

# Twelfth Quarterly Progress Report

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NIH Project N01-DC-2-1002

## **Speech Processors for Auditory Prostheses**

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## **I. Introduction**

The main objective of this project is to design, develop, and evaluate speech processors for implantable auditory prostheses. Ideally, such processors will represent the information content of speech in a way that can be perceived and utilized by implant patients. An additional objective is to record responses of the auditory nerve to a variety of electrical stimuli in studies with patients. Results from such recordings can provide important information on the physiological function of the nerve, on an electrode-by-electrode basis, and can be used to evaluate the ability of speech processing strategies to produce desired spatial or temporal patterns of neural activity.

Work and activities in this quarter included:

- A two-week visit, from February 21 through March 4, by our first Med-El PULSAR subject, ME-25, from Germany.
- A visit by consultant Marian Zerbi, February 17-22, to help prepare for the first PULSAR studies.
- A visit by Peter Nopp of Med-El GmbH in association with studies with subject ME-25.
- Distinguished Guest address by Blake Wilson to the families of implanted children for the Annual Nalli Day, The Hospital for Sick Children, Toronto, Canada, February 17.
- Grand Rounds presentation by Blake Wilson to the Department of Otolaryngology, University of Toronto, Toronto, Canada, February 18.
- A visit by Artur Lorens of the International Center of Hearing and Speech, Warsaw-Kajetany, Poland, March 21-23.
- A visit by subject NP-6, one of four subjects implanted with a research version of the Nucleus device that provides percutaneous access to a Contour electrode array, March 28-30.

In addition to the above-mentioned activities, work continued on analyses of previously collected data and on the preparation of manuscripts for publication.

In the present report we outline our initial studies, conducted this quarter, with a recipient of a Med-El PULSAR cochlear implant system.

Results from other studies, including others completed during the current quarter, will be presented in future reports.

## **II. Initial studies with a recipient of the PULSAR implant system**

QPR 11 for this project described the development of a unique interface system for full laboratory control of the powerful features of the new Med-El PULSAR device. As noted in that report, this work was done with considerable help from our colleagues at the University of Innsbruck and at the Med El GmbH, both in Innsbruck, Austria.

During this quarter we successfully employed the interface in studies with an initial patient.

The hearing loss of this patient (subject ME-25) dates from a 12-year occupational noise exposure in the steel industry. Now 67 years of age, she had documented bilateral loss and tinnitus as of 1981. She received bilateral hearing aids and a diagnosis of profound bilateral loss in 1987, and by 1996 even her aided hearing was gone. She was implanted by Dr. Joachim Müller in Würzburg, Germany, in June 2004, and her PULSAR processor was initially programmed in mid July 2004, affording her immediate speech understanding without visual cues. She presently experiences tinnitus only in her non-implanted ear, and that seems to subside when the processor is operating. There is no other history of deafness in her family.

During this initial two weeks of studies, the subject's clinical processor and a total of 27 distinct research processors were evaluated with tests that included identification of 16 medial consonants in quiet and at the speech-to-noise ratio (S/N) of +10 dB. In many cases tests of sentence recognition also were conducted, using the OLSA formulaic sentences (name-verb-number-adjective-noun, each from a closed set of 10) in quiet and at +10 dB S/N.

Tested research processors ranged from 4 to 22 channels, in some cases including virtual channels achieved by simultaneous stimulation of adjacent electrodes, as supported by the PULSAR implant. As many as 34 distinct stimulation options were available for channel assignment in some processors. Pulse rates ranged from 779 pulses/s/channel to 2326 pulses/s/channel, and pulse durations included 16 and 24  $\mu$ s/phase. Some of the processors included fine structure features and dual resonance nonlinear (DRNL) filters as discussed in QPRs 6, 7, and 8 for the present contract. The triphasic pulse capabilities of the PULSAR system were employed in one processor, and a hybrid processor employing a peak-picking algorithm for apical channels also was included.

Among the processors explored in these initial trials, the highest consonant identification scores in noise ( $84 \pm 2\%$  correct, 86% overall information transmission) were achieved with a 16 channel VCIS processor and a 21/22 channel DRNL processor -- both operating at about 790 pulses/s/channel. The latter processor also supported the highest OLSA scores in noise (96%).

## References

- Schatzer R, Wilson BS, Wolford R, and Lawson D: Signal processing strategies for a closer mimicking of normal auditory functions, **QPR 6** for Project N01-DC-2-1002.
- Schatzer R, Zerbi M, Wilson B, Cox J, Lawson D, and Sun X: Laboratory interface for the new Med-El PULSAR implant, **QPR 11** for Project N01-DC-2-1002.
- Wilson BS, Sun X, Schatzer R, and Wolford R: Representation of fine structure or fine frequency information with cochlear implants, **QPR 8** for Project N01-DC-2-1002.
- Wilson BS, Wolford R, Schatzer R, Sun X, and Lawson D: Combined use of DRNL filters and virtual channels, **QPR 7** for Project N01-DC-2-1002.

### III. Plans for the next quarter

Among the activities planned for the next quarter are:

- Visits by NP-6, a subject with a research version of the Nucleus device that provides percutaneous access to a Contour electrode array, March 28-30, April 11-12, May 3-4, and May 17-24.
- A one-week visit by NP-7, another Nucleus percutaneous subject, May 9-13.
- Five weeks of visits by a third Nucleus percutaneous subject, NP-9, April 4-8, April 18-22, and May 23 through June 14.
- Blake Wilson will be the keynote speaker for the *Annual Meeting of the British Cochlear Implant Group: Pushing the Boundaries of Cochlear Implantation*, Birmingham, UK, April 18-19.
- A visit by Dr. Peter Roland, Chairman of the Department of Otolaryngology -- Head and Neck Surgery, University of Texas Southwestern Medical Center, Dallas, June 15-17.

#### **IV. Acknowledgments**

We thank volunteer research subject ME-25 for her participation in studies during this quarter.

## **Appendix 1: Announcement and summary of reporting activity for this quarter**

Reinhold Schatzer completed his work as an employee with RTI during this quarter. He has had a distinguished career at RTI and has made many important contributions to this and the preceding project in the "speech processors" series. We are delighted to report that, in his new position with the University of Innsbruck, he plans to continue an active collaboration with this laboratory.

Reporting activity during the past quarter included the following:

### **Invited Presentations**

Wilson BS: Where are we and where are we headed with cochlear implants? Nalli Family Lecture, The Hospital for Sick Children, University of Toronto, Toronto, Canada, February 17.

Wilson BS: Advances in cochlear implant research. Grand Rounds presentation, Department of Otolaryngology, University of Toronto, Toronto, Canada, February 18.

### **Additional Presentation**

Adunka A, Unkelbach M, Radeloff A, Wilson BS, Gstoettner W: Outcomes of hearing preservation and cochlear vulnerability in cochlear implant recipients. *10<sup>th</sup> Symposium on Cochlear Implants in Children*, Dallas, TX, March 15-19.