Study pinpoints brain area's role in learning

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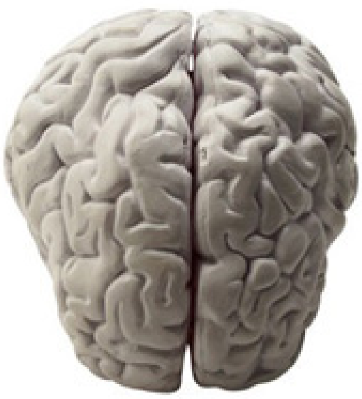

An area of the brain called the orbitofrontal cortex is responsible for decisions made on the spur of the moment, but not those made based on prior experience or habit, according to a new basic science study from substance abuse researchers at the University of Maryland School of Medicine and the National Institute on Drug Abuse (NIDA). Scientists had previously believed that the area of the brain was responsible for both types of behavior and decision-making. The distinction is critical to understanding the neurobiology of decision-making, particularly with regard to substance abuse. The study was published online in the journal *Science*.

Scientists have assumed that the orbitofrontal cortex plays a role in "value-based" decision-making, when a person compares options and weights consequences and rewards to choose best alternative. The Science study shows that this area of the brain is involved in decision-making only when the value must be inferred or computed rapidly or hastily. If the value has been "cached" or pre-computed, like a habit, then the orbitofrontal cortex is not necessary.

The same is true for learning—if a person infers an outcome but it does not happen, the resulting error can drive learning. The study shows that the orbitofrontal cortex is necessary for the inferred value that is used for this type of learning.

"Our research showed that damage to the orbitofrontal cortex may decrease a person's ability to use prior experience to make good decisions on the fly," says lead author Joshua Jones, Ph.D., a postdoctoral researcher at the University of Maryland School of Medicine and a research scientist at NIDA, part of the National Institutes of Health. "The person isn't able to consider the whole continuum of the decision—the mind's map of how choices play out further down the road. Instead, the person is going to regress to habitual behavior, gravitating toward the choice that provides the most value in its immediate reward."

The study enhances scientists' understanding of how the brain works in healthy and unhealthy individuals, according to the researchers.

"This discovery has general implications in understanding how the brain processes information to help us make good decisions and to learn from our mistakes," says senior author Geoffrey Schoenbaum, M.D., Ph.D., adjunct professor at the University of Maryland School of Medicine and senior investigator and chief of the Cellular Neurobiology Research Branch at NIDA. "Understanding more about the orbitofrontal cortex also is important for understanding disorders such as addiction that seem to involve maladaptive decision-making and learning. Cocaine in particular seems to have long-lasting effects on the orbitofrontal cortex. One aspect of this work, which we are pursuing, is that perhaps some of the problems that characterize addiction are the result of drug-induced changes in this area of the brain."

The scientists are continuing their research, examining the specific coding of the neurons in the orbitofrontal cortex during this process, as well as the effects that drugs of abuse have upon this area of the brain.

"Drug addiction is marked by severe deficits in judgment and bad decision-making on the part of the addict," says Dr. Jones. "We believe that drugs, particularly cocaine, affect the orbitofrontal cortex. They coerce the system and hijack decision-making."

The researchers examined the orbitofrontal cortex's role in value-guided behavior. The brain assigns two different types of values to behaviors and choices. Cached value is a value that is learned during prior experience. Inferred value happens on the spur of the moment, considering the entire model of rewards and consequences.

"Cached value is stored during prior experience, says Dr. Jones. "For example, you learn your route home on your commute through experience—the habit of how you get home. You turn right, go left, make another right. Inferred values, however, are based on estimating goals and values on the fly using your knowledge of the entire structure of the environment. For example, instead of just habitually going home on your usual route, you have the full map in your mind of all the roads that you use. You can adjust your route, making different turns, depending on the time of day or the amount of traffic. These inferred decisions are adaptive—much more flexible based on the situation."

The scientists used a rat model for their research, disabling the orbitofrontal cortex and measuring the difference in behavior that resulted. Further study using the same rat model—work not reported in this paper—has shown that cocaine use mimics this damage to the orbitofrontal cortex.

Further study of this neurobiological mechanism is needed, and the results have not been replicated in humans, but certainly the research is promising, says E. Albert Reece, M.D., Ph.D., M.B.A., vice president for medical affairs at the University of Maryland and John Z. and Akiko K. Bowers Distinguished Professor and dean at the University of Maryland School of Medicine. "Our goal here at the School of Medicine is to make groundbreaking discoveries in the laboratory that can be translated into new treatments and new hope for patients and their families," says Dean Reece. "We are hopeful that research tells us more about the basic mechanisms in the brain will translate to new techniques in neurobiology and in treating devastating conditions such as drug addiction."

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