National Institutes of Health

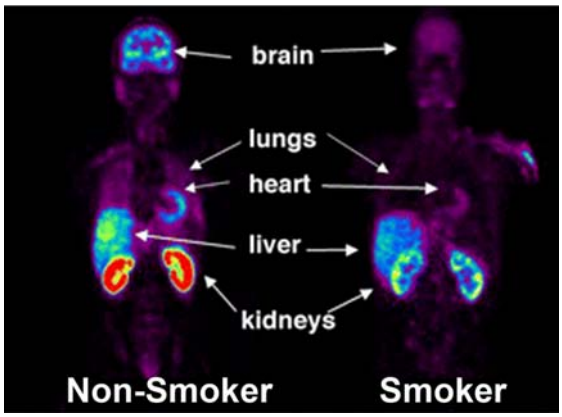
Fact Sheet — *Imaging Diseases of Addiction*

Yesterday

- Substance abuse and addictive disorders were largely attributed to moral weakness or lack of character. This view was fueled by the lack of understanding of how the brain affects behavior and how brain function is disrupted by drugs leading to the pathological behaviors seen in drug addicted individuals. Until very recently, studies that evaluated the effects of drugs in the human brain were limited to anatomical and biochemical analyses of post-mortem samples. The lack of tools to investigate the living human brain left huge gaps in our understanding of drug addiction.

Today

- The advent of noninvasive brain imaging technologies allows the study of the human brain in real-time, at ever increasing spatial and temporal resolutions, and chemical sensitivity. Moreover, these tools allow us to assess many different brain responses under diverse conditions and at different stages of development. This includes being able to ascertain the effects of drugs of abuse directly in the human brain and body.
  - Full body scans, for example, have uncovered profound effects of cigarette smoking in the concentration of MAO-B (a key enzyme in detoxification processes) in the brains and bodies of smokers *(see figure)*. This effect likely contributes to the adverse health consequences of smoking.
  - Longitudinal pediatric neuroimages reveal that brain development continues well into young adulthood. This may explain in part why addiction usually develops during adolescence and why the younger the age of initiation, the greater the risk of becoming addicted.
- This suite of constantly evolving imaging tools has clearly established the deleterious effects of chronic drug abuse on various brain circuits, including those involved in reward/pleasure, learning/conditioning, motivation/drive, and inhibitory control/executive functions. Techniques for imaging brain neurochemistry reveal that abused drugs can disrupt the dopamine, GABA, enkephalin, and glutamate neurotransmitter systems, among others. These tools also provide evidence that some of these brain changes can recover, at least partially, with protracted abstinence.



Whole body PET images showing the level of an enzyme (MAO-B). Decreases are seen in the brain and throughout the body of smokers compared to non-smokers.

Tomorrow

- Preliminary but exciting results demonstrate that it is possible to control pain using a neurofeedback approach that relies on information derived from fMRI-generated brain images. The apparent success of these neurofeedback training sessions suggests that similar strategies could be used to strengthen brain circuits impaired by addiction. Enhancing a diminished faculty to control impulsivity, for example, could greatly improve an individual's ability to control drug cravings, helping to prevent relapse and aid the recovery process.

- Increases in the affordability of brain scans will allow us to deploy these techniques on larger populations. This in turn, will enhance our ability to identify people at risk of becoming addicted, diagnose the presence of the disease, and begin early treatment. Health care providers will be able to use these brain scans to detect the signs of drug-induced brain dysfunctions that can increase a person's risk of addiction. This will allow them to develop better strategies to counter the dysfunction and prevent addiction from ever developing. In this way, medical practice will shift from disease detection and treatment to disease prediction and prevention in asymptomatic, at-risk populations.
- Imaging will be used to uncover how genes that influence addiction risk affect the morphology, biochemistry, and function of the brain at the various developmental stages of an individual's life, and how the environment modifies these processes. Such knowledge will allow us to better tailor drug abuse interventions according to individualized risk factors.

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