

Research Article



Early Communication Skills Training for Infants and Toddlers with Cochlear Implant

Saeid Hassanzadeh¹, Fatemeh Nikkhoo^{2*}¹ Department of Psychology, Faculty of Psychology and Education, University of Tehran, Tehran, Iran² Department of Psychology and Education of Exceptional Children, Faculty of Psychology and Education, Allameh Tabataba'i University, Tehran, Iran

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Highlights

- Early communication training improves auditory skills in children with CI
- Interaction between parents and children with HL changes as a result of intervention
- In the early communication skills training parents learn how to communicate

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* Corresponding Author:

Department of Psychology and
Education of Exceptional Children,
Faculty of Psychology and
Education, Allameh Tabataba'i
University, Tehran, Iran.
fnikkhoo@atu.ac.ir

ABSTRACT

Background and Aim: Early communication skills in children with hearing loss depend on the quantity and quality of information received from parents. The present study aimed to investigate the effectiveness of early communication skills training in developing the communication skills of infants and toddlers with cochlear implants.

Methods: To this end, 54 infants and toddlers at the age range of 8–24 months with severe to profound hearing loss fitted by Cochlear Implant (CI) with their mothers participated in this study. The experimental and wait list control groups had auditory verbal therapy as the main intervention after the CI; however, the experimental group received a systematic early communication skills program. All subjects were assessed using the Communication and Symbolic Behaviour Scales Developmental Profile as the pre-and post-tests.

Results: Multivariate analysis of covariance indicated the effect of systematic training on the early communication development of subjects in intervention group.

Conclusion: Teaching the parents how to interact with infants and toddlers with CI could improve the communication skills of the infants and therefore it's recommended to be included in the auditory rehabilitation programs.

Keywords: Early communication skill; cochlear implant; hearing loss; infant and toddler



Introduction

Cochlear Implantation (CI) can be a safe and reliable technology for children with severe to profound hearing loss. Communication development post CI highlights the role of hearing and oral communication, education, and other factors [1].

It takes a few years for a typically-developing infant to develop gradually from an engagement in early communication interactions with the active use of verbal language in communication [2]. Ninio and Bruner [3] indicated how such non-linguistic interactions build the child's early verbal language. Prior to verbal language acquisition, infants and toddlers communicate with their caregivers using early communication skills such as crying, smiling, eye contact, pointing, joint attention, cooing, and babbling [4]. In other words, infants and toddler's spare efforts to establish communication with others, especially their mothers, by exhibiting such behaviours formed by caregiver-child interactions throughout the early years of life. Above 90% of infants and toddlers with hearing loss are born in hearing families who frequently have no effective means of communication with such children [5].

Early communication skills are essential precursors to understand and use the spoken verbal language in infants and toddlers, including both deaf or hearing ones [6]. Infants and toddlers with normal hearing gain much of their early understanding and use of spoken verbal language from their parents' behaviour during the first two years of their lives. Joint attention is the main early communication skill for verbal language development [7]. This means that parents follow their infant gaze pursuit and verbally comment on what their infants and toddlers are looking, this has been called triadic attention among the parents, the child, and an object [8]. As usual, parental verbal language input is received by a hearing child; however, an infant with Hearing Loss (HL) does not receive it normally. The communication between a mother and her normal hearing infant occurs when the child pays attention to an object or event verbalized by the mother or vice versa.

The third side of the triadic attention is only accessible via vision in an infant with HL [9]. The role of triadic attention in communication may be even more critical

for infants and toddlers with HL since they mostly rely on the speaker's facial expressions and signed communication to receive linguistic inputs. This implies that parents should learn how to capture the infant's attention with their communicative attempts to meet the child's visual needs. Otherwise, it will be difficult for both the parents and the child to make a meaningful and contingent communication. Majorano et al. [10] longitudinally examined the early communication and lexical development of a group of infants and toddlers with HL. Early communication babbling and the production of first words between infants and toddlers and their mothers during free-play were transcribed and highlighted its effect on later lexical development.

Moreover, the emotional effects of the birth of an infant with HL in a family may affect the parent-infant interaction patterns. For example, assuming that their infant cannot hear, parents may expose him/her to fewer communication stimulations or talk less to her/him. This may influence their interactions with the infant, thereby causing a delay in their verbal language development. Furthermore, the growth of early communication skills in infants and toddlers with HL depends on the quantity and quality of information received from adults. Furthermore, exposure to verbal language plays a critical role in developing communication skills in this critical period of verbal language acquisition [11].

Although CI is an evidence-based rehabilitation technology for severe to profound sensorineural hearing loss and is accessible for many infants and toddlers, many studies have supported the effectiveness of family-based interventions on the improvement of linguistic, auditory recognition and perception, communication, emotional and social skills in infants and toddlers with CI [12-14]. Infants and toddlers with HL need a supportive family environment to facilitate their verbal language development. Nicastrì et al. [15] assessed the effects of parent training on communication development using the "It takes two to talk" model, with specific adaptations for families of infants and toddlers with HL. They found out that the families' quality of interaction and the infants and toddlers' verbal language abilities improved more significantly in the trained group than in wait-list control group. The parents seemed to benefit from parent training focusing on techniques to empower and promote communication skills in infants and toddlers/infants and toddlers with

CI. Lund [16] showed that parent training could change parents' behaviour and children's vocabulary growth rate. Moeller [17] examined the relationship between the age of enrolment in intervention programs and verbal language outcomes in a group of five-year-old infants and toddlers with HL. A significant correlation was observed between family involvement and verbal language outcomes; however, the greatest progress was noticed in infants and toddlers/infants and toddlers whose families had the highest level of participation in the early intervention program. Moreover, the families' limited involvement led to delayed verbal language development in five-year-old infants and toddlers. Fantuzzo and McWayne [18] also concluded that interactive home activities such as reading to infants and toddlers, asking infants and toddlers about their school activities, and involving them in training courses, had the strongest relationship with the future academic achievements of infants and toddlers. Parents, especially mothers involved in interventions, communicate better with their infants and toddlers/infants and toddlers and make the highest contribution to the child's progress, compared to mothers not participating in such programs [19]. With newborn hearing screening program, the age of diagnosis in congenital HL has declined to the first weeks after birth, and infants and toddlers with hearing loss can receive CI when they are below 12 months of age. Infants and toddlers in therapy may need their parents to sit beside them throughout each session, highlighting the critical role of parent involvement in rehabilitation. Accordingly, parents can be the first therapists for infants and toddlers with HL.

In Iran, the age of diagnosis of hearing impairment has been declined to one week after the child is born and for cochlear implantation, it has decreased to ten months of age. This signifies the important role of parents/families as the first therapists for children with HL and also the increasing awareness of families. Despite the widespread use of early communication tasks by young infants and toddlers with HL to improve their early communication and linguistic skills, little research has documented the effectiveness of such tasks. Regarding the lack of rich literature on the role of early communication skills in early communication and verbal language development, the effectiveness of early communication skills training on the early communication of infants and toddlers with CI was examined in this study. The present study mainly aimed to investigate the effectiveness of early

communication tasks in a family-based setting in developing early communication skills in infants and toddlers with CI, who were below two years of age.

Methods

Participants

In this study, 54 infants and toddlers with CI aged 8–24 months (mean of CI age: 14.2 months) and their mothers were selected using the purposive sampling method at the Iran cochlear implant center in Tehran. The participants were randomly assigned to experimental and wait-list control groups regarding their age, gender, and age at CI. Table 1 present the demographic information of infants and toddlers. All infants had non-syndromic HL. The mean time interval between the age of performing cochlear implantation in infants and toddlers and beginning early communication training was 2.5 month. Education level, age range and family support subsidy indicated in Table 2. All of family lived in Tehran, capital of Iran. No parents had child marriage and there was no single parent. Mothers' mental health was screened by 12-item General Health Questionnaire, 52 mothers had no distress and 2 had mild distress. All parents and siblings of infants with HL were normal hearing.

Measures

The early communication skills were assessed using Communication and Symbolic Behavior Scales Developmental Profile (CSBSDP). This tool aims to identify infants and toddlers at the risk of communicative problems and monitor the development of communication skills, expressive verbal language, and symbolic speech in infants and toddlers aged 6–24 months. It also investigates factors affecting verbal language learning and communication in the following seven domains: emotion and eye gaze, communication, use of gesture, use of sound, use of words, understanding words, and use of objects. This questionnaire contains 24 questions (often=2, sometimes=1, never=0), and in each question parents must answer. If parents have not observed the desired skill in their child at the time of the questionnaire, they should never choose the option, and if they repeatedly observe the desired behavior, the option is often assigned to the relevant question. Scores are calculated in three subscales of communication,

Table 1. Demographics characteristic of infants and toddlers

Characteristic	Frequency	Percent
Sex		
Female	26	48.1
Male	28	51.9
Age range (month)		
8–12	4	7.40
13–16	23	46.20
17–20	14	25.90
21–24	11	20.37
Age of diagnosis (month)		
0–3	31	57.40
4–6	8	14.80
7–12	5	9.30
13–24	8	14.80
24	2	3.70
Age at CI		
8–12	6	11.10
13–16	23	42.50
17–20	14	25.90
21–24	11	20.37

CI; cochlear implant

expressive speech and symbolic. The checklist takes about 5 to 10 minutes to complete. For caregivers who cannot answer the questions by reading them or writing the responses, the questions may be presented in an interview format with adequate explanations to clarify what is being asked. The validity and reliability of this test are 0.89 and 0.85, respectively [20].

The test-retest reliability and internal consistency of the Persian version of the CSBSDP questionnaire were 0.78 and 0.77 respectively and these tools can be used for early detection of evaluating language problems in infant toddler [21].

Intervention

Early communication tasks are adopted from the

Navayesh intervention program. The intervention program “Navayesh” was designed after reviewing common rehabilitation programs and conducting research in the field of rehabilitation and education for children with HL [22]. Additionally, a researcher-created needs assessment questionnaire was implemented to identify the problems and needs of parents and therapists. The program was tailored based on the linguistic and phonetic characteristics of the Persian language.

This program prioritizes all aspects of a child’s development, encompassing social, emotional, cognitive, and notably, communication skills. The Navayesh program is centred entirely around parents, aiming primarily to enhance the communication abilities of deaf children by improving the quality of interaction between parents and their children. This intervention

Table 2. Demographics characteristic of mothers

Demographic characteristic	Mean	Frequency
Mothers' age (years)	27	
19-24		12
25-29		19
29-34		13
34-39		10
Number of siblings	2	
1		17
2		21
3		11
4		5
Mothers' education level		
Under diploma		11
Diploma		27
Academic		16
Mothers' employment statuses		
Housewife		35
Employed		19
The family support subsidy	not covered (44)	Covered (10)

had some tasks for preverbal skills development, including joint attention, gesture imitation, eye gaze, turn taking, pointing, attention to others' face, attention to others' voices, and babbling. Mothers were trained by researchers to perform tasks on their infants and toddlers using age-appropriate game activities. Navayesh program has two main goals: firstly, to educate parents and, secondly, to provide them with practical strategies and principles for establishing effective communication with deaf children. The ultimate aim is to enhance the communication skills of children with hearing loss by equipping parents with valuable communication techniques. To determine the content validity, the input of eight experts specializing in the rehabilitation and education was sought. The level of agreement among these evaluators, measured by the Content Validity Ratio (CVR), yielded a 69% agreement, indicating an acceptable level of validity for this program [23]. The

early communication skills training items are described in Appendix A.

Procedure

All participants in both experimental and wait-list control groups received the conventional auditory verbal therapy post CI offered by therapists. The experimental group received practices on early communication skills development at home by their mothers. The two experimental and wait-list control groups were tested using CSBSP as the pre-and post-test at the beginning and the end of intervention. To assess the stability of the results, a follow-up reassessment was performed four weeks after the post-test. Early communication skills training included training techniques to promote early communication skills such as joint attention, imitation, vocalization, pointing, hearing, and listening

Table 3. The descriptive findings of the early communication skills score and its subscales in experimental and wait-list control groups

Early communication skill variables	Stage	Mean(SD)	
		Experimental group	Wait-list control groups
Emotion and eye gaze	Pre-test	2.59(1.08)	2.51(1.05)
	Post-test	7.03(1.09)	4.03(0.64)
Communication	Pre-test	1.85(0.90)	1.81(0.78)
	Post-test	6.77(0.89)	3.22(0.89)
Gestures	Pre-test	3.18(1.24)	3.00(0.96)
	Post-test	7.59(1.08)	3.88(0.80)
Sounds	Pre-test	2.44(1.15)	2.44(1.08)
	Post-test	7.07(0.78)	3.74(0.65)
Words	Pre-test	1.96(0.80)	1.85(0.81)
	Post-test	4.96(0.70)	2.51(1.05)
Understanding	Pre-test	2.03(0.85)	2.11(0.69)
	Post-test	5.37(0.62)	3.11(0.50)
Object use	Pre-test	7.66(1.10)	7.66(1.00)
	Post-test	8.81(1.38)	8.55(1.47)

using age-appropriate activities. The training course consisted of 12 individual sessions, held for six weeks, twice a week, at the Iran Cochlear Implant Center. Both mothers and their infants and toddlers with hearing loss took part in these sessions. In the early communication skills training in a family-based situation, mothers learn how to support communicative interactions with their infants and toddlers, even before speech development, to prevent any delay in this critical developmental process. Furthermore, infants and toddlers are not only competent communicators but also sensitive and active for interaction attempts for communication. The mothers were trained to provide the preverbal tasks to their infants and toddlers with hearing loss at home. In other words, the assignments were explained to the mothers in each session. Given the importance of supervision in training, some parts of the homework were performed by mothers and their infants and toddlers in the presence of the researchers. Moreover, some relevant short educational videos were displayed in each session, and written “homework” was provided to mothers. At the beginning

of each session, the topics presented in the previous session were reviewed, and after taking the mothers’ questions, the new task was presented. It is noteworthy that mothers were also provided with a summary of pre-verbal skills training in educational handouts. During the research, weekly phone counseling was conducted to follow the implementation of the program and to answer the parents’ questions.

Data analysis

Descriptive and inferential statistics are used to summarize and analyze the collected data with SPSS software, version 17 (SPSS, San Francisco, CA). A multivariate analysis of covariance (MANCOVA) was performed to determine the efficacy of independent variable. Before performing MANCOVA, the assumptions of normality, covariance matrix (box test), and homogeneity of variance were tested, and the results showed that the pre-assumptions of MANCOVA were met ($p > 0.001$).

Results

Demographic information of infants and toddlers with CI and their mothers participated in this study mothers are shown in Tables 1 and 2. Table 3 shows the mean and standard deviation of the early communication skills and their subscales for the experimental and wait-list control groups. The results showed a significant difference between the pre- and post-test mean scores in the experimental group; however, no difference was observed in the wait-list control group. To determine whether these changes are statistically significant, MANCOVA were used. The results showed that early communication skills training caused significant difference between the experimental and wait-list control groups with regard to the emotion and eye gaze [$F_{(52,1)}=145.47$, $p=0.001$, $\eta^2=0.77$], communication [$F_{(52,1)}=210.91$, $p=0.001$, $\eta^2=0.82$], gestures [$F_{(52,1)}=184.29$, $p=0.001$, $\eta^2=0.80$], sounds [$F_{(52,1)}=308.78$, $p=0.001$, $\eta^2=0.87$], words [$F_{(52,1)}=108.00$, $p=0.001$, $\eta^2=0.70$] and understanding [$F_{(52,1)}=210.72$, $p=0.001$, $\eta^2=0.82$] but not for the object use [$F_{(52,1)}=0.23$, $p=0.63$, $\eta^2=0.005$].

Discussion

The findings revealed significant improvements in early communication skills in infants and toddlers with CI, following early communication skills training. This program also caused more effective communication between mothers and infants, and toddlers.

The importance of family involvement in the child's early years cannot be underestimated. However, earlier enrolment in comprehensive early intervention programs has been linked to better outcomes for infants and toddlers [24]. Moeller [17] proposed that early intervention makes a positive difference in the lives of the majority of infants and toddlers; hence, enhancing family involvement and communicative interactions should be emphasized. Establishing effective communication between parents, especially mothers, and their young infants and toddlers has long been recognized as the key to early verbal language acquisition, family functioning, and the overall development of children with hearing loss [25-27]. Earlier enrolment and longer stays in early intervention programs increased opportunities for families to gain greater understanding of their child's needs and potential.

According to the ease of verbal language understanding model, pre-existing mental representation of lexical items facilitates verbal language understanding, and parental responses to child vocalization are likely to promote verbal language acquisition [28]. In this regard, in early communication skills training, the assignments were directed towards emphasizing the imitation of the infant babbling by the mothers. The mothers were taught how to mimic the sound, like a mirror against gestures and sounds produced by their infants and toddlers.

From the earliest months of life, parents engage in face-to-face interactions with their children, responding to their vocalizations, displaying positive affect, and speaking in a special register known as mother- or child-directed speech. In these early face-to-face interactions, the infants and toddlers gain experience with turn taking and other discourse skills. In early communication skills training, practices are designed to enhance joint attention between mothers and infants and toddlers using attractive games that are easy to play in natural environments, especially at home. Infants and toddlers' ability to engage in complex gaze shifting may be necessary for infants and toddlers with hearing loss to receive relevant verbal language input.

Furthermore, the examination of symbolic behaviour, which is one of the components of communication skills, demonstrates the effectiveness of the program in improving the performance of children participating in this research. In fact, it can be said that the change in the initial parent-child interaction and the provision of tasks and solutions to improve language expression and speech production in participating children in this research have been effective in creating and strengthening symbolic behaviour. The results of this research are consistent with the study conducted by Loots and Devise [29] regarding the role of early interactions in the development of symbolic behaviours in children.

The present findings suggested that early communication skills training was effective in terms of the use of words and the application of sound as a part of communication skills through an emphasis on the use and repetition of objective, tangible, and practical expressions by parents, especially mothers, using daily activities. This intervention improved auditory skills and the use of words in infants and toddlers with HL,

as described in the theory of verbal language usage introduced by Tomasello [30]. This researcher also indicated that infants and toddlers do not try to learn words directly; they try to comprehend utterances, and in doing so, they must often comprehend a word regarding its functional role in the utterance and detect the commonalities of the words in their functional roles across utterances. Since mother-child interaction in the two groups were in the form of Auditory Verbal Therapy tasks, and the mothers were actively involved in all tasks, it might be concluded that the changes in early communication skills in the experimental group were the result of early communication tasks, rather than just the interaction between mothers and their infants and toddlers.

Regarding the subscale 'object use,' there was no difference between pre-and post-test scores in the experimental and wait-list control groups. The items of this subscale are visual in nature but not auditory and lingual; hence, all participants had similar performance on this subscale. Infants and toddlers get sufficient skills in this area when they are below two years of age. The maximum score of the object use subscale was 11, and the participants' mean scores in pre and post-test phases were 7.66 and 8.68, respectively. Teaching parents, especially mothers as the main therapist, who to interact with infants and toddlers with hearing loss can significantly improve infants and toddlers' communication skills.

Limitations

This study had some limitations. All parents in this study and the siblings of the infants and toddlers with hearing loss were normal hearing; hence, the initial interaction of normal hearing parents with their infants and toddlers with HL could be different from that of parents with HL. Moreover, this program was implemented for infants and toddlers with non-syndromic HL; no disorder other than hearing loss was observed and diagnosed in the participants. Accordingly, the findings may not be generalized to infants and

toddlers with syndromic HL. Moreover, lack of previous research on the development of preverbal skills in infants and toddlers with HL should be noted in this study.

Conclusion

It can be concluded that improvements in the mother-child primary interaction patterns is effective in developing early communication skills in infants and toddlers with hearing loss, therefore, this issue is recommended to be made available to rehabilitation centers, instructors, therapists, and families with hearing-impaired children in the form of a package and educational software.

Ethical Considerations

Compliance with ethical guidelines

This study was approval from Allameh Tabataba'i University under process number IR.ATU.REC.1399.084.

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Authors' contributions

SH: Study design, interpretation of the results, statistical analysis, and drafting the manuscript; FN: Study design, acquisition of data, and drafting the manuscript.

Conflict of interest

The authors have no financial or proprietary interests in any material discussed in this article.

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Appendix A. Description of early communication skills training items adopted from the Navayesh intervention program

Early communication skills	Activities	Sample of tasks
Joint attention	Eye contact Eye gazing Following attention by eyes Attention seeking Social smiles Share an interest	<ol style="list-style-type: none"> 1. Focusing on faces and developing eye contact encourage child to look at him/her mother 2. Using index finger to trace the child's eye gaze to the target toy 3. Using immediate positive reinforcement once child looks at familiar person and smiles 4. Using finger puppets as a symbol of family members and speaking on their behalf after getting the child's attention 5. Show enjoyment in any activity that share together 6. Point to a ball and says, "look at the ball!" The child responds by following the parent's gaze and gesture using the index to look at the ball
Imitation	Use of visual cues Motor imitation Vocal imitation	<ol style="list-style-type: none"> 1. Imitation of actions such as stacking blocks, clapping hands, opening cabinet doors 2. Imitation of sounds like animal noises, kissing or smacking lips, and other silly sounds 3. Imitation of eating with utensils, household chores
Vocalization	Babbling, jargon, symbolic noises, sound games	<ol style="list-style-type: none"> 1. Encouraging and imitating any sounds in the child 2. Generating sounds associated with any vehicle or animals, for example, mother say beep beep simultaneously moving the toy car or hopping to see the dog, repeat this activity and encourage child immediately after vocalization
Pointing	To get attention Request something Request assistance	<ol style="list-style-type: none"> 1. Pointing to show child things he/she wants or where he/she wants to go. 2. Pointing to "ask child to name the object or person. 3. Raising arms up to indicate wanting to be held 4. Waving hello and bye-bye 5. Nodding head for "yes" and shake it (sometimes very forcefully) to indicate "no"
Hearing and listening	Attention to speech and sound Active listener Distinguish between Sound and quiet	<ol style="list-style-type: none"> 1. Looking at person who is talking to him/her 2. Changing body situation in response to another Person's voice 3. Hitting things with intent to make sounds 4. Using auditory bombardment 5. Surrounding a child with meaningful sound and verbal language with a focus on particular targets. 6. Singing a song while mother is carrying the child and going around a chair, as soon as the song stops, mother with the child sit on the chair.