The psychophysics of multiple-channel electrical stimulation of residual auditory nerve fibres has been studied in two postlingually deaf patients with total hearing losses, and the information used to design a speech processing strategy that enables them to understand connected speech in everyday situations when used in conjunction with lipreading.

A constant rate of stimulation of different groups of auditory nerve fibres produced different pitch sensations which could be scaled from low to high, and this was consistent with the place theory of frequency coding. The patients were also able to associate the different percepts produced by each electrode with different vowel colours and sharpnesses. In addition, the patient reported that pitch increased with pulse rate and loudness increased with current level. A speech processing strategy was developed whereby the parameters for voicing determine the rate of stimulation for all electrodes, and the parameters for the dominant spectral peak in the mid-frequency range determine the site of electrode stimulation and current level.

The value of the speech processor in helping the two patients understand speech was assessed for electrical stimulation alone (EO), vision alone (VO), and combined electrical stimulation and vision (EV), using three standard audiological tests: open-set everyday sentence tests (Central Institute for the Deaf), open-set word lists (A. Boothroyd), and twelve nonsense syllables (/b/, /d/, /g/, /l/, /n/, /v/, /m/, /l/, /y/, /l/, /t/, /l/), in a vowel-consonant-vowel (VCV) structure. The results for the words-in-sentences were for patient 1: EO-14%, VO-14%, EV-68%, and for patient 2: EO-8%, VO-34%, EV-98%. The word list scores were determined for both isolated words and phonemes-in-isolated words. For isolated words the scores for patient 1 were: EO-10%, VO-10%, EV-40%, and for patient 2: EO-5%, VO-30%, EV-60%. The scores for phonemes in isolated words for patient 1 were: EO-20%, VO-53%, EV-73%, and for patient 2: EO-20%, VO-63%, EV-80%. These findings show a marked improvement in the EV compared to the VO scores, and they are at a level where studies have shown that they correlate with a satisfactory performance in understanding connected speech. The scores obtained with nonsense syllables for patient 1 were: EO-42.5%, VO-32.5%, EV-61.7%, and for patient 2: EO-42.5%, VO-42.5%, EV-68.3%. The average percentage information transmitted for speech features was calculated from the data and is shown in the Table.

<table>
<thead>
<tr>
<th>All</th>
<th>Voice</th>
<th>Nasal</th>
<th>Affrication</th>
<th>Duration</th>
<th>Place</th>
<th>Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>EO</td>
<td>42</td>
<td>33</td>
<td>30</td>
<td>16</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>VO</td>
<td>55</td>
<td>1</td>
<td>7</td>
<td>64</td>
<td>57</td>
<td>69</td>
</tr>
<tr>
<td>EV</td>
<td>72</td>
<td>43</td>
<td>34</td>
<td>79</td>
<td>75</td>
<td>77-98</td>
</tr>
</tbody>
</table>

These results were significantly better than those obtained by Fourcin et al. (1979) for extra-cochlear single-channel stimulation. In addition, a study undertaken to compare our results with multiple-channel stimulation with those obtained by Bilger (1977) for intra-cochlear single-channel stimulation, using a closed-set spondaic word test. Multiple-channel stimulation gave scores of 45% and 52% which were significantly better than single-channel stimulation at the 0.025 probability level, using a Wilcoxon Rank Sum test.

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