# Substance use consequences of adolescent mental health problems: Integrating national and high-risk samples

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Psychology)
in the University of Michigan
2012

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To Mom, Dad, and Al

Acknowledgements

First, I want to extend my sincere thanks to the members of my dissertation committee, John Schulenberg, Dan Keating, Chris Monk, Bob Zucker, and Ginny Delaney-Black, for the time you have devoted to reading and evaluating my dissertation. You are a Dissertation Dream Team, and I am grateful to have each of you as a member of my committee and even more so for the opportunity to have been mentored by each of you over the years.

John Schulenberg, thank you for the countless hours you have invested in me and my training. I could not have asked for a better mentor. Thank you for your high expectations and constant support and encouragement. I leave every meeting with you feeling energized, confident, and excited to get to work. Thanks also for letting me do many (some would say too many) things at once and for helping me to trust my instincts that this is the only way for me.

Dan Keating, thank you for encouraging me to think broadly and integratively about my research, and for, on multiple occasions, helping me to put words to ideas and questions I didn't quite know how to ask yet.

Chris Monk, thank you for demonstrating a logical, formulaic approach to research and to writing that I now use in every project and paper I work on. Thanks also for providing an invaluable example of how to navigate assistant professorship with exceptional professionalism and poise.

Bob Zucker and Ginny Delaney-Black, I could not have asked for two better examples of big scientific thinking coupled with incredibly competent management of incredibly complex longitudinal projects. You make the overwhelming look easy, and I am so grateful to have witnessed your examples.

In addition to my dissertation committee members, I wish to thank several mentors, colleagues, and friends who have been instrumental in my professional and personal development.

Sofia Merajver: you defy words. My proudest accomplishment to date is whatever small part I played in directing some of your might toward Ecuador and Latin America. Thank you for making me believe that research can, and does, change lives.

Rosemary Sarri: no one fights the good fight harder or better. You are an inspiration. Thank you for teaching me.

Bina Valsangkar: you are wise beyond your years. It's been such a privilege to "grow up" professionally together. We have the best kind of collegial relationship, with complementary skill sets, respect for each other's expertise, and honest and open feedback on everything. There is no one I'd rather change the world with. Here's to many more years of good work and good friendship.

Finally, many thanks to my family and friends.

Mom and Dad: you had no idea your farm girl would get a PhD someday, but you nonetheless managed to prepare me for it perfectly. I am often praised for my work ethic, confidence, and "stick-to-it-iveness", but I really can't take credit; I owe them to you. I may be the one getting the official degree, but it's clear that you two, for successfully raising three of the strongest-willed girls in the world, are the ones who really deserve

PhDs in developmental psychology! Jenny and Jill: we couldn't be more different, but no one will ever understand me better (don't tell Al!). Thank you for everything.

Pam, Robin, Sara, Jessie: the best of best friends. Thanks to all of you for keeping it (and me) real.

Al: there is no way to adequately say thank you for everything you have done to support me for the past three years. You are MY champion; let's get married!

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# Chapter 1

## Introduction

Adolescent substance use is a persistent public health problem that results in substantial morbidity and mortality among youth and can instigate a cascade of negative social, health, and economic impacts into adulthood. Alcohol use alone is responsible for over 320,000 deaths per year among young people ages 15-24 worldwide (World Health Organization, 2011b) The annual economic costs of substance abuse exceed $600 billion in the United States alone (National Institute on Drug Abuse, 2011). Early initiation of substance use during adolescence is one of the strongest known predictors of abusing substances as an adult (Grant & Dawson, 1998; Wagner & Anthony, 2002). Early initiation is also associated with increased educational, social, and health difficulties in adolescence and into adulthood (Bonnie & O'Connell, 2004; Brook, Balka, & Whiteman, 1999; DuRant, Smith, Kreiter, & Krowchuk, 1999; Hingson, 2000; Moolchan et al., 2007). Alcohol, marijuana, and cigarettes are the substances most commonly used in adolescence (Johnston, O'Malley, Bachman, & Schulenberg, 2011) and are the focus of the research presented here.

Substance use is understood to result from a developmental sequence that likely begins in childhood (Dodge et al., 2009; Masten, Faden, Zucker, & Spear, 2008; Zucker, Donovan, Masten, Mattson, & Moss, 2008). Elements in this sequence include early behavioral and self-regulation problems, negative parent-child relationship dynamics,

association with deviant peers, and the development of mental health problems in adolescence. The aim of this dissertation is not to examine the entirety of this developmental sequence, but instead to zoom in on one particular link in the chain, that linking adolescent mental health problems with substance use, fill in crucial details that still lack regarding this association, and provide information relevant to determining whether adolescent mental health problems represent a candidate target for intervention in order to prevent subsequent substance use. This dissertation provides additional evidence in two areas highlighted for future research by the Institute of Medicine (1996) in its report on developmental pathways to addiction. These are the role of psychopathology as a predictor of drug abuse and studies that focus on adolescence because it is a key developmental period for the emergence of substance use.

As discussed in each of the studies presented in this dissertation, mental health symptoms, particularly conduct problems (CP) and depressive symptoms (DS), have each been shown to predict early initiation of substance use during adolescence (Boys et al., 2003; King, Iacono, & McGue, 2004; Pilgrim, Schulenberg, O'Malley, Bachman, & Johnston, 2006) and its progression to problematic use (Zucker et al., 2008). CP and DS are the categories of mental health symptoms most strongly associated with substance use during adolescence (Armstrong & Costello, 2002; Kandel, Johnson, Bird, & Canino, 1997) and are therefore the symptoms on which the three studies focus. Although substance use is sometimes included together with CP within the overarching category of externalizing behaviors, such as in the Child Behavior Checklist (Achenbach & Rescorla, 2001), in the majority of developmental literature on substance use, CP is treated as a predictor of substance use. While both CP and substance use involve rule-breaking and

therefore could be considered to be related behaviors, they are by no means synonymous. CP increases risk for substance use but does not guarantee it. In the current study, as in the majority of current literature, I regard CP as a robust early predictor of substance use.

There is a substantial literature examining the individual effects of CP and DS on substance use. The link between CP and substance use is consistently supported by the literature; the research on the link between DS and substance use is less conclusive regarding whether the association exists and for whom. However, although the two symptom types often co-occur, comparatively little research has examined the effect of their interaction on substance use. A systematic study of age and sex differences in this association and timing effects at the population level is still needed.

Thus, while early adolescent mental health problems are candidate developmental risk factors to be targeted in substance use prevention programs, appropriately tailored interventions will require more detailed information on this relationship. Specifically, it will be important to understand the relative contribution of each specific type of mental health problem, whether there are unique time periods at which mental health problems are most impactful on substance use, whether and how these relationships differ across and within major demographic subgroups, and how mental health and substance use fit into the larger ecology of adolescent development.

This dissertation provides new evidence to each of these points via three studies. The first study, presented in Chapter 2, provides an epidemiological perspective on the cross-sectional relationships of mental health and substance use in 8$^{th}$, 10$^{th}$, and 12$^{th}$ grade students surveyed in Monitoring the Future (MTF) national surveys. The second, presented in Chapter 3, uses longitudinal MTF data spanning 8$^{th}$, 10$^{th}$, and 12$^{th}$ grade to

examine the role of early mental health problems in predicting later substance use. The third, presented in Chapter 4, examines mental health as a predictor of substance use in a high-risk sample of urban, African-American adolescents in order to determine whether mental health symptoms are particularly important predictors of substance use in a high-risk sample.

The unifying approach used in all three studies is developmental epidemiology, an emerging subfield that combines methods and principles of epidemiology with theory of developmental psychopathology to examine the population-level patterns and prevalence of child and adolescent mental health and behavioral problems as well as the mechanisms that underlie them (Kellam, Koretz, & Moscicki, 1999; Costello, Foley, & Angold, 2006; Costello & Angold, 2006). I use this approach to integrate epidemiologic and etiologic methods and theory in order to further elucidate the relationship between mental health and substance use during adolescence.

Epidemiology is the study of patterns of disease in human populations (Kleinbaum, Kupper, & Morgenstern, 1982). It has traditionally focused on describing disease phenomena, the "who", "where", "when", and "how many" of diseases. Its strengths include attention to the representativeness of samples and subsequent generalizability of results and attunement to population-level impacts of individual risk factors, often a necessity for policy relevance of findings. These characteristics make it an ideal complement to developmental psychopathology.

Developmental psychopathology is "the study of the origins and course of behavioral maladaptation, whatever the age of onset, whatever the causes, whatever the transformations in behavioral manifestation, and however complex the course of the

developmental pattern may be" (Sroufe & Rutter, 1984, p. 18). Developmental psychopathology emphasizes the importance of studying mental health in the general population as well as in high-risk subgroups in order to formulate a holistic understanding of the etiology of mental health along the entire spectrum of disorders, subclinical symptoms, and well-being. In other words, developmental psychopathology research embraces the complexity of individual ontogeny and the fuzzy lines between symptoms and disorder and between one disorder and the next. Within this complexity, it strives to discover the underlying mechanisms of development of psychopathology by employing analyses at multiple levels of the population in order to understand the specific patterns of occurrence of psychopathological symptoms as well as the risk and protective factors most associated with their development. Masten et al. (2008) note the utility of developmental psychopathology for studying substance use, as the predictors, onset, acceleration, and consequences of substance use are all developmentally patterned.

Buka (2004) describes the emergence of developmental epidemiology as a shift from the 4 Ds of traditional epidemiology (description of the distribution and determinants of diseases) to the 4 Cs of developmental epidemiology (causes and mechanisms underlying complex disorders, with recognition of the role of social contexts). Developmental epidemiology benefits from the expertise of both of its parent fields, the breadth and attention to population-level trends and impacts that are associated with epidemiology, and the theoretical depth and attention to change over time and developmental specificity of risk and protective processes (Cicchetti & Rogosch, 1999; Mason, 2003). Developmental epidemiology merges these two traditions in order to study the development of psychopathology and related phenomena at the population level.

Accordingly, the theories and methods utilized in the studies presented herein draw on both epidemiology and developmental psychopathology. In the tradition of epidemiology, I conduct the studies using national representative samples of American adolescents and attend both to the prevalence of the risk factors and outcomes under study as well as the relationships between them. I stratify analyses by age and gender as appropriate to avoid confounding of the associations between mental health and substance use that may be due to these differential prevalence and distribution by age and gender. In the tradition of developmental psychopathology, the specific research questions under investigation focus on a crucial developmental period for the development of substance use, middle adolescence, incorporate longitudinal data in order to observe patterns of prediction over time, and examine a developmentally important contextual factor, parental support, and its effects on the development of mental health and substance use during adolescence. I attend to prevalence differences in mental health problems and substance use among subgroups (e.g. depressive symptoms are more common among girls, conduct problems and substance use are more common among boys, and substance use is more common among White than African American adolescents), but I challenge a possible accompanying assumption that these prevalence differences dictate differences in how these behaviors are associated with each other among these subgroups. Chapters 2 and 3 test gender differences in these associations, and Chapter 4 conducts a within-group analysis of two diverse samples of African American adolescents to determine the extent to which the relations of mental health symptoms and substance use vary meaningfully across subgroups.

The first study, presented in Chapter 2, aims to build on existing knowledge regarding the relationship between internalizing and externalizing difficulties and substance use during adolescence by adding critical information regarding the effect of the interaction of these two symptom types. I quantify the individual and interactive associations of CP and DS with use of alcohol, cigarettes, and marijuana among a national sample of adolescents. No known study has quantified the respective associations of CP, DS and their interaction (CPxDS) with alcohol, cigarette, and marijuana use in a national non-clinical sample. This study has two primary goals: to quantify the association of CP, DS, and the CPxDS interaction with alcohol, marijuana, and cigarette use during adolescence and to examine whether there are age and/or sex differences in these associations. This study also makes a substantial methodological contribution by demonstrating the estimation and interpretation of latent variable interactions, a technique that has previously been largely inaccessible due to difficulties in interpretation of results.

In Chapter 3, I build on the cross-sectional results presented in Chapter 2 with a longitudinal study of the effect of early adolescent mental health problems on later adolescent substance use. Identifying early predictors of substance use and testing whether there are developmental periods at which they play a particularly strong role are crucial steps in determining whether early adolescent mental health is a suitable candidate for targeted substance use preventive interventions. Interventions that help to delay the onset of substance use in adolescence have been shown to reduce problematic substance use in young adulthood (Spoth, Trudeau, Guyll, Shin, & Redmond, 2009; Kellam & Anthony, 1998). Isolating the effect of early adolescent CP and DS on changes in

substance use across adolescence and the developmental windows at which mental health is most influential will inform the design of appropriately targeted substance use prevention and intervention programs for adolescents.

The study presented in Chapter 3 focuses on the longitudinal effects of adolescent CP and DS in predicting changes in substance use in adolescents during the period from $8^{th}$-$12^{th}$ grades. This study tests whether $8^{th}$ grade mental health problems are truly a particular marker of risk for later substance use problems, ruling out effects of simple temporal proximity to the outcome. To do so, it tests two competing hypotheses. One possibility is that earlier-emerging mental health problems will have stronger effects on substance use than later mental health problems, because earlier-emerging problems tend to be more severe and more strongly associated with other developmental difficulties. The second possibility is that mental health problems occurring more proximally to the substance use outcome will be more strongly associated with substance use than more distal mental health problems, because proximal predictors tend to be stronger than distal predictors, for both methodological and substantive reasons. In epidemiological terms, this study tests the effect of differential timing of the individual's exposure to mental health problems on changes in their levels of substance use. Like the first study (Chapter 2), this study also tests whether DS and CPxDS play a role in predicting substance use across the adolescent period, to attempt to clarify the mixed results in the literature regarding the effect of DS on substance use, and it tests whether there are gender differences in the effects of CP, DS, and their interaction on substance use across adolescence.

Chapter 4 takes a step further in integrating epidemiological and etiological perspectives on the development of substance use by actually combining two datasets, one that represents each of these approaches, in order to examine the role of mental health in the development of substance use in a diverse sample of African American adolescents. Although prevalence of both mental health problems and substance use tend to be lower among African Americans than Caucasian adolescents, those who develop them tend to experience more chronic and disabling mental health symptoms and more negative substance use-related consequences in comparison to White adolescents (Breslau et al., 2006; Williams et al., 2007; Wallace & Muroff, 2002). The lower prevalence of mental health problems and substance use among African Americans may disguise a significant burden that they impose upon those who are affected. However, African American adolescents are underrepresented in the substance use literature, and more information is needed regarding the developmental processes related to mental health and substance use that occur early in adolescence in order to better describe the mental health-substance use association in this population and identify potential protective processes that, if nurtured, could have positive effects on both mental health and substance use in this population.

This study combines national MTF data with data from the School-Based Evaluation Study (SCHOO-BE), a longitudinal study of African Americans at high risk for developing mental health and substance use problems due to high rates of prenatal cocaine exposure and other social and biological risk factors in the sample. It tests whether CP and DS mediate the relationship between parental support, a known protective factor, and substance use. That is, do those adolescents who receive more

support from their parents have better mental health and thus use substances at lower rates? From a methodological standpoint, this study demonstrates the utility of merging epidemiological and etiological theories as well as merging the actual data using rigorous psychological measurement techniques in order to conduct integrative studies that help to further our understanding of developmental processes underlying substance use.

Finally, Chapter 5 offers concluding comments on several aspects of the three studies, including a synthesis of their respective results and a review of their broader implications for future science and practice in the area of adolescent health and development.

# Chapter 2

## Interaction matters: Quantifying conduct problem by depressive symptom interaction and its association with adolescent alcohol, cigarette, and marijuana use in a national sample

Substance use is one of the leading causes of preventable morbidity and mortality in the United States and worldwide (Mokdad, Marks, Stroup, & Gerberding, 2004; World Health Organization, 2008; World Health Organization, 2011a). Alcohol alone is responsible for 9% of all deaths among 15-24-year-olds, over 320,000 worldwide deaths per year (World Health Organization, 2011b). Substance use typically begins in adolescence; marijuana, cigarette, and alcohol use are all most likely to onset and escalate during this period (Johnston, O'Malley, Bachman, & Schulenberg, 2011). Initiating substance use early in adolescence, before age 14, is one of the strongest predictors of developing a substance use disorder as an adult (DeWit, Adlaf, Offord, & Ogborne, 2000; Grant & Dawson, 1997; Wagner & Anthony, 2002). Nonetheless, early initiation is common; in 2010, 36% of American 8$^{th}$ graders reported that they had used alcohol in their lifetime, 20% had used cigarettes, and 17% had used marijuana. Excessive substance use is also relatively common among 8$^{th}$ graders, with nearly half of the lifetime alcohol users reporting being drunk at least once and nearly half of the lifetime marijuana users reporting use in the past 30 days (Johnston et al., 2011).

The serious health effects of substance use across the lifespan necessitate an understanding of its early predictors in order to formulate strategies for delaying its onset and reducing risk of future morbidity and mortality. To that end, the current study aims to build on existing knowledge regarding the relation between internalizing and externalizing difficulties and substance use during adolescence by adding critical information regarding the effect of the interaction of these two symptom types. Namely, I quantify the individual and interactive associations of externalizing difficulties in the form of conduct problems (CP) and internalizing difficulties in the form of depressive symptoms (DS) to use of alcohol, cigarettes, and marijuana among a national sample of adolescents. I incorporate principles of both epidemiology and developmental psychopathology to provide both breadth and depth in the investigation. While CP and DS have been previously studied as predictors of substance use, no known study has quantified their association with alcohol, cigarette, and marijuana use in a national non-clinical sample; most studies use community based, clinical, or convenience samples, and many focus on a single substance. This study uses a national sample of adolescents in order to provide a broad epidemiological perspective on the relations of CP and DS to substance use.

Importantly, this study also incorporates several core principles of developmental psychopathology, including the importance of understanding comorbidity and attending to subgroup differences, such as age and sex differences, that are essential to understanding the etiology of psychopathology (Sroufe, 1997; Cicchetti & Rogosch, 1999). Despite evidence that CP and DS together are more strongly associated with substance use than either one alone (Lansford et al., 2008; Marmorstein & Iacono, 2001)

most studies consider only their main effects. Studying each symptom individually is not sufficient for understanding their relation to substance use, as co-occurring mental health symptoms are known to potentiate each other in relation to a range of poor developmental outcomes (Capaldi, 1991; Capaldi, 1992; Ingoldsby, Kohl, McMahon, & Lengua, 2006). As Sroufe (1997, p. 257) has written, with respect to manifestation of psychopathology, "Comorbidity is the rule, not the exception." Describing the role of the interaction of CP and DS is therefore an essential task for achieving a more complete understanding of the relations among mental health symptoms and substance use in adolescence.

**Conduct Problems and Depressive Symptoms Predicting Substance Use**

For the purposes of the current study, continuous measures of CP and DS symptoms, rather than measures of clinical diagnoses, are employed in order to capture relations between mental health symptoms and substance use as they vary at all levels of severity within a national sample of adolescents. CP refers to behaviors that violate social or legal norms, such as theft, property destruction, and aggression (Hinshaw, 1987). The links between CP and substance use are robust, with the adolescent CP consistently found to have a strong, positive relation with alcohol, cigarette, and marijuana use during adolescence (Brook, Zhang, & Brook, 2011; Ellickson, Tucker, Klein, & McGuigan, 2001; McMahon, 1999; Pardini, White, & Stouthamer-Loeber, 2007; Reboussin, Hubbard, & Ialongo, 2007).

Depressive symptoms (DS) refer to feelings of sadness, hopelessness, and loss of pleasure in normal activities. Unlike CP, empirical evidence regarding the relation of DS to substance use by adolescents is inconsistent. Various studies have found negative, positive, and null relations between DS and substance use during adolescence (Dodge et

al., 2009; Fite, Colder, & O'Connor, 2006; Goodman & Capitman, 2000; McCaffery, Papandonatos, Stanton, Lloyd-Richardson, & Niaura, 2008). When it is detected, the relation of DS to substance use is generally small. There are a number of possible reasons for this. It may be that the main effect of DS on substance use is indeed small, and some studies are underpowered to detect it. Alternatively, DS may relate to substance use only among certain subgroups, implying moderation by sociodemographic or risk profile characteristics. Finally, DS may relate differentially to specific substances during adolescence. The current study tests the relation of DS to use of three substances, alcohol, marijuana, and cigarettes, among a national sample of adolescents and within age and sex subgroups. In doing so, it tests whether DS is related to substance use, and whether this relation is universal or present only in relation to certain substances or within particular subgroups.

**Moderation by Age and Sex**

The prevalence of substance use, CP, and DS vary by age and sex during adolescence. The prevalence of each increases with age across adolescence (Cohen, Cohen, Kasen, & Velez, 1993; Johnston et al., 2011; Zoccolillo, 1992). Alcohol, marijuana, and cigarette use are generally more common among males than females during adolescence, though in recent years these sex gaps have begun to close or even reverse (Johnston et al., 2011). Rates of CP are higher among males than females (Keenan, Wroblewski, Hipwell, Loeber, & Stouthamer-Loeber, 2010), while DS are generally more common among females (Rushton, Forcier, & Schectman, 2002).

Few studies have examined whether these sex differences in prevalence of CP, DS, and substance use translate to sex differences in the relations between them, and

those that have show mixed results. Maslowsky et al. (under review) found that the interaction of CPxDS was more strongly related to polysubstance use by female than male adolescents, while a recent longitudinal study found no sex differences in the relation of adolescent depression to young adult substance use disorders (Marmorstein, 2010).

No known study has tested age as a moderator of the relation of CP and DS to substance use. Thus, while age and sex differences in prevalence of mental health symptoms and substance use may beg the conclusion that the relations between these constructs will vary as their prevalence varies across subgroups, this question remains largely untested. A repeated truism in developmental research is that between-group differences in variables' means do not always translate to between-group differences in the relations between those variables (Miller, Malone, & Dodge, 2010). Thus, this study empirically tests whether the relations between mental health symptoms and substance use vary by age or sex during adolescence.

**Interaction of Conduct Problems and Depressive Symptoms**

CP and DS are two of the most commonly co-occurring symptoms of mental health problems in adolescence (Chen & Simons-Morton, 2009; Kovacs, Paulauskas, Gatsonis, & Richards, 1988; Wolff & Ollendick, 2006; Zoccolillo, 1992). Co-occurring symptoms of multiple mental health problems, compared to a single problem, are related to heightened negative outcomes in a range of domains (Aseltine, Gore, & Colten, 1998). Co-occurring CP and DS are no exception, predicting higher levels of educational failure, adult psychiatric morbidity, and, in the studies that have examined them together,

adolescent substance use (Lansford et al., 2008; Marmorstein & Iacono, 2001, 2003; Pardini et al., 2007).

Despite the common co-occurrence of CP and DS during adolescence, few studies have examined the relation of their interaction to substance use. Most studies examining the interaction of CPxDS have found a significant effect, such that having high levels of both CP and DS is related to higher levels of substance use than DS or CP individually (Marmorstein & Iacono, 2001; Miller-Johnson, Lochman, Coie, Terry, & Hyman, 1998; Pardini et al., 2007). However, not all studies examining this interaction have reported the same direction of effect. Notably, one study found an interaction such that adolescents with low CP and high DS had the highest rates of substance use (Mason, Hitchings, & Spoth, 2008); another found no significant association of CPxDS with substance use (Capaldi & Stoolmiller, 1999). The current study sought to clarify the role of CPxDS in predicting substance use by testing the interaction in a large national sample.

**Aims**

Using nationally representative samples of adolescent respondents to Monitoring the Future surveys, this study had three aims: 1) to quantify the association of the CPxDS interaction with alcohol, marijuana, and cigarette use, 2) to quantify the main effect association of DS with alcohol, marijuana, and cigarette use during adolescence and, 3) to examine whether these relations differ by age and/or sex. Accomplishing these aims will allow for the identification of specific patterns of risk incurred by mental health symptoms for individual substances moderated by age and sex. Four hypotheses were tested: 1) CPxDS would significantly predict use of each of the three substances, such

that those adolescents with high levels of both CP and DS would have the highest rates of substance use; 2) DS would have a small, positive main effect association with substance use; 3) the strength of the relations of CP, DS, and CPxDS would be strongest in 8th grade versus 10th and 12th grade adolescents; and 4) DS would relate more strongly to substance use among females, and CP would relate more strongly to substance use among males.

## Method

Participants were from annual cross-sectional Monitoring the Future (MTF) surveys (Johnston et al., 2011). MTF tracks changes in behaviors and attitudes of American youth, with a primary focus on substance use and its predictors. Each year nationally representative samples of 8th, 10th, and 12th grade students are surveyed[1]. Approximately 16,000 students per grade are sampled from 400 public and private schools. The survey is administered at school during normal class periods (Bachman, Johnston, O'Malley, & Schulenberg, 2011). Each student is randomly assigned to complete one of six survey forms, with item composition varying somewhat by form.

The current study included data from students who completed items regarding both their mental health symptoms and their substance use. Due to item availability on randomly distributed questionnaire forms, this included a random one-third of 8th and 10th graders and a random one-sixth of 12th graders surveyed (total $N$ = 257,273). The characteristics of the sample are described in Table 1. Data for 8th and 10th grade students

[1] The composition of the 12th grade sample differs from that of the 8th and 10th grade samples because it does not contain students who drop out of school before spring of their senior year. To test whether differences in the composition of the 8th and 10th versus 12th grade sample contribute to relation differences among the variables, a supplementary analysis was run in which low-achieving students (GPA lower than 'C' average), those most likely to drop out before 12th grade, were excluded from the 8th and 10th grade samples. The pattern of results did not vary in this analysis versus the primary analyses.

were from 1991-2009; data for 12th grade students were from 1991-1996 due to item availability[2].

**Measures**

Conduct problems (CP) were measured via the mean of four items on a scale of 1 = "Never" to 5 = "5 or more times", α = .76. A sample item is: "In the past twelve months, how often have you taken something not belonging to you?"

Depressive symptoms (DS) were measured via the mean of four items on a scale of 1 = "Disagree" to 5 = "Agree", α = .72. Participants were asked "How much do you agree or disagree with each of the following statements?" A sample item is: "Life often seems meaningless."[3]

Alcohol use was measured via a single standard item, "On how many occasions have you drank alcohol, more than just a few sips, in the past 30 days?" on a scale of 1 = "0" to 7 = "40+". MTF substance use items have been well-validated (Johnston et al., 2011).

Marijuana use was measured via a single standard item, "On how many occasions have you used marijuana in the past 30 days?" using the same scale as alcohol use.

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[2] From 1997 onward, CP and DS were not measured on the same survey form in the 12th grade survey, meaning no 12th grade students provided data on both CP and DS in these years. Analyses for all 12th grade students were thus restricted to years 1991-1996, in which data for both CP and DS were available. To test for potential cohort differences, multiple group models were estimated in the 8th and 10th grade samples in which the sample was divided into three cohorts based on the year of data collection (1991-1996, 1997-2002, 2003-2009). Multiple group structural equation models were used to test whether there were significant differences in the relationships between CP, DS, CPxDS, and the substance use outcomes. These relationships did not vary systematically by cohort in either 8th or 10th grade. Additionally correlations of the mental health and substance use variables in 12th grade on those survey forms on which any combinations of those variables did co-occur did not differ systematically by cohort. Together, these analyses provide reasonable assurance that including only six years of data from 12th grade participants did not bias the subsequent analyses.

[3] This measure, although a brief assessment of depressive symptoms, is valid for the purposes here. The items are similar to those on the Center for Epidemiologic Studies Depression Scale **(**CES-D; Radloff, 1977). In addition, it has been used successfully in other Monitoring the Future analyses (Merline, Jager, & Schulenberg, 2008; Schulenberg & Zarrett, 2006).

Cigarette use was measured via a single standard item, “How frequently have you smoked cigarettes during the past 30 days?” on a scale of 1 = “Not at all” to 7 = “2 packs or more per day”.

The mental health and substance use items used in the study ask the adolescents to report on these constructs over different periods of time. The items assessing CP refer to engagement in those behaviors over the past 12 months. The items assessing DS do not specify a specific time frame, but are worded in the present tense, and thus the most likely interpretation is that these items refer to recent and current levels of these symptoms. Finally, the substance use items refer to use within the past 30 days. The time frames referred to within these items are consistent with our assumption for the current, cross-sectional study that the symptoms and substance use are experienced more or less contemporaneously by the adolescents, and our goals are to measure the strengths of these associations, focusing on how the mental health symptoms predict substance use.

**Analytic Strategy**

Mental health symptoms, like many constructs of interest in psychological research, are best represented by latent variables. Likewise, many psychological research questions involved interactions among the independent variables. Until recently, no method was available to test interactions among latent variables. The latent moderated structural equations (LMS) approach by Klein & Moosbrugger (2000) allows latent interactions to be estimated and tested as predictors within a structural equation modeling framework. Although other methods for estimating latent interactions have been proposed (e.g. Kenny & Judd, 1984; Marsh et al., 2007), LMS is the most rigorous and efficient approach to date (Mooijaart & Bentler, 2010).

Along with many advantages, the estimation of LMS models presents two challenges. First, traditional SEM fit indices such as RMSEA, CFI, and TLI have not yet been developed for these models. Second, these models produce only unstandardized regression coefficients, whose effect sizes are not easily interpretable, particularly in the case of interaction terms. As described in further detail below, the current study overcomes these challenges by incorporating standardization procedures not yet implemented in desktop software to standardize the effects and assess the relative contribution of the latent interaction term in explaining variance in the dependent variable.

All analyses were performed via structural equation modeling implemented in Mplus (Muthén & Muthén, 1998-2010). LMS models were estimated using full information maximum likelihood with robust standard errors. Stratum and cluster variables accounted for the nested structure of the data collection (students within schools within sampling area); sampling weights adjusted for differential sampling probability. Because of the large sample size, significance was tested using $\alpha = .001$ to be conservative regarding significant findings. Moderation by age and sex was tested using the multiple group option.

CP, DS, and each of the substance use outcomes were represented as latent variables, each created using a single indicator variable. For CP and DS, this indicator was the mean of the items on that scale; for substance use, it was the single item measure of use of each substance. Indicators were corrected for reliability by specifying 15% measurement error in each construct (Figure 1). Single indicators, although not ideal, were necessary because the model including the latent interaction of CPxDS could not

converge with multiple indicators for the mental health constructs (L. Muthen, personal communication, September 5, 2010). The amount of measurement error to be specified was determined using sensitivity analysis (Kline, 2004; Schulenberg, Bachman, O'Malley, & Johnston, 1994). The models were estimated specifying 10%, 15%, and 20% measurement error on each construct. 15% measurement error was selected for two reasons: 1) it led to the best rates of model convergence, and 2) it represents a conservative estimate of the amount of error in the measures and avoids false inflation of the estimated relations between the variables that can result from specifying too much measurement error (Schulenberg et al., 1994).

**Model Estimation**

Models were estimated in the following sequence: 1) measurement model, 2) structural model not including the latent interaction term, 3) structural model including the latent interaction term. Alcohol, cigarette, and marijuana use were modeled separately as dependent variables. This sequence was performed first in the models containing the total sample and then in the multiple group models testing for moderation by age and sex. All models controlled for secular trends in mean rates of substance use across the years in which the data were collected, linear trends in alcohol and cigarette use and quadratic trends in marijuana use (Johnston et al., 2011). A linear term reflecting year of data collection was included in the alcohol and cigarette use models, and a quadratic term was included in the marijuana use models. Although secular trends have varied somewhat by gender, with girls' substance use decreasing at a slower rate than boys', preliminary analyses indicated that the linear and quadratic controls used here fit the model well for

both boys and girls and therefore one control variable was adequate for the entire sample. Zero-order correlations of the study variables are contained in Table 2.

First, the measurement model (Figure 1) was estimated to ensure its fit. Model fit was assessed using Hu & Bentler's (1999) guidelines, which specify that CFI and TLI values greater than .95 and RMSEA values below .05 constitute an excellent fit. A separate measurement model was fit for each substance, and each had an excellent fit. Next, the structural model was estimated, omitting the latent interaction term (henceforth referred to as Model 1, Figure 2a). Finally, the structural model with the latent interaction was fit (henceforth referred to as Model 2, Figure 2b).

Loglikelihood comparison was used to determine whether the addition of the latent interaction term significantly improved the fit of Model 2 in comparison to Model 1 (Satorra & Bentler, 2010). A significant difference in -2*loglikelihood values between two nested models indicated an improvement in model fit versus the previous model. Significant interaction terms were probed by graphing (Aiken & West, 1991). This sequence was repeated for each of the three substance use outcomes in the total sample. Table 3 depicts the results of the nested model comparisons.

The same analytic sequence was repeated in multiple group models for each substance by sex (male, female) and age (grade 8, 10, 12). The measurement model was estimated and its fit was assessed in the same manner as in the total sample. Because each construct was created with a single indicator, the measurement model was invariant across groups by default. In Models 1 and 2, equivalence of structural parameters (factor means and variances, regression coefficients, and correlations of residual variances) across groups was tested by comparing nested models with these parameters fixed versus

freed. Equivalence of structural parameters across groups was tested using the robust $X^2$ comparison (Satorra & Bentler, 2010). Loglikelihood comparisons tested whether allowing the relation of the interaction term to the outcome to vary across groups in multiple group comparisons improved the fit of the model. Table 4 summarizes the estimates of latent variable means and variances; Table 5 summarizes regression coefficients and factor correlations.

Model fit indices such as CFI, TLI, RMSEA, and $X^2$ have not yet been developed for LMS models. Therefore, the overall fit of each model was assessed in two steps. First, CFI, TLI, RMSEA, and $X^2$ values were obtained from Model 1, which produced these fit indices because it was estimated using maximum likelihood without numeric integration. Second, the loglikelihood ratios of Model 1 and Model 2 were compared[4]. Although the absolute fit of Model 2 could not be determined, its relative fit versus Model 1 was indicated by the results of this loglikelihood ratio test.

Standardized regression coefficients are not provided by Mplus for LMS models. The standardized beta coefficients presented here were obtained via a two-step process. The standardized estimates of main effects of DS and CP were obtained from Mplus output for Model 1. The effect of the interaction was obtained by standardizing the unstandardized estimate from Model 2 (Mooijaart & Satorra, 2009)[5]. Importantly, main effects and interactions are independent in LMS models (Klein & Moosbrugger, 2000), allowing their estimates to be obtained from separate models. The total percentage of

[4] Model 1 was first re-estimated using the integration algorithm in order to obtain a -2* loglikelihood value comparable to that of Model 2.

[5] Mooijaart & Satorra present a formula for determining the percentage of variance in the dependent variable explained by the interaction term. The standardized beta coefficient presented here is the square root of the percentage of variance explained. The sign of the coefficient is obtained from the unstandardized output of Mplus.

variance explained was computed by summing the percentage of variance explained by the main effects of CP and DS in Model 1 and the percentage of variance explained by the interaction term in Model 2.

## Results

Results of all analyses are summarized in Table 5. The first set of analyses pertained to the total sample of 8th, 10th, and 12th grade students combined. Analyses were conducted separately for alcohol, marijuana, and cigarette use. In the model predicting alcohol use, CP was a strong positive predictor (i.e., higher CP predicted higher alcohol use), DS was a weak negative predictor (i.e., higher DS predicted lower alcohol use), and CPxDS was not significant. Similarly, in the models predicting marijuana and cigarette use; CP was a strong positive predictor, and DS was a weak negative predictor. In contrast to the results for alcohol use, CPxDS was a significant positive predictor of both marijuana and cigarette use (Figure 3). As shown in Figure 3, it is only when both CP and DS are especially high that levels of cigarette and marijuana are high.

### Moderation by Sex

Two group (male and female) multiple group models were estimated to test for sex differences in the relations of CP, DS, and CPxDS to each of the substances. With regards to alcohol, CP was a significantly larger predictor of alcohol use for males than for females. DS was a significantly larger predictor for females than for males. CPxDS was not a significant predictor of alcohol use for either males or females.

With regards to marijuana, CP was a significantly larger predictor of alcohol use for males than for females. DS was a significantly larger predictor for females than for

males. The relation of CPxDS to marijuana use, though significant for both sexes, did not vary for males versus females.

Finally, with regards to cigarette use, CP was again a larger predictor of cigarette use for males than females, and DS was again a larger predictor for females than males. CPxDS was a significant predictor for both males and females but did not differ between them.

In summary, there was no moderation of the relation of CPxDS to substance use by sex. CPxDS was not a significant predictor of alcohol use for either sex. CPxDS did predict use of marijuana and cigarettes among both males and females, but there were no sex differences in these effects. The main effects of CP and DS were moderated by sex, however: as hypothesized, CP was a larger predictor of use of each of the three substances among males than females, while DS was a larger predictor for females than males.

**Moderation by Age**

Three group ($8^{th}$, $10^{th}$, and $12^{th}$ grade) multiple group models were estimated to test for differences by age group in the relations of CP, DS, and CPxDS to each of the substances. The relation of DS to alcohol use did not vary significantly by grade. The relation of CP to alcohol use was comparable among the three grades, though it was significantly smaller among $10^{th}$ graders than $8^{th}$ and $12^{th}$ graders. CPxDS showed a larger age difference in regards to alcohol (Figure 4a). Among $8^{th}$ graders, this effect was positive (B = .24, $p < .001$). Among $10^{th}$ graders, it was not significant. Among $12^{th}$ graders, it was negative (B = -.08, $p < .001$), though smaller in magnitude than the positive effect among $8^{th}$ graders. That is, among 8th graders, highest alcohol use was

found for those highest on CP and DS, whereas for 12th graders, highest alcohol use was found for those highest on CP and lowest on DS.

For marijuana use, the multiple group model was estimated only for 10th and 12th grade students. The model was unable to converge in the 8th grade sample due to low variance in marijuana use among this age group. DS was a stronger predictor for 10th than 12th graders. CP was a stronger predictor for 12th versus 10th graders. CPxDS did not differ in its relation to marijuana use among 10th versus 12th grade students, though it was a positive predictor in each grade (B = .10, $p < .001$ and B = .08, $p < .001$, respectively).

In regards to cigarette use, DS had a fairly consistent positive association across grades 8-12, though it grew slightly stronger in higher grades. The positive associations of CP and CPxDS to cigarette showed the opposite pattern by age, with effects decreasing in higher grades. Among 8th graders, the positive interaction was quite strong (B = .43, $p < .001$) translating to levels of cigarette use that were 1.5 SD higher among those adolescents who had high levels of both CP and DS versus those with high levels of CP and low levels of DS (Figure 4b). Among 12th graders, the effect was smaller (B = .07, $p < .001$), but it still translated to a .5 SD increase in use among those with high CP and DS versus those with high CP and low DS.

In summary, while the relations of CP, DS, and CPxDS clearly differ by age, these results suggest that the age differences are both substance- and symptom-specific. The effects of CP and DS were fairly consistent across the three grades, with CP having a stronger relation to substance use than DS. The largest age differences were seen with regards to the interaction, whose effects, as hypothesized, were strongest in 8th graders and decreased among older students.

## Discussion

This study examined the relations of conduct problems (CP), depressive symptoms (DS), and their interaction (CPxDS) to alcohol, cigarette, and marijuana use among a national samples of 8th, 10th, and 12th grade American adolescents over the past two decades. It aimed to add to the substantial existing literature examining CP and DS individually as predictors of substance use by testing the interaction of CPxDS, clarifying the role of DS, for which there are contradictory findings, and examining differences in the relations of CP, DS, and CPxDS to substance use by age, sex, and substance.

### Interaction of Conduct Problems and Depressive Symptoms

The primary aim of this study was to test the relation of the interaction of CPxDS to alcohol, marijuana, and cigarette use. As hypothesized, this interaction was significant in most models, such that those adolescents who had high levels of both CP and DS had the highest levels of substance use, particularly marijuana and cigarette use. Also as hypothesized, the largest associations of the interaction with substance use were seen among 8th grade students. For example, 8th grade students who had high levels of both CP and DS had levels of cigarette use 1.5 SD higher than those who had equivalent levels of CP but low levels of DS (Figure 4b). Both cigarette and marijuana use become more normative with age; use among 10th and especially 12th graders is less associated with internalizing and externalizing difficulties. In contrast, in 8th grade when use is less normative, high use is thus a more extreme behavior that is more associated with emotional and behavioral difficulties.

With regards to alcohol use, the interaction also had its largest effect in 8th graders, where it explained 6% of the variance in alcohol use. In 12th grade students, the

interaction was negative, such that, among those with high levels of CP, those who had higher DS used less alcohol than those with low DS, but among those with low CP, those with high DS used more alcohol. The shifting direction of the effect of CPxDS from positive in 8th grade, to non-significant in 10th grade, to negative in 12th grade, particularly in terms of the DS component of the interaction, underscores the sometimes paradoxical nature of alcohol use during late adolescence (and early adulthood) whereby it gains some pro-social associations (Maggs & Schulenberg, 2005; Patrick & Schulenberg, 2011) and is thus less a function of low mood than it appears to be in earlier adolescence (Crosnoe, 2011).

Finally, although CPxDS was a significant predictor of substance use among both male and female adolescents, this relation was not moderated by sex. In other words, the relation of CPxDS to alcohol, marijuana, and cigarette use was similar for male and female adolescents.

Overall, these results are consistent with the few other studies that have examined the interaction of CP and DS as a predictor of substance use, and they also speak to some gaps not yet addressed by previous studies. Using data from the Pittsburgh Youth Study, Pardini et al. (2007) found that high levels of both CP and DS related to the highest levels of alcohol use among this all-male adolescent sample. In a sample of 340 African-American adolescents, Miller-Johnson et al. (1998) found a significant CPxDS interaction: adolescents with heightened CP and DS in 6th grade had higher levels of alcohol and marijuana use in 8th grade than those with high levels of just one symptom in 6th grade. Mason et al. (2008) also noted a significant CPxDS interaction in a sample of 429 rural adolescents, though the interaction was negative, such that adolescents with

high CP and low DS used the most substances (a combined measure of alcohol, cigarette, and marijuana use).

The current study builds on this previous work examining the relation of CPxDS to substance use in fairly homogeneous samples by testing the interaction in a large national sample, allowing for population-level generalization of the results. It also individually characterizes the relation of CPxDS to alcohol, cigarettes, and marijuana use. These substance-specific analyses revealed that the effect of CPxDS is particularly strong for marijuana and cigarette use, though it also has a strong relation to alcohol use among 8$^{th}$ grade students. Furthermore, for alcohol, I find that for 12$^{th}$ graders, it is the combination of high CP and low DS (i.e., negative CPxDS interaction) that is associated with higher use, showing the developmental and substance-specific limits of the positive CPxDS interaction.

**Role of Depressive Symptoms in Substance Use**

The second aim of this study was to clarify the relation of DS to substance use among adolescents. Whereas CP has consistently been associated with substance use in past research, and was in the current study as well, previous studies have produced conflicting results regarding whether DS relates to substance use, and if so, whether the association is negative or positive. The results suggest that DS generally has a small but positive relation to use of alcohol, marijuana, and cigarettes. Exceptions were that DS had a small negative relation to alcohol and marijuana use in the models including the total sample. In multiple group comparisons, the effect of DS was stronger for female than male adolescents for use of all three substances, though the effect was small in both

sexes. DS related most strongly to cigarette use, and it showed increasingly strong associations with cigarette use in older adolescents.

While these results indicate that DS alone is not a strong risk factor for contemporaneous substance use, the role of DS in adolescents' substance use should not be disregarded. In fact, as seen in Figures 3 and 4, DS potentiates the relation of CP to substance use. With the exception of alcohol use in 12$^{th}$ grade, high levels of DS in addition to high levels of CP were associated with significantly higher rates of substance use than high rates of CP alone. This result provides some insight into some previous studies' conclusions that DS is not related to substance use during adolescence. Such studies tested the main effect of DS, which I have shown to be small, but may have overlooked the significant interactive effect it has with CP.

**Estimating Latent Variable Interactions**

The use of latent moderated structural equations (LMS) models to estimate the latent variable interaction of CP and DS was an important element of this study, in which I aimed to demonstrate the utility of these models in testing research questions involving interactions between latent variables. The current study provides a needed substantive demonstration of latent interaction methodology. Symptoms of mental health problems are complex constructs best represented as latent variables, and testing the interaction effect of two sets of symptoms thus requires estimation of a latent variable interaction. Although computationally intensive, LMS models are well suited for this task. The two primary limitations of LMS models, lack of fit indices and lack of standardized regression coefficients, can be overcome using the methods described here. Namely, relative fit of the LMS model can be judged by comparing to a well-fitting nested model

estimated without the latent interaction term, and standardized regression coefficients can be computed by hand using the method described by Mooijaart & Satorra (2009). With the addition of these two steps in the analytic process, LMS models are a useful and accessible method for investigating research questions that imply interactions among latent variables.

**Strengths, Limitations, and Implications**

Important strengths of this study include the use of nationally representative data on 8th, 10th, and 12th graders from cohorts spanning the past two decades (providing strong basis for generalizability), the substantively important emphasis on how conduct problems and depressive symptoms interact to predict different forms of substance use, and the methodologically important emphasis of how to model the interaction as a latent term. Of course, there are limitations. The data are cross-sectional, meaning that apparent age differences must be interpreted with caution as the sample compositions vary by grade. Also due to the cross-sectional nature of the data, causal direction between mental health symptoms and substance use cannot be assessed, though I make a theoretically-based argument to support my treatment of mental health as a predictor of substance use. The data are self-reported and may be subject to method covariance as both the mental health symptoms and substance use are reported by the participant. The measures of mental health are brief (four items each for DS and CP), and represent symptoms, not clinical disorders. However, the aim of the study was not to capture clinical disorders but rather to measure symptom-level fluctuations in the general population and model their relation to substance use. Therefore, the study's aims were not unduly impeded by brief measurement. Further, limitations of the brief measures of mental health are mitigated by

the strengths of the large national sample, particularly its diversity and the generalizability of conclusions that it affords. Finally, testing moderating effects of race/ethnicity and socioeconomic status on the relation of CP, DS, and CPxDS was beyond the scope of the current study. These important questions will be addressed in future studies.

Despite some limitations, this study offers several new insights into the relations among mental health and substance use in adolescence. It builds upon work in the area of mental health and substance use epidemiology by moving beyond establishing national prevalence of individual behaviors to quantifying the relations that exist between them during adolescence on a population level and within age and sex subgroups. For the first time in a national sample, it quantifies the association of the interaction of CPxDS to use of each of three substances, alcohol, marijuana, and cigarettes, revealing that the interaction contributes significantly to the prediction of use of these three substances. It also speaks to questions fundamental to developmental psychopathologists, including age and sex differences and the interactive effects of co-occurring mental health symptoms. In particular, it demonstrates that the effect of the interaction is strongest among younger adolescents and that it does not vary by sex, arguing for early identification and intervention into co-occurring mental health problems in both male and female adolescents as a strategy for preventing substance use initiation. Furthermore, it demonstrates that the interaction shifts direction for 12$^{th}$ graders regarding alcohol use, highlighting the paradoxical prosocial aspects of alcohol use during late adolescence.

Most importantly, the results of this study reveal that DS, despite its small main effect relation with substance use, plays an important role in predicting substance use

through its interactive relation with CP. CP is often thought to be a primary driving factor of adolescent substance use, but the current study suggests that this relation is highly dependent on concurrent levels of DS. Thus, the role of DS in adolescent substance use should not be overlooked. DS remains an important predictor to be measured in studies of adolescent substance use. Future studies focused on the development of substance use among adolescents should include DS and CPxDS as predictors. Additionally, preventive interventions should be specifically tailored to those youth who evidence multiple, co-occurring mental health problems in early adolescence. Interventions that delay onset of substance use in adolescence have been shown to reduce rates of problematic substance use in young adulthood (Spoth, Trudeau, Guyll, Shin, & Redmond, 2009). The results of the current study provide clear evidence that targeting young adolescents who display multiple mental health symptoms for early intervention is a promising strategy for reducing early adolescent substance use and its associated morbidity and mortality implications in adolescence and beyond.

# Chapter 3

## Proximity versus early emergence: Longitudinal associations of mental health problems and substance use during adolescence

The costs, both human and economic, of substance use by young people are enormous. Underage alcohol use alone is responsible for over 3,100 deaths, 2.4 million injuries and harmful events, and over $61 billion in economic costs in the United States each year (Miller, Levy, Spicer, & Taylor, 2006). In order to reduce the enormous burden imposed by youth substance use, it is important to identify its early predictors and to test whether there are developmental periods at which they play a particularly strong role. Delaying initiation of substance use in adolescence is an effective strategy for reducing problematic substance use in young adulthood (Spoth, Trudeau, Guyll, Shin, & Redmond, 2009; Kellam & Anthony, 1998). The identification of key predictors as well as developmental windows at which those predictors are most influential will inform the design of appropriately targeted substance use prevention and intervention programs for adolescents.

In pursuit of this goal, the current study focuses on the effects of adolescent mental health problems on subsequent substance use. Specifically, this study examines the role of conduct problems (CP) and depressive symptoms (DS) in predicting changes in substance use in adolescents during the period from $8^{th}$-$12^{th}$ grades. CP and DS are the categories of mental health symptoms most strongly associated with substance use during adolescence (Armstrong & Costello, 2002; Kandel et al., 2007). The current study tests

whether 8th grade mental health problems are a candidate to be targeted by prevention programs by testing two competing hypotheses, both of which have ample support in the developmental, clinical, and developmental psychopathology literatures: 1) that earlier-emerging mental health problems will be more associated with substance use, because earlier-emerging problems tend to be more severe and associated with more developmental difficulties, or 2) that mental health problems occurring closer together in time to the substance use outcome will be more strongly associated with substance use than those occurring at a more distant time, because proximal predictors tend to be stronger than distal predictors. In other words, this study tests whether 8th grade mental health problems are truly a particular marker of risk for later substance use problems, comparing the results of several sets analyses across varying time periods to rule out effects of simple temporal proximity to the outcome.

**Early Emerging Mental Health Symptoms**

There is a clear consensus in the clinical psychology literature with regards to adolescent CP and DS: those that emerge earlier tend to be more chronic, severe, and associated with more developmental difficulties, such as substance use (Fleisher & Katz, 2001; Moffitt, 1993; Weissman et al., 1999). Moffitt (1993) defined two subtypes of conduct problems: life course persistent, which emerge earlier and persist after adolescence, and adolescent-limited, which, as the name implies, emerge in adolescence but recede toward the end of adolescence. The latter subtype is more common and less severe. More recent studies have supported Moffitt's subtypes, including a study by Walters (2011), which demonstrated that although the symptoms of the two subtypes of

CP tend to be qualitatively similar in presentation, those youth whose CP emerges earlier tend to experience a higher number of symptoms with greater severity.

A similar picture emerges with regards to DS. The mean age of emergence of clinically significant DS is approximately age 15, with those that onset before age 14 considered early emerging (Lewinsohn, Clarke, Seeley, & Rohde, 1994; Lewinsohn, Rohde, & Seely, 1998). Like CP, early emerging DS tends to be more severe and recurrent and more closely linked with other developmental difficulties (Fleisher & Katz, 2001; Weissman et al., 1999).

Based on these epidemiological estimates of onset of mental health symptoms, it appears that those emerging by age 14 are more severe. For purposes of the current study, this implies that mental health problems that have emerged by 8$^{th}$ grade are more severe than those that emerge later. The 10$^{th}$ grade time point likely captures a mix of adolescents whose mental health problems had emerged earlier plus those that have onset later, e.g. a mixture of more and less severe symptoms. This study will examine the effects of mental health problems at both 8$^{th}$ and 10$^{th}$ grade on later substance use to determine whether 8$^{th}$ grade mental health problems have unique predictive power as would be expected from the literature on severity of early emerging mental health problems.

**Proximal versus Distal Predictors**

Developmental psychology recognizes the importance of considering both proximal and distal predictors of a phenomenon of interest, as well as the limitations that can be associated with each (e.g. Dodge et al., 2009; Martin & Martin, 2002; Schulenberg & Maslowsky, 2010). Substance use in particular is known to have roots in both early

developmental processes and proximal adolescent development processes (Dodge et al., 2009; Schulenberg & Maggs, 2008; Zucker, Donovan, Masten, Mattson, & Moss, 2008). In general, proximal predictors tend to be stronger than distal ones, but it is not always clear whether the associations between temporally proximal phenomena are wholly true or partially reflective of measurement covariance, which tends to be stronger among closer time points, or shared variance due to unmeasured factors common to more proximal time points. For example, Chapter 2 demonstrated strong associations between CP, DS, the interaction of CPxDS and substance use. However, because the data were cross-sectional, the predictors and outcomes were contemporaneous, and the relationships may have been inflated by the temporal proximity. The current study takes advantage of longitudinal data with a two- and four-year lag between measurement points to test whether mental health problems that emerge relatively early (by 8$^{th}$ grade) in adolescence have unique predictive power versus those that emerge later.

**Effects of Conduct Problems and Depressive Symptoms on Substance Use**

Among clinical samples, conduct disorder and depressive disorders are the disorders most likely to be comorbid with adolescent substance abuse (Armstrong & Costello, 2002; Kandel et al., 2007). In community samples, the link between conduct problems (CP) symptoms, rather than clinical disorder, and substance use is clear. CP refers to rule-breaking, aggressive, and delinquent behaviors that violate social norms in some way, though may not reach the level of clinically significant disorder. Numerous studies have documented the prospective association of CP with alcohol, marijuana, and cigarette use among adolescents (Dodge et al. 2009, King, Iacono, & McGue, 2004;

Lansford et al., 2008; Loeber, Stouthamer-Loeber, & White, 1999; Mason, Hitchings, & Spoth, 2008; Reboussin, Hubbard, & Ialongo, 2007).

Depressive symptoms (DS) refer to feelings of sadness and hopelessness, as well as loss of pleasure in normal activities. Their severity varies, though they need not reach the level of clinical significance in order to negatively impact daily function (Gotlib, Lewinsohn, & Seely, 1995). The link between DS and substance use in community samples is not as clear. Some studies do document a positive, prospective association between DS and substance use (Hooshmand, Willoughby, & Good, 2012; King et al., 2004; Repetto, Caldwell, & Zimmerman, 2005), but others fail to find a link (Mason et al., 2008; Dodge et al., 2009). Several studies have found this relation to be present only among boys (Henry, Feehan, McGee, & Stanton, 1993; Sung, Erklani, Angold, & Costello, 2004), and others have found that the association is actually negative- such that early DS relate to lower levels of substance use in later adolescence (Fite, Colder, & O'Connor, 2006; Maggs, Patrick, & Feinstein, 2008). The evidence regarding the prospective effects of DS on substance use can thus be described as inconsistent and in need of further investigation.

Several potential explanations exist for these inconsistent results of existing studies, and each is tested in the current study. The first potential explanation is that internalizing problems such as DS are part of a distinct, though relatively less common, pathway into substance use (Dierker, Vesel, Sledjeski, Costello, & Perrine, 2007; Hussong, Jones, Stein, Baucom, & Boeding, 2011). Though the majority of substance use problems in adolescence may develop by an externalizing pathway (e.g. are preceded by CP and other externalizing symptoms), the dual pathway hypothesis posits that the

internalizing pathway may represent a second, though less common, route into substance use. Because it is relatively less common, not all studies are able to detect it. A second possibility is that the effect of DS on substance use is through its interaction with CP. A number of studies, including my own work and the preceding Chapter, have observed an interaction between CP and DS, with DS potentiating CP such that those youth who have high levels of both symptoms also tend to use the most substances (Dauber, Hogue, Paulson, & Leiferman, 2009; Lansford et al., 2008; Loeber et al., 1999; Maslowsky, Schulenberg, O'Malley, & Kloska, under review). The current study tests this possibility by examining the interaction of CPxDS to test whether DS effects substance via its interaction with CP. The third possibility is that the association is substance-specific, with DS relating principally to particular substances rather than any given type of substance use. Therefore, the current study examines the three most commonly used substances in adolescence, alcohol, marijuana, and cigarettes, in order to test whether the effect CP, DS, and/or CPxDS on substance use is substance-specific.

Another important consideration is the directionality of the relation between mental health and substance use. The two likely have a reciprocal relation in later adolescence and early adulthood (Brook, Brook, Zhang, Cohen, & Whiteman, 2002; Fergusson, Horwood, & Swain-Campbell, 2002; Needham, 2007). However, there is strong evidence that mental health problems generally precede substance use in adolescence (Birmaher et al., 1996; Deykin et al., 1987; Jackson, Sher, & Schulenberg, 2008; Kessler et al., 2005; Merikangas et al., 2010). In fact, psychiatric epidemiology estimates and reviews of prospective longitudinal studies indicate that CP and DS emerge on average at least 3-4 years before substance use in adolescence (Birmaher, Ryan,

Williamson, & Brent, 1996; Kessler et al., 2005). Therefore, in the current study, I examine mental health problems as predictors of substance use in adolescence.

**Sex Differences in Conduct Problems, Depressive Symptoms, and Substance Use**

DS tends to be more common among girls during adolescence, and CP tends to be more common among boys (Hankin, Abramson, Moffitt, Silva, & McGee, 1998; Latimer, Stone, Voight, Winters, & August, 2002; Loeber & Keenan, 1994). Boys tend to use higher levels of substances than girls during adolescence, though sex gaps are narrowing such that the differences are quite small in recent cohorts (Johnston, O'Malley, Bachman, & Schulenberg, 2011). Several studies testing for sex differences in the relation between CP, DS, and substance use, including the study presented in Chapter 2, have found that DS are more strongly associated with substance use among girls and CP more strongly associated with substance use among boys (Latimer et al., 2002; Maslowsky & Schulenberg., under review). Of note, however, is that the sex differences tend to be quite small, and as Costello and colleagues note, boys and girls tend to show more similarities than differences in the associations between early psychopathology and later substance use (Costello, Erkanli, Federman, & Angold, 1999).

**Research Questions and Hypotheses**

The current study examines three research questions. The primary question pertains to the longitudinal effects of mental health problems on substance use during adolescence. Previous studies have demonstrated that such longitudinal effects exist. The current study attempts to specify these results by testing whether earlier-emerging mental health problems are a particularly strong predictor of substance use and should be targeted in prevention and intervention efforts. Two additional research questions are

tested. The first examines the role of DS in predicting substance use across the adolescent period. Because previous research has yielded mixed results on this question, I seek to clarify the role of DS in substance use, both as a main effect and in interaction with CP, which are a robust and well-known predictor of substance use in adolescence. Finally, I test whether there are sex differences in the effect of mental health problems on substance use across adolescence.

With regards to the primary research question, in order to test whether 8th grade mental health is a particularly important predictor of later substance use, I perform three sets of analyses specifically chosen to pit proximity and early emergence against each other. First, I examine distal effects of early mental health problems by testing the effect of 8th grade mental health on 12th grade substance use. Next, I examine the proximal effects of early mental health problems by analyzing the effect of 8th grade mental health on 10th grade substance use. Finally, I examine proximal effects of later mental health problems by analyzing the effect of 10th grade mental health problems on 12th grade substance use.

This series of analyses could produce several possible results. The analyses examining the effects of 8th grade mental health on 10th grade substance use and of 10th grade mental health on 12th grade substance use could show the strongest pattern of effects, stronger than the analysis of 8th grade mental health predicting 12th grade substance use. This outcome would indicate that 8th grade mental health problems are not "special"; their relation to substance use is better explained by their proximity to the measure of substance use than to the specificity of that developmental period. If, however, the analysis of 8th grade mental health problems predicting 12th grade substance

use showed stronger effects than the analysis of adjacent time points that does not include 8th grade mental health (10th→12th), this would provide evidence that there is a unique predictive power associated with 8th grade mental health symptoms that is not attributable to temporal proximity to the outcome of interest. It could be argued that 12th grade substance use is substantively different than early substance use because substance use is more normative at that age (Johnston et al., 2011), and therefore links between 10th grade mental health problems and changes in substance use from 10th to 12th grade substance use would therefore be expected to be weak. The design of the current study is able to rule out this potential explanation by also testing the effect of 8th grade mental health problems on changes in substance use from 8th through 12th grades. If 12th grade substance use is indeed substantively different from earlier substance use, I would expect that neither 8th grade nor 10th grade mental health problems would predict changes in substance use through 12th grade.

Three specific hypotheses were tested. First, I expected that the effect of earlier emerging mental health symptoms would be stronger than that of later mental health symptoms in predicting substance use. That is, I expected that the analyses in which 8th grade mental health predicts 12th grade substance use would show stronger effects than 10th grade mental health predicting 12th grade mental health. I expected that 8th grade mental health predicting 10th grade substance use would also show strong effects, with these effects reflective of the importance of 8th grade mental health rather than of proximity (which would be ruled out by smaller effects from 10th grade mental health to 12th grade substance use). Second, I expected that DS would relate to substance use both as a main effect and in interaction with CP, such that those with high levels of both CP

and DS at 8th grade would have the highest levels of substance use in 10th and 12th grades. CP was also expected to have a strong main effect on substance use. With regards to sex differences in the effects of CP, DS, and CPxDS on substance use, in keeping with previous research reviewed above, I expected that there would be few differences, and if sex differences were detected, they would be quite small in magnitude.

## Method

### Data and Sample

The data for the current study were from the Monitoring the Future (MTF) Study (Johnston et al., 2011). From 1991-1993, MTF selected a subsample of 8th grade students from their annual cross-sectional surveys to follow longitudinally. Each year, approximately 2,000 students were chosen, for a total of 6,000 students who were surveyed every two years through age 24. Because one original purpose of this study was to examine the effects of school dropout on prevalence estimates of substance use at 12th grade, 8th grade students at high risk for school dropout were oversampled in the original data collection. Risk for dropout was computed via a composite of variables known to predict educational attainment: parent educational attainment, GPA at time of first survey, truancy, and a composite of grade retention, required attendance at summer school, and previous school suspensions or expulsions. This risk index was bracketed into four strata. Those in the two higher-risk strata were oversampled for longitudinal follow-up, and those in the two lower-risk strata were undersampled.

Data at 8th grade were collected in school; follow-up data were collected through mail surveys. Students were randomly assigned at 8th grade to complete one of two questionnaire forms; they completed the same form at each follow-up data collection.

The mental health items used in the current study were only administered on one of these forms, therefore, approximately one half of the students are included in this study ($N$ = 3,014 at 8th grade). Additional information regarding sample selection criteria and other study methods are available in Bachman et al. (2008).

In the current study, the first three time points of data, 8th, 10th, and 12th grades, were used. 3,014 students participated in 8th grade. Follow-up data are available at 10th grade for 2,421 (80.3%) of these students and at 12th grade for 2,003 (66.5%) of these students. While this would generally be considered a high rate of attrition, particularly at the 12th grade time point, it was to be expected in the current study, based on the original study design that oversampled those students who were most likely to drop out by the end of high school. Thus, although the sample at 12th grade was smaller than the original sample, it retains a relatively diverse sample, including adolescents who were at high risk for dropping out of school and likely for other developmental difficulties associated with high school dropout. Data were weighted to adjust for differential probabilities of selection into the larger MTF sample from which the longitudinal sample were drawn (see Johnston et al., 2011 for additional information regarding MTF sampling procedures).

**Measures**

The items used to assess CP, DS, and alcohol, marijuana, and cigarette use were the same as those in Chapter 2. Each item was administered identically at each time point.

Conduct problems (CP) were measured via the mean of four items assessing rule-breaking and aggressive behaviors on a scale of 1 = "Never" to 5 = "5 or more times",

Cronbach's α ranged from .61-.70 at each of the three time points. A sample item is: "In the past twelve months, how often have you stolen something worth $50 or more?"

Depressive symptoms (DS) were measured via the mean of four items assessing negative affect and hopelessness on a scale of 1 = "Disagree" to 5 = "Agree", Cronbach's α ranged from .72-.81 at each of the three time points. Participants were asked "How much do you agree or disagree with each of the following statements?" A sample item is: "Life often seems meaningless." This measure, although a brief assessment of depressive symptoms, is valid for our purposes here. The items are similar to those on the Center for Epidemiologic Studies Depression Scale **(**CES-D; Radloff, 1977). In addition, it has been used successfully in other Monitoring the Future analyses (Merline, Jager, & Schulenberg, 2008; Schulenberg & Zarrett, 2006).

Alcohol use was measured via a single standard item, "On how many occasions have you drank alcohol, more than just a few sips, in the past 30 days?" on a scale of 1 = "0" to 7 = "40+". MTF substance use items have been well-validated (Johnston et al., 2011).

Marijuana use was measured via a single standard item, "On how many occasions have you used marijuana in the past 30 days?" using the same scale as alcohol use.

Cigarette use was measured via a single standard item, "How frequently have you smoked cigarettes during the past 30 days?" on a scale of 1 = "Not at all" to 7 = "2 packs or more per day".

Age was measured at the 8$^{th}$ grade time point via the item, "How old did you turn on your last birthday?" on a scale of 1 = "11 years or younger" to 8 = "18 years or older".

**Analytic Strategy**

The analytic strategy was largely the same as that of Chapter 2. All analyses were performed via structural equation modeling implemented in Mplus (Muthén & Muthén, 1998-2010). The latent moderated structural equations (LMS) approach by Klein & Moosbrugger (2000) was used to estimate latent variable interactions of CP and DS and to test these interactions as predictors of substance use within a structural equation modeling framework. LMS models were estimated using full information maximum likelihood to account for missing data and with robust standard errors to allow estimation of the latent variable interaction. Significance was tested using $\alpha = .05$. Moderation by sex was tested using the multiple group option. All analyses controlled for levels of substance use at the first time point included in each model (either $8^{th}$ or $10^{th}$ grade). The outcome therefore represents change in substance use from the first to second time point modeled in each analysis. Models also controlled for the effect of age at $8^{th}$ grade on levels of CP, DS, and substance use at the first time point. The prevalence of substance use, CP, and DS vary by age and sex during adolescence. The prevalence of each increases with age across adolescence (Cohen, Cohen, Kasen, & Velez, 1993; Johnston et al., 2011; Zoccolillo, 1992). Although the modal age at $8^{th}$ grade was 14, it ranged from 11-18. Because the study hypotheses pertained to the importance of early-emerging mental health symptoms, age was controlled to adjust for differential levels of mental health problems or substance use that are associated with a student's younger or older age relative to peers.

CP, DS, and each of the substance use variables were represented as latent variables, each created using a single indicator. For CP and DS, this indicator was the mean of the items on that scale; for substance use, it was the single item measure of use

of each substance. As in Chapter 2, indicators were corrected for reliability by specifying 15% measurement error in each construct (Figure 1). Single indicators, although not ideal, were necessary because the model including the latent interaction of CPxDS could not converge with multiple indicators for the mental health constructs (L. Muthen, personal communication, September 5, 2010).

**Model Estimation**

Models were estimated in the same sequence as in Chapter 2: 1) measurement model, 2) structural model not including the latent interaction term, 3) structural model including the latent interaction term. Alcohol, cigarette, and marijuana use were modeled separately as dependent variables. This sequence was performed in each of the time period analyses (8→10, 8→12, 10→12), first in the models containing the total sample and then in the multiple group models testing for moderation by sex. Zero-order correlations of the study variables at each time point are contained in Table 2.

First, the measurement model was estimated to ensure its fit. Model fit was assessed using Hu & Bentler's (1999) guidelines, which specify that CFI and TLI values greater than .95 and RMSEA values below .05 constitute an excellent fit. A separate measurement model was fit for each substance and each analysis (8→10, 8→12, 10→12), and each had an excellent fit (all CFI and TLI > .95, all RMSEA < .05). Next, the structural model was estimated without the latent interaction term (this model henceforth referred to as Model 1). Finally, the latent interaction term was added as a predictor of substance use, retaining all other model specifications of Model 1 (this model henceforth referred to as Model 2). Loglikelihood comparison was used to determine whether the addition of the latent interaction term significantly improved the fit of the

model (Satorra & Bentler, 2010). A significant difference in -2*loglikelihood values between two nested models indicated an improvement in model fit versus the previous model. Table 3 depicts the results of the nested model comparisons. Significant interaction terms were probed by graphing (Aiken & West, 1991).

The same analytic sequence was repeated in multiple group models for each substance by sex. The measurement model was estimated and its fit was assessed in the same manner as in the total sample. Because each construct was created with a single indicator, the measurement model was invariant across groups (boys and girls) by default. In Models 1 and 2, equivalence of structural parameters (factor variances, regression coefficients, and correlations of residual variances) across groups was tested by comparing nested models with these parameters constrained to be equal versus free to vary across groups. Factor means were free across group by default. Equivalence of structural parameters across groups was tested using the robust $X^2$ comparison (Satorra & Bentler, 2010). Equivalence of all structural parameters except the effect of the interaction on substance use was tested in Model 1. The specifications from Model 1 were then retained in Model 2, in which the interaction term was added to the model, with its effect constrained to be equal across sex. A third model (henceforth referred to as Model 3) was estimated in which the effect of the interaction was allowed to vary across sex, and loglikelihood comparisons tested whether allowing the relation of the interaction term to the outcome to vary across groups in multiple group comparisons improved the fit of the model (Table 3).

Model fit indices such as CFI, TLI, RMSEA, and $X^2$ have not yet been developed for LMS models. Therefore, the overall fit of each model was assessed in two steps. First,

CFI, TLI, RMSEA, and $X^2$ values were obtained from Model 1, which produced these fit indices because it was estimated using maximum likelihood without numeric integration. Second, the loglikelihood ratios of Model 1 and Model 2 were compared, after re-estimating Model 1 using the integration algorithm in order to obtain a -2* loglikelihood value comparable to that of Model 2. Although the absolute fit of Model 2 could not be determined, its relative fit versus Model 1 was indicated by the results of this loglikelihood ratio test.

Standardized regression coefficients are not provided by Mplus for LMS models. The standardized beta coefficients presented in Table 5 were obtained via a two-step process. The standardized estimates of main effects of CP and DS were obtained from Mplus output for Model 1. The effect of the interaction was obtained by standardizing the unstandardized estimate from Model 2 (for total sample models) or Model 3 (for multiple group models). Mooijaart & Satorra (2009) present a formula for determining the percentage of variance in the dependent variable explained by the latent interaction term. The standardized beta coefficient for the interaction term that is presented in Table 5 is the square root of the percentage of variance explained calculated using the Mooijaart & Satorra method. The sign of the coefficient was obtained from the unstandardized output of Mplus. The total percentage of variance explained was computed by summing the percentage of variance explained by the main effects of CP and DS in Model 1 and the percentage of variance explained by the interaction term in Model 2 or 3. Importantly, main effects and interactions are independent in LMS models (Klein & Moosbrugger, 2000), allowing their estimates to be obtained from separate models.

## Results

As shown in Table 3, the addition of the CPxDS interaction term resulted in a significant improvement in the fit of all models; therefore, the interaction term was included in each of the final models. Allowing the interaction term to vary across sex also resulted in significantly improved model fit; therefore, the effect of the interaction term was free to vary across the two sex groups. Table 4 summarizes the means and variances of the latent variables and whether variances were significantly different across groups. Latent variable means (intercepts) were allowed to vary across groups by default. The variance of CP was larger among males than females, as was the variance of some Time 1 ($8^{th}$ or $10^{th}$ grade) substance use and most substance use outcomes.

### Total Sample Models

Model results are summarized in Table 5. The first set of models tested the hypothesized distal effect of $8^{th}$ grade mental health problems on changes in substance use from $8^{th}$ to $12^{th}$ grade. In these models, higher levels of $8^{th}$ grade CP led to an increase in alcohol and marijuana use, but not cigarette use, from $8^{th}$ to $12^{th}$ grades. Higher levels of $8^{th}$ grade DS predicted increases in cigarette use over this period. The CPxDS interaction was associated with changes in cigarette use, albeit in the negative direction rather than in the positive direction predicted. Figure 2a displays this interaction. Among those with high levels of CP in $8^{th}$ grade, those with high levels of DS had smaller increases in cigarette use than those with low levels of DS. However, among those with low levels of CP, those who had a high level of DS had greater increases in cigarette use than those with a low level of DS. This was a small interaction effect; it explained only .4% of the variance in changes in cigarette use from $8^{th}$ to $12^{th}$ grades. There was no

significant interaction of CPxDS with regards to changes in marijuana or alcohol use from 8th to 12th grades. In summary, in the multivariate models of 8th grade mental health problems predicting 12th grade substance use, the primary effect on alcohol and marijuana use was that of 8th grade CP leading to increases in substance use from 8th-12th grades; for cigarette use, 8th grade DS led to increases from 8th-12th grades. The only significant interaction was a negative effect of 8th grade CPxDS on changes in cigarette use from 8th to 12th grade.

The second set of models tested the proximal effect of 8th grade mental health problems on changes in substance use from 8th to 10th grade. These effects are expected to be strong not only because of the proximity of 8th and 10th grades, but also because of the unique importance for substance use of mental health problems that have emerged by 8th grade. In these models, increased CP led to an increase in alcohol and marijuana use, but not cigarette use. Increased DS led to an increase in marijuana and cigarette use. There was a positive CPxDS interaction with regards to increased marijuana use. As hypothesized, those students with high levels of both CP and DS in 8th grade had the greatest increases in marijuana use from 8th to 10th grades (Figure 2b). This interaction explained an additional 4.7% of variance in the increase in marijuana use from 8th to 10th grades, over and above the effects of 8th grade marijuana use and the main effects of CP and DS. There was no significant interaction with regards to changes in cigarette or alcohol use from 8th to 10th grades. In summary, the 8th→10th grade models showed largely the same patterns as the 8th→12th grade models, with CP relating to increases in alcohol and marijuana use from DS relating to increases in cigarette use, with few significant CPxDS interactions.

The final set of models tested the proximal effect of 10th grade mental health problems on changes in substance use from 10th to 12th grade. Despite the proximity of the time points, these effects are not expected to be strong because mental health problems reported at 10th grade reflect a mix of earlier- and later-emerging symptoms. In these models, only one relation was significant: higher levels of DS in 10th grade led to an increase in marijuana use from 10th-12th grades. There were no other significant links between 10th grade mental health problems and 12th grade substance use. The total amounts of variance explained in the substance use outcomes were highest in these models, versus the models examining the effects of 8th grade mental health problems, but this is due to the much stronger stability coefficients between 10th and 12th grade substance use than between 8th and 10th or 12th grade substance use. In summary, mental health problems explained very little variance in the changes in substance use from 10th-12th grade. This weak pattern of prediction by 10th grade versus 8th grade mental health problems indicates that there may indeed be unique predictive power of early emerging mental health problems, an effect strong enough to supersede the effects of more proximal measurement.

**Moderation by Sex**

Additional models tested the moderating effect of sex, that is, whether the relationships between mental health and subsequent substance use were different for boys and girls. Overall, few sex differences were observed among the significant relationships between mental health problems and substance use. In the model testing the effect of 8th grade mental health problems on 12th grade alcohol use, DS and CPxDS were not significant predictors, higher CP predicted increases in alcohol use among boys only. In

the model predicting 12th grade marijuana use, DS and CPxDS were not significant predictors. Higher CP led to increases in marijuana use for both boys and girls, with no sex difference in the effect. In the model predicting 12th grade cigarette use, higher DS led to higher levels of cigarette use for boys and girls with no sex difference, and there was a negative CPxDS interaction in girls only, such that the greatest increases in substance use were seen among girls with low CP and high DS (same pattern as portrayed in Figure 2b).

In the model testing the effect of 8th grade mental health problems on 10th grade alcohol use, DS and CPxDS were not significant predictors; higher CP led to increased alcohol use in boys and girls with no sex difference. A similar pattern of results emerged regarding 10th grade marijuana use; 8th grade CP led to increased marijuana use from 8th to 10th grade. The CPxDS was significant only among boys when estimated separately for boys and girls, though the negative direction and magnitude of the interaction were similar for girls. With regards to 10th grade cigarette use, higher DS led to greater increases in cigarette use for both boys and girls with no sex difference. CPxDS was significant only among boys, though again the negative direction and magnitude were similar for girls. CP was not a significant predictor of changes in cigarette use from 8th to 10th grades.

The models testing for sex differences in the effects of 10th grade mental health problems on 12th grade substance use revealed several effects of 10th grade mental health on 12th grade substance use that were significant only among girls. Higher levels of CP were associated with decreases in alcohol, marijuana, and cigarette use from 10th-12th grades among girls only; CP were not related to changes in substance use across this

period among boys. Notably, in bivariate analyses, girls' 10th grade CP had a small, positive association with their 12th grade alcohol, marijuana, and cigarette use (r = .09-.14), as would be expected. Potential explanations for the discrepancy in the bivariate and multivariate results are discussed further below. There was a positive relation between 10th grade DS and changes in marijuana and cigarette use from 10th to 12th grades, but this relation did not differ between girls and boys.

In summary, the tests of sex moderation of the effect of mental health problems on substance use during adolescence revealed few sex differences. While the effect of the CPxDS interaction did vary significantly across genders in all models, this effect was not significant in either sex in most cases. The most consistent pattern of sex differences emerged with regards to the effect of conduct problems on substance use. Contrary to hypothesis, among girls only, higher levels of 10th grade CP predicted decreases in alcohol, marijuana, and cigarette use from 10th to 12th grade, and 8th grade CP predicted decreases alcohol use from 8th to 12th grade.

## Discussion

The overall purpose of this study was to examine the effects of early emerging mental health problems on substance use and to determine whether mental health problems that have onset by 8th grade have a particularly strong effect on later substance use. The approach used to test this question was to conduct three sets of analyses: 8th grade mental health problems changes in substance use from 8th to 10th grade and from 8th to 12th grade and 10th grade mental health predicting changes in substance use from 10th to 12th grade. As there is both theoretical and empirical evidence to support both early emerging mental health problems as the more important factor for substance use and the

stronger associations among phenomena occurring more closely together in time, an empirical test was needed to determine which of these possibilities is most applicable in the case of the effect of mental health on substance use during adolescence.

**Early Emergence Versus Proximity**

The results of this study yielded mixed support for the study hypotheses. The first and primary hypothesis, that 8th grade mental health would have a stronger and more consistent pattern of effects on substance use than 10th grade mental health, was supported. 8th grade mental health symptoms showed clear effects on both 10th and 12th grade substance use. In general, higher levels of 8th grade CP led to greater increases in alcohol and marijuana use, and higher levels of 8th grade DS led to greater increases in cigarette smoking. 10th grade mental health problems had few effects on 12th grade substance use. The two exceptions were a positive effect of 10th grade DS on 12th grade marijuana and cigarette use and a negative effect of 10th grade CP on alcohol, marijuana, and cigarette use by girls only. This latter effect was unexpected. In bivariate analyses, girls' 10th grade CP had a small, positive association with their 12th grade alcohol, marijuana, and cigarette use. The discrepancy between the bivariate and multivariate results may be attributable to the strong positive association between CP and substance use at grade 10. Once substance use at grade 10 was controlled, the remaining association between CP and later substance use was negative, as reported. To my knowledge, this result has not been documented in previous research and warrants further research to test its replicability. If replicated, this result may indicate that by 10th grade, or approximately age 16, the association between CP and substance use among girls has reached a

maximum level, and modeling this association later in adolescence yields a negative coefficient as a result of this decreasing association among the two constructs with age.

Certainly substance use has both distal and proximal predictors (Dodge et al., 2009; Schulenberg & Maslowsky, 2009; Maggs et al, 2008), as is to be expected based on developmental theory that emphasizes the contributions of early and concurrent developmental influences (e.g. Martin & Martin, 2002). In the current study, some association between the $10^{th}$ and $12^{th}$ grade time points would have been expected due to measurement covariance and due to similarity of life circumstances, both of which would be greater among these more proximal time points. However, there were almost no significant associations between $10^{th}$ grade mental health problems and $12^{th}$ grade substance use. In contrast, $8^{th}$ grade mental health problems showed clear patterns of association with increases in substance use from $8^{th}$ to $10^{th}$ grade and to $12^{th}$ grade. The results of the $8^{th} \rightarrow 10^{th}$ grade model are quite similar to that of the $8^{th} \rightarrow 12^{th}$ grade model. Although at first glance it would appear that the $10^{th} \rightarrow 12^{th}$ grade models are best due to their high $r^2$ values, the variance explained is almost entirely attributable to strong stability coefficients between $10^{th}$ and $12^{th}$ grade substance use; the $10^{th}$ grade mental health variables showed very little effect on $12^{th}$ grade substance use. This lack of effects was observed despite the relative temporal proximity of $10^{th}$ and $12^{th}$ grades (versus $8^{th}$ and $12^{th}$ grades).

One potential explanation for the relative importance of $8^{th}$ grade mental health symptoms may be that they onset before the middle school to high school transition and may set the stage for a problematic transition. Developmental transitions are often catalysts of increased variance in developmental trajectories, serving as sensitive periods

during which developmental processes are intensified by the changing context (Schulenberg & Maggs, 2002; Schulenberg & Zarrett, 2006). During adolescence, those who are functioning well tend to continue to do so after a major transition such as the school transition, but those who are experiencing developmental difficulties, such as heightened levels of CP and DS, may have more difficulty navigating the transition. This can result in an amplification of previous developmental difficulties. In the case of the current study, 8th grade mental health problems, which precede the high school transition, may have resulted in a more difficult transition and amplified the negative developmental trajectory of those students, making substance use initiation more likely. Those adolescents whose mental health problems onset later, by 10th grade, had already navigated the school transition, and were therefore less likely to have been shifted onto a more problematic trajectory as a result.

In addition to the relative strengths of the effects of 8th grade versus 10th grade mental health problems on substance use, it is also important to consider the absolute sizes of these effects. After controlling for the substantial stability of substance use by including either 8th or 10th grade substance use in the model, CP, DS, and CPxDS accounted for 3-10% of the variance in change in substance use over the two- to four-year period studied. Thus, on average, mental health is explaining a modest amount of variance in the increase in substance use across the adolescent period. However, the results of this study, the cross-sectional study presented in Chapter 2, and my previous work (Maslowsky et al., under review), suggest that the effect of mental health on substance use is strongest among those with the highest levels of mental health problems. In other words, although the effect size of mental health problems predicting increases in

substance use across the adolescent period is small in the total population, it represents a substantial effect among those high-risk groups who have high levels of one, or particularly both, of the CP and DS symptoms.

Overall, the results of this study support the hypothesis that early emerging mental health problems having the strongest influence on adolescent substance use, even when they are relatively more distal from the substance use outcome. This has important implications for both theory and practice. With regards to theory, models of the developmental sequence leading to substance use (e.g. Dodge et al., 2009, Zucker et al., 2008) and empirical studies based on these models should include early adolescent mental health problems in the sequence. With regards to practice, these results indicate that limited prevention dollars are best directed toward early-emerging mental health problems if the aim is to prevent later substance use.

**Effect of Depressive Symptoms on Substance Use**

The second hypothesis, regarding the effect of DS and CPxDS on substance use, was partially supported. I expected that both DS and CPxDS would have positive effects on later substance use. DS did indeed have positive effects, but they applied relatively specifically to later cigarette smoking. This result is consistent with several previous studies documenting a positive prospective relation between DS and cigarette use (Dierker et al.,2007; Repetto et al., 2005). While early intervention in both CP and DS appears to be a promising approach for preventing substance use, results of preventing DS could be expected to manifest primarily in lower levels of cigarette use.

The second portion of the hypothesis, regarding the interaction of CPxDS, was not strongly supported by the results. Based on cross-sectional analyses of a larger set of

data from which the present longitudinal sample is drawn, I expected that CPxDS would have a positive effect on substance use, such that youth with high levels of CPxDS would have the greatest increases in their substance use. This pattern was observed in one case, with regards to the effect of 8th grade CPxDS predicting increases in marijuana use from 8th-10th grades. However, overall, few significant CPxDS interactions were observed, and several (e.g. effect of 8th grade CPxDS on 12th grade cigarette use) were negative rather than positive as predicted.

There are several possible explanations for the lack of significant interactions. First, the interaction effects are small, and interactions are notoriously difficult to detect in non-experimental studies (McClelland & Judd, 1993). Also, the evidence from Chapter 1 indicates that the association of mental health problems and substance use may be strongest in 8th grade. In this study, only 10th and 12th grade substance use were modeled, where, at least according to the cross-sectional evidence from Chapter 2, the interaction effects are smaller. Relatedly, the outcome modeled in the current study was change in substance use after 8th grade. It could be that those with high levels of CP and DS already had elevated levels of substance use at 8th grade and therefore showed a smaller increase in use at 10th and 12th grades.

**Sex Differences in the Effect of Mental Health Problems on Substance Use**

The final hypothesis, regarding sex differences in the effects of mental health problems on substance use, was supported. Based on previous research that has found these relationships to more similar than different in boys and girls (Costello et al., 1999; King et al., 2004), I expected to observe few sex differences, which was largely supported in the results. Although there were a number of significant differences by sex

in the effect of mental health problems on substance use, most were quite small in magnitude (e.g. effect of 8th grade CP on increases in marijuana use from 8th-12th grade was B = .20 for boys and B = .17 for girls). The only differences that were fairly large were in the effects of 10th grade CP on changes in substance use from 10th-12th grade. CP were not significantly associated with substance use over this period in boys but were negatively associated for girls. Again, this unexpected finding warrants further research to test its replicability. Overall, the results regarding sex differences indicate that popular suppositions that DS is a substance use risk factor for girls and CP for boys do not appear to be empirically supported. These results add to the literature concluding that, despite prevalence differences in mental health symptoms, with DS more prevalent in girls and CP more prevalent in boys, those youth of either sex who do manifest each set of symptoms should be considered equally at risk for developing substance use.

**Strengths and Limitations**

This study has numerous strengths. First, the data were a longitudinal study of a national sample of adolescents, which allowed for a test for a unique effect of early emerging mental health problems on later substance use. This effect is implied by psychiatric literature indicating that early emerging symptoms tend to be more severe and more predictive of later problems, but it has not previously been empirically tested. Second, the effect of mental health symptoms on three different, commonly used substances, alcohol, marijuana, and cigarettes, were examined. Previous studies have often examined the effect of mental health either on only one of these substances or on an index variable that combines them and obscures substance-specific effects of mental health problems. Finally, I tested the effect of interaction of CP and DS on substance use,

given the results of Chapter 2 and other studies documenting their interactive effect with regards to substance use (Marmorstein & Iacono, 2001; Miller-Johnson, Lochman, Coie, Terry, & Hyman, 1998; Pardini, White, & Stouthamer-Loeber, 2007). I tested for sex differences, in order to test whether a commonly held perception that higher prevalence of DS among girls and of CP among boys would lead to stronger association those symptoms to substance use among members of the respective sex, an assertion that was not supported by the current results.

There were also several notable limitations. First, attrition was fairly high- 33.5% of the sample had attrited at the 12th grade time point. However, this attrition was anticipated within the study design (those most likely to attrit were oversampled), and because those at risk for dropping out were oversampled, they were still reasonably well represented at 12th grade (Bachman et al., 2008). Second, the measures of the mental health symptoms were brief- four items each to measure CP and DS. Brief measurement is one of the tradeoffs made in survey research in order to obtain large national samples. Of note, however, is that these measures had good internal reliability, and they have been successfully applied in previous studies (Maslowsky et al., under review, Schulenberg & Zarrett, 2006; Pilgrim et al., 2006). Of course, additional studies with more in-depth measurement of mental health symptoms would be important in replicating the results of the current study.

**Conclusions**

Understanding the early predictors of substance use is a key step in enabling the development and implementation of successful interventions to prevent substance-use related harm to youth and to society at large. The results of the current study indicate that

intervening in early emerging CP and DS could lead to a reduction in adolescent substance use in 10th and 12th grades. Previous literature has shown that there is a developmental window between onset of mental health problems and onset of substance use (Birmaher et al, 1996; Merikangas et al., 2010). Screening programs to identify early emerging mental health problems among adolescents could help to break the link between mental health problems and substance use by linking at-risk youth to treatment. One such program is TeenScreen (www.teenscreen.org), which partners with local agencies to implement evidence-based adolescent mental health screenings in schools. A second approach to breaking the link between mental health problems and substance use is the use of early interventions, beginning earlier in the developmental sequence, targeting early emotional and behavioral dysregulation as a strategy for preventing both later mental health problems and their negative sequelae, such as substance use. Some such interventions have already seen success. Kellam and colleagues (Kellam & Anthony, 1998; Kellam et al., 2008) describe a universal intervention delivered in elementary school and aimed at reducing children's behavioral problems resulted in a delay in onset of cigarette use among intervention participants. Delaying substance use initiation may also result in secondary effects, the prevention of other problems such as school dropout (Zimmerman et al.), risky sexual behavior (Brook, Balka, and Whiteman, 1999), a range of health risk behaviors (DuRant, Smith, Kreiter, Krowchuk, 1999), and unintentional injury (Hingson, Heeren, Jamanka, & Howland, 2000). Given the significant morbidity and mortality imparted by adolescent substance use and its developmental sequelae, an investment in early mental health interventions should be considered an investment in overall adolescent health.

# Chapter 4

## Mental health mediates the protective association of parental support with African American adolescents' alcohol and marijuana use in national and high-risk samples: An integrative analysis

Adolescent substance use is associated with a number of poor developmental outcomes, including reduced educational attainment and higher rates of risky sexual behavior and unintentional injury (Bachman et al., 2008; Brook et al., 1999; Hingson et al., 2000; Schuster et al., 2001). In adulthood, those who initiated substance use early in adolescence are more likely to develop a substance use disorder (DeWit et al., 2000; Grant & Dawson, 1998, Palmer et al., 2009; Sung, Erklani, Angold, & Costello, 2004). These negative consequences are amplified for African American adolescents, despite the fact that the prevalence of substance use among African American adolescents is comparable to or lower than that of White adolescents (Johnston et al., 2011). Prevalence differences mask an important paradox involving alcohol and marijuana use by adolescents: despite their lower prevalence rates, African American adolescents who use substances experience significantly higher rates of substance-related negative consequences, including substance use disorder and school dropout (Reardon & Buka, 2002). Additionally, race differences in prevalence reverse in what has been termed the age cross-over effect, wherein African American adolescents have been found to use substances and develop substance use disorders at higher rates in adulthood despite less use during adolescence (Bachman et al., 1996; Reardon & Buka, 2002). Finally, African

Americans experience more physical health consequences as a result of their substance use (Moolchan et al., 2007), making substance use by African American adolescents a serious public health concern.

**Alcohol and Marijuana Use Prevalence and Trends**

There are known racial and ethnic differences in prevalence of substance use during adolescence. In general, fewer African American than White adolescents report lifetime or recent substance use (Johnston et al, 2011; Wallace et al., 2002). In 2003, the year of initial data collection for the current study, 13.0% of African American and 12.6% of White adolescents reported marijuana use in the past year; 25.7% of African American adolescents and 26.9% of White adolescents reported alcohol use in the past year. In current years, among 8$^{th}$ grade students, the prevalence of alcohol and marijuana use among African American and White 8$^{th}$ graders have grown more similar for alcohol, and African American 8$^{th}$ graders now use marijuana at greater rates than White adolescents, although African American adolescents still tend to have lower levels of use of both substances in 10$^{th}$ and 12$^{th}$ grades. In 2010, the annual prevalence of alcohol use was comparable among 8$^{th}$ grade African American and White adolescents; 30.4% and 29.9%, respectively, reported using alcohol in the past year; the annual prevalence of marijuana use among African American 8th graders was 14.1%; for Whites it was 11.5% (Johnston et al., 2011).

Why African American adolescents' rates of substance use are comparable to or lower than those of whites is a particularly compelling question given that they are, on average, exposed to higher rates of known risk factors for substance use compared to White adolescents (Wallace & Muroff, 2002). Despite this paradox and the

disproportionate rates of substance-related negative consequences they experience, African American adolescents are underrepresented in much of the extant substance use etiological literature. One review of developmental theories of substance use found that none address the role of race or race-relevant constructs (Petraitis, Flay, & Miller, 1995). Although the representation of racial and ethnic minorities in the substance use etiological literature has steadily increased over the past two decades (e.g. Buchanan & Smokowski, 2009; Fang & Schinke, 2011; Smith, Phillips, & Brown, 2008; Walls, Whitbeck, Hoyt, & Johnson, 2007), there is still a great deal of work to be done to develop a literature as broad as that which exists regarding the development of substance use among White adolescents. Specifically, the processes underlying the development of substance use by African American adolescents require further study in order to identify potential avenues for prevention (Szapocznik et al., 2007). The current study examines one such process, the role of parental support and mental health in the development of substance use among African American adolescents.

**Integrative Approach**

Rutter and Sroufe (2000) have written that a true understanding of developmental risk processes will result from studies of both high-risk populations and large-scale epidemiological studies. Developmental psychopathology theory stresses the importance of studying both normative and high-risk samples in order to gain complementary knowledge regarding the processes that underlie typical development and the development of psychopathology (Cicchetti, 1993; Garmezy, Masten, & Tellegen, 1984; Sroufe & Rutter, 1984). Developmental psychopathology recognizes that the paths to typical versus problematic development often overlap, and that there may be multiple

developmental paths that can lead to a given outcome (equifinality) and that can follow from a particular starting point (multifinality; Cicchetti & Rogosch, 1996). As a consequence, risk processes may not operate universally across demographic subgroups. A crucial task in the study of risk processes for psychopathology, then, is to describe whether they apply only to specific high-risk groups or to the larger population.

Developmental psychologists have conducted both normative and high-risk studies for decades, though often these two bodies of research operate in parallel rather in dialogue with one another. The field has now advanced to a point, methodologically and theoretically, at which I are poised to integrate these two types of studies, theoretically and empirically. National surveys track representative samples across historical and developmental time, while in-depth, measurement intensive studies complement epidemiological studies' breadth. Whether focusing on specific understudied populations, using intensive data collection methods, or collecting reports from multiple sources, such studies offer insight into the finer details and specific processes of adolescent development. Given the wealth of data available using multiple approaches to sampling, design and measurement, a next logical step for adolescent researchers is to bridge across multiple data sources and make strategic use of the unique insights offered by each to draw novel, complementary, and integrative conclusions, in this case, with regards to substance use by African American adolescents.

An integrative approach offers several advantages. First, it addresses criticisms that many social science research findings may be untrue due to lack of replication (Cohen, 1994; Ioannidis, 2005) by performing a built-in replication of research findings across two independent samples. Second, when a technique such as integrative data

analysis (the method employed here) is used, measurement differences can be ruled out as sources of differences across studies, allowing constructs to be directly compared across studies even if they were originally measured on different scales. Third, it offers some insight into the robustness of research findings across multiple samples, including those, as in the current case, which contain individuals with diverse demographic characteristics.

National surveys and targeted studies of high-risk groups are ideal candidates for integration; they are complementary in several respects. Large-scale survey research is an area of social science research that is not limited by sample size. National surveys offer large, representative samples that can be used to describe social phenomena in the population and its subgroups. Survey research can also be used in an explanatory fashion to establish cross-sectional and longitudinal predictors of substance use. African Americans are underrepresented in psychological research. Studies that do have African American adolescents represented in their samples often lack statistical power to conduct subgroup analyses by race (Szapocznik et al., 2007). Large survey samples provide the opportunity to examine a large, representative sample of members of a minority group that may not be well-represented in smaller studies.

Targeted studies of high risk groups are complementary to survey research. In these studies, participants are specifically selected based on their exposure to hypothesized risk factors. Fewer participants are obtained, but the depth of data is far greater. Such studies yield a well-characterized sample of theoretical interest, which may not be identifiable or present in large enough numbers for analysis in national survey

data. In this study, national and high-risk samples are combined in order to examine substance use among a diverse group of African American adolescents.

**Within-Group Approach**

The current study employs a within-group approach to studying alcohol and marijuana use among African American adolescents. Within-group studies can be thought of as the opposite of the more commonly used race comparative studies, which reveal differences between racial and ethnic groups but do not explain processes within (Phinney & Landin, 1998). While between-group studies are important for describing disparities in social indicators across groups (e.g. SES, health, achievement), they do not explain within-group heterogeneity in the distribution of such indicators or in the developmental processes that lead to them. Other studies, though not necessarily comparative, may tend to focus on differences from whites, implying that minorities are deviant or non-normative (Jones, 1993). Within-group research focuses on defining a psychological process within one racial or ethnic group without comparing to another group or relying upon previously defined frameworks that are based on other racial or ethnic groups.

When conducting research on ethnic minority populations, it is important to avoid the assumption of universality, that is, the assumption that psychological and developmental processes operate equivalently among all racial and ethnic groups (Burlew, 2002). Instead, it is important to empirically test whether developmental processes hold true in ethnic minorities and to explore additional variables that may be of unique or particular importance in the development of minority individuals but may not appear in current developmental models that are based on majority samples. Within-

group approaches are perfectly poised for exploration of within-group heterogeneity in outcomes such as substance use, which is the goal of the current study. Particularly in areas in which racial and ethnic minorities are underrepresented in the literature, within-group approaches are an important tool for describing developmental processes in a particular racial group without imposing constraints of previous framework that is based on research with other racial/ethnic groups. For example, Flory et al. (2006) noted that developmental patterns of alcohol use differ for African American and White adolescents, with substantial within-group heterogeneity in both African American and White adolescents' drinking. Specifically, while African Americans use at levels comparable to Whites, a larger portion of African American than Whites abstain, which may explain overall mean differences in rates of substance use between the two groups. This study demonstrates the benefit of utilizing a within-group approach to explore heterogeneity within subgroups of the population.

The current study uses an integrative and within-group approach to study one potential mechanism underlying the development of substance use among African American adolescents. I focus on parental support as a protective factor against alcohol and marijuana use and test whether the protective association of parental support is mediated by its association with lower levels of two mental health problems, conduct problems (CP) and depressive symptoms (DS). I integrate data from two theoretically important samples of African American adolescents. The first is a nationally representative sample from Monitoring the Future surveys and the second is a high-risk sample of adolescents who were oversampled for prenatal exposure to alcohol and drugs and have experienced numerous other developmental risk factors.

**Parental Support, Adolescent Mental Health, and Substance Use**

Parental support, which includes behaviors such as warmth and talking to the adolescent about his or her problems, has been found to protect against both substance use and mental health problems in adolescents of diverse racial and ethnic backgrounds, including African American adolescents (Brody et al., 2006; Caldwell et al., 2004; Foster et al., 2007; Pilgrim et al., 2006). It is important to note that parental support is distinct from parental monitoring, which refers to parents' knowledge of the child's activities, friendships, and whereabouts (Barnes et al., 2000). Monitoring has also been associated with lower levels of substance use among adolescents, but is not the focus of the current study. Brody et al. (2003) found that lower levels of nurturant, involved parenting predicted higher levels of conduct disorder symptoms among African-American adolescents. Barnes et al. (2000) found that parental support during early adolescence protected against alcohol use five years later, with direct effects on alcohol use as well as indirect associations mediated by the effect of parental support on parental monitoring, in a sample containing both White and African American adolescents.

Parental support may be particularly important for African American adolescents' development (Cleveland et al., 2005). Developmental research indicates that African American adolescents tend to maintain stronger ties with family members during adolescence than White adolescents and tend to be more parent than peer-oriented than White adolescents (Giordano, Cernovich, & DeMaris, 1993; deCindio, Floyd, Wilcox, & McSeveney, 1983). It may also be more important among those in high-risk contexts as parents increase their supportive behavior in order to attempt to protect their children from dangerous contexts (Rankin & Quane, 2002). Effective parenting has been

suggested as one explanation why African American adolescents use fewer substances despite greater exposure to contextual risk factors than White adolescents (Cleveland et al., 2005).

**Mental Health and Substance Use**

The current study focuses on symptoms of two prevalent mental health problems, conduct problems (CP) and depressive symptoms (DS). CP refers to externalizing, rule-breaking behaviors such as aggression and delinquency. DS refers to internalizing symptoms, including sadness and negative affect. Due to our interest in continuous variation in levels of these symptoms and their associations with substance use in two non-clinical samples, I measure CP and DS at the level of symptoms rather than clinical diagnoses. CP and DS typically precede substance use onset in adolescence (Kuperman et al., 2001; Mason et al., 2007; Merikangas et al., 2010). The majority of CP and DS have onset by age 14 (Merikangas et al., 2010).

CP is a robust predictor of adolescent substance use; adolescents with higher levels of CP have consistently been found to have higher levels of alcohol and marijuana use (Sullivan & Farrell, 1999; Boys et al., 2003; King et al., 2004; Mason & Windle, 2002; Repetto et al., 2005). The relation between DS and substance use during adolescence is less clear. Some studies find a positive association between DS and substance use. For example, Gibbons et al. (2007) found that negative affect predicts substance use among African American adolescents and that this effect was stronger for urban versus rural African American adolescents. However, many studies also fail to detect a significant association of DS with substance use (Dodge et al., 2009; Goodman & Capitman, 2000). I chose to test whether DS mediates the association of parent support

to substance use based on the strong association of parent support with DS and the need for more research on the association of DS to substance use, particularly among African American adolescents.

Although prevalence of mental health symptoms and disorders has generally been lower among African Americans than Whites, mental health problems are more chronic and disabling for African Americans who experience them (Breslau et al., 2006; Williams et al., 2007). As with substance use, the lower prevalence of mental health problems among African Americans may disguise a significant burden that they impose upon those who are affected. Thus, understanding the developmental processes related to mental health and substance use that occur early in adolescence may help to shed light on potential protective processes that, if nurtured, could have positive effects on both mental health and substance use in this population.

**Research Questions and Hypotheses**

Two research questions were tested 1) Do CP and DS mediate the relation between parental support and substance use in two samples of African American adolescents? 2) Do the relations between parental support, CP and DS, and substance use vary between a national sample of African American adolescents and a targeted high-risk sample? It was hypothesized that CP would mediate the association of parental support to substance use in both samples. No hypothesis was made regarding the mediation by DS due to the unclear nature of the association of DS with substance use in the extant literature. It was expected that the association of parental support with substance use and the mediation by CP would operate similarly in the MTF and SCHOO-BE samples, based

on previous research documenting the strong roles of parental support and CP in predicting substance use.

## Method

### Sample

Data for this study were drawn from two studies. The first was the Monitoring the Future (MTF) study. MTF conducts annual nationally representative, cross-sectional surveys that track behaviors and attitudes of American youth, primary focus on substance use and its predictors (Bachman et al., 2011; Johnston et al., 2011). Approximately 17,000 8th-grade students in approximately 150 public and private schools are surveyed each year. The participants in the current study were African American 8$^{th}$ graders who participated in surveys conducted from 2003-2005.

The second sample consisted of participants in the School-Based Evaluation Study (SCHOO-BE), a prospective longitudinal investigation of long-term effects of prenatal cocaine exposure (Delaney-Black et al., 2000). In this study, urban African American mothers were recruited from prenatal care clinics over a twenty-four month period, 1989-1991. Those who had engaged in prenatal alcohol and drug use were oversampled; 34% of the children in the current sample were prenatally exposed to cocaine. Data were collected prenatally, at birth, and when the child was age 7 and 14. The current study utilized data from the age 14 wave, which were collected from 2003-2005. Additional information regarding the study protocol is available in Delaney-Black et al., (2000).

### Measures

IDA is a technique that can be used to combine data across multiple datasets when measures are similar but not exactly the same (Bauer & Hussong, 2009; Curran, Hussong, Cai, Huang, Chassin, Sher, & Zucker, 2008). IDA works on the measurement side of an analytic model to identify like measures, scale them identically, and test whether they function similarly across samples. IDA has been used to combine studies that measure the same constructs within samples of different ages (e.g. Hussong et al., 2010) and to combine data from multiple reporters within a study (e.g. Howard et al., under review). The current study demonstrates another application, comparing a process model of substance use development across two African-American samples of theoretical interest, a national and a high-risk sample.

Potential items were selected from each study based on both their face validity in assessing the construct of interest and their successful use in previous research to represent the construct of interest. A pool of potential items from each study was assembled, and was then narrowed down by finding those items that were most similar across the two studies. Analysis items were selected based on the comparability of the item text and measurement scale. Table 1contains the original text and scales of measurement of the items used to measure each construct of interest. Item scales were harmonized in order to create an equivalent scale of measurement for each construct across the two samples. Harmonization occurs by identifying like points on the measurement scales of the items across studies, collapsing categories as needed until the items can be scaled comparably (Bauer & Hussong, 2009; D'Orazio, Di Zio, & Scanu, 2006). Table 2 contains the means and standard deviations of all analysis variables on the harmonized scales.

Parental support was measured via one self-reported item in each study. In MTF, adolescents were asked, “If you were having problems in your life, do you think you would talk them over with one or both of your parents?”, and they responded on a scale of 1 = “no”, 2= yes for at least some of my problems, 3 = “yes for most or all of my problems". In SCHOO-BE, adolescents were asked to respond to the item “Some kids can count on their family for help or advice when they have problems, but other kids cannot. Can you count on your family for help or advice when you have problems?” using a scale of 1 = 'always', 2 = 'most of the time', 3 = ‘sometimes’, 4 = 'hardly ever', 5 = 'never’. This item was from the Survey of Children’s Social Support (Dubow & Ullman, 1989). Responses of 1 in the MTF sample and 4 or 5 in the SCHOO-BE sample were coded as 1, indicating little or no parental support. Responses of 2 in the MTF sample and 3 in the SCHOO-BE sample were coded as 2, indicating some parental support. Responses of 3 in the MTF sample and 1 or 2 in the SCHOO-BE sample were coded as 3, indicating high levels of parental support.

Depressive symptoms were measured via three self-report items in the MTF sample: “I enjoy life as much as anyone”, “It feels good to be alive”, and “I feel I am a person of worth, on an equal plane with others”. These items were reverse coded such that higher scores indicated greater levels of depressive symptoms. The original scale of these items was 1 = 'disagree', 2 = 'mostly disagree', 3 = 'neither', 4 = 'mostly agree, 5 = 'agree'. In SCHOO-BE, depressive symptoms were measured via three items from the Child Behavior Checklist (Achenbach & Rescorla, 2001), which was completed by the parent or caregiver. The parent rated the extent to which the items were true about the adolescent: “there is very little he/she enjoys”, “unhappy, sad, or depressed”, “feels

worthless or inferior". The original scale for these items was 0 = "not true", 1= "somewhat or sometimes true", 2 = "very true or often true". A harmonized scale was created; Responses of 4 or 5 on the MTF items and 1 or 2 on the SCHOO-BE items were coded 1, indicating any endorsement of the symptom. The remaining responses were coded 0, indicating no endorsement of the symptom.

Conduct problems were measured via four items from MTF surveys: "In the past twelve months, how often have you… [gotten into a serious fight at work or school, hurt someone badly enough to need bandages or a doctor, stolen something worth $50 or more, damaged school property on purpose]?" The original scale of these items was 1 = "Never", 2 = 'once', 3 = 'twice', 3 = '3 or 4 times', 5 = "5 or more times". In SCHOO-BE, adolescents reported whether they had engaged in behaviors that are part of the diagnostic criteria for conduct disorder in the DSM-IV: "initiates physical fights", "has been physically cruel to people", "stolen items of nontrivial value without confronting a victim", "has deliberately destroyed others' property (other than by firesetting)". The original scale of these items was 0 = 'never or rarely', 1 = 'sometimes', 2 = 'often', 3 = 'very often'. The scales were harmonized by coding MTF responses of 2 or higher and SCHOO-BE responses of 1 or higher as 1, indicating any endorsement of that behavior; the remaining responses were coded 0, indicating no endorsement of that behavior.

Marijuana use was assessed using one item in each sample. In MTF, the adolescent was asked "On how many occasions (if any) have you used marijuana (weed, pot) or hashish (hash, hash oil) during the last 12 months?", on a scale of ranging from 1 = "Never" 2= "1-2", 3 = "3-5", 4 = "6-9", 5 = "10-19", 6 = "20-39", 7 = "40 or more". A second MTF item regarding lifetime prevalence of marijuana use was used to identify

those adolescents who had never used marijuana in their lifetime (versus never using in the past twelve months, which was assessed in the previous item). In SCHOO-BE, the adolescent was asked "When was the last time you used marijuana?". This item was taken from the Child Health and Illness Profile (CHIP, Starfield et al., 1993) and was measured on a scale of 1= "never", 2 = "more than a year ago", 3 = "in the past year", 4 = "in the past month", – 5 = "in the past week". Those who indicated no lifetime use in MTF and those who responded "never" in SCHOO-BE were coded 0, indicating they had never used marijuana. Those in MTF who indicated that they had used in their lifetime but not within the past year and those in SCHOO-BE who responded that they had last used "more than a year ago", were coded 1, indicating use more than 1 year ago. Those in MTF who indicated having used marijuana 1-2, 3-5, or 6-9 times within the past year and those in SCHOO-BE who indicated they had last used marijuana "within the past year" were coded as 2, indicating last use occurred within the past year. Those in MTF who reported using marijuana 10-19 or 20-39 times in the past year and those in SCHOO-BE who indicated they had used "in the past month" were coded as 3, indicating use within the past month. Finally, those in MTF who indicated they had used marijuana 40 or more times in the past year and those in SCHOO-BE who indicated they had last used marijuana "in the past week" were coded as 4, indicating use within the past week.

Alcohol use was assessed via one (MTF) or two (SCHOO-BE) items assessing frequency of alcohol use. In MTF, the adolescent was asked, "On how many occasions have you had alcoholic beverages to drink--more than just a few sips-- in the past 12 months?", on the same scale as marijuana, above, ranging from 1 = "none" to 7 = "40 or more occasions". As with marijuana, a second item regarding lifetime use of alcohol was

used to identify those who had not used alcohol in their lifetime, (versus those who abstained in the past twelve months but had used at some other point in their lifetime). In SCHOO-BE, the adolescent was asked about drinking beer and wine versus hard alcohol in two separate items: "When was the last time you drank [beer or wine/ hard liquor]?". The higher of the two responses to these items was used to represent last alcohol use. These items were taken from the Child Health and Illness Profile (CHIP, Starfield et al., 1993) and were measured on the same scale as marijuana, above, ranging from 1 = "never" to 5 = "in the past week". The scales were harmonized in the same way as the marijuana scales, described above, yielding a 4-point scale ranging from 0 = "never" to 4 = "in the past week".

## Results

### Preliminary Analyses

Bivariate correlations among the study variables are presented in Table 3. Several preliminary analyses were conducted as part of the integrative data analysis, following the guidelines of Bauer & Hussong (2009). First, exploratory factor analyses were conducted to ensure the unidimensionality of the DS and CP factors in each sample separately. Each factor was found to be unidimensional in each study. Next, a measurement model was fitted to test for measurement invariance across the two studies. Separate measurement models were specified for alcohol and marijuana use. The measurement models were specified as multiple group models, with study as the grouping variable. All factor loadings were constrained to be equal across study. Factor means and variances were free across study. Both measurement models had an excellent fit (CFI > .99, TLI > .99, RMSEA < .03), indicating measurement invariance across the

two studies. All factor loadings were thus constrained to be equal across studies in all subsequent analyses.

**Analysis**

Analyses were conducted in Mplus version 6.1 (Muthén & Muthén, 1998-2010) using weighted least squares with robust standard errors to account for categorical indicators of factors and full information maximum likelihood (FIML) to account for missing data. MTF data were weighted to account for sampling probabilities. Structural equation models were used to examine parental support as a predictor of DS, CP, and alcohol use, with DS and CP as mediators of the relation of parental support to substance use. Differences between the two studies were tested using multiple group models. Models were estimated separately for alcohol and marijuana use as dependent variables. Measurement parameters (factor loadings, item means and variances) were constrained to be equal across the two studies. Factor means and variances were allowed to vary across study if freeing them resulted in significant improvement in model fit (see Table 3). Mediation was tested using the test of indirect effects in Mplus.

**Alcohol Use**

Results of the alcohol use model are displayed in Figure 1. As hypothesized, in both samples, parental support was inversely related to adolescent DS, CP, and alcohol use. Also in both samples, the relation of parental support to alcohol use was partially mediated by CP (MTF: Z = -4.23, $p < .05$; SCHOO-BE: Z = -2.49, $p < .05$) but not DS. In MTF, the mediation by CP explained 54% of the direct effect of parental support on alcohol use. In SCHOO-BE it explained 33% of the direct effect. The model explained

significantly more variance in alcohol use in the MTF than SCHOO-BE sample (MTF: $r^2$ = .21, SCHOO-BE: $r^2$ = .06).

**Marijuana Use**

The results for marijuana use (Figure 2) were similar to those for alcohol use. As hypothesized, in both samples, parental support was inversely related to adolescent DS, CP, and marijuana use. Also in both samples, the relation of parental support to marijuana use was partially mediated by CP (MTF: Z = -4.42, $p < .05$; SCHOO-BE: Z = -2.23, $p < .05$) but not DS. In MTF, the mediation by CP explained 56% of the direct effect of parental support on marijuana use. In SCHOO-BE it explained 35% of the direct effect. After accounting for the mediation, the direct association of parental support with marijuana use was no longer significant in either sample. However, the model explained significantly more variance in marijuana use in the MTF than SCHOO-BE sample (MTF: $r^2$ = .15, SCHOO-BE: $r^2$ = .06).

**Parallel Analysis Using Non-Harmonized Data**

In order to rule out the possibility that the results of the previous analyses were reflective only of the harmonized data and not of the original measures, (e.g., that the harmonization of the item scales across the two studies did not introduce spurious findings into the model), I also tested the same model using a parallel analysis approach. In these analyses, the constructs were formed using the best available measures for those constructs within each study (many, though not all, of the items were the same as those presented in the main analyses; some additional items were used that were unique to each study and thus not eligible for inclusion through IDA). Structural equation models were conducted separately within each study to test the mediation of the association of parental

support to alcohol and marijuana use by CP and DS. The results of these analyses were largely the same as those presented in the IDA above. As in the IDA models, parent support was negatively related to alcohol use, CP, and DS, and CP was a significant mediator of this association. Only one difference was noted between the results of the parallel analysis and of the IDA analysis, the association of DS with alcohol use. In MTF, DS was positively related to alcohol use, and it was a significant mediator of the association of parental support with alcohol use. In SCHOO-BE, DS was negatively associated with alcohol use, and it was not a significant mediator. This same pattern of results was observed in the parallel analysis models of marijuana use. However, when the measures were equated via IDA, this difference was not present, indicating that this difference is attributable to measurement differences between the two studies.

## Discussion

The results of the study largely supported the hypotheses. Specifically, parental support was negatively related to adolescent DS, CP, and alcohol and marijuana use. The effect of parental support was mediated by CP, as expected. DS was not significantly associated with alcohol or marijuana use and therefore was not a mediator of the association of parental support with substance use in either sample. This is consistent with several studies that have failed to detect a significant main effect of depressive symptoms on substance use among adolescent samples (Dodge et al., 2009; Goodman & Capitman, 2000).

Also as expected, the results were largely invariant across the two samples. Parental support was protective against substance use in both the national MTF sample and the more high-risk SCHOO-BE sample. Also in both samples, CP was a mediator of

this association, and, after accounting for this association, the direct association of parental support to alcohol and marijuana use was no longer significant. However, one difference was that the model explained more variance in both alcohol and marijuana use in the MTF than SCHOO-BE study. Additional predictors of substance use among the SCHOO-BE sample are needed in order to formulate a more comprehensive model of substance use among this sample. Notable, however, is the fact that the primary goal of the current study was to demonstrate the application of IDA in within-group analysis, not to comprehensively model the occurrence of alcohol and marijuana use among African American adolescents. The basic approach and model presented here can be expanded in future studies to include additional predictors.

Nonetheless, the results of this study indicate that parental support may be an important target for preventive interventions (e.g. Brody et al., 2006) with African American adolescents, including high-risk samples. Several authors have identified the need to identify mediators of the associations of culturally-relevant variables to developmentally important outcomes such as substance use (Pilgrim et al., 2006; Quintana et al., 2006). Given previous research indicating the particular importance of parenting and parent-adolescent relationships in African American adolescents' development (Giordano et al., 1993; Rankin & Quane, 2002), a particular contribution of this study is that it demonstrates the role of reduced conduct problems as a mediator of a previously identified protective association of parental support to adolescent substance use.

**Strengths, Limitations, and Implications**

The primary strength of this study is its use of two rich data sources to explore within-group heterogeneity in the association of parental support to mental health and substance use during adolescents. Integrating Monitoring the Future's national sample with SCHOO-BE's high-risk sample allowed for a test of the equivalence of a hypothesized protective process in these two theoretically important samples. Although the IDA findings presented here yield a similar pattern of results as a previous parallel analysis completed without IDA, IDA has the specific advantage of allowing an empirical test of whether the process is the same across the two studies, after equating the measures across the samples, therefore offering additional assurance that any similarities or differences that are observed are not attributable to between-study differences in measurement. The current study was thereby able to capitalize on the advantages of the two datasets, the breadth of the MTF national sample and the unique characteristics of the SCHOO-BE sample, in order to construct a within-group analysis of African American adolescents' substance use and test whether the phenomenon is generalizable and replicable across a diverse swath of African American adolescents.

The current study makes several contributions to the extant literature on the development of substance use among African American adolescents. In the tradition of developmental psychopathology, it explores both a normative sample and a sample at high risk for developing substance use problems. It takes the additional step of implementing integrative data analysis (Curran et al., 2008), an established technique for equating measurement constructs across studies, in order to test whether the developmental process at hand was replicable across these two complementary samples. Indeed, the results indicated that the protective association of parent support with

substance use is mediated by lower levels of CP and DS in both samples. The built-in replication of the results across two studies lends additional plausibility to these findings (e.g. Cohen, 1989).

There were of course some limitations to the current study. The cross-sectional data in the current study do not permit causal inference. They are self-report data and represent broad measures of the constructs of interest. Also, in order to generate comparable measures across the two datasets, item scales were harmonized. This could have resulted in a loss of some information provided by the original measurement scales. However, this concern is eased somewhat by the coherence between the IDA analysis and the parallel analysis, in which the items were not harmonized. The one minor difference between the parallel and IDA analyses was in the association of DS with substance use. In the IDA models, DS was not significantly associated with substance use, while in the parallel analyses it showed a small positive association in the MTF sample and a small negative association in the SCHOO-BE sample. When the measurement was equated via IDA, this difference was not present, indicating that it is most likely attributable to differential measurement of the DS construct across the two studies.

Based on the similarity of the results in these two models, it seems that any loss of information that may have occurred due to harmonization did not have a large effect on the overall pattern of results. Another limitation is that parental support and substance use were measured by just one item each, and in the SCHOO-BE sample, the adolescent's depressive symptoms were reported by the parent, not the adolescent. Parent-adolescent agreement on reports of mental health symptoms is generally low (Seiffge-Krenke & Kollmar, 1998), with adolescents tending to report higher levels of internalizing and

externalizing symptoms than parents, and parent reports of their adolescents' symptoms correlating positively with their own levels of symptomatology. This may have influenced the results of the current study, particularly with regards to the association between DS and substance use. As this is a smaller association than that of CP and substance use, this particular pathway in the model may have been more vulnerable to differential measurement. However, I was limited by the measures that were available in the current datasets, a common occurrence in secondary data analysis (Brooks-Gunn et al., 1991) and additionally constrained by the need to select comparable items across the two study samples. Again, the convergence of the IDA with the parallel analysis, completed without selecting like measures or harmonizing measurement scales, offers some reassurance of the robustness of the current results.

In order to build upon the results of the current study, future studies using longitudinal data will help to establish causal directionality in the relations examined here. Future studies may also wish to examine moderation of these relations by sex, age, and socioeconomic status, as variations in these factors within the population of African American adolescents will likely lend additional explanatory power regarding within-group heterogeneity in the development of substance use.

**Conclusions**

This study has demonstrated the importance of a within-group approach to studying one process underlying the development of substance use among African American adolescents, the role of supportive parenting. It has further demonstrated the utility of the IDA method as a tool for within-group analysis, in that it permits the integration of multiple samples with different demographic characteristics in order to

examine a broad sample of the population of interest. In this case, it enabled the integration of the national MTF sample with the unique and theoretically interested high-risk SCHOO-BE sample in order to test for within-group heterogeneity in the role of parental support in mental health and substance use during adolescence.

The results indicated that parental support protects against early alcohol and marijuana use via its association with lower levels of CP in African American adolescents- national and high-risk sample. There appears to be a broadly applicable protective effect of parental support with mental health (lower levels of conduct problems and depressive symptoms) and substance use, even in high-risk conditions (e.g. Brody et al., 2006; Galea et al., 2004). Parental support may thus be an important target for preventive interventions with African American adolescents, including urban and high-risk samples (e.g. Brody et al., 2006; Pilgrim et al., 2006).

# Chapter 5

## Conclusion

The risk for substance use implied by mental health problems during adolescence has been documented in both the epidemiological and developmental psychopathology literatures. Epidemiology shows that conduct and depressive disorders are the most common comorbid conditions with substance use disorders during adolescence (Armstrong & Costello, 2002). Developmental psychopathology documents a developmental sequence from childhood behavioral problems and parenting difficulties into adolescent mental health problems and substance use (Dodge et al., 2009; Zucker et al., 2008). From these two bodies of literature, it is clear that mental health problems are important factors in the development of substance use, namely alcohol, marijuana, and cigarette use, in adolescence. The aim of this dissertation was to generate new evidence to fill some remaining gaps in current knowledge regarding the associations between mental health problems and substance use during adolescence. The focus was on conduct problems (CP) and depressive symptoms (DS), as these are the two types of mental health problems most commonly associated with substance use.

Several crucial questions regarding how CP and DS relate specifically to substance use served as themes for the three studies presented here. One question was the role of DS in substance use. The literature to date has shown mixed results on the association of DS with substance use. Therefore, all three studies examined this

association. Next was the role of the interaction of conduct problems (CP) and depressive symptoms (DS) in substance use. Many studies have examined them individually, but few have examined their interaction. Chapters 2 and 3 tested the interaction of CPxDS as a predictor of substance use. A final substantive theme was documenting the ways in which the associations between each of the two types of mental health problems and substance use varied systematically by demographic subgroup and by substance. All three studies addressed this question, by testing age differences (Chapter 2) and sex differences (Chapters 2 and 3) as appropriate, by analyzing each substance separately in order to examine differential patterns of prediction by CP and DS (Chapters 2, 3, and 4), and by conducting a within-group analysis of a minority group underrepresented in the current literature (Chapter 4).

The guiding approach used in the three studies is developmental epidemiology, which combines theories and methods from developmental psychopathology and epidemiology in order to study the developmental patterns underlying psychopathology at the population level (Buka, 2005; Costello & Angold, 2006). This approach was chosen because it offers an ideal blend of critical theoretical guidance for study hypotheses regarding the development of substance use and psychopathology and of epidemiology's careful attention to sampling, generalizability, and population-level significance of the questions under investigation.

**Summary of Results**

Chapter 2 presented results of cross-sectional models of the associations of CP, DS, and CPxDS with alcohol, marijuana, and cigarette use, and tested for moderation of these effects by age and sex. Overall, the results indicated that CP was a strong positive

predictor of alcohol, marijuana, and cigarette use, and DS was a weak, generally positive predictor of use of the three substances. CP tended to be most strongly associated with alcohol and marijuana use and DS with cigarette use, though the magnitude of the associations between mental health and substance use were largely similar across the three substances. The CPxDS interaction was a strong and nearly always positive predictor of substance use, such that those adolescents with high levels of both CP and DS used the highest levels of alcohol, marijuana, and cigarettes.

The subgroup analyses showed some differences in the associations between mental health and substance use by sex and age. The main effects of CP and DS were moderated by sex: CP was a larger predictor of use of each of the three substances for boys than for girls, and DS was a larger predictor for girls than boys. Although statistically significant, the sex differences were relatively small in magnitude, and the associations were all in the positive direction for both boys and girls. There was no sex difference in the association of the interaction of CPxDS with substance use. With regards to age differences in these associations, the main effect associations of CP and DS with substance use did not vary much by age. The largest age differences were seen with regards to the interaction, whose effects were strongest in 8$^{th}$ graders and decreased among older students. In summary, there do appear to be important differences in the association of mental health with substance use, with the largest being that the association of CPxDS with substance use is significantly stronger among younger adolescents.

Chapter 3 built on Chapter 2 by extending its research questions to a longitudinal framework. It examined the effects of CP, DS, and CPxDS occurring relatively earlier in adolescence to changes in substance use across a four-year period of adolescence, 8$^{th}$-12$^{th}$

grades. Psychiatric epidemiological evidence indicates that mental health problems that onset earlier in adolescence are more severe and more likely to lead to other developmental difficulties such as substance use (McGory, Purcell, Goldstone, & Amminger, 2011). Mental health problems that have onset by 8th grade, or approximately age 14, are considered relatively early onset, versus those that emerge a couple years later, by 10th grade. In addition to testing the longitudinal effects of CP, DS, and CPxDS on substance use, this paper compared the effects of 8th grade and 10th grade mental health problems on changes in substance use through 12th grade to determine whether earlier emerging (8th grade) mental health problems have a unique effect on changes in substance use.

Like Chapter 2, Chapter 3 found a fairly consistent strong and positive association between CP and substance use, and a small but generally positive (when significant) association of DS with substance use. What emerged more clearly in this study than in Chapter 2 was the substance-specificity of the effects of CP and DS. CP was associated most consistently and strongly with alcohol and marijuana use, and DS with cigarette use. This study also provided some evidence that the interaction of CPxDS predicts substance use, particularly with regards to marijuana use, where the interaction was positive such that those adolescents with high levels of CP and DS used the highest levels of marijuana. However, in these longitudinal analyses, the interaction was not as strongly nor as consistently associated with substance use as in the cross-sectional study presented in Chapter 2. Potential explanations for this inconsistency are discussed below.

Adolescent substance use clearly results from both distal and proximal factors (Dodge et al., 2009; Schulenberg & Maslowsky, 2009; Maggs et al, 2008). The results of

the study presented in Chapter 3 indicate that, in the specific case of mental health problems, it appears that early emerging mental health problems have a more powerful influence on adolescent substance use than later emerging problems, even when later-emerging mental health problems are more proximal to the substance use outcome. In summary, this study demonstrates that in the case of the effects of mental health problems on substance use, as in many developmental phenomena, the effects of the risk factor are not static, and are in fact developmentally specific (e.g., Cicchetti & Rogosch, 1999).

Chapter 4 presented a within-group analysis focusing on substance use by African American adolescents. This study integrated two complementary data sources, one national and one high-risk, to explore within-group heterogeneity in the association of parental support to mental health and substance use by African American adolescents. I used integrative data analysis (Curran et al., 2008) to generate comparable measures of parental support, CP, DS, and alcohol and marijuana use across the two datasets. I then tested whether CP and DS mediated the association of parent support, a known protective factor, with substance use. I found that CP, but not DS, mediated this association, such that parents who provided more support to their children had children with lower levels of CP, which related to lower levels of alcohol and marijuana use. This pattern of mediation was similar in the national and high-risk samples, indicating that parental support is an important protective factor against substance use in African American adolescents from a variety of familial and socioeconomic backgrounds.

**Synthesis of Results**

The three studies presented here generated a number of common results. The first is that CP has a large, positive main effect on adolescent alcohol, marijuana, and cigarette use; all three studies' results largely supported this conclusion. This result is not new; it replicates many previous findings in the current literature (Capaldi, 1991, 1992; Henry et al., 1993; Marmorstein & Iacono, 2001, 2003; Miller-Johnson et al., 1998) and therefore lends credence to the other results of the studies.

A second common result of the three studies is that DS does have a small and positive main effect on substance use. In some cases, particularly in Chapters 3 and 4, in which sample size was smaller, this effect was not statistically significant, though the magnitude of the effect was consistent across the three studies. These results offer some clarity into the question of whether and to what extent DS relates substance use during adolescence, a question on which, up to this point, previous studies had yielded conflicting results. It is important not to discount DS simply due to its small main effect on substance use. Small risk factors should not be ignored; they can have significant net effects at the population level if they are commonly occurring in the population, as DS is among adolescents, even though the individual-level effect is small (Mason, 2003). A related contribution of these studies is that they illuminate the interactive association of CPxDS with substance use. Although the main effect of DS is small, its interaction with CP is quite strongly associated with substance use, and in particular with marijuana and cigarette use. Together, the results supporting both a main effect and interaction effect of DS on substance use indicate that DS does play a significant role in adolescent substance use and warrants attention in future research and applied efforts.

A final common result across the three studies was the lack of large sex differences in the associations between CP, DS, and substance use. Chapters 2 and 3 tested for sex differences and found that CP was generally more strongly associated with substance use for boys than girls, and DS was more strongly associated for girls than boys. However, the sex differences were small, and the magnitude and direction of the associations were comparable across sex. The sex differences in the association of the CPxDS interaction to substance use were also few in number and small in magnitude. Based on the results of these studies, it appears that the association of CP, DS, CPxDS, and substance use should be considered to be similar in boys and girls.

Although the results of the three studies were mostly consistent, their inconsistent results should also be discussed. The primary difference in the results was that Chapter 2 noted stronger associations of the CPxDS interaction with substance use than did Chapter 3. There are several possible explanations for these differences. The primary difference between these two studies was their use of cross-sectional versus longitudinal data. Of course, the associations in the cross-sectional study (Chapter 2) would be expected to be larger because the two constructs were measured contemporaneously. A second possibility is that the effect of the CPxDS interaction on substance use is strongest among 8$^{th}$ graders, as Chapter 2 indicated. In Chapter 3, change in substance use after 8$^{th}$ grade was modeled, and effects of mental health problems on substance use may be smaller among older youth. Perhaps adolescents with high levels of DS and CP already had elevated levels of substance use at 8$^{th}$ grade and therefore showed a smaller increase in use at 10$^{th}$ and 12$^{th}$ grades. Unfortunately, no data were available to model mental health and substance use occurring before 8$^{th}$ grade, which would help to address this

possibility. Finally, as is often the case with interaction effects, many of these effects were quite small, especially in Chapter 3, and interactions are notoriously difficult to detect in non-experimental studies (McClelland & Judd, 1993). The smaller sample size, modeling change in substance use rather than raw levels of substance use, and greater temporal separation of mental health and substance use likely explain why the interaction effects were smaller in Chapter 3 than Chapter 2.

**New Contributions of this Work**

Together, the three studies presented here provide substantial new contributions to the study of adolescent mental health and substance use, both substantive and methodological. Substantively, they offer clarity on the question of the role of DS in substance use, both its main effect and its interaction with CP. The results indicate that the main effect of DS is small but positive and that DS also relates positively to substance use through its interaction with CP. For the first time in a national sample, I quantified the concurrent and prospective role of CPxDS in adolescent alcohol, marijuana, and cigarettes use. I found that the interaction contributes significantly to the prediction of use of these three substances, is strongest among younger adolescents, and does not vary by sex. The fact that these results reflect associations in national samples of adolescents provides a strong basis for generalizability of these results. Thus, although CP is often thought to be the mental health factor of primary importance in predicting adolescent substance use, the results of these studies suggest that the role of DS in adolescent substance use should not be overlooked.

Chapter 4 makes several contributions to the extant literature on the development of substance use among African American adolescents. In the tradition of developmental

psychopathology, it explores both a normative sample and a sample at high risk for developing substance use problems. It adds to the scant literature on urban African-American adolescents by testing one mechanism, the link from parent support to mental health that may protect against substance use in this population. This study capitalized on the respective advantages of the broad MTF national sample and the unique high-risk nature of the SCHOO-BE sample, in order to test whether the mechanism in question is generalizable and replicable across a diverse swath of African American adolescents. In doing so, it demonstrated the utility of a within-group approach for studying the processes that underlie or protect against the development of substance use and other problem behaviors among minority adolescents.

Together, the three studies comprise a concrete demonstration of the advantages of integrating epidemiological and etiological perspectives in order to study the development of mental health and substance use. The deep theoretical guidance provided by developmental psychopathology is complemented by the careful attention to sampling and generalizability provided by epidemiology in providing results that are scientifically grounded and widely applicable.

This dissertation also made two important methodological contributions: 1) devising a method for standardizing and interpreting the effects of latent variable interactions, and 2) using IDA to integrate a survey research sample with a selected high-risk sample in order to perform a within-group analysis.

Latent variable interactions are a promising methodological tool for studying many questions in psychology in which it is hypothesized that two latent constructs have synergistic effects on an outcome. One specific area in which this could prove useful in

future studies is in the area of psychiatric comorbidity, as demonstrated here in the examinations of the interaction of CPxDS. Comorbidity is the rule rather than the exception with regards to child and adolescent psychopathology and problem behavior (Angold, Costello,& Erklani, 1999; Sroufe, 1997). Chapter 2 of this dissertation explains how to test latent variable interactions via latent moderated structural equations in an accessible, step-by-step format. I review the challenges of estimating latent variable interactions (lack of fit indices and standardized effects) and demonstrate a method for overcoming these and other limitations are offered. This method of studying the effects of comorbid symptoms or disorders offers all of the advantages structural equation modeling, including the ability to account for measurement error and to accommodate continuous or categorical variables, and empirical model testing to identify the best-fitting model and compare effects across subgroups of interest. This method can be applied to study any combination of comorbid disorders and represents an ecologically valid test of psychological research questions involving interactions of latent variables.

The second methodological contribution of this dissertation is its application of integrative data analysis (IDA; Curran et al., 2008) to within-group analysis. Within-group analysis is an important tool for explaining within-group heterogeneity in psychological phenomena (e.g. Phinney & Landin, 1998). Chapter 4 took a step forward in within-group analysis by implementing an established technique for equating measurement constructs across studies, in order to test whether the developmental process at hand was replicable across these two complementary samples. This technique enabled the integration of the national MTF sample with the unique and theoretically important high-risk SCHOO-BE sample in order to test for within-group heterogeneity in

the role of parental support in mental health and substance use during adolescence. It represents a new, empirical operationalization of the important theoretical principles underlying within-group approaches to studying racial and ethnic minority groups.

**Directions for Future Research**

The substantial substantive and methodological contributions yielded by these three studies demonstrate the advantages of integrating principles of epidemiology and developmental psychopathology. Candidate developmental mechanisms identified through strong developmental theory can be tested in large epidemiological samples to examine the breadth of their applicability across the population and within key subgroups. This approach allowed me to take an important step forward in developing a comprehensive understanding of the development of substance use among adolescents. However, the work presented here is of course not comprehensive. It has several limitations, and it also sheds a light on specific additional research that is needed.

One limitation was the lack of data on very early (prior to age 14) adolescent mental health and substance use. Data beginning earlier in adolescence would be helpful to further define the directionality of mental health and substance use. Although 8$^{th}$ grade/age 14 is fairly early for mental health and substance use, it is on the cusp of not qualifying as early emergence of either. Data beginning around 6$^{th}$ grade, age 10-11, would be ideal to fully explore the question of the directionality of mental health problems and substance use. Given the results of the current studies, it will be important to include the CPxDS interaction in these analyses, as it appears to play an important role in early adolescent substance use. This work should also consider test whether the effects of CPxDS on substance use are applicable to other, related developmental outcomes,

including delinquency and health risk behavior. I would hypothesize that they are, and documenting the multiple risks imparted by early, co-occurring mental health problems could produce further justification for prevention efforts.

It will also be important to examine the role of other types of mental health problems in substance use. Anxiety symptoms are particularly important, as they are thought to be a part of the internalizing pathway to substance use (Hussong et al., 2011). The current data did not measure anxiety and I was therefore unable to consider it in these studies. Finally, additional longitudinal data are needed, particularly for the mediation questions addressed in Chapter 4, in order to examine temporal ordering and causality among parental support and adolescent mental health and substance use.

Future work will need to further contextualize the role of mental health and substance use within the larger ecology of adolescent development, including key contexts such as family, peers, and neighborhood and considering how they contribute to both mental health and substance use during this period. Similarly, testing for moderation of the associations between mental health and substance use by other important demographic factors, including socioeconomic status and neighborhood characteristics, as well as further explorations of whether this mechanism operates similarly across various racial and ethnic groups, are needed.

Finally, in all future work in this area, it will be important to maintain a developmentally informed approach, even within analyses that may be more traditionally epidemiological (such as examinations of patterns of symptom co-occurrence in the population). As Masten et al. (2008) highlight, the incidence, prevalence, use, progression, dependence, expectancies, timing, and consequences associated with

substance use are all developmentally patterned through at least young adulthood. Any attempt to understand the phenomenology of substance use that neglects developmental considerations will likely neglect important elements of the processes by which it develops. On the other hand, purely developmental work that neglects considerations of sample representativeness, a hallmark strength of epidemiology, will be limited by the questionable generalizability of its findings. Thus I hope that the primary contribution of this dissertation will be a convincing argument that a blend of epidemiological and etiological/developmental principles is essential for developing a truly comprehensive understanding of mental health and substance use in young people.

**Broader Implications of this Work**

Keeping in mind its limitations and the substantial research that is still to be done, the current work does have some important implications for both theory and practice. In thinking about the larger implications of the current work, it is important to situate adolescent substance use developmentally within the lifespan. Adolescent substance use is probabilistically associated with childhood factors such as parenting difficulties, self-regulatory deficits, and early behavioral problems. It also increases odds of a range of negative outcomes throughout adolescence and adulthood, including educational failure and dropout, addiction, mental health problems, and chronic disease (Bachman, et al., 2008; Bonnie & O'Connell, 2004, Moolchan et al., 2007; Reardon & Buka, 2002; Zucker, 2006). Of course, not all, and probably not even the majority, of those who use substances in adolescence will experience such drastic negative outcomes in adulthood, but it does increase the odds of these outcomes, particularly when it has an early onset and/or is characterized by comorbidity with other developmental difficulties such as

mental health problems. In these cases, as reviewed throughout this work, the course of substance use tends to be more chronic and severe (Angold et al., 1999; Grant & Dawson, 1997; Palmer et al., 2009).

In this dissertation, my aim was to focus in on one link in the developmental sequence that leads to substance use, that connecting adolescent mental health problems to substance use. Overall, as reviewed above, the results of the three studies documented a significant role of CP and DS in alcohol, cigarette, and marijuana use, particularly in early adolescence and when CP and DS co-occur. What are the implications of these results? One potential implication is that intervening in adolescent CP and DS may have a significant impact on reducing early and problematic substance use in adolescence. This is worth exploring in further detail in order to consider its feasibility.

Some have argued that addressing mental health problems in order to prevent substance use is not a feasible approach for a universal intervention. A cost-benefit analysis performed using data from the National Comorbidity Survey Replication concluded that the treatment of mental health disorders in order to prevent substance use disorders is not a cost-effective strategy because the number of cases of mental disorder that would have to be treated to prevent a case of substance use disorder is too high to justify the cost (Glantz et al., 2008). Cicchetti and Rogosch (1999) also argue that preventing mental health problems to prevent substance use is unlikely to be an effective universal strategy, largely because universal prevention efforts for mental health problems alone have proved difficult to design, implement, and evaluate. Therefore, universal implementation of these programs in hopes of producing a secondary benefit (reduced substance use via reduced mental health) is a risky strategy.

However, there do seem to be two promising options for interventions targeting the mental health-substance use link in adolescence: universal early interventions, which can have distal impacts on substance use, and targeted adolescent interventions, which may help to prevent problematic substance use among the most high-risk adolescents. In public health, these two types of strategies are referred to as strategic (early preventive) and tactical (proximal) approaches (Costello & Angold, 2006). Though the developmental mechanisms by which they operate may differ, both hold promise for preventing adolescent substance use.

Several types of early interventions have been shown to prevent substance use via pathways of improved mental health. One, the Nurse-Family Partnership (Olds, 2006), which involves home visits by nurses to high-risk mothers during the first two years of a child's life, has been shown to reduce early substance use onset in adolescents at age 15. This same intervention also resulted in reduced rates of arrest and risky sexual behavior. A second approach, aimed at improving elementary-aged children's behavioral self-regulation skills and reducing disruptive classroom behavior also resulted in reduced mental health and substance use problems when those children were young adults (Kellam et al., 2008).

A second opportunity to intervene to prevent adolescent substance use is during adolescence itself. During this period, the results of the studies presented here indicate that it may be most effective to target those youth who are experiencing high levels of one or more mental health problems. Not only is preventing or treating adolescent mental health problems a justifiable aim in its own right, the evidence provided here indicates that by targeting those with the highest levels of mental health problems for intervention,

we will also be targeting many of those who use the most substances. This evidence supports the use of selected rather than universal interventions during adolescence. One example is TeenScreen (www.teenscreen.org), which partners with local mental health agencies to provide mental health screenings in schools and link those adolescents in need with mental health services. Although in its early stages, TeenScreen has documented considerable success, with high rates of participation in voluntary screenings—55% of those offered mental health screening participated—and successful linkage to community mental health service—76% of those identified as at risk for mental health problems were successfully linked to treatment in the community (Husky, Sheridan, McGuire, & Olfson, 2011). Such targeted interventions may yield more benefits than universal intervention programs, and indeed one conclusion from the Glantz et al. (2008) cost-benefit analysis was that using mental health information to target substance use prevention efforts may help to identify the highest-risk groups most in need of intervention. Finally, one more important consideration is that the risk factors for substance use, including mental health problems, are nearly all nonspecific, meaning they increase odds of other problematic outcomes as well, including risk taking, educational problems and dropout, and risky sexual behavior (Masten et al., 2008). Thus any intervention that reduces mental health problems among adolescents may have secondary effects on multiple other undesirable outcomes as well.

Regardless of the strategy that is chosen, it is clear that we cannot afford to wait to intervene until mental health and substance use problems have fully manifested. Interventions at that point are expensive and demonstrate less effectiveness than earlier-stage interventions (Henggeler, Melton, Brondino, Scherer, & Hanley, 1997; Lipsey &

Wilson, 1998). Instead, we must seize the opportunities of adolescence to set a foundation for of health and well-being for adulthood (Resnick, Catalano, Sawyer, Viner, & Patton, 2012).Wise investment in prevention of substance use can yield drastic reductions in morbidity and mortality and improvements health. This work suggests that the contributions of mental health to substance use during adolescence must be integrated in such efforts.

Table 1. Sample characteristics by grade

| | 8th grade ($N$ = 127,272) | 10th grade ($N$ = 114,251) | 12th grade ($N$ = 15,750) |
|---|---|---|---|
| Gender (%) | | | |
| Male | 48.7 | 48.8 | 47.6 |
| Female | 51.3 | 51.3 | 52.4 |
| Race (%) | | | |
| White | 59.6 | 67.5 | 68.3 |
| Black | 14.9 | 12.7 | 13.9 |
| Hispanic | 11.6 | 10.3 | 9.2 |
| Other | 13.8 | 9.5 | 8.7 |
| | | M (SD) | |
| Depressive Symptoms | 1.96 (0.97) | 1.97 (0.94) | 1.94 (0.88) |
| Conduct Problems | 1.39 (0.64) | 1.36 (0.61) | 1.32 (0.53) |
| Cigarette Use | 1.26 (0.77) | 1.43 (0.99) | 1.71 (1.27) |
| Alcohol Use | 1.38 (0.90) | 1.70 (1.18) | 2.15 (1.48) |
| Marijuana Use | 1.17 (0.74) | 1.40 (1.16) | 1.47 (1.23) |

Table 2. Zero-order correlations of Chapter 2 variables

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Conduct problems | -- | | | | |
| 2. Depressive symptoms | .23 | -- | | | |
| 3. Alcohol use | .36 | .14 | -- | | |
| 4. Marijuana use | .30 | .12 | .45 | -- | |
| 5. Cigarette use | .30 | .19 | .44 | .45 | -- |

*Note.* All correlations are significant, $p < .001$.

Table 3. Nested model comparisons, Chapter 2

| Substance | Sample | Model | Free parameters | Δ-2*loglikelihood |
|---|---|---|---|---|
| Alcohol | Full sample | 1 | 10 | |
| | | 2 | 11 | 5.0 |
| | Multiple group by gender | 1 | 20 | |
| | | 2 | 21 | 4.1 |
| | | 3 | 22 | 4.4 |
| | Multiple group by grade | 1 | 26 | |
| | | 2 | 27 | 84.7* |
| | | 3 | 29 | 355.6* |
| Marijuana | Full sample | 1 | 10 | |
| | | 2 | 11 | 174.1* |
| | Multiple group by gender | 1 | 21 | |
| | | 2 | 22 | 118.9* |
| | | 3 | 23 | 13.4 |
| | Multiple group by grade (grades 10/12 only) | 1 | 20 | |
| | | 2 | 21 | 12.4 |
| | | 3 | 22 | 0.0 |
| Cigarettes | Full sample | 1 | 10 | |
| | | 2 | 11 | 241.9* |
| | Multiple group by gender | 1 | 21 | |
| | | 2 | 22 | 190.0* |
| | | 3 | 23 | 1.3 |
| | Multiple group by grade | 1 | 28 | |
| | | 2 | 29 | 276.0* |
| | | 3 | 32 | 58.5* |

Table 4. Estimates and equivalence of latent variable means and variances in single and multiple group structural equation models, Chapter 2

| | | | | Depressive Symptoms (DS) | | Conduct Problems (CP) | | Substance Use (Alcohol, Marijuana, or Cigarettes) | |
|---|---|---|---|---|---|---|---|---|---|
| Substance | Model | Group | N | Mean | Variance | Mean | Variance | Mean | Variance |
| Alcohol | Full Sample | | 254,587 | 0.00 | 0.60 | 0.00 | 0.17 | 0.00 | 0.96 |
| | Gender | Male | 120,479 | 0.00 [a] | 0.72 [a] | 0.00 [a] | 0.43 [a] | 0.00 [a] | 1.21 [a] |
| | | Female | 127,568 | 0.04 [a] | 0.82 [a] | -0.20 [a] | 0.19 [a] | -0.13 [a] | 0.82 [a] |
| | Grade | 8 | 125,328 | 0.00 | 0.76 | 0.00 [a] | 0.34 [a] | 0.00 [a] | 0.68 [a] |
| | | 10 | 113,515 | 0.00 | 0.76 | -0.03 [a] | 0.31 [a] | 0.32 [a] | 1.18 [a] |
| | | 12 | 15,744 | 0.00 | 0.76 | -0.07 [a] | 0.24 [a] | 0.77 [a] | 1.87 [a] |
| Marijuana | Full Sample | | 256,273 | 0.00 | 0.60 | 0.00 | 0.17 | -0.06 | 0.77 |
| | Gender | Male | 121,347 | 0.00 [a] | 0.72 [a] | 0.00 [a] | 0.43 [a] | 0.00 | 1.03 [a] |
| | | Female | 128,340 | 0.04 [a] | 0.78 [a] | -0.20 [a] | 0.19 [a] | 0.00 | 0.59 [a] |
| | Grade | 8 | | | | | | | |
| | | 10 | 114,251 | 0.00 | 0.73 | 0.00 [a] | 0.30 | -0.08 [a] | 1.13 [a] |
| | | 12 | 15,748 | 0.00 | 0.73 | -0.04 [a] | 0.30 | -0.01 [a] | 1.34 [a] |
| Cigarettes | Full Sample | | 256,421 | 0.00 | 0.60 | 0.00 | 0.17 | 0.00 | 0.64 |
| | Gender | Male | 121,892 | 0.00 [a] | 0.72 [a] | 0.00 [a] | 0.43 [a] | 0.00 [a] | 0.77 [a] |
| | | Female | 128,714 | 0.04 [a] | 0.79 [a] | -0.20 [a] | 0.19 [a] | -0.02 [a] | 0.66 [a] |
| | Grade | 8 | 126,656 | 0.00 | 0.76 | 0.00 [a] | 0.34 [a] | 0.00 [a] | 0.50 [a] |
| | | 10 | 114,018 | 0.00 | 0.76 | -0.03 [a] | 0.31 [a] | 0.17 [a] | 0.83 [a] |
| | | 12 | 15,747 | 0.00 | 0.76 | -0.07 [a] | 0.24 [a] | 0.46 [a] | 1.38 [a] |

*Note*. Estimates of means and variances are from Model 1, model estimated without latent interaction.

[a] Estimates were significantly different across groups, $p < .001$

Table 5. Results of single and multiple group structural equation models, Chapter 2

| Substance | Model | Group | N | Depressive Symptoms (DS) B | Conduct Problems (CP) B | DSxCP B | $R^2$ | CFI | TLI | RMSEA | $X^2$ | DF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alcohol | Full Sample | | 254,587 | -0.07 | 0.62 | 0.02 n/s | 0.36 | 1.00 | 0.99 | 0.01 | 69.54 | 2 |
| | Gender | Male | 120,479 | 0.04 [a] | 0.41 [a] | 0.01 [b] | 0.19 | 0.99 | 0.96 | 0.02 | 212.78 | 4 |
| | | Female | 127,568 | 0.08 [a] | 0.38 [a] | 0.01 [b] | 0.18 | | | | | |
| | Grade | 8 | 125,328 | 0.07 | 0.46 [a] | 0.24 [a] | 0.29 | 0.99 | 0.98 | 0.02 | 212.08 | 10 |
| | | 10 | 113,515 | 0.06 | 0.41 [a] | -0.01 [a] n/s | 0.19 | | | | | |
| | | 12 | 15,744 | 0.04 | 0.45 [a] | -0.08 [a] | 0.26 | | | | | |
| Marijuana | Full Sample | | 256,273 | -0.07 | 0.57 | 0.25 | 0.21 | 1.00 | 0.99 | 0.01 | 39.92 | 2 |
| | Gender | Male | 121,347 | 0.03 [a] | 0.37 [a] | 0.23 | 0.21 | 1.00 | 0.99 | 0.01 | 59.92 | 4 |
| | | Female | 128,340 | 0.06 [a] | 0.35 [a] | 0.22 | 0.19 | | | | | |
| | Grade | 8 | | | | | | | | | | |
| | | 10 | 114,251 | 0.05 [a] | 0.38 [a] | 0.10 [b] | 0.17 | 0.97 | 0.95 | 0.02 | 274.75 | 7 |
| | | 12 | 15,748 | 0.04 [a] n/s | 0.47 [a] | 0.08 [b] | 0.24 | | | | | |
| Cigarettes | Full Sample | | 256,421 | 0.06 | 0.47 | 0.18 | 0.30 | 0.99 | 0.98 | 0.01 | 74.31 | 2 |
| | Gender | Male | 121,892 | 0.11 [a] | 0.32 [a] | 0.19 | 0.17 | 0.99 | 0.96 | 0.02 | 222.02 | 4 |
| | | Female | 128,714 | 0.15 [a] | 0.31 [a] | 0.14 | 0.18 | | | | | |
| | Grade | 8 | 126,656 | 0.13 [a] | 0.37 [a] | 0.49 [a] | 0.43 | 0.99 | 0.97 | 0.02 | 207.75 | 8 |
| | | 10 | 114,018 | 0.15 [a] | 0.30 [a] | 0.13 [a] | 0.16 | | | | | |
| | | 12 | 15,747 | 0.16 [a] | 0.27 [a] | 0.07 [a] | 0.13 | | | | | |

*Note.* All beta coefficients are standardized.
[a] coefficients were significantly different across groups, $p < .001$.
[b] adding interaction did not improve fit of model versus main effects only model.

Table 6. Sample characteristics and means and standard deviations of analysis variables, grades 8, 10, 12

| | 8th grade ($N$ = 3,014) | 10th grade ($N$ = 2,421) | 12th grade ($N$ = 2,003) |
|---|---|---|---|
| Gender (%) | | | |
| Male | 49.3 | 47.0 | 43.2 |
| Female | 50.7 | 53.0 | 56.8 |
| Race (%) | | | |
| White | 60.8 | 64.8 | 66.2 |
| Black | 14.0 | 12.5 | 11.5 |
| Hispanic | 10.8 | 8.6 | 8.3 |
| Other | 14.4 | 14.1 | 14.0 |
| | | M (SD) | |
| Depressive Symptoms | 1.97 (0.95) | 1.92 (0.90) | 1.86 (0.90) |
| Conduct Problems | 1.33 (0.62) | 1.28 (0.56) | 1.22 (0.49) |
| Cigarette Use | 1.31 (0.84) | 1.54 (1.16) | 1.90 (1.46) |
| Alcohol Use | 1.42 (0.91) | 1.58 (1.04) | 1.97 (1.38) |
| Marijuana Use | 1.09 (0.51) | 1.30 (1.01) | 1.61 (1.52) |

Table 7. Zero-order correlations of Chapter 3 variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Conduct problems- 8th grade | -- | | | | | | | | | | | | | | | |
| 2. Conduct problems- 10th grade | 0.34 * | -- | | | | | | | | | | | | | | |
| 3. Conduct problems- 12th grade | 0.23 * | 0.39 * | -- | | | | | | | | | | | | | |
| 4. Depressive symptoms- 8th grade | 0.20 * | 0.11 * | 0.04 | -- | | | | | | | | | | | | |
| 5. Depressive symptoms- 10th grade | 0.10 * | 0.21 * | 0.12 * | 0.37 * | -- | | | | | | | | | | | |
| 6. Depressive symptoms- 12th grade | 0.10 * | 0.16 * | 0.17 * | 0.27 * | 0.51 * | -- | | | | | | | | | | |
| 7. Alcohol use- 8th grade | 0.35 * | 0.21 * | 0.10 * | 0.18 * | 0.13 * | 0.09 * | -- | | | | | | | | | |
| 8. Alcohol use- 10th grade | 0.23 * | 0.32 * | 0.14 * | 0.11 * | 0.20 * | 0.15 * | 0.33 * | -- | | | | | | | | |
| 9. Alcohol use- 12th grade | 0.16 * | 0.18 * | 0.25 * | 0.03 | 0.09 * | 0.08 * | 0.22 * | 0.43 * | -- | | | | | | | |
| 10. Cigarette use- 8th grade | 0.33 * | 0.12 * | 0.02 | 0.22 * | 0.15 * | 0.11 * | 0.47 * | 0.24 * | 0.13 * | -- | | | | | | |
| 11. Cigarette use- 10th grade | 0.23 * | 0.25 * | 0.08 * | 0.21 * | 0.21 * | 0.16 * | 0.32 * | 0.45 * | 0.20 * | 0.50 * | -- | | | | | |
| 12. Cigarette use- 12th grade | 0.19 * | 0.17 * | 0.17 * | 0.15 * | 0.20 * | 0.20 * | 0.25 * | 0.35 * | 0.38 * | 0.36 * | 0.61 * | -- | | | | |
| 13. Marijuana use- 8th grade | 0.25 * | 0.13 * | 0.04 | 0.12 * | 0.04 | 0.06 * | 0.38 * | 0.15 * | 0.07 | 0.37 * | 0.22 * | 0.13 * | -- | | | |
| 14. Marijuana use- 10th grade | 0.24 * | 0.36 * | 0.22 * | 0.12 * | 0.16 * | 0.14 * | 0.26 * | 0.47 * | 0.24 * | 0.27 * | 0.46 * | 0.31 * | 0.28 * | -- | | |
| 15. Marijuana use- 12th grade | 0.21 * | 0.26 * | 0.31 * | 0.09 * | 0.19 * | 0.19 * | 0.19 * | 0.36 * | 0.41 * | 0.16 * | 0.34 * | 0.44 * | 0.17 * | 0.53 * | -- | |
| 16. Age- 8th grade | 0.10 * | 0.04 | 0.03 | 0.09 * | 0.08 * | 0.06 * | 0.09 * | 0.03 | 0.06 * | 0.14 * | 0.09 * | 0.07 * | 0.08 * | 0.07 * | 0.02 | -- |

*$p < .05$

Table 8. Nested model comparisons, Chapter 3

| Time period | Substance | Sample | Model | Free parameters | Δ-2*loglikelihood |
|---|---|---|---|---|---|
| 8th-12th grade | Alcohol | Full sample | 1 | 14 | |
| | | | 2 | 15 | 260.6 |
| | | Multiple group by gender | 1 | 25 | |
| | | | 2 | 26 | 248.6 |
| | | | 3 | 27 | 1484.2 |
| | Marijuana | Full sample | 1 | 14 | |
| | | | 2 | 15 | 89.6 |
| | | Multiple group by gender | 1 | 21 | |
| | | | 2 | 22 | 304.9 |
| | | | 3 | 23 | 585.7 |
| | Cigarettes | Full sample | 1 | 14 | |
| | | | 2 | 15 | 401.2 |
| | | Multiple group by gender | 1 | 21 | |
| | | | 2 | 22 | 286.8 |
| | | | 3 | 23 | 3153.5 |
| 8th-10th grade | Alcohol | Full sample | 1 | 14 | |
| | | | 2 | 15 | 201.7 |
| | | Multiple group by gender | 1 | 24 | |
| | | | 2 | 25 | 30.2 |
| | | | 3 | 26 | 115.9 |
| | Marijuana | Full sample | 1 | 14 | |
| | | | 2 | 15 | 436.2 |
| | | Multiple group by gender | 1 | 21 | |
| | | | 2 | 22 | 512.6 |
| | | | 3 | 23 | 793.7 |
| | Cigarettes | Full sample | 1 | 14 | |
| | | | 2 | 15 | 480.1 |
| | | Multiple group by gender | 1 | 20 | |
| | | | 2 | 21 | 449.9 |
| | | | 3 | 22 | 356.2 |
| 10th-12th grade | Alcohol | Full sample | 1 | 14 | |
| | | | 2 | 15 | 376.3 |
| | | Multiple group by gender | 1 | 24 | |
| | | | 2 | 25 | 370.4 |
| | | | 3 | 26 | 276.6 |
| | Marijuana | Full sample | 1 | 14 | |
| | | | 2 | 15 | 40.3 |
| | | Multiple group by gender | 1 | 24 | |
| | | | 2 | 25 | 36.3 |
| | | | 3 | 26 | 32.1 |
| | Cigarettes | Full sample | 1 | 14 | |
| | | | 2 | 15 | 133.9 |
| | | Multiple group by gender | 1 | 21 | |
| | | | 2 | 22 | 110.5 |
| | | | 3 | 23 | 53.7 |

Table 9. Estimates and equivalence of latent variable intercepts and variances in single and multiple group structural equation models, Chapter 3

| | | | | | Depressive Symptoms (DS) | | Conduct Problems (CP) | | Substance Time 1 | | Substance Time 2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time Period | Substance | Model | Group | N | Intercept | Variance | Intercept | Variance | Intercept | Variance | Intercept | Variance |
| 8th-12th grade | Alcohol | Full Sample | | 2,944 | 0.74 | 0.74 | 0.52 | 0.32 | 0.28 | 0.73 | 1.33 | 1.65 |
| | | Gender | Male | 1,513 | -0.71 | 0.74 | -0.99 | 0.46 [a] | -0.17 | 0.82 [a] | 0.12 | 1.97 [a] |
| | | | Female | 1,379 | 0.00 | 0.74 | 0.00 | 0.17 [a] | 0.00 | 0.56 [a] | 0.00 | 1.11 [a] |
| | Marijuana | Full Sample | | 2,965 | 0.76 | 0.74 | 0.59 | 0.33 | 0.52 | 0.22 | 0.96 | 1.75 |
| | | Gender | Male | 1,522 | -0.09 | 0.74 | 0.21 | 0.44 [a] | 0.01 | 0.22 | 0.17 | 2.37 [a] |
| | | | Female | 1,388 | 0.00 | 0.74 | 0.00 | 0.19 [a] | 0.00 | 0.22 | 0.00 | 1.32 [a] |
| | Cigarettes | Full Sample | | 2,962 | 0.72 | 0.74 | 0.53 | 0.32 | -0.33 | 0.60 | 0.29 | 1.91 |
| | | Gender | Male | 1,527 | -0.09 | 0.74 | 0.21 | 0.44 [a] | -0.02 | 0.60 | 0.10 | 1.89 |
| | | | Female | 1,386 | 0.00 | 0.74 | 0.00 | 0.18 [a] | 0.00 | 0.60 | 0.00 | 1.83 |
| 8th-10th grade | Alcohol | Full Sample | | 2,951 | 0.73 | 0.74 | 0.49 | 0.32 | 0.29 | 0.73 | 0.89 | 0.96 |
| | | Gender | Male | 1,518 | -0.99 | 0.74 | -0.77 | 0.46 [a] | -0.06 | 0.82 [a] | 0.05 | 1.07 [a] |
| | | | Female | 1,381 | 0.00 | 0.74 | 0.00 | 0.17 [a] | 0.00 | 0.56 [a] | 0.00 | 0.73 [a] |
| | Marijuana | Full Sample | | 2,964 | 0.65 | 0.76 | 0.39 | 0.33 | 0.49 | 0.22 | 1.08 | 0.73 |
| | | Gender | Male | 1,524 | -2.02 | 0.74 | -1.01 | 0.44 [a] | -0.03 | 0.22 | 0.01 | 1.01 [a] |
| | | | Female | 1,388 | 0.00 | 0.74 | 0.00 | 0.19 [a] | 0.00 | 0.22 | 0.00 | 0.67 [a] |
| | Cigarettes | Full Sample | | 2,968 | 0.71 | 0.74 | 0.52 | 0.32 | -0.35 | 0.60 | -0.07 | 1.23 |
| | | Gender | Male | 1,528 | -0.56 | 0.74 | -0.88 | 0.42 [a] | 0.24 | 0.60 | 0.04 | 1.19 |
| | | | Female | 1,388 | 0.00 | 0.74 | 0.00 | 0.19 [a] | 0.00 | 0.60 | 0.00 | 1.18 |
| 10th-12th grad | Alcohol | Full Sample | | 2,363 | 1.05 | 0.65 | 0.99 | 0.25 | 0.96 | 0.86 | 1.53 | 1.56 |
| | | Gender | Male | 1,152 | 0.52 | 0.64 | 0.05 | 0.34 [a] | 0.17 | 1.04 [a] | 0.09 | 1.92 [a] |
| | | | Female | 1,170 | 0.00 | 0.64 | 0.00 | 0.15 [a] | 0.00 | 0.69 [a] | 0.00 | 1.20 [a] |
| | Marijuana | Full Sample | | 2,365 | 1.07 | 0.65 | 1.00 | 0.25 | 0.42 | 0.82 | 0.69 | 1.70 |
| | | Gender | Male | 1,154 | 0.60 | 0.64 | 0.12 | 0.34 [a] | -0.05 | 1.02 [a] | 0.10 | 2.16 [a] |
| | | | Female | 1,170 | 0.00 | 0.64 | 0.00 | 0.14 [a] | 0.00 | 0.64 [a] | 0.00 | 1.38 [a] |
| | Cigarettes | Full Sample | | 2,365 | 1.01 | 0.65 | 0.96 | 0.26 | -0.04 | 1.08 | 0.38 | 1.72 |
| | | Gender | Male | 1,154 | 0.56 | 0.64 | 0.06 | 0.34 [a] | -0.25 | 1.08 | 0.00 | 1.72 |
| | | | Female | 1,170 | 0.00 | 0.64 | 0.00 | 0.15 [a] | 0.00 | 1.08 | 0.00 | 1.77 |

[a] estimates significantly different across groups, $p < .05$

Table 10. Results of single and multiple group structural equation models, Chapter 3

| Time period | Substance | Model | Group | N | Depressive Symptoms (DS) B | Conduct Problems (CP) B | DSxCP B | Substance Time 1 B | $R^2$ | CFI | TLI | RMSEA | $X^2$ | DF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8th-12th | Alcohol | Full Sample | | 2,944 | -0.03 | 0.11 [a] | 0.05 | 0.22 [a] | 0.08 | 0.99 | 0.95 | 0.03 | 3.06 | 1.00 |
| | | Gender | Male | 1,513 | -0.02 | 0.18 [a,b] | 0.05 [b] | 0.24 [a] | 0.12 | 1.00 | 0.99 | 0.01 | 7.19 | 6.00 |
| | | | Female | 1,379 | -0.02 | -0.09 [b] | 0.14 [b] | 0.26 [a] | 0.07 | | | | | |
| | Marijuana | Full Sample | | 2,965 | 0.05 | 0.24 [a] | 0.03 | 0.14 [a] | 0.11 | 1.00 | 1.02 | 0.00 | 0.65 | 1.00 |
| | | Gender | Male | 1,522 | 0.05 | 0.20 [a] | 0.04 [b] | 0.14 [a] | 0.08 | 0.98 | 0.95 | 0.02 | 14.73 | 9.00 |
| | | | Female | 1,388 | 0.06 | 0.17 [a] | -0.02 [b] | 0.19 [a] | 0.10 | | | | | |
| | Cigarettes | Full Sample | | 2,962 | 0.07 [a] | 0.03 | -0.06 [a] | 0.44 [a] | 0.24 | 1.00 | 1.02 | 0.00 | 0.11 | 1.00 |
| | | Gender | Male | 1,527 | 0.07 [a] | 0.03 | -0.07 [a,b] | 0.45 [a] | 0.24 | 0.98 | 0.96 | 0.03 | 22.93 | 10.00 |
| | | | Female | 1,386 | 0.07 [a] | 0.02 | -0.05 [b] | 0.45 [a] | 0.23 | | | | | |
| 8th-10th | Alcohol | Full Sample | | 2,951 | 0.03 | 0.13 [a] | -0.03 | 0.32 [a] | 0.16 | 1.00 | 1.02 | 0.00 | 0.07 | 1.00 |
| | | Gender | Male | 1,518 | 0.02 | 0.13 [a] | -0.01 [b] | 0.35 [a] | 0.18 | 1.00 | 0.99 | 0.01 | 9.06 | 7.00 |
| | | | Female | 1,381 | 0.03 | 0.10 [a] | -0.07 [b] | 0.34 [a] | 0.17 | | | | | |
| | Marijuana | Full Sample | | 2,964 | 0.07 [a] | 0.21 [a] | 0.23 [a] | 0.30 [a] | 0.25 | 1.00 | 0.99 | 0.01 | 1.42 | 1.00 |
| | | Gender | Male | 1,524 | 0.05 | 0.23 [a] | 0.22 [a,b] | 0.27 [a] | 0.22 | 0.98 | 0.96 | 0.02 | 16.56 | 10.00 |
| | | | Female | 1,388 | 0.06 | 0.19 [a] | 0.20 [b] | 0.34 [a] | 0.25 | | | | | |
| | Cigarettes | Full Sample | | 2,968 | 0.09 [a] | 0.01 | -0.05 | 0.60 [a] | 0.40 | 1.00 | 1.00 | 0.00 | 0.82 | 1.00 |
| | | Gender | Male | 1,528 | 0.10 [a] | 0.00 | -0.06 [a,b] | 0.60 [a] | 0.41 | 0.98 | 0.96 | 0.03 | 27.22 | 11.00 |
| | | | Female | 1,388 | 0.09 [a] | 0.00 | -0.07 [b] | 0.60 [a] | 0.40 | | | | | |
| 10th-12th | Alcohol | Full Sample | | 2,363 | -0.01 | 0.00 | -0.05 | 0.54 [a] | 0.29 | 0.99 | 0.93 | 0.04 | 4.95 | 1.00 |
| | | Gender | Male | 1,152 | 0.01 | 0.04 [b] | -0.05 [b] | 0.53 [a] | 0.30 | 0.99 | 0.97 | 0.03 | 11.17 | 6.00 |
| | | | Female | 1,170 | 0.01 | -0.11 [a,b] | -0.05 [b] | 0.54 [a] | 0.25 | | | | | |
| | Marijuana | Full Sample | | 2,365 | 0.09 [a] | 0.03 | 0.06 | 0.63 [a] | 0.45 | 1.00 | 0.97 | 0.03 | 3.08 | 1.00 |
| | | Gender | Male | 1,154 | 0.08 [a] | 0.09 [b] | 0.10 [b] | 0.62 [a] | 0.47 | 0.99 | 0.96 | 0.03 | 15.62 | 7.00 |
| | | | Female | 1,170 | 0.11 [a] | -0.14 [a,b] | -0.05 [b] | 0.66 [a] | 0.42 | | | | | |
| | Cigarettes | Full Sample | | 2,365 | 0.05 | -0.01 | 0.02 | 0.74 [a] | 0.56 | 1.00 | 1.01 | 0.00 | 0.25 | 1.00 |
| | | Gender | Male | 1,154 | 0.06 [a] | 0.06 [b] | 0.03 [b] | 0.74 [a] | 0.59 | 0.99 | 0.97 | 0.03 | 21.22 | 10.00 |
| | | | Female | 1,170 | 0.06 [a] | -0.14 [a,b] | -0.08 [b] | 0.77 [a] | 0.56 | | | | | |

[a] $p < .05$

[b] estimates were significantly different across groups, $p < .05$

Table 11. Original and harmonized items in Monitoring the Future and SCHOO-BE samples

| Construct | MTF item text | SCHOO-BE item text | MTF scale | SCHOO-BE scale | Harmonized scale |
|---|---|---|---|---|---|
| Depressive Symptoms | How much do you agree or disagree with the following statements? | Now or within the past six months… | 1 = "disagree"<br>2 = "mostly disagree"<br>3 = "neither"<br>4 = "mostly agree"<br>5 = "agree" | 0 = "not true"<br>1 = "sometimes/ somewhat true"<br>2 = "very true/often true" | 0 = "no"<br>1 = "yes" |
| | I enjoy life as much as anyone | there is very little he/she enjoys | | | |
| | It feels good to be alive | unhappy, sad, or depressed | | | |
| | I feel I am a person of worth, on an equal plane with others | feels worthless or inferior | | | |
| Conduct Problems | In the past 12 months, how often have you… | Circle the number that best describes your behavior over the past 6 months | 1 = "never"<br>2 = "once"<br>3 = "twice"<br>4 = "3 or 4 times"<br>5 = "5 or more times" | 0 = "never or rarely"<br>1 = "sometimes"<br>2 = "often"<br>3 = "very often" | 0 = "no"<br>1 = "yes" |
| | gotten into a serious fight at work or school | initiates physical fights | | | |
| | hurt someone badly enough to need bandages or a doctor | has been physically cruel to people | | | |
| | stolen something worth $50 or more | stolen items of nontrivial value without confronting a victim | | | |

| | | | | | |
|---|---|---|---|---|---|
| | damaged school property on purpose | has deliberately destroyed others' property (other than by firesetting) | | | |
| Alcohol Use | On how many occasions have you had alcoholic beverages to drink--more than just a few sips--during the past 12 months? | Higher of responses to two items:<br>When was the last time you did this? Drank hard liquor or mixed drinks? / Drank beer, wine, or wine coolers? | 1 = “never”<br>2 = "1-2"<br>3 = "3-5"<br>4 = "6-9"<br>5= "10-19"<br>6 = "20-39"<br>7 = "40 or more" | 1 = “never”<br>2 = "more than a year ago"<br>3 = "in the past year"<br>4 = "in the past month"<br>5 = "in the past week” | 0 = "never"<br>1 = "past year"<br>2 = "1 year ago or more"<br>3 = "past month"<br>4 = "past week" |
| Marijuana Use | On how many occasions (if any) have you used marijuana (weed, pot) or hashish (hash, hash oil) during the last 12 months? | When was the last time you did this? Used marijuana? | 1 = “never”<br>2 = "1-2"<br>3 = "3-5"<br>4 = "6-9"<br>5= "10-19"<br>6 = "20-39"<br>7 = "40 or more" | 1 = “never”<br>2 = "more than a year ago"<br>3 = "in the past year"<br>4 = "in the past month"<br>5 = "in the past week” | 0 = "never"<br>1 = "past year"<br>2 = "1 year ago or more"<br>3 = "past month"<br>4 = "past week" |
| Parent Support | If you were having problems in your life, do you think you would talk them over with one or both of your parents?” | Some kids can count on their family for help or advice when they have problems, but other kids cannot. Can you count on your family for help or advice when you have problems? | 1 = “no”<br>2 = "yes for at least some of my problems"<br>3 = “yes for most or all of my problems" | 1 = "always"<br>2 = "most of the time"<br>3 = "sometimes"<br>4 = "hardly ever"<br>5 = "never" | 0 = "no"<br>1 = "sometimes"<br>2 = "yes" |

Table 12. Means and standard deviations of analysis items across two samples

| Construct | Items | Scale | MTF ($N$ = 2123) M (SD) | SCHOO-BE ($N$ = 432) M (SD) |
|---|---|---|---|---|
| Parental Support | Can talk to parents about problems | 0 = no, 1 = sometimes, 2= yes | .92 (.74) | 1.80 (.47) |
| Depressive Symptoms | 1. Very little I enjoy | 0 = no, 1 = yes | .21 (.40) | .27 (.44) |
| | 2. Feeling sad | 0 = no, 1 = yes | .16 (.37) | .03 (.17) |
| | 3. Feeling worthless | 0 = no, 1 = yes | .26 (.44) | .13 (.34) |
| Conduct Problems | 1. Initiates fights | 0 = no, 1 = yes | .30 (.46) | .13 (.33) |
| | 2. Hurts people | 0 = no, 1 = yes | .21 (.41) | .08 (.28) |
| | 3. Steals | 0 = no, 1 = yes | .11 (.31) | .04 (.20) |
| | 4. Damages property | 0 = no, 1 = yes | .17 (.37) | .07 (.25) |
| Alcohol Use | Last time used alcohol | 0 = never - 4 = past week | .83 (1.01) | .29 (.74) |
| Marijuana Use | Last time used marijuana | 0 = never - 4 = past week | .38 (.84) | .23 (.69) |

Table 13. Zero-order correlations of Chapter 4 variables

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Conduct problems | -- | .35* | .13* | .13* | -0.08 |
| 2. Depressive symptoms | .14* | -- | .12* | .18* | -0.16* |
| 3. Alcohol use | .35* | .08* | -- | .40* | -0.13* |
| 4. Marijuana use | .32* | .10* | .45* | -- | -0.13* |
| 5. Parental and family support | -.13* | -.16* | -.11* | -.09* | -- |

*Note*. Correlations below the diagonal refer to the MTF sample; correlations above the diagonal refer to the SCHOO-BE sample. Conduct problems and depressive symptoms reflect the mean of the 3 (depressive symptoms) or 4 (conduct problems) items used to measure that construct.

* $p < .05$

Table 14. Estimates and equivalence of variable means and variances in multiple group structural equation models, Chapter 4

| | | Parent Support | | Depressive Symptoms (DS) | | Conduct Problems (CP) | | Substance Use (Alcohol or Marijuana) | |
|---|---|---|---|---|---|---|---|---|---|
| Model | Group | Mean | Variance | Mean | Variance | Mean | Variance | Mean | Variance |
| Alcohol | MTF | 0.94 [a] | 0.53 [a] | 0.12 | 0.15 | 0.22 | 0.54 | 0.80 [a] | 1.01 [a] |
| | SCHOO-BE | 1.81 [a] | 0.23 [a] | -0.21 | 0.15 | -0.30 | 0.53 | 0.44 [a] | 0.55 [a] |
| Marijuana | MTF | 0.94 [a] | 0.53 [a] | 0.11 | 0.16 | 0.14 | 0.55 | 0.38 [a] | 0.70 [a] |
| | SCHOO-BE | 1.80 [a] | 0.24 [a] | -0.22 | 0.16 | -0.33 | 0.54 | 0.20 [a] | 0.47 [a] |

[a] estimates were significantly different across groups, $p < .01$

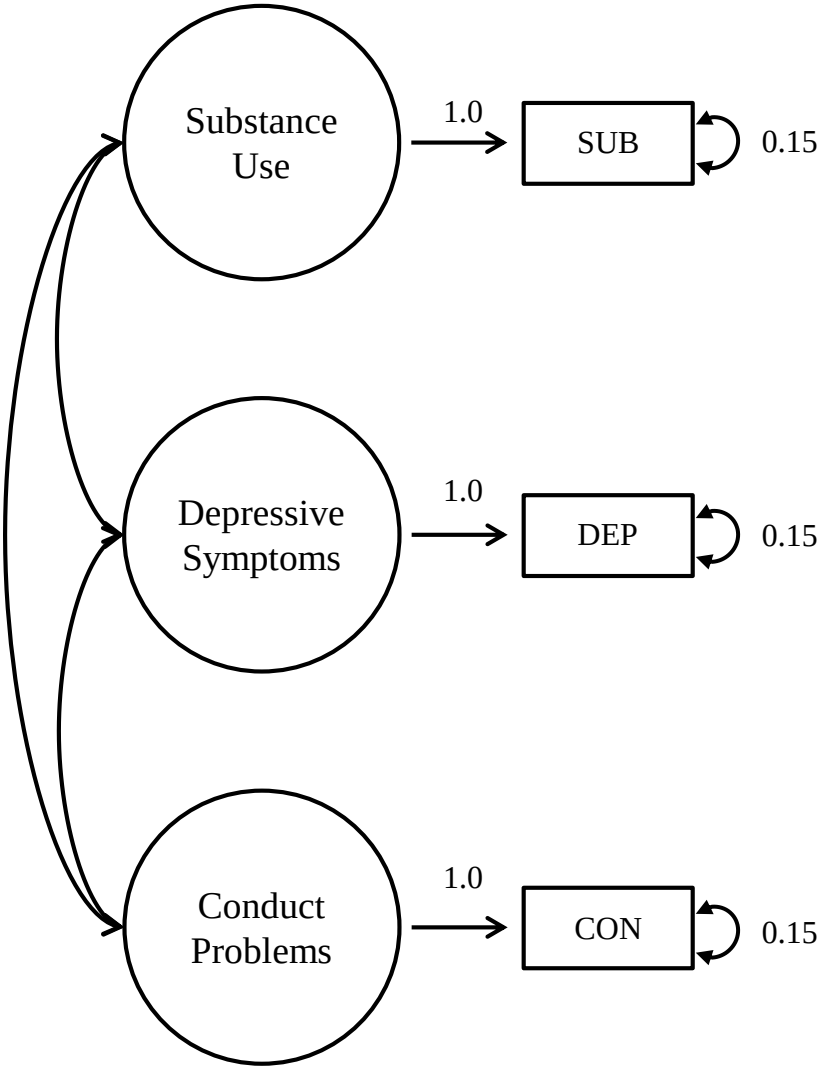



Figure 1. Measurement model.
Each latent variable was created using a single indicator of that construct. Single, rather than multiple, indicators were necessary in order for models to converge. Unique variance for each single indicator was fixed at 15%. A separate measurement model was estimated for each substance: alcohol, marijuana, and cigarettes.

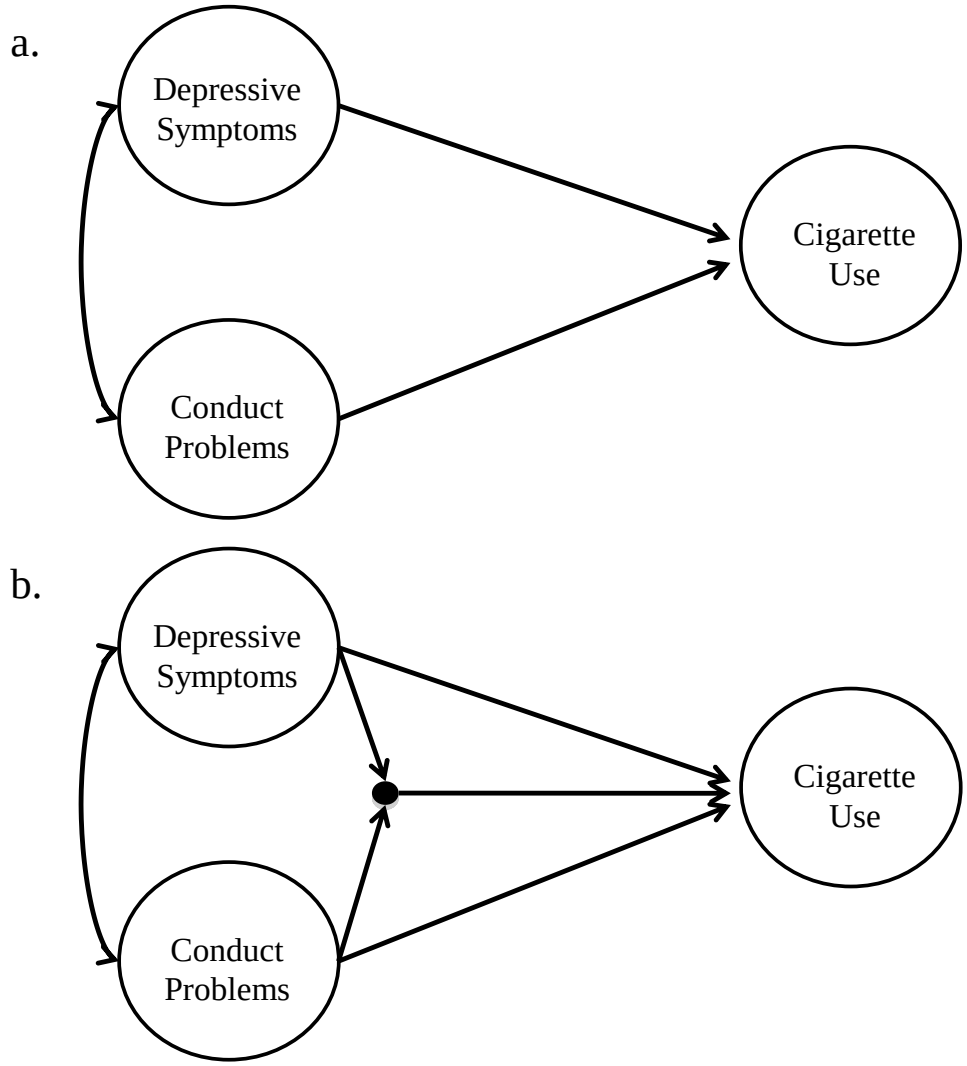



Figure 2. Analytic models 1 and 2
a. Model 1: Model with main effects of depressive symptoms and conduct problems predicting substance use. Each substance (alcohol, marijuana, cigarettes) was modeled separately as the dependent variable. b. Model 2: Model including the latent interaction of depressive symptoms x conduct problems, depicted as a filled circle per Mplus standard notation. A third model was included in multiple group comparisons. In this model, the effect of the latent interaction was allowed to vary freely across groups, whereas it was constrained to be equal across groups in Model 2. Each substance (alcohol, marijuana, cigarettes) was modeled separately as the dependent variable.

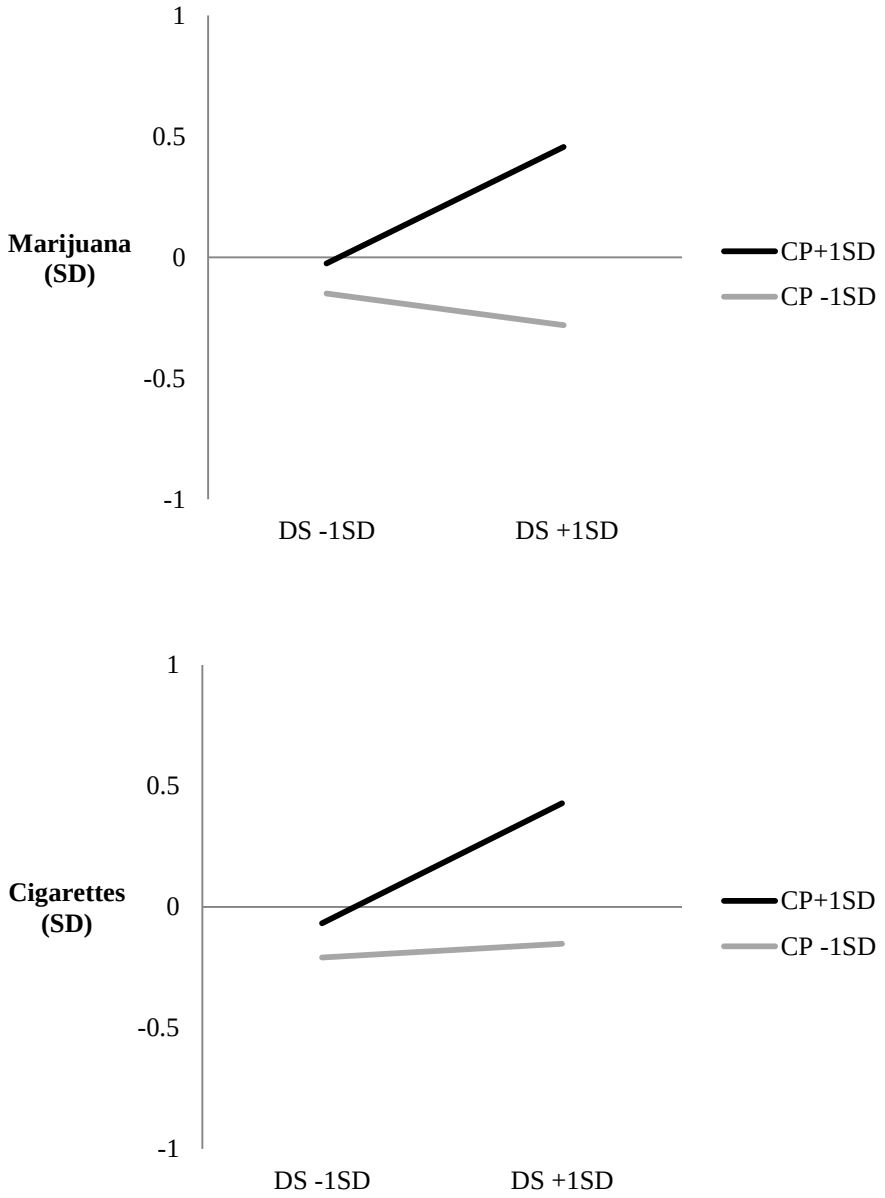



Figure 3. Interaction of depressive symptoms and conduct problems in total sample Interaction of depressive symptoms (DS) and conduct problems (CP) predicting a) marijuana (B = .25, $p < .001$), and b) cigarette use (B = .18, $p < .001$) during the past 30 days in the full sample of 8$^{th}$, 10$^{th}$, and 12$^{th}$ grade students combined. The effect of the interaction was not significant in relation to alcohol use.

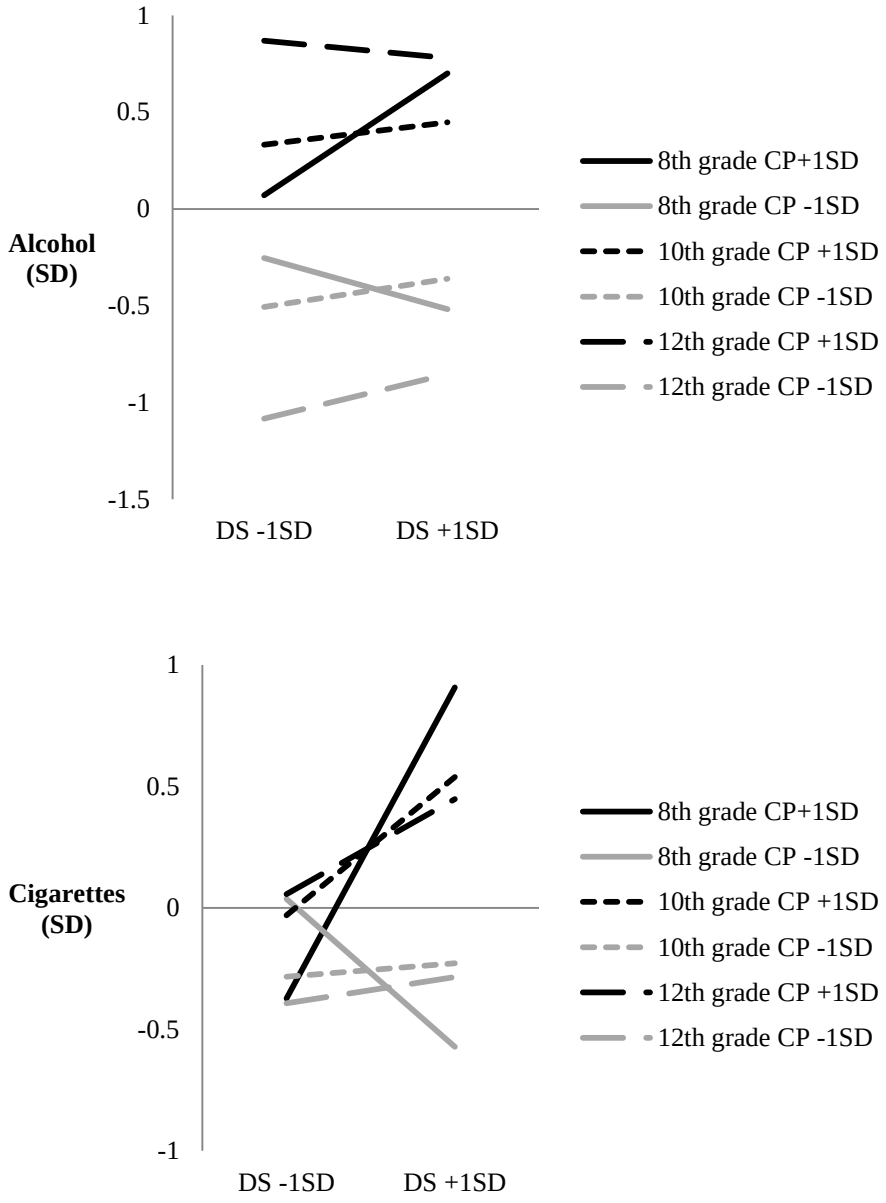



Figure 4. Interaction of depressive symptoms and conduct problems by grade
Models predicting (a) alcohol ($8^{th}$ grade: B = .24, $p < .001$; $10^{th}$ grade: B = -.01, ns; $12^{th}$ grade: B = -.08, $p < .001$) and (b) cigarette use ($8^{th}$ grade: B = .43, $p < .001$; $10^{th}$ grade: B = .16, $p < .001$; $12^{th}$ grade: B = .13, $p < .001$) during the past 30 days in multiple group models by grade. The effect of the interaction in relation to marijuana use did not differ significantly by grade.

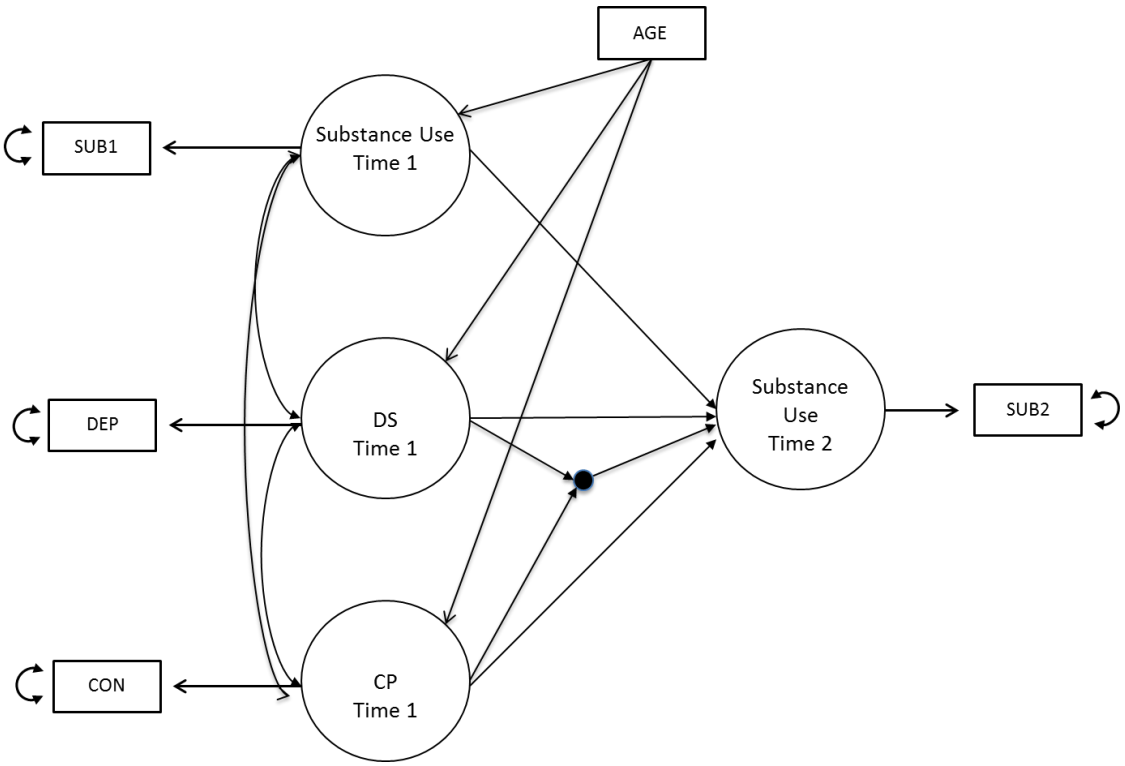
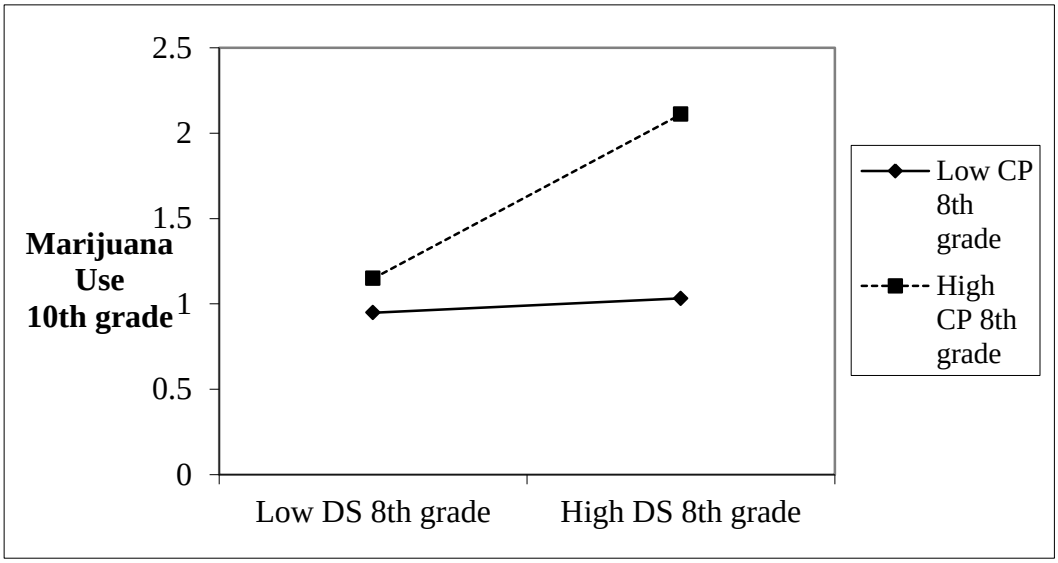



Figure 5. Analytic model of mental health problems predicting substance use in adolescence

Filled circle represents latent interaction term, per Mplus standard notation. DS = Depressive symptoms; CP = Conduct problems.

a




b

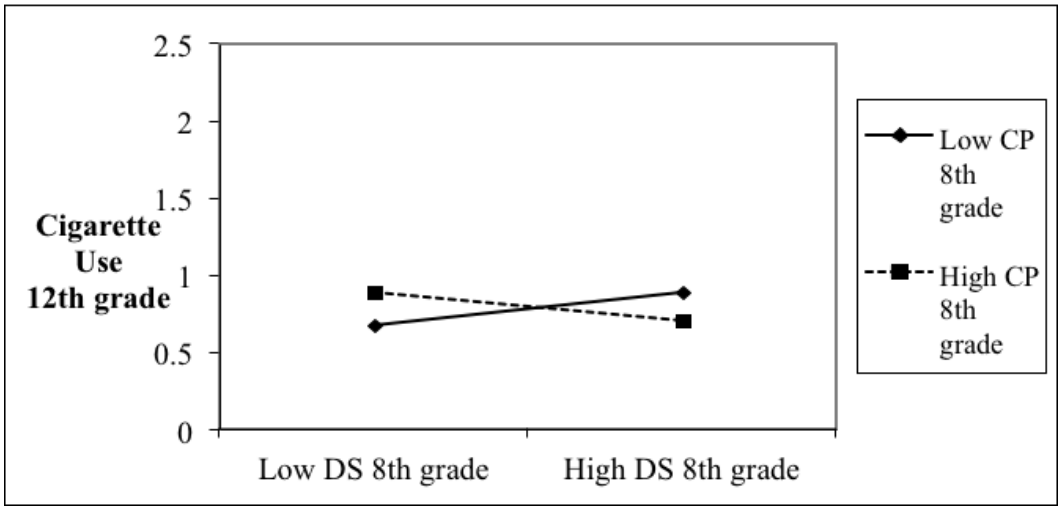



Figure 6. Interaction of 8th grade depressive symptoms and conduct problems

Interaction of 8th grade depressive symptoms (DS) and conduct problems (CP) predicting a) marijuana use in 10th grade, and b) cigarette use in 12th grade among the total sample of adolescents.

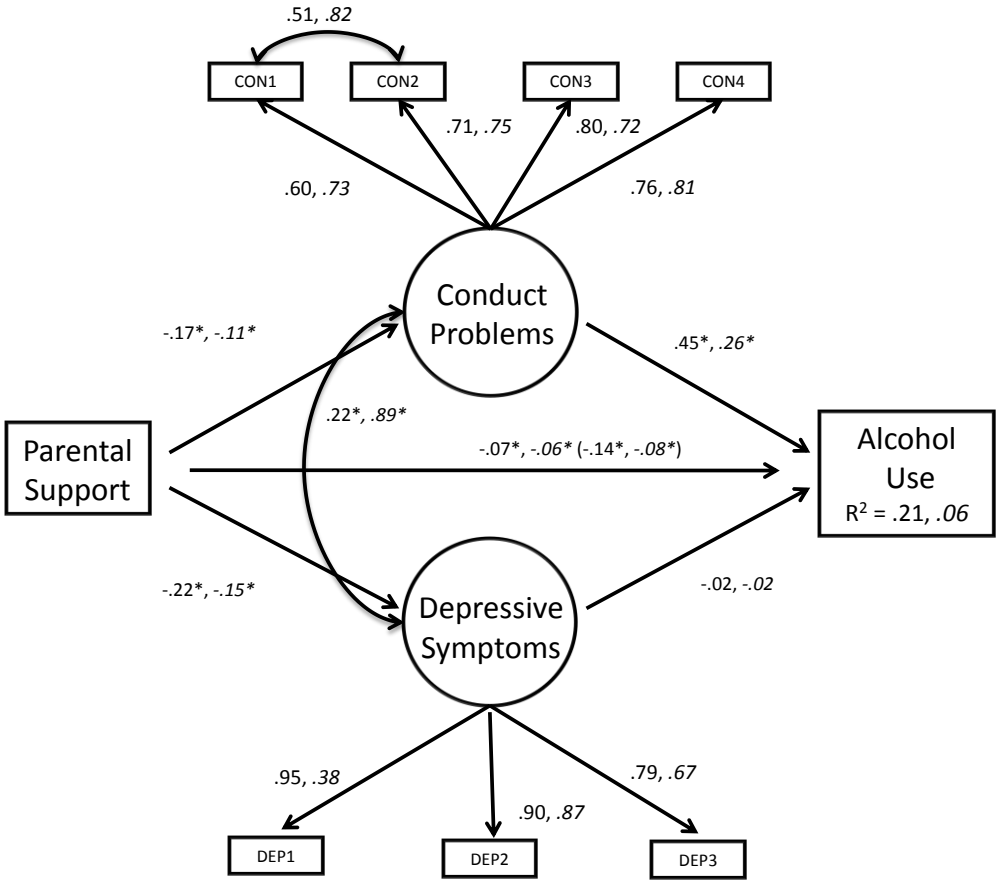



Figure 7. Multiple group structural equation model testing mediation of the relation of parent support to alcohol use among African American adolescents.
*N* = 2102 (MTF), *N*= 432 (SCHOO-BE) $X^2$ (55) = 101.9, p < .001, CFI = .99, TLI = .99, RMSEA = .03. Coefficients in italics refer to the SCHOO-BE sample; Roman font coefficients refer to the MTF sample. Standardized coefficients are presented. Numbers in parentheses indicate the main effect of parental support on alcohol use before adding mediators to the model. All factor loadings and all path coefficients with the exception of conduct problems to alcohol use are constrained to be equal across data sets at the unstandardized level; apparent differences are due to standardization. * $p$<.05

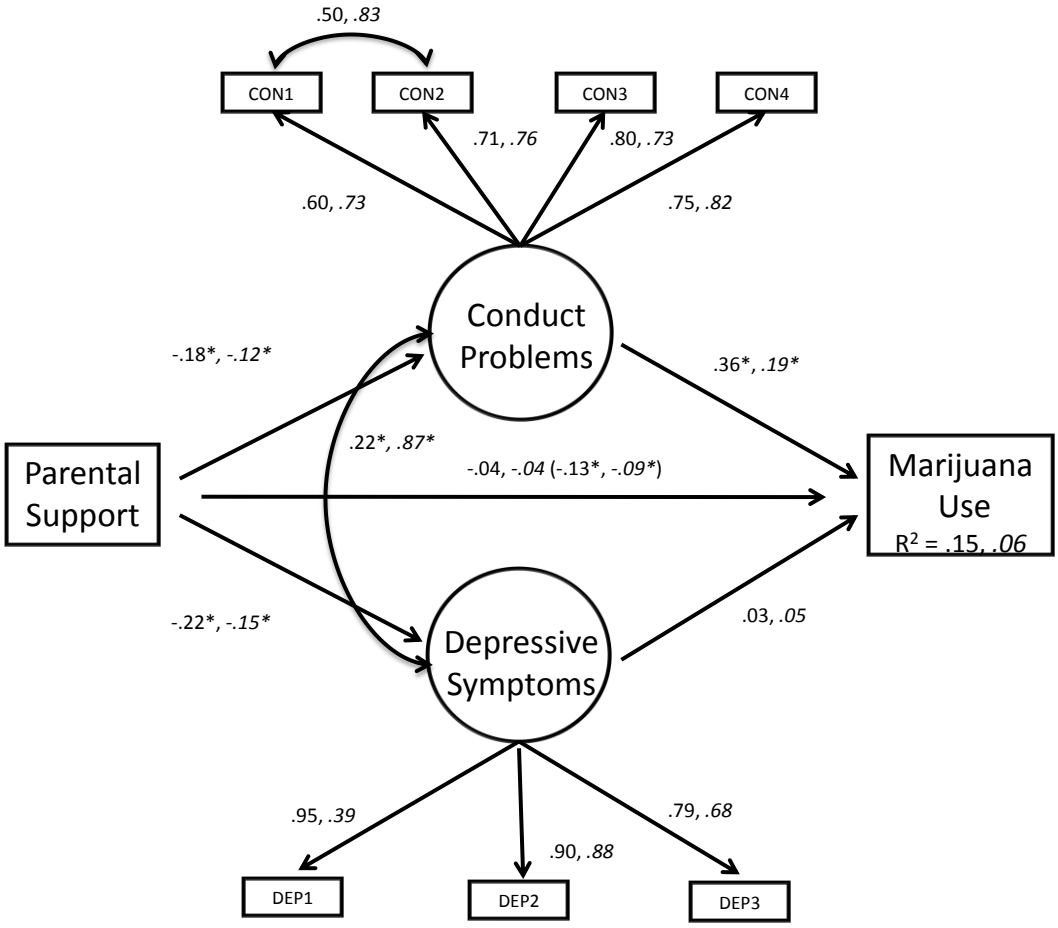



Figure 8. Multiple group structural equation model testing mediation of the relationship of parental support to marijuana use among African American adolescents
*N* = 2117 (MTF), *N*= 432 (SCHOO-BE) $X^2$ (55) = 94.6, p < .001, CFI = .99, TLI = .99, RMSEA = .02. Coefficients in italics refer to the SCHOO-BE sample; Roman font coefficients refer to the MTF sample. Standardized coefficients are presented. Numbers in parentheses indicate the main effect of parental support on marijuana use before adding mediators to the model. All factor loadings and all path coefficients with the exception of conduct problems to marijuana use are constrained to be equal across data sets at the unstandardized level; apparent differences are due to standardization. * *p*<.05

References

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA School-Age forms & profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Alpert, J. E., Fava, M., Uebelacker, L. A., Nierenberg, A. A., Pava, J. A., Worthington, J., & Rosenbaum, J. F. (1999). Patterns of Axis I comorbidity in early-onset versus late-onset major depressive disorder. *Biological Psychiatry, 46*(2), 202-211. doi:10.1016/S0006-3223(99)00017-7

Angold, A., Costello, E. J., & Erkanli, A. (1999). Comorbidity. *Journal of Child Psychology and Psychiatry*, *40*(1), 57–87.

Armstrong, T. D., & Costello, E. (2002). Community studies on adolescent substance use, abuse, or dependence and psychiatric comorbidity. *Journal of Consulting and Clinical Psychology, 70*(6), 1224-1239. doi:10.1037/0022-006X.70.6.1224

Aseltine, R. H., Jr, Gore, S., & Colten, M. E. (1998). The co-occurrence of depression and substance abuse in late adolescence. *Development and Psychopathology, 10*(3), 549-570. doi:10.1017/S0954579498001746

Bachman, J. G., Johnston, L. D., O'Malley, P. M., & Schulenberg, J. E. (2011). The Monitoring the Future project after thirty-seven years: Design and procedures (Monitoring the Future Occasional Study No. 76). Ann Arbor, MI: University of Michigan.

Bachman, J. G., O'Malley, P. M., Johnston, L. D., Rodgers, W. L., Schulenberg, J. E., Lim, J., & Wadsworth, K. N. (1996). *Changes in drug use during ages 18-32* (Monitoring the Future Occasional Paper No. 39.) Ann Arbor, MI: Institute for Social Research.

Bachman, J. G., O'Malley, P. M., Johnston, L. D., Schulenberg, J. E., & Wallace, J. M., Jr. (2011). Racial/ethnic differences in the relationship between parental education and substance use among U.S. 8th-, 10th-, and 12th-grade students: Findings from the Monitoring the Future project. *Journal of Studies on Alcohol and Drugs 72*(2):279-85.

Bachman, J. G., O'Malley, P. M., Schulenberg, J. E., Johnston, L. D., Freedman-Doan, P., & Messersmith, E. E. (2008). *The education-drug use connection: How successes and failures in school relate to adolescent smoking, drinking, drug use, and delinquency*. New York: Lawrence Erlbaum Associates/Taylor & Francis.

Barnes, G. M., Reifman, A. S., Farrell, M. P., & Dintcheff, B. A. (2000). The effects of parenting on the development of adolescent alcohol misuse: A six-wave latent growth model. *Journal of Marriage and the Family, 62*(1), 175-186. doi:10.1111/j.1741-3737.2000.00175.x

Bauer, D. J. & Hussong, A. M. (2009). Psychometric approaches for developing commensurate measures across independent studies: traditional and new models. *Psychological Methods, 14*, 101-125.

Birmaher, B., Ryan, N. D., Williamson, D. E., & Brent, D. A. (1996). Childhood and adolescent depression: A review of the past 10 years, Part I. *Journal of the American Academy of Child & Adolescent Psychiatry*, *35*(11), 1427-1439. doi:10.1097/00004583-199611000-00011

Bonnie, R. J., & O'Connell, M. E. (Eds) (2004). *Reducing underage drinking: A collective responsibility*. Washington, DC: National Academies Press.

Boys, A., Farrell, M., Taylor, C., Marsden, J., Goodman, R., Brugha, T., … Meltzer, H. (2003). Psychiatric morbidity and substance use in young people aged 13-15 years: Results from the Child and Adolescent Survey of Mental Health. *British Journal of Psychiatry, 182*, 509-517. doi:10.1192/bjp.182.6.509

Breslau, J., Aguilar-Gaxiola, S., Kendler, K. S., Su, M., Williams, D., & Kessler, R. C. (2006). Specifying race-ethnic differences in risk for psychiatric disorder in a USA national sample. *Psychological Medicine, 36*, 57-68. doi:10.1017/S0033291705006161

Brody, G. H., Ge, X., Kim, S., Murry, V., Simons, R. L., Gibbons, F. X., & ... Conger, R. D. (2003). Neighborhood disadvantage moderates associations of parenting and older sibling problem attitudes and behavior with conduct disorders in African American children. *Journal of Consulting and Clinical Psychology, 71*(2), 211-222. doi:10.1037/0022-006X.71.2.211

Brody, G. H., McBride, V., Gerrard, M., Gibbons, F. X., McNair, L., Brown, A. C., … Chen, Y., (2006). The Strong African American Families Program: Prevention of youths' high-risk behavior and a test of a model of change. *Journal of Family Psychology, 20*, 1-11. doi:10.1037/0893-3200.20.1.1

Brook, D. W., Brook, J. S., Zhang, C., Cohen, P., & Whiteman, M. (2002). Drug use and the risk of major depressive disorder, alcohol dependence and substance use disorders. *Archives of General Psychiatry, 59*(11), 1039-1044. doi:10.1001/archpsyc.59.11.1039

Brook, J. S., Balka, E. B., & Whiteman, M. (1999). The risks for late adolescence of early adolescent marijuana use. *American Journal of Public Health*, *89*(10), 1549-1554. doi:10.2105/AJPH.89.10.1549

Brook, J. S., Zhang, C., & Brook, D. W. (2011). Developmental trajectories of marijuana use from adolescence to adulthood: Personal predictors. *Archives of Pediatrics & Adolescent Medicine*, *165*(1), 55-60.

Brooks-Gunn, J., Phelps, E., & Elder, G. H. (1991). Studying lives through time: Secondary data analyses in developmental psychology. *Developmental Psychology*, *27*(6), 899-910. doi:10.1037/0012-1649.27.6.899

Buchanan, R., & Smokowski, P. (2009). Pathways from acculturation stress to substance use among Latino adolescents. *Substance Use and Misuse*, *44*(5), 740-762. doi:10.1080/10826080802544216

Buka, S. L. (2005). Developmental epidemiology: The role of developmental psychology for public health in the 21st century. In D. B. Pillemer, S. H. White, D. B. Pillemer, S. H. White (Eds.), *Developmental psychology and social change: Research, history and policy* (pp. 173-202). New York, NY US: Cambridge University Press.

Burlew, A. K. (2002). Research with ethnic minorities: Conceptual, methodological, and analytical issues. In G. Bernal, J. E. Trimble, A. K. Burlew, & F. T. L. Leong (Eds.) *Handbook of racial and ethnic minority psychology,* pp. 179-197. Thousand Oaks, CA: Sage.

Caldwell, C. H., Sellers, R. M., Bernat, D. H., & Zimmerman, M. A. (2004). Racial identity, parental support, and alcohol use in a sample of academically at-risk African-American high school students. *American Journal of Community Psychology, 34,* 71-82. doi:10.1023/B:AJCP.0000040147.69287.f7

Capaldi, D. M. (1991). Co-occurrence of conduct problems and depressive symptoms in early adolescent males: I. Familial factors and general adjustment at Grade 6. *Development and Psychopathology*, *3*(3), 277-300. doi:10.1017/S0954579400005319

Capaldi, D. M. (1992). Co-occurrence of conduct problems and depressive symptoms in early adolescent males: II. A 2-year follow-up at Grade 8. *Development and Psychopathology*, *4*(1), 125-144. doi:10.1017/S0954579400005605

Capaldi, D. M., & Stoolmiller, M. (1999). Co-occurrence of conduct problems and depressive symptoms in early adolescent males: III. Prediction to young-adult adjustment. *Development and Psychopathology*, *11*(1), 59-84. doi:10.1017/S0954579499001959

Chen, R., & Simons-Morton, B. (2009). Concurrent changes in conduct problems and depressive symptoms in early adolescents: A developmental person-centered approach. *Development and Psychopathology*, *21*(1), 285-307. doi:10.1017/S0954579409000169

Cicchetti, D. (1993). Developmental psychopathology: Reactions, reflections, projections. *Developmental Review, 13,* 471-502. doi:10.1006/drev.1993.1021

Cicchetti, D., & Rogosch, F. A. (1999). Psychopathology as risk for adolescent substance use disorders: A developmental psychopathology perspective. *Journal of Clinical Child Psychology, 28*(3), 355-365. doi:10.1207/S15374424jccp280308

Cicchetti, D., & Rogosch, F. A. (1996). Equifinality and multifinality in developmental psychopathology. *Development and Psychopathology, 8*(4), 597-600. doi:10.1017/S0954579400007318

Cleveland, M. J., Gibbons, F. X., Gerrard, M., Pomery, E. A., & Brody, G. H. (2005). The impact of parenting on risk cognitions and risk behavior: A study of mediation and moderation in a panel of African American adolescents. *Child Development, 76*, 900-916. doi:10.1111/j.1467-8624.2005.00885.x

Cohen, J. (1994). The earth is round ($p < .05$). *American Psychologist*, *49*(12), 997-1003. doi:10.1037/0003-066X.49.12.997

Cohen, P., Cohen, J., Kasen, S., & Velez, C. N. (1993). An epidemiological study of disorders in late childhood and adolescence: I. Age- and gender-specific prevalence. *Journal of Child Psychology and Psychiatry*, *34*(6), 851–867. doi:10.1111/j.1469-7610.1993.tb01094.x

Costello, E. J., & Angold, A. (2006). Developmental epidemiology. In D. Cicchetti, & D. J. Cohen (Eds), *Developmental psychopathology, Volume 1: Theory and method (2nd ed.).* (pp. 41–75). Hoboken, NJ, US: John Wiley & Sons Inc.

Costello, E., Erkanli, A., Federman, E., & Angold, A. (1999). Development of psychiatric comorbidity with substance abuse in adolescents: Effects of timing and sex. *Journal of Clinical Child Psychology*, *28*(3), 298-311. doi:10.1207/S15374424jccp280302

Crosnoe, R. (2011). *Fitting in, standing out: Navigating the social challenges of high school to get an education*. Cambridge University Press: New York.

Curran, P. J., Hussong, A. M., Cai, L., Huang, W., Chassin, L., Sher, K. J., & Zucker, R. A. (2008). Pooling data from multiple longitudinal studies: The role of item response theory in integrative data analysis. *Developmental Psychology*, *44*(2), 365-380. doi:10.1037/0012-1649.44.2.365

D'Orazio, M., Di Zio, M., & Scanu, M. (2006). *Statistical matching: Theory and practice.* Hoboken, NJ: Wiley.

Dauber, S., Hogue, A., Paulson, J. F., & Leiferman, J. A. (2009). Typologies of alcohol use in White and African American adolescent girls. *Substance Use and Misuse, 44*(8), 1121-1141. doi:10.1080/10826080802494727

Deas, D., & Brown, E. (2006). Adolescent substance abuse and psychiatric comorbidities. *Journal of Clinical Psychiatry*, *67*(7), e02.

Delaney-Black, V., Covington, C., Templin, T., Ager, J., Nordstrom-Klee, B., Martier, S., … Sokol, R. J. (2000). Teacher-assessed behavior of children prenatally exposed to cocaine. *Pediatrics, 106,* 782-791.

DeWit, D. J., Adlaf, E. M., Offord, D. R., & Ogborne, A. C. (2000). Age at first alcohol use: A risk factor for the development of alcohol use disorders. *American Journal of Psychiatry, 157*, 745-750. doi:10.1176/appi.ajp.157.5.745

Deykin, E. Y., Levy, J. C., & Wells, V. (1987). Adolescent depression, alcohol and drug abuse. *American Journal of Public Health*, *77*(2), 178–182.

di Cindio, L. A., Floyd, H., Wilcox, J., & McSeveney, D. R. (1983). Race effects in a model of parent–peer orientation. *Adolescence*, *18*(70), 369-379.

Dierker, L. C., Vesel, F., Sledjeski, E. M., Costello, D., & Perrine, N. (2007). Testing the dual pathway hypothesis to substance use in adolescence and young adulthood. *Drug and Alcohol Dependence, 87*(1), 83-93. doi:10.1016/j.drugalcdep.2006.08.001

Dodge, K. A., Malone, P. S., Lansford, J. E., Miller, S., Pettit, G. S., & Bates, J. E. (2009). A dynamic cascade model of the development of substance-use onset. *Monographs of the Society for Research in Child Development, 74*(3), vii–119. doi:10.1111/j.1540-5834.2009.00528.x

Dubow, E. F., & Ullman, D. G. (1989). Assessing social support in elementary school children: The Survey of Children's Social Support. *Journal of Clinical Child Psychology, 18*(1), 52-64. doi:10.1207/s15374424jccp1801_7

DuRant, R. H., Smith, J. A., Kreiter, S. R., & Krowchuk, D. P. (1999). The relationship between early age of onset of initial substance use and engaging in multiple health risk behaviors among young adolescents. *Archives of Pediatric and Adolescent Medicine, 153*(3), 286–291. doi:10.1001/archpedi.153.3.286

Ellickson, S. L., Tucker, J. S., Klein, D. J., & McGuigan, K. A. (2001). Prospective risk factors for alcohol misuse in late adolescence. *Journal of Studies on Alcohol, 62*(6), 773-782.

Fang, L., & Schinke, S. P. (2011). Alcohol use among Asian American adolescent girls: The impact of immigrant generation status and family relationships. *Journal of Ethnicity in Substance Abuse, 10*(4), 275-294. doi:10.1080/15332640.2011.623484

Fergusson, D. M., Horwood, L., & Swain-Campbell, N. (2002). Cannabis use and psychosocial adjustment in adolescence and young adulthood. *Addiction, 97*(9), 1123-1135. doi:10.1046/j.1360-0443.2002.00103.x

Fite, P. J., Colder, C. R., & O'Connor, R. M. (2006). Childhood behavior problems and peer selection and socialization: Risk for adolescent alcohol use. *Addictive Behaviors, 31*(8), 1454-1459. doi:10.1016/j.addbeh.2005.09.015

Fleisher, W. P., & Katz, L. Y. (2001). Early onset major depressive disorder. *Paediatrics & Child Health, 6*(7), 444–448.

Flory, K., Brown, T. L., Lynam, D. R., Miller, J. D., Leukefeld, C. & Clayton, R. R. (2006). Developmental patterns of African American and Caucasian adolescents' alcohol use. *Cultural Diversity and Ethnic Minority Psychology, 12,* 740-746. doi:10.1037/1099-9809.12.4.740

Foster, S. E., Zalot, A. A., & Jones, D. J. (2007). Cigarette smoking among African American youth from single mother homes: Examining the roles of maternal smoking and positive parenting within an extended family framework. *International Journal of Behavioral Consultation and Therapy, 3,* 251-265.

Galea, S., Nandi, A., & Vlahov, D. (2004). The social epidemiology of substance use. *Epidemiologic Reviews, 26,* 36-52.

Garmezy, N., Masten, A. S., & Tellegen, A. (1984). The study of stress and competence in children: A building block for developmental psychopathology. *Child Development, 55,* 97-111. doi:10.2307/1129837

Gibbons, F. X., Reimer, R. A., Gerrard, M., Yeh, H. C., Houlihan, A. E., Cutrona, C., … Brody, G. (2007). Rural-urban differences in substance use among African-American adolescents. *Journal of Rural Health, 23,* 22-28. doi:10.1111/j.1748-0361.2007.00120.x

Giordano, P. C., Cernkovich, S. A., & DeMaris, A. (1993). The family and peer relations of black adolescents. *Journal of Marriage and Family, 55,* 277-287. *doi:10.2307/352801*

Glantz, M. D., Anthony, J. C., Berglund, P. A., Degenhardt, L., Dierker, L., Kalaydjian, A., & … Kessler, R. C. (2009). Mental disorders as risk factors for later substance dependence: estimates of optimal prevention and treatment benefits. *Psychological Medicine, 39*(8), 1365–1377. doi:10.1017/S0033291708004510

Goodman, E., & Capitman, J. (2000). Depressive symptoms and cigarette smoking among teens. *Pediatrics, 106*(4), 748-755.

Gotlib, I. H., Lewinsohn, P. M., & Seeley, J. R. (1995). Symptoms versus a diagnosis of depression: Differences in psychosocial functioning. *Journal of Consulting and Clinical Psychology, 63*(1), 90-100. doi:10.1037/0022-006X.63.1.90

Grant, B. F., & Dawson, D. A. (1997). Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: Results from the National Longitudinal Alcohol Epidemiologic Survey. *Journal of Substance Abuse, 9,* 103-110. doi:10.1016/S0899-3289(97)90009-2

Hammen, C., Brennan, P. A., Keenan-Miller, D., & Herr, N. R. (2008). Early onset recurrent subtype of adolescent depression: Clinical and psychosocial correlates. *Journal of Child Psychology and Psychiatry, 49*(4), 433-440. doi:10.1111/j.1469-7610.2007.01850.x

Hankin, B. L., Abramson, L. Y., Moffitt, T. E., Silva, P. A., McGee, R., & Angell, K. E. (1998). Development of depression from preadolescence to young adulthood: Emerging gender differences in a 10-year longitudinal study. *Journal of Abnormal Psychology, 107*(1), 128-140. doi:10.1037/0021-843X.107.1.128

Henggeler, S. W., Melton, G. B., Brondino, M. J., Scherer, D. G., & Hanley, J. H. (1997). Multisystemic therapy with violent and chronic juvenile offenders and their families: The role of treatment fidelity in successful dissemination. *Journal of Consulting and Clinical Psychology, 65*(5), 821-833. doi:10.1037/002

Henry, B., Feehan, M., McGee, R., & Stanton, W. (1993). The importance of conduct problems and depressive symptoms in predicting adolescent substance use. *Journal of Abnormal Child Psychology, 21*(5), 469–480. doi:10.1007/BF00916314

Hingson, R. W., Heeren, T., Jamanka, A., & Howland, J. (2000). Age of drinking onset and unintentional injury involvement after drinking. *Journal of the American Medical Association, 284*(12), 1527-1533. doi:10.1001/jama.284.12.1527

Hinshaw, S. P. (1987). On the distinction between attentional deficits/hyperactivity and conduct problems/aggression in child psychopathology. *Psychological Bulletin, 101*(3), 443-463. doi:10.1037/0033-2909.101.3.443

Hooshmand, S., Willoughby, T., & Good, M. (2012). Does the direction of effects in the association between depressive symptoms and health-risk behaviors differ by behavior? A longitudinal study across the high school years. *Journal of Adolescent Health*, *50*(2), 140-147. doi:10.1016/j.jadohealth.2011.05.016

Howard, A. L., Bauer, D. J., Baldasaro, R., Curran, P. J., & Hussong, A. L. (under review). Combining mother and father reports of children's negative affect using integrative data analysis.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 357-373. doi:10.1080/10705519909540118

Husky, M. M., Sheridan, M., McGuire, L., & Olfson, M. (2011). Mental health screening and follow-up care in public high schools. *Journal of the American Academy of Child & Adolescent Psychiatry*, *50*(9), 881–891. doi:10.1016/j.jaac.2011.05.013

Hussong, A. M., Jones, D. J., Stein, G. L., Baucom, D. H., & Boeding, S. (2011). An internalizing pathway to alcohol use and disorder. *Psychology of Addictive Behaviors*, *25*(3), 390-404. doi:10.1037/a0024519

Ingoldsby, E. M., Kohl, G. O., McMahon, Robert J, & Lengua, L. (2006). Conduct problems, depressive symptomatology and their co-occurring presentation in childhood as predictors of adjustment in early adolescence. *Journal of Abnormal Child Psychology*, *34*(5), 603-621.

Institute of Medicine (1996). *Pathways of addiction: Opportunities in drug abuse research.* Washington, DC: National Academy Press.

Ioannidis, J. P. A. (2005). Why most published research findings are false. *PLoS Medicine, 2,* 696-701.

Jackson, K. M., Sher, K. J., & Schulenberg, J. E. (2008). Conjoint developmental trajectories of young adult substance use. *Alcoholism: Clinical and Experimental Research*, *32*(5), 723-737. doi:10.1111/j.1530-0277.2008.00643.x

Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2011). *Monitoring the Future national survey results on drug use, 1975-2010. Volume I: Secondary school students*. Ann Arbor: Institute for Social Research, The University of Michigan, 744 pp.

Jones, D. J., Hussong, A. M., Manning, J., & Sterrett, E. (2008). Adolescent alcohol use in context: The role of parents and peers among African American and European American youth. *Cultural Diversity and Ethnic Minority Psychology, 14*(3), 266-273. doi:10.1037/1099-9809.14.3.266

Jones, J. (1993). The concept of race in social psychology. In L. Wheler & P. Shaver (Eds.), *Review of personality and social psychology* (Vol. 4, pp. 117-150). Newbury Park, CA: Sage.

Kandel, D. B., Johnson, J. G., Bird, H. R., & Canino, G. (1997). Psychiatric disorders associated with substance use among children and adolescents: Findings from the Methods for the Epidemiology of Child and Adolescent Mental Disorders (MECA) Study. *Journal of Abnormal Child Psychology, 25*(2), 121-132. doi:10.1023/A:1025779412167

Keenan, K., Wroblewski, K., Hipwell, A., Loeber, R., & Stouthamer-Loeber, M. (2010). Age of onset, symptom threshold, and expansion of the nosology of conduct disorder for females. *Journal of Abnormal Psychology, 119*(4), 689-698. doi:10.1037/a0019346

Kellam, S. G., & Anthony, J. C. (1998). Targeting early antecedents to prevent tobacco smoking: Findings from an epidemiologically based randomized field trial. *American Journal of Public Health, 88*(10), 1490-1495.

Kellam, S. G., Brown, C. C. H. , Poduska, J. M., Ialongo, N. S., Wang, W., Toyinbo, P., & ... Wilcox, H. C. (2008). Effects of a universal classroom behavior management program in first and second grades on young adult behavioral, psychiatric, and social outcomes. *Drug and Alcohol Dependence, 95*(Suppl1), S5-S28. doi:10.1016/j.drugalcdep.2008.01.004

Kellam, S. G., Koretz, D., & Mościcki, E. K. (1999). Core elements of developmental epidemiologically based prevention research. *American Journal of Community Psychology, 27*(4), 463–482. doi:10.1023/A:1022129127298

Kenny, D. A., & Judd, C. M. (1984). Estimating the nonlinear and interactive effects of latent variables. *Psychological Bulletin, 96*(1), 201-210. doi:10.1037/0033-2909.96.1.201

Kessler, R. C., Avenevoli, S., McLaughlin, K. A., Green, J. G., Lakoma, M. D., Petukhova, M., Pine, D. S., et al. (2012). Lifetime co-morbidity of DSM-IV disorders in the US National Comorbidity Survey Replication Adolescent Supplement (NCS-A). *Psychological Medicine,* 1–14. doi:10.1017/S0033291712000025

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 593-602. doi:10.1001/archpsyc.62.6.593

King, S. M., Iacono, W. G., & McGue, M. (2004). Childhood externalizing and internalizing psychopathology in the prediction of early substance use. *Addiction, 99*(12), 1548-1559. doi:10.1111/j.1360-0443.2004.00893.x

Klein, A., & Moosbrugger, H. (2000). Maximum likelihood estimation of latent interaction effects with the LMS method. *Psychometrika, 65*(4), 457-474. doi:10.1007/BF02296338

Kleinbaum, D. G., Kupper, L. L., & Morgenstern, H. (1982). *Epidemiologic research: Principles and quantitative methods*. Hoboken, NJ: John Wiley and Sons.

Kline, R. B. (2004). *Principles and practice of structural equation modeling, Second edition*. New York: The Guilford Press.

Kovacs, M., Paulauskas, S., Gatsonis, C., & Richards, C. (1988). Depressive disorders in childhood. III. A longitudinal study of comorbidity with and risk for conduct disorders. *Journal of Affective Disorders, 15*(3), 205-217. doi:10.1016/0165-0327(88)90018-3

Kuperman, S., Schlosser, S. S., Kramer, J. R., Bucholz, K., Hesselbrock, V., Reich, T., Reich, W. (2001). Developmental sequence from disruptive behavior diagnosis to adolescent alcohol dependence. *American Journal of Psychiatry, 158,* 2022-2026. doi:10.1176/appi.ajp.158.12.2022

Lansford, J. E., Erath, S., Yu, T., Pettit, G. S., Dodge, K. A., & Bates, J. E. (2008). The developmental course of illicit substance use from age 12 to 22: Links with depressive, anxiety, and behavior disorders at age 18. *Journal of Child Psychology and Psychiatry, 49*(8), 877-885. doi:10.1111/j.1469-7610.2008.01915.x

Latimer, W. W., Stone, A. L., Voight, A., Winters, K. C., & August, G. J. (2002). Gender differences in psychiatric comorbidity among adolescents with substance use disorders. *Experimental and Clinical Psychopharmacology, 10*(3), 310-315. doi:10.1037/1064-1297.10.3.310

Lewinsohn, P. M., Clarke, G. N., Seeley, J. R., & Rohde, P. (1994). Major depression in community adolescents: Age at onset, episode duration, and time to recurrence. *Journal of the American Academy of Child and Adolescent Psychiatry, 33*(6), 809-818. doi:10.1097/00004583-199407000-00006

Lewinsohn, P. M., Rohde, P., & Seely, J. R. (1998). Major depressive disorder in older adolescents: Prevalence, risk factors, and clinical implications. *Clinical Psychology Review, 18*(7), 765-794. doi:10.1016/S0272-7358(98)00010-5

Lipsey, M. W., & Wilson, D. B. (1998). Effective intervention for serious juvenile offenders: A synthesis of research. In R. Loeber, D. P. Farrington, R. Loeber, D. P. Farrington (Eds.), *Serious & violent juvenile offenders: Risk factors and successful interventions* (pp. 313-345). Thousand Oaks, CA: Sage Publications, Inc.

Loeber, R., & Keenan, K. (1994). Interaction between conduct disorder and its comorbid conditions: Effects of age and gender. *Clinical Psychology Review, 14*(6), 497-523. doi:10.1016/0272-7358(94)90015-9

Loeber, R., Stouthammer-Loeber, M., & White, H. (1999). Developmental aspects of delinquency and internalizing problems and their association with persistent juvenile substance use between ages 7 and 18. *Journal of Clinical Child Psychology, 28*(3), 322-332. doi:10.1207/S15374424jccp280304

Maggs, J. L., & Schulenberg, J. E. (2005). Initiation and course of alcohol consumption among adolescents and young adults. In M. Galanter (Ed.), *Recent developments in alcoholism, Vol. 17: Alcohol problems in adolescents and young adults* (pp. 29–47). New York: Kluwer Academic/Plenum Publishing.

Maggs, J. L., Patrick, M. E., & Feinstein, L. (2008). Childhood and adolescent predictors of alcohol use and problems in adolescence and adulthood in the National Child Development Study. *Addiction*, *103*(Suppl1), 7-22. doi:10.1111/j.1360-0443.2008.02173.x

Marmorstein, N. R. (2010). Longitudinal associations between depressive symptoms and alcohol problems: The influence of comorbid delinquent behavior. *Addictive Behaviors*, *35*(6), 564-571. doi:10.1016/j.addbeh.2010.01.004

Marmorstein, N. R., & Iacono, W. G. (2001). An investigation of female adolescent twins with both major depression and conduct disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*(3), 299-306. doi:10.1097/00004583-200103000-00009

Marmorstein, N. R., & Iacono, W. G. (2003). Major depression and conduct disorder in a twin sample: Sex, functioning, and risk for future psychopathology. *Journal of the American Academy of Child & Adolescent Psychiatry*, *42*(2), 225-233. doi:10.1097/00004583-200302000-00017

Marsh, H. W., Wen, Z., Hau, K.-T., Little, T. D., Bovaird, J. A., & Widaman, K. F. (2007). Unconstrained structural equation models of latent interactions: Contrasting residual- and mean-centered approaches. *Structural Equation Modeling*, *14*(4), 570-580.

Martin, P., & Martin, M. (2002). Proximal and distal influences on development: The model of developmental adaptation. *Developmental Review*, *22*(1), 78-96. doi:10.1006/drev.2001.0538

Maslowsky, J., & Schulenberg, J. (under review). Interaction matters: Quantifying conduct problem by depressive symptoms interaction and its association with adolescent alcohol, cigarette, and marijuana use in a national sample.

Maslowsky, J., Schulenberg, J., O'Malley, P., & Kloska, D. (under review). Depressive symptoms, conduct problems and risk for polysubstance use: Results from national surveys.

Mason, C. A. (2003). Developmental epidemiology: Issues, application, and relevance for clinical child psychologists. *Journal of Clinical Child and Adolescent Psychology*, *32*(2), 178-180. doi:10.1207/S15374424JCCP3202_1

Mason, W. A. & Windle, M. (2002). Reciprocal relations between adolescent substance use and delinquency: A longitudinal latent variable analysis. *Journal of Abnormal Psychology*, *111*, 63-76. doi:10.1037/0021-843X.111.1.63

Mason, W. A., Hitchings, J. E., & Spoth, R. L. (2008). The interaction of conduct problems and depressed mood in relation to adolescent substance involvement and peer substance use. *Drug and Alcohol Dependence*, *96*(3), 233-248. doi:10.1016/j.drugalcdep.2008.03.012

Masten, A. S., Faden, V. B., Zucker, R. A., & Spear, L. P. (2008). Underage drinking: A developmental framework. *Pediatrics*, *121*(Supplement), S235–S251. doi:10.1542/peds.2007-2243A

McCaffery, J. M., Papandonatos, G. D., Stanton, C., Lloyd-Richardson, E. E., & Niaura, R. (2008). Depressive symptoms and cigarette smoking in twins from the National Longitudinal Study of Adolescent Health. *Health Psychology, 27*(S3), S207-215. doi:10.1037/0278-6133.27.3(Suppl.).S207

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological Bulletin, 114*(2), 376-390. doi:10.1037/0033-2909.114.2.376

McGorry, P. D., Purcell, R., Goldstone, S., & Amminger, G. P. (2011). Age of onset and timing of treatment for mental and substance use disorders: Implications for preventive intervention strategies and models of care. *Current Opinion in Psychiatry, 24*(4), 301–306. doi:10.1097/YCO.0b013e3283477a09

McMahon, R. J. (1999). Child and adolescent psychopathology as risk factors for subsequent tobacco use. *Nicotine & Tobacco Research, 1*(S2), S45-50.

Merikangas, K., He, J., Burstein, M., Swanson, S. A., Avenevoli, S., Cui, L., & ... Swendsen, J. (2010). Lifetime prevalence of mental disorders in U.S. adolescents: Results from the National Comorbidity Survey Replication-Adolescent Supplement (NCS-A). *Journal of the American Academy of Child and Adolescent Psychiatry, 49*(10), 980-989. doi:10.1016/j.jaac.2010.05.017

Merline, A., Jager, J., & Schulenberg, J. E. (2008). Adolescent risk factors for adult alcohol use and abuse: Stability and change of predictive value across early and middle adulthood. *Addiction, 103*(Suppl1), 84-99. doi:10.1111/j.1360-0443.2008.02178.x

Miller-Johnson, S., Lochman, J. E., Coie, J. D., Terry, R., & Hyman, C. (1998). Comorbidity of conduct and depressive problems at sixth grade: Substance use outcomes across adolescence. *Journal of Abnormal Child Psychology, 26*(3), 221-232. doi:10.1023/A:1022676302865

Miller, S., Malone, P. S., & Dodge, K. A. (2010). Developmental trajectories of boys' and girls' delinquency: Sex differences and links to later adolescent outcomes. *Journal of Abnormal Child Psychology, 38*(7), 1021-1032. doi:10.1007/s10802-010-9430-1

Miller, T. R., Levy, D. T., Spicer, R. S., & Taylor, D. M. (2006). Societal costs of underage drinking. *Journal of Studies on Alcohol, 67*(4), 519-528.

Moffitt, T. E. (1993). Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review, 100*(4), 674-701. doi:10.1037/0033-295X.100.4.674

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. *Journal of the American Medical Association, 291*(10), 1238 -1245. doi:10.1001/jama.291.10.1238

Mooijaart, A., & Bentler, P. M. (2010). An alternative approach for nonlinear latent variable models. *Structural Equation Modeling, 17*(3), 357-373. doi:10.1080/10705511.2010.488997

Mooijaart, A., & Satorra, A. (2009). On insensitivity of the chi-square model test to nonlinear misspecification in structural equation models. *Psychometrika, 74*(3), 443-455.

Moolchan, E. T., Fagan, P., Fernander, A. F., Velicer, W. F., Hayward, M. D., King, G., & Clayton, R. R. (2007). Addressing tobacco-related health disparities. *Addiction, 102*, 30–42. doi:10.1111/j.1360-0443.2007.01953.x

Muthén, L., & Muthén, B. (1998-2010). *Mplus user's guide, 6th Edition.* Los Angeles, CA: Muthén & Muthén.

National Institute on Drug Abuse. (2011) Understanding drug abuse and addiction. Retrieved from http://www.drugabuse.gov/publications/infofacts/understanding-drug-abuse-addiction

Needham, B. L. (2007). Gender differences in trajectories of depressive symptomatology and substance use during the transition from adolescence to young adulthood. *Social Science and Medicine, 65*(6), 1166-1179. doi:10.1016/j.socscimed.2007.04.037

Olds, D. L. (2006). The nurse–family partnership: An evidence-based preventive intervention. *Infant Mental Health Journal, 27*(1), 5–25. doi:10.1002/imhj.20077

Palmer, R. C., Young, S. E., Hopfer, C. J., Corley, R. P., Stallings, M. C., Crowley, T. J., & Hewitt, J. K. (2009). Developmental epidemiology of drug use and abuse in adolescence and young adulthood: Evidence of generalized risk. *Drug and Alcohol Dependence, 102*(1-3), 78-87. doi:10.1016/j.drugalcdep.2009.01.012

Pardini, D., White, H. R., & Stouthamer-Loeber, M. (2007). Early adolescent psychopathology as a predictor of alcohol use disorders by young adulthood. *Drug and Alcohol Dependence, 88* (S1), S38-49. doi:10.1016/j.drugalcdep.2006.12.014

Patrick, M. E., & Schulenberg, J. E. (2011). How trajectories of reasons for alcohol use relate to trajectories of binge drinking: National panel data spanning late adolescence to early adulthood. *Developmental Psychology, 47*(2), 311-317. doi:10.1037/a0021939

Petraitis, J., Flay, B. R., & Miller, T. Q. (1995). Reviewing theories of adolescent substance use: Organizing pieces in the puzzle. *Psychological Bulletin, 117*(1), 67-86. doi:10.1037/0033-2909.117.1.67

Phinney, J. S. & Landin, J. (1998). Research paradigms for studying ethnic minority families within and across groups. In V. McLoyd & L. Steinberg (Eds.) *Studying minority adolescents: Conceptual, methodological, and theoretical issues,* pp. 89-109. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Pilgrim, C. C., Schulenberg, J. E., O'Malley, P. M., Bachman, J. G., & Johnston, L. D. (2006). Mediators and moderators of parental involvement on substance use: A national study of adolescents. *Prevention Science, 7,* 75-89. doi:10.1007/s11121-005-0019-9

Quintana, S. M., Aboud, F. E., Chao, R. K., Contreras-Grau, J., Cross, W. r., Hudley, C., & ... Vietze, D. L. (2006). Race, ethnicity, and culture in child development: Contemporary research and future directions. *Child Development, 77*(5), 1129-1141. doi:10.1111/j.1467-8624.2006.00951.x

Radloff, L. (1977). The CES-D scale: A self report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385-401.

Rankin, B. H., & Quane, J. M. (2002). Social contexts and urban adolescent outcomes: The interrelated effects of neighborhoods, families, and peers on African-American youth. *Social Problems*, *49*(1), 79-100. doi:10.1525/sp.2002.49.1.79

Reardon, S. F. & Buka, S. L. (2002). Differences in onset and persistence of substance abuse and dependence among whites, blacks, and Hispanics. *Public Health Reports, 117*(Suppl. 1), S51-S59.

Reboussin, B. A., Hubbard, S., & Ialongo, N. S. (2007). Marijuana use patterns among African-American middle-school students: a longitudinal latent class regression analysis. *Drug and Alcohol Dependence*, *90*(1), 12-24. doi:10.1016/j.drugalcdep.2007.02.006

Repetto, P. B., Caldwell, C. H., & Zimmerman, M. A. (2005). A longitudinal study of the relationship between depressive symptoms and cigarette use among African American adolescents. *Health Psychology, 24*(2), 209-219. doi:10.1037/0278-6133.24.2.209

Resnick, M. D., Catalano, R. F., Sawyer, S. M., Viner, R., & Patton, G. C. (2012). Seizing the opportunities of adolescent health. *The Lancet*, *379*(9826), 1564–1567. doi:10.1016/S0140-6736(12)60472-3

Rushton, J. L., Forcier, M., & Schectman, R. M. (2002). Epidemiology of depressive symptoms in the National Longitudinal Study of Adolescent Health. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*(2), 199-205. doi:10.1097/00004583-200202000-00014

Rutter, M. & Sroufe, A. L. (2000). Developmental psychopathology: Concepts and challenges. *Development and Psychopathology, 12*, 265-296. doi:10.1017/S0954579400003023

Satorra, A., & Bentler, P. M. (2010). Ensuring positiveness of the scaled difference chi-square test statistic. *Psychometrika, 75*(2), 243-248. doi:10.1007/s11336-009-9135-y

Schulenberg, J. E., & Maggs, J. L. (2002). A developmental perspective on alcohol use and heavy drinking during adolescence and the transition to young adulthood. *Journal of Studies on Alcohol, Suppl 14*, 54–70.

Schulenberg, J. E., & Maggs, J. L. (2008). Destiny matters: Distal developmental influences on adult alcohol use and abuse. *Addiction, 103*(Suppl1), 1-6. doi:10.1111/j.1360-0443.2008.02172.x

Schulenberg, J. E., & Maslowsky, J. (2009). Taking substance use and development seriously: Developmentally distal and proximal influences on adolescent drug use. *Monographs of the Society for Research in Child Development, 74*(3), 121-130. doi:10.1111/j.1540-5834.2009.00544.x

Schulenberg, J. E., & Zarrett, N. (2006). Mental health during emerging adulthood: Continuity and discontinuity in courses, causes, and functions. In JJ Arnett & JL Tanner (Eds.), *Emerging adults in America: Coming of age in the 21st century* (pp. 135–172). Washington DC: American Psychological Association.

Schulenberg, J. E., Bachman, J. G., O'Malley, P. M., & Johnston, L. D. (1994). High school educational success and subsequent substance use: A panel analysis following adolescents into young adulthood. *Journal of Health and Social Behavior, 35*(1), 45-62. doi:10.2307/2137334

Schuster, C., O'Malley, P. M., Bachman, J. G., Johnston, L. D., & Schulenberg, J. E. (2001). Adolescent marijuana use and adult occupational attainment: A longitudinal study from age 18 to 28. *Substance Use and Misuse, 36,* 997-1014. doi:10.1081/JA-100104486

Seiffge-Krenke, I., & Kollmar, F. (1998). Discrepancies between mothers' and fathers' perceptions of sons' and daughters' problem behaviour: A longitudinal analysis of parent-adolescent agreement on internalising and externalising problem behaviour. *Journal of Child Psychology and Psychiatry, 39*(5), 687–697. doi:10.1111/1469-7610.00368

Smith, A. M., Phillips, C. M., & Brown, T. L. (2008). Ethnic identity, religiousness, and drinking among African Americans: What's the connection?. *Journal of Ethnicity in Substance Abuse, 7*(4), 465-479. doi:10.1080/15332640802508192

Spoth, R., Trudeau, L., Guyll, M., Shin, C., & Redmond, C. (2009). Universal intervention effects on substance use among young adults mediated by delayed adolescent substance initiation. *Journal of Consulting and Clinical Psychology, 77*(4), 620-632. doi:10.1037/a0016029

Sroufe, L. A. (1997). Psychopathology as an outcome of development. *Development and Psychopathology, 9*(2), 251-268. doi:10.1017/S0954579497002046

Sroufe, L. A. & Rutter, M. (1984). The domain of developmental psychopathology. *Child Development, 55,* 17-29. doi:10.2307/1129832

Starfield, B., Forrest, C. B., Ryan, S. A., Riley, A. W., Ensminger, M. E., Green, B. F. (1996). Health status of well vs ill adolescents. *Archives of Pediatrics and Adolescent Medicine, 150,* 1249-1256.

Sullivan, T. N. & Farrell, A. D. (1999). Identification and impact of risk and protective factors for drug use among urban African-American adolescents. *Journal of Clinical Child Psychology, 28,* 122-136.

Sung, M., Erkanli, A., Angold, A., & Costello, E. J. (2004). Effects of age at first substance use and psychiatric comorbidity on the development of substance use disorders. *Drug and Alcohol Dependence*, *75*(3), 287–299. doi:10.1016/j.drugalcdep.2004.03.013

Szapocznik J. & Coatsworth J. D. (1999). An ecodevelopmental framework for organizing the influences on drug abuse: a developmental model of risk and protection. In M. Glantz & C. Hartel (Eds.), *Drug abuse: Origins and interventions*, pp. 331–366. Washington, DC: American Psychological Association.

Szapocznik, J., Prado, G., Burlew, A. K., Williams, R. A., & Santisteban, D. A. (2007). Drug abuse in African American and Hispanic adolescents: Culture, development, and behavior. *Annual Review of Clinical Psychology, 3*, 77-105. doi:10.1146/annurev.clinpsy.3.022806.091408

Wagenaar, A. C., & Perry, C. L. (1994). Community strategies for the reduction of youth drinking: Theory and application. *Journal of Research on Adolescence, 4*(2), 319-345. doi:10.1207/s15327795jra0402_8

Wagner, F. A., & Anthony, J. C. (2002). From first drug use to drug dependence: Developmental periods of risk for dependence upon marijuana, cocaine, and alcohol. *Neuropsychopharmacology 26*(4), 479-488. doi:10.1016/S0893-133X(01)00367-0

Wallace, J. M. & Muroff, J. R. (2002). Preventing substance abuse among African American children and youth: Race differences in risk factor exposure and vulnerability. *Journal of Primary Prevention, 22*(3), 235-261. doi:10.1023/A:1013617721016

Wallace, J. M., Bachman, J. G., O'Malley, P. M., Johnston, L. D., Schulenberg, J. E., & Cooper, S. M. (2002). Tobacco, alcohol, and illicit drug use: Racial and ethnic differences among U.S. high school seniors, 1976-2000. *Public Health Reports, 117*(Suppl. 1), 567-575.

Walls, M. L., Whitbeck, L. B., Hoyt, D. R., & Johnson, K. D. (2007). Early-onset alcohol use among Native American youth: Examining female caretaker influence. *Journal of Marriage and Family, 69*(2), 451-464. doi:10.1111/j.1741-3737.2007.00376.x

Walters, G. D. (2010). The latent structure of life-course-persistent antisocial behavior: Is Moffitt's developmental taxonomy a true taxonomy?. *Journal of Consulting and Clinical Psychology*, doi:10.1037/a0021519

Weissman, M. M., Wolk, S., Wickramaratne, P., Goldstein, R. B., Adams, P., Greenwald, S., & ... Steinberg, D. (1999). Children with prepubertal-onset major depressive disorder and anxiety grown up. *Archives of General Psychiatry, 56*(9), 794-801. doi:10.1001/archpsyc.56.9.794

Williams, D. R., González, H., Neighbors, H., Nesse, R., Abelson, J. M., Sweetman, J., & Jackson, J. S. (2007). Prevalence and distribution of major depressive disorder in African Americans, Caribbean Blacks, and Non-Hispanic Whites: Results from the National Survey of American Life. *Archives of General Psychiatry, 64*(3), 305-315. doi:10.1001/archpsyc.64.3.305

Wolff, J. C., & Ollendick, T. H. (2006). The comorbidity of conduct problems and depression in childhood and adolescence. *Clinical Child and Family Psychology Review, 9*(3-4), 201-220. doi:10.1007/s10567-006-0011-3

World Health Organization. (2008). *WHO Report on the Global Tobacco Epidemic, 2008 - The MPOWER package*. Geneva, Switzerland: World Health Organization. Retrieved from http://www.who.int/tobacco/mpower/2008/en/index.html.

World Health Organization. (2011a). *Global Status Report on Alcohol and Health 2011*. Geneva, Switzerland. Retrieved from http://www.who.int/substance_abuse/publications/global_alcohol_report/en/index.html.

World Health Organization. (2011b). Alcohol fact sheet number 349. Retrieved from http://www.who.int/mediacentre/factsheets/fs349/en/index.html.

Zoccolillo, M. (1992). Co-occurrence of conduct disorder and its adult outcomes with depressive and anxiety disorders: A review. *Journal of the American Academy of Child and Adolescent Psychiatry*, *31*(3), 547-556. doi:10.1097/00004583-199205000-00024

Zucker, R. A. (2006). Alcohol use and the alcohol use disorders: A developmental-biopsychosocial systems formulation covering the life course. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology, Vol 3: Risk, disorder, and adaptation (2nd ed.).* (pp. 620–656). Hoboken, NJ US: John Wiley & Sons Inc.

Zucker, R. A., Donovan, J. E., Masten, A. S., Mattson, M. E., & Moss, H. B. (2008). Early developmental processes and the continuity of risk for underage drinking and problem drinking. *Pediatrics*, *121*(Suppl4), S252-S272. doi:10.1542/peds.2007-2243B