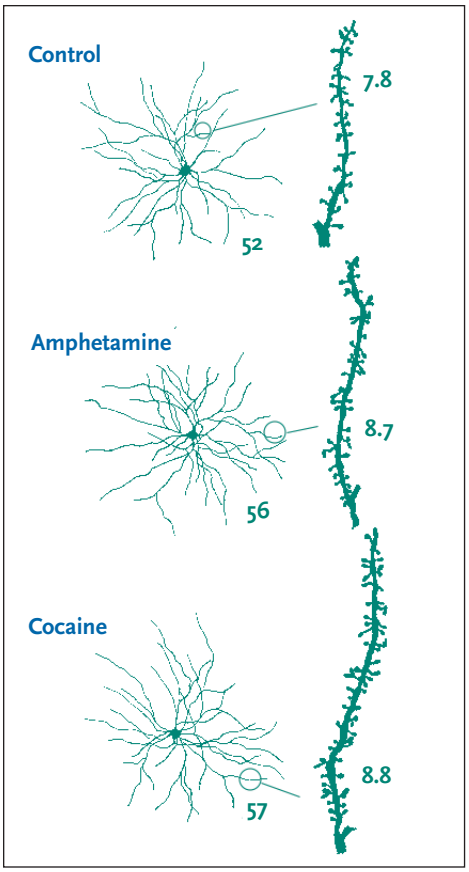
Graphic Evidence



Stimulant Drug-Induced Changes to Brain Cell Structures

Drug abuse is a brain disease, marked by actual physical changes to brain cells. Pictured at far left are neurons from three rats that were exposed to saline solution, amphetamine, or cocaine, respectively, for 4 weeks. The images were made by projecting microscope images of actual neurons onto a screen and using computer software to trace them. Visible are each neuron's cell body (appearing as a dark spot) and dendrites, filament-like structures radiating and branching out from the cell body in all directions.

Stimulant exposure causes increased dendrite branching: The numbers next to the neurons indicate the total number of dendrite branches counted on each. Those for animals exposed to stimulant drugs are 8-10 percent higher.

Stimulant exposure increases the number of dendritic spines: To the right of each neuron is a higher-magnification tracing of a section of one of its dendrites. The sections from the animals exposed to stimulant drugs feature roughly 12 percent more of the protrusions known as dendritic spines.

These changes are significant because dendrites are the sites where neurons form synapses to receive incoming signals from other neurons and parts of the brain. When branches and spines proliferate, neurons may respond to a greater volume of such signals, say Dr. Terry E. Robinson, of the University of Michigan in Ann Arbor, and Dr. Bryan Kolb, of the University of Lethbridge in Alberta, Canada. The researchers suggest that such enhanced signal responsiveness could be the underlying cause of a well-known stimulant effect on rat behavior. Locomotor sensitization, as the effect is called, means that the more an animal has been exposed to a stimulant, the more sensitive it will be to the activating effects of another dose.

The three neurons at top left are of a type called medium spiny neurons, taken from the part of the rat's brain called the nucleus accumbens. At bottom left, a photomicrograph of a rat pyramidal cell from the frontal cortex shows similar changes after exposure to cocaine. In all, Robinson and Kolb and others have demonstrated that different drugs cause a variety of structural changes in several types of neurons in various parts of the brain. Each change may contribute to the disease of addiction as it is experienced by patients and observed by clinicians.

Sources:

Kolb, B., et al., 2003. Amphetamine or cocaine limits the ability of later experience to promote structural plasticity in the neocortex and nucleus accumbens. *Proceedings of the National Academy of Sciences of the United States of America* 100(18):10523-10528.

Robinson, T.E., and Kolb, B., 1999. Alterations in the morphology of dendrites and dendritic spines in the nucleus accumbens and prefrontal cortex following repeated treatment with amphetamine or cocaine. *European Journal of Neuroscience* 11(5):1598-1604.