Your brain on gambling

Science shows how slot machines take over your mind

By Jonah Lehrer | August 19, 2007

When Ann Klinestiver, a high school English teacher in Milton, W.Va., was first diagnosed with Parkinson's disease, she was desperate for anything that might calm the tremors caused by the disease. She found relief in a new drug called Requip.

"At first, the drug was like a miracle," Klinestiver says. "All my movement problems just disappeared."

Over time, however, Klinestiver needed higher and higher doses of the drug in order to ease her symptoms. That's when she became a gambling addict. Although she'd never been interested in gambling before, Klinestiver was suddenly obsessed with slot machines. Every day, she would drive to the local dog racing track and play slots until 3:30 in the morning. After a year of addictive gambling, Klinestiver lost more than $200,000.

Klinestiver's medication worked by imitating the effects of dopamine, a neurotransmitter in the brain. Parkinson's is caused by the death of dopamine neurons in brain areas that control bodily movement. But dopamine also plays a central role in the pleasure centers of the brain, influencing how we see the world and respond to it. Recent medical studies have found that anywhere from 3 to 13 percent of patients on the kind of medication Klinestiver was taking develop severe gambling addictions or related compulsions. In early 2006, Klinestiver was taken off Requip. Her tremors worsened, but her gambling addiction vanished. "I haven't gambled in 18 months," she says. "I still think about the slots, but the obsession isn't there."

Stories like Klinestiver's, and research into dopamine's role in the brain, are helping neuroscientists understand the temptation of gambling and the scourge of gambling addiction. This research may also change the way we see casinos, and help shift the debate over whether the government should further regulate slots, roulette wheels, and other games of chance. From the perspective of the brain, gambling has much in common with addictive drugs, like cocaine. Both work by hijacking the brain's pleasure centers -- a lure that some people are literally incapable of resisting.

"Gambling games grew up around the frailty of our nervous system," says Read Montague, a professor of neuroscience at Baylor University. "They evolved to exploit specific hiccups in our brain."

In recent years, gambling has spread across America, with gambling generating revenues of $2.9 billion in New England in 2006. The question of gambling is of particular relevance for Massachusetts. Last month, the town of Middleborough voted in support of a massive new gambling complex, to be built on lands owned by the Mashpee Wampanoag tribe. Governor Deval Patrick is currently considering proposals to expand gambling across the state, and several developers are looking at sites in Boston.

The growth of the gambling industry has been accompanied by a large amount of new scientific research explaining the effects of gambling on the brain. The neural circuits manipulated by gambling originally evolved to help animals assess rewards, such as food, that are crucial for survival. Dopamine is the neurotransmitter involved with the processing of these rewards. Whenever we experience something pleasurable, such as winning a hand of blackjack or eating a piece of chocolate cake, our dopamine neurons get excited. These neurons help the brain learn about the pleasure, and attempt to predict when it will happen again.

Wolfram Schultz, a neuroscientist at Cambridge University, has exposed how this system operates on a molecular level. He has spent the last two decades measuring the activity of dopamine neurons in the brains of monkeys as they receive rewards of fruit juice. His experiments observe a simple protocol: Schultz flashes a light, waits a few seconds, and then squirts a few drops of apple juice into the monkey's mouth. While the monkeys are waiting for the sweet liquid, Schultz painstakingly monitors the response of individual cells.

At first, the neurons don't get excited until the juice is delivered. The cells are reacting to the actual reward. However, once the animal learns that the light always precedes the arrival of juice, the same neurons begin firing at the sight of the light instead of the reward. Schultz calls these cells "prediction neurons," since they are more interested in predicting rewards than in the rewards themselves.

These predictions are a crucial source of learning, since the monkey constantly compares its expectations of juice with what actually happens. For example, if the light is flashed but the juice never arrives, then the monkey's dopamine neurons stop firing. This is known as the "error signal." The monkey is disappointed, and begins to change its future predictions. However, if the monkey receives an unexpected reward -- the juice arrives without warning -- then the dopamine neurons get extremely excited. A surprising treat registers much larger than an expected one.

"A reward that's unpredictable typically counts three or four times as much," Schultz says.

Games of chance prey on this neural system. Consider, for example, the slot machine. You put in a coin and pull the lever. The reels start to whirr. Eventually, the machine settles on its verdict. Chances are you lost money.

But think about the slot machine from the perspective of your dopamine neurons. Whenever you win some money, the reward activates those brain cells intent on anticipating future rewards. These neurons want to predict the patterns inside the machine, to decode the logic of luck.

Yet here's the catch: slot machines can't be solved. They use random number generators to determine their payout. There are no patterns to decipher. There is only a little microchip, churning out arbitrary digits.

At this point, our dopamine neurons should just turn themselves off: the slot machine is a waste of mental energy. But this isn't what happens. Instead of getting bored by the haphazard payouts, our dopamine neurons become obsessed. The random rewards of gambling are much more seductive than a more predictable reward cycle. When we pull the lever and win some money, we experience a potent rush of pleasurable dopamine precisely because the reward was so unexpected. The clanging coins and flashing lights are like a surprising squirt of juice. The end result is that we are transfixed by the slot machine, riveted by the fickle nature of its payouts.

"The trick of a one-armed bandit," Montague says, "is that it provides us with the illusion of a pattern. We get enough rewards so that we keep on playing. Our cells think they'll figure out the pattern soon. But of course they won't."

The irony of gambling is that it's entertaining because it's so frustrating, at least for our dopamine neurons. One of the big remaining questions for scientists is why only some gamblers get addicted. While most people can walk away from the slot machines, some gamblers, like Klinestiver, can't resist the temptation. For these compulsive gamblers, the misplaced predictions of their dopamine neurons become self-destructive. These people are so blinded by the pleasures of occasionally winning that they slowly lose everything.

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