The cerebellum as navigation assistant: A cognitive map enables orientation

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The cerebellum is far more intensively involved in helping us navigate than previously thought. To move and learn effectively in spatial environments our brain, and particularly our hippocampus, creates a "cognitive" map of the environment. The cerebellum contributes to the creation of this map through altering the chemical communication between its neurones. If this ability is inactivated, the brain is no longer able to to create an effective spatial representation and thus navigation in an environment becomes impaired. The details of these observations were recently published in *Science* by the Ruhr University neuroscientist, Marion André who is a student of the International Graduate School of Neuroscience(IGSN), along with her colleagues in France.

In order to navigate efficiently in an environment, we need to create and maintain a reliable internal representation of the external world. A key region enabling such representation is the hippocampus which contains specialized pyramidal neurons named place cells. Each place cell is activated at specific location of the environment and gives dynamic information about self-location relative to the external world. These neurons thus generate a cognitive map in the hippocampal system through the integration of multi sensory inputs combining external information (such as visual, auditory, olfactory and tactile cues) and inputs generated by self-motion (i.e. optic flow, proprioceptive and vestibular information).

Our ability to navigate also relies on the potential to use this cognitive map to form an optimal trajectory toward a goal. The cerebellum, a

foliate region based at the back of the brain, has been recently shown to participate in the formation of the optimal trajectory. This structure contains neurons that are able to increase or decrease their chemical communication, a mechanism called synaptic plasticity. A decrease in the synaptic transmission of the cerebellar neurons, named long-term depression (LTD) participates in the optimization of the path toward a goal.

Using transgenic mice that had a mutation impairing exclusively LTD of the cerebellar neurons, the neuroscientists were able to show that the cerebellum participates also in the formation of the hippocampal cognitive map. Indeed mice lacking this form of cerebellar plasticity were unable to build a reliable cognitive representation of the environment when they had to use self-motion information. Consequently, they were unable to navigate efficiently towards a goal in the absence of external information (for instance in the dark). This work highlights for the first time an unsuspected function of the cerebellum in shaping the representation of our body in space.

More information: Christelle Rochefort, Arnaud Arabo, Marion André, Bruno Poucet, Etienne Save, and Laure Rondi-Reig: Cerebellum Shapes Hippocampal Spatial Code. *Science*, 21 October 2011: 385-389. DOI:10.1126/science.1207403

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