Hippocampal neural activity in freely moving echolocating bats

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The lab studies the neurobiology of learning & memory, and the relation between brain activity and behavior – more specifically, neural activity in the hippocampus, a brain region that is crucial for episodic and spatial memory in animals and humans. The animal model used in the lab is the echolocating bat, a flying mammal that has extraordinary spatial memory. We pioneered the usage of bats as a model for studies of mammalian hippocampal function; tetrode recording techniques were used, which allow collecting data from dozens of neurons simultaneously. We found 'place cells' in the bat hippocampus (Fig. 1), neurons that respond when the animal passes through a restricted area of the environment; these neurons were similar to place cells in rodents, and this finding was recently published in Nature Neuroscience (2007). Theta-band oscillation was also found in the bat hippocampus, but the theta oscillation differed from theta of rodents in both its behavioral contingency and its time-course, prompting several possible explanations for the reported similarities and differences in theta oscillation between rodents, bats and primates. The current goal of the lab is to use a large bat species (Rousettus aegyptiacus, Fig. 2), which weighs ~150 gr, in order to study neural spiking activity and hippocampal brain oscillations in freely flying bats (as well as in freely crawling bats) – using a custom telemetry system (Fig. 3) – in order to elucidate the role of the hippocampus in episodic memory, spatial memory and navigation.

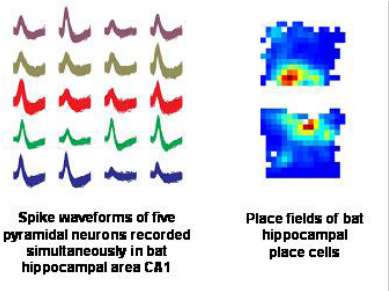
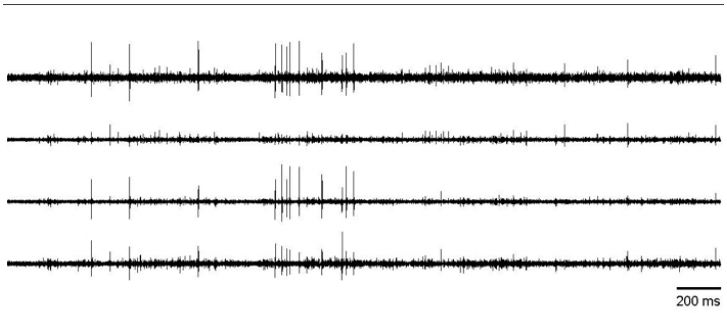


Fig. 1 *Neural recordings from bat hippocampus. Left: spike waveforms of five simultaneously-recorded neurons from bat hippocampal area CA1, recorded using a tetrode. Right: Place fields of two place cells, red color = maximum activity of the neuron.*

Fig. 2 *Bat species studied in the Ulanovsky lab at the Weizmann Institute of Science: Egyptian fruit bat, Rousettus aegyptiacus.*



Spikes recorded from bat hippocampus using a custom radio-telemetry system (the four traces show the four channels of one tetrode)

Fig. 3 *High-quality spike recordings from bat hippocampus using a custom telemetry system.*

Research interests:

- Neurobiology of learning and memory.
- Hippocampal neural activity in freely-behaving echolocating bats.
- Neurophysiological recordings in freely flying bats, using radio-telemetry.
- From the bat's biological sonar system to spatial cognition.
- The neural basis of behavior.
- Computational approaches to analyzing dozens of simultaneously-recorded neurons.

For more details, see: http://www.weizmann.ac.il/neurobiology/labs/ulanovsky/

Selected publications

Ulanovsky, N., Las, L., and Nelken I. (2003) Processing of low-probability sounds by cortical neurons, Nature Neuroscience, 6, 391-398.

Ulanovsky, N., Las, L., Farkas, D., and Nelken, I. (2004) Multiple time scales of adaptation in auditory cortex neurons, Journal of Neuroscience, 24, 10440-10453.

Ulanovsky, N., Fenton, M.B., Tsoar, A., and Korine, C. (2004) Dynamics of jamming avoidance in echolocating bats, Proc. R. Soc. Lond. B, 271, 1467-1475.

Ulanovsky, N. and Moss, C.F., (2007) Hippocampal cellular and network activity in freely moving echolocating bats, Nature Neuroscience, 10, 224-233. [see also Cover Image of Nature Neuroscience]

Acknowledgements

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