## Addiction Research at Brookhaven

In 1987, Brookhaven National Laboratory became the first research institution to use positron emission tomography (PET) and other medical imaging techniques to investigate the brain mechanisms underlying drug addiction.

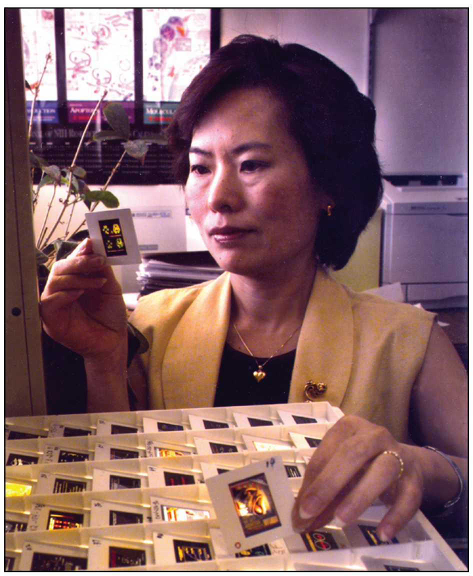
Since then, Brookhaven researchers and their collaborators and colleagues at other institutions have probed the mysteries of how drugs such as cocaine affect the brain and how they lead a person into the cycle of use and abuse that is addiction.

The Brookhaven PET program has gained international recognition for images of human addiction, for introducing novel addiction treatments, for studying brain aging and degeneration, and for drug research and development.

As a result of their outstanding research, several Brookhaven researchers have been recognized with honors and awards. The Laboratory itself has been named a regional drug addiction study center by the National Institute on Drug Abuse.

Among the drugs being studied at Brookhaven are:

- cocaine and related drugs
- heroin and opiates
- amphetamine and methamphetamine
- tobacco
- alcohol
- marijuana
- inhalants



*Chemist Yu-Shin Ding examines brain scans.*

## A View of Brookhaven

Brookhaven National Laboratory is a multipurpose research laboratory funded by the U.S. Department of Energy. Located on a 5,300-acre site on Long Island, New York, the Laboratory operates large-scale facilities for studies in physics, chemistry, biology, medicine, applied science, and advanced technology.

Brookhaven's 3,000 scientists, engineers, and support staff are joined each year by more than 4,000 visiting researchers from around the world.

*An aerial view of Brookhaven Lab*

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BROOKHAVEN
NATIONAL LABORATORY

managed for the U.S. Department of Energy
by Brookhaven Science Associates, a company
founded by Stony Brook University and Battelle

## Sophisticated Tools

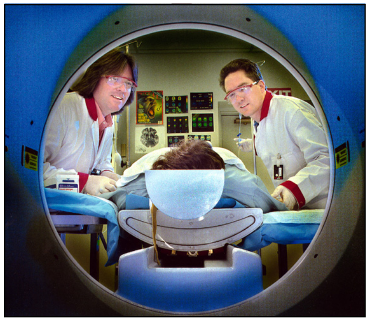
Much of the addiction research at Brookhaven National Laboratory has used medical imaging techniques of ever-increasing sophistication, combined with tailor-made radiotracer chemicals developed at the Laboratory. These research tools are a natural outgrowth of Brookhaven's historical focus on finding valuable applications for advances in nuclear physics.

### Positron Emission Tomography (PET)

Positron emission tomography (PET) is a medical imaging method that can measure the concentration and movement of substances in living tissue. Scientists track substances by labeling them with radio-isotopes, variations of chemical elements that give off particles or energy. Those that emit positrons, a type of subatomic particle, are detected by PET scanners.

*A precursor to today's PET scanners, developed at Brookhaven in the 1960s*

Brookhaven scientists pioneered the development of PET technology and the radiotracers whose movement is tracked by PET. Today, the Laboratory has some of the world's most advanced PET scanners. Due to its inherent quantitative biochemical nature, PET has the technical capability to help reveal the molecular mechanisms of human disease and to facilitate the development of new drugs.

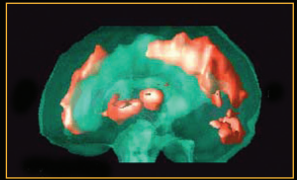


*One of Brookhaven's modern PET scanners*

### Radiotracer Chemistry

Brookhaven chemists were the first to radio-label cocaine so that it could be used for PET addiction studies. They also developed a fluorine-glucose radiotracer now used worldwide to make images of brain function and to diagnose cancer.

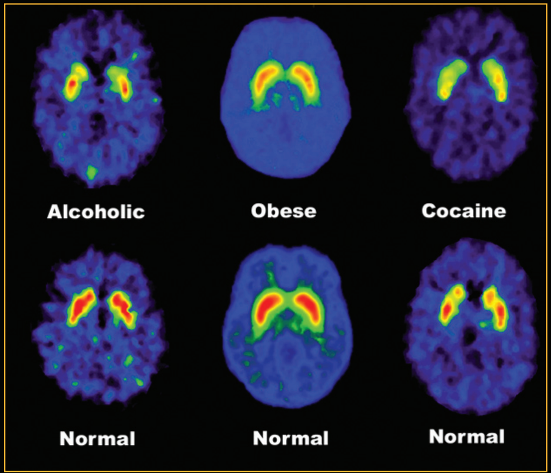
## Key Findings



***Side view of a brain, showing cocaine (red) flooding the brain, including the "pleasure centers."***

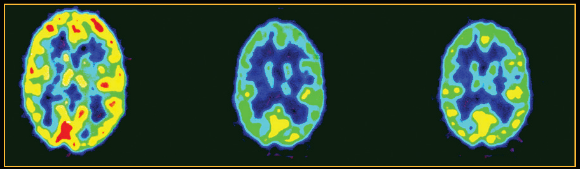
Brookhaven scientists made the first images of cocaine in the brain and the first studies linking cocaine's effects on brain function to the compulsive use of the drug. These efforts led to the first documentation of stroke-like changes in the brains of cocaine abusers and a series of studies to map the biochemical and anatomical changes responsible for drug-addictive behaviors. To date, these studies have shown that:

- Cocaine given intravenously enters the brain rapidly, and it is this rapid entry that parallels the "high."
- Smokers experience a temporary decrease in a brain enzyme that breaks down chemicals involved in pleasure and reward.
- All addictive drugs and behaviors deplete the brain's receptors for dopamine, a natural brain chemical involved in movement, motivation, and the sensations of pleasure and well-being.




***PET scans reveal depleted dopamine receptors (indicated by less red) in alcoholic, obese, and cocaine-abusing subjects (top) compared with normal controls (bottom).***

- Cocaine abuse lowers overall metabolic activity in the brain, and this effect may last long after drug use has stopped.



***A normal brain, left, and a cocaine abuser's 10 and 100 days after taking the drug. Normal metabolic activity, indicated by bright red and yellow, is blunted in the drug user.***

- The extreme increase in brain dopamine triggered by the use of addictive drugs overshadows the effects of normally rewarding activities, such as eating, listening to music, and even sex.
- Environmental cues associated with drugs, such as settings where drugs were administered in the past, elevate brain dopamine in experimental animals.

## Treatment Possibilities

Brookhaven scientists have been exploring a variety of pharmacological agents as potential treatments for addiction. One promising agent is gamma vinyl-GABA, or GVG. Findings from Brookhaven's animal studies on GVG indicate that:

- By indirectly depleting brain dopamine, GVG blocks the biochemical effects of all addictive drugs tested to date, including alcohol, cocaine, nicotine, heroin, and methamphetamine.
- Animals trained to self-administer addictive drugs will no longer take the drugs when given GVG.
- GVG blocks environment-triggered increases in brain dopamine, thereby reducing craving for drugs.

Further studies are necessary to see if GVG can be used safely and effectively for the treatment of addiction in humans. People who need immediate assistance with substance abuse can contact addiction hotlines, such as (800) 662-HELP, for the best available treatments.

Brookhaven's addiction research is funded primarily by the Office of Biological and Environmental Research within the U.S. Department of Energy's Office of Science, and the National Institute on Drug Abuse of the National Institutes of Health. All studies are conducted with strict adherence to ethical standards and only after review by appropriate Institutional Review Boards.