Stochastic resonance in the locomotor CPG: evidence from an in vitro study

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The concept of stochastic resonance, used in the description of certain physical phenomenons, has been recently introduced in current Neuroscience language, to describe the contribution of intrinsically variable inputs in increasing neuronal performance.

Experimentally, I have investigated the phenomenon of stochastic resonance in one of the most studied spinal circuits (the Central Pattern Generator, CPG, for locomotion), using the *in vitro* isolated spinal cord of a neonatal rat.

As for an electrical stimulating protocol, that is provided of its own intrinsic variability, I have applied a trace sampled from a stable fictive locomotion rhythm acquired from the same preparation in the presence of NMDA plus 5HT.

In correspondence to the application of this stimulating protocol (that from now on I will name FL stim) to one dorsal root, now kept in normal Krebs solution, I have simultaneously recorded from the ventral nerves an epoch of alternating cycles, that after tens of events inevitably lapses, even if stimulation is maintained.

The locomotor cycles are not correlated to the frequency of the stimulating protocol and the delivery of stimulii with a different frequency still evoke stereotyped episodes.

Surprisingly, this new stimulating wave shape proved to be capable of eventually inducing a locomotor response, even with subthreshold concentrations, if compared to the intensity required to evoke a reflex response on the same preparation.

To assess the features responsible for the privileged access of this stimulating protocol to the CPG, I have compared the locomotor response obtained from the provision of FL stim to the one evoked by a pure sinusoid of same amplitude and frequency, as well as to the one composed of the sole gaussian noise with the same amplitude as the baseline in our registrations and finally to the sinusoid to which a gaussian background noise has been added.

In the case of registrations using a pure sinousoid wave or a noisy one, I have obtained synchronous responses, that correspond to the peaks of stimulation, while the application of the mere gaussian noise is not able to induce a locomotor response, although, after a certain latency from the application onset, it is able to organize a synchrounous rhythmic pattern recorded from all ventral roots. The FL stim, unique among the tested protocols, thus possesses the appropriate characteristics to activate the locomotor circuits.

This observation indicated the important contribution played by the type of intrinsic signals contained in the afferent inputs in order to activate the CPG. These results cast some light on the integration of sensory inputs into the spinal locomotor networks and may reveal interesting implications for neurorehabilitation, using functional electrical stimulation applied to spinal cord injured persons.

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