Cerebellar model tested in control of a load-carrying robot

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The cerebellum is an evolutionarily old structure that participates in the coordination of motor actions in a predictive manner. It has been suggested that motor learning in the cerebellum involves the development of new input-output associations depending on the context of the task [1].

In order to complete meaningful motor actions, we also need information about our current state provided by our visual, auditory, and somatosensory systems. Each of these modalities has dedicated cortical areas that process mainly information of a single modality. Multisensory regions include posterior auditory association cortex, superior temporal polysensory area, and ventral intraparietal sulcus [2], and subcortical structures such as superior colliculus [3].

We are using a neural model of the cerebellum to stabilize a simulated robot consisting of wheels and an upright body, analogous to an inverted pendulum. The cerebellum receives inputs from its motor (wheels) and sensory systems (position and tilt). It learns to associate and predict its own modified state with its motor actions using a hierarchical reflex as a teaching signal.

The complexity of the stabilization problem increases when the system needs to account for delays in the afferent inputs or changes in context, e.g. changes in the robot's dynamics when carrying a non-stationary load. The cerebellum is able to overcome the delays, but cortical, possibly multisensory, processing is needed to deduce the context. We aim at finding a representation of the context that the cerebellum can utilize in its stabilization task.

[1] D. Manzoni, *Cerebellum* **6** 24-37 (2007)
[2] C.E. Schroeder and J.J. Fox, *Cogn Brain Res.* **14** 187-198 (2002)
[3] J.C. Alvarado *et al., J Neurophysiol*. **97** 3193-3205 (2007)