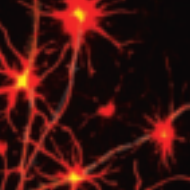

Neuroscience of Drugs and Addiction – summary

Neuroscience is at the core of our understanding of drugs and the brain. This fast-moving area of research tells us how drugs affect the brain, which brain components and circuits are involved in reacting to drugs, how addiction, recovery and relapse occur, and about motivation to use drugs. Current developments are pinpointing genetic and environmental risk factors for drug misuse and the behavioural and economic aspects of drug use. These breakthroughs may lead to better-informed drugs policies and treatments.

The Foresight project on Brain Science, Addiction and Drugs asked Trevor Robbins, Rudolf Cardinal, Patricia DiCiano, Kim Hellemans, Jonathan Lee and Barry Everitt of the University of Cambridge and Peter Halligan of Cardiff University to review what neuroscience is revealing about drugs and the brain.

Drug effects on the brain

The brain functions by releasing chemicals called neurotransmitters. They are released under the influence of the electrical activity of neurons. Their release is affected by chemicals such as drugs and by electrical or magnetic stimulation.

We are now discovering which parts of the brain make up its 'reward system', which reacts to food, sex, drugs and other experiences. Both its anatomy and its chemical workings are being analysed. It is becoming apparent that addiction is associated with long-term structural changes to the brain. Changes in brain chemistry can be put to good use to treat mental disorders and neurological conditions such as Alzheimer's Disease with drugs, and to enhance cognitive function.

Susceptibility

Most people who take drugs, or indulge in potentially addictive behaviour such as gambling, do not become addicts. We are learning about the genetic differences between animal and human groups which are more or less at risk of addiction. The genetic differences between them are reflected in different strengths of reaction of specific brain circuits to drugs.

We also have growing knowledge from animal models of the effects of stress, such as childhood deprivation of maternal care or other social interaction, on propensity to abuse drugs in the adult. Foetal exposure to drugs also seems to be a powerful indicator of later abuse.

Harm

Drugs of abuse cause both long-lasting and temporary harms. Some are more damaging than others. Brain systems involved in executive control and volition are often damaged by drugs and this may encourage further use. The brain's plasticity i.e. its ability to alter over time in response to stimuli, is encouraged by a lively external environment and may be reduced by exposure to drugs of abuse. Research in this field is being extended from animal models into humans, helped by advances in imaging technology.

Our knowledge of the brain effects of alcohol abuse is more complete than for other drugs. Alcohol affects neurotransmitter systems in a way that encourages sedation and impairs memory and learning in brain areas such as the hippocampus. The neural correlates of foetal alcohol syndrome, one of the major causes of mental retardation, in terms of reduced function in brain cortex, are also becoming known.

Social cognitive neuroscience

The gap between laboratory knowledge of brain function and social aspects of human behaviour is now closing rapidly. We know more about which brain areas are activated during drug use and craving and inactivated during abstinence. These areas tend to be more active in drug abusers. Similar brain areas are involved in the impaired decision making seen in addictive behaviour, including the addict's tendency to value short-term rewards over much greater long-term gains. Addicts are often less capable than others of appreciating the serious long-term effects of substance abuse.

The brain areas involved in the loss of voluntary control are also being mapped. They overlap with the brain areas that are affected among sufferers from volition disorders, such as delusions of alien control of the body. These brain areas seem to differ between users of drugs and the general population, but it is not known whether poorer volition control might be caused by drug use or whether it might be a contributor to its incidence.

Behavioural economics

Most conventional economics depends on the assumption that people are rational. Addicts are not fully rational and may be less rational than the average population. However, they can display rational behaviour. For example, about 75% of those dependent on illicit drugs recover. Addicts also respond to economic forces, so that taxing cigarettes more heavily reduces the number smoked.

It is possible that treatments will emerge for the neural systems damaged by drugs of abuse, which could allow addicts to make more rational decisions and assist recovery. But it is more likely that neuroeconomic approaches will be used to make conventional economic incentives, such as taxation, more effective. Psychology may also help to give anti-drug messages more impact.

The future

Future drugs, both pharmaceuticals and drugs of abuse, are likely to be designed to target specific pieces of brain circuitry. Very powerful versions of drugs such as cocaine and heroin may be produced. It may be possible to make psychoactive substances that do not cause long-term neural damage, but these may have the potential to cause other health harms.

It may become possible to target treatment on individuals in light of better knowledge of individuals' reactions to certain drugs. New drugs that limit or prevent neuroadaptations and drug dependence may also enhance the abuse potential of known drugs, or may enhance their acute use.

Novel drugs for treating depression, eating disorders and other conditions may have abuse potential.

The full version of this review is on www.foresight.gov.uk

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