8th Quarterly Progress Report

July 1, 2004 to September 30, 2004

Neural Prosthesis Program Contract N01-DC-02-1006

The Neurophysiological Effects of Simulated Auditory Prosthesis Stimulation: Tripolar Focusing of Auditory Nerve Activation: The Effect of Changing the Remote Current Fraction (RCF)

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This quarterly progress report presents our progress in the 8th quarter of this contract. In this quarter, we conducted 13 experiments that continued and extended our investigations into interaction between cochlear implant channels. The specific results of these experiments, as well as other work completed during the quarter, are summarized briefly in the following section. This summary section describes our experiments, our publications, our presentations and our abstracts submitted. The next section entitled "Work planned for next quarter," outlines the experiments we will conduct in the next quarter. Finally, the bulk of this report, collected in Appendix II, will focus on the results of our investigations into the effects of changing stimulation configuration and will describe the patterns of activation evoked by stimulation in monopolar, tripolar, and partial-tripolar configurations.

(N.B. Appendix II comprises a preliminary manuscript to be submitted for peer-reviewed publication within the next year. The draft title for this manuscript is "Tripolar Focusing of Auditory Nerve Activation: The Effect of Changing the Remote Current Fraction (RCF)". Authors of the final manuscript may include the following: B.Bonham, R.Snyder, S.Rebscher, F. Spelman, S.Corbett, T. Johnson, B. Clopton, and M. Carson. The target journal for this publication has not yet been determined.)

Summary description of work over last quarter

Completion of 13 neurophysiology experiments investigating channel interaction in the inferior colliculus (IC). These experiments include:

- Investigation of current steering using monopolar, bipolar, and tripolar stimulus configurations and waveform symmetry. In particular, investigating the effect of changing the Remote Current Fraction, RCF (defined below) so that the stimulation configuration gradually changes from tripolar to monopolar.
- Continued investigation of 2-channel acoustic interaction (primarily forward masking, some simultaneous masking). This work provides control data for 2-channel electrical stimulation experiments.
- Initial experiments to map guinea pig inferior colliculus response patterns to acoustic stimulation. This work also provides control data for 2-channel electrical stimulation experiments.
- Continued investigation of 2-channel electrical forward masking. Part of this work was conducted in collaboration with John Middlebrooks.
- Continued investigation of 2-channel electrical simultaneous masking.
- Initial studies of 2-channel acoustic interaction using noise bands (rather than tones) which *may* be a better model electrical stimulation.

    - One initial experiment using a fast-recovery amplifier fabricated by Charley Finley to measure electrically-evoked compound action potentials (ECAPs).
- Design and fabrication of guinea pig cochlear implants, including:
    - Fabrication of six guinea pig cochlear implant electrodes.
    - Design review and revisions for the 2nd generation guinea pig electrode mold.
    - Design and 1st run fabrication of new photolithographically-defined implant electrode for the guinea pig.
- Other work, including:
    - Analysis of data collected during above-listed and previous experiments.
    - Acquisition, installation, and debugging of new 8-channel electrical stimulator fabricated by Chris Ellinger at the University of Michigan.
    - Debugging of a problem caused by saline infiltration of Michigan-probe printed circuit boards. We have now begun to coat these PC boards with silastic before use.
    - Updating experiment control software to accommodate the new 8-channel stimulator.
    - Updating experiment display and analysis software to accommodate control of multiple parameters required by new stimulus paradigms (e.g., electrical masking, current steering, partial-tripolar stimulation, multi-channel stimulation, etc.).

Presentations

Bonham, B., Snyder, R., Middlebrooks, J. (2004). The effects of cochlear implant electrode configuration and channel interaction on neuronal responses in the midbrain. AG Bell Society, Anaheim, CA.

Snyder, R. (2004). Neurophysiology of Simulated Auditory Prosthesis Stimulation. NIH Neural Interfaces Workshop, Bethesda, MD.

Snyder, R., Middlebrooks, J., Bonham, B. (2004). Forward masking in acoustic and electrical stimulation: A model of channel interaction in cochlear implants. AG Bell Society, Anaheim, CA.

Publications

Snyder RL, Bierer JA, Middlebrooks JC (2004). Topographic spread of inferior colliculus activation in response to acoustic and intracochlear electric stimulation. J Assoc Res Otolaryngol. 5(3):305-22.

Abstracts submitted (Text of these abstracts is included in Appendix I)

Bierer, S., Bonham, B., Snyder, R. (2005). Inferior colliculus responses to two channel cochlear implant stimulation. Assoc Res Otolaryngol Abst.

Bonham, B., Snyder, S., Corbett, S., Johnson, T., Rebscher, S. (2005). Physiological Measures of Auditory Nerve Activation by Current Steering. Assoc Res Otolaryngol Abst.

Snyder, R. (2005). Patterns of Excitation in the Inferior Colliculus Produced by Intracochlear Electrical Stimulation In Cats and Guinea Pigs: Models of Cochlear Implant Stimulation. Assoc Res Otolaryngol Abst.

Vollmer, M., Tillein, J., Bonham, B. (2005). Forward masking in cat inferior colliculus using combined electric and acoustic stimulation of the cochlea. Assoc Res Otolaryngol Abst.

Work Planned for Next Quarter

1) We will continue our studies of forward masking patterns in the IC using acoustic stimulation. We also plan to continue to examine the forward masking patterns of IC neurons using electric stimulation in order to increase our sample statistics.
2) We will continue to examine the effects of various electrode configurations (i.e., monopolar, tripolar, bipolar) and pulse waveforms (symmetric biphasic and pseudomonophasic).
3) We plan to continue our examination of interactions occurring during interleaved and simultaneous electrical pulse trains presented concurrently on one and two channels.
4) We plan to do begin a series of collaborative experiments with Leo Litvak of Advanced Bionics Corp in which we will make intracochlear measurements of the electrically-evoked compound action potential (ECAP) in guinea pigs.