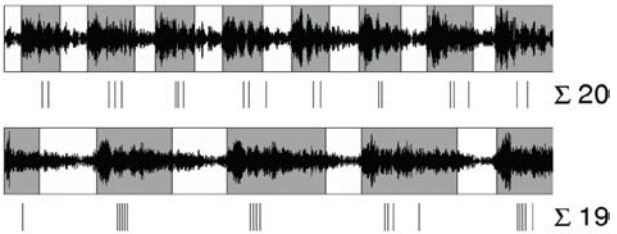
The math trick of neuron nr. 12

When watching soccer, it doesn't matter whether you shout "Goal!" or "Goooooaaaal!"; in either case, our brains will quickly figure out that someone has scored. It's a similar case with certain animals that will also stretch or compress their acoustic signals. Grasshoppers, for example, produce their mating calls by rubbing their hind leg against the veins of the forewing. As they cannot regulate their own body temperature, their biochemical processes slow down in the shade or on colder days – which means the grasshoppers' call, too, becomes longer and more drawn out. It is the female's task to distinguish the mating calls of their own species from those of other species irrespective of the temperature. A research team led by Andreas Herz, Ludwig Maximilians University and Bernstein Center Munich, has now shown that, contrary to expectation, this requires no complex computation by the brain. 'A single neuron takes care of this task,' says Herz.

Grasshoppers mating calls have a fixed sequence of 'syllables' and 'pauses'. The absolute length of syllables and pauses will change with temperature and can therefore hardly be a criteria for distinguishing between species. It is rather the pause-to-syllable ratio that counts. It is the female's task to decode this ratio, in order to recognize an admirer of its own species.

One would be forgiven for assuming that it would take a number of complex operations to calculate this ratio. The temporal lengths of the syllable and pause would first have to be measured and then the former would have to be devided by the latter. Since syllables and pauses are offset in time, the result of the first time measurement would also have to be kept in memory until the second time measurement is complete. Altogether, this is a demanding task, which would appear to require at least a small neural network to solve.



Grasshopper song at different temperatures. The number of spikes of the neuron nr. 12 in a given period of time remains unchanged.

'We were able to demonstrate, however, that this computational problem can be solved by a single nerve cell,' reports Herz. 'In grasshoppers, we can even identify the responsible neuron: It is "ascending neuron No. 12"'. This neuron responds to the onset of a call syllable with a burst-like discharge pattern, where the number of spikes within the burst increases linearly with the length of the preceding pause. Fast calls therefore lead to many bursts, each with few spikes, while slower calls lead to fewer bursts, each with many spikes. If you then sum up the number of spikes over a fixed time window, you obtain an astonishing result: The total number remains the same and accordingly identifies the species of the male grasshopper – irrespective of the pace of the song.

'It is certainly a fascinating angle to our work to have discovered a simple trick that makes complex calculation completely unnecessary, and which might also be exploited by other animals,' states Herz. 'The project undertaken with colleagues from Berlin and Göttingen is concluded, yet the name "Neuron No. 12" alone implies there are at least eleven other similar neurons. And we would really like to know what computational problems those neurons solve.'

Source: Press release of the LMU

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