NEUROSCIENCE

Economic Game Shows How the Brain Builds Trust

As any economist will tell you, people don't always behave rationally when it comes to money. For instance, we sometimes trust complete strangers with our hard-earned dough. This suggests to many that a tendency to trust is hard-wired into the human brain.

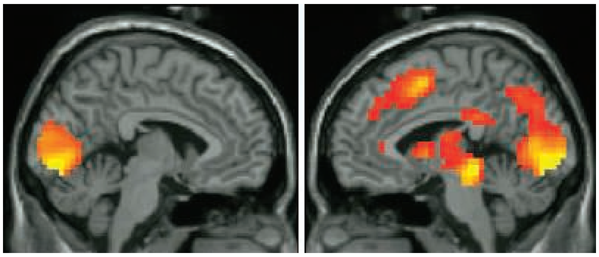
Until now, little was known about the neural circuitry underlying the capacity to trust. But on page 78, neuroscientists and economists from Texas and California report an intriguing insight: Activity in a brain region called the caudate nucleus reflects one person's intention to trust another with a sum of money. Their results also suggest that trust isn't purely noble—it may stem from a cold calculation of expected rewards.

"I think it's a very important paper. It's going to change the way we think of social interactions," says Paul Zak, who directs the Center for Neuroeconomic Studies at Claremont Graduate University in California. "It's an exceedingly well done and rigorous study," agrees Paul Glimcher, a neuroscientist at New York University.

The research exemplifies the fledgling field of neuroeconomics, which combines the brain imaging tools of neuroscience with the exchange games economists have invented to probe how people behave during financial transactions. It's also one of the first studies in which the brains of two people were scanned simultaneously during a social interaction. Two volunteers played a trust game from inside functional magnetic resonance imaging scanners, one at the California Institute of Technology in Pasadena and the other at Baylor College of Medicine in Houston, Texas.

In each of 10 rounds, one player, the designated "investor," received $20. The investor then had the option of sending some, all, or none of the $20 to the other player, the "trustee." According to the rules of the game, which were known to both sides, any money the trustee received tripled. The trustee then had the option of returning a portion of the new sum to the investor. The players' only knowledge of each other came from numbers flashed on a monitor that indicated the amount of money changing hands in each round, as well as each player's total for the game.

The extent to which a player trusted another with his or her money depended on the recent history of the exchange. If an investor increased the contribution to a trustee immediately following a round in which the trustee had reduced payback, the trustee generally rewarded this benevolent reciprocity with a greater return in the next round. But if an investor demonstrated malevolent reciprocity by repaying generosity with stinginess, the trustee usually returned less the next time around.



Tête-à-tête. Brain scans of the investor (*left*) and trustee in an economic exchange game shed light on the neural basis of trust.

Examining the trustees' brain scans, the researchers found that activity in the caudate nucleus was greatest when the investor showed benevolent reciprocity and most subdued when the investor showed malevolent reciprocity. Moreover, caudate activity rose and fell with changes in the amount of money trustees returned to their investors on the subsequent round. The team concludes that activity in a trustee's caudate nucleus reflects both the fairness of the investor's decisions and the trustee's intention to repay those decisions with trust (or not).

The caudate nucleus's "intention to trust" signal appeared about 14 seconds sooner in later rounds of the game, an indicator that the trustee is building an opinion of the investor's trustworthiness, says Read Montague, who led the Baylor team.

The caudate nucleus is well connected to the brain's reward pathways, and previous work has shown that it revs up when subjects expect a reward such as juice or money. Montague and colleagues speculate that trust, admirable trait that it is, boils down to predicting rewards—in this case, the "social juice" of the investor's reciprocity. Trust has been an element of human social interactions for many thousands of years, says Ernst Fehr, a neuroeconomist at the University of Zurich in Switzerland, so it makes sense that it would tap into ancient neural systems like the reward pathways.

–GREG MILLER

MATHEMATICS

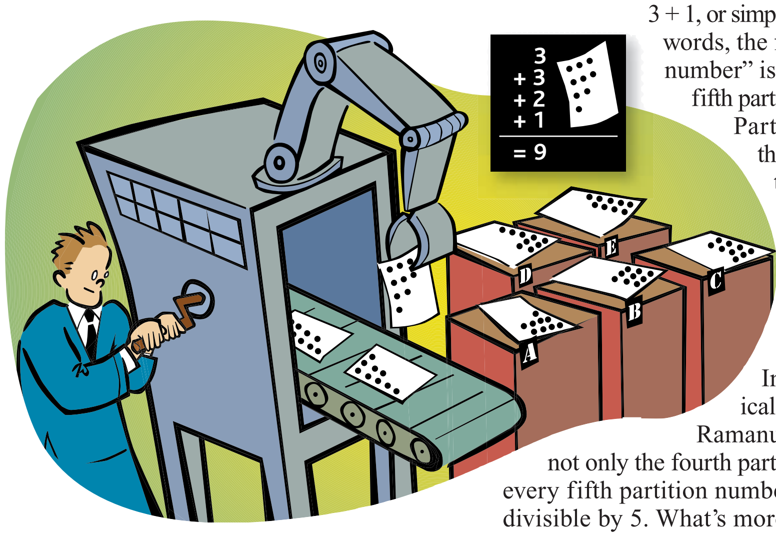
'Cranky' Proof Reveals Hidden Regularities

Mathematicians crave patterns, and nowhere do they find richer pickings than in the theory of numbers. Five years ago, a breakthrough in a long-standing problem connected with one of the simplest functions of number theory yielded an unexpected bonanza of new patterns. Now, a new proof suggests that that was just the beginning. "It's almost certain that there will be more where this came from," says number theorist George Andrews of Pennsylvania State University, University Park, whose work helped pave the way for the new result.

The proof involves the partition function, which counts the number of ways you can reach any integer by adding other positive integers. For instance, the number 4 can be partitioned in five different ways: 1 + 1 + 1 + 1, 2 + 1 + 1, 2 + 2, 3 + 1, or simply 4 itself. In other words, the fourth "partition number" is 5. Similarly, the fifth partition number is 7.

Partitions crop up throughout number theory and have proved handy for balancing energy budgets in particle physics.

In 1910 or so, Indian mathematical genius Srinivasa Ramanujan noticed that not only the fourth partition number but every fifth partition number after it is also divisible by 5. What's more, every seventh partition number (beginning with 7) is divisible by 7, and every eleventh partition ▸



Sorting it out. "Rank" and "crank" functions divide partitions (above, of 9) into classes.

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