NIDA
NATIONAL INSTITUTE
ON DRUG ABUSE

National Institutes of Health
U.S. Department of Health
and Human Services

This publication is in the public domain and may be used or reproduced in its entirety without permission from NIDA. Citation of the source is appreciated.

NIH Pub No. 10-5605
Printed April 2007
Revised February 2008
Revised August 2010

CONTENTS

Preface 1

Introduction 3

I. Drug Abuse and Addiction 5

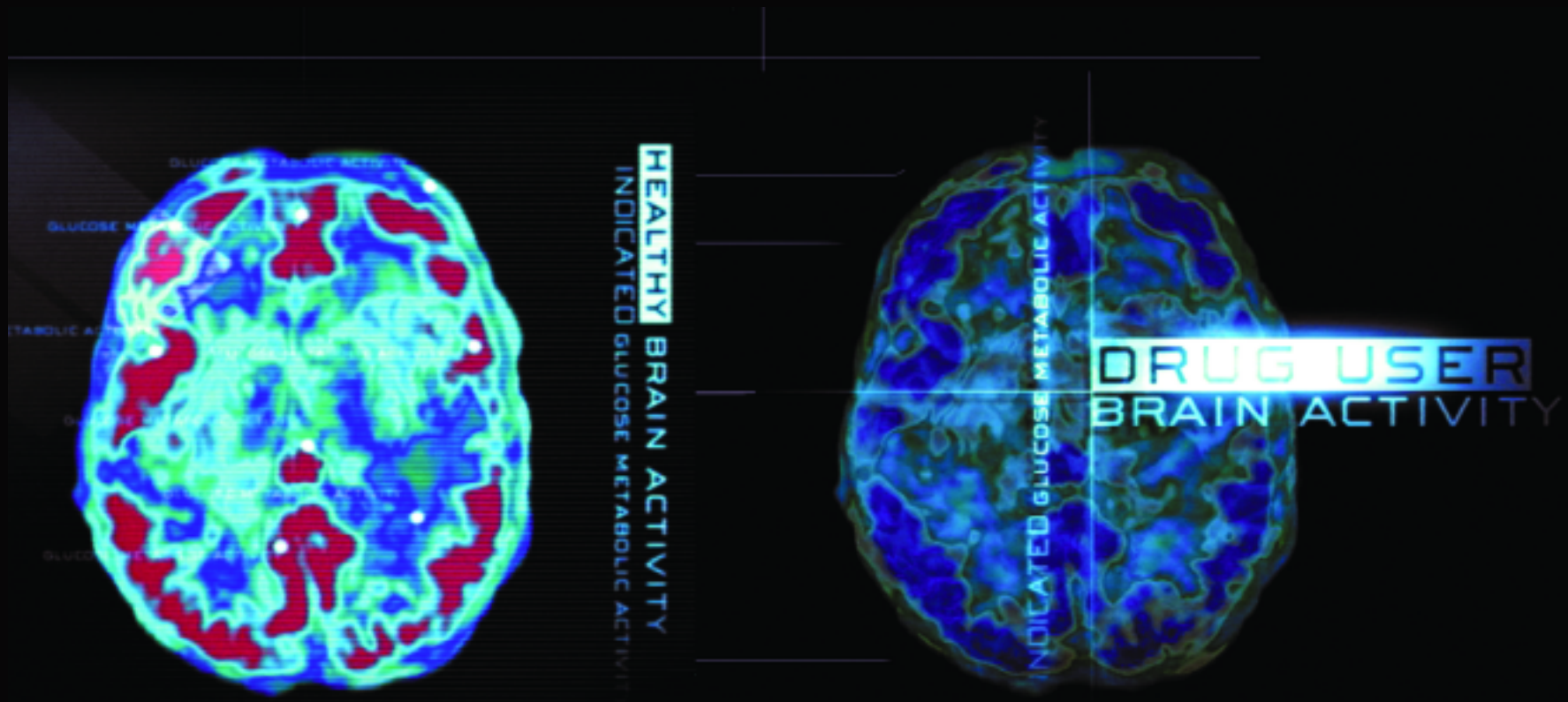
II. Preventing Drug Abuse: The Best Strategy 11

III. Drugs and the Brain 15

IV. Addiction and Health 21

V. Treatment and Recovery 25

VI. Advancing Addiction Science and Practical Solutions 29



"Drug addiction is a brain disease that can be treated."

Nora D. Volkow, M.D.
Director
National Institute on Drug Abuse

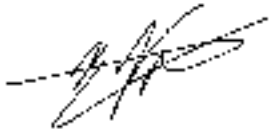
PREFACE

How Science Has Revolutionized the Understanding of Drug Addiction

Throughout much of the last century, scientists studying drug abuse labored in the shadows of powerful myths and misconceptions about the nature of addiction. When science began to study addictive behavior in the 1930s, people addicted to drugs were thought to be morally flawed and lacking in willpower. Those views shaped society's responses to drug abuse, treating it as a moral failing rather than a health problem, which led to an emphasis on punitive rather than preventative and therapeutic actions. Today, thanks to science, our views and our responses to drug abuse have changed dramatically. Groundbreaking discoveries about the brain have revolutionized our understanding of drug addiction, enabling us to respond effectively to the problem.

As a result of scientific research, we know that addiction is a disease that affects both brain and behavior. We have identified many of the biological and environmental factors and are beginning to search for the genetic variations that contribute to the development and progression of the disease. Scientists use this knowledge to develop effective prevention and treatment approaches that reduce the toll drug abuse takes on individuals, families, and communities.

Despite these advances, many people today do not understand why individuals become addicted to drugs or how drugs change the brain to foster compulsive drug abuse. This booklet aims to fill that knowledge gap by providing scientific information about the disease of drug addiction, including the many harmful consequences of drug abuse and the basic approaches that have been developed to prevent and treat the disease. At the National Institute on Drug Abuse (NIDA), we believe that increased understanding of the basics of addiction will empower people to make informed choices in their own lives, adopt science-based policies and programs that reduce drug abuse and addiction in their communities, and support scientific research that improves the Nation's well-being.



Nora D. Volkow, M.D.
Director
National Institute on Drug Abuse

MEDICAL

SOCIAL

ECONOMIC

CRIMINAL JUSTICE

The consequences of drug abuse are vast and varied and affect people of all ages.

INTRODUCTION

Why study drug abuse and addiction?

Abuse and addiction to alcohol, nicotine, and illegal substances cost Americans upwards of half a trillion dollars a year, considering their combined medical, economic, criminal, and social impact. Every year, abuse of illicit drugs and alcohol contributes to the death of more than 100,000 Americans, while tobacco is linked to an estimated 440,000 deaths per year.

People of all ages suffer the harmful consequences of drug abuse and addiction.

- ***Babies*** exposed to legal and illegal drugs in the womb may be born premature and underweight. This drug exposure can slow the child's intellectual development and affect behavior later in life.
- ***Adolescents*** who abuse drugs often act out, do poorly academically, and drop out of school. They are at risk of unplanned pregnancies, violence, and infectious diseases.
- ***Adults*** who abuse drugs often have problems thinking clearly, remembering, and paying attention. They often develop poor social behaviors as a result of their drug abuse, and their work performance and personal relationships suffer.
- ***Parents'*** drug abuse often means chaotic, stress-filled homes and child abuse and neglect. Such conditions harm the well-being and development of children in the home and may set the stage for drug abuse in the next generation.

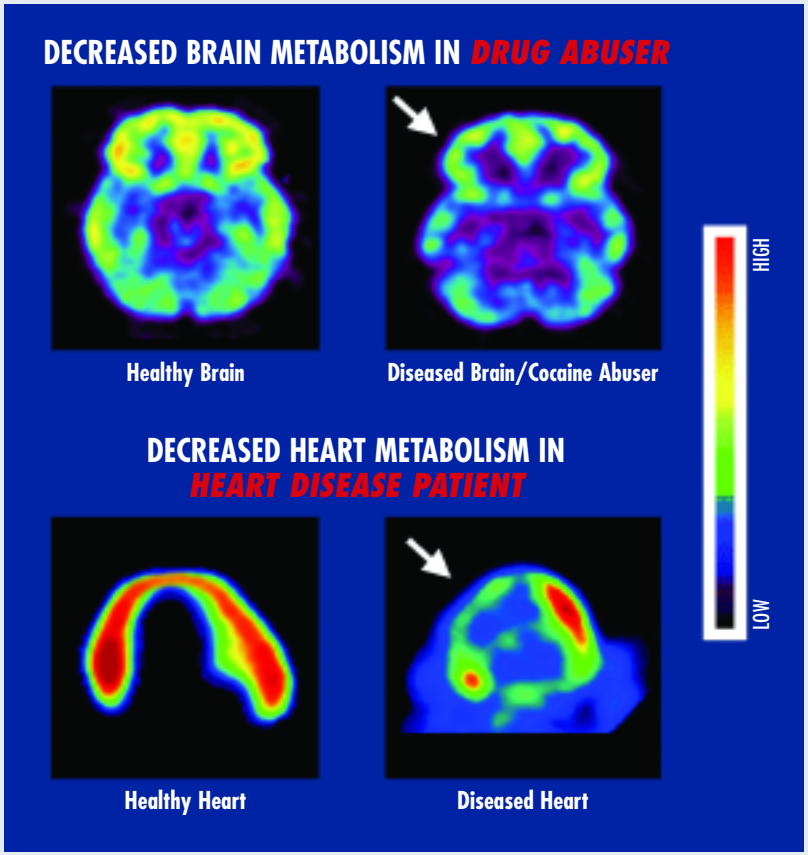
How does science provide solutions for drug abuse and addiction?

Scientists study the effects that drugs have on the brain and on people's behavior. They use this information to develop programs for preventing drug abuse and for helping people recover from addiction. Further research helps transfer these ideas into practice in our communities.

I. DRUG ABUSE AND ADDICTION

What is drug addiction?

Addiction is defined as a chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences. It is considered a brain disease because drugs change the brain—they change its structure and how it works. These brain changes can be long lasting, and can lead to the harmful behaviors seen in people who abuse drugs.



Addiction is similar to other diseases, such as heart disease. Both disrupt the normal, healthy functioning of the underlying organ, have serious harmful consequences, are preventable, treatable, and if left untreated, can last a lifetime.

Source: From the laboratories of Drs. N. Volkow and H. Schelbert.

Why do people take drugs?

In general, people begin taking drugs for a variety of reasons:

- ***To feel good.*** Most abused drugs produce intense feelings of pleasure. This initial sensation of euphoria is followed by other effects, which differ with the type of drug used. For example, with stimulants such as cocaine, the "high" is followed by feelings of power, self-confidence, and increased energy. In contrast, the euphoria caused by opiates such as heroin is followed by feelings of relaxation and satisfaction.
- ***To feel better.*** Some people who suffer from social anxiety, stress-related disorders, and depression begin abusing drugs in an attempt to lessen feelings of distress. Stress can play a major role in beginning drug use, continuing drug abuse, or relapse in patients recovering from addiction.
- ***To do better.*** The increasing pressure that some individuals feel to chemically enhance or improve their athletic or cognitive performance can similarly play a role in initial experimentation and continued drug abuse.
- ***Curiosity and "because others are doing it."*** In this respect adolescents are particularly vulnerable because of the strong influence of peer pressure; they are more likely, for example, to engage in "thrilling" and "daring" behaviors.

Courtesy: Vivian Feken

If taking drugs makes people feel good or better, what's the problem?

At first, people may perceive what seem to be positive effects with drug use. They also may believe that they can control their use; however, drugs can quickly take over their lives. Consider how a social drinker can become intoxicated, put himself behind a wheel and quickly turn a pleasurable activity into a tragedy for him and others. Over time, if drug use continues, pleasurable activities become less pleasurable, and drug abuse becomes necessary for abusers to simply feel "normal." Drug abusers reach a point where they seek and take drugs, despite the tremendous problems caused for themselves and their loved ones. Some individuals may start to feel the need to take higher or more frequent doses, even in the early stages of their drug use.

Is continued drug abuse a voluntary behavior?

The initial decision to take drugs is mostly voluntary. However, when drug abuse takes over, a person's ability to exert self control can become seriously impaired. Brain imaging studies from drug-addicted individuals show physical changes in areas of the brain that are critical to judgment, decisionmaking, learning and memory, and behavior control. Scientists believe that these changes alter the way the brain works, and may help explain the compulsive and destructive behaviors of addiction.

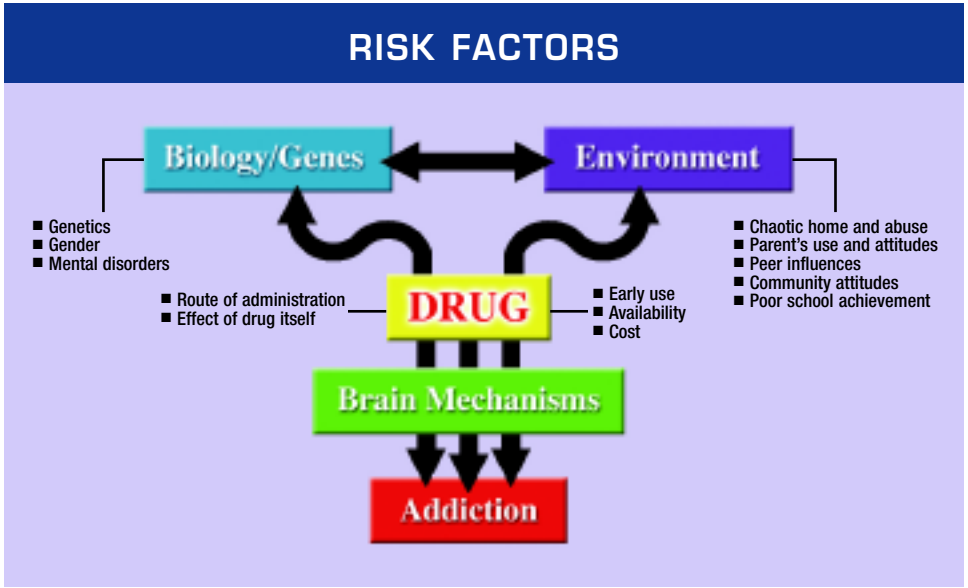
EXAMPLES OF RISK AND PROTECTIVE FACTORS

Risk Factors	Domain	Protective Factors
Early Aggressive Behavior	Individual	Self-Control
Poor Social Skills	Individual	Positive Relationships
Lack of Parental Supervision	Family	Parental Monitoring and Support
Substance Abuse	Peer	Academic Competence
Drug Availability	School	Anti-Drug Use Policies
Poverty	Community	Strong Neighborhood Attachment

No single factor determines whether a person will become addicted to drugs.

Why do some people become addicted to drugs, while others do not?

As with any other disease, vulnerability to addiction differs from person to person. In general, the more risk factors an individual has, the greater the chance that taking drugs will lead to abuse and addiction. "Protective" factors reduce a person's risk of developing addiction.



What factors determine if a person will become addicted?

No single factor determines whether a person will become addicted to drugs. The overall risk for addiction is impacted by the biological makeup of the individual—it can even be influenced by gender or ethnicity, his or her developmental stage, and the surrounding social environment (e.g., conditions at home, at school, and in the neighborhood).

Which biological factors increase risk of addiction?

Scientists estimate that genetic factors account for between 40 and 60 percent of a person's vulnerability to addiction, including the effects of environment on gene expression and function. Adolescents and individuals with mental disorders are at greater risk of drug abuse and addiction than the general population.

Children's earliest interactions within the family are crucial to their healthy development and risk for drug abuse.

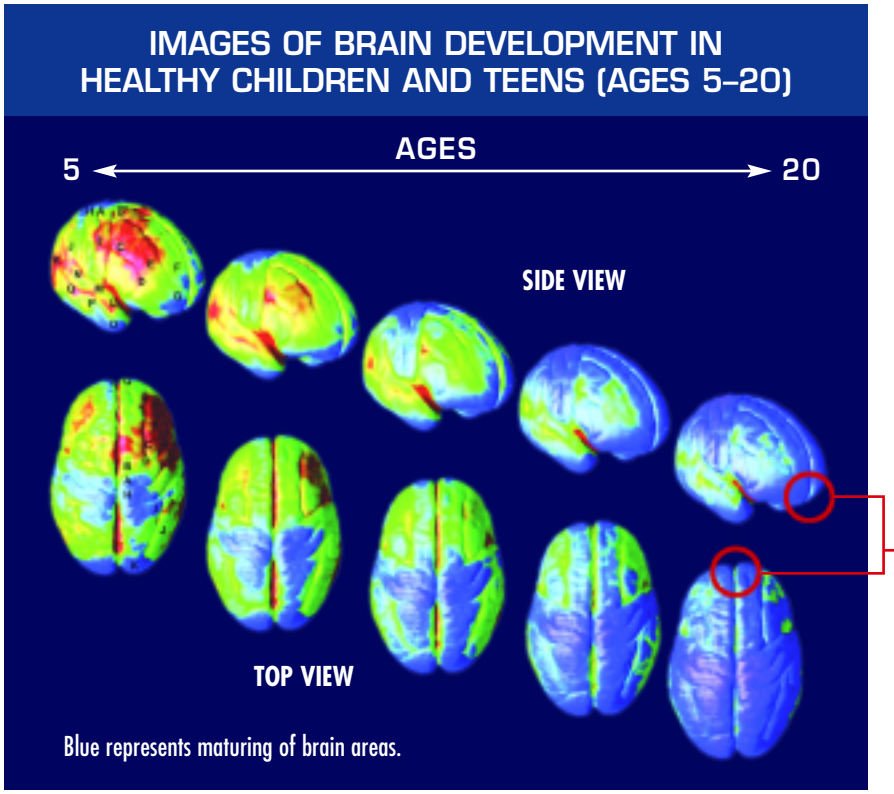
What environmental factors increase the risk of addiction?

- ***Home and Family.*** The influence of the home environment is usually most important in childhood. Parents or older family members who abuse alcohol or drugs or who engage in criminal behavior can increase children's risks of developing their own drug problems.
- ***Peer and School.*** Friends and acquaintances have the greatest influence during adolescence. Drug-abusing peers can sway even those without risk factors to try drugs for the first time. Academic failure or poor social skills can put a child further at risk for drug abuse.

What other factors increase the risk of addiction?

- ***Early Use.*** Although taking drugs at any age can lead to addiction, research shows that the earlier a person begins to use drugs the more likely they are to progress to more serious abuse. This may reflect the harmful effect that drugs can have on the developing brain; it also may result from a constellation of early biological and social vulnerability factors, including genetic susceptibility, mental illness, unstable family relationships, and exposure to physical or sexual abuse. Still, the fact remains that early use is a strong indicator of problems ahead, among them, substance abuse and addiction.
- ***Method of Administration.*** Smoking a drug or injecting it into a vein increases its addictive potential. Both smoked and injected drugs enter the brain within seconds, producing a powerful rush of pleasure. However, this intense "high" can fade within a few minutes, taking the abuser down to lower, more normal levels. It is a starkly felt contrast, and scientists believe that this low feeling drives individuals to repeated drug abuse in an attempt to recapture the high pleasurable state.

Addiction is a developmental disease—it typically begins in childhood or adolescence.



Source: PNAS 101:8174–8179, 2004.

The brain continues to develop into adulthood and undergoes dramatic changes during adolescence.

One of the brain areas still maturing during adolescence is the prefrontal cortex—the part of the brain that enables us to assess situations, make sound decisions, and keep our emotions and desires under control. The fact that this critical part of an adolescent's brain is still a work-in-progress puts them at increased risk for poor decisions (such as trying drugs or continued abuse). Also, introducing drugs while the brain is still developing may have profound and long-lasting consequences.

II. PREVENTING DRUG ABUSE: THE BEST STRATEGY

Why is adolescence a critical time for preventing drug addiction?

As noted previously, early use of drugs increases a person's chances of more serious drug abuse and addiction. Remember, drugs change brains—and this can lead to addiction and other serious problems. So preventing early use of drugs or alcohol may reduce the risk of progressing to later abuse and addiction.

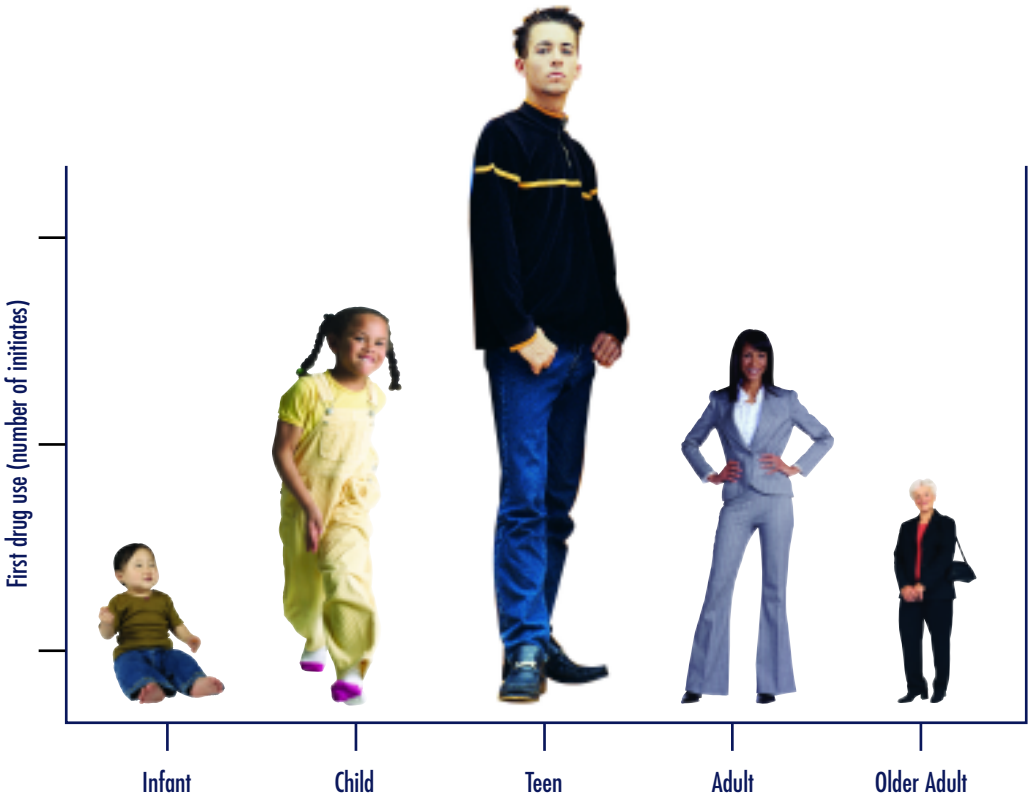
Risk of drug abuse increases greatly during times of transition, such as changing schools, moving, or divorce. If we can prevent drug abuse, we can prevent drug addiction. In early adolescence, when children advance from elementary through middle school, they face new and challenging social and academic situations. Often during this period, children are exposed to abusable substances such as cigarettes and alcohol for the first time. When they enter high school, teens may encounter greater availability of drugs, drug abuse by older teens, and social activities where drugs are used.

At the same time, many behaviors that are a normal aspect of their development, such as the desire to do something new or risky, may increase teen tendencies to experiment with drugs. Some teens may give in to the urging of drug-abusing friends to share the experience with them. Others may think that taking drugs (such as steroids) will improve their appearance or their athletic performance or that abusing substances such as alcohol or ecstasy (MDMA) will ease their anxiety in social situations.

Teens' still-developing judgment and decisionmaking skills may limit their ability to assess risks accurately and make sound decisions about using drugs. Drug and alcohol abuse can disrupt brain function in areas critical to motivation, memory, learning, judgment, and behavior control. So, it is not surprising that teens who abuse alcohol and other drugs often have family and school problems, poor academic performance, health-related problems (including mental health), and involvement with the juvenile justice system.

National drug use surveys indicate some children are already abusing drugs by age 12 or 13.

Drug abuse starts early and peaks in teen years



Can science-validated programs prevent drug addiction in youth?

Yes. The term "science-validated" means that these programs have been rationally designed based on current knowledge, rigorously tested, and shown to produce positive results. Scientists have developed a broad range of programs that positively alter the balance between risk and protective factors for drug abuse in families, schools, and communities. Research has shown that science-validated programs, such as those described in NIDA's *Preventing Drug Use among Children and Adolescents: A Research-Based Guide for Parents, Educators, and Community Leaders,* can significantly reduce early use of tobacco, alcohol, and illicit drugs.

How do science-validated prevention programs work?

These prevention programs work to boost protective factors and eliminate or reduce risk factors for drug use. The programs are designed for various ages and can be designed for individual or group settings, such as the school and home. There are three types of programs—

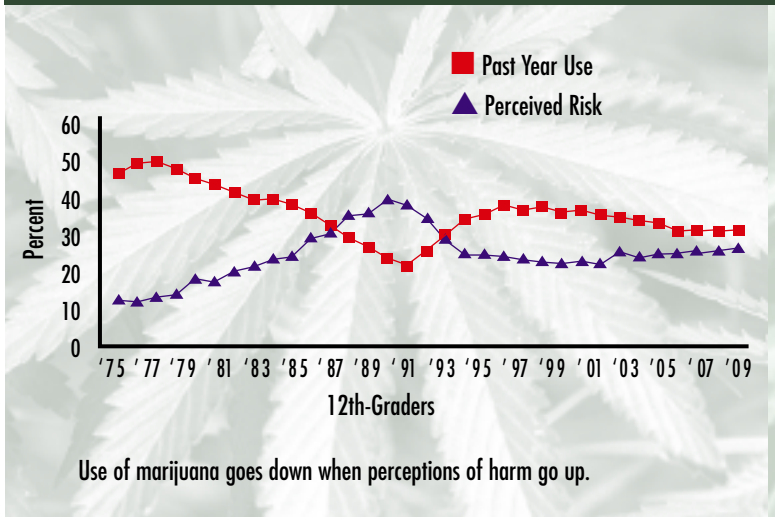
- ***Universal programs*** address risk and protective factors common to all children in a given setting, such as a school or community.
- ***Selective programs*** target groups of children and teens who have factors that further increase their risk of drug abuse.
- ***Indicated programs*** are designed for youth who have already begun abusing drugs.

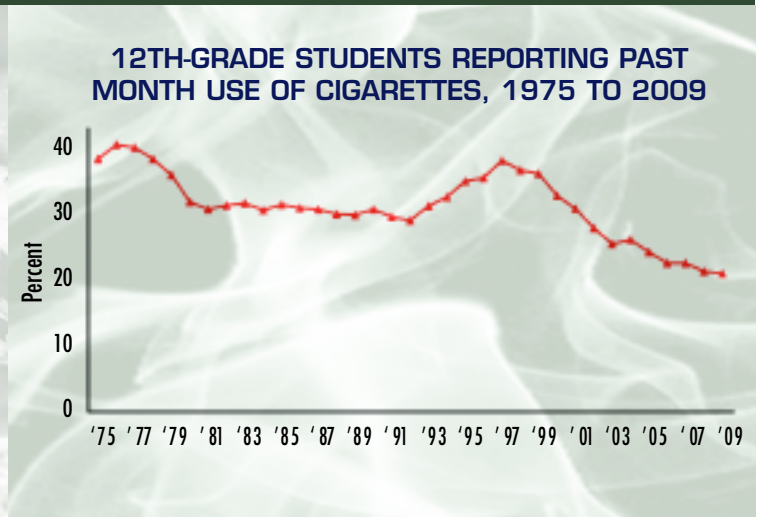
Are all prevention programs effective in reducing drug abuse?

When science-validated substance abuse prevention programs are properly implemented by schools and communities, alcohol, tobacco, and illicit drug abuse are reduced. Such programs help teachers, parents, and healthcare professionals shape youths' perceptions about the risks of drug abuse. While many events and cultural factors affect drug abuse trends, when youths perceive drug abuse as harmful, they reduce their level of abuse.

Drug use decreases when drugs are perceived as harmful.

PREVENTION IS THE BEST STRATEGY





Good news: Cigarette smoking is at its lowest point since NIDA began tracking it in 1975. But declines in illicit drug use, especially marijuana, have stalled in the past few years. Prevention efforts should be redoubled to counter this troubling trend.

Source: 2009 Monitoring the Future survey. University of Michigan, with funding from the National Institute on Drug Abuse.

For more information on prevention, see NIDA's most recent edition of *Preventing Drug Use among Children and Adolescents: A Research-Based Guide for Parents, Educators, and Community Leaders*, at www.drugabuse.gov/Prevention/Prevopen.html.

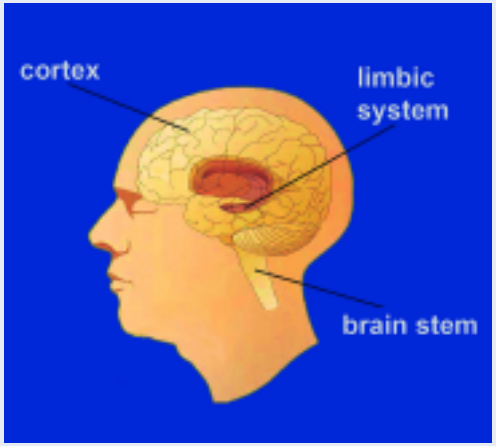
III. DRUGS AND THE BRAIN

Introducing the Human Brain

The human brain is the most complex organ in the body. This three-pound mass of gray and white matter sits at the center of all human activity—you need it to drive a car, to enjoy a meal, to breathe, to create an artistic masterpiece, and to enjoy everyday activities. In brief, the brain regulates your basic body functions; enables you to interpret and respond to everything you experience; and shapes your thoughts, emotions, and behavior.

The brain is made up of many parts that all work together as a team. Different parts of the brain are responsible for coordinating and performing specific functions. Drugs can alter important brain areas that are necessary for life-sustaining functions and can drive the compulsive drug abuse that marks addiction. Brain areas affected by drug abuse—

- ***The brain stem*** controls basic functions critical to life, such as heart rate, breathing, and sleeping.
- ***The limbic system*** contains the brain's reward circuit—it links together a number of brain structures that control and regulate our ability to feel pleasure. Feeling pleasure motivates us to repeat behaviors such as eating—actions that are critical to our existence. The limbic system is activated when we perform these activities—and also by drugs of abuse. In addition, the limbic system is responsible for our perception of other emotions, both positive and negative, which explains the mood-altering properties of many drugs.
- ***The cerebral cortex*** is divided into areas that control specific functions. Different areas process information from our senses, enabling us to see, feel, hear, and taste. The front part of the cortex, the frontal cortex or forebrain, is the thinking center of the brain; it powers our ability to think, plan, solve problems, and make decisions.



How does the brain communicate?

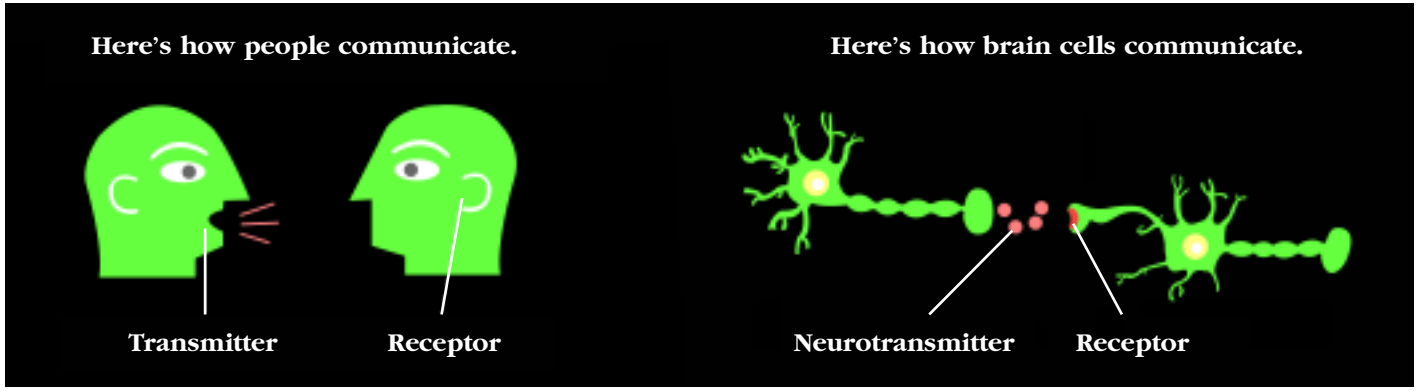
The brain is a communications center consisting of billions of neurons, or nerve cells. Networks of neurons pass messages back and forth to different structures within the brain, the spinal column, and the peripheral nervous system. These nerve networks coordinate and regulate everything we feel, think, and do.

- ***Neuron to Neuron***
  Each nerve cell in the brain sends and receives messages in the form of electrical impulses. Once a cell receives and processes a message, it sends it on to other neurons.

- ***Neurotransmitters—The Brain's Chemical Messengers***
  The messages are carried between neurons by chemicals called neurotransmitters. (They transmit messages between neurons.)

- ***Receptors—The Brain's Chemical Receivers***
  The neurotransmitter attaches to a specialized site on the receiving cell called a receptor. A neurotransmitter and its receptor operate like a "key and lock," an exquisitely specific mechanism that ensures that each receptor will forward the appropriate message only after interacting with the right kind of neurotransmitter.

- ***Transporters—The Brain's Chemical Recyclers***
  Located on the cell that releases the neurotransmitter, transporters recycle these neurotransmitters (i.e., bring them back into the cell that released them), thereby shutting off the signal between neurons.



To send a message a brain cell releases a chemical (neurotransmitter) into the space separating two cells called the synapse. The neurotransmitter crosses the synapse and attaches to proteins (receptors) on the receiving brain cell. This causes changes in the receiving brain cell and the message is delivered.

Concept courtesy: B.K. Madras

Most drugs of abuse target the brain's reward system by flooding the circuit with dopamine.

How do drugs work in the brain?

Drugs are chemicals. They work in the brain by tapping into the brain's communication system and interfering with the way nerve cells normally send, receive, and process information. Some drugs, such as marijuana and heroin, can activate neurons because their chemical structure mimics that of a natural neurotransmitter. This similarity in structure "fools" receptors and allows the drugs to lock onto and activate the nerve cells. Although these drugs mimic brain chemicals, they don't activate nerve cells in the same way as a natural neurotransmitter, and they lead to abnormal messages being transmitted through the network.

Other drugs, such as amphetamine or cocaine, can cause the nerve cells to release abnormally large amounts of natural neurotransmitters or prevent the normal recycling of these brain chemicals. This disruption produces a greatly amplified message, ultimately disrupting communication channels. The difference in effect can be described as the difference between someone whispering into your ear and someone shouting into a microphone.

How do drugs work in the brain to produce pleasure?

Most drugs of abuse directly or indirectly target the brain's reward system by flooding the circuit with dopamine. Dopamine is a neurotransmitter present in regions of the brain that regulate movement, emotion, cognition, motivation, and feelings of pleasure. The overstimulation of this system, which rewards our natural behaviors, produces the euphoric effects sought by people who abuse drugs and teaches them to repeat the behavior.

How does stimulation of the brain's pleasure circuit teach us to keep taking drugs?

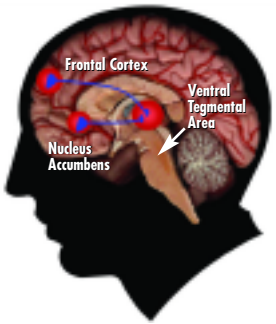
Our brains are wired to ensure that we will repeat life-sustaining activities by associating those activities with pleasure or reward. Whenever this reward circuit is activated, the brain notes that something important is happening that needs to be remembered, and teaches us to do it again and again, without thinking about it. Because drugs of abuse stimulate the same circuit, we learn to abuse drugs in the same way.

Why are drugs more addictive than natural rewards?

When some drugs of abuse are taken, they can release 2 to 10 times the amount of dopamine that natural rewards do. In some cases, this occurs almost immediately (as when drugs are smoked or injected), and the effects can last much longer than those produced by natural rewards. The resulting effects on the brain's pleasure circuit dwarfs those produced by naturally rewarding behaviors such as eating and sex. The effect of such a powerful reward strongly motivates people to take drugs again and again. This is why scientists sometimes say that drug abuse is something we learn to do very, very well.

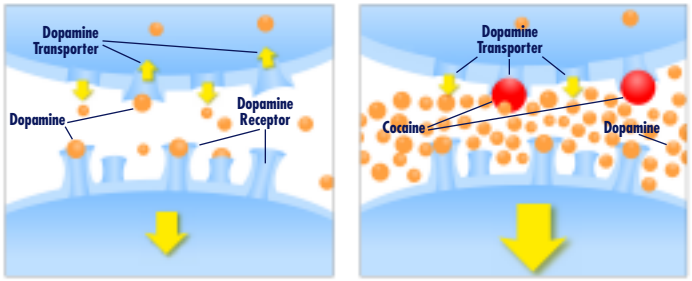
DRUGS OF ABUSE TARGET THE BRAIN'S PLEASURE CENTER

Brain reward (dopamine) pathways



These brain circuits are important for natural rewards such as food, music, and sex.

Drugs of abuse increase dopamine



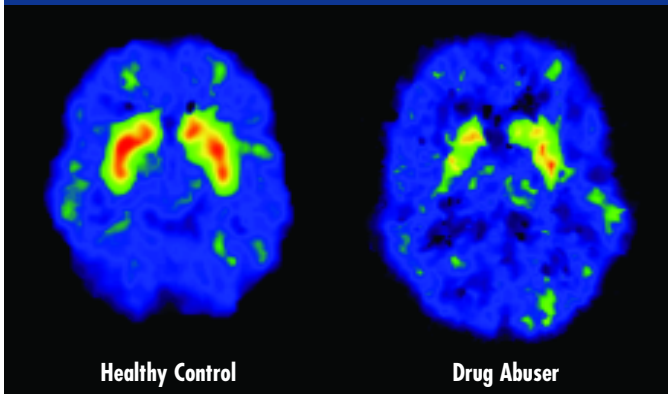
Typically, dopamine increases in response to natural rewards such as food.
When cocaine is taken, dopamine increases are exaggerated, and communication is altered.

Long-term drug abuse impairs brain functioning.

What happens to your brain if you keep taking drugs?

Just as we turn down the volume on a radio that is too loud, the brain adjusts to the overwhelming surges in dopamine (and other neurotransmitters) by producing less dopamine or by reducing the number of receptors that can receive signals. As a result, dopamine's impact on the reward circuit of a drug abuser's brain can become abnormally low, and the ability to experience any pleasure is reduced. This is why the abuser eventually feels flat, lifeless, and depressed, and is unable to enjoy things that previously brought them pleasure. Now, they need to take drugs just to try and bring their dopamine function back up to normal. And, they must take larger amounts of the drug than they first did to create the dopamine high—an effect known as tolerance.

DECREASED DOPAMINE TRANSPORTERS IN A METHAMPHETAMINE ABUSER



Methamphetamine abusers have significant reductions in dopamine transporters.
Source: Am J Psychiatry 158:377–382, 2001.

How does long-term drug taking affect brain circuits?

We know that the same sort of mechanisms involved in the development of tolerance can eventually lead to profound changes in neurons and brain circuits, with the potential to severely compromise the long-term health of the brain. For example, glutamate is another neurotransmitter that influences the reward circuit and the ability to learn. When the optimal concentration of glutamate is altered by drug abuse, the brain attempts to compensate for this change, which can cause impairment in cognitive function. Similarly, long-term drug abuse can trigger

adaptations in habit or nonconscious memory systems. Conditioning is one example of this type of learning, whereby environmental cues become associated with the drug experience and can trigger uncontrollable cravings if the individual is later exposed to these cues, even without the drug itself being available. This learned "reflex" is extremely robust and can emerge even after many years of abstinence.

What other brain changes occur with abuse?

Chronic exposure to drugs of abuse disrupts the way critical brain structures interact to control and inhibit behaviors related to drug abuse. Just as continued abuse may lead to tolerance or the need for higher drug dosages to produce an effect, it may also lead to addiction, which can drive an abuser to seek out and take drugs compulsively. Drug addiction erodes a person's self-control and ability to make sound decisions, while sending intense impulses to take drugs.

For more information on drugs and the brain, order NIDA's Teaching Packets CD-ROM series or the Mind Over Matter series at www.drugabuse.gov/parent-teacher.html. These items and others are available to the public free of charge.

IV. ADDICTION AND HEALTH

What are the medical consequences of drug addiction?

Individuals who suffer from addiction often have one or more accompanying medical issues, including lung and cardiovascular disease, stroke, cancer, and mental disorders. Imaging scans, chest X-rays, and blood tests show the damaging effects of drug abuse throughout the body. For example, tests show that tobacco smoke causes cancer of the mouth, throat, larynx, blood, lungs, stomach, pancreas, kidney, bladder, and cervix. In addition, some drugs of abuse, such as inhalants, are toxic to nerve cells and may damage or destroy them either in the brain or the peripheral nervous system.

THE IMPACT OF ADDICTION CAN BE FAR REACHING

- Cardiovascular disease
- Stroke
- Cancer
- HIV/AIDS
- Hepatitis B and C
- Lung disease
- Mental disorders

Does drug abuse cause mental disorders, or vice versa?

Drug abuse and mental disorders often co-exist. In some cases, mental diseases may precede addiction; in other cases, drug abuse may trigger or exacerbate mental disorders, particularly in individuals with specific vulnerabilities.

Drug abuse and HIV/AIDS are intertwined epidemics.

How can addiction harm other people?

Beyond the harmful consequences for the addicted individual, drug abuse can cause serious health problems for others. Three of the more devastating and troubling consequences of addiction are:

- ***Negative effects of prenatal drug exposure on infants and children.***
  It is likely that some drug-exposed children will need educational support in the classroom to help them overcome what may be subtle deficits in developmental areas such as behavior, attention, and cognition. Ongoing work is investigating whether the effects of prenatal exposure on brain and behavior extend into adolescence to cause developmental problems during that time period.
- ***Negative effects of second-hand smoke.***
  Second-hand tobacco smoke, also referred to as environmental tobacco smoke (ETS), is a significant source of exposure to a large number of substances known to be hazardous to human health, particularly to children. According to the Surgeon General's 2006 Report, *The Health Consequences of Involuntary Exposure to Tobacco Smoke*, involuntary smoking increases the risk of heart disease and lung cancer in never-smokers by 25–30 percent and 20–30 percent, respectively.
- ***Increased spread of infectious diseases.***
  Injection of drugs such as heroin, cocaine, and methamphetamine accounts for more than a third of new AIDS cases. Injection drug use is also a major factor in the spread of hepatitis C, a serious, potentially fatal liver disease. Injection drug use is not the only way that drug abuse contributes to the spread of infectious diseases. All drugs of abuse cause some form of intoxication, which interferes with judgment and increases the likelihood of risky sexual behaviors. This, in turn, contributes to the spread of HIV/AIDS, hepatitis B and C, and other sexually transmitted diseases.

4 OUT OF 10 U.S. AIDS DEATHS ARE RELATED TO DRUG ABUSE

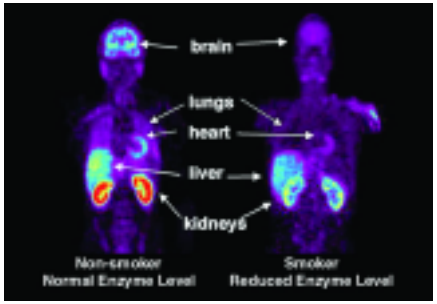
Tobacco use is responsible for an estimated 5 million deaths worldwide each year.

What are some effects of specific abused substances?

- ***Nicotine*** is an addictive stimulant found in cigarettes and other forms of tobacco. Tobacco smoke increases a user's risk of cancer, emphysema, bronchial disorders, and cardiovascular disease. The mortality rate associated with tobacco addiction is staggering. Tobacco use killed approximately 100 million people during the 20th century and, if current smoking trends continue, the cumulative death toll for this century has been projected to reach 1 billion.
- ***Alcohol*** consumption can damage the brain and most body organs. Areas of the brain that are especially vulnerable to alcohol-related damage are the cerebral cortex (largely responsible for our higher brain functions, including problemsolving and decisionmaking), the hippocampus (important for memory and learning), and the cerebellum (important for movement coordination).
- ***Marijuana*** is the most commonly abused illicit substance. This drug impairs short-term memory and learning, the ability to focus attention, and coordination. It also increases heart rate, can harm the lungs, and can increase the risk of psychosis in those with an underlying vulnerability.

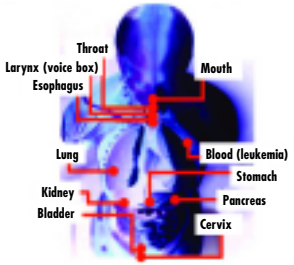
TOBACCO SMOKE AFFECTS THE WHOLE BODY

Monoamine Oxidase B



Source: PNAS 100:11600–11605, 2003.

Smoking causes cancer throughout the body.



Source: The Health Consequences of Smoking: A Report of the Surgeon General. 2004.

- ***Inhalants*** are volatile substances found in many household products, such as oven cleaners, gasoline, spray paints, and other aerosols, that induce mind-altering effects. Inhalants are extremely toxic and can damage the heart, kidneys, lungs, and brain. Even a healthy person can suffer heart failure and death within minutes of a single session of prolonged sniffing of an inhalant.
- ***Cocaine*** is a short-acting stimulant, which can lead abusers to "binge" (to take the drug many times in a single session). Cocaine abuse can lead to severe medical consequences related to the heart and the respiratory, nervous, and digestive systems.

Nearly 1 in 10 high school seniors report nonmedical use of the prescription pain reliever Vicodin.

- ***Amphetamines,*** including methamphetamine, are powerful stimulants that can produce feelings of euphoria and alertness. Methamphetamine's effects are particularly long-lasting and harmful to the brain. Amphetamines can cause high body temperature and can lead to serious heart problems and seizures.
- ***Ecstasy (MDMA)*** produces both stimulant and mind-altering effects. It can increase body temperature, heart rate, blood pressure, and heart wall stress. Ecstasy may also be toxic to nerve cells.
- ***LSD*** is one of the most potent hallucinogenic, or perception-altering, drugs. Its effects are unpredictable, and abusers may see vivid colors and images, hear sounds, and feel sensations that seem real but do not exist. Abusers also may have traumatic experiences and emotions that can last for many hours. Some short-term effects can include increased body temperature, heart rate, and blood pressure; sweating; loss of appetite; sleeplessness; dry mouth; and tremors.
- ***Heroin*** is a powerful opiate drug that produces euphoria and feelings of relaxation. It slows respiration and its use is linked to an increased risk of serious infectious diseases, especially when taken intravenously. Other opioid drugs include morphine, OxyContin, and Vicodin, which have legitimate medical uses; however, their nonmedical use or abuse can result in the same harmful consequences as abusing heroin.
- ***Prescription medications*** are increasingly being abused or used for nonmedical purposes. This practice cannot only be addictive, but in some cases also lethal. Commonly abused classes of prescription drugs include painkillers, sedatives, and stimulants. Among the most disturbing aspects of this emerging trend is its prevalence among teenagers and young adults, and the common misperception that because these medications are prescribed by physicians, they are safe even when used illicitly.

- ***Steroids,*** which can also be prescribed for certain medical conditions, are abused to increase muscle mass and to improve athletic performance or physical appearance. Serious consequences of abuse can include severe acne, heart disease, liver problems, stroke, infectious diseases, depression, and suicide.
- ***Drug combinations.*** A particularly dangerous and not uncommon practice is the combining of two or more drugs. The practice ranges from the co-administration of legal drugs, like alcohol and nicotine, to the dangerous random mixing of prescription drugs, to the deadly combination of heroin or cocaine with fentanyl (an opioid pain medication). Whatever the context, it is critical to realize that because of drug–drug interactions, such practices often pose significantly higher risks than the already harmful individual drugs.

For more information on the nature and extent of common drugs of abuse and their health consequences, go to NIDA's Web site (www.drugabuse.gov) to order free copies of the popular *Research Reports* (www.drugabuse.gov/ResearchReports/ResearchIndex.html), *InfoFacts,* and other publications.

V. TREATMENT AND RECOVERY

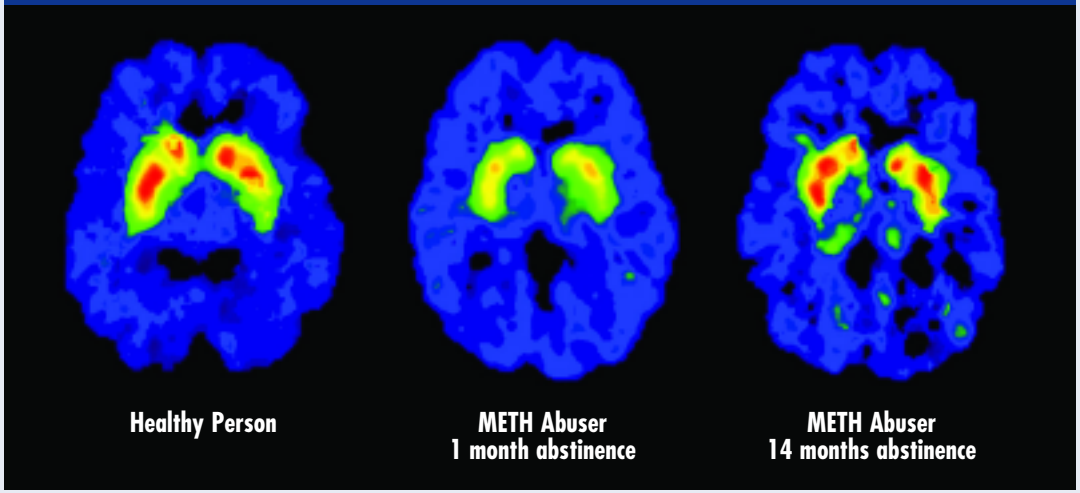
Can addiction be treated successfully?

YES. Addiction is a treatable disease. Discoveries in the science of addiction have led to advances in drug abuse treatment that help people stop abusing drugs and resume their productive lives.

Can addiction be cured?

Addiction need not be a life sentence. Like other chronic diseases, addiction can be managed successfully. Treatment enables people to counteract addiction's powerful disruptive effects on brain and behavior and regain control of their lives.

BRAIN RECOVERY WITH PROLONGED ABSTINENCE



These images of the dopamine transporter show the brain's remarkable potential to recover, at least partially, after a long abstinence from drugs—in this case, methamphetamine.

Source: J Neurosci 21:9414–9418, 2001.

Addiction need not be a life sentence.

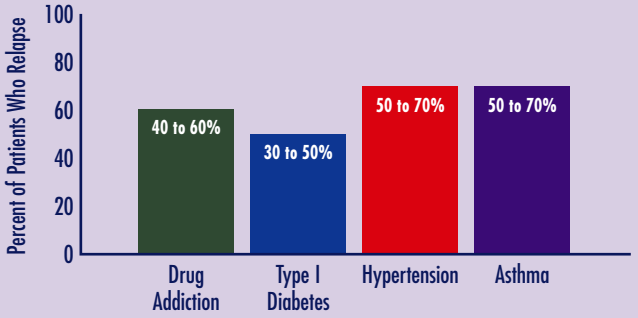
Does relapse to drug abuse mean treatment has failed?

No. The chronic nature of the disease means that relapsing to drug abuse is not only possible, but likely. Relapse rates (i.e., how often symptoms recur) for drug addiction are similar to those for other well-characterized chronic medical illnesses such as diabetes, hypertension, and asthma, which also have both physiological and behavioral components. Treatment of chronic diseases involves changing deeply imbedded behaviors, and relapse does not mean treatment failure. For the addicted patient, lapses back to drug abuse indicate that treatment needs to be reinstated or adjusted, or that alternate treatment is needed.

What are the principles of effective addiction treatment?

Research shows that combining treatment medications, where available, with behavioral therapy is the best way to ensure success for most patients. Treatment approaches must be tailored to address each patient's drug abuse patterns and drug-related medical, psychiatric, and social problems.

COMPARISON OF RELAPSE RATES BETWEEN DRUG ADDICTION AND OTHER CHRONIC ILLNESSES



Relapse rates for drug-addicted patients are compared with those suffering from diabetes, hypertension, and asthma. Relapse is common and similar across these illnesses (as is adherence to medication). Thus, drug addiction should be treated like any other chronic illness, with relapse serving as a trigger for renewed intervention.

Source: JAMA 284:1689–1695, 2000.

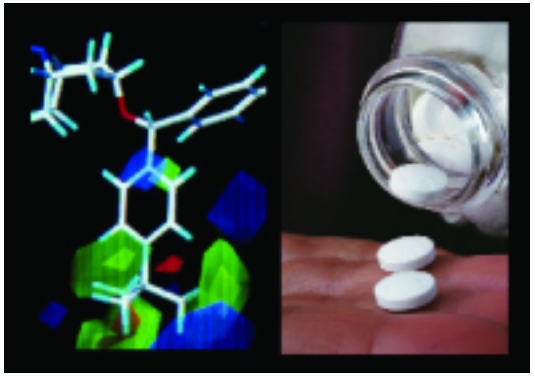
How can medications help treat drug addiction?

Different types of medications may be useful at different stages of treatment to help a patient stop abusing drugs, stay in treatment, and avoid relapse.

- ***Treating Withdrawal.*** When patients first stop abusing drugs, they can experience a variety of physical and emotional symptoms, including depression, anxiety, and other mood disorders; restlessness;

and sleeplessness. Certain treatment medications are designed to reduce these symptoms, which makes it easier to stop the abuse.

- ***Staying in Treatment.*** Some treatment medications are used to help the brain adapt gradually to the absence of the abused drug. These medications act slowly to stave off drug cravings, and have a calming effect on body systems. They can help patients focus on counseling and other psychotherapies related to their drug treatment.



Discoveries in science lead to advances in drug abuse treatment.

- ***Preventing Relapse.*** Science has taught us that stress, cues linked to the drug experience (e.g., people, places, things, moods), and exposure to drugs are the most common triggers for relapse. Medications are being developed to interfere with these triggers to help patients sustain recovery.

How do behavioral therapies treat drug addiction?

Behavioral treatments help engage people in drug abuse treatment, modifying their attitudes and behaviors related to drug abuse and increasing their life skills to handle stressful circumstances and environmental cues that may trigger intense craving for drugs and prompt another cycle of compulsive abuse. Moreover, behavioral therapies can enhance the effectiveness of medications and help people remain in treatment longer.

MEDICATIONS USED TO TREAT DRUG ADDICTION

- **Tobacco Addiction**
  - **Nicotine replacement therapies** (e.g., patch, inhaler, gum)
  - **Bupropion**
  - **Varenicline**
- **Opioid Addiction**
  - **Methadone**
  - **Buprenorphine**
  - **Naltrexone**
- **Alcohol and Drug Addiction**
  - **Naltrexone**
  - **Disulfiram**
  - **Acamprosate**

Treatment must address the whole person.

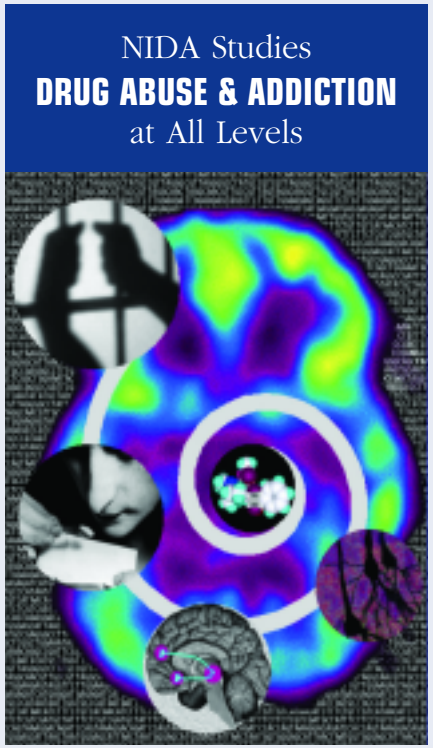
- ***Cognitive Behavioral Therapy.*** Seeks to help patients recognize, avoid, and cope with the situations in which they are most likely to abuse drugs.
- ***Motivational Incentives.*** Uses positive reinforcement such as providing rewards or privileges for remaining drug free, for attending and participating in counseling sessions, or for taking treatment medications as prescribed.
- ***Motivational Interviewing.*** Employs strategies to evoke rapid and internally motivated behavior change to stop drug use and facilitate treatment entry.
- ***Group Therapy.*** Helps patients face their drug abuse realistically, come to terms with its harmful consequences, and boost their motivation to stay drug free. Patients learn effective ways to solve their emotional and interpersonal problems without resorting to drugs.

How do the best treatment programs help patients recover from the pervasive effects of addiction?

Getting an addicted person to stop abusing drugs is just one part of a long and complex recovery process. When people enter treatment, addiction has often taken over their lives. The compulsion to get drugs, take drugs, and experience the effects of drugs has dominated their every waking moment, and drug abuse has taken the place of all the things they used to enjoy doing. It has disrupted how they function in their family lives, at work, and in the community, and has made them more likely to suffer from other serious illnesses. Because addiction can affect so many aspects of a person's life, treatment must address the needs of the whole person to be successful. This is why the best programs incorporate a variety of rehabilitative services into their comprehensive treatment regimens. Treatment counselors select from a menu of services for meeting the individual medical, psychological, social, vocational, and legal needs of their patients to foster their recovery from addiction.

For more information on drug treatment, see *Principles of Drug Addiction Treatment: A Research-Based Guide* (www.drugabuse.gov/PODAT/PODATIndex.html).

VI. ADVANCING ADDICTION SCIENCE AND PRACTICAL SOLUTIONS



Leading the Search for Scientific Solutions

To address all aspects of drug abuse and its harmful consequences, NIDA's research program ranges from basic studies of the addicted brain and behavior to health services research. NIDA's research program develops prevention and treatment approaches and ensures they work in real-world settings. In this context, NIDA is strongly committed to developing a research portfolio that addresses the special vulnerabilities and health disparities that exist among ethnic minorities or that derive from gender differences.

Bringing Science to Real-World Settings

- ***National Drug Abuse Treatment Clinical Trials Network (CTN).*** The CTN "road tests" research-based drug abuse treatments in community treatment programs around the country.
- ***Criminal Justice Drug Abuse Treatment Studies (CJ-DATS).*** Led by NIDA, CJ-DATS is a network of research centers, in partnership with criminal justice professionals, drug abuse treatment providers, and Federal agencies responsible for developing integrated treatment approaches for criminal justice offenders and testing them at multiple sites throughout the Nation.

Sharing Free Information With the Public

NIDA further increases the impact of its research on the problems of addiction by sharing free information about its findings with professional audiences and the general public. Special initiatives target students and teachers, designated populations, and ethnic groups.

NIDA's Special Initiatives for Students, Teachers, and Parents

NIDA Goes Back to School—Targets grade school, middle school, and high school students and teachers.
www.backtoschool.drugabuse.gov

Heads Up: Real News About Drugs and Your Body—A drug education series created by NIDA and SCHOLASTIC INC. for students in grades 6 to 12.
www.teacher.scholastic.com/scholasticnews/indepth/headsup

NIDA for Teens: The Science Behind Drug Abuse—An interactive Web site geared specifically for teens, with age-appropriate facts on drugs.
www.teens.drugabuse.gov

Drug Facts Chat Day—A Web chat between NIDA scientists and teens, held through school computer labs once a year.
www.drugabuse.gov/chat

National Drug Facts Week—A week-long observance that encourages community-based events between teens and scientists.
www.drugfactsweek.drugabuse.gov/

Publications on Prevention and Treatment Principles

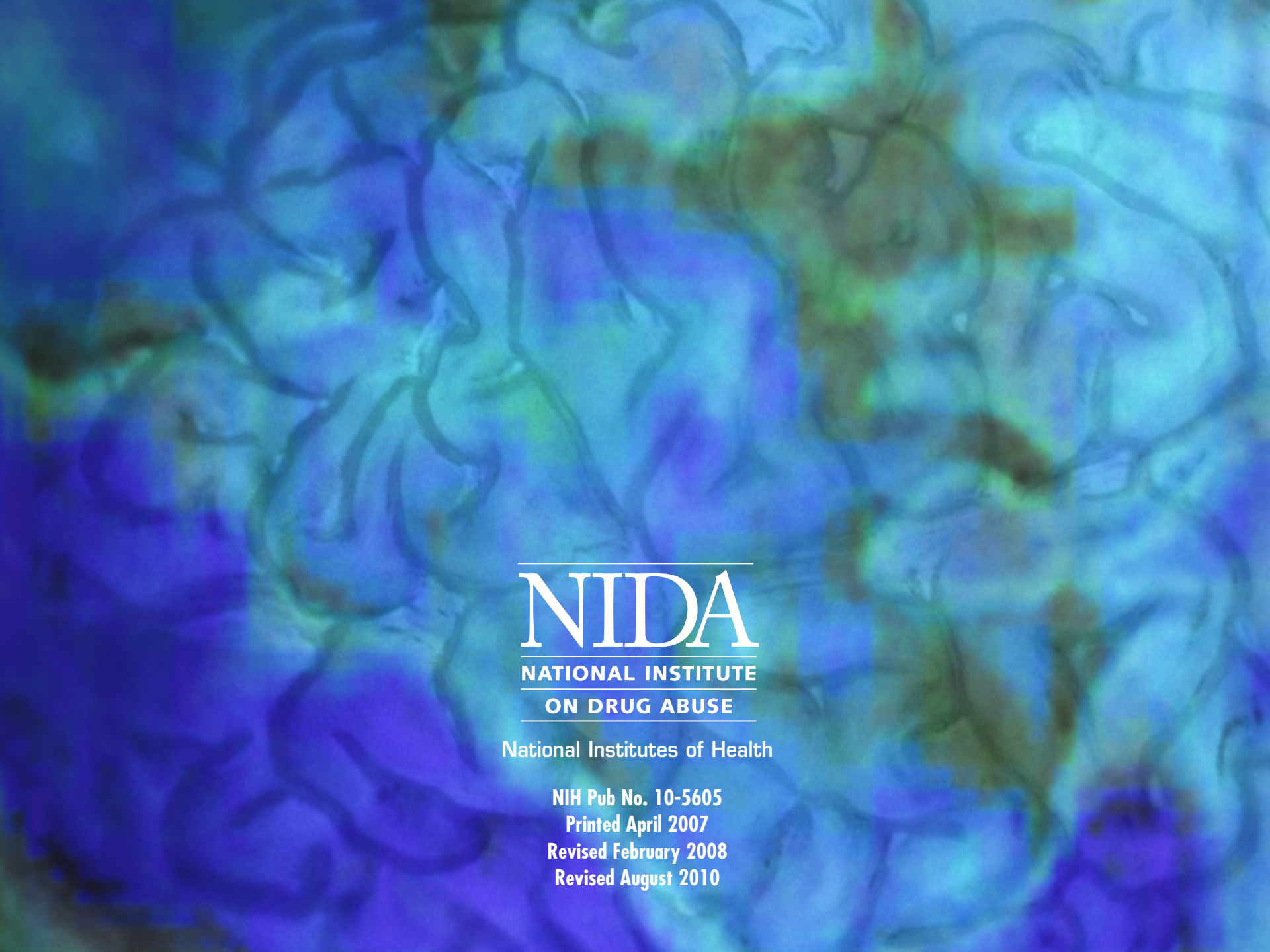
Preventing Drug Use among Children and Adolescents: A Research-Based Guide—NIDA's research-based guide for preventing drug abuse among children and adolescents provides 16 principles derived from effective drug abuse prevention research, and includes answers to questions on risk and protective factors, as well as community planning and implementation.

Principles of Drug Addiction Treatment: A Research-Based Guide—This guide summarizes the 13 principles of effective treatment, answers common questions, and describes types of treatment, providing examples of scientifically based and tested treatment components.

Principles of Drug Abuse Treatment for Criminal Justice Populations: A Research-Based Guide—NIDA's research-based guide for treating drug abusers involved with the criminal justice system provides 13 essential treatment principles, and includes answers to frequently asked questions and resource information.

For more information:
NIDA's publications are available free of charge and are downloadable from the NIDA Web site (**www.drugabuse.gov**). The NIDA site also contains additional research-based information about drugs, drug abuse, and addiction. You can also order NIDA's materials by calling the NIDA DRUG*Pubs* Research Dissemination Center at 877-643-2644.

www.drugabuse.gov



NIDA

NATIONAL INSTITUTE ON DRUG ABUSE

National Institutes of Health

NIH Pub No. 10-5605
Printed April 2007
Revised February 2008
Revised August 2010