COCHLEAR IMPLANTS

Speech Understanding and Music Appreciation With the Ineraid Cochlear Implant

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Two cochlear implants are commercially available in the USA. One, the Nucleus device manufactured by the Cochlear Corporation, has unrestricted U.S. Food and Drug Administration (FDA) approval for use by otolaryngologists, is advertised widely, and thus is widely known. The other, the Ineraid, manufactured by Richards Medical Company (formerly by Symphon, Inc.), is awaiting FDA approval for unrestricted use, and cannot be advertised. As a consequence, it is less well known.

In this article, we describe the Ineraid and report summary data on speech understanding by means of the Ineraid prosthesis. We then describe preliminary data on music appreciation with the Ineraid. Finally, we present a first-person account from a patient with an Ineraid cochlear implant. This patient is a piano instructor, and she describes her reacquisition of music appreciation after implantation of the device.

IMPLANT DESIGN

The Ineraid prosthesis comprises: (1) six monopolar electrodes implanted in the scala tympani with remote reference; (2) a percutaneous pedestal to which the electrode wires are attached; and (3) a portable speech-processing and electrode-stimulation system. The most apical electrode is located about 22 mm from the round window. The electrodes are spaced at 4-mm intervals. In most patients, the four most apical electrodes are activated.

Each of the four activated electrodes is driven by an analogue signal derived from the input signal after the operation of an automatic-gain-control (AGC) circuit and band-pass filtering. The AGC circuit has a very rapid attack time and a relatively slow release time. The center frequencies of the filters for channels 1 through 4 (most apical to most basal electrodes) are 500 Hz, 1000 Hz, 2000 Hz, and 3400 Hz. The filters roll off at 6 dB per octave.

SPEECH UNDERSTANDING

Summary data on speech understanding by implant alone—i.e., without visual cues—for a sample of 50 patients are reproduced in Figure 1. The median score for one-syllable words from the NU-6 list was 14% correct, with a range from 0% to 60%. The median score for spondee words was 44% correct, with a range of 0% to 100%. The median score for words in the CID everyday speech test was 45% correct, with a range of 0% to 100%. With lipreading, the median score for words in the CID sentences was 99% correct.

MUSIC APPRECIATION

In an unpublished survey of 76 patients with the Ineraid device (composed by author McCandless), 47% responded “yes” to the question “Do you listen to music?” A few patients reported that they listen to music several hours per week, 22% indicated that they listen only occasionally, and 31% said that they do not listen at all.

In an objective survey of ability to hear and recognize aspects of music (McCandless), 91% of 16 patients with the Ineraid device were able to identify which third of the piano keyboard was being played. However, when a scale was played on the piano, most of the patients were unable to determine whether the notes were ascending or descending. Figure 2 shows the results of these patients’ open- and closed-set identification of five familiar melodies (“Auld Lang Syne,” “Happy Birthday,” “Silent Night,” “Home on the Range,” “Oh, Susanna”) and of five musical instruments (voice, violin, piano, flute, horn). Although one patient identified two of the five melodies, the majority were unable to recognize any of the melodies in an open-set format. In closed-set format, most of the patients (9 of 16) were able to identify most of the melodies (3 out of 5). In the open-set test of musical instrument identification, the majority correct-
ly identified only one or two instruments. However, in closed-set format, the majority (12 of 16) were able to identify four or five of the instruments.

REACQUISITION OF MUSIC APPRECIATION
Kay Basham, who has used an Ineraid for three years, was a piano instructor before becoming deaf at age 31. Today, at age 35, she continues to teach piano. On the objective tests of ability to discern music, Basham achieved perfect or near-perfect scores on all tasks except open-set melody identification, where she scored 40% correct. The following is her description of her experience with the Ineraid cochlear implant.

As a child, a mild hearing loss sometimes created a frustrating obstacle for me. Yet my love for piano and singing led me to a college degree and a career in music education. In 1981, at the age of 25, I noticed a small drop in my hearing, which progressively worsened until 1987, when I lost all sensation of sound. I continued to teach

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Figure 1. Recognition scores for Ineraid patients for words from the NU-6 list (top), for spondee words (middle), and for words in the CID sentences (bottom).

Figure 2. Open- and closed-set recognition scores for familiar melodies and for musical instruments.
piano lessons privately, but I knew I needed to hear again if I wanted to continue in my profession. I was teaching by keeping one hand on the piano to feel the vibrations and constantly watching the students' fingers. The procedure worked, but it was exhausting to concentrate that much all of the time.

In June of 1988, I underwent an operation for surgical implantation of the Richards/ineraid cochlear prosthesis at the University of Iowa Hospitals and Clinics. I found the results to be beyond my greatest hopes.

The first day of wearing my implant was a confusing mixture of unrecognizable sounds until I sat down at the piano in the lobby of the hospital. The treble notes were the first I could hear again, and they were wonderful. I had lost high-frequency sounds first, and to hear them again was the first sign that music might once again sound like music.

In the beginning, some notes were missing, but as I gained more understanding of the sounds in my environment, my repertoire of notes also increased. Perhaps I had heard these notes on the first day, but did not realize what they were until I learned to perceive them in their new form—that is, with an electronic timbre.

Shortly after the hookup procedure, I was preparing to teach a piano lesson. The student was picking out a few melodies on the keyboard as I gathered my pencils and papers. I entered the room unconsciously humming along. Then I stopped—I had recognized a melody!

Encouragement to continue often came from special moments like this with my family and students. Today, I frequently recognize a familiar tune playing over a public address system or from the car radio.

I hear the keyboard in complete form, but a few notes have a nuance all their own. The G, A, and B above middle C are softer than notes below middle C. But the volume returns for notes above these. Indeed, G, A, and B in the second and third octaves above middle C are the loudest notes on the keyboard. My students discovered this quickly. If I point a finger at them for not practicing, they sometimes jokingly reach up and sharply strike one of these notes to give me a good jolt.

Some instruments have taken on a new sound quality. For instance, brass instruments, when played loudly, can produce a "splat" of tone. However, the sound of horns improves after the initial attack and becomes much more melodic as a piece continues. Most string and reed instruments sound pure at all volume levels. The violin, viola, and flute are particularly pleasant when heard through the implant.

Small group recitals are more enjoyable than large group concerts. A full band or orchestra seems to produce more sound than I can process. I constantly try to piece it together, so sometimes a band concert can wear me out.

Three years ago I was frustrated by a sense of loss. Today, my feelings are quite different. I know I won't ever hear the way I heard when I was younger, but I can accept that. In the past three years, I have learned to accept, and trust, what I hear with the implant. It is wonderful to get up every morning and be able to hear what I heard the day before. I know my hearing is not going away this time—instead it's getting better.

REFERENCES


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