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Press release

How does the brain adapt to different situations?

When we are confronted with an uncertain, changeable or new situation, our brain, after a moment's reflection, will opt for one course of action over another. A team of scientists led by Etienne Koechlin, Director of the Cognitive Neuroscience Laboratory (Inserm/ENS), has just decoded the reasoning process behind the human ability to adapt. The scientists have discovered the algorithm used by the prefrontal cortex to enable human beings to think rationally and hence to adapt to different situations by means of two distinct processes.

The results have been published in the 29 May 2014 issue of *Science Express*.

Decision making occurs in the frontal lobe of the brain, in an area known as the prefrontal cortex. We already knew that this area was involved in decision making and behavioural control. However, we did not understand how it endows human beings with their highly-developed reasoning and analysis skills, which are strongly solicited in new situations.

In the study published in *Science Express*, researchers at the Cognitive Neuroscience Laboratory (Inserm/ENS) analysed the brain activity of 40 healthy young people (aged between 18 and 26), according to a protocol inspired by the board game *Mastermind*. They were placed in an uncertain and changeable situation much like in the game, where players have to use their powers of deduction to find a hidden combination of coloured pegs using fragmented information. They also had to adapt because, in the protocol used, the combination could change without the participants' knowledge.

Using neuroimaging techniques, the researchers have discovered how the problem-solving algorithm in the prefrontal cortex works and explained how human beings reason and adapt to uncertain, changeable and new situations.

The study reveals the key role played by two areas of the prefrontal cortex. The first area, which is located between the ventro and dorsomedial regions of the prefrontal cortex, is able to analyse the situation and arbitrate between adjusting the individual's current behaviour or exploring new strategies coming from the individual's long-term memory.

The second area, known as the 'frontopolar' cortex is found in the most anterior, lateral part of the frontal lobes and is believed to be absent in non-human primates. It is capable of analysing two or three alternative strategies at the same time. *"The frontopolar cortex enables individuals to assess several concurrent hypotheses simultaneously, to judge their reliability and to develop new hypotheses based on long-term memories"*, explains Etienne Koechlin, Inserm research director and the principal author of the study.

These two areas operate jointly and are responsible for the reasoning process that consists in comparing and testing hypotheses and deciding whether to accept them or to reject them in favour of other, newly created strategies.

"Our findings are a major step forward, since it is the first time that the problem-solving algorithm in this part of the brain has been mathematically modelled and updated", he concludes.

Neuropsychiatric disorders massively impair the function of the prefrontal cortex. Its development is delayed late into adolescence and it becomes impaired with age. These findings open up many possibilities, as they will help us to better understand how the development, ageing and impairment of the prefrontal cortex affect the judgement of individuals and how to remedy these effects.

Sources

Foundations of Human Reasoning in the Prefrontal Cortex

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