Medical Xpress

The biological basis of economic behavior: How the brain perceives value and reward

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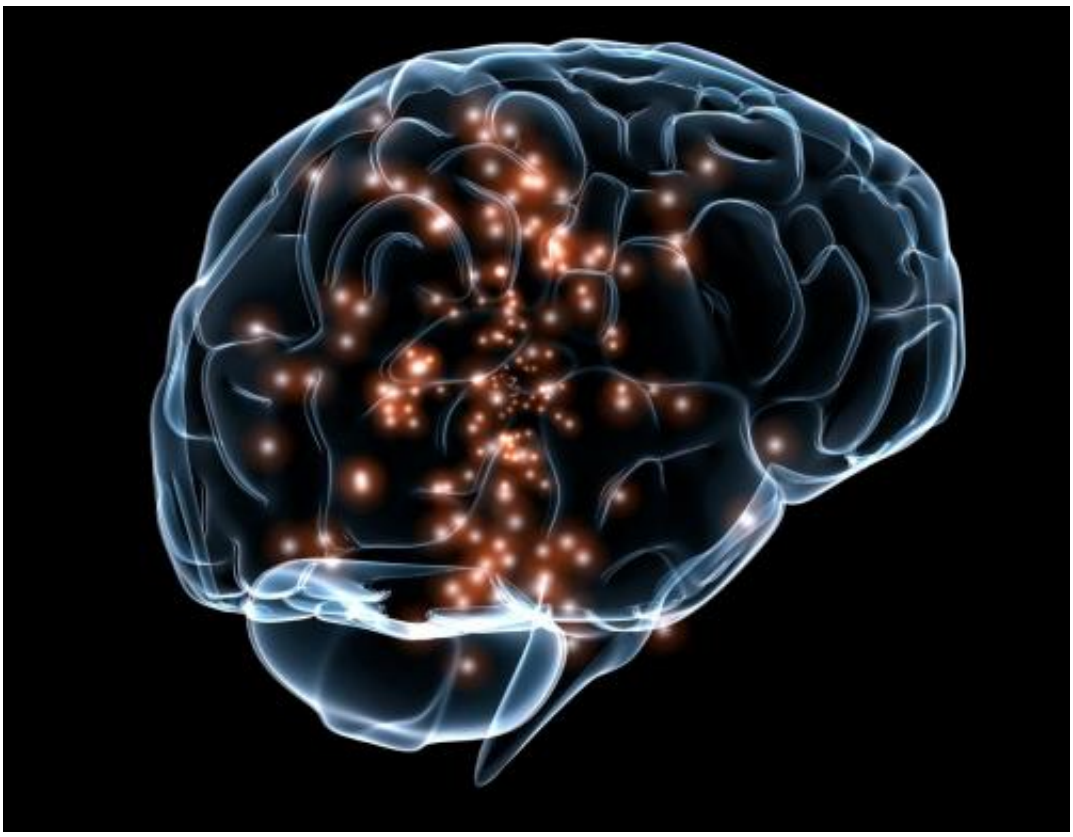

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Holiday shopping season is in full force and consumers who are on the lookout for deals in stores or online may be surprised to learn that a considerable amount of research is underway to elucidate the neuroscience underlying economic behavior.

A cadre of scientists at University College London are not only studying the complex neurobiology of how the brain perceives and determines something of value, they have suggested regions in the brain that they believe are involved in how choices about value and reward are made.

Their research is far from frivolous and can be defined as the quest to document the biological basis of economic behavior, a pursuit for which they didn't even turn to fellow humankind as test subjects. Instead, they chose a highly intelligent but distant cousin: rhesus monkeys.

Relying on simian kin allowed the researchers ample opportunity to explore visual fixation patterns, which they say lie at the core of economic decision-making.

After studying the animals in controlled experiments the researchers concluded that making a choice about the value of an object is based on a variety of factors. One key finding involves how the eyes become fixated on an object in the course of making a decision. Rhesus monkeys choose not only what they like but they deem to be of value. Objects that attract their attention and have value—for monkeys, that means being rewarded with something to eat—are those considered to be of economic importance.

"Where we direct our gaze can have a big impact on what we choose," wrote Drs. Sean E. Cavanagh and Steven W. Kennerley of University College London.

Despite their findings, the science underlying how choices are made is still fraught with unknowns. For example, "where we choose to gaze during the decision process is not well-characterized, despite the important role it plays," the scientists reported in the *Proceedings of the National Academy of Sciences*.

In the study, the monkeys performed a simple decision-making experiment where they were free to look around a computer screen that displayed choice options. They had been trained to perform decision-making tasks that allowed them to make choices that would produce a reward. Two monkeys participated in the project. They were described as two males, Macaca mulatta, Old World rhesus monkeys widely used in scientific research.

When choice options appeared, the monkeys rapidly gazed toward more valuable and novel objects. Despite a gaze "preference" for novel stimuli, subjects did not always prefer to choose them. This suggests there are mechanisms in the brain that govern value-guided choices. The animals would indicate their economic choice by moving a joystick, essentially saying: "That's the one I want."

"We constantly experience a rich assortment of visual information, some of which is highly relevant to future decisions. To make decisions efficiently, we must quickly identify relevant information in our environment—a process often accomplished by orienting our eyes toward this information.

"These findings suggest the primate brain contains fast covert valuation mechanisms to bias fixations toward valuable information," the scientists wrote.

The London-based research isn't the first to search for the neurobiological basis of value-based choices. Scientists at Cambridge University in 2016 embarked on a similar search and noted that they, too, found a physiological basis for economic behavior. That team, led by Dr. Fabian Grabenhorst, concluded in the journal *Nature*: "How such valuations are converted to economic decisions remains unclear." The Cambridge team reported that their work demonstrated that "the dorsolateral prefrontal cortex (of the brain) implements a flexible value

code based on object-specific valuations by single neurons." In short, individual neurons are stimulated in the process of making economic choices.

The London team found evidence that economic choices have a more complex neurobiological basis. "Evidence suggests that the prefrontal cortex is critical for value-based decision making and prefrontal cortex neurons encode the values of choice options," the team said, but countered that their results have led them to another conclusion.

They contend in their research that other brain regions are stronger candidates. "The subcortical saccadic system—composed of the caudate nucleus, substantia nigra pars reticulata, and superior colliculus —is a strong candidate for several reasons. Neurons within these brain regions rapidly receive cortical input, and have been shown to discriminate the value of stimuli," the team wrote.

Also important in understanding the neurobiological basis of economic behavior is learning where the animals first cast their gaze. "Surprisingly, the direction of this first fixation was not random but was strongly influenced by the value of the stimuli."

More information: Sean E. Cavanagh et al. Visual fixation patterns during economic choice reflect covert valuation processes that emerge with learning, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1906662116