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Addiction: new concepts for resolving old problems

Addictive substances and behaviours are as varied as their effects on an addict's health and personality. However, modern neurobiological research has revealed common principles in the development and continuation of addiction, which can be used as an approach for new prevention and therapy strategies including the prevention of relapses. This dossier presents some of the latest research results in the field.

Sumerian beer drinkers with drinking straws, around 3,000 B.C.

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In his book "Why Man Settled. The Greatest Puzzle in History" (2008), renowned evolutionary biologist and ecologist Josef H. Reichholf expresses the view that, during the Neolithic Revolution, rather than exchanging a hunter-gatherer lifestyle for an agricultural one in order to access a more reliable supply of food, human beings began planting crops because they wanted to brew beer. Although this hypothesis possibly appeals to me because I have Bavarian roots, there is, however, no doubt that for thousands of years people have been enormously creative when it comes to finding ways and means to become intoxicated. In the Epic of Gilgamesh, the world's oldest work of literature, the protagonist's divine companion, Enkidu, drinks five jugs of beer, experiences true pleasure and turns into a human being.

Habitual consumption of excessive amounts of substances (e.g. drugs/alcohol) leads to dependence, and eventually becomes an addiction where pleasure-seeking is replaced by compulsive drug seeking. In the International Classification of Diseases and Related Health Problems (World Health Organisation, ICD-10) addiction is "a cluster of behavioral, cognitive, and physiological phenomena that develop after repeated substance use and that typically include a strong desire (i.e. craving) to take the drug, difficulties in controlling its use, persisting in its use despite harmful consequences, a higher priority given to drug use than to other activities and obligations, increased tolerance, and sometimes a physical withdrawal state". Nowadays, addiction is no longer seen as a sign of moral weakness or lack of willpower, but as a chronic disease that leads to structural and functional changes in the brain and for which suitable therapies must be identified.

Tobacco and alcohol are the most common addictive substances

Cocaine and cigarette.
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There is an enormous variety of different substances and behaviours that are addictive. And we are constantly exposed to new temptations. The most common and most well-known are: alcohol, tobacco, heroin and other opioids, cannabis, cocaine, natural and synthetic hallucinogenic drugs (e.g. mescaline and LSD), stimulant drugs (especially amphetamines such as ecstasy and MDMA, as well as ephedrine), sedative drugs and sleeping pills (such as benzodiazepines).

Tobacco and alcohol are by far the most common addictive substances. As legal drugs, they are particularly difficult to deal with due to widespread societal acceptance. Alcohol has been popular for centuries and cigarette smoking is still considered 'cool' amongst adolescents, who are the most vulnerable group. Nevertheless, successful educational and preventive measures alongside regulations to combat powerful interest groups are all steps in the right direction. Drugs are often consumed together; health issues arising from young smokers/drinkers are especially serious because, when consumed together, tobacco and alcohol have a synergistic effect caused by the release of acetaldehyde. Acetaldehyde is known to dramatically increase the risk of cancer in the head and neck region.

Among illegal drugs, cocktails of substances (e.g. speedball, a mixture of heroin and cocaine) are particularly dangerous; they are usually available as variable, uncontrolled mixtures on the illegal market. The way drugs are consumed also plays a key role in the development of drug dependence; in general, drugs that are injected and smoked exert a much quicker effect than drugs that are swallowed.

Over the last ten years, the number of people with problems related to gambling (ludomania) and obsessive eating disorders (anorexia, bulimia, binge eating) has increased alarmingly. External causes of these dependencies are the standard slot machines that represent a huge source of revenue for the government (according to the German Centre for Addiction Issues' 2014 yearbook, the German amusement machine industry paid 1.7 billion euros in VAT, entertainment and trade taxes in

2012) on the one hand, and the buzz and role models in the media, entertainment and advertising industries on the other.

The effects of the various substances are as diverse as their chemistry; some drugs destroy an individual's health and personality very quickly, others act slowly over many decades. Prevention and therapy programmes must therefore be equally diverse. Although the current dossier focuses on the pharmacological treatment of addiction, treatment can only be successful through sustained psychotherapeutic and psychosocial interventions.

Common principles

Modern neurobiological research has shown that, despite the differences shown above, addictive behaviour has some common processes in the brain. These processes can also be observed in animals; we owe a great deal of our current knowledge to investigations carried out on animals, and later transferred to the situation in humans.

In general terms, these processes can be summarised as follows: in the same way as good food, sex, winning money or success in gambling, drugs cause the neurotransmitter dopamine to be released in the reward system of the brain. The reward system is composed of nucleus accumbens, hippocampus and amygdala. The nucleus accumbens is responsible for the characteristics we associate with feelings of happiness; the hippocampus stores memory, for example how a certain feeling of satisfaction came about, and the amygdala creates a conditioned response to certain stimuli. Dopamine interacts with the neurotransmitter glutamate, which is responsible for increased excitability: this creates a connection between vital activities (e.g. food uptake and sex) and feelings of happiness and reward in the brain.

Addictive stimuli (e.g. drugs) increase the production of dopamine in the nucleus accumbens; the amount of dopamine produced is directly related to the dose and speed with which the stimuli occur. The brain adapts to the increased quantity of dopamine by attenuating the action of dopamine in the reward system (e.g. by eliminating dopamine receptors). The feeling of happiness that the addict hopes that the drug will give him or her is progressively reduced, requiring an increase in concentration in order to experience the same "kick" as before – an effect that is referred to as tolerance.

The pleasure of taking a drug eventually disappears altogether; but the memory remains and is expressed as an urge to rediscover the former feeling of pleasure through drug use. Learning processes (i.e. conditioning) remain as well: information stored about situations associated with the drug trigger an intensive desire whenever the person is confronted with an appropriate environmental stimulus. This craving can awaken years after successful abstinence and cause a relapse.

Due to the effects of other neurotransmitters (e.g. serotonin and endorphins) and specific receptors and signalling chains (e.g. the opioid and endocannabinoid systems), the reaction network is actually much more complex and enables differentiated responses to different stimuli. This dossier addresses some of the latest research results on the molecular and genetic causes of addiction and presents new concepts for the prevention and treatment of addiction.

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Further information:

Yearbook entitled "Sucht" (Engl.: addiction). German Centre for Addiction Issues (DHS): www.dhs.de

Reitox Report 2012. Drug Situation 2011/2012 (in Germany). www.drogenbeauftragte.de

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Dossier

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