Decision-making -- Demonstration of a link between cognition and execution

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For the first time, a team of researchers in the Movement, Adaptation, Cognition Laboratory (CNRS/University Victor Ségalen, Bordeaux) has revealed the existence of an interaction at the cellular level between cognitive information and motor information.

This discovery provides the missing link between studies on decision-making processes and those relative to the execution of motor acts. It constitutes a fundamental advance in our understanding of the physiological role of the basal ganglia and, more specifically, of Parkinson's disease. This work was published on January 31 in *The Journal of Neuroscience*.

There are two phases in the genesis of a movement directed towards a target when several choices are possible: firstly decision-making (cognitive information) and then the direction of this movement towards to the target (motor information). The brain is endowed with one or several structures which can integrate both cognitive information (enabling a reasoned choice which is not based on chance) and motor information. It is supposed that the basal ganglia play an essential role in these processes. However, the underlying mechanisms are still generally unknown.

A certain number of studies have suggested that the striatum , the cerebral structure considered as the portal of entry for the basal ganglia, may intervene in decision-making processes; as soon as a choice is offered to an individual, it evaluates the degree of incentive provided by

each of the options possible. This phenomenon is probably controlled by dopamine , one of the neuromodulators present in large quantities in the basal ganglia. Furthermore, it has been shown that the electrical activity of neurons in the internal globus pallidus , the brain structure qualified as the exit point for the basal ganglia, codes the kinetic properties of the movement (direction, amplitude, speed, etc.). However, until now, no studies had demonstrated the existence of a link between the decision-making phase and the executive phase.

To establish this interaction, researchers in the Movement, Adaptation, Cognition Laboratory, a joint CNRS and University of Bordeaux 2 unit affiliated to the Franco-Israeli Neurophysiology and Neurophysics of Systems Laboratory , simultaneously recorded in primates the electrical activity of neurons in the two structures concerned, the striatum and internal globus pallidus. The animals were required to choose between two targets which were rewarded differently, and then perform a movement towards the target chosen. It had previously been determined that each animal had learnt to associate each target with a different probability of obtaining a reward. They therefore had to have memorised these combinations and chosen the target associated with the greatest probability of an optimum reward.

This experiment showed that cognitive information modulates the coding of motor information via neurons which belong to the two key structures in the basal ganglia: at entry and exit. This is the first time that a cellular interaction has been demonstrated between purely cognitive and purely motor information. Above all, the mechanisms by which the basal ganglia integrate these two types of information have been elucidated. This discovery will have a considerable impact on our knowledge of Parkinson's disease, as this condition is caused by a degeneration of dopamine-producing neurons. As a result, it will be necessary to adopt a new approach to this disease. Although Parkinson's disease expresses itself through severely incapacitating motor disorders, such as an

increasing difficulty in initiating and executing movements, marked muscle rigidity and tremor, it should no longer be considered as a purely motor pathology: it will now be necessary to take account of its cognitive dimension as well.

Source: CNRS