Tackling the Mysteries of Alcohol Dependence

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Why does drinking alcohol have such profound effects on people's behavior? Why does alcohol dependence develop and persist in some people but not in others? Scientists attempt to answer these questions by studying the brain, where alcohol intoxication and dependence begin. During the past decade, advances in technology have helped us better understand how alcohol changes the brain and how those changes influence alcohol-related behaviors. In the coming decade, this knowledge will help researchers develop drug and other interventions that can reduce the high social, personal and economic costs of alcohol-related problems.

Research supported by NIAAA in the early 1990s demonstrated that people who abuse alcohol for a long time experience lasting changes within the brain's limbic system, which supports emotion and motivation. These changes, which we call neuroadaptation, involve multiple neurotransmitters and other brain chemicals. Neuroadaptation can result in heightened anxiety and distress during abstinence; the drinker can alleviate this discomfort for a short time by drinking more. This may help explain why people with alcohol dependence steadily increase the amount they drink.

As a person's dependence on alcohol grows, the affected neurotransmitter systems change from those that are involved in the brain's reward system to those that cause negative effects such as anxiety, sweating and tremors. It appears that people with alcohol dependence continue to drink despite recurring health and social problems because of a vicious cycle: They are drinking in an attempt to avoid the unpleasant effects of drinking. In the future, alcohol scientists hope to use their understanding of how neuroadaptation occurs to develop targeted medications for treating alcohol dependence.

Researchers have identified stress as a probable trigger for relapse into alcohol dependence. Alcohol neuroscientists have identified several brain-cell receptors that influence resilience to stress and may be involved in susceptibility to alcohol dependence. For example, researchers found that mice lacking a receptor that mediates stress responses voluntarily drank much less alcohol and were more sensitive to its sedative effects than normal mice. In one study, people who had recently gone through alcohol detoxification took a drug that targets this same receptor. They reported fewer alcohol cravings and improved overall well-being. This finding might lead to a new treatment for some types of alcohol dependence, which is a central part of the NIAAA's mission.

Scientists also are seeking ways to combat underage drinking, a major public health challenge worldwide. For example, researchers conducting studies on animals have found that adolescents are less sensitive than adults to the negative effects of intoxication, including sleepiness, hangover and impaired coordination. That means it takes more alcohol for teens to begin to experience the negative effects that adults recognize as signs that they have had too much to drink. On the other hand, researchers conducting studies on humans have found that adolescents are more sensitive than adults to alcohol's impairment of memory and social inhibition. These findings suggest that adolescents are particularly prone to alcohol-related consequences, such as teenage drinking and driving accidents and lasting cognitive deficits. In addition, the earlier drinking begins in adolescence, the greater the risk of alcohol use disorders in adulthood. Our next challenge, therefore, is to learn how drinking may interfere with normal adolescent brain development at the cellular and molecular level,

as well as how this interference may lead to cognitive impairment and alcohol use disorders. Then we can investigate interventions that will protect people of all ages.

During the Decade of the Brain, scientists developed imaging and electrical recording techniques that allow today's researchers to study how alcohol affects different brain systems and structures. We can also see, in real time, how both the motivation to drink and alcohol itself change the human brain. For example, using functional magnetic resonance imaging (fMRI), scientists can track how the desire to use alcohol changes specific brain regions. Scientists using magnetic resonance spectroscopy (MRS) can monitor chemical and metabolic changes that may cause alcohol's short-term pleasurable effects (intoxication) and long-term detrimental effects (dependence).

Furthermore, about half of a person's risk of developing alcoholism is based on his or her genetic makeup, and real-time recording techniques also are helping scientists to identify genetic risk factors. For instance, using event-related potentials (ERPs), researchers have identified unusual brainwaves that appear in the brains of children of alcoholics before they have taken their first drink. Researchers also have found that certain genetic markers linked to alcohol dependence also are associated with psychiatric disorders such as antisocial personality disorder and attention-deficit/hyperactivity disorder. This finding suggests that these illnesses have genetic connections. In order to investigate the interface of genetics and neuroimaging, the NIAAA has promoted imaging research that may clarify how genes associated with alcohol dependence affect the brain. This new field of imaging genetics offers a powerful research tool to help us understand the genes that underlie alcohol-related disorders.

Understanding the effect of alcohol on the brain through discoveries in neuroscience is integral to understanding why people get into trouble from alcohol use and figuring out how to prevent and reduce alcohol-related problems. During the next decade, animal and human studies using increasingly sophisticated technology will provide information that may help bring us closer to these important goals.

For more information:

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