Sonderforschungsbereich/Transregio 31
"Das aktive Gehör"

E I N L A D U N G

zum Vortrag im Rahmen des Seminars des SFB/TRR 31

Freitag, 4. Juli 2014, 14 Uhr c.t.

im Raum W2 1-143 der Universität Oldenburg
und Raum H28 / R 2.31 des Med. Campus Magdeburg
(per Videoübertragung)

"Functional consequences of spike threshold adaptation for auditory processing"

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Neurons encode information in sequences of spikes, which are triggered when their membrane potential crosses a threshold. In vivo, the spiking threshold displays large variability suggesting that threshold dynamics have a profound influence on how the combined input of a neuron is encoded in the spiking. Using intra-cellular recordings in the inferior colliculus of the barn owl, we showed that spike threshold can be predicted from the membrane voltage and is therefore not artifactual. A fundamental consequence is that the effective integration time constant is lower than the one estimated from the membrane potential, a critical fact for coincidence detection.

We then explored the possible functions of threshold adaptation on auditory processing, in particular the envelope filtering in the auditory nerve fibers and the cochlear nucleus angularis (NA). While the filtering performed by owl's auditory nerve fibers is low-pass, one synapse further, NA neurons can be tuned to a given envelope frequency, i.e. their filtering is of band-pass nature. Using in vivo and in vitro electrophysiology as well as computational analysis we showed that spike threshold adaptation can explain the difference in neural filtering between the two areas. In particular, the non-linearity in the threshold dynamics can explain the fact that NA neurons are low-pass at low sound levels but band-pass at higher levels.

Because the first purpose of the mechanisms underlying threshold adaptation is the generation of action potentials, their functional effects on the sensory stream do not add complexity at the cellular or circuit level nor increases energy consumption, which confer them undeniable advantages compared to other mechanisms implementing the same functions.

Related references:

B. Fontaine, JL. Pena, R. Brette, Spike-threshold adaptation predicted by membrane potential dynamics in vivo, PloS Comput Biol 10(4): e1003560, (2014)

B. Fontaine, KM. MacLeod, ST. Lubejko, LJ. Steinberg, C. Köppl, JL. Peña, Emergence of band-pass filtering through adaptive spiking in the owl's cochlear nucleus, in press, J Neurophysiol (2014)

B Fontaine, V Benichoux, PX Joris, R Brette: Predicting spike timing in highly synchronous auditory neurons at different sound levels, J Neurophysiol, 110: 1672–1688, (2013)