Addiction

Addiction is a disorder of the brain characterized by an impaired ability to refrain from using a psychoactive substance despite serious negative consequences. Such substances include some that are legal, such as alcohol and certain prescription medications, as well as others that are illegal, such as heroin, cocaine, marijuana, and methamphetamine. Addiction afflicts people from all ethnic groups, and all walks of life. According to the National Institutes of Health, more than a third of American adults report having a family member affected by this disease. The widespread nature of this illness coupled with its negative impact on those around the addict make this disease a major social problem.

While addiction is a problem that no group is immune from, much evidence suggests that both biological and environmental risk factors contribute to the expression of addictive behavior. In addition, neuroscientists have learned a great deal about the neural circuitry involved in addictive behavior. However, despite this knowledge, few treatment options are yet available. This lack of treatment options highlights the current importance of prevention strategies.

For people suffering from this illness, the compulsion to continue using the substance they are addicted to is often stronger than any other motivation. Under normal conditions, hunger, thirst, and a healthy fear of death or bodily harm are so powerful that they ensure that our most basic needs for food, water
and physical safety are met. The needs for emotional companionship, financial security, and sexual gratification are also normally potent motivating forces guiding our actions. However, for the addict, some or all of these drives become secondary to obtaining their abused substance. This misdirection of motivation can lead to physical damage to the body, loss of vital relationships, loss of employment, and loss of shelter. Observing addictive behavior can be frightening and puzzling.

Why do addicts risk such harm? The answer seems to be that in the throes of addiction, certain circuits in the brain that normally guide goal-directed behavior are malfunctioning. Evidence for this comes mainly from studies of animal models of addiction, although more recent studies in humans also support this hypothesis. Although addiction is generally viewed as a uniquely human disorder, animals can become addicted to all of the substances that humans do. Thus, it may be simply our unique access to concentrated forms of these substances that selectively precipitates the disease in our species. Animals also demonstrate similar risk factors for susceptibility to addiction. This fact allows scientists to study in detail the relative contribution of each of these risk factors, how they interact, and how they may be remedied or counteracted. These risk factors will be discussed in more detail below.

Animal studies have been instrumental in furthering our understanding of addiction. Such studies have determined which circuits in the brain play a role in
addictive behavior. Important components of these circuits include a brainstem site called the ventral tegmental area (VTA), the prefrontal cortex, and two areas located deep in the brain, the amygdala and the nucleus accumbens. The VTA neurons produce a neurotransmitter called dopamine, which they release into the other three brain areas listed above. Such dopamine release normally occurs in response to natural rewards like food, water, and sex, but it also occurs in response to all drugs of abuse. These circuits are affected by learning, with the result being that cues associated with rewards also trigger dopamine release. Chronic intake of drugs of abuse results in an intensified version of such learning, producing extreme hypersensitivity to drug-related cues.

This knowledge gathered in animal studies has enabled scientists to take a more educated approach to studies of addiction in humans. In addition to clinical trials of therapeutic interventions, developing laboratory measures for pre-clinical testing of potential treatments in humans is essential. This area of research, which falls generally into the domain of cognitive neuroscience, has focused primarily on three aspects of cognition impacted by addiction. First, a great deal of this work has focused on conditioned sensory responses elicited by drug-related sensory cues. Second, a growing area of investigation encompasses different aspects of decision-making. Third, some work has focused on behavioral inhibition, or impulse control. By combining careful studies in these areas with neuroimaging and pharmacology, a great deal of progress toward improved
treatment options is anticipated in coming decades. Already, results have confirmed that the same neural circuits are similarly impacted in human addicts.

However, given the few currently available treatments, understanding risk factors for addiction is an important element in prevention. Known risk factors include both biological and environmental types. Among biological factors, genetic risks for addiction have been repeatedly demonstrated. However, as with other complex neuropsychiatric disorders, such as schizophrenia, there is no single gene that causes the illness. On the contrary, there are clearly a whole host of genes in which particular forms, or “alleles”, increase one’s susceptibility to developing a serious problem with alcohol or other drugs of abuse. Also important are “epigenetic” biological factors, such as exposure to hormones and other chemicals in the womb. For example, maternal nicotine ingestion increases the likelihood of later substance abuse in the exposed offspring.

It is vital to note that these biological predispositions are not equivalent to predetermination. As with diseases like adult-onset diabetes, or heart disease, one’s behavior and environment interact with one’s biological makeup to determine whether the disease will be expressed. In the case of addiction, an obvious necessity is exposure to substances of abuse. Other important environmental factors include attitudes within the family and larger social group towards drug and alcohol use and abuse. Another critical factor is the age of initiation. The earlier that one is exposed to alcohol or other drugs, the more likely
it will be that addiction manifests. Moreover, those who started using earlier find it more difficult to stop abusing drugs or alcohol. Though not yet proven, this is thought to be due to the immaturity of the frontal lobes until relatively late in life. This area of the brain, which helps us to control our behavior and to plan for the future, generally does not mature completely until the late teens to early 20’s. This area, also referred to as the prefrontal cortex, is the brain’s “executive control” center, and is strongly impacted by both acute and chronic abuse of drugs and alcohol. Moreover, much evidence suggests that the prefrontal cortex is under functioning in the setting of addiction.

When addiction does surface, what can be done about it? The available treatment options can be broadly classified as psychotherapeutic or medication based. Within the psychotherapeutic realms, there are two main divisions. Perhaps the most well known are mutual support group methods based on the Twelve Steps of Alcoholics Anonymous, however other more recently established organizations based on approaches such as Cognitive Behavioral therapy are also available. Another commonly employed option is one-on-one therapy with a mental health professional specializing in addictive disorders. Many states currently provide certification for this specialty, both for medical doctors and for clinical psychologists. Medications are also currently available for treating some forms of addiction, especially nicotine, opiates, and alcohol.
All of these forms of treatment are designed to attack the problem using one (or a combination) of three basic approaches. The first is to try and remedy the underlying biopsychological cause of the disease. This assumes that there is a psychological problem or chemical imbalance that causes the addict to “self-medicate” with drugs or alcohol. Some examples include depression, anger, anxiety and stress. This approach tends to focus on treating the presumed underlying cause rather than the addiction per se, with the assumption that the addiction will resolve itself when the root problem is alleviated.

The ideas behind the other main treatment options are designed to more directly address the addiction problem itself. These approaches are generally designed to either eliminate craving, or to block the pleasurable, or “hedonic”, effects of the drugs. The first approach assumes that overwhelming drug cravings are responsible for maintaining the addiction, and if these cravings can be effectively quelled, the addiction can be cured. This can be accomplished with either aversion or replacement therapy. In prophylactic aversion therapy, patients are given a medication that will cause severe sickness if combined with the drug of abuse. Currently this approach is only available for alcohol. Another form of aversion therapy involves sessions in a treatment center where the substance in question, as well as associated items, is paired with aversive stimulation such as electric shock or chemically induced nausea. Unfortunately, this approach may
only be effective for those individuals who have not yet experienced severe negative side-effects as a result of their addiction.

The second tactic for craving prevention involves substituting a non-addictive substance that stimulates the same target sites in the brain. The most commonly known treatment of this sort is methadone, which is used primarily to treat heroin addiction. So-called substitution therapy has a two-fold method of action. First, by stimulating the drug target sites, withdrawal symptoms are prevented. Second, by occupying drug target sites, “getting high” becomes impossible. The success of methadone therapy in treating heroin addiction has motivated scientists to actively pursue similar medications for other classes of drugs of abuse. This approach has also included providing the drug itself in an alternative form. In the case of nicotine, replacement therapy has effectively helped many people conquer their addiction to tobacco products.

The final common therapeutic approach, hedonic effect blockade, is designed to prevent the “high” produced by the drug. By eliminating the pleasurable effects of the substance, presumably the motivation for using it is also abolished. While this approach has proved successful for opiate addiction, the side effects of medications that block other classes of drugs of abuse are too severe to be suitable for addiction treatment. A surprising development however is that medications that block the action of opiates in the brain also reduce the compulsion to drink alcohol. These results indicate that blocking the initial action
of the drug is not the only effective route for hedonic blockade. Moreover, it highlights that common circuitry is being engaged by addictions to substances with differing primary sites of action. Interestingly, opiate receptor blockers are also effective for treating compulsive gambling & eating disorders, lending credence to the idea that these are true addictions with shared underlying mechanisms in the brain.

The limited range of current treatment options emphasizes the importance of addiction prevention. Children should be educated about the risks of drug and alcohol use with particular emphasis on the increased risks associated with use in the teens or earlier. Young people should also be alerted to the increased risks linked to a family history of drug or alcohol abuse. The fact that addressing addiction problems in earlier stages tends to predict better outcomes, calls for education regarding the warning signs of a problem in one’s self and others. Finally, given the prevalence of data suggesting that difficulty coping with negative emotions contributes to addiction problems, society would be well served by expanding and improving early training for handling of negative emotions, thereby reducing the need for people to “self-medicate”.

Much progress remains to be made in understanding the underlying causes of addiction and in developing new treatments. A crucial step, however, has been the acknowledgement that addiction is a brain disease, like depression or schizophrenia. This acknowledgment is reducing the stigma of the disease and
promoting the expansion of research aimed at finding a cure. Emerging scientific fields, such as cognitive neuroscience, show particular promise for contributing to our understanding of the problem by taking new approaches to it.

See also: At-risk Behavior, Adolescent Brain, Nature vs. Nurture


National Institute on Drug Abuse: www.nida.nih.gov

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