Preliminary results of Dynamic FM on language development in cochlear implant recipients

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Introduction

- Children who use cochlear implants experience significant difficulty hearing speech in the presence of background noise, such as in the classroom.

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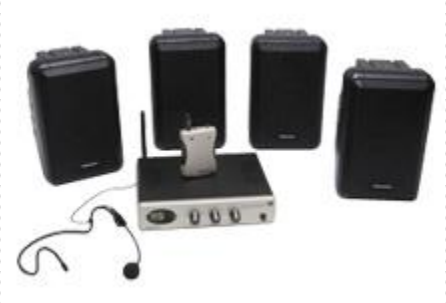
- Considering noisy conditions, in order to increase the signal to noise ratio, using frequency-modulated (FM) system is one of the options.

- Thus, cochlear implant recipients may also experience difficulty understanding soft speech signals, particulary in educational environments (due to distance, noise, reverberation etc.).

- A variety of FM systems exist for cochlear-implant users, including soundfield systems, personal soundfield systems, and electrically-coupled personal FM systems.



- Electrically-coupled FM receivers plug into CI speech processors with specialized receivers, adaptors, and cables bring the FM signal direct to listener's ear ***(Schafer & Thibodeau, 2004)*** .

- This type of system requires individual equipment for the listener. This combination can consistently and significantly improve speech-recognition in noise ***(Anderson et al. 2005, Schafer Thibodeau 2005)***.

- However, for variety of reasons, FM systems are seldomly used in Turkey:

i. Economical reasons

ii. Authorities of social security system in Turkey do not consider FM systems are essential part of speech acquisition process in hearing impaired children.

Aim of the study

- To investigate the effects of fitting FM systems on language development in Turkish children with cochlear implant.

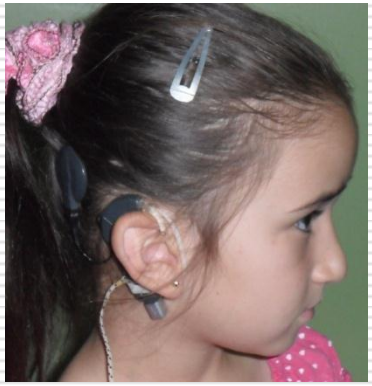
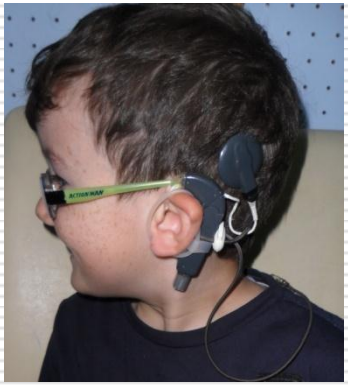
Material and Methods

Subjects:

- 24 children with CI in the age of 4 years and 2 months to 7 years and 6 months were participated in this study:
  - Study group, 12 children, CI users with dynamic FM system,
  - Control group, 12 children, CI users without dynamic FM system.

Selection of the participants

- All children had bilateral profound sensorineural hearing loss.
- They used Advanced Bionics, Medel, or Nucleus cochlear implants associated with BTE speech processors.

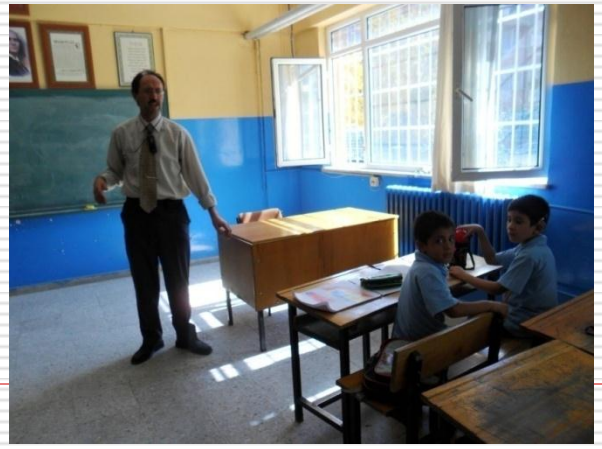

Inclusion Criteria

- Participants were cochlear implant users for minimum 1 year.
- The earliest implantation applied at 1 year of age and the latest implantation at 3 years 5 months.

Inclusion Criteria

- Dokuz Eylül University, Faculty of Medicine and İzmir Education and Research Hospital, Department of Otorhinolaryngology.

- All children were regularly continuing special education sessions besides nursery school or primary school.



Inclusion Criteria

- Native language of every kid was Turkish.
- All children were prelingually deafened and used verbal communication as their primary means of communication.
- Fitting of the all CIs were regularly performed at least for the last one year.

Exclusion criteria

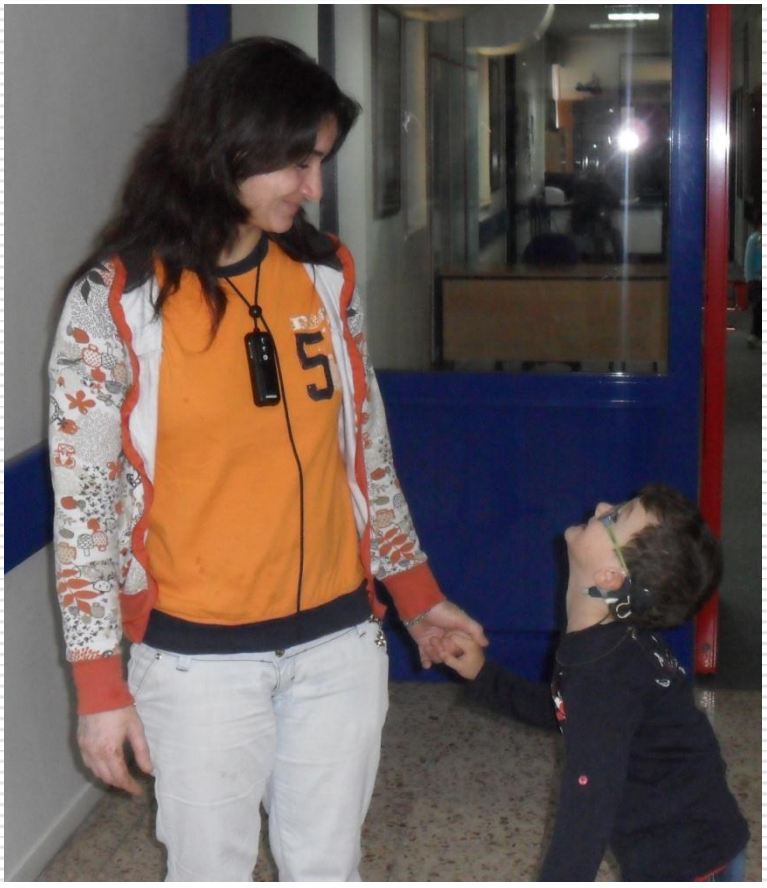
- Children with any kind of mental handicap problems
- Children who did not regulary use CI or FM system
- Those of children who did not regularly follow educational sessions.
- Children did not participate language development tests.

Experimental setting

- Cochlear implants: Implant models were same for both groups (i.e. 5 Advanced Bionics-Auria, 4 Medel-Opus 2 and 3 Nucleus-Freedom).
- Language development tests: PLS4 (Preschool Language Scale) and TIFALDI (Turkish receptive and expressive language test).

- FM systems: Phonak Dynamic FM system, universal form of dynamic FM receiver (MLXi) was connected to all implant models.

- Zoomlink+ Dynamic FM transmitter was selected.



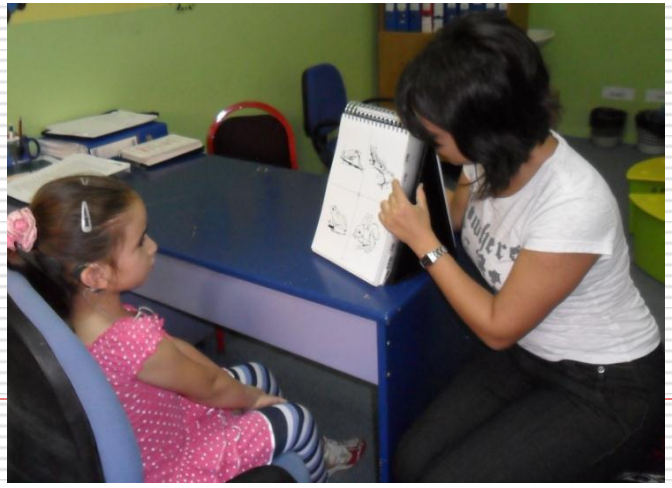
- Groups matched for chronological age.
- As a preliminary statistical analysis, no significant difference was calculated regarding to chronologic age, implantation age, language age, developmental age as well as postimplantation period.

Application steps:

For both groups:

- Families of cochlear implant recipients were invited to the University Hospital and all necessary tests were performed (including Bender Gestalt, Denver II).

- Children's language parameters (PLS-4 and TIFALDI tests) were determined



- Dynamic FM system was introduced to parents and teachers of children in the study group and attached to their cochlear implants as a personal FM system.

- Transmitter microphone: Lavalier model

Dynamic FM system versus Classic FM system

- Dynamic FM system automatically adjusts the gain of the FM receiver depending on noise levels in environment.
- When noise level exceeded 57 dB SPL, the gain of FM receiver is increased automatically (from default +10 dB gain) to maintain favorable signal-to-noise ratio at listener's ear.

(Wolfe J, Schafer E, Programming Cochlear Implants, 2010)

Cochlear implant settings were adjusted to use with Dynamic FM system

(For all implants; equal emphasis audio-mixing ratio setting)

- For Cochlear Freedom, 1:1 audio-mixing ratio, Autosensitivity: Active.
- For MED-EL Opus 2, default audio-mixing ratio, MT was selected on remote control.
- For Advanced Bionics Auria, 50:50 audio-mixing ratio.

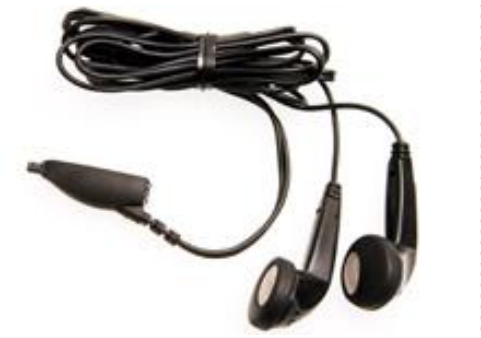
(Effects of Accessory-Mixing Ratio on Performance with Personal FM and Cochlear Implantas, Wolfe J & Schalfe E.C. In: Achieving Clear Communication Employing Sound Solutions-2008)

Three microphone choices

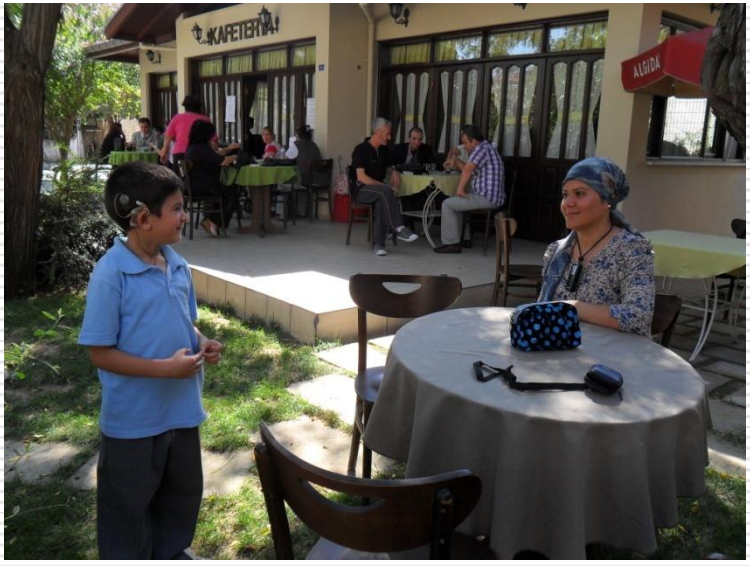
- **Superzoom** (narrow-angle sound pickup, high noise environments- classroom, outside etc.)
- **Zoom** (wide-angle sound pickup, medium noise environments- classroom, outside, at home)
- **Omnidirectional** (360° sound pickup, low noise environments)

- FM systems were controlled by repeating words (apple, baby, child, etc.) away from the reciever (out of the room).

- Also FM systems were controlled via monitor hearing earphones for Nucleus users, by selecting only T mode on remote control for MED-EL users.



- In order to check the proper and regular use of FM systems with CI, we were in close contact with families (using phone calls as well as requesting families to discuss the problems at hospital environment).



- Language tests (PLS4 and TIFALDI), were performed before the experiment and after the 3 months postfitting. Testing and counselling will be performed for three months of intervals (four times in one year)
- Language developmental parameters (PLS-4 and TIFALDI tests) collected from both groups were compared to each other. Thus, between and within-subject comparisons were performed.

- Since this is a longitudinal study, at the end one year of follow-up, final outcome will be determined.

- However, as a preliminary statistical comparison, when FM systems combined with CI, using receptive and expressive language quotients, there is no significantly different results were obtained.

Baseline (Pre-experiment) language age (mean values, in months)

Test	Study group, Mean	Standart Error	Control group, Mean	Standart Error
PLS-4, Receptive	59.83	4.56	61.50	3.62
PLS-4, Expressive	55.08	5.07	53.33	4.75
TIFALDI, Receptive	59.00	7.78	49.91	3.93
TIFALDI, Expressive	54.58	10.54	46.00	5.02

Three Months Postfitting language age, (mean values, in months)

Test	Study group, Mean	Standart Error	Control group, Mean	Standart Error
PLS-4, Receptive	68,33	2.86	68.91	3.80
PLS-4, Expressive	62,27	4.53	61.33	3.64
TIFALDI, Receptive	71.41	9.37	64.41	4.02
TIFALDI, Expressive	60,00	11.40	51,16	6,09

Results of Questionnaire

- When the most acceptable listening conditions were asked to the parents the following most acceptable conditions were encountered:

1. Classroom (%58)
2. Outside (walks, playground, shopping, in the car etc.) (% 33)
3. At home (%8)

Preliminary Results

- Coupling Dynamic FM systems to cochlear implants might help children improve their auditory access.
- However, there is always a role of counselling, coaching and instructions by professionals (for instance, audiologist),in order to improve auditory access of the individual

- Special thanks to families and the kids who contributed to the study
- We are also grateful to Phonak Company for their donation of FM systems