ABSTRACT

Educational Objective: At the conclusion of this presentation, the participants should be able to compare the effects of fine structure processing (FSP) and high definition continuous interleaved sampling (HDCIS) in novel mapping strategies on music and speech perception in an acute setting.

Objectives:
The primary objective of the study is to investigate the effects of FSP on music and speech perception.

Study Design:
This is a prospective study comparing outcomes within subjects.

Methods:
Patients with Med El Sonata or Pulsar implants underwent acute programming for a pair of reduced frequency maps (70-1500 Hz). One map possessed only the HDCIS strategy, containing information about the envelope component of sound. The other contained both HDCIS and FSP strategies, providing additional information regarding the fine structure for lower frequencies. Maps were loaded into the processor randomly, with both the tester and the subject blinded to the use of each map. For each map, instrument identification (timbre), vowel perception, and music quality were assessed.

Results:
Subjects were able to perceive differences between the two maps. Differences in vowel identification scores did not reach statistical significance. Instrument identification was poor for both maps which is consistent with data from cochlear implant users in previous studies. Differences in music quality were apparent to subjects and is undergoing further analysis.

Conclusions:
The acute addition of FSP in a novel reduced frequency map did not appear to make a significant difference in performance on music and vowel tests, although subjects were able to perceive differences in sound quality. Longer-term use of FSP in standard maps may show performance benefit and is being investigated.

METHODS AND MATERIALS

Programming:
15 patients with Med El Sonata or Pulsar implants participated in study.

Audiologists acutely programmed patients for a pair of reduced frequency maps (70-1500 Hz) with one map using the FSP coding strategy, and the other using the HDCIS coding strategy.

Reduced frequency maps were used to provide a sound which the patient was not familiar with, and therefore would not favor, as well as to increase the number of FSP channels available.

Testing:
Subject and the tester were both blinded to the use of each map.

Three tests were performed for each map:
1. Timbre (music identification) using Med-El’s Mu.S.I.C. software
2. Vowel identification using the University of Iowa’s revised cochlear implant test battery
3. Subjective, overall music assessment using a symphony and jazz piece of music. Ratings were provided on a scale of 1-10, worst-best.

INTRODUCTION

In general, sound contains information including two components:

- **Envelope**: outline of the original sound wave reflecting the overall amplitude
- **Fine Structure**: more detailed component within the envelope mirroring the sine wave shape of the original sound wave

Role of each component depends on the task being performed, as shown through constructed chimeras:

- Envelope is important for speech perception
- Fine structure is important for melody recognition

Recently, fine structure processing (FSP) was introduced as a coding strategy:

- Method of extracting and coding for the fine structure.
- When the sine wave crosses the zero axis, stimulation of the cochlear nerve occurs (rate coding).
- This additional temporal information is needed for proper pitch perception
- Only useful at lower frequencies, with studies showing that the rate coding diminishes as frequency increases above 300 Hz.

Our primary objective was to investigate the effects of FSP on music and speech perception in an acute setting using reduced frequency maps.

RESULTS

- **Music and Speech Perception Results**

  - **Figure 1**: There was no significant difference between the results from the timbre test using either the HDCIS or FSP based map (p=0.365).
  - **Figure 2**: No significant difference was noted in the average vowel identification scores between the FSP and HDCIS based map (p=0.701).
  - **Figure 3**: No significant difference between average musical quality ratings between the FSP and HDCIS map for either jazz or symphony (p=0.82, and p=0.733).

- **Map Preference**

  - **Figure 4**: Initially all FSP users scored higher regardless of which map was used. Both of these results may reflect a similar concept. As FSP is designed to provide additional auditory cues, it is possible that FSP users have learned these cues and may be more highly tuned to picking up additional information in the HDCIS map, making it harder to distinguish between the two maps for preference and allowing better instrument identification performance with both maps.

- **Performance grouped by normal coding strategy**

  - **Figure 5**: Individuals using FSP as their normal coding strategy had a higher average timbre score (A), while the scores were combined for performance in both maps (p=0.031). Likewise, the same individuals had higher vowel identification scores (B) when the scores were combined for both maps (p=0.094).

DISCUSSION

Based on music and speech perception, there were no statistically significant differences in performance between either the reduced frequency FSP or HDCIS map.

While the average music quality rating was not significantly different between the two maps, or between the two types of music in each map, individuals still often noted differences in the quality, which was more reflected in the overall map preference.

Other studies have focused on the utilization of FSP over a period of time and monitored the performance and subjective approval of the new strategy. Studying individuals who have a history of FSP use allows for a different comparison between the benefits of each coding strategy.

In looking at map preference, the individuals who normally used FSP were more evenly distributed in their selection of which map they preferred, while the HDCIS users tended to prefer the FSP map. In addition, the timbre results showed that FSP users scored higher regardless of which map was used. Both of these results may reflect a similar concept. As FSP is designed to provide additional auditory cues, it is possible that FSP users have learned these cues and may be more highly tuned to picking up additional information in the HDCIS map.

CONCLUSIONS

While there are no acute differences between the FSP and HDCIS based maps in vowel perception and music identification, the data indicate that FSP use over time may be beneficial.

Given the potential for learning effects with the FSP strategy, future studies include evaluating the effects of auditory training with FSP.

REFERENCES

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CONTACT

Andrew Johnson
Medical College of Wisconsin
Email: ajohnson@mcw.edu