

UT News

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****Cocaine acts on dopamine system
to cause addiction

DALLAS--Why do people get hooked on cocaine? How does it become addictive?

Dr. Dwight German, neurobiologist at The University of Texas Health Science Center at Dallas, says the answer lies in the drug's ability to chemically stimulate dopamine-containing cells that affect our sensations of pleasure.

When snorted or smoked, cocaine easily passes from the bloodstream into the brain. There it causes the release of dopamine from dopamine-containing neurons. Dopamine cells are generously distributed in brain regions regulating emotion (the limbic system) and movement (the basal ganglia).

When stimulated, the cells spew dopamine into these two adjoining brain regions, jointly producing pleasurable sensations and an increased energy level, says German, associate professor in the departments of psychiatry and physiology.

Dopamine-producing nerve cells control the intertwining of emotion and movement in many circumstances, including the euphoria and energetic feeling associated with the "runner's high." But a lack of dopamine produces depression and a slow, shuffling gait as is seen in advanced Parkinson's Disease, when dopamine cells die off.

"It is the ability of stimulants like cocaine and opiates like heroin to chemically activate the pleasure-related dopamine neurons that makes these drugs addictive," says German.

The magnitude of cocaine's effects on the "pleasure centers" of the brain may be overwhelming, German explains. "People think they are in control, but they're not." It is the fierce craving for pleasure associated with cocaine and the inability to feel pleasure without the drug that causes the addict to want to recapture that initial euphoric high. "But euphoria is eventually followed by an equal or greater amount of dysphoria."

German says that the habitual cocaine user pays a high price when cocaine pushes the dopamine system to an extreme. The brain responds to an over-supply of dopamine by gearing down the natural release of dopamine. "The brain works to adapt to the dopamine excess and eventually does so by saying, 'Why should I do the work when the drug will do it for me?'"

In addition, when dopamine levels are pushed too high over a prolonged time, the brain will try to maintain a chemical balance by shutting down the production of receptors on target cells that normally respond to dopamine. This spells trouble since dopamine is then no longer effective in producing normal feelings of pleasure.

"This 'down-regulation' by the brain in controlling receptor production means you have to have more and more drug to get high or to keep from getting depressed during the withdrawal times," says German. "The longer the biochemistry of the brain is pushed to an extreme, the longer it will take to achieve a balance again. Many cocaine users don't want to wait that long."

(more)

With a scarcity of dopamine activity in the brain, the effects of dopamine deprivation are felt--depression and lack of energy. Intense craving for more cocaine to again feel normal pleasure develops and, with more cocaine, the cycle of addiction begins again.

Given time without the drug, the brain's dopamine system will usually regain control and revert to normal, he says.

Cocaine use, particularly high doses of the drug, carries with it dangers of heart attack and sudden death from heart arrhythmias. German explains that the brain's dopamine system is not related to this reaction of the heart. "Cocaine use stimulates other transmitter systems besides dopamine," he says, and it would be these other mechanisms that produce heart over-stimulation.

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NOTE: The University of Texas Health Science Center at Dallas comprises Southwestern Medical School, Southwestern Graduate School of Biomedical Sciences and the School of allied Health Sciences.

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