Brain cell mechanism for decision making also underlies judgment about certainty

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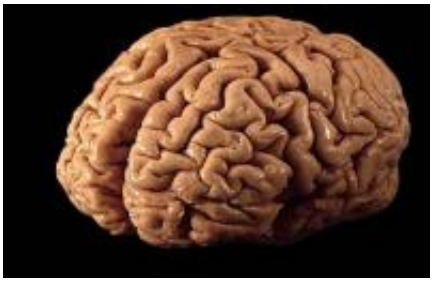

(PhysOrg.com) -- Countless times a day people judge their confidence in a choice they are about to make -- that they now can safely turn left at this intersection, that they aren't sure of their answer on a quiz, that their hot coffee has cooled enough to drink.

University of Washington (UW) researchers who study how the brain makes decisions are uncovering the biological mechanisms behind the belief that a choice is likely to be correct. Their most recent results will be published in the May 8 edition of *Science*.

"Choice certainty," noted one of the researchers, Dr. Roozbeh Kiani, "allows us to translate our convictions into suitable actions." Several other research projects have shown that choice certainty is closely associated with reaction time and with decision accuracy.

Kiani and the co-author of the May 8 *Science* article, Michael N. Shadlen are members of the UW Department of Physiology and Biophysics and of the National Primate Research Center. Shadlen is also an investigator in the Howard Hughes Medical Institute.

The researchers tested the possibility that the same brain cell mechanism that underlies decision making might also underlie judgments about certainty. In their study, rhesus monkeys played a video game in which they watched a dynamic, random dot display. They then had to determine the direction of motion. The difficulty of the task was varied by both the percentage of moving dots and the viewing time. After a short delay, the fixation point faded. This cued the monkey to indicate its choice of direction by moving its eyes toward one of two targets. The monkey would receive a reward for each correct choice, and no reward for an incorrect choice.

On a random half of the trials, the monkey could pass on making a choice and instead pick a third, fixed-position target that guaranteed a small reward. While watching the moving dots, the monkeys didn't know whether this third option would be offered. The sure bet was shown during the short delay.

"The monkeys opted for the sure target when the chance of making a correct decision about the motion direction was small," the researchers noted. They picked the sure bet more frequently when the visual evidence was weaker and duration shorter.

According to the researchers, when the monkeys waived the sure-bet option, they more accurately picked the correct direction than when the wager wasn't offered. This occurred at all levels of difficulty, suggesting that the monkeys chose the sure bet because of uncertainty, not because that round of the game was too hard.

The researchers recorded activity from 70 brain cells while the monkeys made their decisions. The cells were located in the lateral intraparietal cortex of the brain. The parietal lobe is located just under the crown of the head and plays a role in spatial sensations. In rhesus monkeys, the lateral area of the parietal lobe is attuned to movement.

The researchers found that the pattern of firing activity in these brain nerve cells could predict the direction choice and whether the monkey would opt out of the direction decision by taking the sure bet when it was offered. Normally, these brain cells change their firing rates as evidence accrues for one direction or the other, ultimately giving rise to a clear decision through high or low firing rates.

On some trials, however, these same brain cells seemed to dilly-dally and achieve an intermediate "gray zone" of activity. Those were the trials where the monkey declared uncertainty by choosing the sure-bet target.

Analysis of the detailed data from the study results show that the mechanism underlying certainty in these brain cells is linked to the same evidence accumulation that underlies choice and decision time.

"Some research has suggested that brain cells in an area associated with reward expectation or conflict are associated with decision uncertainty," Kiani noted. "However, these brain cells presumably receive this information from neurons involved in decision making."

The results of this study, according to the authors, advance the understanding of brain cell mechanisms that underlie decision making by coupling for the first time the mechanisms that lead to decision formation and the establishment of a degree of confidence in that decision.

"This simple mechanism," the authors said, "brings certainty, which is

commonly conceived as a subjective aspect of decision making, under the same rubric as choice and reaction time."

According to the researchers, it is likely that these cells also carry the relevant signals for assigning the probability of receiving a reward. The researchers noted that it seems likely that this computation of choice certainty is passed from the lateral parietal cortex to brain structures that anticipate reward, and that the response from these structures influence the decision to pick or forgo the sure bet if it is offered.

The authors went on to add, "Our findings suggest that when the brain embraces truth, it does so in a graded way so that even a binary [yes/no, true/false, left/right] choice leaves in its wake a quantity that represents a degree of belief. The neural mechanism of decision making doesn't flip into a fixed point, but instead approximates a probability distribution."

More information: The May 8 *Science* article is titled, "Representation of Confidence Associated with a Decision by Neurons in the Parietal Cortex."

Source: University of Washington (news : web)