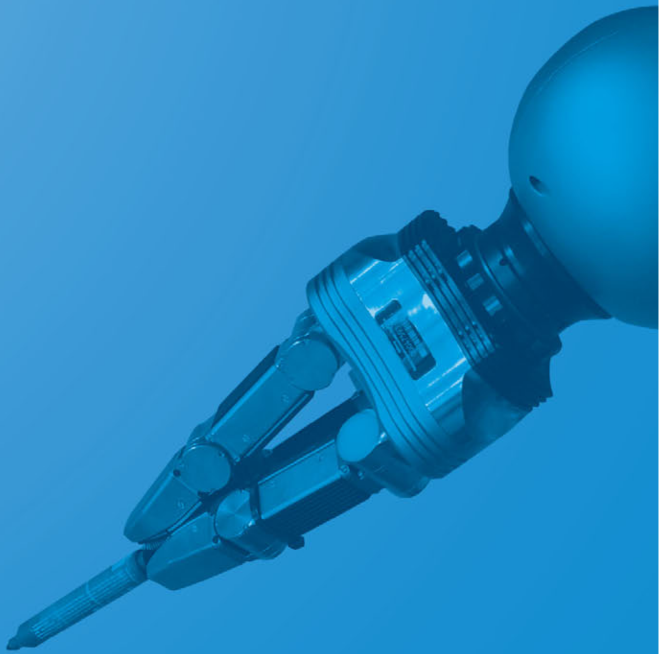
Bernstein Network Computational Neuroscience

Bernstein Newsletter



Recent Publications
Hearing – Learning after stroke – Hearing in grasshoppers – Writing robot – Grasping movements

Meet the scientist
Henning Sprekeler

News and Events
Personalia – Bernstein Conference 2011 – Public dialogue „Neuronal Implants“ – In memory of Valentino Braitenberg – Call for proposals: Bernstein Award 2012 – Lecture series „Neurotechnology“

12/2011

Less is more in the grasshopper's ear

Our senses are constantly flooded with stimuli. In order to distinguish important from unimportant information, our senses already provide a valuable preprocessing step for the brain. Even just a few cells suffice in order to process complex stimuli, as scientists from the Bernstein Center Berlin and the Humboldt-Universität zu Berlin (HU) showed. They investigated how the auditory system of grasshoppers recognizes species-specific courtship songs and found that only three cellular interconnections are needed for song identification. Furthermore, it does not matter that the signals transduced to the brain are far less precise than the input signals.

Millions of stimuli affect us, but only a fraction of these are important to us. The stimuli are filtered by the sensory organs and preprocessed, such that our brain is able to track what is important without becoming overwhelmed. The retina, for instance, does not only send single pixel information to the brain, but also information about movements and edges. For this purpose, a large network of thousands of cells is necessary. However, in many animals the neuronal networks of the sensory organs are much more simply constructed. Researchers led by Bernhard Ronacher, Susanne Schreiber and Sandra Wohlgemuth of the Bernstein Center and the HU in Berlin wondered how efficiently simple networks can perform preprocessing of complex stimuli. To answer this question, they examined the auditory system of grasshoppers, which is important for the recognition of species-specific courtship songs. The studied neurons are found in the thoracic ganglia of the animals.

To their surprise, the researchers discovered that after three cellular processing steps, the information was already heavily modified, and, above all, temporally inaccurate. However, the neuronal signals that were transmitted to the brain did contain the essential information about song features.

The courtship songs of different grasshopper species are characterized by alternating sounds and pauses. The activity of the sensory cells that sit in the ear on the abdomen of the animals was precisely temporally coupled with the incoming stimulus patterns. This allows the animals a very accurate classification of the patterns of courtship songs. But already the following cells showed a specific pattern of activity that forwarded only a fraction of the information. "At the beginning, we were very surprised that the network destroys that important precision," says first author Jan Clemens. However, their analysis shows the reason for the change in signals. "While at the beginning of processing, most information lies in the precise timing of neuronal signals, the output signals are rather a yes-no answer," says group leader Susanne Schreiber. Thus, many details are lost on the way to the grasshoppers' brain, but the essential content about song features is much more readily available to the animal.

Thus, this small network also matches the prediction that information processing should be highly efficient in nervous systems in order to survive in evolution. For the next step, the scientists in Berlin aim to rebuild this neuronal network on the computer in order to understand such important data processing more thoroughly.

The ears of grasshoppers are located in the abdomen; neurons that are also important for sound processing are in the thorax region. Only highly filtered information reaches the brain.

Clemens J, Kutzki O, Ronacher B, Schreiber S*, Wohlgemuth S* (2011): Efficient transformation of an auditory population code in a small sensory system, PNAS doi:10.1073/pnas.1104506108, *equal contribution