Activity of individual brain cells predicts cognitive flexibility

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A new study provides intriguing insights into mechanisms of cognitive flexibility at the single cell level. The research, published by Cell Press in the March 26th issue of the journal *Neuron*, may help to explain how we can change our point of view when faced with conflict.

We rely on an appropriate configuration of mental resources, known as a cognitive set, to help facilitate our behavior. However, behavioral flexibility relies on an ability to quickly shift to a new cognitive set (i.e. change our point of view) in response to changing external demands.

Brain imaging in human subjects while they engaged in trials that induced cognitive set shifts (known as shift trials) identified the posterior parietal cortex (PPC) as a brain region that appears to be involved in set shifting. However, due to imaging limitations, it was not possible to determine whether the PPC neurons were responding to the stimulus presentation or behavioral response or any other cognitive process during the shift trials.

Single cell recording studies in monkeys engaging in set-shifting paradigms have been unsuccessful because animals often have difficulty promptly shifting their cognitive sets under experimental conditions. "As a result, dynamic processes of cognitive set shifting have not been explored at the single-unit level in the primate brain," explains the first author Dr. Tsukasa Kamigaki from the Department of Physiology at The University of Tokyo School of Medicine.

Dr. Kamigaki and colleagues trained two monkeys to promptly shift their cognitive sets and compared neuronal activity during shift and non-shift trials to detect shift-related activity in the PPC. The experimental paradigm, originally devised for humans but modified to test cognitive flexibility in monkeys, required monkeys to match a sample stimulus to one of three choice stimuli based on one "dimension", shape or color. "Whenever the relevant dimension changed, the monkeys had to shift their cognitive set in order to respond based on the new dimension," explains Dr. Kamigaki.

The researchers discovered that PPC neurons were transiently activated when the monkeys shifted from one cognitive set to another (e.g., color to shape), but not when they shifted in the opposite direction (e.g., shape to color). Importantly, the shift-related activity preceded the corresponding behavioral responses by about four seconds and accurately predicted whether or not the cognitive set would be successfully shifted.

"Beyond the previous views that the PPC is involved mostly in cognitive processes directed to external visual objects or space, the results in the present study provide unprecedented evidence that PPC neurons contribute to flexible shifting of internal cognitive sets in primates," concludes Dr. Kamigaki.

Source: Cell Press (news : web)