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# NIDA NOTES

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## Director's Column

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## NIDA's Brain Imaging Studies Serve as Powerful Tools to Improve Drug Abuse Treatment

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In recent years, powerful new research tools have been developed that are proving invaluable in unraveling the neurobiological complexities that underlie drug abuse and addiction. Prominent among these tools is a variety of rapidly evolving, noninvasive neuroimaging techniques that let us do something that scientists in other ages could only imagine - see images of what is happening inside the brain while humans think, learn, remember, and experience the effects of drugs.

Previously, probing the brain required invasive procedures that limited scientific investigations. Now, functional neuroimaging techniques, such as positron emission tomography (PET), single photon emission computed tomography (SPECT), and functional magnetic resonance imaging (fMRI), along with electroencephalography (EEG), an earlier technique for monitoring brain activity, provide windows through which we can observe the working brain as research subjects experience a variety of drug abuse-related phenomena. (For information about how these neuroimaging techniques work, see [The Basics of Brain Imaging](#)) With imaging techniques, we can view the changes that occur in the brain as drugs enter and exert their psychoactive effects. We can measure long-term changes in brain function that occur with chronic drug abuse. And we can discern the effects of drug abuse treatment on brain functions. At the same time, we can interview research subjects as they experience the effects of drugs of abuse and correlate their responses with the changes we are observing in their brains.

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Although functional brain imaging is fairly new, NIDA has moved rapidly to take advantage of these developing technologies. In the last few years, we have established in our Division of Clinical and Services Research an Etiology and Clinical Neurobiology Branch headed by Dr. Joseph Frascella that has put together a broad portfolio of clinical neuroimaging studies. We have issued a number of requests for applications and program announcements on the neuroscience of drug addiction that express specific

interest in both basic and clinical neuroimaging studies. We have built, with financial support from the [White House Office of National Drug Control Policy \(ONDCP\)](#), the first PET imaging center in the Nation dedicated to drug abuse research at our Division of Intramural Research (DIR) in Baltimore. This state-of-the-art facility, which is directed by Dr. Edythe London, will be a resource for both intramural and extramural researchers. And, under an interagency agreement with the Department of Energy and ONDCP, we have just established a comprehensive neuroimaging center at the Brookhaven National Laboratory in Upton, New York. This center, which has PET, SPECT, and MRI capabilities, will be used to study drug abuse and addiction and will also serve as a regional resource to other scientists who lack the facilities to do neuroimaging studies. (See [NIDA's Regional Neuroimaging Center](#))

NIDA's expanded neuroimaging initiatives have already produced exciting research findings. A number of NIDA-funded neuroimaging studies have confirmed what we have learned from years of neuroscience research-that drug addiction is a complex brain disorder. For example, PET studies conducted at Brookhaven National Laboratory show that, compared to the brains of non-drug-using individuals, the brains of chronic cocaine abusers exhibit substantial differences in neurochemical function. Studies now under way are probing the role these brain differences may play in such aspects of drug addiction as craving, loss of control, and relapse to drug use.

NIDA's intramural and extramural clinical neuroimaging studies are already contributing to a better understanding of the complex brain and behavioral processes that are involved in drug craving. Imaging studies are uniquely suited to studying craving because they can show us activity in the brain and where it is happening as drug craving is occurring. For example, researchers conducting PET studies at NIDA's DIR recently reported that items or places that chronic cocaine abusers associate with using cocaine appear to activate a neural network that links brain areas involved in remembering strong emotions or feelings with areas involved in planning future drug use. The DIR PET studies built on physiological and behavioral research conducted at the University of Pennsylvania showing that drug craving can be elicited by cocaine-related stimuli and can activate areas of the brain's limbic system, a seat of memories and emotions. This system plays an important role in the rewarding effects of many drugs of abuse. Further PET studies of craving are under way at our DIR and the University of Pennsylvania. (For more information about the DIR study and NIDA's new PET center, see [NIDA Brain Imaging Research Links Cue-Induced Craving to Structures Involved in Memory](#), and [New Imaging Center Enhances NIDA's Brain Research](#))

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Other NIDA brain imaging studies are examining a broad range of other important questions about drug abuse and addiction. For example, at Johns Hopkins Medical Institutions in Baltimore, PET studies are following up on animal studies to assess the possible long-term neurotoxic effects of chronic methamphetamine and MDMA abuse in humans. At Harbor-UCLA Medical Center in Torrance, California, MRI and SPECT studies are examining whether cocaine use speeds the progression of AIDS dementia complex. And, at McLean Hospital in Belmont, Massachusetts, combined EEG and MRI studies are assessing brain activity during cocaine-induced euphoria. (For more information about NIDA-funded neuroimaging studies, see [NIDA-Supported Researchers Use Brain Imaging to Deepen Understanding of Addiction](#))

Although much of the scientific excitement about neuroimaging comes from our newfound ability to study the living human brain, neuroimaging studies with animals also are playing an important role in furthering our knowledge about the neurobiology of drug abuse. For example, a major unanswered question about the altered brains of drug abusers is whether any of these abnormalities existed in their brains before their chronic drug use. Basic research can help us answer this question. NIDA is supporting imaging studies with nonhuman primates at the Bowman Gray School of Medicine at Wake Forest University in Winston-Salem, North Carolina, to see whether exposing these animals, whose brains are similar to those of humans, to chronic drug administration produces the same changes we see in humans who have abused drugs chronically.

Our ultimate goal is to apply the knowledge we gain from our brain imaging studies to the development of better targeted, more effective pharmacological and behavioral treatments for drug abuse and addiction. To accomplish this, NIDA recently solicited applications from researchers to conduct neuroimaging studies that will assess and characterize the effects of current and potential drug abuse treatment medications and behavioral therapies on human brain structures and functions.

As I have often said, no one medication or behavioral treatment will be able to address the complex interaction of different neurobiological, behavioral, and environmental factors that comprise the chronic, relapsing brain disorder we call drug addiction. However, NIDA's neuroimaging studies are bringing us closer to the day when we can offer a sophisticated blend of behavioral and pharmacological treatments that will gradually reverse the brain damage wrought by drug abuse, normalize brain function, curb drug craving, reduce the likelihood of relapse, and restore individuals to productive lives.

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