BMC Neuroscience

BioMed Central

Poster presentation

Amplitude modulation discrimination in a model of the electrically stimulated auditory nerve

Joshua H Goldwyn* and Eric Shea-Brown

Address: Department of Applied Mathematics, University of Washington, Seattle, WA 98195, USA

Email: Joshua H Goldwyn* - jgoldwyn@amath.washington.edu

* Corresponding author

from Seventeenth Annual Computational Neuroscience Meeting: CNS*2008
Portland, OR, USA. 19–24 July 2008

Published: 11 July 2008

BMC Neuroscience 2008, **9**(Suppl 1):P119 doi:10.1186/1471-2202-9-S1-P119

This abstract is available from: http://www.biomedcentral.com/1471-2202/9/S1/P119

Cochlear implants (CI) are neural prostheses that can restore hearing for individuals with severe to profound hearing loss through electrical stimulation of the auditory nerve (AN). Despite continuing advances in CI function, complicated listening tasks such as speech perception in noise, sound localization, and music perception remain difficult for CI users. It is believed that a key to enhancing performance on these tasks is improving fine-structure temporal processing. A valuable test of such temporal processing is amplitude modulation discrimination, wherein subjects are asked to distinguish between stimuli of constant intensity and weakly amplitude-modulated waveforms. Amplitude modulation discrimination has been tested in CI listeners and the key finding is that performance is typically good for low modulation frequencies, but degrades rapidly for modulation frequencies above ~100 Hz [1].

We use a computational model to ask: *Can performance on this task be explained based on the spiking properties of electrically stimulated auditory nerve fibers?*

We use the model of AN response to CI stimulation developed in [2,3]. Spike trains are generated in response to stimuli with and without amplitude modulation of the applied current. We quantify correct detection in a two-alternative forced choice task using three different measures. First, we predict performance based on spike-count over the duration of the stimulus. Second, we consider a spike-time metric applied to spike trains from a single AN fiber. Third, we feed output of the spiking AN cell into an idealized downstream neuron with a varying time constant of integration and construct a spike-time metric for this cell.

Our preliminary results are as follows. The spike-count metric gives frequency-independent, low fidelity performance. The spike-time metric on the AN fiber predicts threshold values comparable to observed thresholds for low modulation frequencies but does not exhibit any fall-off at high frequencies. Initial findings based on the spike-time metric applied to the downstream neuron indicate that this method partially predicts the frequency dependent trends in psychophysical data. Ongoing work seeks to identify the model features necessary to better predict psychophysical data. This will include more detailed modeling of AN responses, more biophysically realistic representations of downstream neurons, and multi-fiber population encoding.

Acknowledgements
The authors thank Jay Rubinstein for helpful advice and ideas in motivating this research.

References
1. Shannon RV: **Temporal modulation transfer functions in patients with cochlear implants.** *J Acoust Soc Amer* 1992, **91:**2156-2164.
2. Bruce IC, White MW, Irlicht LS, O'Leary SJ, Dynes S, Javel E, Clark GM: **A stochastic model of the electrically stimulated auditory nerve: single-pulse response.** *IEEE Trans Biomed Eng* 1999, **46(6):**617-629.
3. Bruce IC, Irlicht LS, White MW, O'Leary SJ, Dynes S, Javel E, Clark GM: **Astochastic model of the electrically stimulated auditory nerve: pulse-train response.** *IEEE Trans Biomed Eng* 1999, **46(6):**630-637.