

An Examination of Neighborhood Contexts and Substance Use Across the Life Course

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**Abstract**

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Substance use and abuse takes a substantial toll on the health and well-being of youth and adults in America each year. For the past three decades, prevention scientists have sought to identify and understand the range of malleable factors that place individuals at greater risk for substance use and abuse. Key contextual risk factors across youth and adulthood have been identified in neighborhoods, schools, places of employment, peer groups, and families. Neighborhood socioeconomic contexts, however, have been associated with both increased and decreased risk for substance use and abuse across studies. This dissertation examines three sets of interrelated questions concerning the potential role of neighborhood contexts in substance use and abuse across the life course. The first study considered growth in alcohol use and smoking from grades 5 through 9. Results indicated that youth living in more socioeconomically disadvantaged neighborhoods reported more frequent cigarette smoking and alcohol use over time. After accounting for demographic differences, family factors, and peer factors, a unique association for neighborhood socioeconomics remained for smoking but not for alcohol use. In both cases, affiliations with deviant peers predicted more frequent smoking and alcohol use and mediated the association between neighborhood and substance use. The second study examined cross-sectional associations between a broad range of neighborhood, schools, peer, and family and cigarette smoking, binge drinking, marijuana use, and polysubstance use among 9<sup>th</sup> grade

students. Youth living in more socioeconomically disadvantaged neighborhoods were at greater risk for cigarette smoking, binge drinking, and polysubstance use, but not marijuana use in fully controlled models considering all domains of risk factors, race/ethnicity, gender, multiple indicators of family SES, and initiation of substance use by the 5<sup>th</sup> grade. The third study considered growth in alcohol use disorder (AUD) symptoms from age 21 to 39. Adults living in more disorganized neighborhoods over time reported more symptoms of AUD. A unique association between neighborhood disorganization and AUD symptoms remained in fully controlled models accounting for anxiety or depression and sociodemographic factors including education, marital status, income, parenthood, gender, and race/ethnicity. Anxiety or depression partially mediated the association between neighborhood disorganization and AUD symptoms over time. Results of these studies suggest that neighborhood socioeconomic factors play an important role in substance use and abuse during critical periods of youth and adult development above and beyond well-established risk and protective factors. Future research should seek to understand the unique risks for substance use and abuse associated with disadvantaged neighborhoods.

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## **DEDICATION**

This dissertation is dedicated to the hundreds of youth struggling with substance use, family, and school problems that I encountered prior to enrolling at the University of Washington. Hopefully, my current and future work can help nudge our communities, schools, and families closer to a perspective whereby we have the foresight to identify preventable problems before they take root and the willingness to thoughtfully act before young lives are needlessly derailed.

## INTRODUCTION

Each year, substance use and abuse enacts a substantial toll on the health and well-being of youth and adults across America. A recent report to the Surgeon General highlighted the societal costs connected to substance use and abuse emanating from reduced physical, mental, and social health (Office of Surgeon General, 2016). Approximately 480,000 annual deaths and more than 300 billion dollars of economic costs are attributed to the effects of smoking-related disease and disability in America, with more than half coming in direct medical care costs (US Department of Health and Human Services, 2014; Xu, Bishop, Kennedy, Simpson, & Pechacek, 2015). Similarly, approximately 88,000 annual deaths in America are attributable to alcohol-related causes and economic estimates of the alcohol-related costs of health care, mortality, and reduced worker productivity reached \$249 billion for 2010 (National Institute on Alcohol Abuse and Alcoholism, 2016; Sacks, Gonzales, Bouchery, Tomedi, & Brewer, 2015). Estimates of economic costs for marijuana use are not currently available, but experts suggest that direct health related costs are likely to be substantially smaller than for cigarette smoking or alcohol use (Fuster et al., 2014). Indirect costs from regular or heavy marijuana use may, however, manifest from reduced educational attainment, lost worker productivity, and other social problems (Cerdá et al., 2016; Volkow, Baler, Compton, & Weiss, 2014).

Specifically among youth, alcohol use increases short term risk for unintentional physical injury to oneself and or others (Hingson & Zha, 2009). Systematic reviews suggest that adolescent cigarette smoking, alcohol use, and marijuana use may each inhibit normative cognitive development and lead to changes in brain structure that make individuals more susceptible to addiction (Ewing, Sakhardande, & Blakemore, 2014; Kendler, Myers, Damaj, & Chen, 2013; Volkow et al., 2014). In the longer term, adolescent substance use has been consistently implicated as a risk factor for later substance abuse and dependence (Breslau &

Peterson, 1996; Grant, 1998; Grant, Stinson, & Harford, 2001; Guttmanova et al., 2011; Hawkins et al., 1997; Volkow et al., 2014) as well as academic failure, interpersonal violence, and mental health issues (Grant & Dawson, 1997; Hanna & Grant, 1999; Hingson & White, 2014). As such, adolescent cigarette smoking, alcohol use, and marijuana use likely contribute to the substantial societal costs derived from substance use and abuse across the life course.

There is now a consensus that preventing substance use is a key strategy in improving health across the life course and mitigating the substantial societal costs associated with substance use (Catalano et al., 2012; Currie et al., 2009; Harrop & Catalano, 2016; Hawkins et al., 2015; Office of Surgeon General, 2016; Viner et al., 2012). Achieving this aim requires strategies to identify and alter malleable predictors that place youth and adults at increased risk for substance use and abuse (Catalano et al., 2012; Hawkins, Catalano, & Miller, 1992a; Jenson & Bender, 2014). Substance use and prevention science researchers have identified key malleable risk factors for substance use and abuse within families, peer groups, and school/work environments. These factors, however, may be interrelated with more distal influences such as neighborhoods. To understand the etiology of substance use and abuse, it is important to examine the interrelationships of proximal and distal risk factors. The unique influence that neighborhoods may have on substance use and abuse above and beyond other more proximal risk factors, however, remains an open and important question that will be examined in this dissertation (Gardner, Barajas, & Brooks-Gunn, 2010; Jackson, Denny, & Ameratunga, 2014).

### **Theoretical Background**

This dissertation is built upon multiple theories as well as empirical studies employing these theories. Bronfenbrenner's *social ecological model* of human development (Bronfenbrenner, 1977) and subsequent specifications of the theory provide a broad basis for

investigating environmental influences on human development. This theory, widely employed by social scientists conducting research on both substance use and neighborhood contexts, posits that behavior is best understood as embedded within social contexts such as neighborhoods, schools, peer groups, and families (Leventhal & Brooks-Gunn, 2000). *Life course theories* of development detail the importance of examining relevant individual and contextual factors across different developmental periods (Catalano & Hawkins, 1996; Elder, 1998; Farrington, 2011). The *social development model* (SDM, Catalano & Hawkins, 1996) is both a social ecological and life course theory that organizes empirical predictors from multiple ecological contexts (neighborhood, school, peer, and family) and individual characteristics (Hawkins et al., 1992a) into mechanisms through which risk and protective factors impact substance use and delinquency (Beyers, Toumbourou, Catalano, Arthur, & Hawkins, 2004; Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996; Hill, Hawkins, Catalano, Abbott, & Guo, 2005; Kosterman, Hawkins, Guo, Catalano, & Abbott, 2000; Lonczak et al., 2001). The SDM specifies the pathways through which pro- and antisocial social bonds emanate from exposure to pro or antisocial opportunities, involvement, and rewards. Social bonds across peers, families, schools, and neighborhoods work together to impact pro or antisocial beliefs and, in turn, pro or antisocial behaviors. SDM-inspired studies have also established the importance of differentiating the general quality of environments and the substance use-specific features of environments in the etiology of substance using behavior (Bailey, Hill, Meacham, Young, & Hawkins, 2011; Epstein, Hill, Bailey, & Hawkins, 2013; Lee et al., 2012a; Lee et al., 2014). *Social disorganization* theory provides recognition of the importance in understanding social processes at work within neighborhoods (Bursik, 1988; Sampson & Groves, 1989; Shaw & McKay, 1969) and posits that interactional social processes are an important mechanism by which neighborhoods impact

individual-level health and behavior (Sampson, Morenoff, & Gannon-Rowley, 2002). Social disorganization theory provides a complement to the social development processes described in the SDM and offers a theoretical justification for both census-based and self-report measures of neighborhood context employed by numerous studies (Herrenkohl, Hawkins, Abbott, & Guo, 2002; Sampson et al., 2002). Each of these theories is essential for examining the unique importance of neighborhood contexts in understanding the etiology of substance use across the life course.

### **Neighborhood Contexts and Substance Use**

Empirical and theoretical work has suggested that the accrued impacts of neighborhood and place-based socioeconomic disadvantage may be an important means through which health disparities are perpetuated across socioeconomic groups (Diez Roux & Mair, 2010) and racial/ethnic groups (Leung & Takeuchi, 2011). Much of this research examining the implications of both growing up and residing in disadvantaged neighborhoods has been rooted in social justice perspectives given the long history of residential segregation and unequal distribution of resources in America by race, ethnicity, and social class (Wilson, 1987). There is currently widespread agreement across disciplines that neighborhoods characterized by socioeconomic deprivation are related to poorer health-related behaviors and outcomes for both children and adults (Diez Roux & Mair, 2010; Pickett & Pearl, 2001). Noted neighborhood scholars Patrick Sharkey and Jacob Faber recently offered a commentary on the state of neighborhood-focused research entitled “Where, when, why, and for whom do residential contexts matter?” (2014). Despite agreement on the importance of neighborhoods for health among social scientists, these authors urge researchers to conduct more detailed neighborhood studies to understand which health behaviors and outcomes are impacted by neighborhoods as

well as the varied mechanisms through which neighborhoods may exert their influence. This notion is specifically relevant for research examining the relationship between neighborhoods and substance use. While a range of studies have investigated associations between neighborhood socioeconomic factors and substance use among youth adults, systematic reviews have reported inconsistent findings (Bryden, Roberts, Petticrew, & McKee, 2013; Collins, 2016; Gardner et al., 2010; Jackson et al., 2014; Karriker-Jaffe, 2011).

Neighborhood-focused scholars have offered four broad categories of potential explanations for this inconsistency in findings across studies.<sup>1</sup> First (1), measures of neighborhood socioeconomic disadvantage typically include census-based estimates of median household income, percentage of residents dropping out of high school, and percentage of single-parent households (Herrenkohl et al., 2002; Sampson et al., 2002) and without those same factors measured at the family-level, analyses run the risk of conflating neighborhood and family socioeconomic factors in their relationship to adolescent development (Leventhal & Brooks-Gunn, 2000). It is therefore important that indicators of family-level socioeconomic status (SES) such as employment status, marital status, income, individual and parental education, and family structure be included in statistical models estimating the effect of neighborhood socioeconomic factors on substance using behaviors (Leventhal & Brooks-Gunn, 2000; Wodtke, Harding, & Elwert, 2011). A second (2) explanation for inconsistent findings across studies is the span of time individuals have resided in a specific neighborhood. Scholars have contended that the duration of exposure is a key, but often unmeasured, factor in studies assessing the impact of neighborhood contexts on adolescents (Jackson & Mare, 2007; Wodtke et al., 2011). As such, individuals

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<sup>1</sup> Each category of explanation is given a number in parenthesis in this section and referred to by this number in the “Goals” section as each paper of the dissertation is introduced.

exposed to socioeconomically disadvantaged neighborhoods for only brief periods of time may display different patterns of association between neighborhoods and substance use when compared to those with sustained exposure to disadvantaged neighborhoods (Wodtke et al., 2011). It is, therefore, important to account for length of exposure to a neighborhood context in models seeking to understand the impact of neighborhoods on substance use. Thirdly (3), the association between neighborhood factors and substance use may be mediated or confounded by other social process or more proximal contexts of risk for substance use (Fagan, Wright, & Pinchevsky, 2015; Leventhal & Brooks-Gunn, 2000; Sampson et al., 2002). Social processes within neighborhoods such as collective efficacy or informal social control have been shown to be connected to both neighborhood socioeconomic factors as well as health-related behaviors (Sampson et al., 2002). A substantial amount of research has also shown increased risk of substance use and abuse in the context of poorly functioning families, negative peer influences, and poor connections with school or work (Hawkins et al., 1992a; Kosterman et al., 2011). Neighborhood scholars have suggested that the extent to which these social processes and risk factors mediate or confound associations between neighborhood socioeconomics and substance use is an important empirical question (Fagan et al., 2015; Leventhal & Brooks-Gunn, 2000). Finally (4), scholars have emphasized that neighborhoods may be differentially important for different substances and few studies have examined the association of neighborhood contexts with multiple substances within the same sample (Fagan et al., 2015; Galea, Nandi, & Vlahov, 2004). Considering multiple substances within the same sample can help shed light on whether inconsistent findings across other studies are rooted in sample-specific or substance-specific associations.

## **Sample**

Data for this dissertation are drawn from the Seattle Social Development Project (SSDP), a longitudinal study consisting of a gender-balanced, ethnically diverse sample of 808 participants who were in the 5<sup>th</sup> grade in the Seattle Public Schools in 1985. Participants have been followed prospectively from approximately age 10 through age 39 with the most recent data collection occurring in 2014. Schools from high crime neighborhoods were overrepresented in the sample and some students received a social development intervention in elementary school. The specific sample characteristics and details about the measures employed for each analysis are described accordingly within each paper.

## **Goals and Analyses**

Borrowing from the prevention science paradigm that has identified a wide-range of risk factors for substance use in multiple domains of socialization across the life-course (Harrop & Catalano, 2016; Hawkins et al., 1992a) and incorporating suggested approaches from neighborhood-based researchers (Fagan et al., 2015; Jackson & Mare, 2007; Leventhal & Brooks-Gunn, 2000; Sampson et al., 2002; Wodtke et al., 2011), this dissertation examines associations between neighborhood contexts, multiple domains of risk and promotive factors for substance use, and substance use and abuse over the life course in three distinct empirical papers.

Paper 1 examines time-varying associations between census-based measures of neighborhood socioeconomic factors, family general and substance use specific risk factors, and peer risk factors and cigarette smoking and alcohol use from grade 5 to 9. To my knowledge, paper 1 joins only two other studies that have modeled neighborhood socioeconomic factors in conjunction with trajectories of adolescent cigarette smoking (Mathur, Erickson, Stigler, Forster, & Finnegan Jr, 2013) or alcohol use (Trim & Chassin, 2008). Furthermore, paper 1 is the first

study to consider time-varying measures of neighborhood contexts in conjunction with time-varying measures of family and peer risk factors for early adolescent smoking and alcohol use. This study addressed all 4 critiques of previous neighborhood-based substance use research described in the “Neighborhood Context and Substance Use” section above. Paper 2 estimates cross-sectional associations between both census-based and self-reported neighborhood contexts as well as school, peer, and family general and substance use specific risk factors and cigarette smoking, binge drinking, marijuana use, and polysubstance use among 9<sup>th</sup> graders. To our knowledge, this is the first neighborhood-focused analysis to incorporate such an extensive set of risk factors for adolescent substance use across multiple domains of context while also controlling for a range of sociodemographic factors and early initiation of substance use. Paper 2 addresses critiques 1, 3, and 4 of previous neighborhood-focused substance use research. Paper 3 examines associations between self-reported, time-varying measures of neighborhood disorganization and growth in symptoms of alcohol use disorder (AUD) from ages 21 to 39. Paper 3 is the first empirical paper to consider the trajectory of AUD symptoms in conjunction with time-varying neighborhood contexts, mental health factors, and sociodemographic factors across nearly 20 years of adulthood. This paper addresses critiques 1, 2, and 3 of previous neighborhood-focused substance use research.

Collectively, these papers are designed to address multiple critiques of current neighborhood-focused research with the purpose of examining two distinct and critically important developmental periods for substance use. First, early initiation, increased frequency of use, and polysubstance use are of primary concern for adolescents from grades 5 through 9. Youth initiating substance use at an earlier age, using more frequently, and engaging with multiple types of substances are likely at greater risk for negative outcomes (Office of Surgeon

General, 2016). Second, substance abuse becomes the primary concern for health and well-being among adults. Individuals demonstrating symptoms of AUD early in adulthood tend to reduce their problem drinking as they age and take on more adult responsibilities (Connor, Haber, & Hall, 2016). Those who do not reduce their problem drinking are at substantial risk for alcohol-related disease and disability (Rehm et al., 2014). Latent growth modeling as applied in Paper 1 and 3 provides a powerful tool to examine developmental trajectories of substance use during both of these critical periods. As well, this strategy allows us to examine factors that may increase or decrease substance use in relation to average trajectories for that developmental period. Paper 2 provides an in depth cross-sectional consideration of associations between multiple neighborhood contexts, multiple domains of other contextual risk factors, and multiple substances during the 9<sup>th</sup> grade when youth may begin experimenting with substances. It is essential that we understand if unique risks for substance use are conferred by neighborhoods both within time and over time after accounting for possible confounders and mediators across multiple domains of youth life including schools, peers, and families.

### **Relevance for Preventive Interventions**

This dissertation is motivated by a goal of preventing or reducing the negative impacts of substance abuse across the life course. Multiple community-based programs have demonstrated efficacy in preventing substance use among youth by reducing risk factors and enhancing protective factors at the community-level (Fagan & Hawkins, 2012). However, interventions designed to relocate families out of impoverished neighborhoods such as Moving to Opportunity (MTO), while showing significant improvements in physical and mental health in the short term among both adolescents and adults (de Souza Briggs, Popkin, & Goering, 2010), have shown either no impact on substance use among adolescents or increased use among adolescents in the

intervention condition (Kling, Liebman, & Katz, 2007). The most recent long term follow-ups have shown general improvements in educational attainment and earnings among children of families who received the intervention (Chetty, Hendren, & Katz, 2016). More research is needed to unpack the processes by which neighborhoods are impacting health, well-being, and potentially substance use among both adolescents and adults. In positing a social justice model of youth development programs, Shawn Ginwright and Julio Cammarota (2002) suggest that “the limits of current youth development models are bound by an inability to examine... complex social, economic and political forces” (p. 82). Detailed consideration of neighborhood contexts in conjunction with well-established risk factors for substance use and sociodemographic differences can help understand the complex forces at work across the life course and potentially enhance community-based strategies to mitigate the negative impacts and societal costs of substance use and abuse.

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## **PAPER 1: NEIGHBORHOOD, FAMILY, AND PEER FACTORS ASSOCIATED WITH EARLY ADOLESCENT SMOKING AND ALCOHOL USE**

### **Adolescent Smoking and Alcohol Use**

There is now a consensus that preventing early initiation of smoking and alcohol use is a key strategy in improving both short and long term adolescent health (Catalano et al., 2012; Currie et al., 2009; Office of Surgeon General, 2016; Viner et al., 2012). Smoking initiation in the early teenage years has consistently been associated with increased risk of developing nicotine dependence and decreased likelihood of smoking cessation in adulthood (Breslau & Peterson, 1996; Grant, 1998; Kendler et al., 2013). Systematic reviews also suggest that early smoking may inhibit normative cognitive development and enhance susceptibility to nicotine and other drug addiction (Lydon, Wilson, Child, & Geier, 2014). As such, early adolescent smoking contributes to the substantial societal costs attributable to smoking-related disease, disability, and mortality across the life course (Centers for Disease Control Prevention, 2008). Similar to smoking, early initiation of alcohol use has repeatedly been identified as a risk factor for later alcohol misuse, abuse, and dependence (Grant & Dawson, 1997; Grant et al., 2001; Guttmannova et al., 2011; Hawkins et al., 1997). Further, adolescents who begin using alcohol at earlier ages are at increasing risk for unintentional physical injury to themselves, unintentional injury to others, and regularly driving under the influence of alcohol (Hingson & Zha, 2009). Systematic reviews suggest that early adolescent alcohol use can lead to adverse changes in brain structures that regulate risk and reward systems and, in turn, increase risk for developing alcohol addiction (Ewing et al., 2014; Welch, Carson, & Lawrie, 2013). Early initiation of alcohol use, therefore, plays an important role in the considerable societal costs emanating from problem drinking (Rehm et al., 2014) and the alcohol-related burden of injury and disease across the life course (Sacks et al., 2015). While many youth experiment with smoking and alcohol, delayed

onset and restricted use among those who do use may help mitigate the negative consequences of adolescent substance use (Spoth, Reyes, Redmond, & Shin, 1999). Given the current breadth and depth of findings highlighting the preventable harms associated with adolescent smoking and alcohol use (Catalano et al., 2012), it is essential to continue refining our understanding of risk factors associated with the dynamics of early onset of smoking and alcohol use.

### **Neighborhood Socioeconomics and Adolescent Substance Use**

There is broad agreement that neighborhood socioeconomic factors represent an important component of the social determinants of health and well-being (Diez Roux & Mair, 2010). More specifically, researchers have sought to understand the extent to which exposure to impoverished or unstable neighborhoods may undermine healthy adolescent development (Elliott et al., 1996; Jencks & Mayer, 1990; Leventhal & Brooks-Gunn, 2000; Wilson, 1987). These studies have largely drawn from socioecological theories of human development (Bronfenbrenner, 1977) which posit that adolescent behaviors and developmental outcomes are best understood as embedded within social contexts such as neighborhoods, peer groups, and families. Neighborhoods characterized by high poverty, low educational attainment, and lack of stability among residents are theorized to contain low levels of informal social control important for inhibiting deviant behavior among youth, a shortage of collective social support mechanisms for parents and children, and a higher concentration of deviant peer groups (Elliott et al., 1996; Jencks & Mayer, 1990; Sampson et al., 2002). While research has shown that children growing up in disadvantaged neighborhoods are at increased risk of high school dropout (Wodtke et al., 2011) and mental health problems (Leventhal & Brooks-Gunn, 2000), studies explicitly testing the association of neighborhood disadvantage and adolescent substance use have not produced consistent results (Jackson et al., 2014; Karriker-Jaffe, 2011; Mathur et al., 2013). Depending on

study design, sociodemographic features of the study sample, and the range of control variables considered, living in a disadvantaged neighborhood has been connected with both increased and decreased alcohol use and smoking among adolescents (Jackson et al., 2014; Karriker-Jaffe, 2011; Mathur et al., 2013). Neighborhood-focused scholars have offered two categories of potential explanations for this inconsistency in findings across studies. First, measures of neighborhood socioeconomic disadvantage typically include area-level estimates of median household income, percentage of residents dropping out of high school, and percentage of single-parent households (Herrenkohl et al., 2002; Sampson et al., 2002) and without those same factors measured at the family-level, analyses run the risk of conflating neighborhood and family socioeconomics in their relationship to adolescent development (Leventhal & Brooks-Gunn, 2000). Thus, it is important that measures of family-level socioeconomics such as income, parental education, and family structure be included in statistical models estimating the effect of neighborhood socioeconomics on adolescent outcomes (Leventhal & Brooks-Gunn, 2000; Wodtke et al., 2011). A second explanation for inconsistent findings across studies is the span of time adolescents have resided in a specific neighborhood. Scholars have contended that the duration of exposure is a key, but often unmeasured, factor in studies assessing the impact of neighborhood contexts on adolescents (Jackson & Mare, 2007; Wodtke et al., 2011). As such, adolescents exposed to socioeconomically disadvantaged neighborhoods for only brief periods of time may display different patterns of association between neighborhoods and substance use when compared to those with sustained exposure to disadvantaged neighborhoods (Wodtke et al., 2011). Thus, it is important to account for length of exposure to neighborhood disadvantage in models seeking to understand the impact of neighborhood disadvantage on substance use.

## **Family and Peer Risk Factors for Substance Use**

Studies investigating the role of family-level socioeconomics in predicting adolescent smoking and alcohol use have also been unable to produce consistent results across studies (Blum et al., 2000; Devenish, Hooley, & Mellor, 2017; Hanson & Chen, 2007; Patrick, Wightman, Schoeni, & Schulenberg, 2012). While epidemiological surveillance and systematic reviews have reported higher rates of smoking among adults of lower socioeconomic status (SES), it remains less clear if this relationship extends to adolescents (Galea et al., 2004; Hiscock, Bauld, Amos, Fidler, & Munafò, 2012). Research examining relationships between family SES and adolescent alcohol use have produced varied results with a range of studies finding positive, negative, and null effects of lower family SES on adolescent alcohol use (Hanson & Chen, 2007). It is important to consider that, similar to challenges faced by neighborhood-based studies, adolescents may be exposed to markedly different levels of family SES across development as parents potentially gain promotions, obtain new jobs, or experience bouts of unemployment (Wodtke, Elwert, & Harding, 2016).

In addition to family socioeconomic status, socioecological models also suggest that other family factors and social contexts are important potential influences that may contribute to substance use beyond neighborhood factors (Cambron, Catalano, & Hawkins, in press; Catalano & Hawkins, 1996). Prevention scientists and substance use researchers have highlighted the clear role that poor functioning families and deviant peer groups play in escalating adolescent substance use (Galea et al., 2004; Hawkins et al., 1992a). A meta-analysis of 77 studies identified multiple features of family relationship quality including positive parental monitoring, shared activities between parents and children, parental warmth, quality of communication, parent-child bonding, and use of positive discipline strategies as important factors in delaying early adolescent initiation of alcohol use (Ryan, Jorm, & Lubman, 2010). Similar measures of

family relationship quality have been linked with adolescent smoking by multiple studies (Darling & Cumsille, 2003; Hill et al., 2005; Skinner, Haggerty, & Catalano, 2009). Parent and sibling substance using behaviors as well as more permissive family norms regarding substance use have also shown strong associations with increased early adolescent smoking and alcohol use across numerous studies (Darling & Cumsille, 2003; Hawkins et al., 1992a; Hill et al., 2005; Kosterman et al., 2000; Tobler, Komro, & Maldonado-Molina, 2009). More recent investigations have suggested the importance of considering the unique role of substance use specific features of family relationships in addition to general features of family environments (Bailey et al., 2014; Bailey et al., 2011; Epstein et al., 2013; Hill et al., 2005). Findings from these studies have shown that, net of adolescent general family functioning, more permissive adolescent family smoking environments uniquely predict a higher likelihood of initiation of daily smoking during adolescence (Hill et al., 2005) and nicotine dependence among young adults (Bailey et al., 2014; Bailey et al., 2011). Results have also indicated that more permissive adolescent family smoking and alcohol environments predicted higher levels of engagement in multiple problem behaviors including polysubstance use, antisocial behavior, and risky sex among young adults net of impact of adolescent general family functioning (Bailey et al., 2014; Bailey et al., 2011).

In addition to family SES and functioning, researchers have noted differences in adolescent smoking and alcohol use by demographic features such as family structure and race or ethnicity. Results from studies employing nationally representative samples have found that African American youth engage in less smoking and alcohol use compared to Whites after controlling for family income, family structure, and gender (Blum et al., 2000; Hoffmann & Johnson, 1998). These same studies have also shown that adolescents in single-parent households are at increased risk for substance use after controlling for other sociodemographic

factors. Research employing multi-ethnic, longitudinal samples have similarly observed less smoking and alcohol use among Asian American and African American youth when compared to Whites after controlling for differences in family SES, family structure, and gender (Catalano et al., 1992; Hill et al., 2005; Kosterman et al., 2000).

Numerous researchers have identified substantially increased risk of smoking and alcohol use among adolescents affiliated with deviant or substance using peers (Harrop & Catalano, 2016; Hawkins et al., 1992a). Some studies have suggested that lack of appropriate parental monitoring and poor parenting practices may set the stage for increased affiliation with deviant peers (Oxford, Harachi, Catalano, & Abbott, 2001; Skinner et al., 2009). Researchers have also suggested that socioeconomically disadvantaged neighborhoods may be important for adolescent smoking and alcohol use in the extent to which these environments degrade positive family functioning (Byrnes & Miller, 2012; Roosa, Jones, Tein, & Cree, 2003) or facilitate deviant peer group formation (Brody et al., 2001; Chuang, Ennett, Bauman, & Foshee, 2005; Elliott et al., 2006; Ingoldsby et al., 2006).

### **Goals of the Current Study**

Given that many adolescents experiment with substance use, it is important to understand factors related to both early initiation and escalation of use that lead to negative health consequences. To date, only two studies have sought to examine associations between neighborhood socioeconomics and trajectories of adolescent smoking (Mathur et al., 2013) or alcohol use (Trim & Chassin, 2008). Neither study, however, considered neighborhood socioeconomic factors or other important contexts for smoking and alcohol use over time. Mathur and colleagues (2013), using latent growth curve modeling to estimate smoking trajectories for adolescents aged 12 to 18, found no direct effect of neighborhood

socioeconomics on either smoking at age 12 or growth in smoking over time after controlling family SES, gender, and ethnicity. Lower family SES predicted increased smoking at age 12 and over time. Trim and Chassin (2008) also used latent growth curve modeling to estimate trajectories of alcohol use among adolescents aged 10 to 15 and compared trajectories for adolescents with an alcoholic parent to adolescents without. Recognizing the temporal importance of neighborhood socioeconomic factors, Trim and Chassin restricted their analysis to families that did not move to neighborhoods with different socioeconomic profiles during the study period. Results indicated that among adolescent without an alcoholic parent, living in a more socioeconomically advantaged neighborhood was predictive of increased alcohol use over time after controlling for age, ethnicity, and parent education. Estimating the same model for adolescents with an alcoholic parent produced the opposite result indicating that living a more disadvantaged neighborhood was predictive of increased alcohol use over time. No differences by ethnicity or parent education were noted.

In the present study, we incorporated family and peer risk factors for substance use established by prevention science frameworks (Harrop & Catalano, 2016; Hawkins et al., 1992a) as well as the conceptual guidance from neighborhood-focused researchers (Jackson & Mare, 2007; Wodtke et al., 2011) to examine trajectories of adolescent smoking and alcohol use. We employed time-varying measures of neighborhood socioeconomics, family SES, low family functioning, family substance using environments, and deviant peer affiliations. Building upon the above described studies, we hypothesized that lower family functioning, more permissive family smoking environments, and affiliations with deviant peers would be related to higher levels of smoking. We also hypothesized that lower family functioning, more permissive family alcohol environments, and affiliation with deviant peers would be related to higher levels of

alcohol use. Associations between neighborhood disadvantage, residential stability, and family SES and smoking or alcohol use among adolescents remains an open and important question to be examined here. Given findings from previous studies, we also expected that more proximal risk factors of low family functioning, more permissive family substance use environments, and deviant peers would attenuate any observed relationships between neighborhood factors and youth smoking or alcohol use.

### **Sample**

Data were drawn from the Seattle Social Development Project (SSDP), a longitudinal, theory-driven study originating in 18 Seattle elementary schools over-representing high crime neighborhoods. SSDP conducted paper and pencil interviews in 1985 with 808 students in the 5th grade when most participants were 10 years old ( $M = 10.3$ ,  $SD = .52$ ). The 808 respondents accounted for 77% of 1,053 5th grade students initially invited to participate in the study. Retention rates for the participating sample across the four waves of data collection for the analysis sample were 69%, 81%, and 97% in grades 6, 7, and 9 respectively. Of the longitudinal sample, 49% were female, 46% were European American, 24% were African American, 21% were Asian American and 9% were Native American.

### **Measures**

Table 1.1 provides descriptive statistics for all measures by grade.

*Past month smoking and alcohol use.* Participants responded to a single question for smoking at each grade and a single question for alcohol at each grade indicating the number of times they used each substance in the past month. A four category ordinal variable for past month smoking was created at each grade and coded as 0 = no past month use, 1 = less than one cigarette per day, 2 = 1 to 5 cigarettes per day, 3 = 10 or more cigarettes per day. A four category ordinal

variable for past month alcohol use was created at each wave and coded 0 = no past month use, 1 = drank alcohol 1 or 2 times, 2 = drank alcohol 3 to 5 times, 3 = drank alcohol 6 or more times. Participants missing on past month smoking or alcohol use questions who also consistently reported no lifetime smoking or alcohol use at previous and later waves of data were set to 0 for past month smoking and alcohol use.

*Neighborhood disadvantage and residential stability.* Two factor scores from a principal components analysis summarizing 10 block group-level variables from the 1990 census were used to measure neighborhood socioeconomic disadvantage and residential stability. Identical measures of neighborhood factors derived from the census have been employed by other studies (Herrenkohl et al., 2002). Previous research has also indicated that census block groups containing roughly 2,000 to 3,000 residents most closely reflect adolescent perceptions of their neighborhood (Elliott et al., 2006). Participant home address data that could be geocoded and matched with census block groups included 792, 732, 724, and 766 addresses for grades 5, 6, 7, and 9 respectively. Table 1.2 reports census items used, the results of the principal components analysis, and descriptive statistics for census variables. Higher scores on the neighborhood disadvantage factors indicate neighborhoods with lower socioeconomic resources and higher scores on the residential stability factor indicate more stable resident populations.

*Time-fixed sociodemographic factors.* Gender was coded as female = 1 and male = 0. Dummy variables for ethnicity were coded such that the three ethnic groups were compared to European Americans. Two parent household was measured by a series of questions indicating family structure and was coded as 1 for two acting parents present and 0 for two acting parents not present. Parent college education was indicated by the maximum of educational attainment of the mother and father and was coded as 1 for at least one parent completing a 4-year college degree

and 0 for neither parent completing a college degree.<sup>2</sup> Family structure and education were reported by parents of study participants.

*Time-varying general family factors.* Family income was reported by parents and measured at each grade by a seven category question with response options ranging from less than \$5,000 to greater than \$40,000 annual income. Low family functioning was indicated by the mean of 21 questions about family management, involvement, and bonding. Family management questions asked about parental monitoring, communication practices, family rules, and conflict resolution strategies. Family involvement questions recorded the child's level of involvement with their parents in the past week in household chores, recreational activities, family meals, or conversations about school. Family bonding questions asked if the participant wanted to be like their mother or father and how often the participants shared their thoughts and feelings with parents and siblings. All items were coded such that higher scores indicated lower family functioning (internal consistency = .79 to .85 across grades).

*Time-varying family substance use.* An index of family smoking environment was indicated by the mean of three questions. Parents reported their perceived risk of harm from smoking with responses from no risk to very great risk. Parents also reported their hypothetical response to their child smoking with responses ranging from "okay for the child to use if he or she wants" to "I would absolutely forbid my child to use." All items were coded such that higher scores indicated more permissive smoking norms. Participants reported if he or she had any siblings who smoked cigarettes with responses coded as 1 = smoking sibling(s) and 0 = no smoking

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<sup>2</sup> Sensitivity tests were conducted with two parent household and parent education modeled as time-varying covariates. These models showed worse fit on SABIC and did not alter the substantive interpretation of other variables in the models. As a result, two parent household and parent education were included as time-fixed predictors.

siblings. Higher scores on the index indicated more exposure to family smoking environments. An index of family alcohol environment was indicated by the mean of five questions regarding parent alcohol use and alcohol norms. Parents reported how often they drank alcohol with response options ranging from never to 3 or more drinks a day. Parents reported their perceived risk of harm from occasional and daily alcohol use with response options ranging from no risk to very great risk. Parents also reported their hypothetical parental response to their child drinking alcohol with responses ranging from “okay for the child to use if he or she wants” to “I would absolutely forbid my child to use.” All items were coded such that higher scores on the index indicated more exposure to family alcohol environments.

*Time-varying deviant peers.* A scale of associations with deviant peers was constructed from the mean of six questions regarding the three best friends of the participant. Items asked if the participant’s three best friends did things to get in trouble with their teachers or tried alcohol without the knowledge of their parents. All items were coded to indicate more deviant behavior (internal consistency = .62 to .72 across grades).

Table 1.1.  
*Sample descriptive statistics*

Variable	Min	Max	Grade 5		Grade 6		Grade 7		Grade 9	
			M	SD	M	SD	M	SD	M	SD
Past Month Smoking	0	3	.08	.37	.12	.41	.16	.51	.35	.85
none			94.6%		92.7%		90.4%		82.5%	
less than 1 cigarette / day			3.4%		5.1%		6.4%		7.1%	
1 to 5 cigarettes / day			2.0%		2.3%		2.4%		5.7%	
10+ cigarettes / day			0%		0%		0.7%		4.7%	
Past Month Alcohol Use	0	3	.23	.52	.24	.54	.27	.59	.41	.79
none			82.0%		84.7%		81.0%		72.4%	
1 or 2 times			13.4%		10.6%		15.3%		18.4%	
3 to 5 times			4.6%		4.7%		2.3%		6.0%	
6+ times			0%		0%		1.5%		3.2%	
Neighborhood Disadvantage	-1.40	5.67	.00	1.00	.00	1.00	.00	1.00	.00	1.00
Residential Stability	-5.11	2.15	.00	1.00	.00	1.00	.00	1.00	.00	1.00
Family Income	1	7	4.38	1.92	4.53	1.93	4.61	1.96	4.99	1.85
Low Family Functioning	1	4	2.52	.40	2.46	.39	2.55	.35	2.41	.41
Family Smoking Environment	0	5	1.26	.87	1.60	.75	1.48	.67	1.45	.68
Family Alcohol Use Environment	0	4	1.58	.69	1.55	.69	1.65	.67	1.41	.64
Deviant Peers	1	2	1.13	.22	1.18	.27	1.22	.27	1.31	.28
Female	0	1	49%		-		-		-	
African American	0	1	26%		-		-		-	
Asian American	0	1	22%		-		-		-	
Native American	0	1	5%		-		-		-	
European American	0	1	47%		-		-		-	
Two Parent Household	0	1	69%		-		-		-	
Parent College Education	0	1	56%		-		-		-	

*Notes.* M = mean, SD = standard deviation.

Table 1.2.  
*Principal components analysis for census-based measures*

Variable	Neighborhood Disadvantage	Residential Stability	M	SD	Min	Max
Percent of youth (ages 10-17)	.95	.32	8.98	3.61	.42	21.39
Percent single-parent, female-headed households	.94	-.01	15.22	10.58	1.62	60.12
Percent of individuals receiving public assistance income	.84	-.20	10.72	12.04	.00	64.41
Percent of adults without high school diploma	.84	-.03	20.49	12.19	.00	61.98
Number of racial groups with 10% or more representation	.83	.24	2.03	.90	1.00	4.00
Percent of families in poverty	.80	-.24	11.97	15.85	.00	86.81
Percent of females unemployed	.73	-.10	6.28	7.61	.00	52.86
Percent of males unemployed	.69	-.14	7.37	7.44	.00	56.14
Percent of individuals living in same residence for 5+ years	.20	.96	49.16	13.44	.00	80.40
Percent of owner-occupied homes	-.24	.83	57.64	24.80	.00	100.00
Eigenvalue	5.64	1.92				
Percent of variance	.56	.19				

*Notes.* N = 792, M = mean, SD = standard deviation; results shown are for grade 5 and closely align with results for grades 6, 7, and 9.

### **Analytic Strategy**

Longitudinal latent growth modeling is regularly employed to examine changes in substance use over time and offer the flexibility to estimate individual differences in initial levels of substance use and rates of change over time as well as deviation from average levels of use at each time point (Curran & Hussong, 2003). Deviation from average levels of substance use can be examined by simultaneously estimating a growth curve and regressing the indicators of the growth curve parameters (i.e., outcomes at each time point) on the time-varying predictors (Hussong, Curran, Moffitt, Caspi, & Carrig, 2004). Figure 1 provides a conceptual diagram of this strategy employing both time-fixed and time-varying covariates. Identical analytic strategies were employed for past month smoking and alcohol use models. First, an unconditional growth model estimated the trajectory of past month substance use from grades 5 to 9. Next, Model 1

examined the impact of time-fixed sociodemographic predictors on the latent intercept and latent slope and used time-varying measures of neighborhood disadvantage and residential stability to predict the ordinal indicators of substance use. Model 2 included time-varying measures of family income, low general family functioning, family substance use environments, and deviant peers also predicting ordinal indicators of substance use. Associations of each time-varying measure with the substance use measures were constrained to be equal over time in both Model 1 and 2. This strategy improved model fit and facilitated ease of interpretation. Model fit was compared across models using sample-size adjusted Bayesian Information Criteria (BIC) and a reduction of five or more in BIC was considered an improvement in model fit (Singer & Willett, 2003). Missing data were handled via the multiple imputation procedure in Mplus (Asparouhov & Muthén, 2010). Forty datasets were created and subsequently analyzed using latent growth modeling for categorical outcomes in Mplus 7.1 and mediation tests were conducted using the Model Constraint command (Muthén & Muthén, 2006). All models employed the maximum likelihood estimator for robust standard errors (MLR) and are averaged across the 40 imputed datasets. Parameter estimates and model fit statistics from unconditional models, Model 1, and Model 2 for smoking and alcohol use are reported in Table 3.<sup>3</sup> Growth models for smoking and alcohol use testing for non-linear growth did not show improved fit or substantively alter the results presented in Table 3. Results of tests for indirect effects are reported in Table 4.

## Results

Results of unconditional growth models for both past month smoking and alcohol use showed significant variance on the intercept and slope warranting the inclusion of time-fixed and

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<sup>3</sup> Some SSDP participants received a social development intervention during elementary school (Hawkins et al., 1992b). Sensitivity tests controlling for the intervention in Model 2 for both smoking and alcohol use did not show any substantive changes to the findings reported in Table 3.

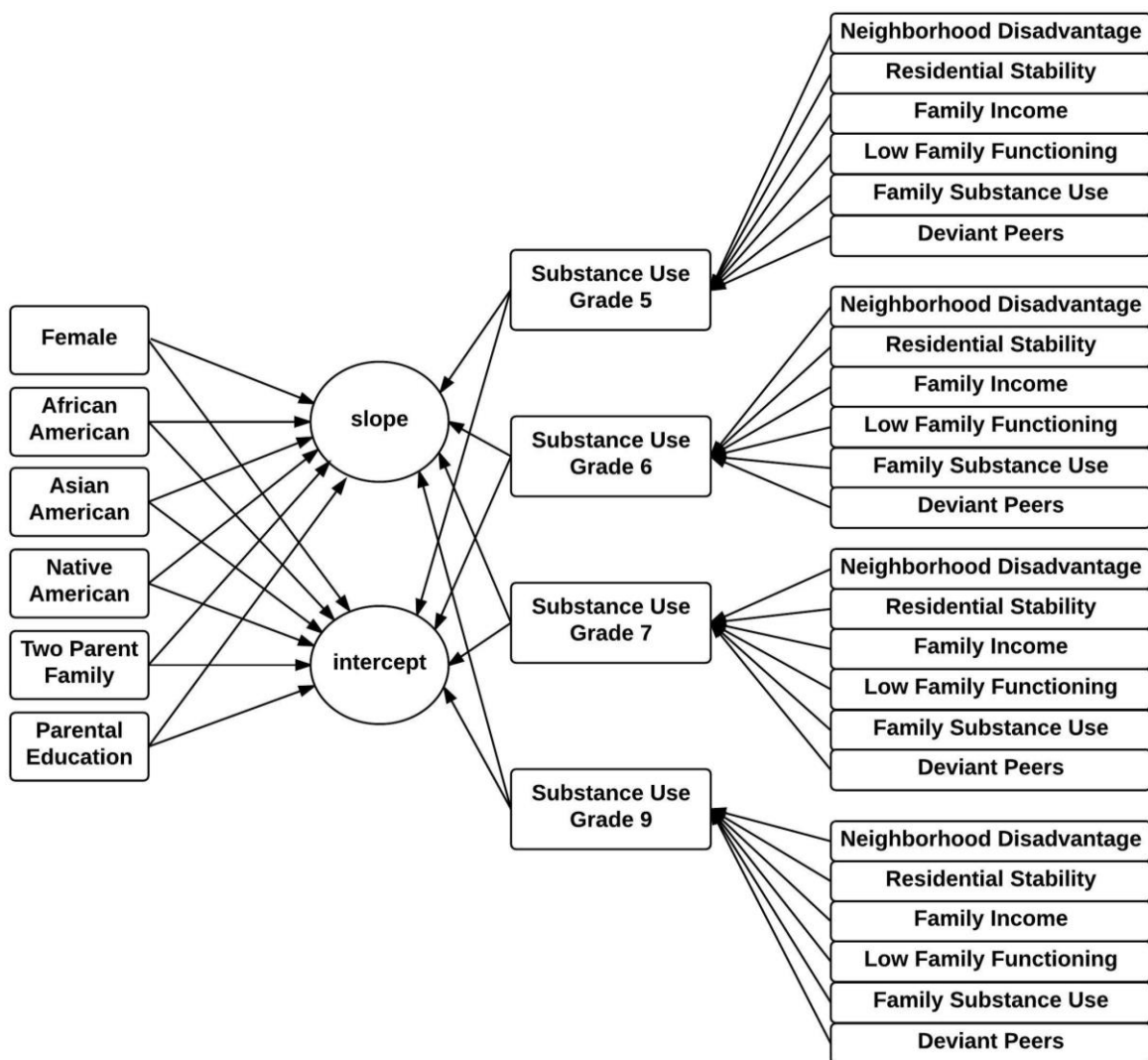
time-varying covariates. As expected, we found significant differences in initial levels of use and growth over time in smoking and alcohol use by time-fixed sociodemographic factors. All results for time-fixed sociodemographic factors described below are after controlling for time-varying neighborhood, family, and peer factors in Model 2. Females had significantly lower levels of initial alcohol use as compared to males and no differences in growth of alcohol use over time. No differences in initial levels of use or growth in smoking were noted for females. African Americans had significantly lower levels of initial smoking and alcohol use as compared to European Americans and no significant differences in growth of either smoking or alcohol use over time.<sup>4</sup> Asian Americans also had lower initial levels of alcohol use and smoking as compared to European Americans. Asian Americans, however, showed faster growth in alcohol use over time as compared to European Americans and no differences for growth in smoking. Native Americans showed no differences in initial levels of smoking and alcohol use and faster growth in both smoking and alcohol use over time as compared to European Americans. Youth living in two parent households had no differences in initial levels of smoking or alcohol use and slower growth in both smoking and alcohol use over time as compared to youth not living in two parent households. No differences in initial levels of use or change in use over time were found for adolescents with at least one college educated parent on either smoking or alcohol use when compared to adolescent without a college educated parent.

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<sup>4</sup> The direction and magnitude of associations between time-fixed sociodemographic factors and both smoking and alcohol use was similar across models; one difference was noted for African Americans. African Americans showed no differences in initial levels of smoking and slower growth in smoking over time as compared to European Americans in Model 1. With the inclusion of time-varying family and peer factors in Model 2, African Americans showed lower initial levels of smoking but no differences in growth in smoking when compared to European Americans. This change is likely attributable to the improved precision in estimation of the growth curve intercept and slope after including time-varying family and peer factors in Model 2.

Results of Model 1 for smoking indicated that greater neighborhood disadvantage was associated with increased smoking after controlling for time-fixed sociodemographic factors and average growth in smoking. No significant association was noted between residential stability and smoking. In Model 2, increased neighborhood disadvantage, low family functioning, family smoking environment, and affiliation with deviant peers were uniquely associated with higher levels of smoking from grades 5 to 9. Higher family income was uniquely associated with lower levels of smoking from grades 5 to 9. The inclusion of time-varying family and peer factors in Model 2 attenuated the association between neighborhood disadvantage and smoking observed in Model 1. Mediation analyses found an indirect effect of neighborhood disadvantage on smoking through both family income and deviant peers in Model 2.

Results of Model 1 for alcohol use found that increased neighborhood disadvantage was associated with higher levels of alcohol use after controlling for time-fixed sociodemographic factors and average growth in alcohol use. No significant association was noted between residential stability and alcohol use. Results of Model 2 for alcohol use showed a similar pattern of unique associations between increased low family functioning, family alcohol use environment, and affiliation with deviant peers and higher levels of alcohol use. No significant association between family income and alcohol use was noted in Model 2. The inclusion of time-varying family and peer factors in Model 2 rendered the association between neighborhood disadvantage and alcohol use observed in Model 1 non-significant. Mediation analyses found an indirect effect of neighborhood disadvantage on alcohol use through affiliation with deviant peers.



*Figure 1.1.* Latent growth curve for past month smoking and alcohol use from grades 5 to 9. Separate models for smoking and alcohol use at each grade were regressed on time-varying measures of neighborhood, family, and peer factors controlling respectively for average growth in smoking and alcohol use from grades 5 to 9.

Table 1.3.  
*Results of latent growth curves for past month smoking and alcohol use*

		Smoking <sup>b</sup>		Alcohol Use <sup>c</sup>	
		Model 1	Model 2	Model 1	Model 2
<u>Time-varying Covariates</u>		Est. (SE)	Est. (SE)	Est. (SE)	Est. (SE)
Neighborhood Disadvantage		.64 (.15) ***	.43 (.14) **	.24 (.11) *	.11 (.10)
Residential Stability		-.02 (.15)	-.04 (.13)	.09 (.10)	.09 (.09)
Family Income			-.53 (.15) ***		-.17 (.10)
Low Family Functioning			.40 (.12) **		.38 (.08) ***
Family Substance Use Environment <sup>a</sup>			.34 (.11) **		.17 (.07) *
Deviant Peers			1.09 (.11) ***		.83 (.07) ***
<u>Time-fixed Covariates</u>					
Female	Int.	-.18 (.37)	-.07 (.37)	-.72 (.26) **	-.54 (.25) *
	Slope	-.03 (.14)	-.03 (.13)	.13 (.09)	.12 (.09)
African American	Int.	-.82 (.49)	-1.18 (.49) *	-.92 (.35) *	-.94 (.35) *
	Slope	-.43 (.18) **	-.29 (.18)	.06 (.12)	.10 (.12)
Asian American	Int.	-2.22 (.65) **	-1.91 (.63) **	-2.43 (.43) ***	-2.12 (.41) ***
	Slope	-.32 (.23)	-.19 (.22)	.29 (.14) *	.38 (.14) *
Native American	Int.	-.40 (.70)	-.83 (.70)	-.99 (.59)	-1.17 (.60)
	Slope	.68 (.24) **	.66 (.23) **	.43 (.17) *	.43 (.18) *
Two Parent Household	Int.	.32 (.47)	.84 (.47)	.49 (.33)	.70 (.33) *
	Slope	-.35 (.17) *	-.32 (.17)	-.29 (.12) **	-.25 (.12) **
Parent College Education	Int.	-.86 (.49)	-.45 (.47)	.03 (.24)	.21 (.29)
	Slope	-.08 (.19)	-.04 (.18)	-.09 (.10)	-.13 (.10)

Table 1.3. (continued)

Intercept & Slope

	Int.	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
	Slope	.65 (.26) *	.74 (.25) **	.19 (.18)	.26 (.16)
Residual Variance	Int.	5.97 (1.4) ***	4.53 (1.1) ***	4.71 (.85) ***	4.31 (.82) ***
	Slope	.67 (.20) **	.61 (.17) **	.42 (.11) ***	.33 (.09) ***
Intercept & Slope Covariance		-.59 (.34)	-.74 (.33) *	-.78 (.22) ***	-.92 (.22) ***
BIC <sup>d</sup>		2187 (2203)	2011 (2032)	3504 (3518)	3296 (3303)

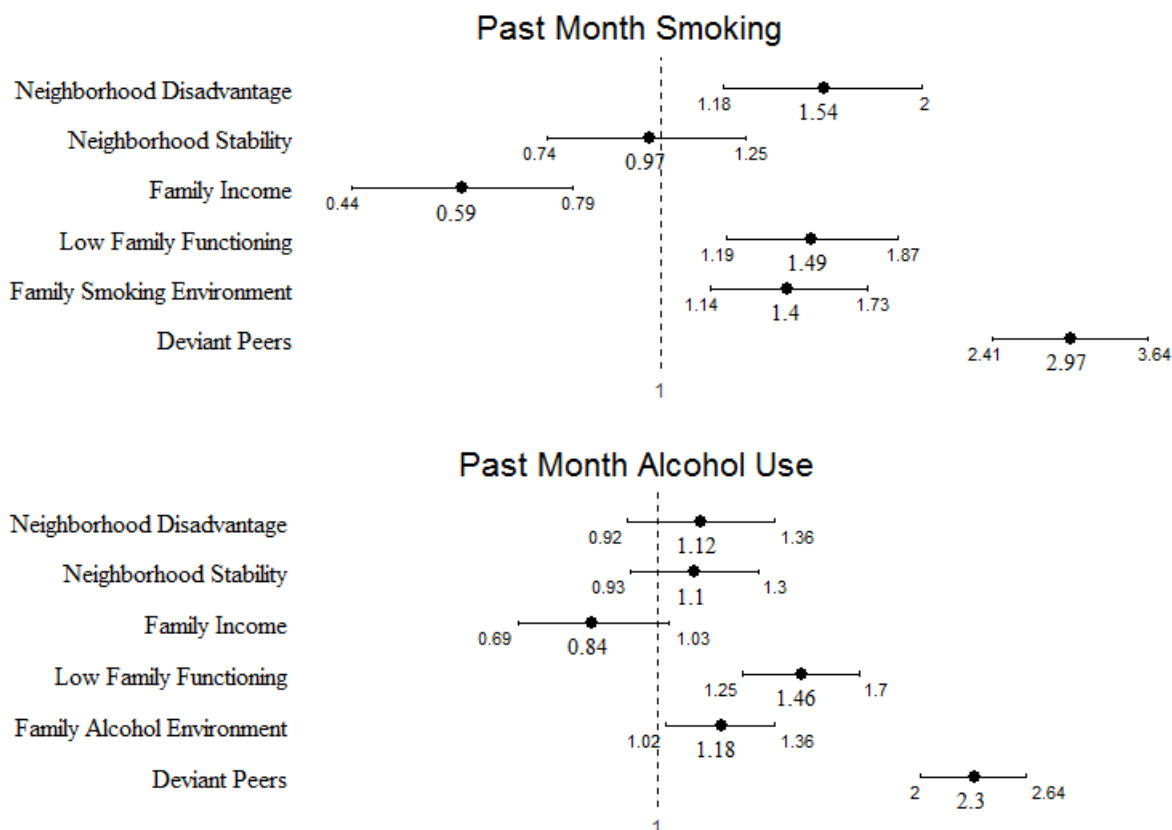
Notes. N=808; \* p<.05, \*\* p<.01 \*\*\* p<.001; Est. = unstandardized estimates; SE = standard error; Int = intercept; time-varying predictors were standardized prior to inclusion in the model and predicted smoking and alcohol use after controlling for the average intercept and growth for the sample; ethnicity variables are compared to European Americans.

a = family smoking environment and family alcohol environment correspond to each outcome respectively.

b = Results of unconditional smoking model with intercept set at 0, intercept variance (Est = 6.58, SE = 1.54), slope (Est = .16, SE = .13), slope variance (Est = .93, SE = .24), BIC (2256).

c = Results of unconditional alcohol use model with intercept set at 0, intercept variance (Est = 5.48, SE = .90),

d = BIC in parenthesis represents fit with additional time-varying covariates unconstrained over time.



*Figure 1.2.* Odds ratios (ORs) and 95% confidence intervals (CIs) for neighborhood, family, and peer factors.

OR and 95% CIs for past month smoking and alcohol use from grades 5 to 9 after controlling for average growth in smoking and alcohol use. Estimates are conditional on sociodemographic differences in overall intercept and slope of smoking and alcohol use. Each OR indicates that a one standard deviation increase in the predictor corresponds to an increase or decrease in the odds of higher levels of smoking or alcohol use across grades 5 through 9. The x-axis is presented on the log scale and CIs that include 1 indicate a non-statistically significant association.

Table 1.4  
*Indirect Effects of Neighborhood Disadvantage on Smoking and Alcohol Use*

	Smoking	Alcohol Use
	Est. (SE)	Est. (SE)
NH Disadvantage -> Family Income		
Indirect Effect	.08 (.03) **	.03 (.02)
Total Effect	.49 (.14) ***	.14 (.10)
NH Disadvantage -> Low Family Functioning		
Indirect Effect	.01 (.01)	.01 (.01)
Total Effect	.43 (.14) **	.13 (.10)
NH Disadvantage -> Family Substance Use Environment <sup>a</sup>		
Indirect Effect	.01 (.01)	.00 (.01)
Total Effect	.42 (.13) **	.12 (.10)
NH Disadvantage -> Deviant Peers		
Indirect Effect	.08 (.03) *	.06 (.03) *
Total Effect	.48 (.14) ***	.18 (.10)

Notes. N=808; \* p<.05, \*\* p<.01, \*\*\* p<.001; Est. = unstandardized estimates; SE = standard error; NH = neighborhood; each mediation model was run separately; all models controlled for associations between sociodemographic, family, and peer factors and each mediator; a = family smoking environment and family alcohol environment corresponded to each outcome.

## Discussion

The results of this study help clarify the role of neighborhood, family, and peer contextual factors in understanding early onset adolescent smoking and alcohol use and, in particular, highlight the an association between neighborhood disadvantage and increased smoking. We are not aware of another study that has examined time-varying measures of neighborhood socioeconomic factors in concert with established family and peer risk factors for early adolescent smoking and alcohol use. Importantly, we find evidence that living in more socioeconomically disadvantaged neighborhoods is associated with early adolescent smoking above and beyond average growth in smoking as well as the impact of low family functioning,

more permissive family smoking environments, affiliations with deviant peers, and a range of key sociodemographic factors. Given that higher family income was also uniquely protective against smoking but not alcohol use, our results suggest that neighborhood-level and family-level socioeconomic factors are particularly relevant for the etiology of early adolescent smoking. This is consistent with findings from prior studies showing that while smoking has decreased across the American population in the past decade, rates have remained persistently higher among those in lower socioeconomic groups (Hill, Amos, Clifford, & Platt, 2014; Leventhal, 2016). Our findings suggest that tobacco-related health disparities associated with neighborhood and family socioeconomic factors are already detectable in early adolescence. Furthermore, given the increased risk of nicotine dependence conferred by early adolescent smoking (Grant, 1998; Kendler et al., 2013), our results suggest that childhood neighborhood and family socioeconomics may impact tobacco-related health disparities across the life course net of other family and peer contextual risk factors.

Future neighborhood-based studies investigating adolescent smoking and alcohol use should note at least three methodological components of this study. First, employing measures of neighborhood socioeconomics across time may improve our ability to detect neighborhood effects by more accurately reflecting neighborhood exposure (Wodtke et al., 2011). Second, our results indicate that the effect of neighborhood socioeconomic disadvantage on smoking and alcohol use was mediated by increased affiliation with deviant peers even after controlling for sociodemographic factors as well as family income, functioning, and permissiveness of substance using environments. Examining only direct effects of neighborhood socioeconomics on adolescent smoking and alcohol use may obfuscate important indirect associations between neighborhoods, other contexts, and adolescent substance use (Fagan et al., 2015). Finally,

neighborhood socioeconomics may differentially impact smoking and alcohol use. Past studies examining the role of neighborhood contexts in adolescent development have not found direct effects of neighborhood socioeconomic disadvantage when collapsing measures of substance use and delinquency together into a more general measure of problem behaviors (Elliott et al., 2006; Elliott et al., 1996). Our results suggest that neighborhood and family-level socioeconomics may operate differentially with respect to early smoking and alcohol use among adolescents.

The current findings also offer evidence for a unique contribution of low general family functioning and more permissive family substance use environments to both adolescent smoking and alcohol use. While general family functioning and substance using family environments have shown relevance for young adult substance use (Bailey et al., 2014; Bailey et al., 2011; Hill et al., 2005; Kosterman et al., 2000), we are not aware of any study that has examined the role general and substance-specific family environments for early adolescent smoking and alcohol use in conjunction with neighborhood socioeconomic factors and deviant peer affiliations. Given the contribution of early smoking and alcohol use to the substantial societal costs associated with smoking and alcohol-related disease and disability across the life-course (Centers for Disease Control Prevention, 2008; Sacks et al., 2015), strategies for preventing or delaying early adolescent smoking and alcohol use by addressing modifiable family and peer risk factors are essential (Catalano et al., 2012; Spoth et al., 1999). Specifically, preventive interventions improving family functioning during adolescence have shown the ability to inhibit deviant peer affiliations and early initiation of substance use (Harrop & Catalano, 2016; Van Ryzin, Stormshak, & Dishion, 2012). Importantly, family functioning and family substance use did not mediate the impact of neighborhood disadvantage on adolescent smoking and alcohol use suggesting the relevance of universal preventive interventions. Future studies explicitly testing

the ability of preventive interventions to mitigate the negative impact of neighborhood disadvantage on deviant peer affiliations and early adolescent substance use can provide important information to practitioners and prevention scientists. Challenges may exist, however, for addressing the direct impact of neighborhood disadvantage on smoking and further clarification of other mechanisms by which neighborhood socioeconomics may impact adolescent smoking is essential. Observational studies have found that socioeconomically disadvantaged neighborhoods contain a higher concentration of tobacco-related advertising which, in turn, has been linked to smoking among adolescents (Henriksen, Schleicher, Feighery, & Fortmann, 2010; Lee, Henriksen, Rose, Moreland-Russell, & Ribisl, 2015). Further research investigating strategies to counteract the negative impact of tobacco marketing on adolescents living in disadvantaged neighborhoods may prove important for addressing tobacco-related health disparities.

It is important to note that family structure and ethnicity remained significantly associated with both smoking and alcohol use after accounting for time-varying neighborhood, family, and peer factors. Adolescents living in two parent households showed slower growth in both smoking and alcohol use. While this finding concurs with previous studies (Blum et al., 2000; Hoffmann & Johnson, 1998), our results suggest the reduced risk for substance use associated with living in a two parent household persists after also accounting for differences in race/ethnicity, neighborhood contexts, family SES, low family functioning, family substance use environments, and affiliations with deviant peers. Further research should investigate the role of family structure in early adolescent growth in smoking and alcohol use. In concert with previous studies with the SSDP sample (Hill et al., 2005; Kosterman et al., 2000) and research with nationally representative data (Blum et al., 2000; Hoffmann & Johnson, 1998), our results also

showed differences in both early adolescent smoking and alcohol use by race/ethnicity. Importantly, these differences were not explained by family structure, neighborhood contexts, low family functioning, family SES, or affiliations with deviant peers. Further research should examine factors related to early adolescent substance use across racial or ethnic groups.

Some limitations of the current study should also be noted. First, the SSDP study was not designed to assess neighborhood effects. As such, there are few students per census block group which precludes multilevel modeling strategies to examine contextual effects (Jackson et al., 2014). Secondly, the SSDP survey did not gather sufficient data to assess the role of parent and peer smoking from grades 5 to 9. Given established associations between SES and smoking among adults (Hiscock et al., 2012) and the importance of peer behavior for adolescent substance use, it is possible that the direct effect of neighborhood disadvantage on adolescent smoking would be partially mediated by a measure of parent and peer smoking. Future analyses should seek to further disentangle general and substance specific environmental risk factors for adolescent substance use.

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## **PAPER 2: NEIGHBORHOOD CONTEXT AND PROXIMAL RISK FACTORS FOR ADOLESCENT SUBSTANCE USE**

### **Adolescent Substance Use**

Preventing substance use can improve both short and long-term health and well-being for youth (Catalano et al., 2012; Office of Surgeon General, 2016; Viner et al., 2012). Adolescent substance use is linked to both immediately preventable harms such as unintentional injury and motor vehicle crashes (Hingson & Zha, 2009) as well as later life problems including substance use disorders, academic failure, interpersonal violence, and mental health issues (Grant & Dawson, 1997; Hanna & Grant, 1999; Hingson & White, 2014). Nationally-representative data from high school students in 2015 estimated that approximately 16% had smoked cigarettes, 25% had 5 or more alcoholic drinks at one time, and 22% had smoked marijuana in the past month (Kann, 2016). A recent report to the Surgeon General highlighted the substantial societal costs connected to substance use and abuse emanating from reduced physical, mental, and social health and called for increased efforts to prevent adolescent substance use (Office of Surgeon General, 2016). Achieving this aim requires acting upon the range of modifiable factors that place adolescents at increased risk for substance use (Catalano et al., 2012; Hawkins et al., 1992a). While researchers have identified key risk factors for substance use in multiple domains of adolescent life including families, peer groups, and school environments, the role that neighborhood factors play in adolescent substance use remains an open and important question (Gardner et al., 2010; Jackson et al., 2014).

### **Neighborhood Context and Adolescent Substance Use**

Social ecological theories of development (Bronfenbrenner, 1977) posit that human behavior is best understood situated within multiple social contexts including neighborhoods, schools, peer groups, and families. A broad range of scholarship has employed social ecological

theories to examine the potential impact of neighborhood contexts on health and well-being (Diez Roux & Mair, 2010; Sampson et al., 2002). Social disorganization theorists have hypothesized that neighborhood structural features such as high poverty, low educational attainment, and lack of stability among residents underlie low levels of informal social control important for inhibiting deviant behavior among youth, a lack of institutional or collective social support mechanisms for parents and children, and a higher concentration of residents engaging in crime and other deviant behaviors (Elliott et al., 1996; Jencks & Mayer, 1990; Sampson et al., 2002). The impact of neighborhood socioeconomic disadvantage is theorized to be transmitted through social processes within the neighborhood (Sampson et al., 2002). While systematic reviews have indicated that living in more socioeconomically disadvantaged neighborhoods is associated with poorer adolescent mental health (Truong & Ma, 2006) and physical health (Sellström & Bremberg, 2006), empirical studies examining the role of neighborhood socioeconomic factors in adolescent cigarette smoking, alcohol use, or marijuana use have largely reported inconsistent findings (Gardner et al., 2010; Hanson & Chen, 2007; Jackson et al., 2014; Karriker-Jaffe, 2011). A range of studies have found neighborhood socioeconomic disadvantage to be associated with both increased or decreased adolescent substance use while many others have found no association (Gardner et al., 2010; Jackson et al., 2014).

Neighborhood scholars, suggesting sources of this inconsistency, have noted that insufficient control variables for family-level characteristics may lead to improper estimation of neighborhood effects. For instance, studies including area-level measures of educational attainment or single-parent families but failing to model family-level parental education and family structure among study participants run the risk of conflating the effects of neighborhood and family socioeconomic factors (Leventhal & Brooks-Gunn, 2000). Others have suggested that

modeling neighborhood socioeconomic factors, but not explicitly considering the social processes or the experience of youth within their neighborhoods, may face challenges in detecting the impact of neighborhoods on adolescent behavior (Sampson et al., 2002). Yet, studies considering both structural features of neighborhoods and social processes have also yielded inconsistent findings in predicting adolescent substance use (Duncan, Duncan, & Strycker, 2002; Ennett, Flewelling, Lindrooth, & Norton, 1997; Fagan et al., 2015; Jackson, Denny, Sheridan, Zhao, & Ameratunga, 2016). Concurrent examinations of multiple neighborhood structural factors and neighborhood social processes across multiple substance use outcomes are needed in order to better understand the dynamics of these associations (Fagan et al., 2015).

### **Proximal Risk Factors for Adolescent Substance Use**

Over the past 30 years, prevention scientists have identified factors that increase risk of substance use located in proximal contexts of adolescent life including schools, peer groups, and families (Hawkins et al., 1992a; Jenson & Bender, 2014). More recently, researchers have highlighted the utility of differentiating general and substance use-specific risk factors within each of these contexts (Bailey et al., 2011). For instance, while meta-analyses have highlighted poor family management practices or weak parent-child bonds as risk factors for substance use (Ryan et al., 2010), studies have also shown unique risks emanating from family environments characterized by high levels of substance use or permissive substance use norms even after accounting for the effects of general family factors not specifically related to substance use (Bailey et al., 2014; Epstein et al., 2013; Hill et al., 2005). Similar findings have been demonstrated across peer and school domains whereby the general features of the environment (i.e. deviant peer groups, weak bonds to school) and substance specific features of the

environment (i.e. alcohol use among close friends, high percentage of students in a school using alcohol) uniquely predict substance using behavior (Kosterman et al., 2000; Lee et al., 2012a; Lee et al., 2014).

Social processes within neighborhoods can also be categorized as general or substance specific and likely represent a more proximal measure of risk in relation to neighborhood structural features. We located only two studies that modeled general and substance specific neighborhood factors in conjunction with neighborhood structural features. Duncan and colleagues (2002) specified a multilevel path model from neighborhood structural factors (i.e. neighborhood poverty measured by the census) to social cohesion (self-report general neighborhood environment) to youth drug and alcohol problems in the neighborhood (i.e. self-report substance specific neighborhood environment) ultimately predicting police records of youth drug and alcohol arrests. While each path significantly predicted the next in the sequence, these analyses did not consider direct effects of objective or general neighborhood features on youth substance use or include controls for family-level SES. Fagan and colleagues (2015) used multilevel models to examine an extensive set of neighborhood structural features, general and substance-specific social processes, and family-level controls predicting adolescent cigarette, alcohol, and marijuana use. Results indicated little evidence for an impact of neighborhood structural factors or neighborhood social processes on adolescent substance use leading the authors conclude that social ecological or disorganization theories may not be applicable to adolescent substance use. Neither of these studies sought to concurrently test general and substance use-specific risk factors across neighborhood, school, peer, and family domains.

Researchers have also examined differences in adolescent substance use by a range of sociodemographic factors. Results from studies employing nationally representative samples

have found that African American youth engage in less smoking and alcohol use compared to Whites (Blum et al., 2000; Hoffmann & Johnson, 1998). These same studies have also shown that adolescents in single-parent households are at increased risk for substance use after controlling for other race/ethnicity and family socioeconomic status (SES). Studies employing multi-ethnic, longitudinal samples have similarly observed less smoking and alcohol use among Asian American and African American youth when compared to Whites after controlling for differences in family SES, family structure, and gender (Catalano et al., 1992; Hill et al., 2005; Kosterman et al., 2000). While epidemiological surveillance and systematic reviews have reported higher rates of smoking among lower SES adults, it remains less clear if this relationship extends to adolescents (Galea et al., 2004; Hanson & Chen, 2007; Hiscock et al., 2012). Systematic reviews of studies examining associations between family SES and adolescent marijuana or alcohol use have identified positive, negative, and null effects of lower family SES on adolescent alcohol or marijuana use (Hanson & Chen, 2007).

### **The Current Study**

Inconsistent findings across empirical studies assessing the impact of neighborhood contexts on adolescent substance use paired with the consistency of findings demonstrating the importance of school, peer, and family contexts for adolescent substance use warrant concurrent examination of neighborhood contexts with other domains of proximal risk factors for adolescent substance use. To our knowledge, the current study is the first to examine objective measures of neighborhood socioeconomic factors (neighborhood disadvantage and residential stability) concurrently with both general and substance use-specific risk factors across neighborhood, school, peer, and family domains as well as a broad range of sociodemographic controls in predicting adolescent cigarette smoking, binge drinking, marijuana use, and polysubstance use.

We hypothesized that both general and substance specific risk factors within schools, peer groups, and families would be associated with increased likelihood of substance use among adolescents in the 9<sup>th</sup> grade.

### **Sample**

Data were drawn from the Seattle Social Development Project (SSDP), a longitudinal, theory-driven study originating in 18 Seattle elementary schools and over-representing schools serving high crime neighborhoods. SSDP conducted paper and pencil interviews in 1985 with 808 students in the 5<sup>th</sup> grade when most participants were 10 years old ( $M = 10.3$ ,  $SD = .52$ ). The 808 respondents accounted for 77% of 1,053 5<sup>th</sup> grade students initially invited to participate in the study. Retention rates for the participating sample in grade 9 was 97%. Of the longitudinal sample, 49% were female, 46% were European American, 24% were African American, 21% were Asian American, and 5% were Native American. The current study employs data from 766 participants with available home address data at grade 9.

### **Measures**

Descriptive statistics are presented in Table 1. All constructs are measured at the 9<sup>th</sup> grade except for early initiation of substance use measured at the 5<sup>th</sup> grade.

*Past month smoking, binge drinking, marijuana use.* Participants responded to three questions indicating the number of times in the past month they smoked cigarettes, had 5 or more drinks in a row, or smoked marijuana. Each question was coded such that 0 = no past month use and 1 = any past month use. Participants missing on past month smoking, binge drinking, or marijuana use questions at the 9<sup>th</sup> grade who also consistently reported no lifetime cigarette, alcohol, or

marijuana use at previous and later waves of data were set to 0.<sup>5</sup> Dichotomized measures for past month smoking, binge drinking, and marijuana use were summed to create a four category ordinal variable for past month polysubstance use.

*Early initiation smoking, alcohol use, marijuana use.* Dichotomous measures of ever smoking a cigarette, drinking alcohol, or smoking marijuana in their lifetime were drawn from three questions asked at the 5<sup>th</sup> grade and coded as 0 = never used or 1 = ever used. Responses were summed to create a measure of 5<sup>th</sup> grade polysubstance use.

*Neighborhood.* Principal components analysis (PCA) summarizing 10 block group-level variables from the 1990 census were used to measure objective neighborhood factors. Participants were located in 419 block groups with an average of 1.8 students per block group. Two factors scores from the PCA represented *socioeconomic disadvantage* and *residential stability*. Identical measures of neighborhood context derived from the census have been employed by other studies (Herrenkohl et al., 2002). Research has indicated that census block groups containing roughly 2,000 to 3,000 residents most closely reflect adolescent perceptions of their neighborhood (Elliott et al., 2006). Table 2 reports census items and PCA results. Higher scores on the neighborhood disadvantage factors indicated neighborhoods with lower socioeconomic resources and higher scores on the residential stability factor indicated more stable resident populations. Measures of youth experience with their neighborhood environment were constructed from self-report data. A mean scale of *negative general neighborhood environment* were drawn from 11 questions concerning neighborhood bonding, feelings of safety, and the presence of gangs, crime, rowdy or undesirable people, or kids who got in trouble (internal consistency = .87). All items were coded such that higher scores indicated low bonding,

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<sup>5</sup> Descriptions of other waves of data collection have been published elsewhere (Kosterman et al., 2000).

low safety, and more gangs, crime, rowdy people, or kids who got in trouble in the neighborhood. *Neighborhood alcohol environment* was measured by a single question asking the number of adults the participant knew that have been drunk in the last year. An index of *neighborhood drug environment* was constructed from the mean of three questions concerning the number of adults the youth knew who sold drugs, the number of adults the youth knew who used marijuana or other drugs, and if there was drug selling in their neighborhood. The natural log was taken for each item of the number of adults known who got drunk, sold drugs, or used drugs. All items were coded such that higher scores indicated more exposure to neighborhood alcohol and drug environments.

*School.* A mean scale of *negative general school environment* was constructed from youth answers to 18 questions concerning school opportunities, involvement, rewards, and bonding (internal consistency = .85). Opportunity questions asked about chances to get involved in classroom and extracurricular activities, involvement questions asked about the extent to which youth were involved in classroom and extracurricular activities, rewards questions asked about positive or negative feedback the youth received from teachers, and bonding questions asked about strength of connections with school and teachers. All items were coded such that higher scores indicated low opportunities, involvement, rewards, and bonding. An index of *school alcohol environment* was measured as the mean of two questions gauging the youth's perceptions of the percent of students who drank alcohol in the past year and whether people at school thought it was acceptable for students to drink alcohol. An index of *school drug environment* was measured as the mean of two questions gauging the youth's perception of the percent of students who smoked marijuana in the past year and whether people at school thought

it was acceptable for students to smoke marijuana. All items were coded such that higher scores indicated more exposure to school alcohol and drug environments.

*Peer.* A mean scale of *negative general peer environment* was constructed from youth answers to 14 questions concerning antisocial behavior of their three best friends and opportunities for antisocial behavior among peer groups (internal *consistency* = .76). Antisocial behavior of friends questions asked about getting in trouble with teachers or other adults, respondents gang involvement, and numbers of kids the respondent knew that were in a gang. Antisocial opportunity questions included being asked to do illegal things by three best friends or being asked to join a gang. The natural log was taken for the number of kids known who were in gangs. All items were coded such that higher scores indicated more antisocial friends or opportunities. An index of *peer alcohol environment* was created from the mean of 7 questions asking if the participant's three best friends drank alcohol without their parents' permission or drank alcohol within the past year and the number of kids the participant knew who drank alcohol without parental permission. An index of *peer drug environment* was created from the mean of 4 questions asking if the participant's three best friends had smoked marijuana and the number of kids the participant knew who smoked marijuana or used other drugs. The natural log was taken for each measure of the number of kids known who drank alcohol or used drugs. All items were coded such that higher scores indicated more exposure to peer alcohol and drug environments.

*Family.* *Family income* was reported by parents and measured by a seven category question with response options ranging from less than \$5,000 to greater than \$40,000 annual income. *Two parent household* was measured by a series of questions indicating family structure and was coded as 1 for two acting parents present and 0 for two acting parents not present. *Parent college*

*education* was indicated by the maximum of educational attainment of the mother and father and was coded as 1 for at least one parent completing a 4-year college degree and 0 for neither parent completing a college degree. Family income, structure, and parent education were reported by parents of study participants. A mean scale of *negative general family environment* was constructed from youth answers to 24 questions concerning family management, conflict, involvement, and bonding (internal consistency = .86). Management questions asked about parental monitoring and communication, conflict questions asked about problem solving strategies, involvement questions asked about a range of shared activities between parent and child, and bonding questions asked about the child's connection with parents and sibling. All items were coded such that higher scores indicated poor management, high conflict, low involvement, and low bonding. An index of *family smoking environment* was created from the mean of 4 questions. Parents reported their perceived harm from smoking cigarettes, their hypothetical response to their child smoking cigarettes, and if the child has ever smoked a cigarette with their permission. Youth reported if they had any siblings who smoked cigarettes. An index of *family alcohol environment* was constructed from the mean of 11 questions regarding parent or sibling alcohol use and family norms regarding alcohol use. Parents reported the quantity and frequency of alcohol consumption for themselves and their spouse, their perceived harm from alcohol use, and their hypothetical response to their child drinking alcohol at a party. Youth reported if their parents had given them permission to drink alcohol or if they had sibling who drank alcohol. An index of *family drug environment* was constructed from the mean of 6 questions regarding parent or sibling drug use and family norms regarding marijuana use. Parents reported the frequency of marijuana use for themselves and their spouse, perceived harm from marijuana use, and their hypothetical response to their child smoking marijuana.

Youth reported if they had any siblings who used marijuana or other drugs. All items were coded such that higher scores indicated more exposure to cigarette smoking, alcohol use, and drug environments or more permissive cigarette, alcohol, or marijuana norms.

Table 2.1.  
*Sample descriptive statistics*

Variable	M	SD	Min	Max	Variable	M (%)	SD	Min	Max
Neighborhood Objective (census)					Past Month Substance Use				
NH Disadvantage	.00	1.00	-1.40	5.67	Cigarette Smoking	18%	-	0	1
Residential Stability	.00	1.00	-2.81	2.24	Binge Drinking	8%	-	0	1
Neighborhood Experience					Marijuana Use				
Negative NH General	1.83	.58	1.00	4.00	Polysubstance Use	.33	.68	0	3
NH Alcohol Env.	1.23	1.02	.00	5.53	1 substance only	14%	-	-	-
NH Drug Env.	.62	.79	.00	4.86	2 substances	6%	-	-	-
NH Polysubstance Env. <sup>1</sup>	.93	.81	.00	5.02	3 substances	2%	-	-	-
School					Early Initiation Substance Use <sup>2</sup>				
Negative School General	2.10	.41	1.00	3.60	Cigarette Smoking	17%	-	0	1
School Alcohol Env.	1.93	.90	.00	3.50	Alcohol Use	37%	-	0	1
School Drug Env.	1.24	.90	.00	3.50	Marijuana Use	5%	-	0	1
School Polysubstance Env. <sup>1</sup>	1.59	.83	.00	3.50	Polysubstance Use	.57	.80	0	3
Peer					Sociodemographics				
Negative Peer General	1.44	.33	1.00	2.98	Two Parent Household	61%	-	0	1
Peer Alcohol Env.	.67	.48	.00	2.51	Parent College Education	25%	-	0	1
Peer Drug Env.	.42	.52	.00	3.26	Family Income	4.99	1.85	1	7
Peer Polysubstance Env. <sup>1</sup>	.55	.46	.00	2.89	Family Housing Instability	2.16	1.11	1	5
Family					Female				
Negative Family General	2.26	.44	1.00	3.80	African American	26%	-	0	1
Family Smoking Env.	.50	.37	.00	1.67	Asian American	22%	-	0	1
Family Alcohol Env.	.73	.44	.00	2.42	Native American	5%	-	0	1
Family Drug Env.	.28	.33	.00	2.78					
Family Polysubstance Env. <sup>1</sup>	.50	.31	.00	1.75					

*Notes.* N = 766, M = mean, SD = standard deviation, NH = neighborhood, Env. = environment, 1 = polysubstance environments are the mean of available measures of alcohol, drug, and smoking environments within each domain, 2 = initiation of lifetime substance use by the 5th grade.

Table 2.2.  
*Principal components analysis for census-based measures*

Variable	Neighborhood Disadvantage	Residential Stability	M	SD	Min	Max
Percent single-parent, female-headed households	.90	-.05	14.15	9.44	2.13	60.12
Percent of individuals receiving public assistance income	.85	-.18	9.50	10.82	.00	64.41
Percent of adults without high school diploma	.83	.03	19.35	12.40	.00	64.69
Percent of youth (ages 10-17)	.80	.39	9.42	3.58	1.09	21.39
Percent of families in poverty	.80	-.29	10.86	14.44	.00	86.81
Number of racial groups with 10% or more representation	.78	.23	1.86	.89	1.00	4.00
Percent of females unemployed	.66	-.17	5.80	6.73	.00	52.86
Percent of males unemployed	.69	-.11	6.70	6.89	.00	56.14
Percent of individuals living in same residence for 5+ years	.14	.91	48.46	13.83	5.42	86.87
Percent of owner-occupied homes	-.29	.81	59.90	24.37	.00	100.00
Eigenvalue	5.18	1.90				
Percent of variance	.52	.19				

*Notes.* N = 766 in 419 census block groups, M = mean, SD = standard deviation.

### **Analytic Strategy**

Logistic regression was used to examine associations between covariates and the likelihood of past month cigarette smoking, binge drinking, and marijuana use; ordinal logistic regression was used for polysubstance use.<sup>6</sup> All non-binary covariates across neighborhood, school, peer, and family domains were standardized prior to analysis. Results from each model are presented as odds ratios with 95% confidence intervals. For each substance use outcome, six domain-specific models independently considered objective neighborhood, experienced neighborhood, school, peer, family, and sociodemographic factors. All models included covariates for sociodemographic factors and early initiation of substance use. A fully controlled model including all domains simultaneously, sociodemographic factors, and early initiation of

<sup>6</sup> Multilevel models were also tested and produced substantively similar results.

substance use was also estimated for each outcome. For each substance use outcome, the corresponding substance use-specific environmental risk factors and measure of early initiation were employed. For example, models for adolescent marijuana use considered neighborhood, school, peer, and family drug use environments and controlled for early initiation of marijuana use; models for binge drinking employed neighborhood, school, peer, and family alcohol use environments and controlled for early initiation of alcohol use. Measures assessing neighborhood, school, or peer cigarette smoking environments were not available in our data and averages of alcohol and drug environments were used as a proxy in models predicting cigarette smoking. Polysubstance use environment in each domain was constructed from the average of smoking, alcohol, and drug specific environmental risk factors within each domain. Missing data were handled via the multiple imputation procedure in Mplus and 40 datasets were created (Asparouhov & Muthén, 2010). Data were present for over 98% of possible data points across the 35 variables used in these analyses (26,307 out of 26,810). Data were analyzed using the maximum likelihood estimator for robust standard errors (MLR) for categorical outcomes in Mplus 7.1, standard errors were clustered at the block group level, and reported results were combined across the 40 imputed datasets according to Rubin's rules (Muthén & Muthén, 2006).<sup>7</sup>

## Results

Bivariate correlations among variables are presented in Table 3. Odds ratios and 95% confidence intervals for all models are presented in Table 4 and a graphical comparison across outcomes of fully controlled models is depicted in Figure 1. Domain-specific models found that the odds of past month cigarette smoking increased with higher neighborhood disadvantage

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<sup>7</sup> Some SSDP participants received a social development intervention during elementary school (Hawkins et al., 1992b). Sensitivity tests controlling for the intervention in all domain models did not show any substantive changes to the reported results.

(OR=1.35), neighborhood polysubstance use (OR=1.91), negative general school experiences (OR=1.31), school polysubstance use (OR=1.54), peer substance use (OR=2.20), negative general family experiences (OR=1.29), and family smoking (OR=1.89). In the fully controlled model considering all domains of risk, sociodemographic factors, and early initiation of cigarette use simultaneously, odds of cigarette smoking increased with greater neighborhood disadvantage (OR=1.30), peer polysubstance use (OR=2.03), and family smoking (OR=1.64). In the fully controlled model, odds of cigarette smoking were lower for youth identifying as African American (OR=.24) and Asian American (OR=.36) as compared to European Americans and for youth from higher SES families (OR=.73).

Domain-specific models found that the odds of past month binge drinking increased with higher neighborhood disadvantage (OR=1.34), neighborhood alcohol use (OR=1.99), school alcohol use (OR=2.95), negative general peer experiences (OR=1.78), peer alcohol use (OR=3.64), more negative general family experiences (OR=1.45). In the fully controlled model considering all domains of risk, sociodemographic factors, and early initiation of alcohol use simultaneously, odds of binge drinking increased with higher levels of neighborhood disadvantage (OR=1.53), school alcohol use (OR=1.77), negative general peer environment (OR=1.60), and peer alcohol use (OR=3.48). No differences in odds of binge drinking were noted by sociodemographic factors in the fully controlled model.

Domain-specific models found that the odds of past month marijuana use increased with higher neighborhood drug use (OR=2.58), negative general school experiences (OR=1.34), school drug use (OR=3.31), negative general peer experiences (OR=1.53), peer drug use (OR=2.61), more negative general family experiences (OR=1.60), and family drug use (OR=1.64). In the fully controlled model considering all domains of risk, sociodemographic

factors, and early initiation of marijuana use simultaneously, odds of marijuana increased with greater school drug use (OR=1.83) and peer drug use (OR=2.08). In the fully controlled model, youth with at least one parent with a college degree had lower odds of marijuana use (OR=.36) and no differences were noted by other sociodemographic factors.

Domain-specific models found that the odds of using any additional type of substance (cigarette smoking, binge drinking, or marijuana use) increased with higher neighborhood disadvantage (OR=1.34), neighborhood polysubstance use (OR=2.33), negative general school experiences (OR=1.31), school polysubstance use (OR=2.10), negative general peer experiences (OR=1.36), peer polysubstance use (OR=2.54), negative general family experiences (OR=1.36), and family polysubstance use (OR=1.75). In the fully controlled model, odds of using any additional type of substance increased with greater neighborhood disadvantage (OR=1.38), neighborhood polysubstance use (OR=1.41), peer polysubstance use (OR=2.13), and family polysubstance use (OR=1.26). In the fully controlled model, odds of using any additional type of substance were lower for youth identifying as African American (OR=.31) and Asian American (OR=.41) as compared to European Americans and for youth from higher SES families (OR=.69).

Table 5 provides the proportion of variance explained by domain-specifics model and the all domain models described in Table 4. Domain-specific models controlled for sociodemographic factors and early initiation of substance use. The peer domain-specific model predicted the highest proportion of variance in past month cigarette smoking, binge drinking, and polysubstance use when compared to other domain-specific models. The school domain-specific model predicted the highest proportion of variance in past month marijuana use (.43 as compared to .40 for the peer domain). The neighborhood objective domain models consistently predicted

the smallest proportion of variance as compared to other domains (ranging from .17 for binge drinking to .24 for cigarette smoking and polysubstance use). Fully controlled models predicted 41%, 58%, 48%, and 45% of the variance in past month cigarette smoking, binge drinking, marijuana use, and polysubstance use respectively.



Table 2.3. (continued)

		Neighborhood					School			Peers			Family				Substance Use								Sociodemographics				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Polysubstance Use (PM)	<b>16</b>	.14	-.20	.21	.47	.44	.22	.41	.43	.47	.55	.53	.26	.36	.31	.34	-												
Smoking (PM)	<b>17</b>	.14	-.21	.22	.40	.35	.16	.28	.30	.35	.45	.43	.19	.40	.30	.36	.96	-											
Binge Drinking (PM)	<b>18</b>	.16	-.21	.15	.43	.34	.25	.46	.39	.48	.63	.39	.26	.27	.24	.13	.94	.65	-										
Marijuana Use (PM)	<b>19</b>	.10	-.12	.23	.51	.50	.27	.53	.57	.52	.56	.51	.33	.26	.30	.39	.95	.68	.67	-									
Polysubstance Use (G5)	<b>20</b>	-.06	-.09	.07	.20	.18	.12	.18	.15	.17	.26	.17	.16	.15	.20	.14	.26	.29	.24	.24	-								
Smoking (G5)	<b>21</b>	.02	-.10	.04	.21	.16	.16	.22	.21	.18	.25	.23	.15	.16	.11	.13	.32	.36	.25	.28	.99	-							
Alcohol Use (G5)	<b>22</b>	-.16	-.04	.05	.15	.12	.08	.16	.09	.16	.24	.09	.14	.12	.23	.09	.18	.17	.26	.13	.97	.57	-						
Marijuana Use (G5)	<b>23</b>	.12	-.26	.17	.31	.31	.21	.12	.19	.12	.24	.25	.18	.14	.14	.25	.35	.47	-.06	.33	.92	.75	.50	-					
Two Parent Household	<b>24</b>	-.20	.16	-.19	-.20	-.28	-.16	-.21	-.27	-.23	-.17	-.21	-.16	-.17	-.10	-.15	-.21	-.20	-.17	-.18	-.07	-.06	-.05	-.23	-				
Parent College Education	<b>25</b>	-.38	.20	-.25	-.15	-.29	-.06	.04	-.09	-.04	.09	-.07	-.07	.00	.08	-.07	-.21	-.17	-.07	-.28	.05	-.07	.12	-.13	.23	-			
Family Income	<b>26</b>	-.42	.27	-.24	-.11	-.26	-.03	.03	-.16	-.12	.02	-.17	-.09	-.06	.08	-.05	-.24	-.23	-.19	-.22	.11	.03	.17	-.03	.51	.58	-		
Family Housing Instability	<b>27</b>	.07	-.23	.14	.13	.12	.02	.10	.15	.14	.09	.14	.03	.07	.02	.17	.19	.12	.20	.25	-.02	-.02	-.04	.04	-.22	-.20	-.21	-	
Female	<b>28</b>	.05	.02	.02	.04	.08	-.11	.20	.18	-.15	.01	.07	-.10	.00	.00	.06	.01	.03	-.14	.04	-.18	-.11	-.23	-.04	-.07	-.10	-.07	.05	
African American	<b>29</b>	.32	-.06	.22	.03	.35	.05	.22	.30	.23	.04	.12	.05	-.05	-.11	.03	-.08	-.21	-.09	.08	-.09	-.14	-.05	-.03	-.52	-.21	-.34	.14	
Asian American	<b>30</b>	.36	.01	.03	-.21	-.35	-.05	-.49	-.44	-.30	-.43	-.43	.00	-.20	-.40	-.46	-.27	-.23	-.15	-.37	-.33	-.18	-.38	-.25	.38	-.16	-.18	-.12	
Native American	<b>31</b>	.08	-.06	.13	.25	.25	-.04	.15	.19	.13	.24	.28	-.05	.24	.22	.28	.46	.46	.38	.43	.17	.27	-.09	.50	-.05	-.08	-.08	.10	

Notes. N=766; NH = Neighborhood; Env. = Environment; PM = Past Month; G5 = Early initiation measured at grade 5.

Table 2.4.

*Odds ratios [95% confidence intervals] for domain-specific and fully controlled models*

Variable	<u>Cigarette Smoking</u>		<u>Binge Drinking</u>		<u>Marijuana Use</u>		<u>Polysubstance Use</u>	
	Domain-Specific	All Domains	Domain-Specific	All Domains	Domain-Specific	All Domains	Domain-Specific	All Domains
<u>Neighborhood Objective (census)</u>								
NH Disadvantage	<b>1.35</b> [1.11 - 1.64]	<b>1.30</b> [1.03 - 1.64]	<b>1.34</b> [1.03 - 1.74]	<b>1.53</b> [1.02 - 2.32]	1.22 [.94 - 1.58]	1.11 [.76 - 1.61]	<b>1.34</b> [1.13 - 1.60]	<b>1.38</b> [1.12 - 1.72]
Residential Stability	.91 [.73 - 1.13]	.87 [.69 - 1.11]	.89 [.65 - 1.22]	.86 [.59 - 1.24]	1.15 [.85 - 1.54]	1.10 [.74 - 1.63]	.99 [.82 - 1.20]	.94 [.74 - 1.18]
<u>Neighborhood Experience</u>								
Negative NH General	1.23 [1.00 - 1.52]	1.08 [.84 - 1.40]	1.10 [.82 - 1.46]	.69 [.46 - 1.04]	.89 [.65 - 1.23]	.72 [.47 - 1.11]	1.09 [.90 - 1.31]	.85 [.67 - 1.08]
NH Substance Use Env.	<b>1.91</b> [1.50 - 2.42]	1.35 [.99 - 1.85]	<b>1.99</b> [1.51 - 2.62]	1.22 [.87 - 1.70]	<b>2.58</b> [1.96 - 3.39]	1.33 [.92 - 1.93]	<b>2.33</b> [1.87 - 2.91]	<b>1.41</b> [1.05 - 1.89]
<u>School</u>								
Negative School General	<b>1.31</b> [1.07 - 1.60]	1.15 [.89 - 1.49]	1.18 [.90 - 1.56]	.94 [.66 - 1.34]	<b>1.34</b> [1.02 - 1.77]	1.10 [.75 - 1.59]	<b>1.31</b> [1.08 - 1.60]	1.14 [.90 - 1.44]
School Substance Use Env.	<b>1.54</b> [1.20 - 1.97]	.84 [.62 - 1.15]	<b>2.95</b> [2.00 - 4.35]	<b>1.77</b> [1.13 - 2.78]	<b>3.31</b> [2.45 - 4.49]	<b>1.83</b> [1.24 - 2.71]	<b>2.10</b> [1.65 - 2.67]	1.15 [.87 - 1.51]
<u>Peer</u>								
Negative Peer General	1.11 [.85 - 1.46]	1.00 [.74 - 1.34]	<b>1.78</b> [1.31 - 2.4]	<b>1.60</b> [1.12 - 2.27]	<b>1.53</b> [1.12 - 2.08]	1.24 [.84 - 1.83]	<b>1.36</b> [1.10 - 1.70]	1.21 [.96 - 1.53]
Peer Substance Use Env.	<b>2.20</b> [1.71 - 2.83]	<b>2.03</b> [1.51 - 2.72]	<b>3.64</b> [2.34 - 5.66]	<b>3.48</b> [2.13 - 5.69]	<b>2.61</b> [1.97 - 3.44]	<b>2.08</b> [1.52 - 2.84]	<b>2.54</b> [2.02 - 3.20]	<b>2.13</b> [1.65 - 2.75]
<u>Family</u>								
Negative Family General	<b>1.29</b> [1.02 - 1.63]	.92 [.69 - 1.23]	<b>1.45</b> [1.10 - 1.92]	1.08 [.75 - 1.57]	<b>1.60</b> [1.20 - 2.12]	1.18 [.80 - 1.74]	<b>1.36</b> [1.10 - 1.67]	.98 [.76 - 1.27]
Family Substance Use Env.	<b>1.89</b> [1.57 - 2.28]	<b>1.64</b> [1.35 - 1.99]	1.33 [.99 - 1.77]	.93 [.65 - 1.32]	<b>1.64</b> [1.33 - 2.02]	1.12 [.87 - 1.44]	<b>1.75</b> [1.46 - 2.10]	<b>1.26</b> [1.03 - 1.53]

Table 2.4. (continued)

Variable	<u>Cigarette Smoking</u>		<u>Binge Drinking</u>		<u>Marijuana Use</u>		<u>Polysubstance Use</u>	
	Domain-Specific	All Domains	Domain-Specific	All Domains	Domain-Specific	All Domains	Domain-Specific	All Domains
<u>Sociodemographics</u>								
Two Parent Household	.92 [.58 - 1.48]	1.02 [.63 - 1.67]	.89 [.47 - 1.69]	1.09 [.53 - 2.25]	1.23 [.62 - 2.40]	1.33 [.57 - 3.10]	.96 [.63 - 1.48]	1.12 [.69 - 1.83]
Parent College Education	.74 [.43 - 1.28]	.83 [.46 - 1.49]	.91 [.43 - 1.93]	.97 [.39 - 2.44]	.44 [.19 - 1.01]	<b>.36</b> [.13 - .99]	.62 [.37 - 1.04]	.67 [.37 - 1.21]
Family Income	<b>.59</b> [.46 - .76]	<b>.73</b> [.55 - .98]	.71 [.50 - 1.01]	.71 [.46 - 1.09]	.74 [.52 - 1.05]	.99 [.61 - 1.62]	<b>.60</b> [.47 - .76]	<b>.69</b> [.52 - .93]
Family Housing Instability	1.09 [.90 - 1.32]	1.00 [.79 - 1.26]	1.19 [.94 - 1.51]	1.11 [.82 - 1.48]	1.21 [.98 - 1.50]	1.19 [.91 - 1.57]	1.16 [.99 - 1.35]	1.07 [.89 - 1.27]
Female	.93 [.62 - 1.4]	.88 [.53 - 1.46]	.64 [.36 - 1.14]	.52 [.25 - 1.05]	1.13 [.65 - 1.96]	1.02 [.51 - 2.03]	1.00 [.69 - 1.44]	.87 [.56 - 1.37]
African American	<b>.36</b> [.19 - .66]	<b>.24</b> [.11 - .51]	.56 [.25 - 1.25]	.34 [.11 - 1.05]	1.04 [.52 - 2.05]	.62 [.25 - 1.55]	<b>.51</b> [.32 - .83]	<b>.31</b> [.16 - .60]
Asian American	<b>.26</b> [.14 - .50]	<b>.36</b> [.16 - .79]	.61 [.25 - 1.52]	1.43 [.49 - 4.22]	<b>.21</b> [.07 - .64]	.58 [.13 - 2.62]	<b>.26</b> [.14 - .49]	<b>.41</b> [.20 - .87]
Native American	<b>3.72</b> [1.71 - 8.13]	1.96 [.68 - 5.66]	<b>4.05</b> [1.56 - 1.47]	2.71 [.73 - 10.08]	<b>2.37</b> [1.01 - 5.55]	1.66 [.52 - 5.28]	<b>3.66</b> [1.84 - 7.27]	1.69 [.70 - 4.08]
<u>Early Initiation Substance Use</u>	<b>2.78</b> [1.72 - 4.52]	<b>1.83</b> [1.06 - 3.17]	<b>2.50</b> [1.35 - 4.62]	2.08 [.97 - 4.47]	<b>3.16</b> [1.35 - 7.41]	2.23 [.81 - 6.19]	<b>1.60</b> [1.32 - 1.95]	1.22 [.98 - 1.51]

*Notes.* N=766; **bold** indicates  $p < .05$ ; NH= neighborhood; Env. = environment; substance use-specific environmental risk factors and early initiation measures in each model reflect constructs relevant to that outcome (i.e. NH substance use environment = NH alcohol environment for the binge drinking model and NH substance use environment = NH drug environment for the marijuana use model); neighborhood, school, and peer alcohol and drug environment measures are used as a proxy for the cigarette smoking; each domain-specific model accounts for sociodemographic factors and early initiation; all domain models include all covariates simultaneously; all neighborhood, school, peer, and family risk factors were standardized prior to analysis; race/ethnicity variables are compared to European Americans.

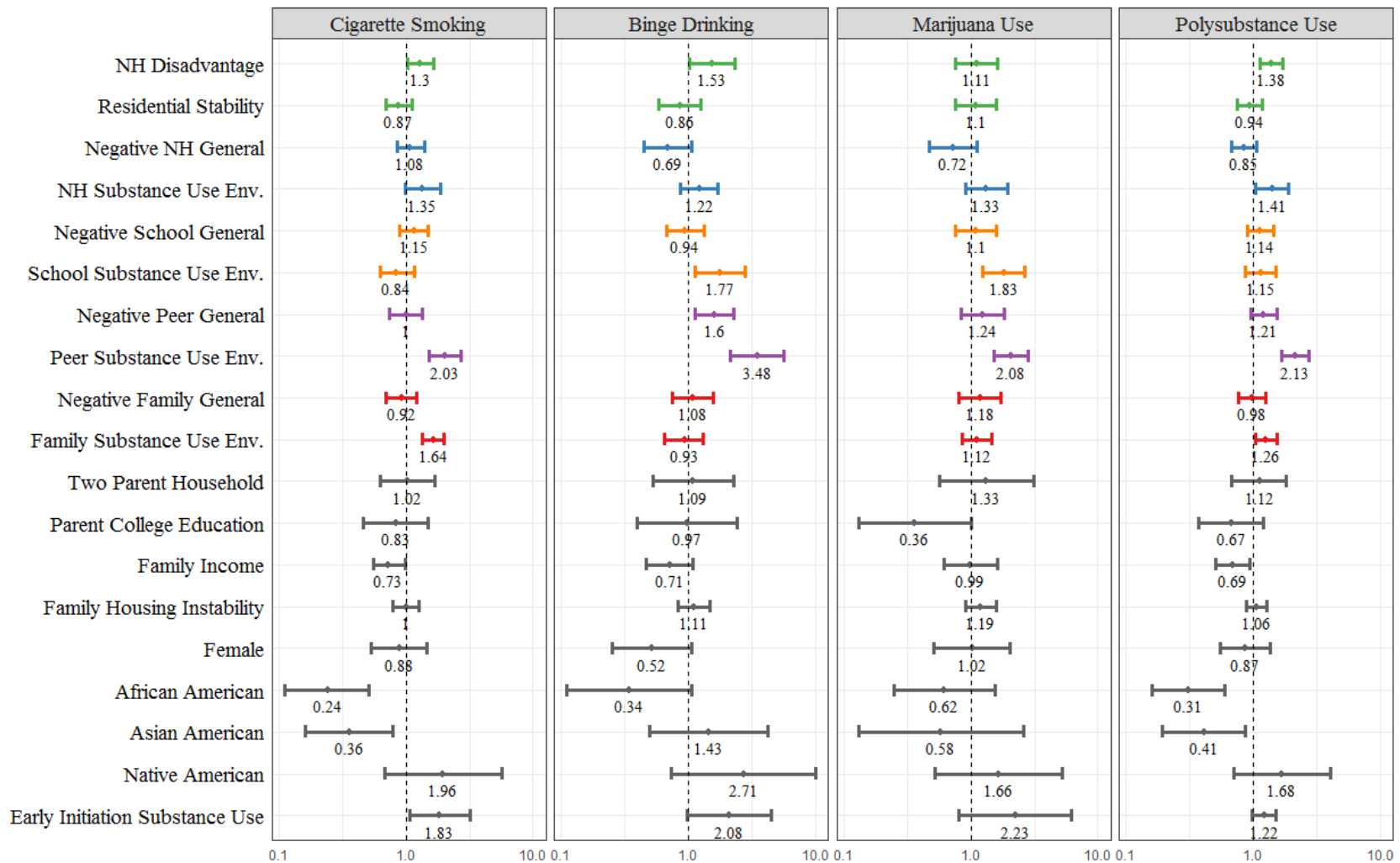


Figure 2.1. Odds ratios (ORs) and 95% confidence intervals (CIs) for fully controlled models of past month smoking, binge drinking, marijuana use, and polysubstance use. CIs crossing the dotted line indicate a non-significant association. Substance use-specific environmental risk factors and early initiation measures in each model reflect constructs corresponding to that outcome (i.e. peer substance use environment = peer alcohol environment for the binge drinking model and peer substance use environment = peer drug environment for the marijuana use model). An average of neighborhood, school, and peer alcohol and drug measures are used as a proxy in the cigarette smoking model.

Table 2.5.  
*Proportion of variance explained in past month substance use by domain*

Models	Cigarette Smoking	Binge Drinking	Marijuana Use	Polysubstance Use
Domain-specific				
Neighborhood Objective (census)	.24	.17	.23	.24
Neighborhood Experience	.31	.25	.31	.33
School	.27	.35	.43	.34
Peer	.33	.51	.40	.40
Family	.31	.20	.30	.29
All Domains	.41	.58	.48	.45

*Notes* . Maximum proportion = 1; each Domain-specific model included general and substance use-specific factors for that domain only, sociodemographic factors, and early initiation of substance use by the 5th grade; the All Domain models included all covariates simultaneously.

## Discussion

The results of this study provide important information for understanding the etiology of adolescent substance use. We are not aware of any study that has examined as extensive a set of modifiable general and substance use-specific risk factors across neighborhood, school, peer, and family domains while also controlling for family-level sociodemographic factors and early initiation of substance use. As such, fully controlled models provide a conservative estimate of associations between each domain of covariates and substance use. Domain-specific models found a number of significant associations of general and substance use-specific risk factors across neighborhood, school, peer, and family with adolescent substance use even after accounting for sociodemographic differences and early initiation of substance use (see Table 4). Domain-specific models also showed that the peer domain accounted for the highest proportion of variance in cigarette smoking, binge drinking, and polysubstance use when compared to other domain-specific models. Fully controlled models highlight the importance of exposure to substance use-specific environments in the etiology of youth cigarette smoking, binge drinking,

marijuana use, and polysubstance use. While environments characterized by greater neighborhood, school, and family substance use were important in each fully controlled model, the strongest and most consistent relationships were noted for peer substance use environments. In fully controlled models, exposure to greater peer substance use environments was significantly associated with a higher odds of past month substance use for all outcomes.

A goal of this study was to clarify the potential role of neighborhood socioeconomic factors in adolescent substance use. Even after accounting for the impact of key general and substance use-specific risk factors across multiple domains, family-level sociodemographic factors, and early initiation of substance use, living in a more socioeconomically disadvantaged neighborhood was associated with a higher likelihood of past month cigarette smoking, binge drinking, and polysubstance use, but not marijuana use. Comparing odds ratios across models that considered objective neighborhood factors alone and fully controlled models including all domains of risk factors showed little evidence that domain-specific risk factors were accounting for the association between neighborhood disadvantage and adolescent substance use. In models for both binge drinking and polysubstance use, the association between neighborhood disadvantage and past month use strengthened once general and substance use-specific risk factors across other domains were added to the model. Domain-specific models indicated that objective, census-based measures of neighborhood context accounted for the smallest proportion of variance in each substance use outcome as compared to neighborhood experience, school, peer, and family domains. This suggests that neighborhood socioeconomic factors represents the most distal contextual factor for substance use among those considered by this study. It is also important to note that our models found little evidence of an association between residential stability or negative general neighborhood environment and adolescent substance use despite

some moderate bivariate correlations among these constructs (see Table 3). Other studies, however, have found direct effects of low neighborhood bonding or more unstable resident populations (i.e. low social cohesion or collective efficacy) on increased adolescent problem behavior (Sampson et al., 2002) and, more specifically, greater alcohol use among young adolescents even after controlling for neighborhood socioeconomic disadvantage (Jackson et al., 2016).

Further research is needed to understand the mechanisms connecting neighborhood socioeconomic disadvantage and adolescent substance use. One possible explanation is found in the increased risk for substance use associated with greater exposure to tobacco and alcohol outlets and advertising (Anderson, De Bruijn, Angus, Gordon, & Hastings, 2009; Bryden, Roberts, McKee, & Petticrew, 2012; Henriksen et al., 2010; Jackson et al., 2014). Research has shown that children in more disadvantaged neighborhoods are likely exposed to more alcohol and tobacco outlets as well as a higher concentration of cigarette and alcohol-related advertising (Lee et al., 2015; Moore, Jones-Webb, Toomey, & Lenk, 2008). Increased exposure to outlets may offer more opportunities for youth to obtain alcohol or cigarettes or normalize alcohol use and cigarette smoking within a youth's neighborhood (Jackson et al., 2014). Thus, exposure to outlets may be one mechanism connecting neighborhood disadvantage with adolescent cigarette smoking and alcohol use. This hypothesis is consistent with the findings of the current study given that cigarette smoking and binge drinking were significantly associated with neighborhood disadvantage, but marijuana use was not. The study period for these analyses predated recently adopted laws in many states allowing for storefront sales of medical and recreational marijuana (Cambron, Guttmanova, & Fleming, 2017). Therefore, youth in this study were precluded from exposure to legal marijuana-related businesses or advertising. Recent research has reported that

greater exposure to legal medical marijuana businesses and advertising is associated with increased marijuana use and intentions to use marijuana among adolescents (D'Amico, Miles, & Tucker, 2015). Other studies have noted that marijuana-related stores are concentrated in neighborhoods with higher poverty rates (Morrison, Gruenewald, Freisthler, Ponicki, & Remer, 2014). Some researchers have suggested that higher density of alcohol or tobacco outlets may serve as a proxy for neighborhood substance use-specific environments (Jackson et al., 2014) and may be most relevant when considering the accumulation of neighborhood risk factors along with socioeconomic disadvantage, low collective efficacy, or low social cohesion (Chilenski & Greenberg, 2009; Duncan et al., 2002). Future research should explicitly examine exposure to outlets and advertising for cigarettes, alcohol, and marijuana as a potential mechanism relating neighborhood socioeconomic disadvantage to adolescent substance use and consider the potential impact of accumulated neighborhood risks for substance use. A better understanding of these links could help inform prevention policies designed reduce opportunities for youth to obtain substances illegally, limit adolescent exposure to substance use-specific advertising, and facilitate the development and appropriate placement of media campaigns promoting healthy adolescent behavior.

We found some differences in adolescent substance use by family income, parental education, and race/ethnicity in fully controlled models. In particular, African American and Asian American youth showed a lower odds of past month cigarette smoking and polysubstance use as compared to European Americans. Results of fully controlled models also indicated that youth from higher income families had lower odds of cigarette smoking and polysubstance use and youth with at least one parent with a college degree had a lower odds of marijuana use. Given inconsistent results across studies examining associations between family SES and

adolescent substance use (Hanson & Chen, 2007), it is important to note that indicators of lower SES were associated with greater odds of substance use even after controlling for multiple domains of established risk factors, race/ethnicity, and other indicators of family SES. Future research should seek to unpack the mechanisms through which race/ethnicity, family income, and parental education are associated with adolescent substance use.<sup>8</sup>

Some limitations to this study should be noted. The SSDP sample also included a small number of students per block group and, as such, participants in this study may not be representative of their neighborhoods. Measures of neighborhood, school, or peer cigarette smoking and neighborhood laws, policing, or enforcement strategies were not available and may, as well, represent important omitted variables. Adolescents perceiving greater enforcement of substance use laws may be less likely to use (Toumbourou et al., 2007). It is also worth considering that there is likely overlap across domains for some of our substance use-specific environment measures. For instance, respondents may be describing some the same individuals when answering questions about peer and school substance use environments. As well, when asked about substance use and drug selling among adults they know, respondents may be including some parents and siblings. Analyses of multicollinearity, however, suggested that constructs across domains contributed unique variance to the models.

We did not consider possible mediated associations among risk factors and adolescent substance use. Research has reported that negative family environments can impact the development of negative peer groups which, in turn, increase the likelihood of adolescent substance use (Chilcoat, Dishion, & Anthony, 1995; Oxford et al., 2001; Skinner et al., 2009).

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<sup>8</sup> Some studies have suggested race-specific effects of neighborhood disadvantage on substance use (Kravitz-Wirtz, 2016). Further analysis testing for moderation of neighborhood disadvantage or residential stability by race/ethnicity and gender did not find significant moderation (results not shown).

Studies have also found that family factors, parenting practices, and peer factors may mediate associations between neighborhood contexts and adolescent alcohol use and cigarette smoking (Chuang et al., 2005; Tobler et al., 2009). Future studies should examine longitudinal paths interrelating neighborhood, school, peer, and family contexts to adolescent substance use.

Despite some limitations, this study examined the most comprehensive set of neighborhood, school, peer, and family contextual risk factors for adolescent cigarette smoking, binge drinking, marijuana use, and polysubstance use to date. As such, these results provide important information for prevention scientists. While deviant and substance using peers offer a clear intervention target (Harrop & Catalano, 2016; Hawkins et al., 1992a), malleable neighborhood, school, and family factors all remained relevant in fully controlled models suggesting multiple potential points of intervention. Interventions leveraging the results of this study and others examining the etiology of substance use across multiple domains of youth experience can help ameliorate the damaging and costly impacts of substance use on youth (Hawkins et al., 2015).

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### **PAPER 3: AN EXAMINATION OF ALCOHOL USE DISORDER AND NEIGHBORHOOD DISORGANIZATION FROM AGE 21 TO 39**

#### **Problem Drinking and Mental Health Problems**

Excessive alcohol use has been closely linked to a range of health issues including mental health problems such as anxiety and depression, violence and sexual assault, motor vehicle crashes, and multiple physical health problems including heart disease, cancer, and stroke (Centers for Disease Control and Prevention, 2016; Gutjahr, Gmel, & Rehm, 2001).

Approximately 88,000 annual deaths in America are attributed to alcohol-related causes and economic estimates of the alcohol-related costs of health care, mortality, and reduced worker productivity reached \$249 billion for 2010 (National Institute on Alcohol Abuse and Alcoholism, 2016; Sacks et al., 2015). Research suggests causal relationships between heavy alcohol consumption and at least 60 different diseases (Connor et al., 2016).

The term Alcohol Use Disorder (AUD) is used to collectively describe diagnoses of either alcohol abuse or dependence as defined by the Diagnostic and Statistical Manual of Mental Disorders (4th Edition)(DSM-IV, American Psychological Association, 1994).<sup>9</sup> For 2013, epidemiological studies estimated that 7 to 13 percent of adults age 18 and older meet diagnostic criteria for AUD in the past year (Grant et al., 2015; Substance Abuse and Mental Health Services Administration, 2014). Over a lifetime, approximately 29 percent of adults in the United States are estimated to experience AUD, yet many never receive treatment for AUD (Connor et al., 2016; Grant et al., 2015). Epidemiological surveillance has consistently shown higher rates of AUD for males and decreases in prevalence of AUD with age (Delker, Brown, &

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<sup>9</sup> Under the more recent DSM-V, alcohol abuse and dependence disorders are collapsed into a single alcohol use disorder diagnosis given methodological challenges of differentiating abuse and dependence. See Goldstein et al. (2015) for a discussion.

Hasin, 2016; Grant et al., 2004a; Grant et al., 2015). Peak prevalence of AUD occurs between ages 18 and 25 with recent rates of 15-18% in the United States (Hedden, 2015; Rehm et al., 2014). Binge drinking among young adults is viewed by many researchers as a normative behavior peaking in the early 20s (Schulenberg, O'Malley, Bachman, Wadsworth, & Johnston, 1996) that tends to wane as individuals grow older and take on more significant adult roles in work and family life (Connor et al., 2016). Young adults who develop mild alcohol problems often later reduce drinking below problem levels when they transition to adult roles (Connor et al., 2016).

Epidemiological and longitudinal studies have documented high rates of comorbidity among substance use, anxiety, and depression disorders (Burns & Teesson, 2002; Grant et al., 2004b; Jones et al., 2016; Regier et al., 1990) that may suggest the presence of a common etiology (Hasin, Stinson, Ogburn, & Grant, 2007). Analyses of nationally representative data from the United States, Australia, and the Netherlands have all found similar results suggesting that those meeting diagnostic criteria for depression or anxiety disorder have roughly twice the odds of experiencing a co-occurring AUD compared to those not experiencing anxiety or depression (Boschloo et al., 2011; Burns & Teesson, 2002; Grant et al., 2004b). While multiple factors may independently impact anxiety, depression, or AUD, comorbid disorders are hypothesized to develop through shared antecedents such as exposure to adverse environments or events paired with cognitive vulnerability to stress (Brady & Sinha, 2005; Hankin & Abramson, 2001; Keyes, Hatzenbuehler, & Hasin, 2011). Exposure to adverse environments or events can overwhelm individual coping skills, harm neurobiological functioning, increase cognitive vulnerability to stress, escalate risk for anxiety and depression, and, in turn, risk of AUD (Hankin & Abramson, 2001; Pollack, 2004). It has been well-documented that, faced with exposure to

repeated stressful experiences or acute instances of stress, individuals with reduced coping skills are at increased risk for developing AUD or relapsing into AUD (Brady & Sinha, 2005; Witkiewitz & Marlatt, 2004). Furthermore, those experiencing stress, anxiety, or depression may use alcohol as a coping strategy to regulate distress (Holahan, Moos, Holahan, Cronkite, & Randall, 2001, 2003).

### **Neighborhoods, Mental Health, and Alcohol Use**

Studies examining the role of neighborhood contexts, mental health, and substance use are often built upon socioecological models of human behavior posited by Bronfenbrenner (1977). Socioecological models of health behavior suggest that individual-level factors alone are insufficient for understanding health behaviors and that larger social environments such as neighborhoods contextualize both positive and negative health behaviors at the individual-level (Diez Roux & Mair, 2010; Wilson, 1987). Socioecological theories are regularly applied to substance use and mental health research to warrant examination of both structural features of neighborhoods as well as social processes occurring within neighborhoods (Galea et al., 2004; Sampson et al., 2002). Systematic reviews have found that studies examining associations between neighborhood socioeconomic disadvantage and alcohol use are yet to produce consistent results (Bryden et al., 2013; Jackson et al., 2014; Karriker-Jaffe, 2011, 2013). While prevalence of alcohol use and misuse tend to cluster geographically, areas with both lower and higher levels of socioeconomic advantage appear to be related to increased alcohol use depending on the study design, methods, type of alcohol use being measured, and population considered (Karriker-Jaffe, 2011). Multiple studies have shown that disorganized neighborhoods categorized by concentrated poverty, high levels of crime, violence, or physical deterioration are associated with heavy drinking (Hill & Angel, 2005; Kuipers, van Poppel, van den Brink,

Wingen, & Kunst, 2012) and alcohol or substance use disorders (Martin-Storey et al., 2013; Stockdale et al., 2007; Winstanley et al., 2008). Neighborhood disorganization has been found to be largely a function of neighborhood socioeconomic disadvantage (Herrenkohl et al., 2002) and a key mediator in the relationship between neighborhood socioeconomic disadvantage and substance use problems (Martin-Storey et al., 2013; Stockdale et al., 2007).

A clearer picture emerges from the research literature regarding relationships between neighborhood socioeconomic disadvantage and increased anxiety, depression, and other serious mental health problems (see Truong and Ma (2006) for a systematic review and Hill and Mamion (2013) for a recent theoretical discussion). Similar to results from studies examining alcohol use, mental health researchers have identified neighborhood disorganization as an important mediator of the relationship between neighborhood socioeconomic disadvantage and increased mental health problems (Casciano & Massey, 2012; Kim, 2010; Ross & Mirowsky, 2001). Both empirical and theoretical work has suggested that the accumulation of fear and stress, which are normative psychological responses to exposure to disorganized and unsafe neighborhoods, are a mechanism by which neighborhood disorganization impacts mental health (Casciano & Massey, 2012; Hill & Maimon, 2013; Mirowsky & Ross, 2003; Ross & Mirowsky, 2001; Sampson et al., 2002; Stockdale et al., 2007).

Three studies are of particular relevance for the current investigation. Stockdale and colleagues (2007) study identified significant cross-sectional associations among neighborhood disorganization and comorbid alcohol, drug, and mental health disorders among adults. Models from their study considering anxiety and depression separately from substance abuse disorders (SUD) found effects of characteristics of disorganized neighborhoods (i.e. neighborhood violence) on anxiety and depression but not on SUD (Stockdale et al., 2007). A second study by

Buu and colleagues (2007) considered data from fathers with AUD at two time points over 12 years. Respondents living in more disadvantaged neighborhoods exhibited higher AUD symptoms 12 years later after accounting for baseline AUD symptoms and other sociodemographic controls. We located only one study examining neighborhood disorganization, anxiety and depression, and problem drinking over time among adults. Hill and Angel (2005) examined data from approximately 2,400 low-income women with children across two waves of data. Employing a single-item ordinal measure of how often individuals were intoxicated in the past 12 months (never = 0, once or twice = 1, several times = 2, often = 3), Hill and Angel found an association between neighborhood disorganization and increased drinking that was fully mediated by anxiety and depression after controlling for a range of sociodemographic factors. The current study is built upon the work of these authors, as well as many others, to examine the longitudinal trajectory of AUD symptoms across adulthood and associations with time-varying self-report measures of neighborhood disorganization, anxiety and depression, and sociodemographic factors.

### **Hypotheses**

Based on our review of the literature, we expect that, on average, individuals will show reduced symptoms of AUD from age 21 to 39. We also hypothesize that women will exhibit fewer AUD symptoms. We expect that individuals living in more disorganized neighborhoods will likely exhibit higher AUD symptoms across adulthood after controlling for sociodemographic factors. Finally, we expect that depression or anxiety will operate as a mediator of the association between neighborhood disorganization and AUD symptoms.

## Sample

Data were drawn from the Seattle Social Development Project (SSDP), a longitudinal, theory-driven study originating in 18 Seattle elementary schools that over-represented high crime neighborhoods. SSDP began conducting in-person interviews in 1985 with 808 students in the 5<sup>th</sup> grade when most participants were 10 years old ( $M = 10.3$ ,  $SD = .52$ ). The 808 respondents accounted for 77% of 1,053 5<sup>th</sup> grade students invited to participate in the study. Retention rates for the participating sample ranged from 88% to 96% of the still living sample across the six waves of data employed in this study. Of the longitudinal sample, 49% were female, 46% were European American, 24% were African American, 21% were Asian American and 9% were Native American. This study employed prospectively gathered data across six waves from ages 21 through 39 from 790 participants with data available on AUD symptoms.

## Measures

Descriptive statistics for all measures are shown in Table 3.1.

*Alcohol Use Disorder.* Past year AUD symptoms were measured as the sum of criteria for alcohol abuse or dependence met by respondents in the past year. Eleven diagnostic symptoms defined by the DSM-IV (American Psychological Association, 1994) were evaluated at each wave using a modified version of the Diagnostic Interview Schedule (DIS; McGee et al., 1990; Robins, Helzer, Croughan, Williams, & Spitzer, 1981). These symptoms included inability to fulfill life role obligations due to alcohol use, recurrent alcohol-related legal problems, alcohol use in dangerous situations, repeated social problems due to alcohol use, and physical or mental health problems resulting from alcohol consumption. Internal consistency for AUD items (Cronbach's  $\alpha$ ) for each wave ranged from .75 to .84. We employed a count measure of AUD symptoms as our dependent variable throughout this study to capture both individuals with a

diagnosable AUD and those engaging in subclinical levels of problem drinking. Similar strategies have been used by other studies and higher symptoms counts are considered indicative of more severe drinking problems (Buu et al., 2007; Goldstein et al., 2015; Lee, Kosterman, McCarty, Hill, & Hawkins, 2012b).

*Anxiety and Depression.* Generalized anxiety disorder (GAD) and major depressive episode (MDE) was assessed at each wave using the DIS. To create a single dichotomous measure, participants were first classified with MDE if they reported at least five out of nine potential symptoms and at least three of those symptoms disrupted daily life. Symptoms included changes in weight or appetite, sleep difficulties, moving or talking slowly, fatigue, difficulty concentrating or making decisions, guilt or worthlessness, and thoughts of suicide or death spanning most days for at least two weeks in the past year. Next, participants were classified with GAD if they endorsed at least two out of six potential symptoms concerning problems with irritability, recurrent worrying, and distractibility spanning most days for at least two weeks in the past year and disrupting daily life. Similar to other studies, those meeting criteria for a likely MDE or GAD were coded as 1 (or 0 otherwise) on a single anxiety/depression measure at each wave (Stockdale et al., 2007).

*Neighborhood Disorganization.* A self-report measure of neighborhood disorganization was represented by the mean of seven items that assessed the extent to which crime or drug dealing, shootings or knifings, fights, gangs, undesirable neighbors, graffiti, and empty or abandoned buildings described the respondent's neighborhood. Each item offered the same response options (1=YES!, 2=yes, 3=no, 4=NO!), scale internal consistency across waves ranged from .87 to .93, and items were standardized within each year prior to analysis. Similar measures of

neighborhood disorganization have been employed in other studies (Herrenkohl et al., 2002; Sampson et al., 2002).

*Sociodemographic Factors.* Multiple studies have shown that sociodemographic factors including education, marital status, income, and parenthood are associated with alcohol consumption. Currently being married and parenting children have consistently shown protective effects against problem drinking (Dawson, Grant, Chou, & Pickering, 1995; Miller-Tutzauer, Leonard, & Windle, 1991; O Malley, 2004). While higher socioeconomic status (SES) as measured by income and educational attainment has often been associated with *increased* alcohol consumption (Dawson et al., 1995; Moore et al., 2005; Van Oers, Bongers, Van de Goor, & Garretsen, 1999), higher SES is also consistently related to *decreased* problem drinking (Van Oers et al., 1999) and diagnoses of alcohol dependence (Gilman et al., 2008; Hasin et al., 2007; Keyes & Hasin, 2008). For the SSDP sample, educational attainment was assessed at each wave with an ordinal variable coded as 1 for less than high school completion, 2 for high school diploma or GED, and 3 for completion of a 4 year college degree or higher. Current marital status was assessed at each wave with 1 indicating married and 0 indicating not married. A six category measure of household income broken into \$20,000 increments was assessed at each wave and measures were standardized within wave prior to analysis. Parenthood was measured at each wave as a current biological or adoptive parent and coded with current parenthood equal to 1.

Table 3.1.

*Sample descriptive statistics*

			Age 21		Age 24		Age 27		Age 30		Age 33		Age 39	
	<u>Min</u>	<u>Max</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Alcohol Use Disorder (AUD) symptoms	0	11	1.26	1.81	1.09	1.78	.92	1.84	.80	1.73	.78	1.86	.55	1.55
No AUD symptoms	0	1	52%		57%		68%		71%		74%		81%	
Anxiety   Depression <sup>a</sup>	0	1	22%		17%		16%		14%		13%		17%	
Anxiety	0	1	6%		8%		6%		6%		6%		11%	
Depression	0	1	20%		13%		13%		12%		10%		11%	
Neighborhood Disorganization	1	4	1.65	.62	1.59	.59	1.55	.58	1.54	.57	1.56	.64	1.63	.64
Educational Attainment <sup>b</sup>	1	3	1.85	.38	2.04	.59	2.12	.56	2.15	.58	2.17	.58	2.23	.55
Household Income <sup>c</sup>	1	6	1.47	.83	3.02	1.56	3.10	1.61	3.17	1.60	3.70	1.68	3.74	1.84
Married	0	1	9%		23%		30%		40%		42%		51%	
Parenthood	0	1	27%		43%		50%		59%		67%		79%	
Female	0	1	49%		-		-		-		-		-	
African American	0	1	26%		-		-		-		-		-	
Asian American	0	1	22%		-		-		-		-		-	
Native American	0	1	5%		-		-		-		-		-	
European American	0	1	47%		-		-		-		-		-	

Notes. M = mean, SD = standard deviation.

a: indicated as experiencing a probable diagnosis of anxiety or depression.

b: 1 = less than high school, 2 = high school diploma or GED, 3 = college degree or higher.

c: 1 = less than \$20,000, 6 = greater than \$100,000 household income annually.

## **Analytic Strategy**

Latent growth curve modeling provides an established method of examining change in substance use over time and is flexible enough to allow for individual differences in initial levels of substance use, rates of change over time, and deviation from average levels of use at each time point (Curran & Hussong, 2003). Deviation from average levels of substance use can be examined by simultaneously estimating the growth curve and regressing covariates on the indicators constituting the growth parameters (Hussong et al., 2004). Figure 1 presents a conceptual diagram including time-fixed and time-varying covariates. An initial unconditional model estimated the average trajectory of AUD symptoms from ages 21 to 39 and found a statistically significant mean and variance of the growth parameters (i.e., intercept and slope) warranting further examination of time-fixed and time-varying covariates. Model 1 included time-fixed covariates for gender and ethnicity as well as time-varying covariates of educational attainment, marital status, household income, and parenthood status predicting AUD symptoms controlling for average growth in AUD symptoms. Models 2 and 3 included neighborhood disorganization and anxiety or depression respectively as time-varying covariates associated with AUD symptoms. Model 4 examined indirect effects for anxiety or depression as a mediator of the association between neighborhood disorganization and AUD symptoms independent of time-fixed and time-varying sociodemographic factors. All models constrained the association of time-varying covariates with AUD symptoms to estimate their average association across adulthood and the same procedure was employed for the mediational model. Models with time-varying covariates constrained over time consistently showed better fit compared to those with covariates free to vary across time. Model fit was compared across models using sample size

adjusted BIC (Curran & Hussong, 2003) and a reduction of five or more in BIC was considered an improvement model fit (Singer & Willett, 2003).

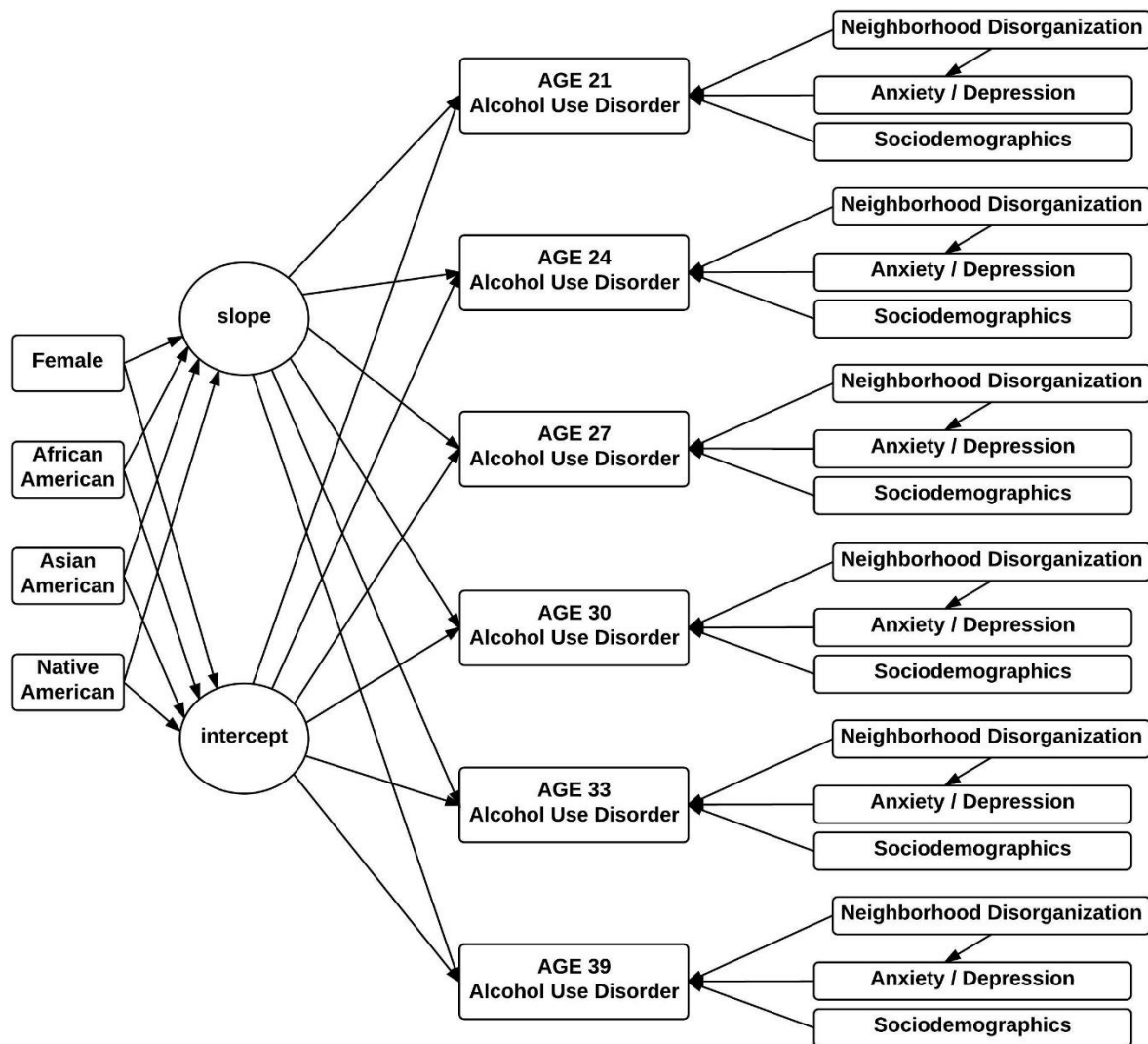


Figure 3.1. Latent growth curve of alcohol use disorder (AUD) symptoms.

Path diagram for negative binomial latent growth curve of alcohol use disorder (AUD) symptoms with time-varying measures of sociodemographic factors, neighborhood disorganization, and anxiety or depression. Anxiety or depression was tested as a mediator between neighborhood disorganization and AUD symptoms. Covariance between the slope and intercept and covariances among exogenous predictors not shown.

Missing data were handled via multiple imputation (Asparouhov & Muthén, 2010). Forty datasets were created and subsequently analyzed using the multiple imputation and latent growth

modeling procedures in Mplus version 7.1 (Muthén & Muthén, 2006). All reported model results employ the MLR estimator for robust standard errors and are averaged across 40 datasets using Rubin's rules (Rubin, 1987). Initial results of an unconditional growth model showed over-dispersion on measures of AUD symptoms warranting the use of a negative binomial distribution. Given the preponderance of zeros for counts of AUD symptoms at each time point and the potential for non-linear growth, we also examined zero-inflated negative binomial latent growth models and the inclusion of a quadratic growth term. These specifications did not alter our substantive findings and, as a result, parameter estimates and model fit statistics from negative binomial growth curves without a quadratic term are reported in Table 2.<sup>10</sup>

## Results

Results of descriptive analyses and Models 1 through 4 are found in Tables 3.1 and 3.3 respectively. Correlations among constructs are presented in the Table 3.2. Among the SSDP sample, approximately 21% of 21-30 year olds met criteria for a DSM-IV AUD diagnosis in the past year while national estimates place the prevalence of AUD diagnoses in the past year at 16% for 18-29 year olds (Hasin et al., 2007) and 18% for 18 to 25 year olds (Hedden, 2015). Differences may reflect lack of diagnostic data in the SSDP sample for individuals under age 21. Approximately 30% of the SSDP sample (n=240) never displayed any symptoms of AUD. Results of the unconditional growth model confirmed that individuals reduced their problem drinking on average from age 21 to 39. The unconditional model also found heterogeneity across individuals in both AUD symptoms at age 21 and rates of decrease in AUD symptoms through

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<sup>10</sup> Some SSDP participants received a social development intervention during elementary school (Hawkins et al., 1992b). Sensitivity tests controlling for the intervention on all paths in Model 4 did not show any substantive changes to the findings reported in Table 2.

the 30s as indicated by significant variance in the intercept (Est. = 1.35,  $p < .001$ ) and slope (Est. = .01,  $p < .001$ ) of the latent growth curve respectively. The variance of the slope and intercept remained significant across all models indicating variability in trajectories of AUD symptoms across individuals. A positive and significant covariance between intercept and slope parameters indicated that individuals with higher counts of AUD symptoms at age 21 tended to reduce problem drinking more slowly across adulthood. The covariance between the intercept and slope remained positive and significant across all models.

Model 1 found that, as expected, women showed a lower initial count of AUD symptoms at age 21 and a significantly quicker reduction in problem drinking through the 30s compared to men after accounting for educational attainment, marital status, household income, and parenthood. Native Americans showed a higher initial count of AUD symptoms at age 21 when compared to European Americans. On average, married individuals and those with higher levels of educational attainment showed significantly fewer AUD symptoms across adulthood after accounting for average slope of AUD symptoms over time and other sociodemographic factors. With the inclusion of a time-varying measure of neighborhood disorganization in Model 2, African Americans showed a lower initial count of AUD symptoms at age 21 as compared to European Americans. Higher levels of neighborhood disorganization were associated with increased AUD symptoms after accounting for average change in AUD symptoms and sociodemographic factors. Model 3 included a time-varying measure of anxiety or depression and found it to be associated with increased AUD symptoms across adulthood after accounting for all other factors included in the model. With the inclusion of anxiety or depression in Model 3, Asian Americans showed a lower initial count of AUD symptoms at age 21 as compared to European Americans and parenthood emerged as a significant predictor of fewer AUD

symptoms. Figure 2 provides a comparison of associations between time-varying covariates and AUD symptoms.

Mediational analyses in Model 4 found a significant indirect effect of neighborhood disorganization through psychological distress after accounting for all other factors in the model and controlling for sociodemographic differences in anxiety or depression. Women showed an increased likelihood of anxiety or depression compared to men across adulthood. Higher household income and being currently married were associated with reduced anxiety or depression over time. In Model 4, neighborhood disorganization maintained a significant direct effect on AUD symptoms across adulthood and no other changes in the substantive interpretation of coefficients for time-fixed or time-varying covariates were noted. Anxiety or depression accounted for approximately one third of the total association between neighborhood disorganization and AUD symptoms.

Table 3.2.

*Average correlations from age 21 to 39*

		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
AUD Symptoms	<b>1</b>	.61						
Anxiety   Depression	<b>2</b>	.10	.46					
NH Disorganization	<b>3</b>	.16	.12	.55				
Education	<b>4</b>	-.13	-.10	-.18	.86			
Married	<b>5</b>	-.13	-.09	-.13	.11	.55		
Household Income	<b>6</b>	-.09	-.14	-.19	.26	.17	.59	
Parenthood	<b>7</b>	-.05	.06	.06	-.27	.12	-.18	.73
Female	<b>8</b>	-.20	.09	-.04	.10	.04	-.10	.14
African American	<b>9</b>	.00	.08	.16	-.17	-.19	-.25	.21
Native American	<b>10</b>	.14	.04	.07	-.15	-.02	-.06	.09
Asian American	<b>11</b>	-.07	-.08	-.11	.17	.08	.18	-.07

*Notes.* N=790; AUD = Alcohol Use Disorder, NH = neighborhood.

Table 3.3.

*Results of latent growth curves predicting Alcohol Use Disorder (AUD) symptoms*

Independent Variable	Dependent Variable	Model 1	Model 2	Model 3	Model 4
<u>Time-varying Covariates</u>		<u>Est. (SE)</u>	<u>Est. (SE)</u>	<u>Est. (SE)</u>	<u>Est. (SE)</u>
Educational Attainment <sup>a</sup>	AUD	-.30 (.08) ***	-.27 (.08) ***	-.26 (.08) ***	-.26 (.08) ***
	Anx   Dep				-.11 (.06)
Married <sup>b</sup>	AUD	-.42 (.09) ***	-.41 (.09) ***	-.38 (.09) ***	-.38 (.09) ***
	Anx   Dep				-.25 (.07) **
Household Income <sup>c</sup>	AUD	-.05 (.03)	-.05 (.03)	-.04 (.03)	-.04 (.03)
	Anx   Dep				-.09 (.02) ***
Parenthood <sup>b</sup>	AUD	-.18 (.10)	-.18 (.10)	-.19 (.10) *	-.19 (.10) *
	Anx   Dep				.06 (.07)
Neighborhood Disorganization <sup>c</sup>	AUD		.17 (.04) ***	.15 (.04) ***	.15 (.04) ***
	Anx   Dep				.16 (.03) ***
Anxiety   Depression <sup>b</sup>	AUD			.46 (.07) ***	.46 (.07) ***
<u>Mediation Analyses<sup>d</sup></u>					
Indirect Path	AUD				.08 (.03) ***
Total Path	AUD				.22 (.04) ***
<u>Time-fixed Covariates</u>					
Female	Intercept	-.89 (.11) ***	-.88 (.11) ***	-.91 (.11) ***	-.91 (.11) ***
	Slope	-.03 (.01) *	-.03 (.01) *	-.03 (.01) *	-.03 (.01) *
	Anx   Dep				.28 (.12) ***
African American	Intercept	-.28 (.15)	-.33 (.14) *	-.35 (.14) *	-.35 (.14) *
	Slope	.00 (.02)	.00 (.02)	.00 (.02)	.00 (.02)
	Anx   Dep				.00 (.16)
Asian American	Intercept	-.25 (.14)	-.26 (.14)	-.27 (.14) *	-.27 (.14) *
	Slope	-.04 (.02)	-.03 (.02)	-.03 (.02)	-.03 (.02)
	Anx   Dep				-.06 (.)
Native American	Intercept	.59 (.17) **	.55 (.17) **	.53 (.16) **	.53 (.16) **
	Slope	-.01 (.03)	-.02 (.03)	-.02 (.03)	-.02 (.03)
	Anx   Dep				.09 (.14)

Table 3.3 (continued)

AUD Intercept & Slope

AUD	Intercept	.92 (.18) ***	.89 (.17) ***	.79 (.17) ***	.79 (.17) ***
	Slope	-.08 (.01) ***	-.08 (.01) ***	-.08 (.01) ***	-.08 (.01) ***
Residual Variance	Intercept	1.03 (.13) ***	.96 (.13) ***	.86 (.13) ***	.86 (.13) ***
	Slope	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***	.01 (.00) ***
Intercept & Slope Covariance		.03 (.01) **	.03 (.01) **	.03 (.01) **	.03 (.01) **
BIC <sup>e</sup>		9462 (9498)	9444 (9463)	9402 (9416)	13545 (13596)

Notes: N=790; \*p<.05, \*\*p<.01, \*\*\*p<.001; Est. = unstandardized estimate; SE = standard error; Anx|Dep = Anxiety or Depression; estimates are constrained to be equal from age 21 to 39; all ethnicity variables are compared to European Americans.

a: 1 = less than high school, 2 = high school completion, 3 = college degree or higher.

b: variables coded as 0 | 1 with 1 indicating the variable name.

c: variables were standardized with mean = 0 and SD = 1 within year prior to analysis.

d: Indirect Path indicates the estimate of Neighborhood Disorganization through Anx|Dep to AUD and Total Path indicates the sum of the Direct and Indirect Paths from Neighborhood Disorganization to AUD.

e: BIC in parentheses indicates fit for a model with time-varying predictors unconstrained over time.

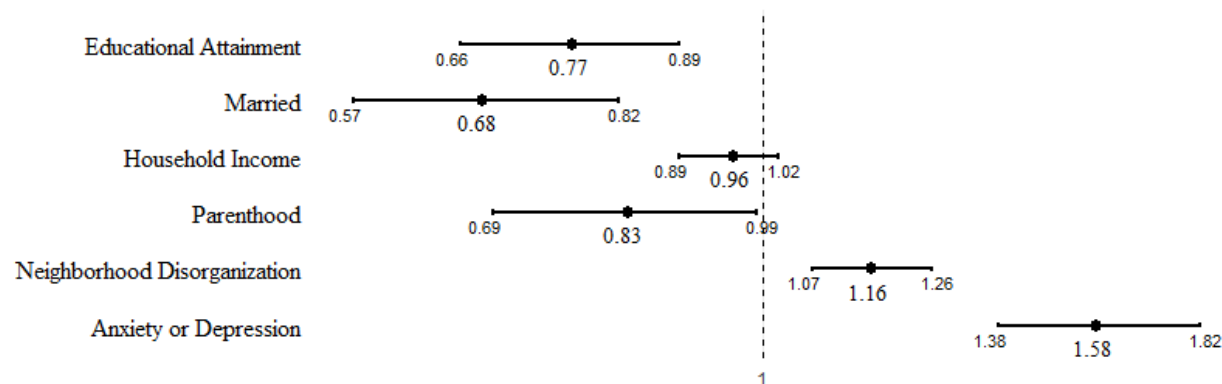


Figure 3.2. Count ratios and 95% confidence intervals (CIs) from Model 3.

Count ratios and 95% confidence intervals (CIs) from Model 3 for time-varying covariates predicting Alcohol Use Disorder (AUD) symptoms from age 21 to 39 after controlling for average reductions in AUD symptom severity, gender, and ethnicity. CIs fully above 1 indicate that variable is significantly associated with increased AUD symptoms and CIs fully below 1 indicate that variable is significantly associated fewer AUD symptoms. Confidence intervals crossing 1 indicate a non-significant association.

## Discussion

The current study is the first to examine trajectories of AUD symptoms and the role of neighborhood contexts across nearly 20 years of adulthood. While other studies have considered individual components of this study, we are aware of no other studies incorporating neighborhood disorganization, anxiety or depression, and sociodemographic factors into a longitudinal model of AUD symptom severity. These analysis provide an opportunity to address important questions across multiple domains of inquiry.

We sought to understand risk and protective factors associated with increased severity of AUD symptoms above and beyond average reductions in AUD severity over time. Most importantly, our results provide evidence that individuals living in more disorganized neighborhoods are at increased risk of anxiety or depression and more severe AUD net of educational attainment, household income, marital status, parenthood, gender, and ethnicity. Consistent with reports by others, individuals on average engaged in less problem drinking as they moved through adulthood (Delker et al., 2016; Grant et al., 2004a; Grant et al., 2015; Hasin et al., 2007). We also observed heterogeneity in initial starting levels of AUD at age 21 and rates of change for AUD over time. As suggested by other researchers (Connor et al., 2016), individuals with lower initial levels of AUD at age 21 reduced their problem drinking more quickly. We noted lower levels of AUD among women (Dawson et al., 1995; Hasin et al., 2007) at age 21 as well as more rapid reductions in AUD symptoms across adulthood. Similar to AUD symptoms, we also found that anxiety or depression was significantly associated with lower educational status and currently being unmarried. Unlike for AUD symptoms, lower household income and being female were significantly associated with increased risk of anxiety or depression. The latter associations between anxiety or depression, household income, and gender

have been found in nationally representative studies (Grant et al., 2005; Kessler et al., 2003). This study has replicated and extended results of previous studies and has found that the hypothesized interrelationships between neighborhood disorganization, anxiety or depression, and AUD symptom severity extends across the 30s, contributing to the substantial societal costs associated with problem drinking (Sacks et al., 2015).

Our results suggest implications for practitioners seeking to understand and ameliorate the potential impacts of disorganized neighborhoods on mental health problems and AUD symptoms. First, our findings add evidence to suggestions by other researchers that regular exposure to crime, drug selling, violence, and deteriorating infrastructure in one's neighborhood may create a shared risk for anxiety, depression, and heavy alcohol use (Hill & Maimon, 2013). Our results support calls for treatment of anxiety and depression to be provided to individuals diagnosed with an AUD as needed (Grant et al., 2004b). We should, however, consider any treatment suggestions in context for those living in more disorganized neighborhoods. Given that residents of disorganized neighborhoods are likely to experience accumulated impacts of stress, they may particularly benefit from trauma-informed models of health care (Butcher, Galanek, Kretschmar, & Flannery, 2015). Trauma-informed care recognizes that symptoms of mental health disorders may represent adaptive coping strategies operating in response to previous experiences. See Butler, Critelli and Rinfrette (2011) for recent discussion of trauma-informed mental health care and service delivery models. A second treatment-oriented contextual issue is found in consistent reports that residents of socioeconomically disadvantaged neighborhoods contend with reduced health care service availability, lower service utilization rates, increased likelihood of experiencing unmet health care needs, and decreased likelihood of receiving preventive care (Kirby & Kaneda, 2005; Lurie & Dubowitz, 2007; O'Campo, Salmon, & Burke,

2009). Coordinated federal, state, and local policy efforts are needed to not only increase the safety and quality of poor neighborhoods (Brooks-Gunn, Duncan, & Aber, 1997; Wilson, 1987), but also to address disparities in health care service availability and utilization in disadvantaged neighborhoods (see Almgren (2012) for an extensive discussion on the topic).

The current findings in conjunction with consistent documentation of comorbid diagnoses of anxiety, depression, and AUD (Hasin et al., 2007; Regier et al., 1990) suggest that the links between neighborhood disadvantage and problem drinking are likely mediated in part by exposure to stressful environments, accumulated stress, and anxiety or depression. It is important to keep in mind, however, the substantial challenges faced by individuals and families seeking to migrate out of socioeconomically disadvantaged or disorganized neighborhoods (Massey, 2013; Sharkey, 2013). These challenges may be further exacerbated by the presence of anxiety, depression, and AUD. While lack of individual and family economic resources undoubtedly deter residential and social mobility, poor mental health or substance abuse problems among residents of disadvantaged neighborhoods may add to mobility limitations (Massey, 2013).

Despite the range of findings suggesting the impact of neighborhood contexts on individual-level outcomes, some additional limitations should be noted regarding the complexity and direction of these relationships. First, we suspect that reciprocal relationships may exist among the time-varying factors considered by this study. Examining the within time associations of AUD symptoms and neighborhood disorganization, anxiety or depression, and sociodemographic factors over time does not warrant causal claims regarding the direction of our findings. In particular, individuals suffering from significant anxiety or depression problems may potentially perceive and report higher levels of neighborhood disorganization (Hill & Maimon, 2013). In addition, analyses were limited to a non-representative sample originating from a

single U.S. city; as such, caution should be taken in generalizing these findings to other populations. Future studies that utilize systematic social observations of neighborhood disorganization may offer a promising avenue to help improve our understanding of the relationships among neighborhood disorganization, mental health, and problem drinking (Sampson et al., 2002). As scholars have hypothesized that family or individual-level socioeconomics may function to mediate or moderate relationships between neighborhood contexts and mental health or alcohol use problems (Cerdá, Diez-Roux, Tchetgen, Gordon-Larsen, & Kiefe, 2010; Hill & Maimon, 2013), we think future studies seeking to refine our understanding of how, when, and for whom neighborhood factors, mental health problems, substance use disorders, and sociodemographic factors are associated can provide important insights for etiology, treatment and preventive intervention (Sharkey & Faber, 2014).

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## CONCLUSION

This dissertation examined associations between neighborhood contexts and substance use during elementary school, early high school, and adulthood. The results are relevant for both substance use and neighborhood-focused research. The findings are also important for interventions aimed at preventing or reducing the negative impacts of substance use and abuse across the life-course. The concluding pages provide a brief overview of results, highlight the salience of these findings for both research and practice, and offer suggestions for future neighborhood-focused research.

Significant findings regarding neighborhood contexts from these three papers emerged from two different, but largely overlapping, measures of neighborhood context: socioeconomic disadvantage and neighborhood disorganization. Previous work with the SSDP sample has shown that census-based measures of neighborhood socioeconomic disadvantage accounted for approximately 70% of the variance in self-reported measures of neighborhood disorganization (Herrenkohl et al., 2002). Neighborhood socioeconomic disadvantage in the current studies was measured by 8 block-group level variables from the 1990 census including percentage of adults with a high school diploma, families living in poverty, single-parent female-headed households, individuals receiving public assistance, males and females in labor force and unemployed, youth age 11-17, and the number of racial groups with more than 10% representation. Neighborhood disorganization was measured by self-reports that the participants' current neighborhood was characterized by high levels of poverty, crime, violence, rowdy neighbors, and deteriorating buildings. Importantly, the significant associations between these measures of neighborhood context and substance use outcomes were net of multiple indicators of family-level socioeconomic status (SES), race/ethnicity, and multiple other risk factors for substance use in

both adolescence and adulthood. Also importantly, census-based measures of residential stability and self-report measures of neighborhood bonding and prosocial opportunities (i.e. general neighborhood environment in Paper 2) did not show a significant association with substance use after controlling for family-level SES. These findings suggest that certain features of neighborhood contexts are important above and beyond the sociodemographic factors that largely influence the type of neighborhood in which a family or individual resides.

More specifically, Paper 1 estimated trajectories of past month cigarette smoking and alcohol use from grades 5 to 9. Results indicated that youth living in more socioeconomically disadvantaged neighborhoods over time engaged in more cigarette smoking and alcohol use after accounting for average trajectories smoking and alcohol use and differences in race/ethnicity and gender. A fully controlled model for smoking accounting for low family functioning, more permissive family smoking environments, affiliations with deviant peers, family SES, and race/ethnicity showed that a unique effect of neighborhood disadvantage remained and was partially mediated by family income and deviant peers. A fully controlled model for alcohol use accounting for low family functioning, more permissive family alcohol environments, affiliations with deviant peers, family SES, and race/ethnicity did not show a unique neighborhood effect, but that the neighborhood disadvantage was mediated by deviant peer affiliations. Results suggested that neighborhood and family socioeconomic factors have different patterns of association with cigarette smoking and alcohol use for adolescents from 5<sup>th</sup> to 9<sup>th</sup> grade and may be particularly important for early cigarette smoking. Results also indicated that low family functioning, permissive family substance using environments, and affiliations with deviant peers were common risk factors for both smoking and alcohol use from 5<sup>th</sup> to 9<sup>th</sup> grade.

Paper 2 examined cross-sectional associations between neighborhood, school, peer, and family risk factors and any past month cigarette smoking, binge drinking, marijuana use, or polysubstance use in the 9<sup>th</sup> grade. Youth living in more socioeconomically disadvantaged neighborhoods were at greater risk for cigarette smoking, binge drinking, and polysubstance use, but not marijuana use in models considering all domains of risk factors, race/ethnicity, gender, multiple indicators of family SES, and initiation of substance use by the 5<sup>th</sup> grade. Within each domain, youth reporting exposure to substance use-specific environments had a higher likelihood of cigarette smoking, binge drinking, marijuana use, and polysubstance use. Peer factors accounted for the highest proportion of variance in fully controlled models for cigarette smoking, binge drinking, and polysubstance use while school factors accounted for the highest proportion of variance in marijuana use. Census-based measures of neighborhood socioeconomics consistently accounted for a smaller proportion of variance compared to other domains of risk factors. Results of this study suggested that neighborhood disadvantage is a unique risk factor for adolescent substance use; but one that is more distally related to adolescent substance use than self-reported neighborhood, school, peer, or family risk factors. Self-reported substance use-specific measures of neighborhood, school, peer, and family contexts showed the most consistent significant direct associations with substance use outcomes in fully controlled models.

Paper 3 estimated trajectories of alcohol use disorder (AUD) symptoms from age 21 to 39. Adults living in more disorganized neighborhoods over time reported higher counts of AUD symptoms after controlling for average trajectories of AUD symptoms, mental health problems, and sociodemographic factors including education, marital status, income, parenthood, gender, and race/ethnicity. Mediation tests found that neighborhood disorganization significantly increased risk of anxiety or depression and about 1/3 of the association between neighborhood

disorganization and AUD symptoms was mediated by anxiety or depression. A unique association of neighborhood disorganization with adult AUD remained in the presence of all other controls. Results suggested that interrelationships among AUD symptoms, anxiety or depression, and neighborhood disorganization persist across adulthood net of important sociodemographic differences.

The results of these three papers largely agree with the findings of noted youth scholar Delbert Elliot and his colleagues in their book *Good Kids from Bad Neighborhoods* (2006). While Elliot and colleagues did not specifically examine associations between neighborhood contexts and substance use, their findings suggest that the quality of youth developmental outcomes depends on “the combined influences of their neighborhood, family, school, and peer group” (Elliott et al., 2006, p. 276).

### **Implications for Research & Practice**

Results of these three studies demonstrated that neighborhood contexts have a unique and persistent association with substance use in adolescence and substance abuse in adulthood that is not fully accounted for by family-level socioeconomic factors, race/ethnicity, or more proximal risk or protective factors. The strength of association between neighborhood disadvantage and substance use among adolescents, however, tended to be smaller than more proximal factors such as deviant peer affiliations or low functioning family. A similar trend was found among adults whereby a weaker association was noted between AUD symptoms and neighborhood disorganization than between AUD symptoms and being married or experiencing anxiety or depression. Furthermore, the strength of association between neighborhood disadvantage and cigarette smoking, alcohol use, and marijuana use was not uniform across substances within the same developmental periods. Paper 1 suggested stronger effects of neighborhood disadvantage

on past month cigarette smoking as compared to alcohol use from grades 5 to 9. Paper 2 suggested that neighborhood disadvantage increased risk for cigarette smoking, binge drinking, and polysubstance use among 9<sup>th</sup> grade students, but did not confer unique risks for marijuana use above and beyond family-level SES. The persistent association of lower SES neighborhood contexts with substance use and abuse, however, should spur prevention scientists to consider the role of neighborhood contexts in the design and implementation of prevention programs (Roosa et al., 2003).

More precise information, however, is necessary regarding the dynamics through which neighborhoods may be increasing risk for substance use to successfully incorporate this information into prevention programming (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). On top of the unique risk that neighborhoods can confer, these studies identified deviant peer associations as a mechanism connecting neighborhood disadvantage with adolescent cigarette smoking and alcohol use and identified anxiety or depression as a mechanism connecting neighborhood disorganization with adult AUD symptoms. These findings concur with empirical and theoretical work suggesting that socioeconomically disadvantaged neighborhoods may lack informal social controls or institutional resources to inhibit youth deviance (Sampson et al., 2002) and may provoke increased stress among residents exposed to crime, disorder, or violence (Mirowsky & Ross, 2003; Stockdale et al., 2007). To date, interventions acting directly upon these mediators to reduce adolescent deviant peer affiliations (Dodge, Dishion, & Lansford, 2006; Jenson & Bender, 2014) and to promote mental health among adults (Butterfoss, Goodman, & Wandersman, 1993) or increase access to mental health care (Kawachi & Berkman, 2003) are already well-established.

More research is needed concerning the variance in substance use or abuse that is uniquely associated with neighborhoods above and beyond mediating factors, other domains of risk, and sociodemographic factors. One hypothesis offered in Paper 2 is that youth in more socioeconomically disadvantaged neighborhoods may be exposed to more alcohol and cigarette advertising and retail outlets (Bryden et al., 2012; Henriksen et al., 2010; Lee et al., 2015). Greater exposure might, in turn, increase opportunities to illegally obtain alcohol and cigarettes or support more permissive community norms regarding youth substance use. Further research explicitly testing the hypothesis that greater exposure to alcohol, cigarette, or marijuana sales and marketing is one mechanism connecting neighborhood socioeconomic disadvantage to adolescent alcohol use and cigarette smoking is needed. Among adults, the associations among neighborhood disorganization, anxiety or depression, and AUD may in part be reflective challenges in obtaining mental health care among socioeconomically disadvantaged populations (Almgren, 2012; Kawachi & Berkman, 2003). Different types of neighborhood data in addition to census measures or self-reports help understand the unique impact of neighborhoods on substance use. In particular, ecological momentary assessment (EMA) procedures provide a recently developed opportunity for assessing patterns of activity within neighborhoods and cities to better understand the content and frequency of neighborhood exposures (Heron, Everhart, McHale, & Smyth, 2017). Recent studies have suggested that witnessing substance use within neighborhoods increases risk of same day antisocial behavior among youth (Russell, Wang, & Odgers, 2016). Recent research in California found that youth perceptions of neighborhood disorganization during travel outside their home census tracts was associated with youth problem behavior when census-based measures of neighborhood disorganization were not (Byrnes et al.,

2017). Further research with EMA or mobile data collection methods to assess activity patterns can provide more information on place-based, contextual influences on substance use and abuse.

It is important to consider the interrelated dynamics of mechanisms through which neighborhoods may impact youth and adult substance use across the life course (Kraemer et al., 2001; Roosa et al., 2003). Prosocial neighborhood, school, peer, and family environmental influences may act as protective factors against the unique association of neighborhood socioeconomic factors on substance use (Kim, Gloppen, Rhew, Oesterle, & Hawkins, 2015). Moderation hypotheses, however, were not examined in this dissertation but should be addressed by future neighborhood-focused substance use research seeking to design strategies to combat the unique impact of neighborhoods on substance use (Cerdá et al., 2010; Roosa et al., 2003). I am not aware of any study to date that has examined moderation of neighborhood socioeconomic disadvantage by protective factors.

Moderation hypotheses should also be applied to research examining the impact of interventions. For instance, we might imagine that strong prosocial family or school influences might offer some measure of protection against increased substance use opportunities potentially experienced by youth living in socioeconomically disadvantaged neighborhoods. As such, programs strengthening the protective effect of school bonding (Catalano, Oesterle, Fleming, & Hawkins, 2004) or positive family functioning (Ryan et al., 2010) may already be countervailing the increased risk of substance use conferred by living in socioeconomically disadvantaged neighborhoods. Similarly, social capital building programs promoting positive adult engagement in communities may be improving mental health (Kawachi & Berkman, 2001) and, in turn, dampening the impact of neighborhood disorganization on substance abuse. Explicit tests examining whether current interventions among youth and adults can break the link between

disadvantaged or disorganized neighborhoods and substance use or abuse are necessary. Hypotheses concerning possible protective effects by prosocial intervention targets (e.g. improved family functioning, school bonding, community engagement) may provide more information on these complex questions. Hopefully, the results of this dissertation will be considered by those evaluating the impact of preventive interventions on youth substance use.

Finally, from an implementation perspective, recent research has highlighted that neighborhood socioeconomic disadvantage may negatively impact enrollment in prevention programming. A recent study from California reported that families living in disadvantaged neighborhoods were less likely to be recruited into a family-based prevention program (Byrnes, Miller, Aalborg, & Keagy, 2012). Specific recruitment strategies for youth and families experiencing socioeconomic disadvantage are likely important for maximizing the impact of preventive interventions.

### **Implications for Policy**

Would simply moving from a lower SES neighborhood to a higher SES neighborhood reduce substance use among adolescents and adults? This is an important policy question that could not be addressed by this dissertation. Results from Paper 3 do, however, show interesting parallels to evaluations of the Moving to Opportunity (MTO) experiment which explicitly examined the effects of moving families out of impoverished neighborhoods and into higher income neighborhoods. While the intervention condition families in MTO did not show reductions in substance use among children, they did note substantial reductions in anxiety and depression among adults (de Souza Briggs et al., 2010). MTO, however, did not assess AUD among adults in either intervention or control conditions. Paired with findings from Paper 3, MTO results suggest that moving from low SES to higher SES neighborhoods has the potential

to reduce symptoms of AUD by improving adult mental health. It is important to also note that children of families in the intervention conditions of MTO have shown longer term educational and economic success (Chetty et al., 2016) if not explicit reductions in substance use.

A final, and perhaps more challenging, means by which to potentially lessen the unique impact of socioeconomically disadvantaged or disorganized neighborhoods on substance use and abuse is to reduce the incidence of individual, family, and neighborhood poverty. Successful public policy programs such as the Earned Income Tax Credit have shown the ability to lift families out of poverty (Magnuson, 2013). Other family or community-level poverty reduction strategies centering on the provision of education, health care, and nutrition among others have shown some success in the longer term (Garfinkel, Rainwater, & Smeeding, 2010). While beyond the scope of this dissertation, it is essential to recognize that public policy initiatives to reduce poverty and improve neighborhood economic conditions may also reduce substance use and abuse across the life course. Any intervention that can reduce individual, family, or community poverty is likely to improve numerous indicators of health and well-being beyond reductions in substance use (Diez Roux & Mair, 2010). Social justice perspectives require that we continue to develop and refine interventions with the explicit purpose of reducing health disparities resulting from socioeconomic disadvantage.

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