4th Quarterly Progress Report

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The Neurophysiological Effects of Simulated Auditory Prosthesis Stimulation: First IC paper

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Abstract

This Quarterly Progress Report presents our progress in the fourth quarter of this contract. During this period, we have made progress in following areas: 1) We have fabricated four new multi-channel intracochlear electrodes designed specifically for the guinea pig. One of these electrodes was designed to allow us to examine the effects of channel interaction. It has 8 contacts arrayed longitudinally. In principle, this electrode would allow us to activate contacts 4,5 in bipolar mode and forward mask the resultant responses using bipolar activation of the three sets of contacts apical and basal to these contacts. In addition this electrode has two contacts placed on the side of the carrier, rotated 120º from the longitudinal contacts. These additional contacts are positioned to allow radial bipolar stimulation with contacts 5 and 8. It is hoped that these rotated contacts will allow us to stimulate the auditory nerve array win a more selective manner than is possible with the longitudinally oriented bipolar contacts. 2) We have continued to examine the effects of channel interaction using a forward masking paradigm with acoustic tones in normal hearing animals prior to deafening and implantation and forward masking of two electrical channels after implantation. 3) Most of these channel interaction studies were conducted using the 16-channel silicon probes. Consequently, they involved recording and quantifying responses from multi-neuronal clusters in the central nucleus of the inferior colliculus (ICC). The results of these forward masking experiments have been sufficiently unusual that we have been obliged to conduct some experiments using high impedance tungsten microelectrodes to record from well isolated single neurons. Therefore, in this quarter, we have begun single neuron channel interaction studies. To date, the results of these tungsten electrode experiments have confirmed our multi-neuronal results of using silicon probes. We hope that these experiments will convince ourselves (and others) that our interaction results are not a consequence of our multi-channel recording procedures. 4) Presented some of our preliminary results at the Neuroprosthesis conference in Washington DC. We also prepared an abstract of a poster of our acoustic and electric forward masking experiments to be presented at the Association for Research in Otolaryngolgy Meetings in February (Bonham et al, 2004). 5) We have completed the final revisions of our initial ICES experiments using the 16-channel recording probes and single channel stimulation. These experiments describe the basic response properties of inferior colliculus (IC) neurons in guinea pigs to single tones and single ICES pulses recorded with the 16-channel probes. This revised manuscript has been accepted for publication and should appear shortly in the Journal of the Association for Research in Otolarynglogy. The accepted final draft of this paper is being submitted as part of this progress report. It can be downloaded from the JARO website (see http://www.aro.org/)

Work Planned for the Next Quarter

1) We will begin experiments looking at channel interaction using high impedance tungsten microelectrodes. We will attempt to correlate the masked tuning curves that we record using these electrodes with those that we record with the multi-channel silicon probes.

2) We will begin experiments employing intracochlear electrodes that have higher numbers of contacts, which are more closely spaced. In addition we will try stimulation with contacts in a radial orientation to see if we can activate the auditory nerve array more selectively.

3) Work will continue the acoustic channel interaction studies. We will quantify the spread of stimulus inhibition using non-overlapping masker and probe stimuli, either two-tones or two-electrode channels, in a forward masking paradigm. We will define the time course of the inhibition by varying the gap between the end of the first tone and the beginning of the second tone. We will define the development of the interaction by varying the duration of the first tone. Finally, we will estimate the relative magnitude of the interaction by varying the intensity of the second tone.

4) Our current experiments have convinced us that we need to develop a better multi-channel stimulation system, which includes a computer addressable switch that operates on the microsecond time scale. This must allows us to select among two or more constant current stimulators as current sources and to select among up to16 intracochlear electrode sites to which to direct that current. During the next quarter, we will make an effort to develop such a switch.