SPEECH RECOGNITION ABILITIES IN PROFOUNDLY DEAFENED ADULTS USING THE NUCLEUS 22 CHANNEL COCHLEAR IMPLANT SYSTEM


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Research in the area of cochlear prostheses to restore a level of hearing sensation to the profoundly deaf has been ongoing at a number of centers throughout the world since the 1960's. Work on a multichannel cochlear implant that utilizes a speech feature extraction coding strategy and multi-sited, sequential, bipolar stimulation to enhance pitch perception began at the University of Melbourne under the direction of Professor Graeme Clark in the 1970's. Collaboration with Nucleus Limited, a multi-national biomedical corporation from Australia, led to the development of the current version of the prosthesis. The Nucleus 22 Channel Cochlear Implant System has been described in detail elsewhere. As of June 30, 1987, 540 adult patients have been implanted with the Nucleus device. The patients are distributed amongst approximately 100 clinics in 12 countries and at least 12 languages are represented. About 80% of these patients are English speaking, and of these, 60% are in North America and 20% in Australia. This paper presents results from these two groups.

Speech recognition scores from 53 North American patients were obtained on selected subtests of the Iowa Cochlear Implant Battery. This battery incorporates subtests of the Minimal Auditory Capabilities Battery, in addition to tests developed at the University of Iowa. The subtests used were: 1. Four-choice Spondee (a 20 item, 4 alternative, closed-set test), 2. Medial Consonant (a 70 item, 14 alternative, closed-set test, using a /iC/C/ context), 3. Iowa Vowel (a 45 item, 9 alternative, closed-set test, using a /hVd/ context), 4a. NU #6 Monosyllabic Words (a 50 item, open-set test), 4b. NU #6 scored phonetically (a 150 item, open-set test), 5. CID Everyday Sentences (a 20 sentence, 100 key word, open-set test). All stimuli were tape recorded using an unfamiliar male speaker, with a general American dialect. Tests were administered preoperatively using either high-gain hearing aids or a tactile device, and were
readministered postoperatively following approximately 3 months of experience with the Nucleus device. All patients used the speech feature coding strategy that extracted an estimate of the fundamental frequency and the first and second formants (F0/F1/F2). Patients ranged in age from 20 to 75 years with a mean of 48 years. They varied in years of profound deafness from 1 to 69 with a mean of 12 years of profound hearing loss.

Results, presented in Table 1, revealed that as a group, patients consistently scored higher in the postoperative condition. For those patients who had both a preoperative and postoperative score, the paired t-tests were highly significant for all speech recognition measures.

Results of speech tracking on 59 patients revealed a mean word per minute (wpm) difference score of 28.9 wpm (S.D. 16.9 wpm). The average lipreading only tracking rate was 21.8 wpm (S.D. 13.9 wpm), while the lipreading plus speech processor rate was 50.7 wpm (S.D. 20.5 wpm). A paired t-test showed this difference to be highly significant (p < .001). In addition, 21 patients obtained speech tracking scores in the hearing only condition. The average tracking rate was 25.9 wpm with a S.D. of 15.1 wpm.

Thirty patients from the University of Melbourne also were studied. They ranged in age from 19 to 70 years with a mean of 50 years; the years of profound deafness ranged from 1 to 40, with a mean of 12 years. An analysis of factors affecting postoperative patients performance revealed that patients deafened for less than 15 years and those who could discriminate differences in pitch on preoperative promontory stimulation performed better postoperatively. Older patients (> 50 years) did not perform significantly different than younger patients (< 50 years).

Statistical analyses of the North American postoperative speech recognition data confirmed both trends. These findings suggest that for appropriately selected profoundly deafened candidates, the Nucleus cochlear implant system can provide significant benefit in speech recognition with and without lipreading.
Table 1. Preoperative and postoperative mean speech recognition scores, standard deviations (S.D.), and paired t-tests for selected subtests of the Iowa Cochlear Implant Battery

<table>
<thead>
<tr>
<th>Test</th>
<th>Preoperative Mean (%)</th>
<th>Postoperative Mean (%)</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Choice Spurdee</td>
<td>37.0 (25.3)</td>
<td>70.3 (25.4)</td>
<td>8.62*</td>
</tr>
<tr>
<td>Medial Consensus</td>
<td>8.8 (7.7)</td>
<td>30.9 (18.8)</td>
<td>6.43*</td>
</tr>
<tr>
<td>Iowa Vowel</td>
<td>14.7 (15.5)</td>
<td>40.7 (22.8)</td>
<td>8.0*</td>
</tr>
<tr>
<td>NU 86 Word</td>
<td>0.6 (2.8)</td>
<td>6.5 (4.4)</td>
<td>6.65*</td>
</tr>
<tr>
<td>NU 86 Phoneme</td>
<td>5.7 (9.1)</td>
<td>21.8 (14.5)</td>
<td>6.64*</td>
</tr>
<tr>
<td>C10 Sentences</td>
<td>2.3 (7.5)</td>
<td>20.7 (19.5)</td>
<td>6.42*</td>
</tr>
</tbody>
</table>

* p ≤ 0.001
REFERENCES


Author/s:
Brimacombe, J. A.; Webb, R. L.; Dowell, R. C.; Mecklenburg, D. J.; Beiter, A. L.; Barker, M. J.; Clark, Graeme M.

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