Equipe : Architectures et modèles pour l'adaptation et la cognition (AMAC)
Responsable : GIRARD Benoît

SUJET PROPOSE

Titre : Modélisation des régime oscillatoires conjoints des ganglions de la base et du cortex

Projet : (4500 signes espaces compris) Brain activity displays multiple oscillation modes, but we don't yet know for certain whether oscillations are a byproduct of the physical properties of the brain or an active component of its computations. Recent results suggest the implication of β oscillations (13-35Hz) in cognitive processes: β activity is prominent in decision-making tasks such as in free choice decision (Pesaran et al., 2008). These decision-making processes involve circuits arranged in loops connecting frontal cortex
areas, the basal ganglia and the thalamus.

The team of E. Procyk (INSERM, Lyon) with whom we collaborate, have a set of electro-physiological data acquired in the anterior cingulate and prefrontal cortex (ACC and PFC) of monkeys performing the self-paced decision-making EE (Exploration/Exploitation) task (Procyk & Goldman-Rakic, 2006), which has revealed complex modulations of β oscillations (Stoll, Wilson et al., 2016; Wilson et al., 2016). Their results suggest β bursts might reflect on-going, unitary short-lived network dynamics subserving the deliberative processes generating endogenous flexible decisions.

The ISIR team has already developed spiking models of the components of the cortico-baso-thalamo-cortical loop involved in decision-making in the EE task:
ACC and PFC recurrent networks have already been developed to explain data from the Procyk team (Fontanier et al., In Prep). They display dopamine (DA) modulation and emerging attractor dynamics, based on Hebbian learning. They exhibit discrete β bursts at rest, with a relatively flat distribution of the power in the various frequency bands.
The monkey basal ganglia model, initially developed at the population level (Liénard et al., 2014), is based on realistic spiking neurons, synaptic delays and displays emerging selection properties (Girard et al., submitted). It also exhibits discrete β bursts, but only in the upper part of the β band, and it has a bimodal distribution of power, in the upper β and in the ɣ band.
The thalamic network model, already published (Paz et al., 2012), will close the loop.
Connecting these models will provide an exceptional tool to investigate emerging spiking dynamics, β bursts and decision-making in frontal loops.
The EE task includes both working memory and reinforcement learning components. Thus, our final objective is to build a network that will incorporate DA-reinforcement synaptic rules 1) at cortico-cortical synapses, to learn associative attractors of task states representations (PFC) and of meta-learning valuation (ACC), and 2) at cortico-basal synapses to learn task contingencies.

The goal of the thesis is to assemble the complete model in order to explain the EE experimental data.

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