The thalamo-presubicular loop for signalling head-direction

Spatial orientation in animals and in humans relies on networks of specialized neurons in extended brain regions. In this project, we will focus on cells in the anterior thalamus and in the presubiculum, that are sensitive for head direction: these cells fire specifically when the head of the animal is oriented in their preferred direction, contributing as a sort of compass to navigation. While presubiculum signals the current head direction, the thalamic head direction cells anticipate the future direction of the head. How the head-directional signal is updated and coherently organized across different brain areas is unknown.

Our group has characterized the functional neuroanatomy of the principal neurons and interneurons in the presubiculum in the slice preparation (Nassar et al., Frontiers, 2015; Simonnet et al., EJN, 2013 ; Simonnet et al., Nature Communications, 2017). For this M2 project, anatomical, electrophysiological and optogenetic techniques will be used to map the cell-type specific connectivity of the reciprocal thalamocortical loop. What are the target neurons of thalamic inputs to the presubiculum ? Which presubicular neuron types project to the thalamus ? To test this, the candidate will perform in vivo stereotaxic injections of retrograde tracers and viral

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A envoyer à Claire Legay claire.legay@parisdescartes.fr avant le 30 avril 2016
constructs in the mouse brain. He or she will virally express ChR2 in principal neurons or, in a cre dependent manner, in PV or SST interneurons. Patch clamp recordings will be combined with photostimulation to study synaptic connectivity. To identify the nature of long-range neurons, the candidate will stimulate their axon terminals in the slice, while searching for excitatory or inhibitory postsynaptic events in patch clamp recordings of nearby neurons. Preliminary data suggest presubicular long-range GABAergic connections, which could be important for shifting the population of active thalamic head direction units in relation to visual landmark information.

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