Influence of non-optimal levels of electrical stimulation in cochlear implantees on hearing benefits

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Introduction

To obtain hearing benefits after cochlear implantation it is crucial to optimally fit the system to the individual need of each patient(Wasowski et al. 2004). Great variability between patients and changes in optimal values that can be observed in time make this a difficult task. To assure optimal fitting of the system, fitting procedure that contains psychophysics and objective measurements was introduced in the Institute of Physiology and Pathology of Hearing. However, it is still very interesting to find out how non-optimal fitting may influence hearing benefits.

Aim

The aim of this short paper is to present the methodology and results of three experiments that tried to asses an influence of non-optimal fitting to hearing benefits in terms of psychophysical measurements and speech comprehension tests results.

Material and Method

Material of the study consists of 61 patients aged from 14 to 62 years, using MedEl cochlear implant system from 3 to 25 months. 26 subjects were included in experiment 1, 28 in experiment 2 and 21 subjects in experiment 3. All subjects were previously fitted according to the fitting procedure introduced in the Institute of Physiology and Pathology of Hearing (Lorens et al., 2005; Lorens et al., 2004).

In three experiments, different characteristic of the patient's map: loudness, balance or threshold were non-optimally changed. In first and second experiment, map 1 was created according to the fitting procedure. In third experiment map created according to the fitting procedure was map number 3

In the first experiment new map 2 was created with MCL values lowered for 4 apical electrodes by 25% of dynamic range. On map 3, the same change was applied to 4 basal electrodes. Those changes simulated non-optimal balance of current levels across the electrode.

In second experiment, amplitude growth function was measured with the use of 50 points, 7 categories loudness scale. On map 2, MCL values were lowered on all electrodes by one loudness category, and by 2 loudness categories on map 3. Those changes simulated non-optimal loudness of the speech processor program.

In third experiment, THR values were lowered to 0 on map 1, set on 10% of MCL values on map 2, and set on soft category in amplitude growth function on map 4. Map 3 was created according to the fitting procedure. Those changes simulated non-optimal thresholds setting in speech processor program.

Monosyllabic word tests in quiet and noise (SNR 10 dB) were conducted in all cases after short period of getting used to different maps.

Results

In the first experiment best results were obtained on map 1, both in quiet and in noise. On map 2 mean deterioration reached 15% in quiet and noise. On map 3, mean deterioration was 12,7% in quiet and 14% in noise. (Figure 1.)

In experiment 2, best results were obtained also on map 1. Changing loudness of all MCLs by one category lowered mean word test score by 6,5% in quiet and 8,5% in noise. Lowering loudness by two categories worsen the results by 12% and 18% respectively in quiet and noise (Figure 2.).

In experiment 3, best results were obtained on map 3, fitted according to the procedure. 15% deterioration in speech understanding in quiet and noise was observed on map 4. Setting THR values to 0 worsen the word test score by 12% and 10% respectively in quiet and noise, and by 6% and 3% on map 2, but on this map the results were not statistically significant. Moreover, on map 4 constant humming, caused probably by high THR values, was reported (Figure 3.).

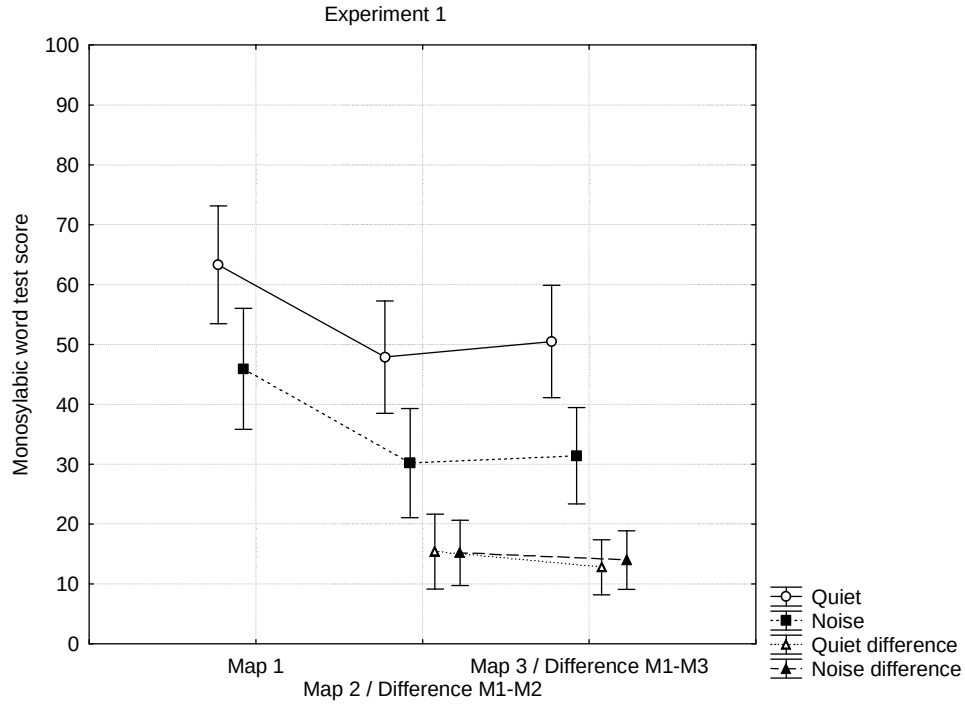

Figure 1. Results of experiment 1: monosyllabic word test score in quiet and noise on all maps and mean difference between map 1 and map 2 – 3.

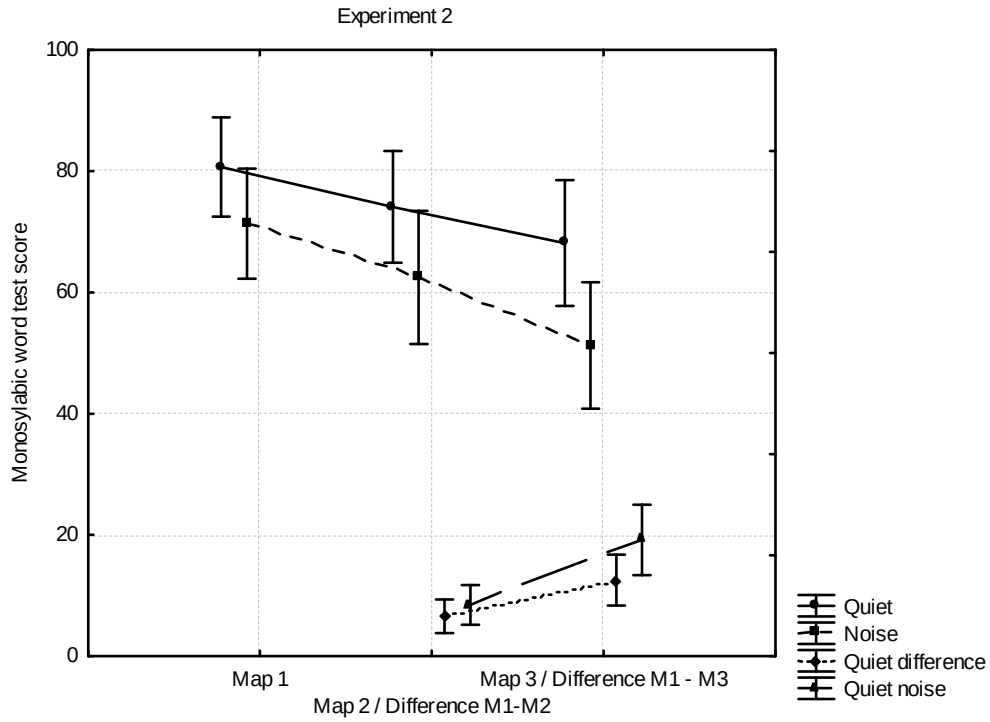

Figure 2. Results of experiment 2: monosyllabic word test score in quiet and noise on all maps and mean difference between map 1 and map 2 – 3.

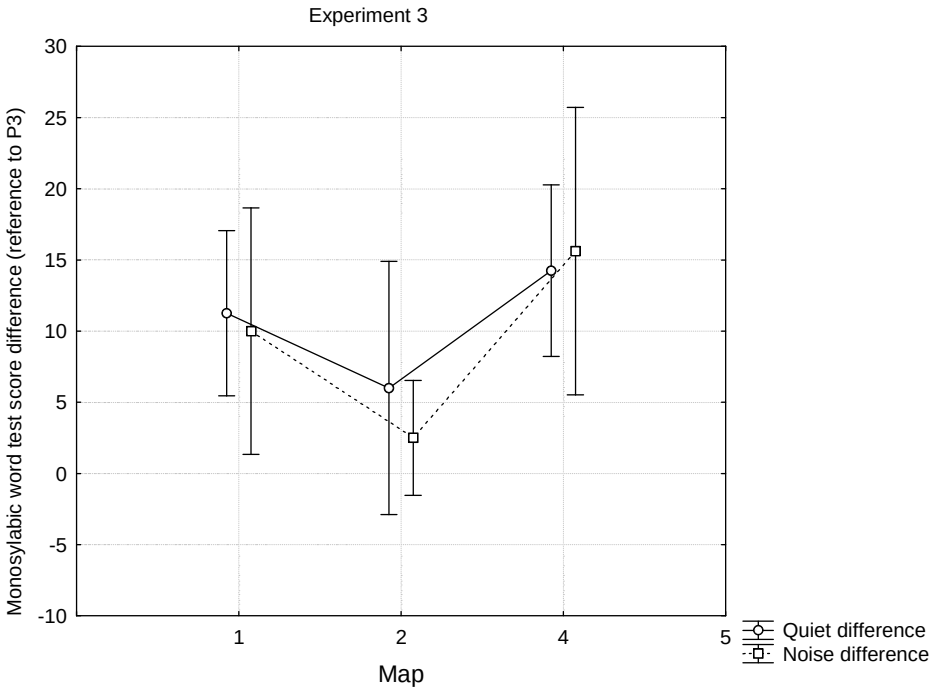

Figure 3. Results of experiment 3: mean monosyllabic word test score difference between map 3 and maps 1,2, 4 in quiet and noise.

Conclusions

Significant deteriorations of speech comprehension test were observed after relatively small changes in electrical stimulation parameters. Changing map's MCL balance, overall loudness and electrical threshold values seems to have comparable influence on benefits obtained by the patients. Optimal fitting of the system is of a profound importance, as even small deviations from the optimal settings have large influence on hearing benefits.

References

Lorens A, Piotrowska A, Skarzyński H, Obrycka A. (2005) Application of implantable electronic prostheses for patients with hearing impairment. Pol. Merkur. Lekarski. 19:487-9.

Lorens A, Walkowiak A, Piotrowska A, Skarzynski H, Anderson I.(2004) ESRT and MCL correlations in experienced paediatric cochlear implant users. Cochlear Implants Int. 5:28-37.

Wasowski A, Lorens A, Śliwa L, Walkowiak A, Obrycka A, Piotrowska A, Zgoda M, Skarżyński H. (2004) Assessment of implanted patients rehabilitation progress based on multiparametric statistical analysis of medical database. Proceedings of the 8th World Multiconference on Systemics, Cybernetics and Informatics (SCI 2004) Orlando, USA