Effects of local gain modulation on probabilistic selection of actions

Elif Köksal-Ersöz | Lyon Neuroscience Research Center

Adaptation of behavior requires the brain to change goals in a changing environment. Synaptic learning has demonstrated its effectiveness in changing the probability of selecting actions based on their outcome. In the extreme case, it is vital not to repeat an action to a given goal that led to harmful punishment. Here, we propose a multiple timescale model where a simple neural mechanism of gain modulation that makes possible immediate changes in the probability of selecting a goal after punishment of variable intensity. Results show how gain modulation determine the type of elementary navigation process within the state space of a network of neuronal populations of excitatory neurons regulated by inhibition. Immediately after punishment, the system can avoid the punished populations by going back or by jumping to unpunished populations. This does not require particular credit assignment at the 'choice' population but only gain modulation of neurons active at the time of punishment. Gain modulation does not require statistical relearning that may lead to further errors, but can encode memories of past experiences without modification of synaptic efficacies. Therefore, gain modulation can complements synaptic plasticity.

Elif Köksal-Ersöz (Inria, Villeurbanne, France; Cophy Team, Lyon Neuroscience Research Center, Bron, France), Pascal Chossat (Project Team MathNeuro, Inria-CNRS-UNS, Sophia Antipolis, France), Frédéric Lavigne (Université Cote d'Azur, CNRS, BCL, Nice, France).
