Switching between habitual and goal-directed actions—a 'two in one' system in our brain

August 6 2013

To unravel the circuit that underlies this capacity, the capacity to "break habits," was the goal of the study, carried out by Christina Gremel and Rui Costa, at NIAAA, National Institutes of Health, USA and the Champalimaud Foundation, in Portugal published in *Nature Communications*.

"Pressing the button of the lift at your work place, or apartment building is an automatic action – a habit. You don't even really look at the different buttons; your hand is almost reaching out and pressing on its own. But what happens when you use the lift in a new place? In this case, your hand doesn't know the way, you have to locate the buttons, find the right one, and only then your hand can press a button. Here, pushing the button is a goal-directed action." It is with this example that Rui Costa, principal investigator at the Champalimaud Neuroscience Programme (CNP), explains how critical it is to be able to shift between habits and goal-direct actions, in a fast and accurate way, in everyday life.

To unravel the circuit that underlies this capacity, the capacity to "break habits", was the goal of this study, carried out by Christina Gremel and Rui Costa, at NIAAA, National Institutes of Health, USA and the Champalimaud Foundation, in Portugal, that is published today (Date) in *Nature Communications*.

"We developed a task where mice would shift between making the same action in a goal-directed or habitual manner. We could then, for the first time, directly examine brain areas controlling the capacity to break habits," explains the study's lead author Christina Gremel from NIAAA. Evidence from previous studies has shown that two neighbouring regions of the brain are necessary for these different functions – the dorsal medial striatum is necessary for goal-directed actions and the dorsal lateral striatum is necessary for habitual actions. What was not known, and this new study reveals, is that a third region, the orbital frontal cortex (OFC), is critical for shifting between these two types of actions. As explained by Rui Costa, "when neurons in the OFC were inhibited, the generation of goal-directed actions was disrupted, while activation of these neurons, by means of a technique called optogenetics, selectively increased goal-directed actions."

For Costa, the results of this study suggest "something quite extraordinary – the same neural circuits function in a dynamic way, enabling the learning of automatic and goal-directed actions in parallel."

These results have important implications for understanding neuropsychiatric disorders where the balance between habits and goal-directed actions is disrupted, such as obsessive-compulsive disorder.

The neural bases of behaviour, and their connection to neuropsychiatric disorders, are at the core of ongoing work by neuroscientists and clinicians at the Champalimaud Foundation.

Provided by Champalimaud Foundation