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A Review of Psychosocial Factors Linked to Adolescent Substance Use

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Abstract

Purpose: Informed by ecological theories and models of influence, this review discusses various psychosocial risk and protective factors that contribute to adolescent substance use behavior.

Given typical patterns of substance use initiation during this developmental period, an emphasis is placed on alcohol, cigarette, and marijuana use.

Findings: Consistent with bioecological theories, peers and parents tend to have the strongest effect on adolescent substance use behavior. Influences can be both direct, such as offers and availability to use substances, as well as indirect influences, such as the perception of substance use approval. Schools and neighborhoods also contribute to adolescent substance use behavior, but this effect is often less direct. Moreover, the effect of neighborhoods on adolescent behavior reflects both structural components (e.g., neighborhood racial composition, teacher-student ratios) in addition to social process (e.g., neighborhood social cohesion, school connectedness). A review of parallel studies conducted with animals is also provided.

Summary: Adolescent substance use behavior does not occur in a vacuum. Investigations must encompass the relevant social ecologies that affect adolescent behavior, including family, peer, school, and neighborhood contexts to provide a more complete understanding of substance use etiology.

Keywords

adolescence; peers; parents; neighborhood; school; substance use

Epidemiological findings demonstrate that substance use is typically initiated during adolescence (Substance Abuse and Mental Health Services Administration, 2010). Adolescence is defined as youth ages 10 to 18, consistent with the American Psychological Association's terminology (2002). In addition, adolescent substance use, which encompasses the use of alcohol, tobacco, marijuana, and more illicit drugs, is relatively common. Namely, as part of the 2019 Monitoring the Future (MTF) survey (Johnston et al., 2020), 29% of 12th graders and 18% of 10th graders reported alcohol use in the prior month

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and 36% of 12th graders and 29% of 10th graders reported past-year marijuana use. Although rates of cigarette smoking continue to decline and reached the lowest levels in the history of the survey (i.e., current prevalence of half-pack-a-day smoking is less than 1 percent for both 12th and 10th graders), rates of electronic cigarettes in 2019 reflect one of the largest absolute increases MTF has ever tracked for any substance. For example, 30-day prevalence of vaping nicotine rose from 11.9% in 2017 to 25.5% in 2019 among 12th graders (Johnston et al., 2020). These statistics are of great concern not only due to the short-term negative consequences related to substance use that include emotional (e.g., depression), interpersonal (e.g., relationship strain), physical (e.g., accidental injuries), and occupational (e.g., academic problems) effects (Branstetter & Furman, 2013; Miotto et al., 2013), but also the established long-term negative consequences, such as elevated risk for developing a substance use disorder. The prevalence of lifetime alcohol use disorder is approximately 41% for individuals who initiated use by age 12, compared to 17% and 11% for those initiating use at age 18 and 21, respectively (Committee on Substance & Kokotailo, 2010). Therefore, it is critical to identify risk and protective processes that are associated with adolescent substance use in order to help inform effective prevention programming.

The current review will focus on established risk and protective psychosocial factors that have the greatest effect on adolescent substance use. In addition, a discussion regarding possible differences across biological sex and age on the effect of each socialization context will be provided when available. An emphasis will be placed on alcohol, cigarette, and marijuana use as historically these substances are typically initiated during adolescence (Johnston et al., 2020). Despite their emerging popularity, given the relative lack of studies on electronic nicotine delivery systems, findings based on these devices will not be discussed in this review.

Theoretical Underpinnings of Adolescent Substance Use

Notwithstanding the overwhelming evidence supporting the role of social factors on the initiation of substance use and progression to regular use, prior research has focused disproportionately on individual factors (Zimmerman & Farrell, 2017). Consistent with theory, an examination that reflects family, peer, school, and neighborhood contexts (see Figure 1) will provide a more comprehensive understanding of adolescent substance use as this behavior does not occur in a vacuum.

Bioecological Model of Development

Bronfenbrenner's Bioecological Model (1979) has been instrumental in organizing the myriad socialization factors that contribute to the etiology of adolescent substance use. This model posits that multiple contextual factors, including peers, families, schools, and neighborhoods, shape adolescent development and health behavior. These different contexts are viewed as "systems", which can either directly or indirectly affect the development of adolescents' health behavior, including substance use (see Figure 1). The *microsystem* encompasses immediate socialization areas that affect the child directly (e.g., peers, siblings, parents). The *mesosystem* is comprised of the connections and interactions between the individual's microsystems (e.g., the interaction between the individual's peers and parents).

The *exosystem* refers to the larger social systems that do not have a direct effect on the individual, but operate indirectly with structures in the individual's microsystem (e.g., neighborhoods). Finally, the *macrosystem* is the outermost socialization arena encompassing cultural values, politics, religion and laws, which are viewed as having a cascading role on the development of the individual through interactions across all socialization settings (Bronfenbrenner, 1979). Accordingly, some contexts that encompass the adolescent's social ecology may be more salient to adolescent behavior and have a more direct effect on substance use outcomes, such as peers and parents, whereas other contexts, such as neighborhoods, may have a more distal and indirect effect on behavior, operating primarily through these more proximal factors.

Individual characteristics of the adolescent are reflected in the center of these concentric circles. These encompass biological sex, biological differences (e.g., genes, neurobiology), and temperament (i.e., heritable differences in emotional, motor, attentional, and self-regulation processes) among other innate factors. Biologically based individual characteristics often contribute to the degree to which adolescents are susceptible to socialization contexts. Although biology is not the focus of the current review, several models are highlighted that characterize its role on increasing sensitivity to socialization contexts, especially during adolescence.

Relevant Models Encompassing Genes and Neurobiology

Prior work indicates that an individual's genetic information plays a notable role in the degree to which individuals are susceptible to socialization contexts. Historically, the interplay between an individual's genes and their environment (gene x environment or GxE) have been conceptualized within a diathesis-stress framework. Diathesis-stress models (e.g., Zuckerman, 1999) posit that some individuals may be more vulnerable to maladaptive socialization contexts due to their genes and therefore at greater risk for developing psychopathology, including problematic substance use. For example, one study found that lenient parental rule-setting was associated with increased odds of alcohol use and that this association was strongest among adolescents with a certain risk genotype (*DRD2* A1 and *OPRM1* G-allele; Pieters et al., 2012).

Given evidence that adaptive socialization contexts also contribute to adolescents' decision on whether to engage in substance use behavior, more recent conceptualizations focus on genetic factors that may increase sensitivity to a wider range of environmental exposures. Vantage sensitivity models posit that youth with certain genetic factors may be particularly sensitive to adaptive socialization contexts, while those not carrying this variant are unaffected (Pluess, 2017). For example, one study (Cleveland et al., 2015) testing the joint contribution of a preventative intervention of underage alcohol use and maternal involvement across variants of a particular candidate gene supported an effect of the intervention on 9th-grade alcohol use. Yet, this effect was only significant for youth carrying a certain genetic variant (i.e., at least one copy of the *DRD4* 7 repeat allele) in addition to those reporting average and higher levels of maternal involvement (Cleveland et al., 2015).

A third model, the differential susceptibility hypothesis, posits that some youth are characterized by increased sensitivity to environmental contexts spanning the maladaptive to

adaptive continuum based on their genetic makeup, while those without these genetic variants are unaffected (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007). For example, when testing differential effects of a preventive intervention on subsequent alcohol use across dopaminergic and GABAergic genes, Brody and colleagues (2013) found that adolescents carrying genetic factors traditionally conceptualized as risk factors reported more alcohol use in the control condition. Yet, youth carrying these same genetic variants demonstrated the greatest reduction in alcohol use over time in the treatment condition (Brody, Chen, & Beach, 2013).

Other critical factors that relate to the impact of genetic effects on substance use include developmental period and stage of substance use; albeit contributions may be confounded. Socialization effects tend to have a stronger association on earlier stages of substance use that typically occur during adolescence (e.g., initiation). In contrast, genes tend to have a stronger association on later stages of use that typically arise in adulthood (e.g., heavy use). For example, a study examining alcohol initiation and progression to more severe alcohol use (e.g., binge drinking) among 11-19-year-old twins found that shared environmental influences accounted for most (~65%) of the variance in initiation compared to genetic factors (~26%) when controlling for age (Fowler et al., 2007). In contrast, when examining severe alcohol use, less than half of the variance was due to shared environmental influences (~47%) and approximately one-third (~35%) was due to genetic effects (Fowler et al., 2007). Another study found that at age 14, genes accounted for close to 20% of the variance in alcohol use, compared to nearly 50% at age 18 (Rose, Dick, Viken, Pulkkinen, & Kaprio, 2001). Some researchers theorize that differences across stage of substance use and development may reflect differences in social worlds of youth compared to adults. During adolescence, parents tend to closely monitor and put restrictions on their child's social world. When youth transition into adulthood and have more freedom to shape their social world, genetic vulnerabilities may be more likely to be expressed (Dick & Foroud, 2003). In sum, findings support the importance of synergistic effects of genes and socialization contexts on adolescent substance use (see Trucco, Madan, & Villar, 2019 for a review).

Neurobiological changes that occur during adolescence may also contribute to the etiology of adolescent substance use. The dual systems model posits that increased risk taking that occurs during the adolescent years, including substance use, can be attributed in part to the imbalance in developmental courses of two brain systems (Steinberg, 2008; Caset, Getz, & Galvan, 2008). The first reflects a rapidly developing socioemotional system (located primarily in the striatum), which contributes to an adolescent's pursuit of rewarding, exciting, and novel experiences (Shulman et al., 2016). The second reflects a more gradually developing cognitive control system (located primarily in the prefrontal cortex), which contributes to more judicious decision making and the restraint of potentially harmful impulses (Shulman et al., 2016).

More recently, researchers have indicated that frontal cortical immaturity may be too simplistic when understanding adolescents' decisions to engage in risky behavior and that a more nuanced perspective on adolescents' processing of social, cognitive, and affective information is necessary. There is growing evidence indicating that the cognitive control system during adolescence may not necessarily be immature, but rather more flexible

compared to adulthood (Jolles, van Buchem, Crone & Rombouts, 2011). Moreover, the degree to which the cognitive control system is recruited during adolescence is largely a result of motivational salience, such as the value placed on performing the task or the presence of peers (Johnson, Grossmann, & Cohen Kadosh, 2009). This flexibility in making rapid adjustments with respect to the degree to which cognitive control processes are engaged may contribute to increased vulnerability toward potentially harmful incentives, such as substance use, but it may also contribute to adaptive motivations relevant to positive social development (see Crone & Dahl, 2012 for a review).

Social Learning Theory

According to Social Learning Theory (Bandura, 1977), modeling is a critical mechanism by which social environments affect behavior. By observing influential people's (e.g., parents, siblings, friends) attitudes and behaviors, adolescents develop cognitive representations that are invoked when making their own decision to engage in substance use behaviors. If valued social referents maintain favorable attitudes toward substances or actually use substances, then an adolescent is more likely to also endorse these attitudes or mirror these behaviors. In addition, Social Learning Theory posits that the adoption of favorable attitudes towards use or engagement in a behavior is reinforced when youth perceive that: 1) the role model is rewarded for engaging in these behaviors, 2) the role model is perceived as similar to oneself, and 3) the role model seems to have greater social status (Bandura, 1997; Huang, Soto, Fujimoto, & Valente, 2014).

Social Control Theory

According to Social Control Theory (Hirschi, 1969), the combination of close ties to conventional societal institutions (e.g., family, school) and strong prosocial values decreases the likelihood that individuals will engage in deviant behavior. Family attachment is seen as a key critical social bond in an adolescent's decision to deviate from conventional conduct (Mahabee-Gittens et al., 2011). That is, adolescents are less likely to engage in deviant behaviors, such as substance use, and value socially accepted norms when they feel a sense of belonging, support, and connection within their family, and other conventional institutions (Reeb et al., 2015).

Social Development Model

The Social Development Model (Catalano & Hawkins, 1996) integrates Social Learning Theory (Bandura, 1977) and Social Control Theory (Hirschi, 1969) by postulating that youth develop social bonds with socializing agents across four contextual domains (i.e., family, school, religious and community institutions, and peers) based on the perceived opportunities and rewards for involvement in either prosocial or antisocial activities. That is, youth who anticipate rewards for prosocial actions will be more likely to engage in prosocial activities. Whereas youth who anticipate rewards for antisocial activities are more likely to engage in antisocial behavior, including substance use (Cleveland, Feinberg, & Jones, 2012). The Social Development Model also integrates a developmental perspective reflecting changes that occur in social environments. It is proposed that the salience of socializing agents across these four contextual domains change as youth mature (Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996). Namely, while parents are the key socialization unit

during childhood and early adolescence (Catalano & Hawkins, 1996), this shifts to peers becoming the primary socialization unit during middle and late adolescence as more time is spent outside of the family (Furman & Buhrmester, 1992).

This review will focus on parents, peers, school contexts, and neighborhoods as these are the socialization factors that have the strongest effect on adolescent substance use across both theoretical models and empirical investigations. Although this review is not intended to be exhaustive, an emphasis is placed on specific factors that have the most empirical support.

Parent Socialization Context

Parents are influential referents in adolescents' social worlds, affecting both adolescent substance use behavior directly, as well as friendship tie choices. Research examining the role of parental socialization on adolescent substance use has focused on two broad components: parental control (demandingness) and parental warmth (responsiveness). Parental control reflects behaviors directed to the child intended to shape behavior viewed as acceptable by the parent, including setting explicit rules regarding adolescent behavior, supervision, and discipline (e.g., Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2006; Ladis, Trucco, Huang, Thomlison, & Fava, 2020). In contrast, parental warmth reflects behavior directed toward the child that supports the message that they are loved, including involvement, praise, affection, and emotional availability (e.g., Barnes et al., 2006; Ladis et al., 2020). Both parental warmth and control have been demonstrated to play a protective role in reducing risk for substance use (e.g., Donaldson, Handren, & Crano, 2016; Fleming, Mason, Thompson, Haggerty, & Gross, 2016). Moreover, two perspectives have been offered regarding how to conceptualize these constructs: a dimensional approach that examines these two aspects of parenting separately, and a categorical approach that combines these facets into overall parenting styles. Namely, four parenting styles are derived given each possible combination of the two-dimensional framework of parental control and warmth: authoritative (high control, high warmth), authoritarian (high control, low warmth), permissive (low control, high warmth), and neglectful (low control, low warmth) (Baumrind, 1991; Maccoby & Martin, 1983). These classifications of parenting style continue to be widely used in examining the role of parenting on adolescent substance use (Abar, Jackson, Colby, & Barnett, 2015). Yet, this review will focus on the broader dimensional approaches.

Other parenting behaviors more specific to substance use have been demonstrated to predict early onset of adolescent substance use, as well as patterns of use (e.g., quantity and frequency). Namely, parental substance use and parental permission to use substances (primarily alcohol use) have shown a strong impact on adolescent substance use behavior (Colder, Shyhalla & Frndak, 2018; Jackson, Ennett, Dickinson, & Bowling, 2012; Rusby, Light, Crowley, & Westling, 2018). Consistent with Social Learning Theory, when youth witness their parents using substances, a modeling effect can occur. Moreover, in households where parents use substances there is likely an increase in the availability of that substance to their child (Rusby et al., 2018). Parents who give permission to their child to take sips of alcohol may also convey a message of acceptance regarding the use of that substance to their child (Colder et al., 2018). Both broad and more substance use specific parenting behaviors will be discussed.

Parental Monitoring and Knowledge

Proactive parental family management practices that encompass the broader context of parental control are associated with the initiation of adolescent substance use. Namely, parents who are high in control are more likely to supervise their children, which in turn limits their child's initiation of substance use (Barnes, Reifman, Farrell, & Dintcheff, 2000). Prior research supports the importance of isolating the unique effects of specific aspects of parenting control practices. A robust predictor of substance use initiation and escalation during adolescence is parental monitoring (e.g., Fleming et al., 2016; Van Ryzin, Fosco, & Dishion, 2012). Yet, some researchers have questioned interpretations derived from previous work due to how parental monitoring is operationalized (Kerr, Stattin, & Burk, 2010). Namely, early work defined parental monitoring as "parenting behaviors involving attention to and tracking of child whereabouts, activities, and associations" (Dishion & McMahon, 1998, p. 61). Yet, when examining the content of items used to assess parental monitoring, they tend to reflect actual knowledge of their child's activities and associations rather than active tracking efforts (Kerr & Stattin, 2000). This is a critical distinction, as parents are likely to obtain this knowledge either from active monitoring, solicitation, or voluntary disclosure from children (Kerr et al., 2010).

To address this, Kerr and Stattin (2000) developed a measure assessing parental knowledge, parental solicitation, and youth disclosure separately. Research demonstrates that when examined in the same model, youth disclosure is a more robust predictor of adolescent substance use than the knowledge parents acquire through active surveillance methods (Jiang, Yu, Zhang, Bao, & Zhu, 2016). It is likely that youth disclosure may be facilitated in part to an open and trusting parent-child relationship and strong emotional family bonds (Kerr et al., 2010).

Since the work of Kerr and colleagues (2010), there has been a notable shift from studies examining parental monitoring to investigations focused on parental knowledge. A number of these studies are noteworthy given that they reflect innovative methods and study designs that extend our understanding of parental knowledge as a predictor of adolescent substance use. For example, Lippold and colleagues (2014) applied a propensity score analysis to examine maternal knowledge as a predictor of adolescent alcohol, cigarette, and other drug use during middle school. In propensity score analyses, a host of confounding variables that precede initiation of substance use can be accounted for to simulate random assignment and establish more robust causal associations between the predictor and outcome (see Rubin, 2005). When controlling for 33 confounders, including other aspects of parenting (e.g., monitoring, discipline, and supervision), maternal knowledge of youth activity predicted substance use initiation and attitudes towards substance use (Lippold, Coffman, et al., 2014). These findings offer strong support for the role of parental knowledge on a youth's decision to engage in substance use.

Another study extends the parental knowledge literature to include behaviors of peers' parents (Cleveland, Feinberg, Osgood, & Moody, 2012). Cleveland and colleagues (2012) used sociometric data and social network analyses to determine whether parenting received by other members of an adolescent's friendship group leads to their own substance use behaviors. Results indicate that high levels of parental knowledge and low levels of

inconsistent discipline as reported by an adolescent's friendship group predicted low rates of cigarette, marijuana, and alcohol use during mid-adolescence (Cleveland, Feinberg, Osgood, et al., 2012). Thus, parental knowledge is likely to have a broader effect than expected; high levels of parental monitoring protects against substance use behaviors within the family, as well as the larger friendship group.

Other work investigates possible mechanisms through which parental knowledge reduces adolescent risk for substance use. High levels of parental knowledge may minimize adolescent exposure to deviant and substance-using peer groups (Fallu et al., 2010; Hemovich, Lac, & Crano, 2011). Moreover, high levels of parental knowledge may be especially critical for girls. For example, one study found that low parental knowledge in girls predicted greater involvement with male friends during mid-adolescence, which in turn predicted more problematic alcohol use during late adolescence (Poulin & Denault, 2012). Thus, parental knowledge may reduce exposure to negative peer influences that contribute to substance use initiation.

Lastly, there is research indicating that the association between parental knowledge and adolescent substance use is best characterized as a bidirectional and transactional process. That is, even though the prospective link between parental knowledge and substance use has been widely replicated (e.g., Fletcher, Steinberg, & Williams-Wheeler, 2004; Van Ryzin et al., 2012), it is also likely that adolescent substance use may contribute to the degree to which parents engage in monitoring and acquire knowledge. Prior work indicates that adolescents who engage in substance use may be especially reluctant to spend time with family members or disclose details about their activities, which results in less parental knowledge (Jones, Ehrlich, Lejuez, & Cassidy, 2015). In turn, parents of adolescents who use substances may disengage from effective parenting practices, such as acquiring knowledge about their adolescents' activities, due to frustration (Racz & McMahon, 2011). This is consistent with Patterson's (1986) coercion theory, which posits a negative reinforcement mechanism whereby escalation in an adolescent's problem behavior may lead to parents becoming disenfranchised from parenting. It is also possible that reductions in parental monitoring reflect parents' perceptions that their child is trustworthy and responsible. Namely, a decrease in parental solicitation and monitoring may indicate an adaptive response to allow youth to increase their independence (Lippold, Greenberg, & Collins, 2014).

Several caveats should be noted regarding current work examining parental monitoring on adolescent substance use. First, although parental monitoring is widely supported as a protective factor for adolescent substance use, there is also work indicating that in certain contexts it may increase risk. For example, extreme parental monitoring can exacerbate risk among youth who are already at-risk for problematic substance use when parent-child attachment is low (Fallu et al., 2010). It may be that these youths find high monitoring to be unwarranted given an already tenuous relationship with their parents. Inconsistent parental knowledge or knowledge lability has also been demonstrated to increase risk for adolescent alcohol, cigarette, and marijuana use (Lippold, Fosco, Ram, & Feinberg, 2016; Tobler & Komro, 2010).

Another aspect to consider is the reporter of parental knowledge. Overall, parents tend to over-report knowledge due in part to social desirability bias (Abar et al., 2015), while youth reports of parental knowledge tend to be more strongly predictive of adolescent substance use than parent report (Kerr & Stattin, 2000). Some authors indicated that mixed findings across reporters may be due to the fact that parent- versus child-report may capture subtle differences of parental monitoring/knowledge. Parents' reports may reflect behaviors they feel that they have engaged in, whereas adolescents' reports may reflect parental behaviors that youth are aware of or perceive (Abar et al., 2015). In addition, discrepancies between parent and youth perceptions of parental knowledge predict youth substance use. For example, parent-child discrepancies in reports of parent knowledge were positively associated with a measure of risk-taking behaviors, including substance use (Reynolds, MacPherson, Matusiewicz, Schreiber, & Lejuez, 2011). Discrepancies may reveal disharmony or indicate an underlying dysfunction in the parent-child relationship (De Los Reyes, Goodman, Kliewer, & Reid-Quinones, 2010; Fleming et al., 2016).

Aspects of Parental Warmth

Although parental monitoring and knowledge is considered one of the more robust parental predictors of adolescent substance use, aspects of parental warmth, such as family cohesion, bonding, involvement, and parent-child relationship quality have also been found to affect adolescent behavior. For example, family cohesion, defined as the level of affection, acceptance, support, and connectedness within the family, had a protective effect against future adolescent alcohol-related problems (Reeb et al., 2015). A similar construct, parental support, as characterized by praise, affection, and encouragement, has been associated with lower levels of adolescent and young adult substance use and alcohol dependence (Branstetter, Low, & Furman, 2011). It is posited that adolescents of parents high in warmth are more likely to turn to their parents for guidance and information (Van Ryzin et al., 2012), endorse unfavorable perceptions of substance users (Wills, Gibbons, Gerrard, Murry, & Brody, 2003), and internalize parental rules against substance use (Mahabee-Gittens, Xiao, Gordon, & Khoury, 2013). In turn, parent-child relationship quality is likely to have both a direct effect on reducing risk of adolescent substance use initiation, as well as a more indirect effect reflected in choices of peers, who are likely to provide pressure or access to substances (Van Ryzin et al., 2012). Importantly, parent-child conflict or disruptions in the parent-child relationship quality, may also contribute to selecting into a substance-using peer group and greater risk for a substance use disorder in adulthood (Brook, Brook, Zhang, & Cohen, 2009). Although a certain degree of parent-child conflict (e.g., where they go after school, the friends that they spend time with) is normative as adolescents seek to gain autonomy from their parents and an adolescent's social world shifts to peers, highly conflictual relationships increase risk for adolescent maladjustment, including substance use (see Smetana & Rote, 2019 for a review).

Parental Substance Use and Permission to Use in the Home

Prior work indicates that important correlates of adolescent substance use include substance use specific attitudes and behaviors of parents. Chief among these is the actual substance use behavior of parents. Parental alcohol use on adolescent alcohol use (Alati et al., 2014; Cranford, Zucker, Jester, Puttier, & Fitzgerald, 2010; Rossow, Keating, Felix, McCambridge,

2016; Rusby et al., 2018), parental cigarette smoking on adolescent cigarette use (Gilman et al., 2009), and parental marijuana use on adolescent marijuana use (Miller, Siegel, Hohman & Crano, 2013) have been supported in the literature, as well as evidence for cross-substance links (e.g., parental cigarette use predicting adolescent alcohol use; Capaldi, Tiberio, Kerr, & Pears, 2016). Moreover, this work indicates that the likelihood of offspring substance use increases in relation to the number of parents that use the substance in the household and the duration of direct exposure to parental substance use, signifying a potential dose-response relationship (Gilman et al., 2009; Smit, Otten, Voogt, Kleinjan, Engels, & Kuntsche, 2018). Other literature attempts to specify whether the link between parent and adolescent alcohol use is greater for mother's substance use or father's substance use. Yet, findings are mixed. Some studies suggest that father's substance use is a stronger contributor to adolescent alcohol use (Mares, Van der Vorst, & Engels, 2011; Van der Vorst, Engels, & Burk, 2013). Other studies indicate that mother's use is a stronger predictor of adolescent substance use (Marsden et al., 2005; Walls et al., 2017). Still others indicate that parents have an equal effect on adolescent substance use behavior (Bjorkqvist, Batman, & Aman-Back, 2004; Scholte et al., 2008).

Another substance-specific parenting practice that contributes to adolescent substance use involves parental permission of sipping and tasting alcoholic beverages. A study conducted by Jackson and colleagues (2012) reported that parental pro-sipping attitudes may be driven by beliefs that allowing children to sample alcoholic beverages under their supervision will increase the likelihood of responsible drinking later in life or minimize risk for future alcohol use given that most children do not like the taste of alcoholic beverages. Yet, it is also possible that parental permission of sipping/tasting could increase risk for problematic alcohol use by conveying a message to children that underage drinking is both permissible and unlikely to lead to punishment. Prior studies indicate that tasting alcohol under parental supervision during late childhood increased the likelihood of consuming a full drink by mid-adolescence (Donovan & Molina, 2011; Jackson, Henriksen, Dickinson, & Levine, 1997). A more recent study not only demonstrated that sipping and tasting alcohol with parental permission prior to age 13 years was associated with increased frequency and quantity of alcohol consumption and alcohol related problems in late adolescence, they also determined possible mechanisms contributing to this association (Colder, Shyhalla, & Frndak, 2018). Early sipping and tasting alcohol with parental permission may lead to increased problematic alcohol use via its impact on the formation of youth cognitive appraisals of alcohol. More specifically, early alcohol sipping/tasting was associated with weak negative alcohol expectancies (e.g., "I'll get sick") and negative implicit alcohol associations, as well as strong positive expectancies and subjective evaluations (e.g., "I'll feel more happy") of alcohol use (Colder et al., 2018). Taken together, these findings indicate that parental substance use and parental permission to use substances are risk factors for the early onset of substance use, as well as escalation to more problematic levels of substance use.

Varying Effects Across Age and Biological Sex

Prior work offers some evidence that differences in terms of the role of parental control and warmth on substance use may differ across biological sex. Gender development theory indicates that relationships with parents are more salient for girls compared to males

(Gilligan, 1982) and thereby girls' substance use may be more susceptible to parental influences than that of boys. For example, prior work finds that not only are girls more highly monitored by parents compared to boys (Hemovich et al., 2011), but the role of deviant peers on subsequent drug use among girls is greater in the context of low parental monitoring compared to boys (Ryan, Roman, & Okwany, 2015; Svensson, 2003). Similarly, prior work indicates that relationship quality (especially mother-daughter ties) played a stronger role on girls' alcohol use compared to boys' alcohol use (Kelly et al., 2011). However, other research indicates that parental knowledge (Tebes et al., 2011) and interactions between parental knowledge and deviant peer affiliation on substance use outcomes were significant for boys, but not for girls (Jiang et al., 2016). Overall, findings indicate that boys and girls are equally at risk for engaging in adolescent substance use in the context of parental substance use (Rusby et al., 2018; Smit et al., 2018). Yet, there are some studies indicating a stronger effect for fathers' smoking on boys' compared to girls' smoking (Gilman et al., 2009), as well as fathers' and mothers' regular drinking having a stronger effect on males than females among 12-15-year old adolescents (Scholte et al., 2008).

Prior work indicates that parental monitoring and knowledge may be most influential during early adolescence compared to late adolescence (Cleveland, Feinberg, Bontempo, & Greenberg, 2008; Fagan, Van Horn, Antaramian, & Hawkins, 2011). Prior work has found that parental control, parental knowledge, and youth disclosure decline during the adolescent period as youth seek out independence and autonomy (Keijsers, Frijns, Branje, & Meeus, 2009; Kerr et al., 2010). Namely, parental knowledge has been demonstrated to be a stronger predictor of substance use during the middle school years compared to the high school years (Tebes et al., 2011). Other work examining the relative impact of parental monitoring and family relationship quality on tobacco, alcohol, and marijuana use from age 12 to age 23 demonstrated that parental monitoring was predictive of tobacco and marijuana use in early adolescence, family relationship quality was a significant predictor of all three substances from the transition to high school and into late adolescence, while neither aspect of parenting predicted substance use during early adulthood (Van Ryzin et al., 2012). Similarly, prior work indicates that the risk posed by fathers' and mothers' substance use on offspring alcohol use decreases with age, whereby effects were stronger among 12-15-year-olds compared to 21-25-year-olds, but still significant during early adulthood (Scholte et al., 2008). Yet, other work suggests that parental monitoring/knowledge and involvement consistently predicts substance use across adolescence (Guo, Hill, Hawkins, Catalano, & Abbott, 2002) and into the college years (Cleveland, Feinberg, & Jones, 2012). **During late adolescence, parent-child communication and youth self-disclosure may become a more effective way to obtain information regarding substance use behavior compared to active monitoring and solicitation strategies (Tebes et al., 2011).**

Peer Socialization Context

From a developmental perspective adolescence is a period in which youth spend less time with parents, levels of family involvement decrease, **there is an emphasis on gaining autonomy from parents, and the quality of parent-child communication is reduced** (Hill, Bromell, Tyson, & Flint, 2007; Mahabee-Gittens et al., 2013). At the same time, adolescence

is characterized by increased time spent with peers, heightened sensitivity to social reward, and engagement in novel experiences that emphasize socializing with peers and conforming to perceived peer group standards (Leung, Toumbourou, & Hemphill, 2014; Van Ryzin et al., 2012). As such, peers are believed to become increasingly more influential relative to parents during the transition from childhood to adolescence (Trucco, Colder, & Wiczorek, 2011). This section will cover various dimensions of the peer socialization context, as associations between youth and peer substance use are believed to operate through both direct (e.g., pressure, substance use availability) and indirect (e.g., norms) socialization mechanisms (Trucco, Colder, Bowker, & Wiczorek, 2011).

Peer Selection and Peer Socialization

It is well-established that friends' substance use and attitudes are robust predictors of adolescents' risk behaviors (Branstetter et al., 2011; Mathys, Burk, & Cillessen, 2013; Rowan, 2016), such as cigarette smoking (Huang et al., 2014), marijuana use (de la Haye, Green, Kennedy, Pollard, & Tucker, 2013), and alcohol use (Chassin, Pitts, & Prost, 2002; Edwards, Maes, Prescott, & Kendler, 2015; Guyll, Madon, Spoth, & Lannin, 2014; Mundt, 2011). Yet, there are several important methodological issues which may obfuscate the strength and direction of the adolescent-peer association. First, studies that include both adolescent reports of their own substance use and their perception of their peers' substance use may inflate the true association between peer and adolescent behavior. This includes methodological issues pertaining to shared reporter bias (Scalco, Trucco, Coffman, & Colder, 2015), the tendency for youth to project their own behaviors onto their peers (Bauman & Ennett, 1996; Trucco, Colder, & Wiczorek, 2011), and youths' overestimation of others' engagement in risk behaviors (Perkins, Haines, & Rice, 2005). Second, it is often challenging to disaggregate whether the peer group's substance use behavior and attitudes contribute to an adolescent's substance use behavior, or whether an adolescent's own substance use promotes the selection of friends who engage in similar behaviors. These processes have been termed peer socialization and peer selection, respectively.

Peer socialization reflects an adolescent's decision to modify their own substance use behavior in response to peer influences to adapt to the social norms of the group (i.e., peer substance use behavior predicting adolescent substance use). It is important to note, that although prior work indicates that peer socialization is strongest in the context of close friendships, adolescents can be socialized by high status peers with whom they have less direct interpersonal contact outside of dyadic friendship contexts (Branstetter et al., 2011; Helms et al., 2014). In contrast, consistent with the principle of homophily whereby individuals are drawn to others that are similar to themselves, peer selection refers to an individual choosing to affiliate with individuals similar to themselves (i.e., adolescent substance use predicting peer substance use).

Prior work supports the role of both selection and socialization of adolescent substance use. For example, prior work demonstrates that perceived alcohol use or approval of use prospectively predicts adolescent alcohol use even after controlling for prior levels of adolescent risk behaviors, including alcohol use (Leung et al., 2014; Trucco, Colder, & Wiczorek, 2011), which supports the role of peer socialization. Prior work has also

demonstrated that adolescent alcohol use predicts peer alcohol use after controlling for prior levels of peer use (Burk, van der Vorst, Kerr, & Stattin, 2012; Leung et al., 2014), which supports the role of peer selection. Yet, the literature is mixed with regard to which of these processes has the strongest effect on adolescent behavior. For example, some findings indicate that during adolescence peer socialization plays a stronger role on substance use behavior, due in part to the fact that substance use rates are relatively low (Pearson, Steglich, & Snijders, 2006). Other studies indicate that selection effects are stronger during adolescence across alcohol, cigarette, and marijuana use (Huang et al., 2014; Kiuru, Burk, Laursen, Salmela-Aro, & Nurmi, 2010; McDonough, Jose, & Stuart, 2016). Yet, another study that adopted propensity score analysis to account for a large number of confounding factors demonstrated that these processes were relatively equal in magnitude with respect to adolescent alcohol use (Scalco et al., 2015).

It is important to note that although prior work has supported the role of selection and socialization related to alcohol, smoking, and marijuana use, a majority of studies have examined these processes separately for each of these substances, which ignores the possibility of youth using multiple substances concurrently (Mathys et al., 2013). Two notable exceptions are studies conducted by Pearson and colleagues (2006) and Mathys and colleagues (2013), which assessed alcohol, tobacco, and marijuana use in the same model. Pearson and colleagues (2006) demonstrated that both socialization and selection processes contribute to alcohol use, socialization was a stronger predictor of marijuana use, and neither socialization nor selection processes predicted tobacco use. In contrast, Mathys and colleagues (2013) found that selection was a stronger predictor of tobacco use, and socialization was a stronger predictor of alcohol use.

Descriptive and Subjective Peer Norms

In addition to direct peer influences, adolescent substance use behavior develops through indirect processes. Consistent with Social Learning Theory, adolescents do not need to observe their peers engaging in substance use behavior for it to be socially reinforced. That is, the mere belief that a peer group approves of the behavior or the perception of pressure to adopt attitudes of the larger peer group promotes substance use behavior (Petraitis, Flay, & Miller, 1995; Trucco, Colder, & Wieczorek, 2011). Namely, perceived peer approval and use of substances during early adolescence may be especially influential given that direct pressure from peers is often rare (Bauman & Ennett, 1996). This is consistent with social norm theories (Azjen & Fishbein, 1980; Cialdini & Trost, 1998), which expand upon Social Learning Theory by characterizing two additional distinctions: descriptive and subjective norms. Descriptive norms reflect the perception of normative peer group behavior. Subjective, or injunctive norms, reflect the perception of how approving the peer group is of that behavior, which contributes to a youth's desire to conform with peer group views (Azjen & Fishbein, 1980).

Adolescents tend to be largely inaccurate when estimating others' behaviors and social norms pertaining to substance use, including unfamiliar peers, classmates, as well as close friends (Borsari & Carey, 2003). Not only do adolescents erroneously overestimate peers' engagement in health risk behavior, they also tend to mistakenly underestimate peers'

engagement in adaptive behaviors, with the magnitude of these misperceptions amounting to large effect sizes. For example, one study found that when asking popular teens directly about their substance use, they reported virtually no cigarette smoking or marijuana use in the prior month. Yet, peers perceived these same high-status teens as smoking up to three cigarettes per day and smoking marijuana up to nine times per month (Helms et al., 2014). These misperceptions in turn are believed to increase substance use behavior.

Overestimation of substance use among peers and high-status classmates has led to the development of social norm campaigns designed to dispel these common misperceptions by providing information regarding the actual frequency of substance use primarily on college campuses (Wechsler et al., 2003). Unfortunately, these campaigns have only yielded modest effects (Prentice, 2008).

Positive Peer Effects

Even though it is assumed that peers have both positive and negative effects on adolescent behavior, research has largely focused on negative effects as they relate to problem behaviors, including substance use (Steinberg & Monahan, 2007; Trucco, Villafuerte, Burmeister, & Zucker, 2017). Prior work indicates that some adolescents may feel socialization pressure to engage in prosocial behaviors (e.g., excelling in academics, avoiding drugs). For example, research has demonstrated that friendships categorized by positive characteristics, such as support, engagement in school and academics, and involvement in religious activities, had a protective effect against substance use (Branstetter et al., 2011; de la Haye et al., 2013).

Varying Effects Across Age and Biological Sex

Prior work indicates that peer effects likely wax and wane across certain developmental periods and across biological sex. For example, one study examining the transition from experimentation to regular smoking from grades 8 to 10 (middle adolescence), grades 10 to 12 (late adolescence), and grades 12 to age 23 (young adulthood) found that friends' smoking was only a significant predictor during middle adolescence when controlling for other confounding variables (Tucker et al., 2003). When comparing the relative risk of friends' alcohol use on drinking behavior across three different age groups (i.e., 12-15, 16-20, and 21-25) there was evidence for an age dependent effect whereby the risk of drinking based on friends' alcohol use declined with age (Scholte, Poelen, Gonneke, Boosma, & Engels, 2008). Another study conducted on two independent longitudinal samples spanning grades 6 to 11 demonstrated that the link between peer influence on alcohol use was greatest during grades 9 and 10, when adolescents were 14 to 16 years old (Cleveland, Feinberg, & Jones, 2012). Consistent with prior work (Erickson, Crosnoe, & Dombusch, 2000; Mahabee-Gittens et al., 2013), these findings indicate that peer influence may not increase during adolescence in a linear pattern, rather the association is curvilinear and peaks during mid-adolescence. As previously discussed, research examining cognitive control and self-regulatory systems suggest that increased susceptibility to peer influence during early- to mid-adolescence compared to later adolescence may have to do with the later maturation of areas of the brain (e.g., prefrontal cortex) that increase the capacity to resist negative peer influences compared to those more aligned with social reward (e.g., striatum; Albert, Chein, & Steinberg, 2013; Steinberg & Monahan, 2007).

Overall, the empirical work on the peer socialization context has tended to focus on adolescents and college students, with a relative dearth of studies focused on the general population of adults (Patrick, Schulenberg, Maggs & Maslowksy, 2016). Moreover, empirical work on adults has tended to focus on marital partners as opposed to friends and peers (Andrews, Tildesley, Hops, & Li, 2002), which indicate significant levels of mate-based selection due to substance use behavior, especially for women (Windle, 1997). A notable exception examining the role of peers on young adult substance use found evidence for peer socialization with respect to cigarette use and binge drinking indicating that the influence of peers remains in adulthood (Andrews et al., 2002). In contrast, selection effects, as well as the maintenance of friendships with peers displaying similar behaviors, were more prominent with respect to overall alcohol and marijuana use. The authors state that the lack of support for strong peer influence effects on overall use may be due in part to the high prevalence and normative use of alcohol and marijuana during this developmental period (Andrews et al., 2002).

Findings are mixed with regard to differences in peer susceptibility across biological sex. Some studies indicate that boys are more susceptible to deviant and non-deviant peer influences, including substance use (e.g., Miller, 2010; Steinberg & Monahan, 2007). Others report that either girls have a greater tendency to conform to peers' behaviors than boys (e.g., Kung & Farrell, 2000), or that there are no significant differences across biological sex (e.g., Larsen, Overbeek, Vermulst, Granic, & Engels, 2010; Rabaglietti, Burk, & Giletta, 2012). Although most work has not supported significant differences regarding peer susceptibility across biological sex among adults, when differences were noted, men were shown to be more similar and susceptible to their friends compared to women (Andrews et al., 2002).

School Socialization Context

The school context is an important socialization factor to consider in the context of adolescent substance use given that youth spend most of their days at school. Prior work indicates that school climate can be understood via two primary dimensions: school organization and class climate (Tomczyk, Isensee, & Hanewinkel, 2015). School organization is conceptualized as structural components of the school environment, such as student-to-teacher ratio (i.e., class sizes), policies, location of school, and number of staff. In contrast, school climate refers to the personal connections that are established within the school, such as student-teacher relationship quality, class atmosphere, and level of bonding within classes (Tomczyk et al., 2015). Factors falling within school organization are believed to be somewhat distal to student substance use. School organization consists of the promotion of a less tolerant community in regard to adolescent substance use through school policies, as well as opportunities for teachers to provide support and guidance to students regarding health risk behaviors based on student-to-teacher ratios (Tomczyk et al., 2015). Class climate is thought to have a more direct effect on student substance use. For example, prior work indicates that positive student-teacher relationship quality (Patrick & Schulenberg, 2013) and a more accepting school climate (Curcio, Mak, & George, 2013) protected against early onset of alcohol use and the likelihood of problematic alcohol use (e.g., binge drinking). Other work indicates that strong emotional attachments that students

form with schools (i.e., connectedness, engagement) are integral in protecting against substance use as youth may be more likely to endorse substance use norms and expectations established within the school context (Li et al., 2011; Rovis, Jonkman, & Basic, 2015; Tomczyk et al., 2015; Vogel, Rees, McCuddy, & Carson, 2015).

School Connectedness and Disengagement

School connectedness not only reflects the degree to which students feel connected at school, but also comprises the value students place on educational goals and commitment towards participating in academic and school-based social activities (Li et al., 2011). Prior studies indicate that high school connectedness is associated with lower rates of alcohol, tobacco, and drug use (Henry et al., 2010; Li et al., 2011; Vogel et al., 2015). For example, one study demonstrated that greater levels of school engagement (both behavioral and emotional) significantly predicted lower risk of substance use initiation through the use of discrete-time survival analysis (Li et al., 2011). Namely, the odds of initiating substance use were about one-third lower than the odds for a student whose behavioral school engagement was one point lower and 40% lower than the odds for someone whose emotional school engagement was one point lower (Li et al., 2011). It is likely that adolescent students who are highly connected with schools may form a common identity with other students and refrain from using substances as a way to avoid disappointing teachers and classmates (Vogel et al., 2015).

In contrast, adolescents failing to develop strong connections within schools are at greater risk of developing antisocial attitudes and behavior (Henry & Thornberry, 2010). One indicator of poor school disengagement that has received attention as it relates to adolescent substance use is truancy (i.e., skipping school without a valid excuse). Prior work indicates that truancy is a strong predictor of substance use onset and involvement (Henry & Thornberry, 2010; Henry, Thornberry, & Huizinga, 2009). One mechanism through which truancy is linked to increased substance use is through escalation in unsupervised, unstructured, and risky environments with peers that are afforded by not attending school. Truancy was demonstrated to be associated both concurrently and prospectively to high levels of polysubstance use, as well as greater escalation of polysubstance use once an adolescent initiated use (Henry & Thornberry, 2010).

In another study conducted by the same group, school disengagement as a predictor of problematic substance use during adolescence and early adulthood was examined (Henry, Knight, & Thornberry, 2012). A school disengagement warning index was operationalized as a sum of five binary risk indicators based on official school records where the sample was recruited: a score reflecting a lack of proficiency in one or more subjects based on standardized test scores, poor attendance as indicated by missing 20% or more of school days in a given school year, failing one or more core subjects, one or more school suspensions, and repeating a grade. In middle adolescence, school disengagement was positively associated with problem drug use, but not problem alcohol use. In late adolescence, school disengagement was positively associated with both problem drug use and problem alcohol use. In early adulthood, school disengagement was positively associated with problem drug use. A curvilinear association was demonstrated for problem

alcohol use in early adulthood, whereby the association demonstrated a downward trend across low levels of school disengagement compared to a steep incline at high levels of school disengagement (Henry et al., 2012). Thus, school disengagement represents an early warning sign for short-term and long-term risk for engagement in substance use.

In sum, these findings are consistent with Hirschi's (1969) Social Control Theory and Catalano & Hawkins' Social Development Model (1996), which posit that a lack of strong bonds with conventional societal institutions, including schools, increases risk for engagement in substance use behaviors. Adolescence is a developmental period characterized by strong goals to develop independence and obtain autonomy from parents, which often leads to attenuation of school engagement (Henry et al., 2012). Although school engagement is believed to be more volatile during adolescence compared to other developmental stages, the effect of low school connectedness on substance use behavior continues into adulthood (Henry et al., 2012).

Neighborhood Socialization Context

Compared to individual factors and other socialization contexts, research investigating how neighborhood factors contribute to the etiology of adolescent substance use is more nascent. A greater understanding regarding the role of neighborhood socialization factors on substance use is critical given that adolescents increasingly value independence from the family unit and spend more time outside their homes (Tucker, Pollard, de la Haye, Kennedy, & Green, 2013). Prior work makes an important distinction between two aspects of the neighborhood, which may differentially contribute to adolescent functioning: neighborhood structure and neighborhood social processes (Trucco, Colder, Wiczorek, Lengua, & Hawk, 2014). Despite clear distinctions, there has been significant empirical support for the association between both structural and social neighborhood factors on adolescent substance use (Brenner, Bauermeister, & Zimmerman, 2011; Buu, DiPiazza, & Wang, 2009; Handley, Rogosch, Guild, & Cicchetti, 2015; Tucker et al., 2013). Moreover, research conducted on neighborhood context tends to focus on either objective measures typically derived from census data (i.e., socioeconomic status, poverty indicators) or more subjective measures (i.e., youth/parent report of neighborhood cohesion, safety; Handley et al., 2015; Tucker et al., 2013). By and large, prior work demonstrates stronger and more consistent effects for residents' perceptions of their neighborhood and adolescent engagement in alcohol and drug use behavior compared to objective measures (Tucker et al., 2013).

Neighborhood Structure

Neighborhood structure encompasses sociodemographic or compositional characteristics of the community (e.g., employment and poverty rates, racial composition, median income) that are traditionally measured with objective data from census data based on the census tract in which the individual resides (Warner, 2016). Prior work indicates that higher unemployment rates enhanced adolescent risk for marijuana use initiation (Tucker et al., 2013). Similarly, neighborhood disadvantage was associated with more marijuana dependence symptoms, but only among maltreated youth (Handley et al., 2015). Work focused on a middle school sample found that witnessing various high-risk events in the

neighborhood (e.g., arrests, drug use, robbery) was associated with higher rates of substance use initiation by 8th grade (Burlew et al., 2009). Similarly, children living in unstable neighborhoods characterized by high residential mobility (i.e., residents moving in and out frequently) were more likely to develop various negative mental health outcomes, including alcohol use disorder, marijuana use disorder, and nicotine dependence symptomatology during late adolescence (Buu et al., 2009). Moreover, adolescents living in disadvantaged neighborhoods are likely to have greater exposure to substances, which enhances availability and opportunities to use substances that in turn elevate levels of alcohol and drug use among adolescents (Cerda, Diez-Roux, Tchetgen, Gordon-Larsen, & Kiefe, 2010). One study demonstrated a positive association between alcohol outlet density and perceptions of alcohol, tobacco, and other drug availability, which in turn was associated with increased use of substances especially among boys (Milam, Johnson, Furr-Holden, & Bradshaw, 2016).

Nonetheless, there are several studies that have not found strong associations between neighborhood structural factors and adolescent substance use (e.g., Trucco et al., 2014; Zimmerman & Farrell, 2017). In fact, there are some studies supporting an inverse association between neighborhood disadvantage and adolescent substance use. For example, Snedker and colleagues (2009) found that adolescents living in disadvantaged neighborhoods had lower rates of marijuana use. Mixed results may be due in part to differences in terms of which specific structural aspects of the neighborhood are measured across studies and accounting for potential individual differences (e.g., race, ethnicity, deviant peers) in susceptibility to risky neighborhood conditions (Handley et al., 2015; Snedker et al., 2009; Zimmerman & Farrell, 2017). For example, prior work indicates that living in disadvantaged neighborhoods may be associated with increased parental monitoring, which in turn is associated with lower rates of substance use (Chuang, Ennett, Bauman, & Foshee, 2005). Other work indicates that neighborhoods characterized by risky structural components may lead to adolescent risk behavior indirectly via neighborhood social processes and differences in parenting practices (Mrug & Windle, 2009; Trucco et al., 2014). This is consistent with Bronfenbrenner's Bioecological Model (1979) regarding the degree to which socialization contexts contribute to adolescent behavior depending on varying system-level differences, as well as other conceptual frameworks described below.

Neighborhood Social Processes

Neighborhood social processes refer to a community's social organization (e.g., social cohesion among neighbors). Neighborhood social processes are often more subjective in nature compared to structural factors and are typically measured via an individual's perception of ties to neighbors in the community, informal social control, and level of community function (Mrug & Windle, 2009). Collective efficacy theory (Sampson, 1992), drawn largely from social disorganization theory, posits that characteristics of economically disadvantaged neighborhoods thwart neighborhood social cohesion, support, and informal social control (Leventhal & Brooks-Gunn, 2000). Neighborhoods characterized by social disorganization and low levels of collective efficacy (i.e., residents' willingness to intervene on neighborhood problems on behalf of the community) are less likely to effectively monitor and enforce the proper conduct of community residents, including the behavior of adolescents, resulting in higher levels of adolescent substance use (Handley et al., 2015). For

example, prior work indicates that an adolescent's sense of community and perception of adult community involvement was negatively related to school mean alcohol, cigarette, and marijuana use (Mayberry, Espelage, & Koenig, 2009).

Similar to other contextual factors, there are mixed findings with regard to the role of neighborhood social processes on adolescent substance use. For example, one study found that greater neighborhood collective efficacy was related to greater substance use than neighborhoods with lower levels of collective efficacy when controlling for concentrated neighborhood disadvantage, exposure to violence, and individual-level variables (e.g., sex, race, SES; Fagan, Wright, & Pinchevsky, 2014). The authors speculate that these contradictory findings may be due to rates of substance use among adults in the community or failure in condemning substance use among youth. That is, adolescent substance use may be elevated if youth feel connected to individuals in their community who either approve of or use substances, consistent with Social Learning Theory (Bandura, 1977). Another explanation reflects levels of parental supervision. Parents may feel less of an onus to closely supervise their children if they feel shared responsibility with other adult community members within neighborhoods high in collective efficacy, thus increasing opportunities to engage in substance use behavior (Fagan et al., 2014).

Varying Effects Across Age and Biological Sex

Investigations focused on understanding how neighborhood factors affect substance use differently across biological sex and age are limited. However, there is some indication that neighborhood structural factors are not strong predictors of substance use during childhood given limited direct exposure to the community (Buu et al., 2009). Even during adolescence, parents are viewed as gatekeepers of neighborhood influences, whereby potential negative effects of high-risk neighborhoods are transmitted to youth via increased parental stress (Trucco et al., 2014). During later developmental stages, as individuals become more independent, peers and parents may have a weaker role on substance use behaviors, while neighborhood socialization may increase in salience (e.g., McBride Murry, Berkel, Gaylord-Harden, Copeland-Linder, & Nation, 2011). For example, prior work demonstrates a significant association between neighborhood disadvantage and daily tobacco use among adult men and women and regular use of other drugs by adult women (Karriker-Jaffee, 2013). In terms of differences across biological sex, a seminal study on residential mobility, Moving to Opportunity, which randomly assigned low-income families residing in disadvantaged neighborhoods vouchers to relocate to low-poverty neighborhoods, found that girls benefitted from the relocation in terms of risky behaviors, education, and physical health compared to boys who demonstrated adverse effects (Kling, Liebman, & Katz, 2007). Additional research focusing on the role of biological sex and age in the association between neighborhood factors and substance use is warranted.

Animal Models

The use of animal models to manipulate aspects of the social environment to investigate psychosocial paradigms of addiction based on constructs identified through research in humans can have significant utility in testing hypothesized causal relations. This is

especially the case for adolescent research where ethical concerns impose limits on study designs. A key consideration is that animals do not develop substance use disorders or abuse drugs in nature; thus, attempts to model these human conditions in animals may pose notable challenges (Stephens, Crombag, & Duka, 2011). For this reason, researchers suggest adopting methods reflecting key functional aspects of the addiction process (e.g., biomarkers, neurobiological mechanisms, and discrete human behavioral phenotypes), rather than prioritizing phenotypically similar paradigms (Duka, Crombag, & Stephens, 2010; Sher, Dick, Crabbe, Hutchison, O'Malley & Heath, 2010). Accordingly, there are several aspects of substance use that tend to demonstrate greater concordance. These include: self-administration of drugs (e.g., Roehrs & Samson, 1981), conditioned place preference (i.e., drug experiences repeatedly paired with exposure to a specific environment; Stephens, Duka, Crombag, Cunningham, Heilig, & Crabbe, 2010), drug-related conditioning (Everitt & Robbins, 2005), subjective experiences of substances (e.g., hedonic reactions to taste; Berridge, 2000), binge drinking (Crews, Braun, Hoplight, Switzer, & Knapp, 2000), withdrawal (Stephens et al., 2005), and relapse (Shalev, Grimm, Shaham & 2002).

In terms of understanding the etiology of adolescent substance use, there are a number of behaviors and neurobiological processes that characterize adolescence that may represent highly conserved features. Most notably, the increased focus on peer interactions and various aspects of parenting occurs across a variety of species (Primus & Kellogg, 1989; Spear, 2004). Consistent with neuropharmacological models related to substances affecting dopamine circuits, substances' reinforcing effects are often conditional upon social interactions, especially during adolescence (Berridge & Robinson, 1998). Interactions with known conspecifics is reinforcing in rats (Douglas, Varlinskaya, & Spear, 2004) and the presence of peers has been found to enhance the rewarding properties of nicotine among adolescent rats (Thiel, Sanabria, & Neisewander, 2009).

In addition, there is evidence for increased risk-taking behaviors among adolescents across a broad range of species (Trimpop, Kerr, & Kirkcaldy, 1999). For example, through the use of a plus-maze apparatus, Laviola and colleagues (2003) demonstrated that adolescent mice spent an equal amount of time in both protected and unprotected areas of the apparatus that increased risk of falling and the absence of protecting walls, compared to juvenile and adult mice that demonstrated a clear preference for closed and protected areas. The authors posit that this may be indicative of greater motivation in exploring and risk taking (Laviola, Macrí, Morley-Fletcher, & Adriani, 2003), which characterizes adolescence consistent with the dual systems model. Also consistent with human research, there is evidence that decision-making in adolescent mice does not necessarily reflect a immaturity in cognitive processes, but rather motivational flexibility. For example, in a odor-based foraging task where mice learned that different odors were paired with a reward, and subsequently, the reward was paired with a different odor, adolescent mice learned a four-choice discrimination and reversal faster than the adult mice, indicative of greater behavioral flexibility (Johnson & Wilbrecht, 2011).

In terms of social influence models of substance use intake, animal models tend to focus on social play and social contact (Marcolin, Hodges, Baumbach, & McCormick, 2019; Varlinskaya, Truxell, & Spear, 2015). One study found that social interactions with a peer

intoxicated with ethanol affected social behavior among both male and female adolescent rats, but only increased voluntary ethanol intake among female rats (Gamble et al., 2019). Other work also supports sex-dependent effects of ethanol intake under social conditions. For example, a study conducted by Varlinskaya and colleagues (2015) demonstrated that adolescent males consumed more ethanol under social compared to alone conditions, whereas adolescent females consumed more ethanol when alone. Adolescent females with high levels of social anxiety-like behavior also had the highest rates of ethanol consumption under social, but not alone conditions. In contrast, social anxiety-like behavior was not associated with differences in ethanol intake for adult rats, which supports potential age-dependent effects (Varlinskaya et al., 2015).

Prior rodent models examining adolescence and substance use have also focused on stress, often tested using electric shock, restraint stress, swim stress, and social defeat (Burke & Miczek, 2014). For example, several studies demonstrate that stress exposure increases ethanol intake among various rodent strains following social defeat-induced stress (Croft, Brooks, Cole, & Little, 2005), swim stress (Lowery, Sparrow, Breese, Knapp, & Thiele, 2008), and restraint stress (Chester, Blose, Zweifel, & Froehlich, 2004). Furthermore, using a drinking-in-the-dark (DID) paradigm that promotes high levels of ethanol intake, Evans and colleagues (2020) found that social isolation increased anxiety-like and depression-like behavior, which in turn predicted sex-dependent changes in ethanol intake. For example, social females drank more than isolated females in the 30% ethanol concentration level condition (Evans et al., 2020). Prior work also suggests age-dependent effects between stress and substance use behavior. For example, adolescence has been found to be associated with increased vulnerability to stress compared to adulthood on cross-sensitization to drugs of abuse (Chester, Barrenha, Hughes, & Keuneke, 2008; Zago et al., 2012). A potential unique neural mechanism underlying adolescent social stress cross-sensitization to drugs of abuse may be the reduction of mesocortical dopamine through D2 dopamine receptor regulation of dopamine synthesis or glucocorticoid facilitated pruning of dopamine-related fibers (Burke & Miczek, 2014). This work mirrors studies conducted with humans indicating that living in more stressful contexts (e.g., neighborhoods characterized by violence) may increase substance use in order to reduce symptoms of anxiety or depression consistent with the self-medication hypothesis (Khantzian, 1997).

Consistent with human research, work with animal models indicates that peer selection and socialization processes, as well as social facilitation motives, are key factors contributing to substance use initiation among adolescents compared to adults. Moreover, this work is consistent with human research indicating that externalizing pathways to substance use (i.e., substance use as a product of increased sensation seeking, impulsivity, and social facilitation) may be more relevant for adolescent boys compared to internalizing pathways (i.e., substance use as a product of increased anxiety and depression), which may be more relevant for adolescent girls.

Yet challenges arise when trying to identify consilient models where social behaviors may not represent highly conserved features or seem to have no clear counterparts in non-human animal species, such as aspects of the school or neighborhood contexts. It is important to keep in mind that the ecological representation of an environment and the effect it has on

neurobiological processes may be more important than maintaining phenotypic equivalence to its human counterpart (Sher et al., 2010). For example, what may be referred to as neglect in humans (e.g., lack of providing resources, nurturance, and supervision to minors) may look very different phenotypically among rodents (e.g., lack of maternal licking), but be judged as consilient.

Conclusions and Implications

Identifying factors associated with substance use during adolescence, when use is typically initiated, will help inform the development and refinement of prevention and intervention programs. Theoretical accounts, such as Bronfenbrenner's Bioecological Model (1979), Social Learning Theory (Bandura, 1977), Social Control Theory (Hirschi, 1969), and the Social Development Model (Catalano & Hawkins, 1996), highlight the importance of ecological systems and the role of influential figures' actual substance use, as well as attitudes towards substance use in the etiology of substance use. Attempts to understand adolescent substance use behavior without the implementation of an ecological perspective is likely to provide an incomplete picture given that risk behavior among adolescence is nested within multiple systems. The current review covers several key socialization contexts, including parents, peers, schools, and the neighborhood. The work examined here indicates that peers and parents tend to have a stronger and direct effect on adolescent behavior compared to other factors. Moreover, these influential figures may act as gatekeepers of more distal socialization factors. For example, high parental monitoring may offset risk associated with living in disadvantaged neighborhoods, while deviant peers can offset protective effects of schools high in connectedness.

It is also important to note that even though adolescents may be especially prone to taking risks and susceptible to certain socialization contexts given the vast array of affective, physical, and cognitive changes that transpire during this development period, this does not always represent increased vulnerability. For example, prior work indicates that genes are not deterministic and adolescents who were considered at increased risk for substance use based on traditional conceptualizations actually fared better than their peers when exposed to adaptive environments (e.g., Trucco et al., 2017). Similarly, work on neurobiological changes transpiring during the teenage years suggest that counter to traditional conceptualizations that adolescents have an immature cognitive control system, they may have a more flexible cognitive control system compared to adults that offers distinct advantages (Crone & Dahl, 2012).

In terms of clinical implications, this review demonstrates that more comprehensive approaches that focus on the complex social ecologies of adolescents, such as Multidimensional Family Therapy (MDFT; Liddle, 2010), represent treatment modalities that may have particular utility in treating adolescent substance use. These multidimensional approaches focus on the importance of intervening across multiple levels of socialization, including parents, peers, schools, and the juvenile justice system. The focus on multiple ecological models may contribute to MDFT's notable effect on adolescent substance use compared to other standard treatments (Liddle, 2010). Overall, psychosocial risk and protective factors during this key developmental period represent important contributors in

the initiation of alcohol, cigarettes, and marijuana use. An exciting challenge is to gain a greater understanding of youth's motivation to engage in certain behaviors and how to harness adolescents' flexibility in cognitive engagement away from unhealthy behaviors and promote opportunities for learning and motivations towards health.

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Highlights

- Various social ecologies are relevant in the etiology of adolescent substance use
- Peers, parents, schools, and neighborhoods represent critical psychosocial factors
- The effect of socialization contexts on behavior often varies across sex and age
- Substance use treatment should address influences from multiple social contexts

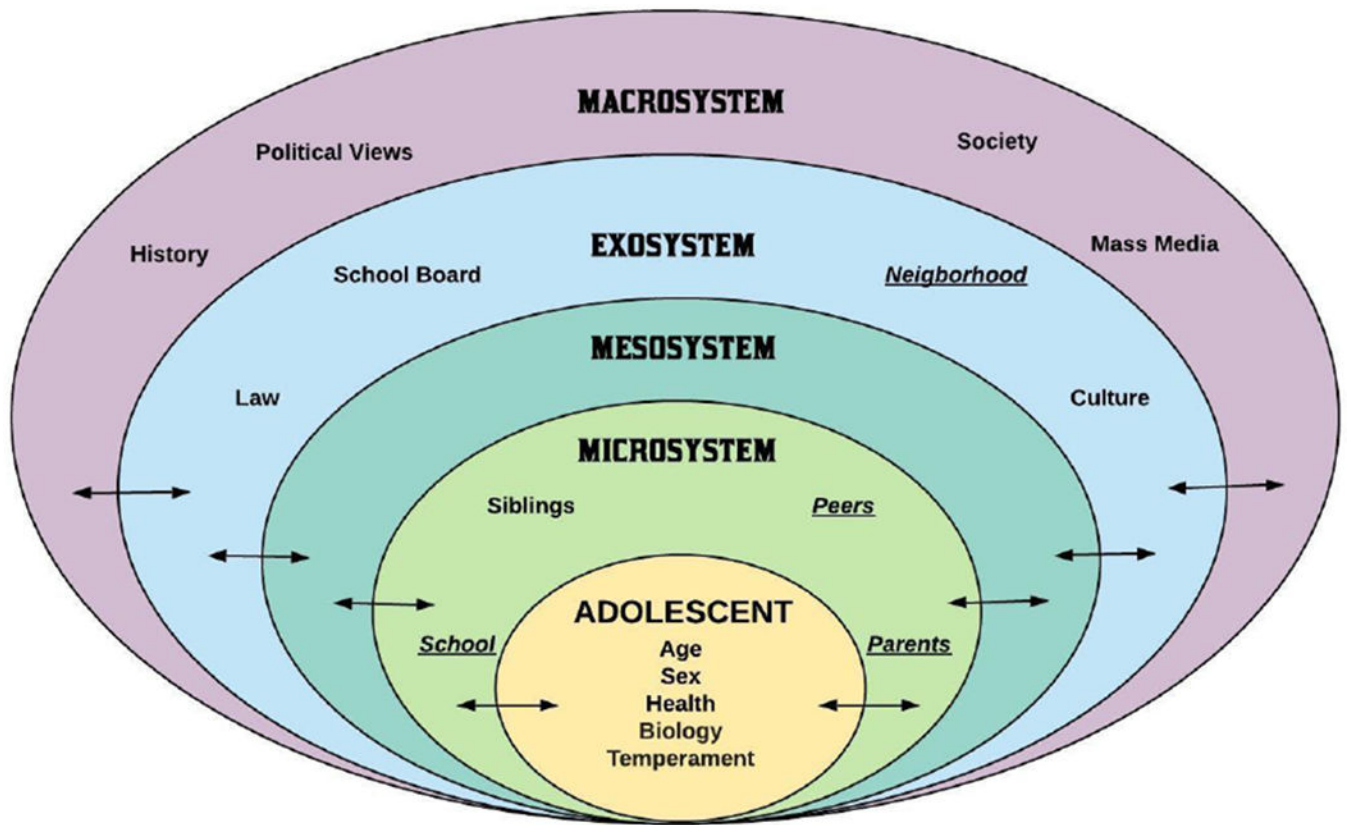


Figure 1. Psychosocial Factors Relevant to Adolescent Substance Use Based on Bronfenbrenner's Bioecological Model. Italicized contexts represent those reflected in the current review.