How Does Your Brain Respond When You Think about Gambling or Taking Risks?

January 26 2007

Should you leave your comfortable job for one that pays better but is less secure? Should you have a surgery that is likely to extend your life but poses some risk that you will not survive the operation? Should you invest in a risky startup company whose stock may soar even though you could lose your entire investment? In the Jan. 26 issue of the journal *Science*, UCLA psychologists present the first neuroscience research comparing how our brains evaluate the possibility of gaining versus losing when making risky decisions.

Participants in the study, mostly UCLA students in their 20s, were given $30 and then asked whether they would agree to each of more than 250 gambles in which they had a 50-50 chance of winning an amount of money or losing another amount of money. Would they, for example, agree to a coin toss in which they could win $30 but lose $20? While the 16 participants were considering the possible wagers, they were in a functional magnetic resonance imaging (fMRI) scanner at UCLA's Ahmanson-Lovelace Brain Mapping Center, where researchers studied their brain activity; the technique uses magnetic fields to spot active brain areas by telltale increases in blood oxygen.

For each question, the participants answered whether they would strongly agree to the gamble, weakly accept it, weakly refuse it or strongly reject it. Participants were not told whether they had won or lost until after they left the scanner; afterwards, the researchers randomly selected three of the gambles, and if the participants had previously agreed to accept those, the researchers flipped a coin and the participants

either won or lost the money. What interested the researchers, however, was the activity of the brain's regions during the decision-making process, not the subject's reaction to winning or losing.

On average, participants needed to be offered a 50 percent chance of winning about $19 to risk losing $10, but that amount varied widely among the subjects. One subject, for example, needed the chance to win $60 to risk losing $10, while another needed only the chance to win $11 to risk losing $10. The researchers could predict people's tolerance to risk by analyzing their brain patterns.

"Looking at how your brain responds to potential gains versus potential losses, we can predict how risk-averse you are going to be in your choices," said study co-author Russell Poldrack, UCLA associate professor of psychology, who holds UCLA's Wendell Jeffrey and Bernice Wenzel
Term Chair in Behavioral Neuroscience. "Brain activity predicts behavior."

"Individual differences in brain activity correspond very closely to individual differences in participants' actual choices," said co-author Craig Fox, an associate professor of policy at the UCLA Anderson School of Management and an associate professor of psychology. "The people who show much more neural sensitivity to losses relative to gains are the same people who are very reluctant to gamble unless they are offered extremely favorable gambles. The people who are about as sensitive to losses as gains neurologically are the ones who are more willing to gamble."

Thinking about the possibility of winning money turns on some of the same areas of the brain that are activated when people take cocaine, eat chocolate or look at a beautiful face, Poldrack said.

The researchers studied which parts of the brain became more active or less active as the amount of money participants could win or lose increased. Regions that become more active as the amount increases are considered "reward centers" in the brain, such as the prefrontal cortex and the ventral striatum, Poldrack said.

The researchers also found that reward centers in the brain respond not only when we actually receive rewards but also when we make decisions about potential rewards, and that when we make decisions, the reward circuitry in the brain is more sensitive to possible losses than to possible gains.

What happens in our brain when we think about potentially losing money? Some of the same areas that get turned on when we think about winning money get turned off when we think about losing money.

A surprising finding is that as the amount of a potential loss increases, the parts of the brain that process fear or anxiety, such as the amygdala or the insula, are not activated.

"What we found instead," Poldrack said, "is you don't turn anything up. You turn down the reward areas of the brain, and you turn them down more strongly for losses than you turn them up for gains. Just as people respond more strongly to a $100 potential loss than a $100 potential gain, the brain responds more strongly to a $100 potential loss versus a $100 potential gain."

Fox, a behavioral decision theorist, said the study confirms previous research showing that people are more turned off by losses than they are turned on by gains and it provides, for the first time, neural evidence to support this pattern.

"We found for the first time that the neural response to potential losses

is larger than the neural response to potential gains," Fox said.

Poldrack and Fox said they are both comfortable with risk in their lives, declining, for example, to buy insurance when they rent cars and declining to buy extended warranties for products.

When Fox was an undergraduate at the University of California, Berkeley, his faculty mentor was Daniel Kahneman, who later won the 2002 Nobel Memorial Prize in Economic Sciences. A key principle from Kahneman's seminal prospect theory, which describes how individuals evaluate losses and gains, is loss aversion: When people consider future actions, they are more sensitive to potential losses than to potential gains. Most people are about twice as sensitive to potential losses as to potential gains, which leads to risk aversion.

"In this new study, we found for the first time neurophysiological evidence for prospect theory, the most important behavioral model of decision-making to emerge in the past 50 years, whose components include the asymmetry between how losses and gains are valued," Fox said.

Sabrina Tom, a UCLA research assistant in psychology and lead author of the study, said the people who have the most deactivation in the reward pathways were also the most loss-averse.

A woman in a bad marriage, Tom said, is not likely to leave unless she has prospects that are much better than what she has.

"She's probably not going to leave for something that's only moderately better," Tom said. "She needs to know it's going to be a lot better before giving up what she already has."

The people who were most willing to gamble were least turned on as the

stakes got higher, while the people who were most averse to gambling were most turned on as gains and losses increased, Poldrack said.

The biggest risk-takers, who are willing to accept very risky gambles, have brains that respond less as the stakes increase, Poldrack said.

Source: UCLA