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ADOLESCENCE AND ALCOHOL:

AN ALARMING RITE OF PASSAGE

Adolescents' brains and physiology are constantly developing for adulthood – and thus drugs including alcohol and tobacco affect them differently than adults. Aaron White shares the latest research results.

Adolescence is a time of great tumult. It is the transitional stage between childhood dependence and adult independence. Bodies grow, hair sprouts in strange places, members of the opposite sex suddenly become interesting and parents like aliens. It is also a time of intense brain development: a recent revelation in science.

We are now beginning to understand that the changes which unfold during adolescence, from neurobiological to social, serve to push children out of the cozy nests made by caregivers and into the world beyond. Conflict with authority, a predilection for risk taking and novelty seeking, disruptive attitudes and even sheer boredom at home, serve as natural wedges to separate adolescents from parents and help to prepare them to function autonomously when the time is right. In this day and age, in most of the western world, the right time tends to come toward the end of the teen years or during the early 20s.

Regardless of nationality, the psychological makeup of the typical adolescent predisposes them to make mistakes. The frontal lobes of the brain – which are central to decision making, planning for the future and controlling impulses that are inconsistent with those plans – enter a state of flux soon after the age of 10. During the next decade, the frontal lobes are shaped, molded and fine-tuned to meet the demands of the current environment.

All of this is with an eye toward eventual autonomy. The frontal lobes will eventually serve as the brakes which stop us from doing things that could have disastrous consequences. In the meantime, while being remodelled during adolescence, the frontal lobes can be ineffective at controlling short-sighted urges, leading teenagers to trade safety for thrills, to break the rules in order to be accepted by peers, and spout angry words at parents with apparent disregard for their emotions.

It is natural, and even healthy, for adolescents to challenge authority, push the limits and deviate from the paths which adults pave for them. As adults, it would be disingenuous to deny that we did the same when we were coming of age. These natural inclinations can lead eager teenagers to make mistakes, most of which are relatively harmless. Sadly, many adolescents find out the hard way that some mistakes can have lasting and damaging consequences.

GENERATIONAL CYCLES

Mistakes made by adolescents are sometimes unique to their generation. Perhaps equally as often, people simply repeat the mistakes made by generations before them. In this way, mistakes are handed like batons from those exiting adolescence to those just entering it.

Without intervention, the cycles simply continue and each generation is doomed to make the same errors, and suffer the same consequences, as those before them.

For example, we now recognize the dangers posed by cigarette smoking at any age, particularly during the teen years, when the likelihood of becoming addicted to, and dependent on, nicotine is greater. Very few adult smokers started during adulthood. Most began as mildly rebellious teenagers asserting their right to decide what to put in their own bodies. It is safe to assume that most older smokers wish they had found a different way to scratch that itch during their youth.

The dangers posed by smoking during adolescence are now widely recognised by current adults. As a result, efforts have been made to break that particular cycle of poor decision-making during the teen years. Smoking during adolescence is now on the decline.

ALCOHOL AND THE ADOLESCENT BRAIN

The risks of alcohol exposure during teenage years are beginning to come to light, and could be worse in many ways than those posed by nicotine exposure. These realisations have fuelled concern among the public and have led to changes in attitudes toward teenage drinking – even among teens themselves. In the US, as with cigarette smoking, rates of alcohol consumption during teenage years are now on the decline. The same, sadly, cannot be said of the UK.

Research conducted over past decade or so – with both laboratory rats and humans – suggests that the changes taking place in the brain during adolescence lead them to respond to alcohol differently, in some way, than adults. Below are a few examples of these findings (with the species on which the work was based listed in parentheses):

>> brain circuitry involved in memory is more vulnerable to alcohol during adolescence (rats)
>> more brain damage after a four-day drinking binge in adolescents than adults (rats)
>> alcohol prevents cell birth in the brain more potently in adolescents than adults (rats)
>> alcohol impairs memory more in adolescents and young adults relative to adults (rats and humans)
>> alcohol produces less sedation (sleepiness) in adolescents and young adults relative to adults (rats
and personal experience!)
>> alcohol impairs balance and coordination less in adolescents and young adults relative to adults (rats and some human work)
>> repeated alcohol exposure during adolescence alters the way in which individuals respond to alcohol later in life (rats and humans)
>> repeated alcohol exposure during adolescence leads to long-lasting deficits in attention and memory (humans)

>> repeated alcohol exposure during adolescence increases rates of various disease states in young adulthood (humans).

It is clear from the above list that much of the available data on the potential brain damage caused by exposure to alcohol during adolescence comes from studies done with rats. I am often asked how relevant such data could be to the human condition. After all, rats and humans are not exactly the same. The truth is that most of what we know about how all drugs – illicit and prescription – affect the brain has been gleaned from research with rats.

Research on Fetal Alcohol Syndrome serves as a prime example of the sometimes beneficial interplay between human and rat research. We know that women who drink during pregnancy can give birth to children with physical and/or cognitive abnormalities. Yet there is no proof from the human work that alcohol causes the symptoms seen in Fetal Alcohol Syndrome. On the other hand, rat research, in which pregnant rats are given alcohol and their offspring are studied, provides support for the damaging effects of alcohol on fetal brain development. It is true that rats are not humans, but our brains are similar enough that insights gleaned from rat research can be used to guide hypothesis-driven research with humans.

As time goes by and technology advances, the stack of specifically human research on this topic will continue to grow.

COGNITIVE IMPAIRMENT

The available evidence from human research strongly suggests that repeated exposure to alcohol during adolescence can lead to long-lasting deficits in cognitive abilities, including learning and memory. Much of this work has been pioneered by Drs Susan Tapert and Sandra Brown, alcohol researchers at UCSD, the University of California in San Diego. They conducted a series of trailblazing studies examining the impact of alcohol abuse on neuropsychological functioning in adolescents and young adults. It is worth summarizing some of their findings here.

In one such study, adolescent residents of an inpatient substance-abuse treatment program with at least three weeks' sobriety were compared to 'controls' from the community on a battery of neuropsychological tests. Ages ranged from 15 to 16 years old. Frequent drinkers – those with 100 or more total drinking sessions – particularly those who experienced alcohol withdrawal during their initial days at the treatment center, performed more poorly than control subjects on several tests, including tests of learning, memory, and visuospatial functioning.

In a longitudinal study of subjects aged 13 to 19 years old recruited from treatment programs, Tapert and her colleagues observed that a return to drinking after the program led to further declines in cognitive abilities, particularly in tests of attention, over the next four years. Once again, withdrawal from alcohol was a powerful predictor of such impairments.

Similarly, Tapert assessed neuropsychological functioning and levels of substance use at seven time points during an eight-year period in subjects beginning, on average, at the age of 16 and ending at 24 years old.

Cumulative levels of substance use, including alcohol use, were correlated with impairments in verbal learning and memory during the final assessment. In other words, the heavier any participant was involved in substance use during their adolescence, the lower their scores on tests of learning and memory at year eight, when subjects were in their early twenties.

Heavier drinking alone was linked to lower scores on tests of attention. And experiencing withdrawal symptoms from alcohol predicted additional deficits in visuospatial abilities.

INEVITABLE ADULT DAMAGE

Research by Tapert and her colleagues clearly suggests that alcohol use during the teenage years, particularly when such use is heavy enough to result in withdrawal symptoms on cessation of drinking, negatively impacts memory and attention – abilities vital for negotiating the tasks of adolescence and successfully making the transition into adulthood.

These impairments stem, it would appear, from changes in brain function. Additional projects byTapert suggest exactly that. She and her colleagues conducted several studies employing functional magnetic resonance imaging – fMRI – to investigate changes in brain activity after alcohol abuse during the teen years. While MRI is used to create images of the anatomy of the brain, fMRI is used to measure changes in oxygen levels in the brain over time, such as while subjects perform different cognitive tasks. The changes in oxygen levels are used to measure, indirectly, changes in brain activity.

In one study on this topic, alcohol-dependent young women and healthy controls between the ages of 18 to 25 years old performed tests of working memory and vigilance (attention) while brain oxygen levels were measured using fMRI. The sample sizes were not quite big enough to detect significant impairments in working memory, though a clear trend toward such impairments was observed. But it is worth noting that those who were alcohol dependent exhibited significantly less brain activity while performing the working-memory task. Weaker activity was observed in several parts of the frontal lobes.

A subsequent study with alcohol-dependent young women showed that alcohol-related cues – such as words associated with drinking – elicited craving and led to greater increases in brain activity in a variety of regions relative to controls,. Thus a link was established between craving for alcohol and brain function in key areas. This demonstrated that the brains of alcohol-dependent young women function differently than those of their peers.

IS THERE A SAFE LEVEL FOR ADOLESCENTS?

In otherwise healthy adults, there is nothing wrong with drinking in moderation. For adolescents, it is unclear whether a safe level of drinking can be established.

Given the critical importance of brain development during the teenage years, and the potential deleterious effects of alcohol on such brain development, science suggests that every effort should be made to delay the onset of drinking until after individuals have made the transition out of adolescence and into adulthood.

Research in other domains – including the contributions made by alcohol to teenage pregnancy, the spread of sexually transmitted infections, injuries, overdose deaths, car crashes, sexual and physical assaults, and others – supports this position.

Like cigarette smoking, alcohol consumption during adolescence is a right of passage which carries a high risk of consequences and simply does not need to occur. The first step is to learn and shares the facts.

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