Dissecting an auditory transduction chain *in vivo*: How to disentangle the biophysical processes that shape the neural code.

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Every sensation begins with the conversion of a sensory stimulus into the response of a receptor neuron. Typically, this involves a sequence of multiple biophysical processes that cannot all be monitored directly. Here, we present an approach that is based on analyzing different stimuli that cause the *same* final output. Comparing such iso-response stimuli within the framework of non-linear dynamical models allows us (a) to extract the characteristics of individual signal-processing steps with a temporal resolution much finer than the trial-to-trial variability of the measured output spike times, (b) to unmask input-driven components of spike-frequency adaptation, and (c) to identify the biophysical origin of firing-rate saturation.

Applied to insect auditory receptor cells, the technique reveals the sub-millisecond dynamics of the ear-drum vibration and of the electrical potential and yields a quantitative four-step cascade model. The model accounts for the tuning properties of the investigated neurons and explains their high temporal resolution under natural stimulation. Firing-rate adaptation is shown to depend on output-driven as well as on input-driven components. Similarly, firing-rate saturation cannot be caused by the spike-generating mechanism only. Owing to its simplicity and generality, the presented method is readily applicable to other non-linear cascades and a large variety of signal-processing systems.

Apart from new, unpublished results about the origin of firing-rate saturation, details can be found in the following publications:

T. Gollisch, H. Schütze, J. Benda and A.V.M. Herz
Energy integration describes intensity coding in an insect auditory system.
Journal of Neuroscience, **22,** 10434-10448 (2002).

T. Gollisch and A.V.M. Herz
Input-driven components of spike-frequency adaptation can be unmasked in vivo.
Journal of Neuroscience **24**, 7435-7444 (2004).

T. Gollisch and A.V.M. Herz
Disentangling sub-millisecond processes within an auditory transduction chain.
Public Library of Science – Biology **3**, e8 (2005).