

Aided by brain imaging advances, scientists are looking for evidence that compulsive nondrug behaviors lead to long-term changes in reward circuitry

# 'Behavioral' Addictions: Do They Exist?

People toss around the term "addiction" to describe someone's relationship to a job, a boyfriend, or a computer. But scientists have traditionally confined their use of the term

to substances—namely alcohol and other drugs—that clearly foster physical dependence in the user.

That's changing, however. New knowledge about the brain's reward system, much gained by superrefined brain scan technology, suggests that as far as the

brain is concerned, a reward's a reward, regardless of whether it comes from a chemical or an experience. And where there's a reward, there's the risk of the vulnerable brain getting trapped in a compulsion.

"Over the past 6 months, more and more people have been thinking that, contrary to earlier views, there is commonality between substance addictions and other compulsions," says Alan Leshner, head of the National Institute on Drug Abuse (NIDA) and incoming executive officer of the American Association for the Advancement of Science, publisher of *Science*.

Just where to draw the line is not yet clear. The unsettled state of definitions is reflected in psychiatry's bible, the *Diagnostic and Statistical Manual IV*. Addictions, obsessions, and compulsions—all related to loss of voluntary control and getting trapped in repetitious, self-defeating behavior—are scattered around under "substance-related disorders," "eating disorders," "sexual and gender identity disorders," "anxiety disorders," and "impulse-control disorders not elsewhere classified." In that last grab-bag are compulsive gambling, kleptomania, fire-setting, hair-pulling, and "intermittent explosive disorder."

Addiction used to be defined as depen-

dence on a drug as evidenced by craving, increased tolerance, and withdrawal. But even some seemingly classical addictions don't follow that pattern. Cocaine, for example, is highly addictive but causes little withdrawal. And a person who gets hooked on morphine while in the hospital may stop taking the drug without developing an obsession with it.

Now many researchers are moving to-

ence," he says. But it's become clear that neuroadaptation—that is, changes in neural circuitry that help perpetuate the behavior—occurs even in the absence of drug-taking, he says.

The experts are fond of saying that addiction occurs when a habit "hijacks" brain circuits that evolved to reward survival-enhancing behavior such as eating and sex. "It stands to reason if you can derange these circuits with pharmacology, you can do it with natural rewards too," observes Stanford University psychologist Brian Knutson. Thus, drugs are no longer at the heart of the matter. "What is coming up fast as being the central core issue ... is continued engagement in self-destructive behavior despite adverse consequences," says Steven Grant of NIDA.

Not everybody is on board with this open-ended definition. For one thing, says longtime addiction researcher Roy Wise of NIDA, drugs are far more powerful than any "natural" pleasure when it comes to the amounts of dopamine released. Nonetheless, behavioral resemblances to addiction are getting increasing notice.

## Gambling

In a class of its own as the disorder that most resembles drug addiction is pathological gambling. Compulsive gamblers live from fix to fix, throwing away the rest of their lives for another roll of the dice—and deluding themselves that luck will soon smile on them. Their subjective cravings can be as intense as those of drug abusers; they show tolerance through their need to increase betting; and they experience highs rivaling that of a drug high. Up to half of pathological gamblers "show withdrawal symptoms looking like a mild form of drug withdrawal," says Shaffer—including churning guts, sleep disturbance, sweating, irritability, and craving. And like drug addicts, they are at risk of sudden relapse even after many years of abstinence.

Furthermore, what's going on inside gamblers' heads looks like what goes on in



**Getting a fix.** Gamblers get high and show tolerance and withdrawal symptoms—a lot like drug addicts.

ward a definition of addiction based more on behavior, and they are starting to look at whether brain activity and biochemistry are affected the same way in "behavioral" addictions as they are by substance abuse. One who endorses this perspective is psychologist Howard Shaffer, who heads the Division on Addictions at Harvard. "I had great difficulty with my own colleagues when I suggested that a lot of addiction is the result of experience ... repetitive, high-emotion, high-frequency experi-

## ADDICTION

The concept of addiction is changing, as this special news package describes: There's more emphasis on how drugs and even behaviors may wreak long-term damage to the brain.

## COMPULSIVE BEHAVIORS LONG-TERM CHANGES

addicts' heads. Yale psychiatrist Marc Potenza finds that when pathological gamblers are exposed to videos of people gambling and talking about gambling, they show activity changes in some of the same frontal and limbic brain regions as do cocaine addicts exposed to images that stir up drug craving, as assessed by functional magnetic resonance imaging (fMRI). And a positron emission tomography study of pathological gamblers playing blackjack, conducted by psychiatrist Eric Hollander of Mount Sinai School of Medicine in New York City, showed significant changes in cortical arousal depending on whether they were just playing cards or betting with a \$100 stake. He says it resembles another study showing alcoholics' brain reactions to looking at a bottle of Coke versus a bottle of whiskey.

Like addicts, gamblers also respond to drugs that block drug highs. Suck Won Kim, a psychiatrist at the University of Minnesota Medical School in Minneapolis, has tried naltrexone, an opiate antagonist, on a variety of compulsive behaviors including gambling. In an 11-week trial on 45 gamblers, naltrexone inhibited both the urge to gamble and the high from it in 75% of the group—compared with 24% of a comparable group on placebo—suggesting that drugs and gambling stimulate some of the same biochemical pathways.

And finally, there's cognitive evidence: Gamblers, like drug addicts, do badly at a "gambling task," success at which requires the ability to perceive that delayed gains will be larger than immediate ones.

### Food

Can food be said to be an addiction? Overeaters Anonymous—which, like Gamblers Anonymous, is patterned on Alcoholics Anonymous—says yes. The experts, however, say it depends on the disorder.

Compulsive overeating certainly has the look of an addiction that can dominate a person's life. There's also biochemical evidence suggesting a kinship. Psychiatrist Nora Volkow of Brookhaven National Laboratory in Upton, New York, and colleagues found that in a group of compulsive overeaters, dopamine receptor availability was lower, an anomaly also seen in drug addicts. "Dopamine deficiency in obese individuals may perpetuate pathological eating as a means to compensate for decreased activation of these circuits," Volkow's team suggests.

Bulimia, which is characterized by bingeing and vomiting, also looks a lot like an addiction, Hollander notes. Unlike anorexia, which involves rigidly controlled behavior and no high, "bulimia and binge eating have an impulsive com-

ponent—pleasure and arousal followed by guilt and remorse."

Patricia Faris, a gastrointestinal physiologist at the University of Minnesota, Minneapolis, believes that as with drug addictions, bulimic behavior is initially voluntary but is transformed into a compulsion because of changes that it wreaks on the nervous system. Bulimia clearly affects reward



**Racing circuits.** A rat model may cast light on human compulsive running, often dubbed a "positive" addiction.

centers: Faris says patients become increasingly depressed and anxious before episodes; immediately following, they uniformly report a pleasant "afterglow."

Faris has come up with a novel hypothesis: that bulimia disregulates the vagal nerve, which regulates heart and lungs as well as the vomiting impulse. She suspects that a binge-purge episode then brings the vagal nerve back to its normal role. This retraining of the vagal nerve also has long-term effects on the brain's reward circuitry, she believes, as suggested by the fact that bulimics have a high relapse rate and are very hard to help once they've been at it for a few years. Kim says that although the theory is speculative, he believes Faris is on the right track in approaching the problem "from neural system concepts" as opposed to a more traditional emphasis on biochemistry.

### Sex

There's not much research on sex as an addiction, and some researchers are dubious about whether such a basic function can have that distinction. Sex is really a distinct subject because it's "wired separately," in the opinion of Kim of Minnesota. He notes, for example, that the opioid antagonist naltrexone "really doesn't affect sexual desire that much," so it doesn't follow the same

pathways as, say, gambling.

Yet so-called sex addicts do display behaviors characteristic of addiction: They obsess about whatever their favorite practice is, never get enough, feel out of control, and experience serious disruption of their lives because of it. That leads Shaffer to conclude that some behaviors qualify as sex addictions: "I think those things that are robust

and reliable shifters of subjective experience all hold the potential for addiction." To be sure, he adds, sex trails behind drugs or gambling, being "relatively robust but unreliable" in delivering satisfaction.

Anna Rose Childress, who does brain imaging studies at the University of Pennsylvania in Philadelphia, says sex addicts resemble cocaine addicts and probably share with them a defect in "inhibitory circuitry." In both instances, "people say when they're in this big 'go' state they feel as though there is override [of inhibition] ... a feeling of being unable to stop," says Childress.

Scientists are just beginning to use imaging to try to determine whether there's a tangible basis to these feelings. Childress has been comparing the circuits activated by cocaine in addicts and sexual desire in normal subjects in hope of identifying the "stop!" circuitry. And psychiatrist Peter Martin at Vanderbilt University in Nashville, Tennessee, says a preliminary study with normal subjects indicates that brain activity associated with sexual arousal looks like that accompanying drug consumption. He plans to do further comparisons using self-described sex addicts.

### Shopping, running, clicking...

Although there is no shortage of therapies for every imaginable addiction, there is little or no published research on other disorders. One problem that afflicts a great many women, in particular, is compulsive shopping, says Kim. Compulsive shoppers typically end up with huge debts and their houses stuffed with unused merchandise. Shopping binges are very often precipitated by feelings of depression and anxiety, Shaffer says; the shopping itself can generate temporary druglike highs before the shopper—like a cocaine addict—crashes into depression, guilt, anxiety, and fatigue.

Some have no doubt this is an addiction. "In my clinical experience, [compul-

sive shoppers] have a similar kind of withdrawal,” says Shaffer. Kim agrees: “These people can’t control it. We think it’s essentially the same thing as gambling.” Kim thinks compulsive shoplifting (kleptomania) is also closely related and, in fact, has published the first formal study trying doses of naltrexone with kleptomania; 9 of 10 patients, he says, were much improved after 11 weeks of treatment.

Then there’s Internet abuse, the country’s fastest growing “addiction.” But whether any such phenomenon exists is something about which scientists—if not therapists—are cautious. There are indeed people who neglect the rest of their lives as they spend every waking moment at the monitor. But is it the technology or the behavior that the technology enables that people are really hooked on? The things people are addicted to on the Net are the same things people get hooked on without it: gambling (including day trading), pornography, and shopping, notes Marc Pratarelli of the University of Southern Colorado in Pueblo. His group is doing factor analysis of questionnaire responses by computer users to get at the “core issues” and to determine “if it is in fact just one more fancy tool” to enable a primary habit.

And what about “positive addictions”? Some years ago jogging was touted as one that raised endorphin levels (which in turn stoke up the dopamine) and resulted in a “natural high.” Although human behavioral addictions are difficult if not impossible to model in animals, Stefan Brené of the Karolinska Institute in Stockholm, Sweden, thinks he has done it with running. He says

rats that have been bred to be addiction-prone spend much more time on the running wheel than other rats do. Furthermore, biochemical tests indicate the impulses both to run and to consume cocaine are governed by “similar biochemical adaptations.” He also says the work—most of it as yet unpublished—shows that in an addiction-prone rat, running can increase preference for ethanol—“indicating that a natural, nontoxic ... addiction can under some instances potentiate the preference for a drug.”

The above by no means exhausts the list of behaviors that some scientists see as addictive. And it seems to be true across the board that having one addiction lowers the threshold for developing another, says Walter Kaye, who does research on eating disorders at the University of Pittsburgh Medical Center. Just what form addictions take has a lot to do with one’s sex, says Pratarelli. Men are overwhelmingly represented among sex “addicts” and outnumber women by about 2 to 1 in gambling and substance abuse; women are prone to what psychiatrist Susan McElroy of the University of Cincinnati College of Medicine calls the “mall disorders”—eating, shopping, and kleptomania. (Kim says the ratio of females to males in kleptomania is 2 or 3 to 1; perhaps 90% of compulsive shoppers are women.)

To cast more light on the mechanisms of addiction, scientists have taken a growing interest in behavior of the brain’s reward circuitry in normal subjects. In a much-cited paper in last May’s issue of *Neuron*, Hans Breiter of Massachusetts General Hospital in Boston and his colleagues used fMRI to map the re-

sponses of normal males in a roulette-type game of chance. Blood flow in dopamine-rich areas, the scientists found, indicated that “the same neural circuitry is involved in the highs and lows of winning money, abusing drugs, or anticipating a gastronomical



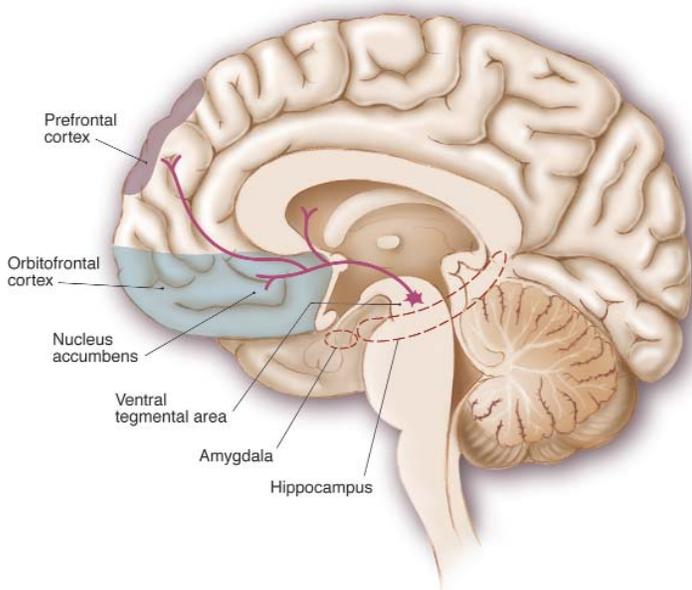
**Buying high.** Compulsive shoppers, mostly women, go on binges triggered by anxiety and depression.

treat.” Other research has been showing that many types of rewards besides money—including chocolate, music, and beauty—affects those reward circuits.

Shaffer and others in his camp believe that if such a reward is powerful enough, it can retrain those circuits in a vulnerable person. Not everyone, however, buys the idea that nondrug stimuli really can be potent enough to generate what has been traditionally thought of as addiction. “Many people believe that [only] addictive drugs alter the circuitry in some critical way,” says Wise of NIDA. And, he says, drugs are far more powerful than “natural” rewards, increasing dopamine “two to five times more strongly.” Kaye also warns that the fact that certain disorders share the same pathways does not necessarily prove they’re closely linked. After all, he notes, “stroke and Parkinson’s also involve the same pathway.”

Despite the uncertainties, addiction research is “going beyond the earlier conceptual framework,” says neuroscientist Read Montague of Baylor College of Medicine in Houston. “Historically, these definitions have come out of animal behavior literature,” and addiction has been defined in terms of rats frenziedly pressing levers for cocaine. Now, he says, “we need a better theory of how the brain processes rewarding events,” one that involves discovering the “algorithms” people follow that lead them into and then keep them trapped in their disastrous behaviors.

—CONSTANCE HOLDEN



**Wired.** Dopamine projections link the ventral tegmental area, nucleus accumbens, and parts of the frontal lobe in a reward circuit that even nondrug compulsions may alter.

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