



AUDITORY PERCEPTION IN PAEDIATRIC COCHLEAR IMPLANT RECIPIENTS - ROLE OF FINE STRUCTURE CUES

Medical Science

Kamala Sarathy*	Institute of Speech and Hearing, Madras Medical College, Chennai-03, TamilNadu, India, *Corresponding Author
Jaya.V	Institute of Speech and Hearing, Madras Medical College, Chennai-03, TamilNadu, India,
Reenu Celshiya.A	Institute of Speech and Hearing, Madras Medical College, Chennai-03, TamilNadu, India,
Sampath Kumar.R	Institute of Speech and Hearing, Madras Medical College, Chennai-03, TamilNadu, India,
Saraswathi.K	Institute of Speech and Hearing, Madras Medical College, Chennai-03, TamilNadu, India,

ABSTRACT

The main aim of the study is to find the importance of fine structure cues for auditory perception in paediatric cochlear implantees. Auditory perception was evaluated in four paediatric cochlear implantees with FS4P speech coding strategy under five conditions. In each condition, a fine structure electrode were disabled successively. Auditory perception was assessed by obtaining aided audiogram and speech identification scores using ling sounds. Baseline aided audiogram was compared to the audiograms obtained in different conditions to evaluate the difference in auditory perception. The lesser availability of fine structure electrodes, reduced the temporal and fine structure information which resulted in impaired auditory perception which was evident from increase in aided thresholds. Apical electrodes are primarily responsible for fine structure and temporal processing, loss of fine structure and temporal cues markedly affects auditory perception.

KEYWORDS

fine structure electrodes, cochlear implant, auditory perception, fine structure cues.

Introduction:

The Fine Structure contains information about instantaneous frequency of a sound. It is contribute differentially to the comprehension of sounds. Music and other tonal instances of sounds like prosody or tonal languages are mainly conveyed by the fine structure of the sound signal. Temporal Fine Structure (TFS) plays a role in the perception of pitch for both pure and complex tones. It is important for understanding speech in complex background [1]. The fine structure is the very detailed frequency information the brain uses to enhance the hearing experience. It contains information on temporal timbre and pitch, and it is the primary source of interaural timing information [2].

The aim of our study to find the importance of fine structure cues for auditory perception in paediatric cochlear implantees.

Materials and Methods:

a) Subjects:

Four paediatric severe to profound hearing loss patients (3 male , 1 female ; age range 4-13years , mean 9 years) who underwent cochlear implantation with the Med-El Sonata Ti 100 device were included in this study. All were reported to have full electrode insertion in surgery assuming on an insertion depth of 31.5.

C1, C2 and C3 were prelingually and C4 was post linguallly deafened. All subjects were born into hearing families, used oral communication as their main communication mode and had been provided Auditory Verbal Therapy for 2-3 months with a mean of 11.5 sessions.

b) Stimuli :

Tone: The auditory perception task consisted of warble tone at the frequency range of 250 Hz to 4 KHz in Free Field via Inventis Piano audiometry through the speakers of creative model.

Speech: The speech identification task consisted of ling sounds (/aa/, /ee/, /oo/, /s/, /sh/, /m/) routed from the Sennheiser microphone in Free Field via Inventis Piano audiometry through the speakers of creative model.

Subject C4 had post lingual deafness, Recorded spondee words were given by Speech audiometry via Inventis Piano through the speakers of creative model.

Med-El Sonata Ti 100 Implant system:

Sonata Ti100 flex soft electrode array consists 7 pairs and 5unpaired electrode equally disturbed over 26.4mm total length. The electrode are numbered 1to 12 from apex to base. The array is inserted through a round window. In this study we used Opus II speech processor worn behind the ear, which can process frequency from 100 Hz to 8.5 KHz.

Sound coding strategy:

FS4P-Fine structure information is delivered to designated low frequency apical channels (1-4), (i.e; 4 fine structure channels). In FS4P strategy the processing is simultaneous - stimulates 2 fine structure channels at given point of time. Hence in FS4P the temporal cues specific to each of the two channels is coded with higher accuracy.

Procedure:

The study explores that importance of fine structure cues on Auditory Perception. The subjects were tested in the sound attenuated room. The subject received the free field presentation of pure tone and proceed speech stimuli over loud speaker. Response were collected with audiogram sheets.

We changed the number of active fine structure electrodes were the most apical electrodes for each successive condition. In the baseline conditions 4 fine structure electrodes were activated. In this conditions we tested the aided audiogram and auditory identification for ling sounds were measured by picture identification tasks. (/aa/-airplane, /ee/-tooth brush,/oo/-train,/sh/-water flowing from the tap,/s/-snake,/m/-chocolate)

In second condition 3 fine structure electrodes were activated, we measured the thresholds of aided audiogram and picture identification tasks.

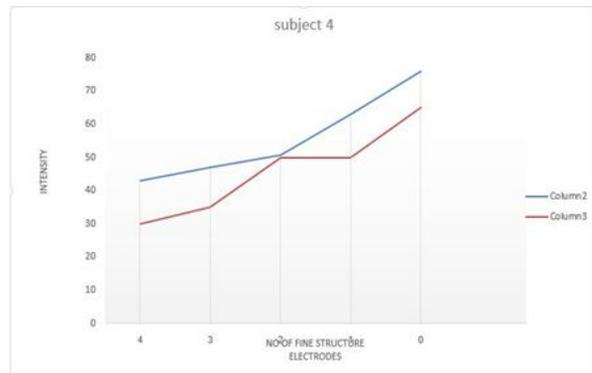
We disabled the fine structure electrodes 1-4 at each successive condition we measure the threshold of aided audiogram and speech identification task. The average thresholds of each subjects were showed in FIGURE I and II

Statistical analysis was performed using SPSS software. Independent sample *t* test was utilized to analyse the thresholds of aided audiogram and speech identification task results. The test results were compared with baseline thresholds. *p* values ≤ 0.05 were considered significant.

FIG I Average aided thresholds for warble tones and ling sounds of subject 1, 2 and 3.

S.No	No of electrodes	fine Length of the electrode (mm)	Aided Audiogram (dBHL)						Ling sounds (dBHL)					
			250Hz	500Hz	1KHz	2KHz	4kHz	/aa/	/ee/	/oo/	/s/	/Sh/	/m/	
1)	4	31.5	30	38.3	40	43.3	48.3	21.6	23.3	25	30	30	28.3	
2)	3	29.1	35	43.3	45	48.3	55	23.3	26.6	28.3	36.6	36.6	25	
3)	2	26.7	50	58.3	61.6	63.3	66.6	31.6	40	41.6	50	50	41.6	
4)	1	24.3	56.6	63.3	65	68.3	71.6	46.6	51.6	55	61.6	65	51.6	
5)	0	21.4	70	76.6	81.6	81.6	85	61.6	66.6	68.3	75	75	66.6	

FIG II : Aided Thresholds for Warble tones (Upper line) and Spondees(lower line)



Results and discussion:

The responses of aided thresholds of each conditions for four subjects were shown in the FIG 1-2. The number of active electrodes reduced which results in increases the aided thresholds.

An independent sample *t* Test was applied to the score to compare the each conditions. The findings implies there was a significant difference when the lesser availability of fine structure electrodes (from Table II). FIG IV shows subject 4 also have significant effects on speech understanding.

Thus the lesser availability of fine structure electrodes, reduced the temporal and fine structure processing which resulted in impaired auditory perception which was evident from increase in aided thresholds.

TABLE II Comparison conditions for all four fine structure electrodes.

s.no	Conditions between the fine structure electrodes	Aided audiogram (subjects 1-4)	Ling sounds (subjects 1-3)
1	4-3	NSD(0.440)	NSD(0.397)
2	4-2	SD(0.000)	SD(0.000)
3	4-1	SD(0.000)	SD(0.000)
4	4-0	SD(0.000)	SD(0.000)
5	3-2	SD(0.000)	SD(0.000)
6	3-1	SD(0.000)	SD(0.000)
7	3-0	SD(0.000)	SD(0.000)
8	2-1	NSD(0.083)	SD(0.021)
9	2-0	SD(0.000)	SD(0.000)
10	1-0	SD(0.027)	SD(0.000)

*NSD- statistically no significant difference *SD- statistically significant difference.

Conclusion:

The study shows fine structure electrodes are most important for auditory perception in cochlear implantees. As in FS4P strategy, the apical most 4 electrodes codes the fine structure information and disabling these electrodes would have resulted in loss of fine structure or temporal cues crucial for speech perception with cochlear implants. Apical electrodes are primarily responsible for the fine structural and temporal processing, loss of fine structure and temporal cues markedly affect auditory perception.

Reference:

- [1] Christoph Arnoldner et. al. (12 february 2007). Speech and music perception with the new fine structure speech coding strategies; preliminary results. The Journal of Acta - Oto laryngological
- [2] Deniz Baskent and Robert V.Shannon (15 December 2004). Interactions between the cochlear implant electrode insertion depth and frequency place mapping. The Acoustical Society of America .
- [3] Craig A Buchman et.al (2004) Influence of cochlear implant insertion depth on performance : a prospective randomized trial. The Otology and Neurology.
- [4] Yukawa K , Cohen L , Balmey P (November 20 2003). Effects of insertion depth of cochlear implant electrodes upon speech perception.
- [5] Joon Moon and Sung Hwa Hong (2014). What is temporal fine structure and why is it important. The Korean journal of audiology.