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Simple brain mechanisms explain arbitrary human visual decisions

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Mark Twain, a skeptic of the idea of free will, argues in his essay "What Is Man?" that humans do not command their minds or the opinions they form.

"You did not form that [opinion]," a speaker identified as "old man" says in the essay. "Your [mental] machinery did it for you—automatically and instantly, without reflection or the need of it."

Twain's views get a boost this week from researchers at Washington University School of Medicine in St. Louis and University of Chieti, Italy. In *Nature Neuroscience*, scientists report that a simple decision-making task does not involve the frontal lobes, where many of the higher aspects of human cognition, including self-awareness, are thought to originate. Instead, the regions that decide are the same brain regions that receive stimuli relevant to the decision and control the body's response to it.

Other researchers had already demonstrated the same principle in primates. But many still assumed that the more complex human brain would have a more general decision-making module that involved the frontal lobe independently of the neural systems for perception and action.

"It is important to understand how the brain makes decisions under normal conditions to gain insight into diseases like Alzheimer's disease, traumatic brain injury or stroke in which decision-making is disrupted,"

says senior author Maurizio Corbetta, M.D., the Norman J. Stupp Professor of Neurology. "We like to think of our decisions as willful acts, but that may be an illusion. Many decisions may be much more directly and automatically driven by what our brain is sensing."

For the study, lead author Annalisa Tosoni, a graduate student at the University of Chieti, trained volunteers to perform a task that involved discriminating between an image of a face and an image of a building. Varying degrees of noise obscured the image during the brief time it was visible. Volunteers were asked to indicate which type of image they believed they had seen by either moving their eyes in a particular direction if they had seen a face or pointing their hand in the same direction if they had seen a building.

"This decision is not automatic," Corbetta says. "It requires both attention to the stimuli and control of the response."

Researchers took functional magnetic resonance imaging scans of subjects' brains as they performed the task. The scans were conducted at the Institute of Technology and Advanced Bio-imaging in Chieti as a collaboration between Corbetta; Gaspare Galati, Ph.D., associate professor of psychology at the University of Rome; and Gian Luca Romani, Ph.D., professor of physics at the University of Chieti. To help distinguish between the influx of sensory information and the decision to move the eye or hand, subjects had to wait for 10 seconds after seeing the image before indicating which type it was.

Scientists concentrated on regions of the brain that are responsible for planning actions (eye or hand movements) in the parietal lobe. Activity in these different regions would increase in correspondence with the type of stimulus a subject was being shown (face or building) and the type of response they were planning as a result (eye or hand movement). When the stimulus had less noise and subjects were more confident in

their choice, brain activity levels in the appropriate area rose proportionally. In addition, these regions showed activity that related to the choice even when the stimulus was ambiguous.

"This suggests that these regions in the parietal lobe processed all the sensory, decision and motor signals necessary to make and act on the decision," Tosoni says. "In contrast, no area in the frontal lobe, thought to be involved in decision-making, significantly increased its activity at the time of decision."

The training period that preceded the scans could have involved the frontal lobes, Corbetta notes. Those areas may have delegated responsibility for the decision to premotor brain regions as the volunteers learned the task. But once the task was learned, the frontal lobes were silent.

"Even for arbitrary and somehow complex visual decisions, it seems to be purely a matter of the amount of sensory information pushing the brain toward one choice or another " he says.

Tosoni and Corbetta plan next to probe whether more complicated decisions are carried out by this relatively simple sensory-motor mechanism and how decisions are affected by the amount of reward the subject expects when performing simple and complex decisions.

Source: Washington University School of Medicine