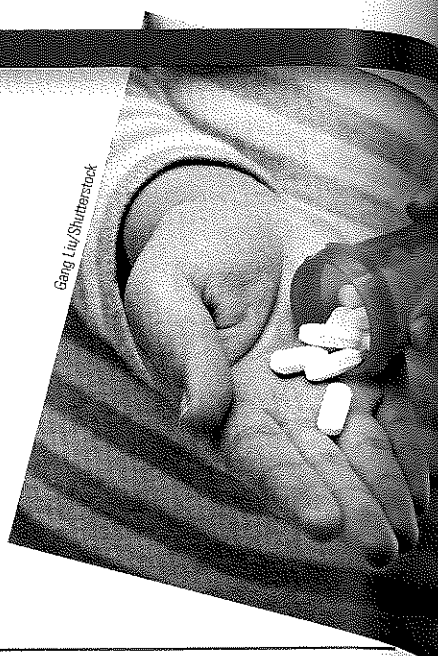


Module 25

Psychoactive Drugs

Module Learning Objectives

- 25-1** Define substance use disorders, and explain the roles of tolerance, withdrawal, and addiction.
- 25-2** Identify the depressants, and describe their effects.
- 25-3** Identify the stimulants, and describe their effects.
- 25-4** Identify the hallucinogens, and describe their effects.



Let's imagine a day in the life of a legal-drug-using business executive. It begins with a wake-up latte. By midday, several cigarettes have calmed frazzled nerves before an appointment at the plastic surgeon's office for wrinkle-smoothing Botox injections. A diet pill before dinner helps stem the appetite, and its stimulating effects can later be partially offset with a glass of wine and two Tylenol PMs. And if performance needs enhancing, there are beta blockers for onstage performers, Viagra for middle-aged men, hormone-delivering "libido patches" for middle-aged women, and Adderall for those hoping to focus their concentration. Before drifting off into REM-depressed sleep, our hypothetical drug user is dismayed by news reports of pill-sharing, pill-popping students.

Tolerance and Addiction

25-1 What are substance use disorders, and what role do tolerance, withdrawal, and addiction play in these disorders?

Most of us manage to use some nonprescription drugs in moderation and without disrupting our lives. But some of us develop a self-harming **substance use disorder** (TABLE 25.1). In such cases, the substances being used are **psychoactive drugs**, chemicals that change perceptions and moods. A drug's overall effect depends not only on its biological effects but also on the psychology of the user's expectations, which vary with social and cultural contexts (Ward, 1994). If one culture assumes that a particular drug produces euphoria (or aggression or sexual arousal) and another does not, each culture may find its expectations fulfilled. In Module 81, we'll take a closer look at these interacting forces in the use and potential abuse of particular psychoactive drugs. But here let's consider how our bodies react to the ongoing use of psychoactive drugs.

Why might a person who rarely drinks alcohol get buzzed on one can of beer while a long-term drinker shows few effects until the second six-pack? The answer is **tolerance**. With continued use of alcohol and some other drugs (marijuana is an exception), the user's brain chemistry adapts to offset the drug effect (a process called *neuroadaptation*). To experience the

substance use disorder continued substance craving and use despite significant life disruption and/or physical risk.

psychoactive drug a chemical substance that alters perceptions and moods.

tolerance the diminishing effect with regular use of the same dose of a drug, requiring the user to take larger and larger doses before experiencing the drug's effect.

Table 25.1 When Is Drug Use a Disorder?

A person may be diagnosed with *substance use disorder* when drug use continues despite significant life disruption. Resulting changes in brain circuits may persist after quitting use of the substance (thus leading to strong cravings when exposed to people and situations that trigger memories of drug use). The severity of substance use disorder varies from *mild* (two to three symptoms) to *moderate* (four to five symptoms) to *severe* (six or more symptoms) (American Psychiatric Association, 2013).

Impaired Control

1. Uses more substance, or for longer, than intended.
2. Tries unsuccessfully to regulate substance use.
3. Spends much time gaining, using, or recovering from substance use.
4. Craves the substance.

Social Impairment

5. Use disrupts obligations at work, school, or home.
6. Continues use despite social problems.
7. Use causes reduced social, recreational, and work activities.

Risky Use

8. Continues use despite hazards.
9. Continues use despite worsening physical or psychological problems.

Drug Action

10. Experiences tolerance (needing more substance for the desired effect).
11. Experiences withdrawal when attempting to end use.

same effect, the user requires larger and larger doses (FIGURE 25.1). In chronic alcohol abuse, for example, the person's brain, heart, and liver suffer damage from the excessive amounts of alcohol being "tolerated." Ever-increasing doses of most psychoactive drugs can pose a serious threat to health and may lead to **addiction**: The person craves and uses the substance despite its adverse consequences. (See Thinking Critically About: Addiction on the next page.) The World Health Organization (2008) has reported that, worldwide, 90 million people suffer from such problems related to alcohol and other drugs. Regular users often try to fight their addiction, but abruptly stopping the drug may lead to the undesirable side effects of **withdrawal**.

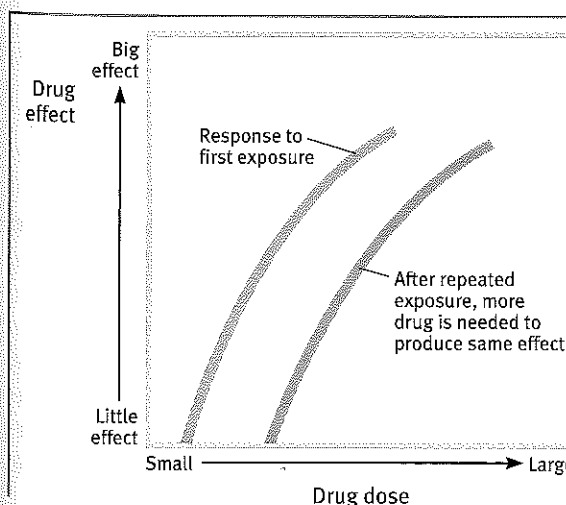


Figure 25.1

Drug tolerance With repeated exposure to a psychoactive drug, the drug's effect lessens. Thus, it takes larger doses to get the desired effect.

FYI

The odds of getting hooked after using various drugs:

Tobacco	32%
Heroin	23%
Alcohol	15%
Marijuana	9%

Source: National Academy of Science, Institute of Medicine (Brody, 2003).

addiction compulsive craving of drugs or certain behaviors (such as gambling) despite known adverse consequences.

withdrawal the discomfort and distress that follow discontinuing an addictive drug or behavior.

Thinking Critically About

Addiction

In recent years, the concept of addiction has been extended to cover many behaviors formerly considered bad habits or even sins. Psychologists debate whether the concept has been stretched too far, and whether addictions are really as irresistible as commonly believed. For example, “even for a very addictive drug like cocaine, only 15 to 16 percent of people become addicted within 10 years of first use,” observed Terry Robinson and Kent Berridge (2003).

Addictions can be powerful, and many addicts do benefit from therapy or group support. Alcoholics Anonymous has supported millions of people in overcoming their alcohol addiction. But viewing addiction as an uncontrollable disease can undermine people’s self-confidence and their belief that they can change. And that, critics say, would be unfortunate, for many people do voluntarily stop using addictive drugs, without any treatment. Most ex-smokers, for example, have kicked the habit on their own.

The addiction-as-disease-needing-treatment idea has been offered for a host of driven, excessive behaviors—eating, shopping, gambling, work, and sex. However, critics suggest that “addiction” can become an all-purpose excuse when used not as a metaphor (“I’m a science fiction addict”) but as reality. Moreover, they note that labeling a behavior doesn’t explain it. Attributing serial adultery, as in the case of Tiger Woods, to a “sex addiction” does not explain the sexual impulsiveness (Radford, 2010).

Sometimes, though, behaviors such as gambling, video gaming, or online surfing do become compulsive and dysfunctional,

Our connected world...



A social networking addiction?

much like abusive drug taking (Gentile, 2009; Griffiths, 2001; Hoeft et al., 2008). Thus, psychiatry’s manual of disorders now includes behavior addictions such as “gambling disorder” and proposes “Internet gaming disorder” for further study (American Psychiatric Association, 2013). Some Internet users, for example, display an apparent inability to resist logging on, and staying on, even when this excessive use impairs their work and relationships (Ko et al., 2005). Stay tuned. Debates over the nature of addiction continue.

Types of Psychoactive Drugs

The three major categories of psychoactive drugs are *depressants*, *stimulants*, and *hallucinogens*. All do their work at the brain’s synapses, inhibiting, stimulating, or mimicking the activity of the brain’s own chemical messengers, the neurotransmitters.

Depressants

25-2 What are depressants, and what are their effects?

Depressants are drugs such as alcohol, barbiturates (tranquilizers), and opiates that calm neural activity and slow body functions.

ALCOHOL

True or false? In small amounts, alcohol is a stimulant. *False*. Low doses of alcohol may, indeed, enliven a drinker, but they do so by acting as a *disinhibitor*—they slow brain activity that controls judgment and inhibitions. Alcohol is an equal-opportunity drug: It increases (disinhibits) helpful tendencies, as when tipsy restaurant patrons leave extravagant tips (Lynn, 1988).

AP® Exam Tip

These three categories—depressants, stimulants, and hallucinogens—are important. There are likely to be questions on the AP® exam that will require you to know how a particular psychoactive drug is classified.

depressants drugs (such as alcohol, barbiturates, and opiates) that reduce neural activity and slow body functions.

And it increases harmful tendencies, as when sexually aroused men become more disposed to sexual aggression.

Alcohol + sex = the perfect storm. When drinking, both men and women are more disposed to casual sex (Cooper, 2006; Ebel-Lam et al., 2009). *The urges you would feel if sober are the ones you will more likely act upon when intoxicated.*

SLOWED NEURAL PROCESSING Low doses of alcohol relax the drinker by slowing sympathetic nervous system activity. Larger doses cause reactions to slow, speech to slur, and skilled performance to deteriorate. Paired with sleep deprivation, alcohol is a potent sedative. Add these physical effects to lowered inhibitions, and the result can be deadly. Worldwide, several hundred thousand lives are lost each year in alcohol-related accidents and violent crime. As blood-alcohol levels rise and judgment falters, people’s qualms about drinking and driving lessen. In experiments, virtually all drinkers who had insisted when sober that they would not drive under the influence later decided to drive home from a bar, even when given a breathalyzer test and told they were intoxicated (Denton & Krebs, 1990; MacDonald et al., 1995). Alcohol can also be life threatening when heavy drinking follows an earlier period of moderate drinking, which depresses the vomiting response. People may poison themselves with an overdose that their bodies would normally throw up.

MEMORY DISRUPTION Alcohol can disrupt memory formation, and heavy drinking can have long-term effects on the brain and cognition. In rats, at a developmental period corresponding to human adolescence, binge drinking contributes to nerve cell death and reduces the birth of new nerve cells. It also impairs the growth of synaptic connections (Crews et al., 2006, 2007). In humans, heavy drinking may lead to blackouts, in which drinkers are unable to recall people they met the night before or what they said or did while intoxicated. These blackouts result partly from the way alcohol suppresses REM sleep, which helps fix the day’s experiences into permanent memories.

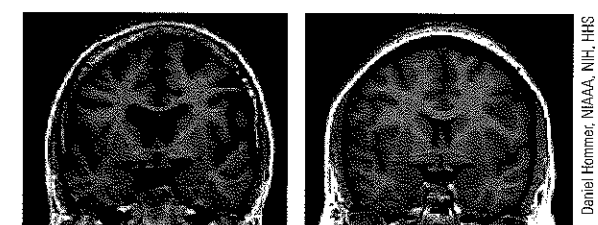
The prolonged and excessive drinking that characterizes **alcohol use disorder** can shrink the brain (**FIGURE 25.2**). Girls and young women (who have less of a stomach enzyme that digests alcohol) can become addicted to alcohol more quickly than boys and young men do, and they are at risk for lung, brain, and liver damage at lower consumption levels (CASA, 2003; Wuethrich, 2001).

REDUCED SELF-AWARENESS AND SELF-CONTROL In one experiment, those who consumed alcohol (rather than a placebo beverage) were doubly likely to be caught mind-wandering during a reading task, yet were *less* likely to notice that they zoned out (Sayette et al., 2009). Alcohol not only reduces self-awareness, it also produces a sort of “myopia” by focusing attention on an arousing situation (such as a provocation) and distracting attention from normal inhibitions and future consequences (Giancola et al., 2010; Hull et al., 1986; Steele & Josephs, 1990).

Reduced self-awareness may help explain why people who want to suppress their awareness of failures or shortcomings are more likely to drink than are those who feel good about themselves. Losing a business deal, a game, or a romantic partner sometimes elicits a drinking binge.



Dangerous disinhibition Alcohol consumption leads to feelings of invincibility, which become especially dangerous behind the wheel of a car, such as this one totaled by a teenage drunk driver. This Colorado University Alcohol Awareness Week exhibit prompted many students to post their own anti-drinking pledges (white flags).



Scan of woman with alcohol use disorder Scan of woman without alcohol use disorder

Figure 25.2 Disordered drinking shrinks the brain. MRI scans show brain shrinkage in women with alcohol use disorder (left) compared with women in a control group (right).

alcohol use disorder (popularly known as *alcoholism*). Alcohol use marked by tolerance, withdrawal, and a drive to continue problematic use.

EXPECTANCY EFFECTS As with other drugs, expectations influence behavior. When people *believe* that alcohol affects social behavior in certain ways, and *believe*, rightly or wrongly, that they have been drinking alcohol, they will behave accordingly (Moss & Albery, 2009). In a classic experiment, researchers gave Rutgers University men (who had volunteered for a study on “alcohol and sexual stimulation”) either an alcoholic or a nonalcoholic drink (Abrams & Wilson, 1983). (Both had strong tastes that masked any alcohol.) In each group, half the participants thought they were drinking alcohol and half thought they were not. After watching an erotic movie clip, the men who *thought* they had consumed alcohol were more likely to report having strong sexual fantasies and feeling guilt free. Being able to *attribute* their sexual responses to alcohol released their inhibitions—whether or not they had actually consumed any alcohol. Alcohol’s effect lies partly in that powerful sex organ, the mind.

BARBITURATES

Like alcohol, the **barbiturate** drugs, or *tranquilizers*, depress nervous system activity. Barbiturates such as Nembutal, Seconal, and Amytal are sometimes prescribed to induce sleep or reduce anxiety. In larger doses, they can impair memory and judgment. If combined with alcohol—as sometimes happens when people take a sleeping pill after an evening of heavy drinking—the total depressive effect on body functions can be lethal.

OPIATES

The **opiates**—opium and its derivatives—also depress neural functioning. When using the opiates, which include *heroin*, a user’s pupils constrict, breathing slows, and lethargy sets in as blissful pleasure replaces pain and anxiety. For this short-term pleasure, opiate users may pay a long-term price: a gnawing craving for another fix, a need for progressively larger doses (as tolerance develops), and the extreme discomfort of withdrawal. When repeatedly flooded with an artificial opiate, the brain eventually stops producing *endorphins*, its own opiates. If the artificial opiate is then withdrawn, the brain lacks the normal level of these painkilling neurotransmitters. Those who cannot or choose not to tolerate this state may pay an ultimate price—death by overdose. Opiates include the *narcotics*, such as codeine and morphine, which physicians prescribe for pain relief.

barbiturates drugs that depress central nervous system activity, reducing anxiety but impairing memory and judgment.

opiates opium and its derivatives, such as morphine and heroin; they depress neural activity, temporarily lessening pain and anxiety.

stimulants drugs (such as caffeine, nicotine, and the more powerful amphetamines, cocaine, Ecstasy, and methamphetamine) that excite neural activity and speed up body functions.

amphetamines drugs that stimulate neural activity, causing speeded-up body functions and associated energy and mood changes.

nicotine a stimulating and highly addictive psychoactive drug in tobacco.

Stimulants

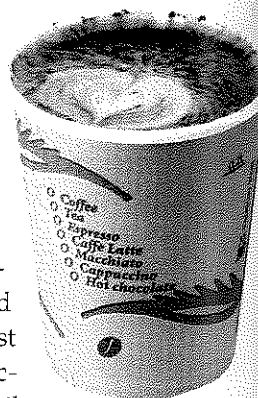
25-3 What are stimulants, and what are their effects?

A **stimulant** excites neural activity and speeds up body functions. Pupils dilate, heart and breathing rates increase, and blood sugar levels rise, causing a drop in appetite. Energy and self-confidence also rise.

Stimulants include caffeine, nicotine, the **amphetamines**, cocaine, methamphetamine (“speed”), and Ecstasy (which is also a mild hallucinogen). People use stimulants to feel alert, lose weight, or boost mood or athletic performance. Unfortunately, stimulants can be addictive, as you may know if you are one of the many who use caffeine daily in your coffee, tea, soda, or energy drinks. Cut off from your usual dose, you may crash into fatigue, headaches, irritability, and depression (Silverman et al., 1992). A mild dose of caffeine typically lasts three or four hours, which—if taken in the evening—may be long enough to impair sleep.

NICOTINE

One of the most addictive stimulants is **nicotine**, found in cigarettes and other tobacco products. Imagine that cigarettes were harmless—except, once in every 25,000 packs, an occasional innocent-looking one is filled with dynamite instead of tobacco. Not such a bad



Vasca/Shutterstock

risk of having your head blown off. But with 250 million packs a day consumed worldwide, we could expect more than 10,000 gruesome daily deaths (more than three times the 9/11 fatalities each and every day)—surely enough to have cigarettes banned everywhere.¹

The lost lives from these dynamite-loaded cigarettes approximate those from today’s actual cigarettes. A teen-to-the-grave smoker has a 50 percent chance of dying from the habit, and each year, tobacco kills nearly 5.4 million of its 1.3 billion customers worldwide. (Imagine the outrage if terrorists took down an equivalent of 25 loaded jumbo jets today, let alone tomorrow and every day thereafter.) By 2030, annual deaths are expected to increase to 8 million. That means that 1 billion twenty-first-century people may be killed by tobacco (WHO, 2008). Eliminating smoking would increase life expectancy more than any other preventive measure.

Those addicted to nicotine find it very hard to quit because tobacco products are as powerfully and quickly addictive as heroin and cocaine. Attempts to quit even within the first weeks of smoking often fail (DiFranza, 2008). As with other addictions, smokers develop *tolerance*, and quitting causes nicotine-withdrawal symptoms, including craving, insomnia, anxiety, irritability, and distractibility. Nicotine-deprived smokers trying to focus on a task experience a tripled rate of mind-wandering (Sayette et al., 2010). When not craving a cigarette, they tend to underestimate the power of such cravings (Sayette et al., 2008).

All it takes to relieve this aversive state is a cigarette—a portable nicotine dispenser. Within 7 seconds, a rush of nicotine signals the central nervous system to release a flood of neurotransmitters (**FIGURE 25.3**). Epinephrine and norepinephrine diminish appetite and boost alertness and mental efficiency. Dopamine and opioids calm anxiety and reduce sensitivity to pain (Nowak, 1994; Scott et al., 2004).

¹This analogy, adapted here with world-based numbers, was suggested by mathematician Sam Saunders, as reported by K. C. Cole (1998).

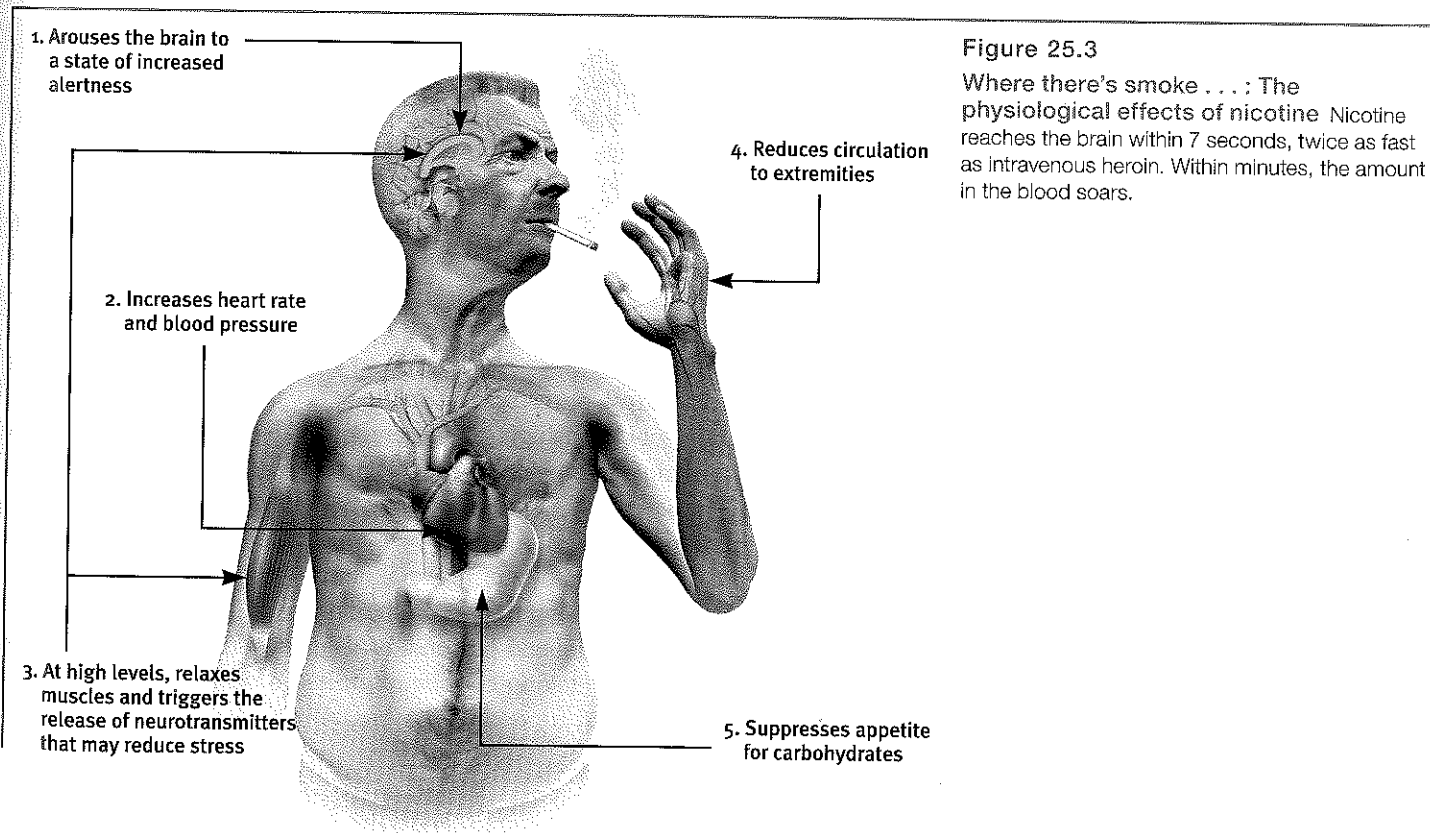


Figure 25.3

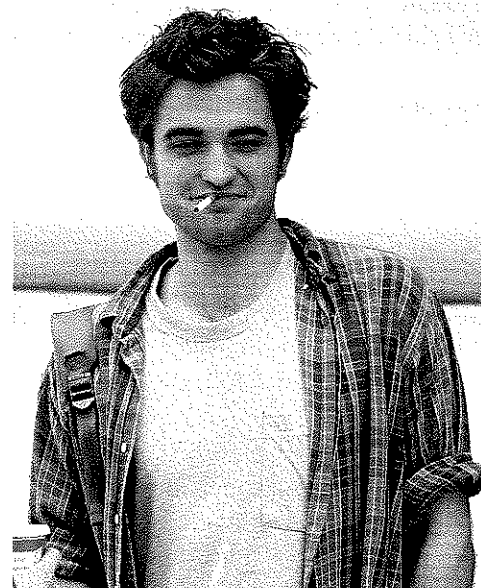
Where there’s smoke . . . : The physiological effects of nicotine. Nicotine reaches the brain within 7 seconds, twice as fast as intravenous heroin. Within minutes, the amount in the blood soars.

FYI

Smoke a cigarette and nature will charge you 12 minutes—ironically, just about the length of time you spend smoking it (*Discover*, 1996).

Humorist Dave Barry (1995) recalling why he smoked his first cigarette the summer he turned 16: “Arguments against smoking: ‘It’s a repulsive addiction that slowly but surely turns you into a gasping, gray-skinned, tumor-ridden invalid, hacking up brownish gobs of toxic waste from your one remaining lung.’ Arguments for smoking: ‘Other teenagers are doing it.’ Case closed! Let’s light up!”

Nic-A-Teen Virtually nobody starts smoking past the vulnerable teen years. Eager to hook customers whose addiction will give them business for years to come, cigarette companies target teens. Portrayals of smoking by popular actors, such as Robert Pattinson in *Remember Me*, entice teens to imitate.



James Denehy/WireImage

These rewards keep people smoking, even among the 8 in 10 smokers who wish they could stop (Jones, 2007). Each year, fewer than 1 in 7 smokers who want to quit will be able to. Even those who know they are committing slow-motion suicide may be unable to stop (Saad, 2002). Asked “If you had to do it all over again, would you start smoking?” more than 85 percent of adult smokers have answered *No* (Slovic et al., 2002).

Nevertheless, repeated attempts seem to pay off. Half of all Americans who have ever smoked have quit, sometimes aided by a nicotine replacement drug and with encouragement from a counselor or a support group. Success is equally likely whether smokers quit abruptly or gradu-

ally (Fiore et al., 2008; Lichtenstein et al., 2010; Lindson et al., 2010). For those who endure, the acute craving and withdrawal symptoms gradually dissipate over the ensuing 6 months (Ward et al., 1997). After a year’s abstinence, only 10 percent will relapse in the next year (Hughes et al., 2010). These nonsmokers may live not only healthier but also happier lives. Smoking correlates with higher rates of depression, chronic disabilities, and divorce (Doherty & Doherty, 1998; Vita et al., 1998). Healthy living seems to add both years to life and life to years.

“Cocaine makes you a new man. And the first thing that new man wants is more cocaine.” -COMEDIAN GEORGE CARLIN (1937–2008)

COCAINE

The recipe for Coca-Cola originally included an extract of the coca plant, creating a **cocaine** tonic for tired elderly people. Between 1896 and 1905, Coke was indeed “the real thing.” But no longer. Cocaine is now snorted, injected, or smoked. It enters the bloodstream quickly, producing a rush of euphoria that depletes the brain’s supply of the neurotransmitters dopamine, serotonin, and norepinephrine (**FIGURE 25.4**). Within the hour, a crash of agitated depression follows as the drug’s effect wears off. Many regular cocaine users chasing this high become addicted. In the lab, cocaine-addicted monkeys have pressed levers more than 12,000 times to gain one cocaine injection (Siegel, 1990).

In situations that trigger aggression, ingesting cocaine may heighten reactions. Caged rats fight when given foot shocks, and they fight even more when given cocaine *and* foot shocks. Likewise, humans who voluntarily ingest high doses of cocaine in laboratory experiments impose higher shock levels on a presumed opponent than do those receiving a placebo (Licata et al., 1993). Cocaine use may also lead to emotional disturbances, suspiciousness, convulsions, cardiac arrest, or respiratory failure.

In national surveys, 3 percent of U.S. high school seniors and 6 percent of British 18- to 24-year-olds reported having tried cocaine during the past year (ACMD, 2009; Johnston et al., 2011). Nearly half had smoked *crack*, a faster-working crystallized form of cocaine that produces a briefer but more intense high, followed by a more intense crash. After several hours, the craving for more wanes, only to return several days later (Gawin, 1991).

Cocaine’s psychological effects depend in part on the dosage and form consumed, but the situation and the user’s expectations and personality also play a role. Given a placebo, cocaine users who *thought* they were taking cocaine often had a cocaine-like experience (Van Dyke & Byck, 1982).

cocaine a powerful and addictive stimulant, derived from the coca plant, producing temporarily increased alertness and euphoria.

methamphetamine a powerfully addictive drug that stimulates the central nervous system, with speeded-up body functions and associated energy and mood changes; over time, appears to reduce baseline dopamine levels.

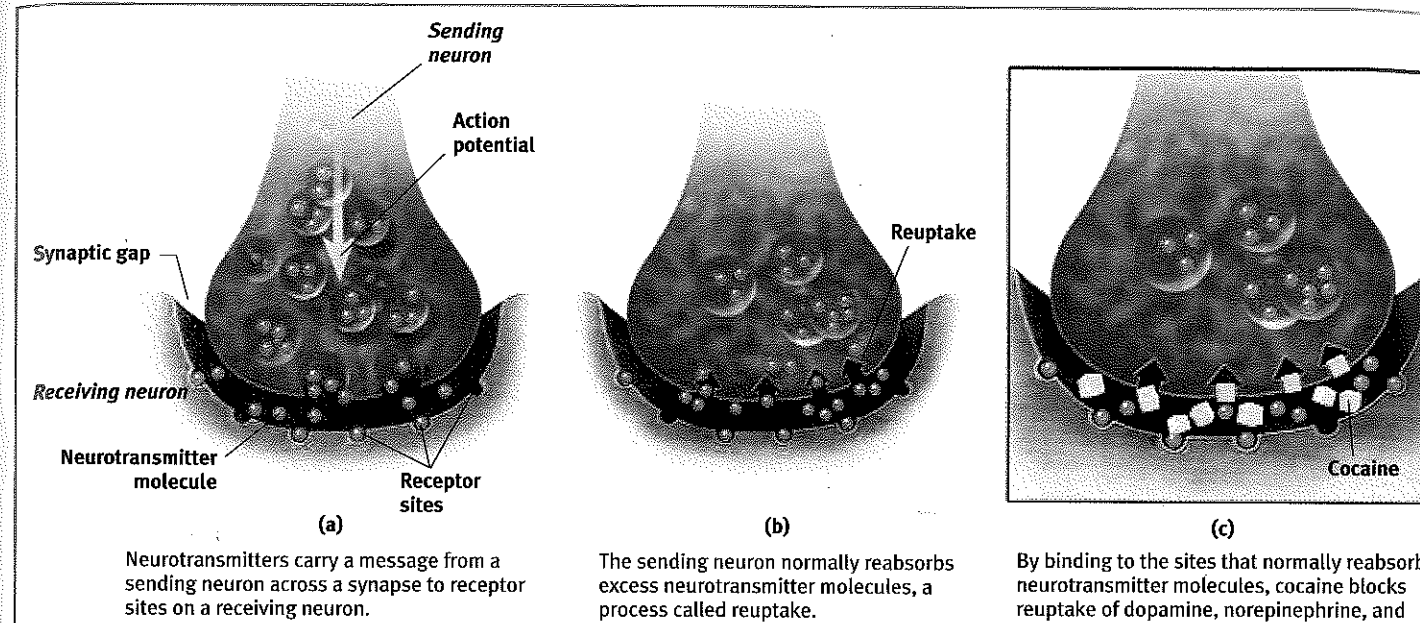


Figure 25.4 Cocaine euphoria and crash

By binding to the sites that normally reabsorb neurotransmitter molecules, cocaine blocks reuptake of dopamine, norepinephrine, and serotonin (Ray & Ksir, 1990). The extra neurotransmitter molecules therefore remain in the synapse, intensifying their normal mood-altering effects and producing a euphoric rush. When the cocaine level drops, the absence of these neurotransmitters produces a crash.

METHAMPHETAMINE

Methamphetamine is chemically related to its parent drug, *amphetamine* (NIDA, 2002, 2005) but has even greater effects. Methamphetamine triggers the release of the neurotransmitter dopamine, which stimulates brain cells that enhance energy and mood, leading to eight hours or so of heightened energy and euphoria. Its aftereffects may include irritability, insomnia, hypertension, seizures, social isolation, depression, and occasional violent outbursts (Homer et al., 2008). Over time, methamphetamine may reduce baseline dopamine levels, leaving the user with depressed functioning.

ECSTASY

Ecstasy, a street name for **MDMA** (methylenedioxymethamphetamine), is both a stimulant and a mild hallucinogen. As an amphetamine derivative, Ecstasy triggers dopamine release, but its major effect is releasing stored serotonin and blocking its reuptake, thus prolonging serotonin’s feel-good flood (Braun, 2001). Users feel the effect about a half-hour after taking an Ecstasy pill. For three or four hours, they experience high energy, emotional elevation, and (given a social context) connectedness with those around them (“I love everyone”).

During the 1990s, Ecstasy’s popularity soared as a “club drug” taken at nightclubs and all-night raves (Landry, 2002). The drug’s popularity crosses national borders, with an estimated 60 million tablets consumed annually in Britain (ACMD, 2009). There are, however, reasons not to be ecstatic about Ecstasy. One is its dehydrating effect, which—when combined with prolonged dancing—can lead to severe overheating, increased



National Pictures/Topham/The Image Works

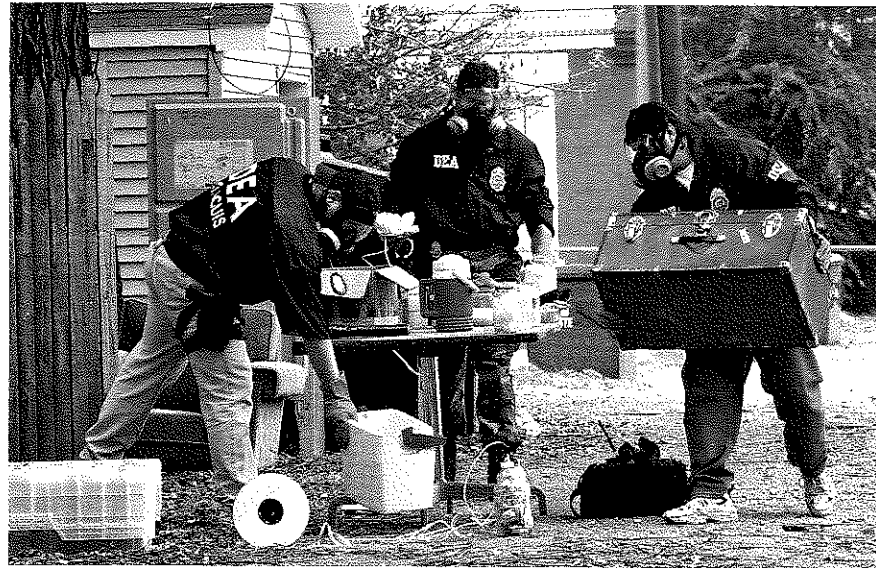
AP® Exam Tip

Figure 25.4 is an excellent review of how neurotransmitters work. If there is any part of this that you don’t understand, head back to Module 9 for a complete explanation.

Dramatic drug-induced decline This woman’s methamphetamine addiction led to obvious physical changes. Her decline is evident in these two photos, taken at age 36 (left) and, after four years of addiction, at age 40 (right).

Ecstasy (MDMA) a synthetic stimulant and mild hallucinogen. Produces euphoria and social intimacy, but with short-term health risks and longer-term harm to serotonin-producing neurons and to mood and cognition.

Meth bust As use of the dangerously addictive stimulant methamphetamine has increased, enforcement agencies have increased their efforts to snuff out the labs that produce it.



Bill Greenblatt/UP Photo Service/Newscom

blood pressure, and death. Another is that long-term, repeated leaching of brain serotonin can damage serotonin-producing neurons, leading to decreased output and increased risk of permanently depressed mood (Croft et al., 2001; McCann et al., 2001; Roiser et al., 2005). Ecstasy also suppresses the disease-fighting immune system, impairs memory, slows thought, and disrupts sleep by interfering with serotonin's control of the circadian clock (Laws & Kokkalis, 2007; Pacifici et al., 2001; Schilt et al., 2007). Ecstasy delights for the night but dispirits the morrow.

Hallucinogens

25-4 What are hallucinogens, and what are their effects?

hallucinogens psychedelic ("mind-manifesting") drugs, such as LSD, that distort perceptions and evoke sensory images in the absence of sensory input.

LSD a powerful hallucinogenic drug; also known as acid (*lysergic acid diethylamide*).

Hallucinogens distort perceptions and evoke sensory images in the absence of sensory input (which is why these drugs are also called *psychedelics*, meaning "mind-manifesting"). Some, such as LSD and MDMA (Ecstasy), are synthetic. Others, including the mild hallucinogen marijuana, are natural substances.

LSD

Chemist Albert Hofmann created—and on one Friday afternoon in April 1943 accidentally ingested—**LSD** (lysergic acid diethylamide). The result—"an uninterrupted stream of fantastic pictures, extraordinary shapes with intense, kaleidoscopic play of colors"—reminded him of a childhood mystical experience that had left him longing for another glimpse of "a miraculous, powerful, unfathomable reality" (Siegel, 1984; Smith, 2006).

The emotions of an LSD trip vary from euphoria to detachment to panic. The user's current mood and expectations color the emotional experience, but the perceptual distortions and hallucinations have some commonalities. Whether provoked to hallucinate by drugs, loss of oxygen, or extreme sensory deprivation, the brain hallucinates in basically the same way (Siegel, 1982). The experience typically begins with simple geometric forms, such as a lattice, cobweb, or spiral. The next phase consists of more meaningful images; some may be superimposed on a tunnel or funnel, others may be replays of past emotional experiences. As the hallucination peaks, people frequently feel separated from their body and experience dreamlike scenes so real that they may become panic-stricken or harm themselves.

These sensations are strikingly similar to the **near-death experience**, an altered state of consciousness reported by about 15 percent of patients revived from cardiac arrest (Agrillo, 2011; Greyson, 2010). Many describe visions of tunnels (**FIGURE 25.5**), bright lights or beings of light, a replay of old memories, and out-of-body sensations (Siegel, 1980). Given that oxygen deprivation and other insults to the brain are known to produce hallucinations, it is difficult to resist wondering whether a brain under stress manufactures the near-death experience. Following temporal lobe seizures, patients have reported similarly profound mystical experiences. So have solitary sailors and polar explorers while enduring monotony, isolation, and cold (Suedfeld & Mocellin, 1987).

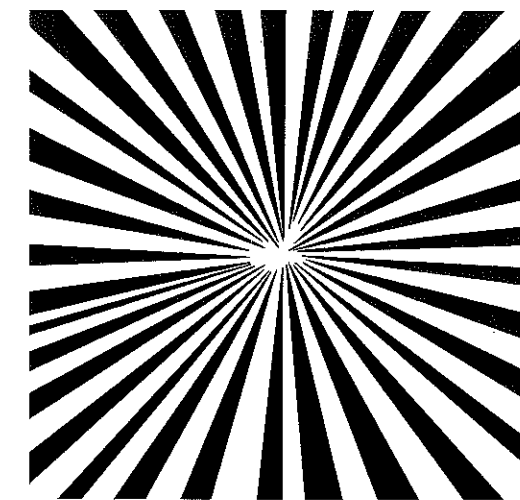


Figure 25.5 Near-death vision or hallucination? Psychologist Ronald Siegel (1977) reported that people under the influence of hallucinogenic drugs often see "a bright light in the center of the field of vision. . . . The location of this point of light create[s] a tunnel-like perspective." This is very similar to others' near-death experiences.

MARIJUANA

For 5000 years, hemp has been cultivated for its fiber. The leaves and flowers of this plant, which are sold as marijuana, contain **THC** (delta-9-tetrahydrocannabinol). Whether smoked (getting to the brain in about 7 seconds) or eaten (causing its peak concentration to be reached at a slower, unpredictable rate), THC produces a mix of effects. *Synthetic marijuana* (also called *K2* or *Spice*) mimics THC. Its harmful side effects, which can include agitation and hallucinations, led to its ingredient becoming illegal under the U.S. Synthetic Drug Abuse Prevention Act of 2012.

Marijuana is a difficult drug to classify. It is a mild hallucinogen, amplifying sensitivity to colors, sounds, tastes, and smells. But like alcohol, marijuana relaxes, disinhibits, and may produce a euphoric high. Both alcohol and marijuana impair the motor coordination, perceptual skills, and reaction time necessary for safely operating an automobile or other machine. "THC causes animals to misjudge events," reported Ronald Siegel (1990, p. 163). "Pigeons wait too long to respond to buzzers or lights that tell them food is available for brief periods; and rats turn the wrong way in mazes."

Marijuana and alcohol also differ. The body eliminates alcohol within hours. THC and its by-products linger in the body for a week or more, which means that regular users experience less abrupt withdrawal and may achieve a high with smaller amounts of the drug than would be needed by occasional users. This is contrary to the usual path of tolerance, in which repeat users need to take larger doses to feel the same effect.

A user's experience can vary with the situation. If the person feels anxious or depressed, using marijuana may intensify these feelings. The more often the person uses marijuana, especially during adolescence and in today's stronger, purified form, the greater the risk of anxiety or depression (Bambico et al., 2010; Hall, 2006; Murray et al., 2007). Daily use bodes a worse outcome than infrequent use.

Marijuana also disrupts memory formation and interferes with immediate recall of information learned only a few minutes before. Such cognitive effects outlast the period of smoking (Messinis et al., 2006). Heavy adult use for over 20 years is associated with a shrinkage of brain areas that process memories and emotions (Yücel et al., 2008). Prenatal exposure through maternal marijuana use impairs brain development (Berghuis et al., 2007; Huizink & Mulder, 2006).

To free up resources to fight crime, some states and countries have passed laws legalizing the possession of small quantities of marijuana. In some cases, legal *medical marijuana* use has been granted to relieve the pain and nausea associated with diseases such

near-death experience an altered state of consciousness reported after a close brush with death (such as by cardiac arrest); often similar to drug-induced hallucinations.

THC the major active ingredient in marijuana; triggers a variety of effects, including mild hallucinations.

as AIDS, glaucoma, and cancer (Munsey, 2010; Watson et al., 2000). In such cases, the Institute of Medicine recommends delivering the THC with medical inhalers. Marijuana smoke, like cigarette smoke, is toxic and can cause cancer, lung damage, and pregnancy complications.

* * *

Despite their differences, the psychoactive drugs summarized in **TABLE 25.2** share a common feature: They trigger negative aftereffects that offset their immediate positive effects and grow stronger with repetition. And this helps explain both tolerance and withdrawal. As the opposing, negative aftereffects grow stronger, it takes larger and larger doses to produce the desired high (*tolerance*), causing the aftereffects to worsen in the drug's absence (*withdrawal*). This in turn creates a need to switch off the withdrawal symptoms by taking yet more of the drug (which may lead to *addiction*).

Table 25.2 A Guide to Selected Psychoactive Drugs

Drug	Type	Pleasurable Effects	Adverse Effects
Alcohol	Depressant	Initial high followed by relaxation and disinhibition	Depression, memory loss, organ damage, impaired reactions
Heroin	Depressant	Rush of euphoria, relief from pain	Depressed physiology, agonizing withdrawal
Caffeine	Stimulant	Increased alertness and wakefulness	Anxiety, restlessness, and insomnia in high doses; uncomfortable withdrawal
Methamphetamine	Stimulant	Euphoria, alertness, energy	Irritability, insomnia, hypertension, seizures
Cocaine	Stimulant	Rush of euphoria, confidence, energy	Cardiovascular stress, suspiciousness, depressive crash
Nicotine	Stimulant	Arousal and relaxation, sense of well-being	Heart disease, cancer
Ecstasy (MDMA)	Stimulant; mild hallucinogen	Emotional elevation, disinhibition	Dehydration, overheating, depressed mood, impaired cognitive and immune functioning
Marijuana	Mild hallucinogen	Enhanced sensation, relief of pain, distortion of time, relaxation	Impaired learning and memory, increased risk of psychological disorders, lung damage from smoke

To learn about the influences on drug use, see Module 81.

Before You Move On

▶ ASK YOURSELF

Do you think people can become addicted not only to psychoactive drugs but also to other repetitive, pleasure-seeking behaviors (such as gambling or "Internet game playing")?

▶ TEST YOURSELF

Why do tobacco companies try so hard to get customers hooked as teens?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 25 Review

25-1

What are substance use disorders, and what role do tolerance, withdrawal, and addiction play in these disorders?

- Those with a *substance use disorder* may exhibit impaired control, social disruption, risky behavior, and the physical effects of tolerance and withdrawal.
- *Psychoactive drugs* alter perceptions and moods.
- These drugs may produce *tolerance*—requiring larger doses to achieve the desired effect—and *withdrawal*—significant discomfort accompanying efforts to quit.
- *Addiction* is compulsive craving and use of drugs or certain behaviors (such as gambling) despite known adverse consequences.

25-2

What are depressants, and what are their effects?

- *Depressants*, such as alcohol, *barbiturates*, and the *opiates* (which include narcotics), dampen neural activity and slow body functions.
- Alcohol tends to disinhibit, increasing the likelihood that we will act on our impulses, whether harmful or helpful. It also impairs judgment, disrupts memory processes by suppressing REM sleep, and reduces self-awareness and self-control.
- User expectations strongly influence alcohol's behavioral effects.

25-3

What are stimulants, and what are their effects?

- *Stimulants*—including caffeine, *nicotine*, cocaine, the *amphetamines*, *methamphetamine*, and *Ecstasy*—excite neural activity and speed up body functions, triggering energy and mood changes. All are highly addictive.
- Nicotine's effects make smoking a difficult habit to kick, yet the percentage of Americans who smoke has been dramatically decreasing.
- Cocaine gives users a fast high, followed within an hour by a crash. Its risks include cardiovascular stress and suspiciousness.
- Use of methamphetamines may permanently reduce dopamine production.
- Ecstasy (MDMA) is a combined stimulant and mild hallucinogen that produces euphoria and feelings of intimacy. Its users risk immune system suppression, permanent damage to mood and memory, and (if taken during physical activity) dehydration and escalating body temperatures.

25-4

What are hallucinogens, and what are their effects?

- *Hallucinogens*—such as *LSD* and marijuana—distort perceptions and evoke *hallucinations*—sensory images in the absence of sensory input. The user's mood and expectations influence the effects of LSD, but common experiences are hallucinations and emotions varying from euphoria to panic.
- Marijuana's main ingredient, *THC*, may trigger feelings of disinhibition, euphoria, relaxation, relief from pain, and intense sensitivity to sensory stimuli. It may also increase feelings of depression or anxiety, impair motor coordination and reaction time, disrupt memory formation, and damage lung tissue (because of the inhaled smoke).