

New study challenges scientific dogma on how the brain generates actions

April 4 2016

It would certainly be pretty strange to see someone trying to call an elevator by pressing the button using their nose, or elbow. But actually why not? Anyone who has ever asked a young child to call the elevator knows very well that using their pointing finger wouldn't necessarily be their first choice, nor the second for that matter ... How does it happen? How does the brain choose the optimal action to achieve a goal and then repeats it to the point where it becomes a deeply ingrained habit that we perform without reflection?

In a study published today (April 4) in the scientific journal *Current Biology*, neuroscientists at Champalimaud Centre for the Unknown in Lisbon report novel findings that challenge the way the scientific community has been thinking about how actions are selected and habits are formed.

The process of action selection is thought to be mediated by two competing subsystems that co-reside in a brain structure called the Basal Ganglia. One is called the direct pathway. It is thought to send a positive 'Go' signal that drives the execution of a desired action, like pressing the elevator button. The other is called the 'indirect pathway', and it is believed to send a 'No-Go' signal that leads to avoidance of the action.

The novel findings show that these two pathways are not actually always competing against each other. Instead, they work concurrently to promote distinct, but positive, outcomes. "We found that contrary to common belief, the indirect pathway does not always prevent actions

from being performed, it can actually reinforce the performance of actions" - Explains Dr. Rui Costa, the leading researcher of the study. "However the indirect pathway promotes a different type of actions, habits".

"Habits are very important in our everyday lives." Says Dr. Pedro Galvão-Ferreira, one of the co-authors of the study. "Habits are reliable, well-rehearsed actions that free us from the need to pay close attention to what we are doing. It remains to be proven whether performing habits is less energetically costly to the brain, but as many of us know from experience, it is easier to perform a few habitual actions at once, such as driving home while singing a nursery song to your child, than simultaneously performing goal-directed actions such as driving to a new place while trying to invent a song at the same time."

The researchers discovered the different functions of the two pathways by using advanced techniques that enable the selective activation of each pathway in mice. "Contrary to the present view, when the indirect pathway was selectively activated, instead of inhibiting the behaviour of the mice all together, we saw a slow-rising, but consistent reinforcement of habitual behaviour", explains Dr. Ana Mafalda Vicente, co-author of the study.

"Understanding the Basal Ganglia is crucial not only for figuring out how the brain selects and generates [actions](#), but also for understanding the basis of neural disorders such as Parkinson's Disease and Obsessive Compulsive Disorder, which occur due to malfunction in the this brain region", concludes Dr. Costa. "There is still much to reveal about these brain areas. For example, the direct and indirect pathways may not always opponents of each other; they can be both important for us to do what we want - the direct pathway could promote pressing the elevator button with your hand while the indirect pathway could inhibit pressing the button with your nose."

More information: Direct and indirect dorsolateral striatum pathways reinforce different action strategies, *Current Biology*, 2016.

Provided by JLM&A, SA

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