

# SECTION 2

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## Alcohol Use and Adolescent Development

Adolescence, the period between the onset of puberty<sup>8</sup> and the assumption of adult roles, is a time of particular vulnerability to alcohol use and its consequences for a variety of developmental reasons, some specific to the individual and others related to the biological and behavioral changes produced by adolescence itself. It also is a time when the developing brain may be particularly susceptible to long-term negative effects from alcohol use (Brown et al. 2000; Crews et al. 2000; De Bellis et al. 2000; Swartzwelder et al. 1995*a*, 1995*b*; Tapert and Brown 1999; White and Swartzwelder 2005). New research indicates that the brain continues to develop into the twenties (Giedd 2004), creating a significant and extended period during its development of potential exposure to alcohol's harmful effects, particularly because so many youth drink alcohol, so many start drinking relatively early (Johnston et al. 2006*a*; Johnston et al. 2006*b*; SAMHSA 2006), and so many binge drink (Johnston et al. 2006*a*; Johnston et al. 2006*b*; SAMHSA 2006). Preventing and reducing underage alcohol use is a complex process, however. To succeed, it must involve not only parents but other adults, youth, schools, communities, govern-

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<sup>8</sup> For the purpose of this document, *puberty* is defined as a sequence of events by which a child becomes a young adult characterized by secretions of hormones, development of secondary sexual characteristics, reproductive functions, and growth spurts.

ments at all levels, private institutions, and society itself. This section will describe:

- The developmental characteristics of adolescents that make them particularly vulnerable to alcohol involvement.
- Emerging research on potential long-term consequences of early alcohol use, including effects on the brain.
- The dynamic interaction between internal characteristics (e.g., personality) of adolescents and their external environment (e.g., school, family, peers).
- The developmental approach that provides a means by which the Nation as a whole can address underage alcohol use in a systematic, integrated way.

Adolescence is the extraordinary period of dynamic change when a person moves from childhood to adulthood. During this transition, adolescents must cope with dramatic changes in their bodies, feelings, perspectives, and environments. They face new sexual and aggressive urges, the drive for autonomy, and the demands of their peer group as they seek to develop a stronger sense of themselves. They will experience unfamiliar situations, pressures, desires, and challenges for which they have no prior frame of reference and often are not fully prepared to deal with effectively on their own. Furthermore, adolescence is associated with increased freedom, decreased monitoring by adults, and an increased affiliation with peers. This period of dramatic change and expanding opportunities “may herald a risky passageway until the regulatory capacity develops to manage new skills, opportunities or impulses” (Masten 2004).

Adolescence is a time of heightened risk taking, independence seeking, and experimentation, although the extent of these behaviors varies widely among individuals. It is “a period when an appetite for adventure, a predilection for risks, desire for excitement, and inclination toward passionate

action, seem to reach naturally high levels” (Dahl and Hariri 2004). During this period, alcohol can present a special allure to some adolescents for social, genetic, psychological, and cultural reasons. This attraction occurs at the very time adolescents may not be fully prepared to anticipate all the effects of drinking alcohol and when they are more vulnerable to certain of its adverse consequences. Further, alcohol has been shown to impair one’s ability to evaluate risk and reward when making decisions (George et al. 2005).

Adolescents operate within many different social systems, which both influence them and are, in turn, influenced by them (Bronfenbrenner 1979). As shown in Figure 8, these systems include the adolescent’s family, peers, school, extracurricular and community activities, sports teams and clubs, religious institutions, other diverse organizations with which the adolescent interacts, part-time work, the community itself, the culture, and even influences from around the world accessed through the Internet and other electronic resources. Each of these social systems exposes the

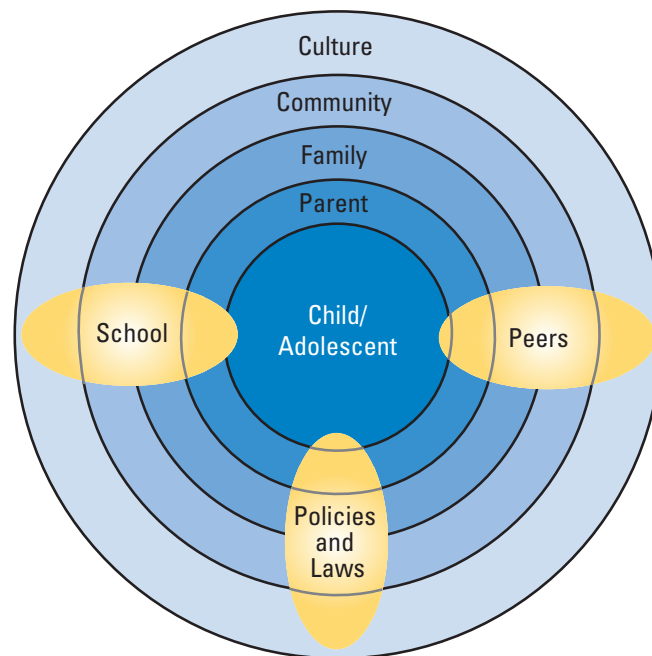


Figure 8: Systems That Influence Adolescent Behavior.

This schematic represents the multiple systems in which adolescents are embedded. Their relative influences vary across development.

adolescent to both positive and negative influences, potentially increasing or decreasing the adolescent's risk of alcohol use. The multiple systems also overlap—reinforcing or contradicting each other—and they interact: each is affected in some way by the other.

Because adolescents are involved in multiple systems, all of which may affect their decision to use alcohol, each system plays a part in that decision. For example, a stable family environment contributes to positive outcomes, as does a supportive community. To properly protect adolescents from alcohol use, parents and other adults must engage in multiple social systems as individuals, citizens, and voters. By understanding the role these systems play in the teen's life and by acting strategically on the basis of established and emerging research, the Nation can reduce the risk and consequences of underage alcohol use.

## A DEVELOPMENTAL FRAMEWORK

Underage alcohol use is best addressed and understood within a developmental framework, because this behavior is directly related to the processes that occur during adolescence. Recent advances in the fields of epidemiology, developmental psychopathology, human brain development, and behavioral genetics have provided new insights into adolescent development and its relationship to underage alcohol use. Research indicates that adolescent alcohol consumption is a complex behavior influenced by:

- Normal maturational changes that all adolescents experience (e.g., biological and cognitive changes, such as sexual development and differential maturation of specific regions of the brain, and psychological and social changes, such as increased independence and risk taking).
- Multiple social and cultural contexts (i.e., the social systems) in which adolescents live (e.g., family, peers, and school).
- Genetic, psychological, and social factors specific to each adolescent.

- Environmental factors that influence the availability and appeal of alcohol (e.g., enforcement of underage alcohol policies by schools and others, community support for enforcement of underage drinking laws, marketing practices, pricing, and the physical availability of alcohol).

The development of adolescent alcohol use involves multiple processes that influence one another. Biological factors internal to the adolescent, such as genes and hormones, interact with factors external to the adolescent, which range from peers to school to the overall culture, in determining whether he or she will use alcohol. Some external factors are chosen by the adolescent, such as peers, and some are determined for them, such as family and neighborhood. Internal and external factors influence each other in reciprocal ways as the adolescent's development unfolds over time. For example, a tendency toward risky behavior may lead the adolescent to join a risk-taking peer group, which, in turn, may encourage the adolescent to take greater risks. Importantly, because of the interplay of internal and external factors in a given individual, youth are not at uniform risk for alcohol consumption nor are individual adolescents uniformly at risk over the span of their own adolescence. Instead, the relative influence of various risk and protective factors shifts throughout adolescence.

## THE DEVELOPING ADOLESCENT BRAIN

Age, experience, and overall physical maturation, including puberty, are among the multiple factors influencing brain development. In adolescence, brain development is characterized by dramatic changes to the brain's structure, neuron connectivity (i.e., "wiring"), and physiology (Restak 2001). For example, during late childhood and early adolescence the number of neural connections increases. By contrast, in later adolescence the number of connections is reduced through selective pruning at the same time that myelination of neurons is increasing, thereby enhancing the efficiency of the brain. These changes in the brain affect everything

from emerging sexuality to emotionality and judgment. Because not all parts of the adolescent brain mature at the same time, the adolescent may be at a disadvantage in certain situations (Dahl 2004). For example, the limbic areas of the brain, which are thought to regulate emotions and are associated with an adolescent's lowered sensitivity to risk and propensity for novelty and sensation seeking, mature earlier than the frontal lobes, which are thought to be responsible for self-regulation, judgment, reasoning, problem-solving, and impulse control. This difference in maturational timing across the brain can result in impulsive decisions or actions, a disregard for consequences, and emotional reactions that can put teenagers at serious risk in ways that may surprise even the adolescents themselves. There is, however, tremendous individual variability among adolescents, the pathways they follow, and the outcomes they experience. For example, the emotional and physical energy that is characteristic of adolescence can be channeled into sports, academics, music, art, and various causes as well as in negative directions that produce adverse outcomes, including alcohol use (Dahl and Hariri 2004). Experiences that promote self-reliance and self-regulation may involve some risk, but they contribute to the attainment of the adolescent's independence—a principle that holds true even though adolescents follow different pathways.

## ADOLESCENT DECISIONMAKING AROUND ALCOHOL

Despite a body of literature suggesting that adolescents have not yet reached full cognitive maturity, they generally do as well as adults when called upon to make reasoned decisions using abstract processes in emotionally neutral situations. Differences in decisionmaking between adults and adolescents are most evident in situations with heightened social or emotional overtones. Such contexts may intensify the innate drive adolescents experience for novelty and sensation seeking. As a result, they may be more likely to make decisions that place themselves at greater risk when peers are present and/or in emotionally charged settings (Steinberg 2004). Given that certain situations can override an adolescent's good

intentions and sound decision-making capacity, it is important to structure the social system surrounding youth to minimize negative outcomes.

Although all adolescents are subject to having their decisions influenced by peers and/or emotional arousal, those who associate with a more deviant peer group may be at additional risk because of the kinds of activities with which this peer group may be involved. Relevant to underage drinking, studies show that adolescents who spend more time with peers who consume alcohol are more likely to drink (Colder and Chassin 1999; Curran et al. 1997; Sieving et al. 2000; Stice et al. 1998).

## STRESS, PUBERTY, AND SIGNIFICANT ADOLESCENT TRANSITIONS

The physical effects of puberty create dramatic changes in the sexual and social experience of maturing adolescents that require significant psychological and social adaptation. Together with hormonally induced mood and behavior changes, these sexual and social maturation stressors may contribute to increased consumption of alcohol during the adolescent period (Tschann et al. 1994). In graduating from elementary to middle school, from middle school to high school, and from high school to college or the workplace, adolescents move in and out of different social contexts and peer groups, which exposes them to new stressors. These transitions lead to increased responsibilities and academic expectations, which are also potential sources of stress. This is important because research shows a link between stress and alcohol consumption. For example, research on nonhuman primates shows that adolescent monkeys double their alcohol intake under stress and that excessive alcohol consumption is related to changes in stress hormones and serotonin (reviewed in Barr et al. 2004).<sup>9</sup>

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<sup>9</sup> Serotonin is a *neurotransmitter* that modifies neuron function, exerting its effects by interacting with receptors on the neuron's surface.

Significant contextual transitions and achievement of milestones for adolescents often occur at specific ages, not at specific developmental periods. For example, the moves to middle and high school and the acquisition of a driver's license and job experience are generally age-based. As a result, some adolescents may be developmentally out of step with the majority of their peers or with the demands of their social environment, particularly in the case of early- and late-maturing adolescents. A mismatch between social pressures and the cognitive and emotional abilities of an adolescent may increase vulnerability to involvement with alcohol. In the case of early-maturing adolescent girls, for example, having an older or adult boyfriend raises the risk for underage use of alcohol and other drugs and the adoption of delinquent behaviors (Castillo Mezzich et al. 1999). For boys, same-gender peers rather than older romantic interests tend to increase the risk for initiation into alcohol and other drug use (Dishion et al. 1994; Elliot and Menard 1996; Fergusson and Horwood 1996, 1999; Hawkins et al. 1992; Kandel 1978; Sampson and Laub 1993). During significant transitions, adolescents can benefit from extra support to avoid alcohol use.

## CHANGE IN EXPECTATIONS<sup>10</sup> ABOUT ALCOHOL USE IN ADOLESCENCE

Expectations about the effects of drinking alcohol are measurable in children before they begin to drink and can influence how early a child drinks and how much he or she will drink at initiation. Research suggests that people who have expectations of more positive experiences from drinking tend to drink more than others and are at highest risk for excessive drinking. Children in general shift from a primary emphasis on the negative or adverse effects of drinking alcohol before about age 9 to a primary emphasis on the positive and arousing effects of alcohol by about age 13 (Dunn and Goldman 1996, 1998). Those at highest risk for excessive drinking show the largest emphasis on alcohol's positive or arousing

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<sup>10</sup> This concept is commonly referred to as *expectancies* in the alcohol research literature.



effects. Therefore, it is important to be aware of the messages about alcohol use that youth receive and the attitudes that these messages engender in children and adolescents about alcohol and its use.

## PERSONALITY TRAITS, MENTAL DISORDERS, AND ADOLESCENT ALCOHOL USE

Research studies on adolescent drinking have examined the impact of particular personality traits on drinking risk. These studies have repeatedly failed to find specific sets of traits that uniquely predict alcohol use in adolescents. Despite the fact that no set of traits has been found that predicts alcohol use, research does show that adolescents who are heavy alcohol users or have alcohol use disorders (AUDs) often exhibit certain personality traits (which also are shared by some adolescents who do not abuse alcohol). High levels of impulsiveness, aggression, conduct problems, novelty seeking (Gabel et al. 1999), low harm avoidance (Jones and Heaven 1998), and other risky behaviors in childhood and early adolescence may be associated with future heavy alcohol use and AUDs (Soloff et al. 2000).

Depression and anxiety also are risk factors for alcohol problems because some people use drinking as a coping strategy for dealing with internal distress. And, more generally, adolescents with defined mental disorders have significantly elevated rates of alcohol and other drug use problems. In these cases, early treatment of mental disorders, such as depression or excessive anxiety, is warranted before an adolescent begins to drink as well as after initiation of drinking. Furthermore, it is important to recognize that youth who use alcohol are also more likely to use other substances and vice versa. Because many young people are involved not only with alcohol but also with other substances and may have a mental disorder, interventions should be designed to address this complexity.

## ADOLESCENTS FROM FAMILIES WITH A HISTORY OF ALCOHOL DEPENDENCE

Children from families of alcoholics are at increased risk for alcohol dependence throughout their lives. More than three decades of research has firmly established that genes account for over half of the risk for alcohol dependence, and environmental factors account for the remainder. Researchers have succeeded in identifying regions of chromosomes associated with an altered risk of developing alcohol dependence and, in some cases, individual genes and candidate genes<sup>11</sup> but no single gene that accounts for the majority of risk. The development of a complex behavioral disorder such as alcohol dependence likely depends on specific genetic factors interacting with one another, multiple environmental factors, and the interaction between genetic and environmental factors. Important when considering underage drinking is research suggesting that genes have a stronger influence over the development of problem use, whereas environment seems to play a greater role in the initiation of alcohol use (Rhee et al. 2003).

## SENSITIVITY TO THE EFFECTS OF ALCOHOL USE

Animal research indicates that adolescents in general are more sensitive than adults to the stimulating effects of alcohol and less sensitive to some of the aversive effects of acute alcohol intoxication, such as sedation, hangover, and ataxia (loss of muscular coordination) (Doremus et al. 2003; Little et al. 1996; Silveri and Spear 1998; Varlinskaya and Spear 2004; White et al. 2002; for review, see Spear 2000 and Spear and Varlinskaya 2005). This difference in sensitivity between adolescents and adults may make adolescents more vulnerable to certain harmful effects of alcohol use. For example, adolescents are able to drink more than adults (who might pass out or be inclined to go to sleep) and therefore are

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<sup>11</sup> A *candidate gene* is a gene that has been implicated in causing or contributing to a particular disease. For a review of candidate genes that may contribute to alcohol dependence, see *Alcohol Research & Health* 28(3):133–142, 2004/2005.

more likely than adults to initiate activities when they are too impaired to perform them competently, such as driving, and also are more likely to drink to the point of coma. Furthermore, in the case of driving, each drink increases impairment more for adolescents than adults (Hingson and Winter 2003). Children with alcoholic parents may be at even greater risk for excessive drinking resulting from a combination of genetic and developmental factors that lower sensitivity to alcohol.

## THE EFFECTS OF ALCOHOL ON PHYSIOLOGICAL PROCESSES AND BIOLOGICAL DEVELOPMENT

A question of primary concern is whether adolescent alcohol consumption can disrupt physiological processes and biological development to produce long-term negative consequences. Recent research shows that adolescent alcohol use has the potential to trigger long-term biological changes that may alter an adolescent's development as well as affect the adolescent's immediate behavior. The resulting adverse outcomes may include mental disorders such as anxiety and depressive disorders. Furthermore, early alcohol use may have detrimental effects on the developing brain, including neurocognitive impairment (Brown and Tapert 2004).

Animal studies show that a sustained pattern of binge-like drinking in adolescence affects memory, alters sensitivity to motor impairment, and damages frontal-anterior cortical regions (Crews et al. 2000; Spear and Varlinskaya 2005; White and Swartzwelder 2005). The frontal cortex is important in the development of self-regulation, judgment, reasoning, problem-solving, and impulse control. Studies in animals indicate that alcohol consumption before and during adolescence produces long-lasting effects that increase alcohol consumption in adulthood (reviewed in Rodd et al. 2004 and Siciliano and Smith 2001), which may help explain the correlation between early use and later dependence in humans. Moreover, human studies indicate that long-term heavy alcohol use continued throughout one's lifetime can result in more severe effects on the

brain's structure and functioning (Jacobson 1986; Pfefferbaum et al. 2001; Victor et al. 1989). Although there have been only a few studies, there is some indication that adolescents who drink heavily may experience adverse effects that disrupt normal growth and affect liver, bone, and endocrine development (*Alcohol Research & Health* 28(3), 2004/2005 [see Table on p. 127]).

## INTERVENING AMIDST COMPLEXITY

Underage alcohol use is a highly complex phenomenon with multiple potential scenarios and unpredictable outcomes. Young people who are vulnerable to alcohol involvement as pre-adolescents can acquire positive, health-promoting, low-risk behaviors upon reaching adolescence. Others who are at low risk as pre-adolescents can develop substantial problems with alcohol in later adolescence. A developmental approach to preventing and reducing underage alcohol use takes into account the complex forces and factors that shape how an adolescent will respond to the availability of alcohol in different situations at different times across the span of adolescence. Complex interactions among biological, social, cultural, and environmental factors also evolve as maturation proceeds; thus, the same adolescent at age 13 and later at age 17 will have different developmental needs and require different protective structures and skills to succeed. To further complicate matters, periods of rapid transition, reorganization, and growth spurts alternate with periods of quiet and consolidation—all within a social context that is changing. A developmental approach to prevention and reduction of underage drinking recognizes the importance of all the environmental and social systems that affect adolescents as well as their own maturational processes and individual characteristics.