VOWEL IDENTIFICATION AND VOWEL MASKING PATTERNS IN MULTI-ELECTRODE ELECTRICAL STIMULATION

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Overview
Patients wearing multichannel cochlear implants (CIs) exhibit a large variability in vowel identification. Channel interactions (as a consequence of spread of electrical fields) are believed to disrupt the “internal” spectral patterns. For non-stimulated electrodes, interaction strategies, these interactions are not related to so-called neural population interactions; that result from multiple processes acting on individual neural responses. (Fig. 1). This paper presents measurements of internal representations of steady-state vowels, processed through a CI processor, stimulating in multiprocessor configuration. Vowel masking patterns (VMPs) are measured, representing “neural spectra”, which include the channel interactions effects. VMPs of lowly and highly confused vowel pairs are analyzed to find the spectral cues relevant for identification.

Design
Subjects and stimulation parameters
7 periodically deafened adults supported either with 8 or 12-channel CIs by MedEl (Combi-480, Comb-Kr, respectively) in monopolar electrode configuration;
- 8-channel CI-stimulation: CIS-strategy; 1515 pps; logarithmic compression (cc=90°); staggered electrode stimulation; “mimbruck Modus” calibration of input signal level

Vowel Identification
- Additional stimulation to induce all steady-state german vowels A, AE, E, I, Ö, UE, U (F0 – 100 Hz)
- 8 or 12 sine-phase stimuli at CI-filterbank center frequencies, fitting into dynamic range of the input filterbank (Fig. 2)
- Digital synthesis and stimulus control via custom made routine lines (STF-software package)
- Signal transmission: auxiliary input of processor
- 8 - channel minimum: 9” stimuli; relative intermodulated distortion (ITD) and “Klatt’s” (1982) peak versus RMS levels
- Selection of vowel pair with smallest RTI (r=0.41, p<0.01) indicates stronger confidence.

Vowel Masking Patterns
- Measurement of vowel masking patterns for selected vowel maskers s (900 ms), consisting of masked thresholds for annual/oral stimuli (100 ms) temporally centered within the masker, at center frequencies of processor-filterbank
- Modified Shyde threshold: minimum of 9 reversals; threshold calculation over last 6 reversals (standard deviation: r=0.35 dB, acoustically)
- Average deviation between 1st and 2nd measurement: 1.9 dB (acoustically)

VMP Features
- Significant correlations between Susskind Distance and RTI (r=0.58, p<0.001) and Weighted Slope Metric and RTI (r=0.6, p<0.001)
- Significant correlations between “loudness” and masked thresholds (by Lim et al., 1998)
- Calculation of masked thresholds in mPa from acoustical masked threshold by software simulation of CI-processors, applying individual subject’s settings: checking with cerebrospinal fluid (MedEl 6.8 kHz)
- Loudness normalization to account for differences between masked and unmasked thresholds across probe electrodes (in dB/PA)
- VMP = (masked threshold – threshold in quiet) / loudness correction factor

References

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