

AD-A253 614



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ONR/Code 1142
Arlington, VA 22217-5000
NWW 8/5/92

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Simulation of Excitatory/Inhibitory Interactions in Single Auditory Neurons
N00014-92-J-1558

AUG 6 1992

Progress Report: 1 April 1992-30 September 1992

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Accession For
NTIS
DTIC
Unclassified
Justification

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Distribution/
Availability Cod

Availability Cod
DTIC QUALITY INSPECTED 8

Overview. Characterization of the function of single neurons has become essential for developing advanced nodes for massively parallel computational structures. The lateral superior olive (LSO) is a nucleus located early in the ascending auditory pathway. Anatomically, each LSO neuron receives input from both ears; this fact led researchers to hypothesize that the LSO is involved in binaural hearing. Recordings from this nucleus not only confirm that LSO neurons are responsive to sounds presented in either ear, but in a particularly interesting and simple way: sounds presented in one ear excite an LSO neuron (increase its discharge rate) while sounds present at the other ear inhibit the neuron (discharge rate decreases). This mode of operation—the interaction of excitatory and inhibitory inputs to produce neural output—is the fundamental mode of neural processing. Thus, modeling LSO neurons represents a particularly clear-cut opportunity to understand basic neural processing.

Long-Term Goals. The approach taken in this research is to create anatomical and biophysical models of single LSO neurons and demand that the discharges patterns thus produced statistically match single-neuron recordings. With this strategy, this project seeks to (1) understand the neural mechanisms that underly basic LSO response patterns (transient chopping response to tone bursts and serial interspike interval correlations), (2) understand the transformation of fractal inputs by the LSO neuron, and (3) characterize excitatory/inhibitory interactions.

Accomplishments to Date. With matching funds from Rice University and grant monies, two SUN workstations were purchased specifically for this project. The latest version of the neural simulation system (*GENESIS*) has been installed. We are currently modifying the simulator to accomodate multiple inputs from files so that the output of our well-developed model of LSO inputs can be interfaced with *GENESIS*. A preliminary geometric model of an LSO neuron has been produced. Simulations confirm that complicated potassium channels will be needed to model accurately LSO discharge patterns [1]. Allied work supported by NIH has produced a detailed model of single LSO neuron discharge patterns to both monaural and binaural input [2]. Consequently, tight constraints have been placed on the simulations, which will force a rapid weeding out of potential biophysical and anatomical models.

References

1. D.H. Johnson. Simulation of Single LSO Unit Responses. *Proc. MidWinter Meeting ARO*, February 1992.
2. M. Zacksenhouse, D.H. Johnson, and C. Tsuchitani. Spatial tuning revealed by point process model of lateral superior olive units. *Proc. MidWinter Meeting ARO*, February 1992.

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