystem variables. The inverse results seen for the age by peer norm and age by parent norm interactions for marijuana use, allude to developmentally specific circumstances, that should be further explored. Specifically, the positive relationship between peer norm and marijuana use found for younger adolescents might be explained by identity and "out group" formation in younger adolescents, that is, younger adolescents may be more willing to go against their peers' beliefs in order to establish themselves as "risk takers" or to form their own subgroups, both of which are developmental features of adolescence (Boeree, 1997). The negative relationship found for males might be explained by them transitioning to new friends and a new phase in life where friends may no longer judge them by their risk taking behavior but by their ability to be responsible and make good decisions. Another possible explanation might be that the "out groups" or other subgroups formed when they were younger are made up of peers who share in their beliefs and their behavior, therefore those whose peers disapproved of marijuana use may also disapprove of and refrain from marijuana use themselves (see next section for further explanation). Additionally, the relationship seen between parent norm and marijuana use dependent on age might be explained by rebelliousness from parents or decreased need for acceptance by parents in all adolescents, especially older adolescents. The relationship between peer norm and smoking was strongly dependent on gender, although for males the relationship was slightly positive. One possible reason for this might be that adolescent males are more likely to be exposed to social environments that promote smoking cigarette behaviors and having a social network to do this increases the chances that they will actually engage in the behavior. Another possible explanation is that males might be more prone to risk taking and sensation seeking behavior and their friends' disapproval may act as confirmation that the behavior is risky.

As seen in Hypothesis 1, the Exosystem failed to be a significant predictor of any health risk behaviors. The previous section elaborates on reasons this may be so.

The Bioecological Model Moderating the Path Between Risk Perception and Health Risk Behaviors

In examining the relationship between risk perception and health risk behavior, it is important to acknowledge the possibility of a circular relationship between the two variables. It is possible that adolescents perceive risks associated with a behavior to be low and decide to engage in the behavior because of this (based on Health Belief Model), but it is also possible that adolescents engage in a behavior and in order to rationalize their behavior they report their risk perception as low.

As predicted adolescent variables significantly moderated the path between risk perception and reported smoking cigarette behavior and alcohol use, however it had no effect on the path between risk perception and reported marijuana use. As explained in risk perception, because marijuana is illicit and is not as accessible or in full view as alcohol and cigarettes, it is possible that external influences have more impact on marijuana use than personal variables. Another possible explanation might be that the sub-sample of individuals who engaged in marijuana use, was relatively smaller than the total sample for marijuana use, making it difficult to achieve significance. Age only moderated the relationship between risk perception and alcohol use, and gender only moderated the path between risk perception and smoking cigarette behavior, note that risk perception was only measured by one item and therefore it was a weak measure of the construct, so insignificant moderator effects should be re-visited when risk perception is better measured. Adolescents' poor decision making may be understood by their propensity for sensation seeking as described previously by Arnett (1992). The need to form "out groups" or be classified as "risk takers" may explain why adolescents engage in behaviors, specifically males may be more likely to engage in smoking cigarettes despite their knowledge of the risks associated with the behavior because they want to belong to a subgroup and younger adolescents may choose to engage in alcohol use despite the risks because they want to be classified as a "risk taker." Also for

younger adolescents, opportunities for alcohol use may be more available than opportunities for any other of the other health risk behaviors identified by Grunbaum et al. (2004). As previously discussed, sensation seeking in conjunction with poor impulse control can lead to poor decision making in adolescents, therefore it is not surprising that impulse control strongly moderated the path between risk perception and smoking cigarette behavior such that adolescents with high impulse control were able to make better decisions. Contrary to what was predicted, the path between risk perception and alcohol use was positively moderated by body and self image. One possible reason for this might be that individuals' body and self image may be directly related to their "personal fable" which may lead them to believe that they are invincible to harm, and because of this, they engage in the behavior regardless of the risks associated with it. The relationship was more positive for individuals with low body and self image, and according to Shedler and Block (1990) and Kaplan et al (1984) individuals with a diminished self image are more likely to engage in health risk behaviors. As mentioned before, this gives more support for the need for substance use prevention and intervention programs targeting adolescents to focus on building morale and helping adolescents regulate their emotions and their behavior, and also to focus on reality testing. Mastery of external world moderated the relationships between risk perception and alcohol use and also smoking cigarette behavior but in different directions, however in both behaviors adolescents who had high mastery of external world were more likely to engage in the behaviors regardless of risk perception. Mastery of external world is a measure of adolescents' perceived competence in themselves, and it is likely that those with high mastery of external world may view themselves as invincible to harm, therefore their inability to make decisions about health risk behaviors based on their risk perception may be an indication of them making decisions based on the "personal fable" that is characteristic of adolescence. Further research should target this anomaly seen in mastery of external world moderating the relationship between risk perception and alcohol use, and also smoking cigarettes.

I hypothesized that the Microsystem will moderate the relationship between risk perception and health risk behaviors after controlling for adolescent variables and this was true for smoking cigarette behavior and alcohol use, but not marijuana use. As mentioned previously, the discrepancy in the sample size for marijuana use might be responsible for nonsignificance. Contrary to what was found in predicting risk perception and health risk behaviors, peer variables failed to moderate the path between risk perception and health risk behaviors. According to Arnett (1992) peer relationships may not cause individuals to choose to engage in health risk behaviors but may be a result of an initial tendency to engage in health risk behaviors, therefore the failure of peer variables to moderate the relationship between risk perception and reported behavior may be a result of adolescents choosing peers who have similar risk perceptions and behavior patterns as themselves. Also consistent with these findings, are the results of Kandel et al. (1984) study where individuals who engaged in early drug use had more drug using friends at follow up. Parent norm was the only individual variable in the Microsystem that moderated the path between risk perception and health risk behaviors (smoking cigarette and marijuana use). This confirms that parents continue to have influence over there children's decision making process even more so than peers. Peers' influence is probably more associated with maintenance of behaviors, since adolescents seek out peers who share their risk perceptions and behavior patterns (Arnett, 1992). Hence, peers being more predictive of actual behavior than of the decision to engage in behavior based on risk perception.

Similar to findings in Hypotheses 1 and 2, the Mesosystem was a significant moderator for the paths between risk perception and smoking cigarette behavior and marijuana use but not alcohol use. As described in the previous section, the relationship between smoking cigarette and marijuana use may be responsible for similar individual Mesosystem variables moderating the relationship between these behaviors and risk perceptions of these behaviors. The interactions of age by parent norm, age by peer norm, gender by parent norm, and gender by peer norm were all significant moderators of the path between risk perception and adolescent smoking cigarette behavior. Because

adolescence, is a period of physical, emotional and developmental change and the major counterplayers in their lives are their parents and their peers (Erikson & Erikson, 1997; Boeree, 1997), it is expected that parent and peer attitudes toward smoking behavior, along with the developmental changes brought on by age and gender significantly influence how their risk perception will translate into their behavior. More specifically, peer norm by itself did not moderate the relationship between risk perception and any health risk behavior, but when interacted with age, it became a significant moderator for risk perception and smoking cigarettes and marijuana use. Among adolescents whose peers approved of smoking cigarette the relationship between risk perception and the behavior was stronger for older adolescents, however among those whose peers approved of marijuana use the relationship between risk perception and marijuana use was stronger for younger adolescents. As mentioned before, the difference in the legal connotations and consequences associated with the use of these substances might influence adolescents' decisions differently. Also, for younger adolescents other factors such as access to marijuana and level of unsupervised time might negate any opportunities for marijuana use and hence decrease the influence peers have on their decision to use marijuana. Among adolescents whose peers disapproved of smoking cigarettes or marijuana use, the relationship between the risk perception and the behaviors were stronger for older adolescents. This may be reflective of older adolescents having peers who share their beliefs and behaviors. In looking at the age by parent norm interaction, among those whose parents approve of smoking cigarettes the relationship between risk perception and the behavior is stronger for older adolescents. Two possible reasons for this result is that older adolescents are better able than younger adolescents to make logical decisions despite their parents' beliefs, or that older adolescents might be rebelling against their parents. Among adolescents whose parents disapprove of the behavior, younger adolescents had a stronger negative relationship, and this might be due to them being more dependent on their parent than older adolescents, or as mentioned previously, they still consider their parents opinion to be important in their decision-making. Based on the results of the gender by parent norm

interaction, parents who approve of smoking cigarette have little influence on male and female adolescents' decision-making, however for adolescents whose parents disapprove of the behavior, the relationship between risk perception and smoking cigarette is stronger. These results are unexpected and should be further explored.

Also, consistent with Hypotheses 1 and 2, the Exosystem failed to moderate the path between risk perception and adolescent health risk behavior. Refer to Hypothesis 1 discussion section for possible reasons for this.

Conclusions

As discussed before the combination of the Bioecological Model and the Health Belief Model provides the unique opportunity to understand adolescents' decision to engage in health risk behaviors. The results of this study clearly show that bioecological variables help in understanding risk perception, reported health risk behaviors and decisions adolescents make in relation to risk perception and health risk behaviors. Because the Bioecological Model is viewed as part of a generative process, results here can be used to produce a more integrated Health Belief Model specific to adolescents.

Limitations

The major limitation of the study is the weak measurement of risk perception, this construct was measured by one question per health risk behavior examined and in so doing it reduced chances of getting significant results. Another limitation of the study is the Exosystem variables, as previously discussed, were also insufficiently measured. The variables peer norm for marijuana use, parent norm for marijuana use, and peer use of marijuana was not directly measured, these variables were measures of general illicit drug use and this may have affected the results of this study. Another limitation of the study was that parent use was only measured for smoking cigarettes.

Bronfenbrenner and Morris (2005) argued the importance of ethnicity when explaining the environment that influences a person's role in society and this study failed to examine this important variable. This study also failed to measure sensation-seeking,

which is believed to be a key influence in explaining adolescents' behavior, specifically health risk behaviors.

Future Directions

Although the entire Bioecological Model did not moderate the path between risk perception and health risk behavior, future studies should apply the Bioecological Model to the Health Belief Model to test for moderation. It may be that some paths may be more influenced by some systems in the model than others in the same way there were differences in the way the Bioecological Model predicted risk perception and health risk behaviors respectively. Future studies should also restructure the Bioecological Model so that the Exosystem is considered a more immediate influence, because as explained earlier, the Exosystem permeates throughout all the other systems in the model. Future studies should also further explore the relationship between smoking cigarettes and marijuana use as it pertains to variables in the Bioecological Model. The interaction variables in the Mesosystem were arbitrarily chosen in order to preserve power and variance, therefore it is hard to generalize about the ability of the Mesosystem to effectively moderate the paths in the Health Belief Model. To resolve this issue, I propose salient Mesosystem variables be identified using the reiterative process proposed by Bronfenbrenner and Morris (2006).

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APPENDIX I

Exploratory Hypotheses for Hypothesis I – Bioecological Model Predicting Adolescent Risk Perception of Health Risk Behaviors

System/Variable	Null Hypothesis	Alternative Hypothesis
Adolescent		
Age	Age will have no influence on risk perception	Age will be negatively associated to adolescent risk perception - older adolescents will have lower risk perception than younger adolescents
Gender	Gender will have no influence on risk perception	Female adolescents' risk perception will be higher than male adolescents' risk perception
Impulse Control	Impulse control will have no influence on risk perception	Impulse control will be positively associated with adolescents' risk perception - adolescents with less impulse control will have lower risk perception than those with higher impulse control
Body and Self Image	Body and self image will have no influence on risk perception	Body and self image will be positively associated with adolescents' risk perception – adolescents with low body and self image will have lower risk perception than those with high body and self image
Mastery of External World	Mastery of external world will have no influence on risk perception	Mastery of external world will be positively associated with adolescents' risk perception - adolescents' with higher mastery of external world will have higher risk perception than those with lower mastery of external world

System/Variable	Null Hypothesis	Alternative Hypothesis
Microsystem	***Controlling for adolescent variables***	***Controlling for adolescent variables***
Parent Use	Parent use will have no influence on risk perception	Parent use will be negatively associated with adolescent risk perception - adolescents' whose parents engage in substance use will have lower risk perception than those whose parents do not engage in substance use
Family Structure	Family structure will have no influence on risk perception	Adolescents from single parent families will have lower risk perception than those from two parent families
Parent Norm	Parent norm will have no influence on risk perception	Parent norm will be positively associated with adolescents' risk perception - adolescents whose parents had a positive attitude toward substance use (lower parent norm scores) will have lower risk perception than those whose parents disagree with substance use.
Peer Use	Peer use will have no influence on risk perception	Peer use will be negatively associated with adolescent substance use - adolescents whose peers engage in substance use will have lower risk perception than those whose peers do not engage in substance use
Peer Prosocial Behavior	Peer prosocial behavior will have no influence on risk perception	Peer prosocial behavior will be positively associated with adolescents' risk perception - adolescents whose peers engage in prosocial behavior will have higher risk perception than those whose peers do not engage in prosocial behavior

System/Variable	Null Hypothesis	Alternative Hypothesis
Peer Delinquent Behavior	Peer delinquent behavior will have no influence on risk perception	Peer delinquent behavior will be negatively associated with adolescents' risk perception - adolescents whose peers engage in delinquent behavior will have lower risk perceptions than those whose peers do not engage in peer delinquent behavior
Peer Norm	Peer norms will have no influence on risk perception	Peer norm will be positively associated with adolescent risk perception - adolescents whose peers had a positive attitude toward substance use (lower peer norm scores) will have lower risk perception than those whose peers disagree with substance use
Mesosystem	***Controlling for adolescent and microsystem variables***	***Controlling for adolescent and microsystem variables***
Age x Gender	The relationship of age and risk perception will not be dependent on gender	The relationship of age and risk perception depends on gender such that the relationship is stronger for female adolescents than for male adolescents
Age x Parent Norm	The relationship of parent norm and risk perception will not be dependent on age	The relationship of parent norm and risk perception depends on age such that the relationship is stronger for younger adolescents
Age x Peer Norm	The relationship of peer norm and risk perception will not be dependent on age	The relationship of peer norm and risk perception depends on peer norm such that the relationship is stronger for younger adolescents
Gender x Parent Norm	The relationship of parent norm and risk perception will not be dependent on gender	The relationship of parent norm and risk perception depends on gender such that the relationship is stronger for female adolescents
Gender x Peer Norm	The relationship of peer norm and risk perception will not be dependent on gender	The relationship of peer norm and risk perception depends on gender such that the relationship is stronger for female adolescents

System/Variable	Null Hypothesis	Alternative Hypothesis
Exosystem	***Controlling for adolescent, microsystem and mesosystem variables***	***Controlling for adolescent, microsystem and mesosystem variables***
School Culture	School culture will have no influence on risk perception	Adolescents who attend private school will have higher risk perception than those who attend public school
Socioeconomic Status	Familial socioeconomic status will have no influence on adolescent risk perception	Socioeconomic status will be positively associated with adolescent risk perception - adolescents whose familial socioeconomic status is higher will have higher risk perception than those whose familial socioeconomic status is lower

APPENDIX II

Exploratory Hypotheses for Hypothesis II – Bioecological Model Predicting Adolescent Health Risk Behaviors

System/Variable	Null Hypothesis	Alternative Hypothesis
Adolescent		
Age	Age will have no influence on adolescent health risk behaviors	Age will be positively associated with adolescent health risk behaviors – older adolescents will be more likely engage in health risk behaviors
Gender	Gender will have no influence on adolescent health risk behaviors	Adolescent males will be more likely engage in health risk behaviors than adolescent females
Impulse Control	Impulse control will have no influence on adolescent health risk behaviors	Impulse control will be negatively associated with adolescent health risk behaviors – adolescents with poor impulse control will more likely engage in health risk behaviors
Body and Self Image	Body and self image will have no influence on health risk behaviors	Body and self image will be negatively associated with adolescent health risk behaviors – adolescents with low body and self image will more likely engage in health risk behaviors
Mastery of External World	Mastery of external world will have no influence on adolescent health risk behaviors	Mastery of external world will be negatively associated with adolescent health risk behaviors - adolescents with higher mastery of external world will be less likely engage in adolescent health risk behavior
Microsystem	***Controlling for adolescent variables***	***Controlling for adolescent variables***
Parent Use	Parents' use will have no influence on adolescent health risk behaviors	Parents' use will be positively associated with adolescents' health risk behaviors - adolescents whose parents engage in health risk behaviors will be more likely to engage in health risk behaviors

System/Variable	Null Hypothesis	Alternative Hypothesis
Family Structure	Family structure will have no influence on adolescent health risk behaviors	Adolescents coming from two-parent families will be less likely to engage in health risk behaviors than those coming from single-parent families
Parent Norm	Parents' norm will have no influence on adolescent health risk behavior	Parents' positive attitudes toward health risk behaviors will be positively related to adolescents' health risk behaviors – adolescents whose parents agree with health risk behaviors will be more likely to engage in health risk behaviors
Peer Use	Peers' use will have no influence on adolescent health risk behavior	Peers' use will be positively associated with adolescents' health risk behaviors – adolescents whose peers engage in health risk behaviors will be more likely to engage in health risk behaviors
Peer Prosocial Behavior	Peers' prosocial behavior will have no influence on adolescent health risk behavior	Peers' prosocial behavior will be negatively associated with adolescents' health risk behaviors – adolescents whose peers engage in prosocial behavior will be less likely to engage in health risk behaviors
Peer Delinquent Behavior	Peers' delinquent behavior will have no influence on adolescent health risk behavior	Peers' delinquent behavior will be positively associated with adolescents' health risk behavior – adolescents whose peers engage in delinquent behavior will be more likely to engage in health risk behaviors
Peer Norm	Peers' norms will have no influence on adolescent health risk behavior	Peers' positive attitudes toward health risk behaviors will be positively associated with adolescents' health risk behaviors – adolescents whose peers agree with health risk behaviors will be more likely to engage in health risk behaviors

System/Variable	Null Hypothesis	Alternative Hypothesis
Mesosystem	***Controlling for adolescent and microsystem variables***	***Controlling for adolescent and microsystem variables***
Age x Gender	The relationship of age and health risk behavior will not be dependent on gender	The relationship of age and health risk behavior depends on gender such that the relationship is stronger for female adolescents than male adolescents
Age x Parent Norm	The relationship of parent norm and health risk behavior will not be dependent on age	The relationship of parent norm and health risk behavior depends on age such that the relationship is stronger for younger adolescents
Age x Peer Norm	The relationship of peer norm and health risk behavior will not be dependent on age	The relationship of peer norm and health risk behavior depends on age such that the relationship is stronger for younger adolescents
Gender x Parent Norm	The relationship of parent norm and health risk behavior will not be dependent on gender	The relationship of parent norm and health risk behavior depends on gender such that the relationship is stronger for female adolescents
Gender x Peer Norm	The relationship of peer norm and health risk behavior will not be dependent on gender	The relationship of peer norm and health risk behavior depends on gender such that the relationship is stronger for female adolescents
Exosystem	***Controlling for adolescent, microsystem and mesosystem variables***	***Controlling for adolescent, microsystem and mesosystem variables***
School Culture	School culture (private vs public) will have no influence on adolescent health risk behavior	Belonging to a private school will be negatively associated with health risk behaviors and belonging to a public school will be positively associated with health risk behavior
Socioeconomic Status	Familial socioeconomic status will have no influence on adolescent health risk behavior	Familial socioeconomic status will be negatively associated with health risk behavior – adolescents whose families' socioeconomic status is high are less likely to engage in health risk behaviors

APPENDIX III

Exploratory Hypotheses for Hypothesis III – Bioecological Model Moderating the Path Between Risk Perception and Adolescent Health Risk Behaviors

System/Variable	Null Hypothesis	Alternative Hypothesis
Adolescent		
Age	Age will have no influence on the relationship between risk perception and adolescent health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on age - age will moderate the path between risk perception and health risk behaviors such that the relationship is negative and stronger for older adolescents than for younger adolescents
Gender	Gender will have no influence on the relationship between risk perception and adolescent health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on gender such that the relationship will be stronger for females than for males
Impulse Control	Impulse control will have no influence on the relationship between risk perception and adolescent health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on impulse control – impulse control will negatively moderate the path such that the relationship is stronger for adolescents with high impulse control
Body and Self Image	Body and self image will have no influence on the relationship between risk perception and health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on body and self image – body and self image will negatively moderate the path such that the relationship is stronger for adolescents with high body and self image
Mastery of External World	Mastery of external world will have no influence on the relationship between risk perception and adolescent health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on mastery of external world - mastery of external world will negatively moderate the path such that the relationship is stronger for adolescents with high mastery of external world

System/Variable	Null Hypothesis	Alternative Hypothesis
Microsystem	***Controlling for adolescent variables***	***Controlling for adolescent variables***
Parent Use	Parents' use will have no influence on the relationship between risk perception and adolescent health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on parent use – parent use will moderate the path such that the relationship is stronger for adolescents whose parents do not engage in health risk behaviors
Family Structure	Family structure will have no influence on the relationship between risk perception and adolescent health risk behaviors	The relationship between risk perception and health risk behaviors will be dependent on family structure - family structure will moderate the path between risk perception and health risk behaviors such that the relationship is stronger for adolescents who belong to two-parent families
Parent Norm	Parents' norm will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on parent norm - parent norm will moderate the path such that the relationship is stronger for adolescents whose parents had negative attitudes (high scores) to health risk behaviors
Peer Use	Peers' use will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on peer use- peer use will moderate the path such that the relationship is stronger for adolescents whose peers did not engage in health risk behaviors
Peer Prosocial Behavior	Peers' prosocial behavior will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on peer prosocial behavior - peer prosocial behavior will negatively moderate the path such that the relationship is stronger for adolescents whose peers engage in prosocial behavior

System/Variable	Null Hypothesis	Alternative Hypothesis
Peer Delinquent Behavior	Peers' delinquent behavior will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on peer delinquent behavior – peer delinquent behavior will moderate the path such that the relationship is stronger for adolescents whose peers did not engage in delinquent behavior
Peer Norm	Peers' norms will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on peer norm - peer norm will moderate the path such that the relationship is stronger for adolescents whose peers had negative attitudes to health risk behaviors
Mesosystem	***Controlling for adolescent and microsystem variables***	***Controlling for adolescent and microsystem variables***
Age x Gender	The relationship of risk perception and health risk behavior will not be dependent on the interaction of age and gender	The relationship of risk perception and health risk behavior depends on the interaction of age and gender such that among younger adolescents the relationship is stronger for female, and among older adolescents the relationship is stronger for female adolescents
Age x Parent Norm	The relationship of risk perception and health risk behavior will not be dependent on the interaction of age and parent norm	The relationship of risk perception and health risk behavior depends on the interaction of age and parent norm such that among adolescents whose parents disapprove the relationship is stronger for younger adolescents and among those whose parents approve the relationship is stronger for younger adolescents

System/Variable	Null Hypothesis	Alternative Hypothesis
Age x Peer Norm	The relationship of risk perception and health risk behavior will not be dependent on the interaction of age and peer norm	The relationship of risk perception and health risk behavior depends on the interaction of age and peer norm such that among adolescents whose peers disapprove the relationship is stronger for younger adolescents and among those whose peers approve the relationship is stronger for younger adolescents
Gender x Parent Norm	The relationship of risk perception and health risk behavior will not be dependent on the interaction of gender and parent norm	The relationship of risk perception and health risk behavior depends on parent norm such that among adolescents whose parents disapprove the relationship is stronger for female adolescents and among those whose parents approve the relationship is stronger for female adolescents
Gender x Peer Norm	The relationship of risk perception and health risk behavior will not be dependent on the interaction of gender and peer norm	The relationship of risk perception and health risk behavior depends on peer norm such that among adolescents whose parents disapprove the relationship is stronger for female adolescents and among those whose parents approve the relationship is stronger for female adolescents
Exosystem	***Controlling for adolescent, microsystem and mesosystem variables***	***Controlling for adolescent, microsystem and mesosystem variables***
School Culture	School culture (private vs public) will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on school culture - school culture will moderate the path such that the relationship is stronger for adolescents in private school
Socioeconomic Status	Familial socioeconomic status will have no influence on the relationship between risk perception and adolescent health risk behavior	The relationship between risk perception and health risk behaviors will be dependent on socioeconomic status – socioeconomic status will moderate the path such that the relationship is stronger for adolescents whose parents have high socioeconomic status

VITA

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