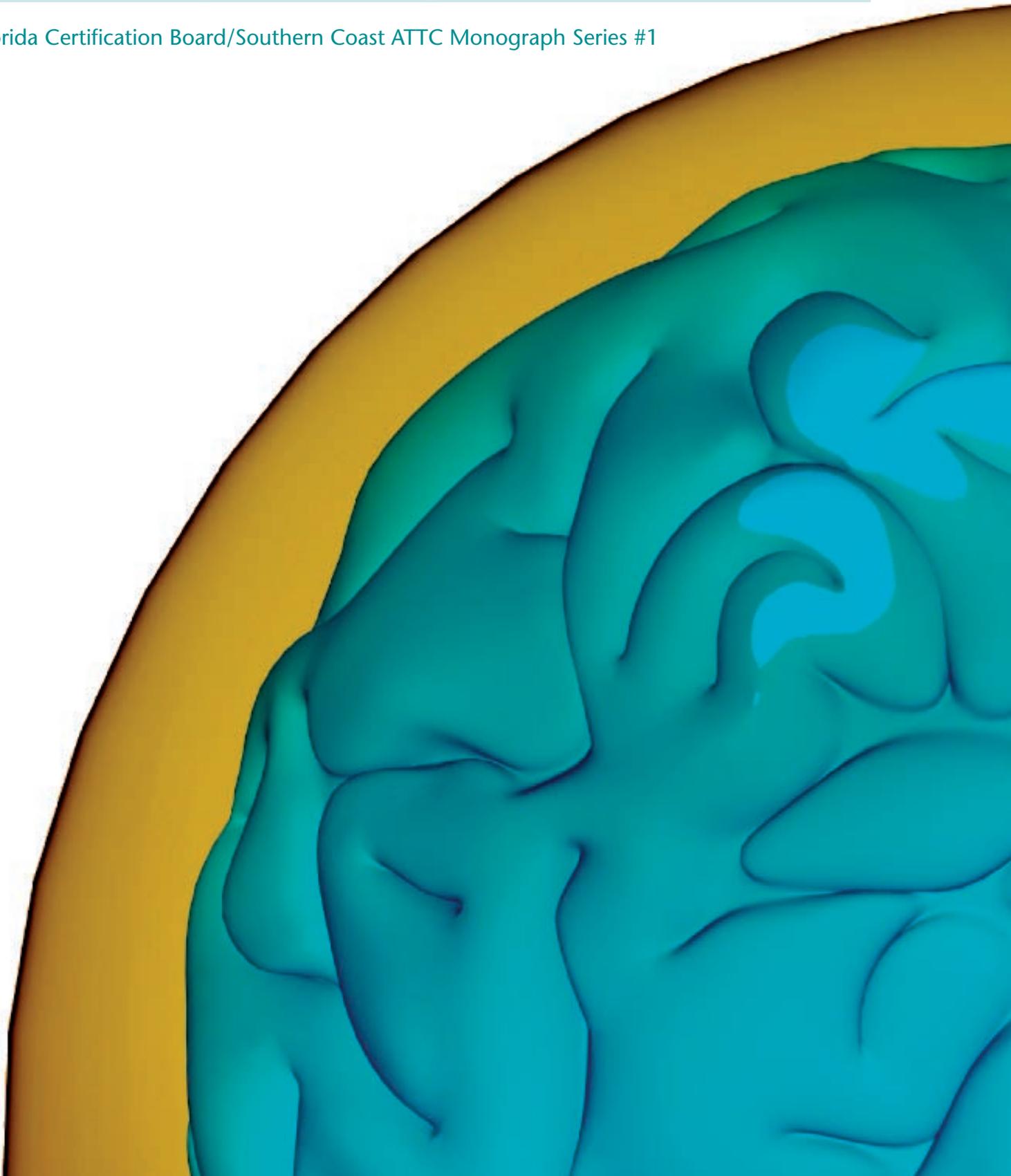


# Adolescent Substance Use: Developmental Considerations

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## Introduction

The study of adolescence over the past 30 years has exploded with breakthroughs that have pushed thinking about interactions among the complex systems that affect adolescents - from the endocrine system to the social peer group - forward at a dizzying pace. Researchers and practitioners are now exploring important connections among these complex systems, and examining the impacts of different social environments on the development of biological systems and psychological processes. Similarly, researchers are examining the relationships between certain biological factors and the motivations, impulses, and social behaviors of young people. The diversity of specialized fields and theoretical frameworks that have emerged in these studies has provided an increasingly integrated theoretical structure that offers more cohesion within the health fields to improve understanding of the implications of findings (Institute of Medicine, 2006).



The professionals who work with young people need a clear understanding of the processes of adolescence and how developmental factors – such as increased sensitivity to immediate rewards, a focus on peers and social rewards, immature inhibitory and self-regulatory processes, increased risk taking and sensation seeking, and difficulty with mood regulation - affect the trajectories that lead to substance abuse and addiction. Likewise, clinicians who provide addiction services need to cultivate a repertoire of assessment and treatment practices that take into consideration the links between developmental factors, substance abuse, and treatment outcomes. This monograph addresses these issues through an overview of current research findings and offers suggestions for assessment and treatment strategies that are congruent within adolescent behavioral, biological, and social contexts.

## Adolescent Substance Use

Adolescent substance use is prevalent in our communities and schools. Despite the fact that alcohol use is illegal for anyone under the age of 21 years, and illicit drug use is illegal for everyone, it remains normative and commonplace (Wagner & Austin, 2006-2007). Seventy-five percent of high school seniors have tried alcohol at some point during their lifetime, and 50% of high school seniors have tried at least one illicit drug (Johnston, O'Malley, Bachman, & Schulenberg, 2006). While some experimentation with alcohol, marijuana, and other drugs may be normative for this developmental period, adolescents who use alcohol, marijuana, and other drugs run the risk of experiencing negative consequences from their use of substances. These negative consequences may appear rather immediately, and be the direct result of the acute effects of intoxication (e.g., car crashes, fights, unwanted sexual encounters). They also may be more insidious and emerge only after a substantial history of substance involvement (e.g., the development of a substance use disorder). Moreover, a small but significant minority of adolescents who use alcohol, marijuana, or other drugs will demonstrate diagnosable substance use problems during their teenage years.

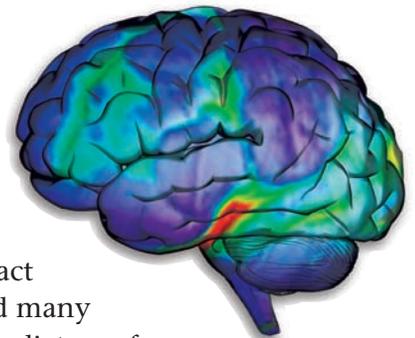
It follows, then, that substance use is rather prevalent among teenagers presenting for treatment in mental health settings. In such settings, substance use may be (a) the primary presenting problem, (b) a co-occurring problem with other mental health problems (e.g., conduct disorder, mood disorders, etc.), or (c) an issue of relatively minor concern relative to other more acute mental health problems. For clinicians who treat adolescents, there is an urgent need for developmentally appropriate and effective methods to address substance use problems among teenagers. In addition, there is a need for different intervention methods for different presenting problems—i.e., one set of treatments for primary substance use problems, another set of treatments for co-occurring substance use problems, and a third set for addressing substance use in the context of treatment focused primarily on other presenting problems

## Unique Developmental Issues of Adolescence

Adolescence has long been recognized as a major developmental period during which individuals undergo dramatic biological, psychological, and social transformations as they move toward adulthood. These transformations occur simultaneously, somewhat (though not entirely) interdependently, and without conscious awareness by adolescents undergoing these changes. These changes are so emblematic of adolescence that White (2004) has argued that adolescence is better defined not by time (e.g., the second decade of life), but rather by the set of changes that occur during the teenage years. As suggested by Wagner (Wagner/NIAAA, 2006), the key developmental transformations characteristic of the adolescent years can be grouped into the following domains:

- Biological transformations: menarche, pubertal status, pubertal timing, hormonal changes, physical appearance and size, and maturation of prefrontal cortex/limbic system
- Psychological transformations: individuation, identity formation, problem solving, self-regulation, executive mental functions, autonomy, ego development, negative affect, positive affect, cognitive capacity, moral reasoning, perspective taking
- Social transformations: intimacy and heterosexual involvement, peer influences, parent-child influences and parental control, sibling influences, interpersonal negotiation and social problem-solving, gender roles, media and information sources, role transitions (role selection & role socialization)
- Role transformations: elementary to middle school, middle to high school, getting a driver's license, getting a job outside the home, loss of virginity.

While the list above is not exhaustive, it highlights many of the key developmental transformations which occur during adolescence. Any of these transformations may impact the initiation and progression of teenage substance use, and many of them have been examined in the research literature as predictors of alcohol and drug involvement. For example, adolescents who experience



the early onset of puberty are significantly more likely to use alcohol, marijuana, and other drugs than adolescents who reach puberty later; this association is particularly strong among teenage girls (Susman & Rogol, 2004). Also, it is important to recognize that the timing of these transformations varies across domains and individuals; for example, a teenager may physically resemble an adult but still lack the brain maturation to think and act like one. Thus, expecting adolescents to make adult-like decisions in regard to the use of substances is an unrealistic expectation for most teenagers. A corollary of this is that it may be unrealistic to expect adolescents to respond to substance abuse treatment in the same way and to the same extent as adults.

## Resources on Adolescent Brain Development

PBS - *The Secret Life of the Brain*  
<http://www.pbs.org/wnet/brain/>

PBS - *The Teenage Brain*  
<http://www.pbs.org/wnet/brain/episode3/index.html>

Frontline - *Inside the Teenage Brain*  
<http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/>

TIME Magazine - *Secrets of the Adolescent Brain*  
<http://www.time.com/time/covers/1101040510/>

NIDA Curriculum - *The Brain: Understanding Neurobiology Through the Study of Addiction*  
<http://www.drugabuse.gov/Curriculum/HSCurriculum.html>

University of Utah: Genetic Science Learning Center  
<http://learn.genetics.utah.edu/units/addiction/factors/>

## Adolescent Brain Development

One of the primary areas of physical development during adolescence is the maturation of the brain. While the size of the brain remains approximately the same throughout adolescence, important and dramatic structural and functional changes occur during the teenage years and continue into the early twenties (Giedd et al., 1999; Spear, 2000; White, 2004). Specific examples of these changes include the overproduction and elimination of synapses, progressive myelination of nerves, neurotransmitter system development, and changes in the rate of electrical and metabolic activity in the brain. These brain changes lead to increased mastery over self-regulation, executive mental functions, and cognitive capacity (i.e., the emergence of adult-like cognitive capability), and ultimately produce a more fully conscious, self-directed, and self-regulating mind (Keating, 2004).

It is remarkable that these structural and functional changes co-occur with the period of life during which most individuals initiate and increase their consumption of alcohol, marijuana, and other drugs. As a result, it is critical to consider the potential deleterious effects of substance use on brain functioning during and after adolescence. Recent research literature reviews indicate that adolescent substance use is associated with brain alterations and neurocognitive deficits, with negative implications for learning and other cognitive abilities that may continue into adulthood (Brown & Tapert, 2004; Spear & Varlinskaya, 2005; Zeigler et al., 2005). As a result, there is a desperate need for longitudinal studies exploring whether, and to what extent, substance use during adolescence interferes with the normal trajectory of brain and behavioral development. Related issues such as whether substance-related



changes in adolescent brain development are permanent or reversible, and whether, and to what extent, differences between the brains of substance using and non-substance using adolescents predate or result from their alcohol and other drug use, also need to be examined.

White (2004) explains that brain circuitry is “rewired” during adolescence and that experience has a greater influence on adolescent brain development than it does on adults. This rewiring process prepares a teenager to be more independent and survive on his/her own, and ultimately to be a fully functional adult. White (2004) further argues that adolescent brain development is not merely a continuation of childhood brain development, but rather a qualitatively deeper and broader set of developmental changes. The changes include substantial alterations in the frontal, parietal, occipital, and temporal lobes, as well as changes in the corpus callosum and for several neurotransmitter receptors. Each of the changes is described in additional detail below.

The frontal lobes direct important functions, including impulse control, planning, judgment, language, memory, coordination, motor function, and problem solving. Within the brain, gray matter is responsible for the processing of information. During childhood, gray matter increases and peaks at age 12; during adolescence, there is actually a decrease in gray matter which can most likely be attributed to an elimination of synapses and an increase in myelination (White, 2004). Adolescent development of the parietal lobes appears to mirror that of the frontal lobes. The parietal lobes are responsible for the processing and integration of sensory information. This pattern differs for the occipital lobe, which is responsible for visual processing. Here, gray matter continues to increase during adolescence and into early twenties (Geidd et al., 1999). In the temporal lobes, responsible mainly for memories and auditory sensory information, gray matter peaks between the ages of 16 and 17 (Geidd et al., 1999). Also during adolescence, there is growth of the corpus callosum, which connects the two hemispheres of the brain (Geidd et al., 1999). Other significant changes during adolescence include increases in dopamine receptors and GABAA receptors (Teicher et al., 1995; Moy et al., 1998).

One of the most important behavioral changes produced by these brain changes is an increase in the ability to exercise control over impulsive urges. However, Keating (2004) points out that there exist individual differences in the integration of cognition, emotion, and behavior may impact the development of self-control, and adolescents with less self-control may be at greater risk for substance use problems. Further support for the relationship between brain function and substance use can be found in neuropsychological and fMRI studies of adolescent substance abusers, which have found that heavy alcohol use, and especially heavy alcohol use combined with heavy marijuana use, is associated with neurocognitive and brain response deficits (Brown, Tapert, Granholm, & Delis, 2000; Moss, Kirisci, Gordon, & Tarter, 1994; Schweinsburg, Schweinsburg, Cheung, Brown, Brown, & Tapert, 2005; Tapert, Granholm, Leedy, & Brown, 2002; Tapert et al., 2004). However, it is important to note to date research has only confirmed a relation between adolescent brain functioning and substance use; suspected causal connections have yet to be determined.



An area of increasing research attention is the developmentally specific, short-term effects of substance intoxication. Research is now suggesting that adolescents, in comparison with adults, are differentially impaired by substance use and substance intoxication (Smith, 2003; White, 2004). In fact, White (2004) makes the point that adolescents appear to be more vulnerable to some effects of substances and less vulnerable to others, though it is important to note that much of this research has been done with animal participants rather than with human participants. To date, animal studies suggest that the adolescent brain is particularly susceptible to damage by alcohol (the effects of other drugs have yet to be sufficiently studied) when alcohol exposure is prolonged and at very high levels. However, subtle yet long-term changes in behavioral sensitivity to alcohol exposure appear to occur at lower doses among adolescent animals than among adult animals. These behavioral effects are typically interpreted as resulting from alcohol-induced central nervous system changes, though at present it is not clear whether such changes are the result of overt neurotoxicity or an alteration in the normal trajectory of brain and neural circuit development during adolescence. While there is good reason to believe that the findings from these adolescent animal studies are generalizable to adolescent humans, additional research is necessary to establish whether, and the degree to which, the kinds of alcohol and other drug related effects seen among animals also occur among teenage boys and girls.

Regarding studies of the impact of alcohol and other drugs on the developing adolescent brain that have been conducted with human participants, it should be noted that this research is overwhelmingly correlational in nature, primarily examines alcohol exposure (vs. other drugs), and typically relies on quasiexperimental research designs (e.g., adolescents with pre-existing substance use problems are compared to adolescents without substance use problems). Thus, it is important to remember that these studies may identify associations between adolescent brain functioning and substance use, but do little toward addressing possible causal linkages between alcohol and other drug exposure and changes in brain structure and function. Longitudinal studies, begun prior to exposure to alcohol and other drugs, are necessary to address the strength and direction of hypothesized causal connections. With this caveat in mind, several noteworthy findings have emerged from the studies which have been conducted with human participants. For example, the right amygdala has been found to be smaller in teenagers with a family history of alcohol dependence than in teenagers without a family history, even after taking experience with alcohol use into account. Another finding of note is that adolescents with alcohol abuse or dependence demonstrate smaller hippocampal volumes than do age-matched non-drinking adolescents. However, whether these hippocampal differences are a cause or a consequence of alcohol use remains uncertain. In other work, neuropsychological and functional magnetic resonance imaging (fMRI) studies have shown that heavy alcohol use during adolescence is associated with poorer scores on tests of information retrieval, attention, visuospatial functioning, and abnormal brain response during spatial working memory.



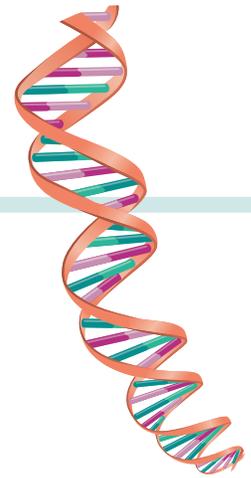
Another growing area of research concerns how the effects alcohol and drugs on mental functioning may vary by age (i.e., adolescents vs. adults). Memory formation under the influence of substances is one of several functions

that appear to vary by age. Alcohol seems to impair memory formation more among adolescents than it does among adults, and there is a positive association between the amount of alcohol consumed and the degree of memory impairment (Ryback, 1971; White, 2004). While it is not known exactly how memory is affected, it seems that alcohol interferes with the brain circuitry involved in learning and may be associated with decreased size of the hippocampus, especially among adolescents (Swartzwelder et al., 1995; Pyapali et al., 1999; White, 2004; De Bellis et al., 2000). In contrast, adolescents seem to be less affected than adults by the sedation or calming effects of alcohol and to the motor impairments caused by alcohol (Little et al., 1996; Swartzwelder et al., 1998; Silveri and Spear, 1998; White et al., 2001; White, 2004). White (2004) explains that during a drinking episode, the sedation and motor difficulties that an adult experiences may lead to a decrease in drinking. In contrast, adolescents may continue to drink since they are not experiencing these same dramatic effects and may actually have higher blood alcohol levels with less impairment than an adult would have at that same level. This may help explain the relatively high prevalence of binge drinking among adolescents.

Regarding binge drinking, such high volume consumption patterns among adolescents not only can lead to negative consequences in the short-term, but also to negative consequences in the longer term (White, 2004). Somewhat counterintuitively, it is the symptoms of withdrawal between the binge drinking episodes, rather than the periods of acute intoxication, that may have the greatest negative impact (White, 2004). Brown et al. (2000) found that adolescents who drank frequently had poorer results on tests of learning, memory, and visuospatial functioning, but this finding that was especially applicable to those who had experienced one or more periods of withdrawal Tapert et al. (1999) concluded that relapse, especially after withdrawal, led to further cognitive impairment over four years. In another study, Tapert et al. (2002) found that greater substance use during adolescence was associated with poorer learning and memory in early adulthood. Remarkably, Tapert's studies were conducted with humans, and demonstrated that the brains of young females who were alcohol-dependent functioned differently than controls (Tapert et al., 2004). Based on these findings, White (2004) cautions that adolescent alcohol users are at great risk for cognitive impairments and permanent damage to brain structures, primarily because they are likely to stay awake and active and to continue to drink long after an adult would be expected to cease drinking, and they are more likely than older drinkers to engage in binge drinking.

Studies of adolescent marijuana use and its impact on brain development have not been as conclusive as those of adolescent alcohol use. While marijuana use is commonly associated with impairments in short-term memory and emotional regulation, at least one recent study found that frequent marijuana use during adolescence did not seem to produce lasting or long term changes in brain development (DeLisi, Bertisch, Szulc, Majcher, Brown, Bappal, & Ardekani, 2006). It is important to note that this was a preliminary study with limitations including a very small sample size, a correlational (rather than longitudinal research design), and retrospective reporting (i.e., study participants were young adults looking back on their substance use, rather than adolescents reporting

current substance use). Nonetheless, its findings are intriguing, and additional studies are urgently needed in this underdeveloped yet significant area of research.



## Genetic and Environmental Influences

The relative influence of genetic versus environmental factors in determining adolescent alcohol, marijuana, and other drug use remains an unresolved issue. Most research in this topic to date has been conducted with adult samples, and results from these studies may or may not generalize to younger drinkers and drug users. In adults, specific chromosomal regions have been identified that are associated with a greater likelihood of developing alcohol dependence (Foroud et al., 2000). Moreover, specific genes (i.e., GABRA2 & GABRA3) that influence the risk for alcohol use disorders have been identified in samples of adults with alcohol use problems (Edenberg & Kranzler, 2005). Finally, specific alcohol metabolizing enzymes that appear to protect against the development of alcohol problems in certain populations have been identified (Oroszi & Goldman, 2004). It is important to note that these studies have been conducted primarily with participants with alcohol use problems, so the generalizability of their findings to other substances remains in question.

While genetic factors do appear to influence the development of alcohol use problems in adults, the interaction between genes and environment may to be particularly important in determining alcohol problems among adolescents (Rose & Dick, 2004/2005). In fact, environmental factors have a greater effect on the initiation of alcohol use during the teenage years than do genetic factors (Hopfer, Crowley, & Hewitt, 2003; Rhee et al., 2003; Rose & Dick, 2004/2005). However, genetic influences appear to become increasingly important as an adolescent moves from experimentation to more regular drinking to problematic drinking (Rhee, 2003; Rose & Dick, 2004/2005).

## Social Changes and Peers

While brain development and genetics certainly play a role in the emergence of adolescent alcohol, marijuana, and other drug use problems, it is essential to recognize that social factors are key determinants of adolescent substance use patterns. There is strong and unequivocal evidence for a positive relationship between peer substance use and adolescent substance use (Chassin et al., 2004). Furthermore, peer use appears to be an important predictor of relapse among adolescents who have been treated for substance use problems; Brown, Vik, and Creamer (1989) found that 90% of adolescent relapses occurred in the presence of other people and were related to direct and indirect social pressure to use alcohol, marijuana, or other drugs. It is not clear exactly how peers impact adolescent substance use, however, Chassin et al. (2004) suggests that peer selection processes, peer influence processes, and cognitive biases (i.e., the false consensus effect) all may play a role. From a slightly different perspective, Brown (2004) characterized the relations between peer and personal use as resulting from a complex set of components including: (1) characteristics of

the individual; (2) characteristics of relationship partners (e.g., age, attitudes, behaviors of friends); (3) characteristics of the relationships (e.g., intimacy, support, trust, conflict, stability); and (4) relationship dynamics (e.g., power dynamics, conflict resolution styles). While the association between peer and personal alcohol, marijuana, and other drug use is well established, it is important to remember that the peer context grows increasingly influential, complex, and multilayered as adolescents mature (Brown, 2004). The adolescent, his or her peers, and his or her social contexts are concurrently changing and developing, although not always at the same rate (Wagner/NIAAA, 2006). The degree to which peer influences affect or are affected by adolescent brain development is currently unknown.

## Parental Influences

The strengthening of peer influence often coincides with alterations in relationships with parents. During adolescence, interactions shift from the unilateral parental control typical during childhood to increasingly bilateral relations based on conversation, negotiation, and joint decision making (Collins & Laursen, 2004). While the exact mechanisms of association remain unclear, there is much research supporting a relation between adolescent alcohol, marijuana, and other drug use and parenting variables such as parenting style, family climate, parent-adolescent relationships, and parents' specific socialization about the use of substances (Chassin et al., 2004). These associations appear to be particularly strong during early adolescence, and suggest that parental influences may be more important in determining the initiation of substance use than in determining transitions from experimentation to regular use or transitions from regular use to substance use problems.

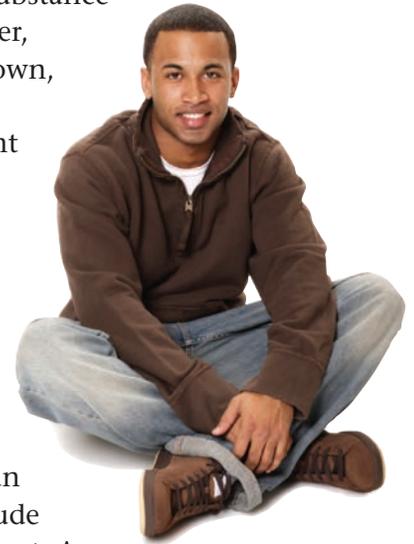


## Adolescent Transitions

Adolescence is characterized by important environmental transitions, and these transitions appear to play a role in adolescent alcohol, marijuana, and other drug use trajectories. Given that peaks in the onset of alcohol use typically co-occur between the 7th and 10th grades (Chassin et al, 2004), the effects of the transition from elementary to middle school and the transition from middle school to high school must be considered (Wagner/NIAAA, 2006). Another typical adolescent transition, obtaining a job outside the home, appears to impact adolescent substance use as well (Staff, Mortimer, & Uggen, 2004). There is evidence that the number of work hours during adolescence is positively associated with substance use, especially for alcohol and cigarettes. In sum, the transitions that characterize adolescence are associated with shifts in alcohol, marijuana, and other drug use, and thus attempts to prevent or treat adolescent substance use must take such transitions into account.

## Developmental Considerations

While (a) most adolescents will use substances, (b) a significant minority of adolescents will develop substance use problems, and (c) adolescents differ developmentally from adults in important ways across multiple domains, scant research to date has examined the impact of development variables on substance abuse treatment response among adolescents (D'Amico, Ellickson, Wagner, Turrisi, Fromme et al., 2005; Deas, Riggs, Langenbucher, Goldman, & Brown, 2000; Wagner, Brown, Monti, Myers, & Waldron, 1998). Moreover, we currently know very little about the developmental congruence of current adolescent treatment practices. In fact, the potential developmental incongruence of currently available treatments may contribute to the striking low rates of treatment involvement among teenagers with substance use problems. Current estimates indicated that only one in ten adolescents with substance use problems actually receive treatment (Clark, Horton, Dennis, & Babor, 2002; Dennis, Dawud-Noursi, Muck, & McDermiet, 2003).



Given the foregoing, what is a clinician to do when faced with treating an adolescent with substance use problems? Current best practices will include a comprehensive and standardized assessment prior to beginning treatment. A clinically sound assessment usually includes an interview with the adolescent and parent(s). Wagner and Austin (2006-2007) recommend that the interviewer query about the negative consequences or “bad things” that are associated with their substance use as opposed to focusing on the specifics of the frequency, type, or quantity of use. Wagner and Austin (2006-2007) also recommend a standardized and clinically valid adolescent substance abuse assessment as the next step – examples include the Personal Experiences Inventory (Winters et al., 1999), the Drug Use Screening Inventory (Tarter & Hegedus, 1991), the Customary Drinking and Drug Use Record (Brown et al., 1998), the Teen-Addiction Severity Index (Kaminer, Wagner, Plummer, & Seifer, 1993), and the Global Appraisal of Individual Needs (GAIN; Dennis et al., 2004), all of which are developmentally sensitive and focus on behaviors, contexts, and choices. Wagner and Austin’s final step in the assessment process entails feedback shared with the client; in this regard, they recommend Miller and Rollnick’s (2002) motivational interviewing approach.

Establishing a diagnosis is among the typical goals of assessment. However, as argued by Wagner and Austin (2006-2007), there are inherent difficulties in distinguishing adolescent “substance use” from “substance use problems.” Even among experts there is little agreement about the necessary and sufficient criteria to diagnose a substance use disorder among adolescents (Hays & Ellickson, 1996). The standard among clinicians has been to diagnose based on the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV; American Psychiatric Association, 1994). However, there is considerable debate about the developmental appropriateness of the DSM-IV criteria for estimating alcohol and other drug problems among youth (e.g., see Bailey, Martin, Lynch, & Pollack, 2000; Chung et al., 2000; Martin & Winters, 1999; Wagner, Lloyd, & Gil, 2003). Some concerns identified are that DSM-IV criteria have not been adequately studied with adolescents, several symptoms are

atypical for adolescent substance users (e.g., withdrawal, substance-related medical problems), and some symptoms tend to occur only in particular subgroups of teenagers (e.g., hazardous use and legal problems appear primarily among older conduct-disordered males) (Martin & Winters, 1999). In addition, the DSM-IV diagnostic criteria do not take into consideration the quantity or frequency of alcohol consumption, which introduces the possibility that a teenager could be heavily involved with alcohol yet not qualify for a diagnosis of alcohol abuse or dependence. Furthermore, while frequent or heavy substance use is usually associated with more negative consequences, it is important to note that even using substances sporadically or in small amounts remains a concern as it may increase risk for negative events such as car crashes, unwanted or unprotected sexual encounters, and violent interpersonal exchanges.

Given these diagnostic constraints, Wagner and Austin (2006-2007) suggest that clinicians are best advised to look at use patterns and negative consequences resulting from use when making diagnostic decisions about their adolescent clients. In fact, negative consequences are the only type of diagnostic criteria on which adolescent substance use experts agree (Hays & Ellickson, 1996). For adolescents, these are typically related to: (1) school or vocational adjustment, (2) recreation and leisure activities, (3) personality characteristics, (4) friends, (5) trouble with the law, and (6) physical health and somatic concerns (Wagner & Austin, 2006-2007).

In regard to intervention, the current empirical literature indicates that treatments: can succeed for teens with alcohol and other drug use problems; produce outcomes comparable to those found among adults with alcohol use problems; yield varied improvement across different domains of functioning (e.g., school performance, emotional distress, family relations); and, with the possible exception of outpatient family therapy do not differ substantially from one another in their likelihood of success (Brown, Cleghorn, Schuckit, Myers, & Mott, 1996; Catalano, Hawkins, Wells, Miller, & Brewer, 1990; Wagner et al., 1999; Williams, Chang, & Addiction Centre Adolescent Research Group, 2000). Studies of treatment response among adolescents with alcohol and other drug use problems indicate those with greater substance abuse problem severity at intake are just as likely to reap short-term benefit from treatment as youths with lesser problem severity (Latimer, Newcomb, Winters, & Stinchfield, 2000; Wagner, Dinklage, Cudworth, & Vyse, 1999; Winters & Stinchfield, 2000). However, the literature also indicates that one out of every two teenagers treated for substance use problems will relapse within three months of the completion of treatment, and two thirds will relapse within six months of the completion of treatment (Brown, Mott, & Myers, 1990; Brown, Vik, & Creamer, 1989; Latimer, Newcomb, Winters, & Stinchfield, 2000). Thus, while treatment can be effective for teenagers with substance use problems, relapse rates remain high, with most treated adolescents returning to alcohol or other drug use with most treated adolescents returning to alcohol or other drug use between three and six months after the completion of treatment.

The limited success of treatments for adolescent drinking problems may be at least partly attributable to a lack of attention to developmental



issues that could influence treatment response. Despite growing enthusiasm for developmentally informed investigations of treatment effectiveness, scant research has been conducted to date. While adolescent alcohol abuse treatment experts increasingly are calling for research on how developmental factors, including brain development, may influence treatment response (e.g., D'Amico, Ellickson, Wagner, Turrisi, Fromme et al., 2005; Deas, Riggs, Langenbucher, Goldman, & Brown, 2000; Wagner, Brown, Monti, Myers, & Waldron, 1998), we currently know very little definitively about how developmental issues may influence treatment response among adolescents with substance use problems. As a result, it is important to recognize that relations between developmental level and treatment response are speculative, awaiting direct evaluation in rigorous studies of adolescents undergoing treatment for alcohol problems.

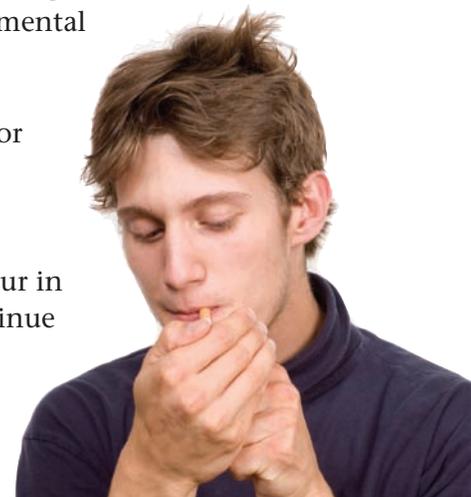
While developmentally informed research on the effectiveness of clinical trials with substance abusing adolescents is scant, there currently exist several research-based treatment approaches which appear both effective and developmentally appropriate for use with substance abusing teenagers. Liddle and Rowe's (2006) edited volume entitled *Adolescent Substance Abuse: Research and Clinical Advances* provides a nice overview of many of these treatment approaches, as well information about the developmental contexts and developmental congruence of current treatments for adolescent substance use problems. The book is an excellent resource for both clinicians and researchers interested in effectively treating alcohol and drug abuse among teenagers, and includes information on a wide range of empirically supported intervention approaches such as therapeutic communities, student assistance programs, pharmacotherapies, family interventions, motivational interventions, and cognitive-behavioral treatments.

## Summary

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Experimentation with alcohol, marijuana, and other drugs is normative for adolescents, but even adolescents who use substances infrequently place themselves at risk for negative consequences. In mental health settings, adolescents often present with concerns related to their substance use, so clinicians who work with teenagers need to be familiar with the assessment and treatment of substance use problems. Unfortunately, developmentally appropriate and effective methods to address substance use problems among teenagers remain few in number. Taking into consideration the developmental changes that characterize adolescence is central to the success of any intervention; the failure to do so will constrain our ability to address adolescent alcohol and drug problems, and may in part be responsible for the limited effectiveness of adolescent treatment to date.

One particularly important area of adolescent development is the maturation of the brain; dramatic structural and functional changes occur in the brain and central nervous system during the teenage years and continue into the early twenties. The changes include substantial alterations in the frontal, parietal, occipital, and temporal lobes, as well as changes in the corpus callosum and for several neurotransmitter receptors.



Remarkably, these structural and functional changes are taking place at the same time when most individuals initiate and increase their consumption of alcohol and other drugs. As a result, most researchers suspect that heavy and frequent substance use will have deleterious effects on brain functioning during and after adolescence, though it is important to note that research has only confirmed a relation between substance use and adolescent brain functioning; the strength and direction of hypothesized causal connections have yet to be determined. Research also has suggested that adolescents, in comparison with adults, are differentially impaired by substance use and substance intoxication; e.g., compared to adults, alcohol using adolescents demonstrate greater alcohol-related memory impairment effects, but less sedation, calming, and motor impairment effects.

In regard to the determinants of adolescent drinking and drug use, environmental factors have a greater effect on the initiation of use, and genetic influences become increasingly important as a teenager moves from experimentation to more regular use to problematic use. Especially influential environmental determinants of adolescent alcohol and other drug use include peer substance use, which is strongly and positively related both to adolescent substance use and to relapse among adolescents who have been treated for substance use problems. Parental variables (e.g., parenting style, family climate, parent-adolescent relationships, & parents' specific socialization about the use of substances) also are important influences on teenagers' use of alcohol, marijuana, and other drugs, and appear to be more important in determining the initiation of substance use than in determining transitions to more intensive substance use patterns. Finally, environmental transitions common to the teenage years (e.g., taking a job outside the home, leaving middle school and entering high school) appear to play an influential role in adolescent alcohol, marijuana, and other drug use trajectories.

When faced with the prospect of assessing and treating an adolescent with alcohol or drug use concerns, current best practices are to conduct a comprehensive and standardized assessment emphasizing use patterns and experienced negative consequences. Remarkably, negative consequences are the only type of diagnostic criteria on which adolescent substance use experts currently agree. Regarding treatment, several current interventions have been demonstrated to be effective for treating teenagers with substance use problems. However, even state-of-the-science interventions remain plagued by relatively high relapse rates. Such limitations in the long term success of adolescent substance abuse treatments may be at least partly attributable to a lack of attention to developmental issues. Only with greater attention to (a) how development may be impacted by alcohol and drug use, and (b) how substance use may affect biological, social, and psychological development during adolescence, will our ability to treat substance abusing teenagers be improved.

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