The Analysis of Emotion Recognition Skills of Children with Cochlear Implants from Facial Expressions and Scenarios

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Abstract

Objectives: In our cross-sectional research study, the emotion-recognition ability of cochlear-implanted (CI) children is compared to that of normally-hearing (NH) children between four and six years old. For this purpose, thirty (CI) children and thirty NH children were assessed. **Materials and Methods:** The emotion recognition abilities of each child were evaluated with two tasks. In the first task, emotion recognition abilities were assessed by using the facial expressions cards. Children were expected to point out the card which was matching the emotion. Then facial expression cards were shuffled and children were asked to name the emotions from the cards which were shown by the professional. In the second task, emotion recognition abilities from the scenarios were assessed by scenario cards. Five emotion cards were shown to the children and they were asked to point out the emotion card that matching the scenario, and also named the emotion**. Results:** The results showed that CI children were not able to recognize the five emotion from the two-dimensional stimuli as well as NH children. Even if CI children had similar language scores with typically developing children, they had difficulties mostly in recalling and expressing emotion words. The most easily recognized emotions were sad and happy in both groups. **Conclusion:** Our findings support other studies in the literature and aimed to increase awareness for emotion recognition abilities of children, which may promote the establishment of appropriate training programs to improve emotion recognition abilities of children with hearing loss. Emotion recognition tasks should be included in the training programs from early ages, because these abilities are supported children's communication skills, especially children with hearing loss.

Key words: *cochlear implants; children; emotion recognition*

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Introduction

Emotion recognition skills from facial expressions are crucial in the socialization of children (Hesse & Cicchetti, 1982). From very early on in life, children begin to discover the relationship between the verbal and facial expressions of emotions, and start using this relationship. The ability to build links between emotions and events, and exhibit appropriate responses, is an important factor in a child's adaptation to the social environment (Lewis & Michalson, 1983).

Mostly in emotion recognition studies, children were asked to predict another person's emotions from their facial expressions or context; this emphasized that predicting another person's emotion is the important aspect of emphatic ability and "essential for understanding other people" (Dyck, 2012). After the age of six months, babies understand emotions such as *happy, sad, disgust, anger, fear and surprised* as a mental process (Lewis & Michalson, 1983). Typically developing children start to use emotion words and understand the relation between actual emotions and words that describe emotion when they are nearly two years old. The children in this age group can both understand and express four emotion expressions: *happiness, sadness, anger and, fear*. Bretherton & Beeghly reported that babies can discriminate the emotions from pictures (Bretherton & Beeghly, 1982). Before 2 years old they express emotions with verbs. They could say "crying" instead of "sad" (Wellman, Harris, Banerjee, & Sinclair, 1995). Children's vocabulary of emotion words expand between 2 and 5 years old. By the age of about four, children can discriminate the basic emotions through facial expressions (Denham, 1986; Harris & Saarni, 1989).

Emotion recognition performances of deaf children are varied in the literature when facial expressions are presented with cards or photos. Dyck et al., in their study on recognizing and understanding the emotions, have stated that deaf, or hard of hearing children and teenagers significantly differ from their normal hearing peers (Dyck, Farrugia, Shochet, & Holmes-Brown, 2004). Another study aimed to determine the relationship between emotion concepts and reasoning in adolescents with hearing impairment (Kusché, Garfield, & Greenberg, 1983). The authors reported that the language level of children is the most important factor, rather than the subject's age. However Ludlow et al demonstrated that deaf children recognized emotions from facial expressions less than typically developing peers. Recently, Hao and Su reported that deaf children recognized emotions better when emotions were presented with visually clear facial and body expressions (Hao & Su, 2014).

Early identification of hearing loss and providing early intervention strategies to babies with hearing impairment help their receptive and expressive language performances to reach similar scores to that of typically developing peers (Nicholas & Geers, 2007; Yoshinaga-Itano, 2003). Moreover, it was found that hearing-impaired children with age-equivalent language scores have better social skills (Bat-Chava, Martin, & Kosciw, 2005; Calderon, 2000; Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007). Even though early implantation was shown to have a positive effect on language development, children with cochlear implants still need social support, especially concerning pragmatic skills (Goberis et al., 2012).

Pragmatic skills are related to understanding other's emotions. These skills can be evaluated with specific scenarios, which can be complex in nature and which may include, e.g., information about the environment, behaviors and the power of motivation in one's self or others. In the scenarios related to emotion, if someone has knowledge about the situation, then they can predict their own emotions, or others' emotions, or vice versa. Children can identify emotions through scenarios by the time they are 6 years old (Harris, Olthof, & Terwogt, 1981). Complex situations can be identified and expressed by a child of between 6 to 11 years old (Harris, Olthof, Terwogt, & Hardman, 1987). Children with hearing impairment struggled more in predicting emotions from scenarios compared to their peers with normal hearing (Hosie et al., 2000).

The aim of this study is to compare the emotion recognition skills of preschool children that use cochlear implants with those that have normal hearing. We assumed that NH children would be performed better on emotion recognition tasks than CI children. On these skills of children, family dynamics and the viewpoint of parents could have an impact. Lastly, we investigated whether if there is a relation between child's temperament and emotion analysis skills.

Materials and Methods

Participants

The study has two groups and each group has 30 children, all between 4 to 6 years old (Table 1). The study group includes 19 girls and 11 boys with cochlear implant and the control group includes 12 girls and 18 boys with normal hearing. Parents of the children speak only Turkish at home. The intelligence level and hearing thresholds were collected retrospectively from their files indicating no cognitive delay or hearing impairment in the

control group. All children in the study group had used their cochlear implant for more than a year. Language level of children in both groups was in normal limits, according to PLS-4. Children who had delayed language were excluded from the study. In Table 2, we provide descriptive information about the age of detection, identification, hearing aid use and cochlear implantation. Additionally, cochlear implant users had attended auditory-verbal therapy programs in our cochlear implantation center and visited local special education centers for more than a year. The children had not received any specific training in emotion recognition, as part of a specialized program.

Table 1: Number of children in age groups.

Group	n	Four years old	Five years old	Six years old
Study Group	30	6	14	10
Control Group	30	7	15	8
Total	60	13	29	18

Table 2: Descriptive statistics related to hearing loss.

	Min (month)	Mean (month)	Max (month)	SD (month)
Age of detection	1	6.9	18	5.8
Age of diagnosis	1	12	25	7.8
Age of hearing aid use	2	12	30	6.9
Age of cochlear implantation	12	30.54	60	12.1
Duration of cochlear implant use	12	30.07	60	12.9

Materials

Demographic Form

A demographic form is completed by the parents of the children, and includes questions regarding the medical and family history of children, Analysis of these forms allows one to determine the socio-demographic aspects of the family. In the form, some items

addressed children with hearing loss, such as hearing loss detection age, age of cochlear implantation and age of starting the use hearing aid for the first time.

Family Assessment Device (FAD)

The FAD was developed by Epstein, Bishop and Baldwin for assessing the family system with a dynamic viewpoint and describing family problems perception of family members (Epstein, Baldwin, & Bishop, 1983). The validity and reliability study of the FAD Turkish version was done by Bulut (Bulut, 1990). The Turkish version of FAD has 60 items which are ranked between 1 and 4. If the family scored two or more in each subtest, this is indicative of problematic functioning. These family functions are evaluated with six subtests: affective involvement, affective responsiveness, behavioral control, communication, problem solving, and roles. In addition, it provides a general family functioning score, as another subscale. Test-Retest reliability of the device for subscales ranged from 0.62 to 0.89. Cronbach Alfa coefficients of the Turkish Form were found to be 0.80 for Problem Solving, 0.71 for Communication, 0.42 for Roles, 0.59 for Affective Responsiveness, 0.38 for Affective Involvement, 0.52 for Behavior Control, and 0.86 for General Functioning.

The EAS Temperament Survey for Children (EAS)

The emotionality activity sociability (EAS) temperament survey, for Children, was developed by Buss and Plomin in order to assess temperament using parental ratings (Rowe & Plomin, 1977). The survey is recommended for children between the ages of one and nine years old. It provides information about 4 dimensions: (i) "Emotionality", which is the tendency to become aroused easily; (ii) "Activity", which is the observed levels of activity of children; (iii) "Sociability", which is the tendency to prefer the presence of others; "Shyness" which is the tendency to be diffident around others. All the items are scored between one (never) to four (always). Due to chronbach's alphas, reliability of the subscales were between 0.57 (sociability) and 0.76 (shyness).

Emotion Cards

For this study, five emotions were selected: *happiness, sadness, surprised, fear* and *anger*. These emotion expressions were expressed as cartoon faces. The drawings were reviewed by experts from the *developmental psychology, child development and education, clinical audiology, speech disorders* and *educational audiology departments*; necessary changes were carried out as a result of their recommendations. Then the drawings were shown

to ten normal hearing children in the four to six age group, having no language delays in the pilot study. Children found it very difficult to discriminate between the 'surprise' and 'sadness' expressions. Only five children could distinguish between the two expressions. These two drawings were revised and until all children in the pilot study discriminate these two emotions. On the other hand, the children were able to differentiate between the other emotion expression cards quickly.

Emotion Scenario Cards

Having two scenarios for each emotion, ten scenario cards were prepared to discriminate five emotions. The cards were used as a clue for the scenario, and scenarios were also applied in the pilot study. The specialists revised and approved all scenario cards. All children in the pilot study could discriminate and recognize the scenarios and emotions from them.

Procedure

The study protocol was approved by the Hacettepe University Non-interventional Clinical Research Ethics Board and was issued on August 2009 (LUT 09/112). All procedures performed in the study followed relevant ethical guidelines. Informed consent was obtained from all individual participants included in the study. The assessment procedure was held in two steps. In the first step of the study, five different face drawings were shown to children. Each drawing showed a different emotion, namely *happy, sad, surprised, and frightened* and *anger*. The children's ability to discriminate between and understand the emotions was evaluated. To evaluate their ability at distinguishing between the emotions, the instruction "please, show which one is happy" was given in the first part. In the second part, the pictures were presented one by one in closed-set condition. In order to assess the child's ability to recognize emotion expressions, the children were asked to express in words how the person in the sequence of pictures is feeling. In both parts, each correct answer was scored as '1' and wrong ones as '0'.

In the next part of the study, the children were asked to identify the emotions from the scenario pictures, which was achieved by using the emotion cards and by expressing the emotions verbally. The character in the scenario was named as "Deniz" which is a unisex name in Turkish. However, the children were first given the opportunity to use a name of their own choice. A short story about the scenario card was told to the child, when the picture

of the scenario was presented. After describing the scenario, the child was asked to express what the appropriate emotion for the scenario was.

In the analysis each child's performance in the two tasks described above was assessed using a score for each task. The first score was for the emotion-discrimination task, where cards in the closed set condition were scored by asking the child to point to the appropriate card. The second score was for the child's verbal response to the pictures. The study is composed of 2 experiments, with 2 phases in each, please clarify the scoring in each experiments and phases separately for the sake of clarity.

Results

In this study, the emotion analysis skills of preschool children with cochlear implantation were compared with their typically developing peers. Emotion analysis performances were evaluated through two experiments: (i) a child's emotion-discrimination performance was assessed by getting the child to point to the appropriate emotion cards; (ii) a child's ability to recognize emotion was assessed by allowing the child to verbally express the appropriate emotions.

Emotion discrimination performances from facial expressions

In emotion discrimination performances task, children were asked to point out the five emotions (happy, sad, surprise, angry, fear) from facial expressions on cards. In the control group, nearly all children recognized emotions from facial expression cards (Figure 1); but children in the study group mostly recognized more than half of the emotions. The study group performances reached peak in emotion recognition task in happiness and sadness. According to Mann-Whitney U test; there were significant difference between control and study groups both in the emotion discrimination tasks from cards (Table 3) and in the emotion recognition tasks (Table 4). Kruskal-Wallis H analysis showed the difference between both groups were significant in to emotions: angry ($H = 10.15$, $p < 001$) and afraid ($H = 10.06$, $p < 002$).

Figure 1: Emotion recognition scores from facial expression cards

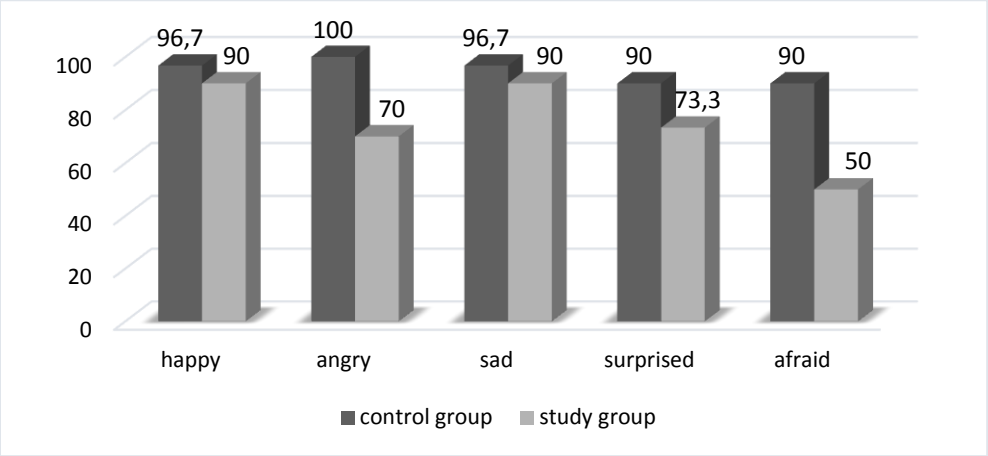


Table 3: Mann-Whitney U results of both groups in emotion discrimination from facial expressions

n=60	Mean Rank	Sum of Ranks	Mann-Whitney U	p
Study Group (n=30)	24.83	745.00		
Control Group (n=30)	36.17	1085.00	280.00	.003

Table 4: Mann-Whitney U results of both groups in recognition of the emotions from facial expressions

n=60	Mean Rank	Sum of Ranks	Mann-Whitney U	p
Study Group (n=30)	24.20	726.00		
Control Group (n=30)	36.80	1104.00	261.00	.001

Emotion recognition performances from scenario cards

Despite the children in the study group performed in normal range in language development test, their emotion discrimination in scenario cards were poorer than control group. According to Mann-Whitney U test, there was a significant difference in both discriminating the emotions and expressing the emotions from scenarios cards in two groups (Table 5 and Table 6). Emotion discrimination performances using scenario cards are demonstrated in all scenarios to show the differences in between cochlear implant group and normal hearing group (Figure 2).

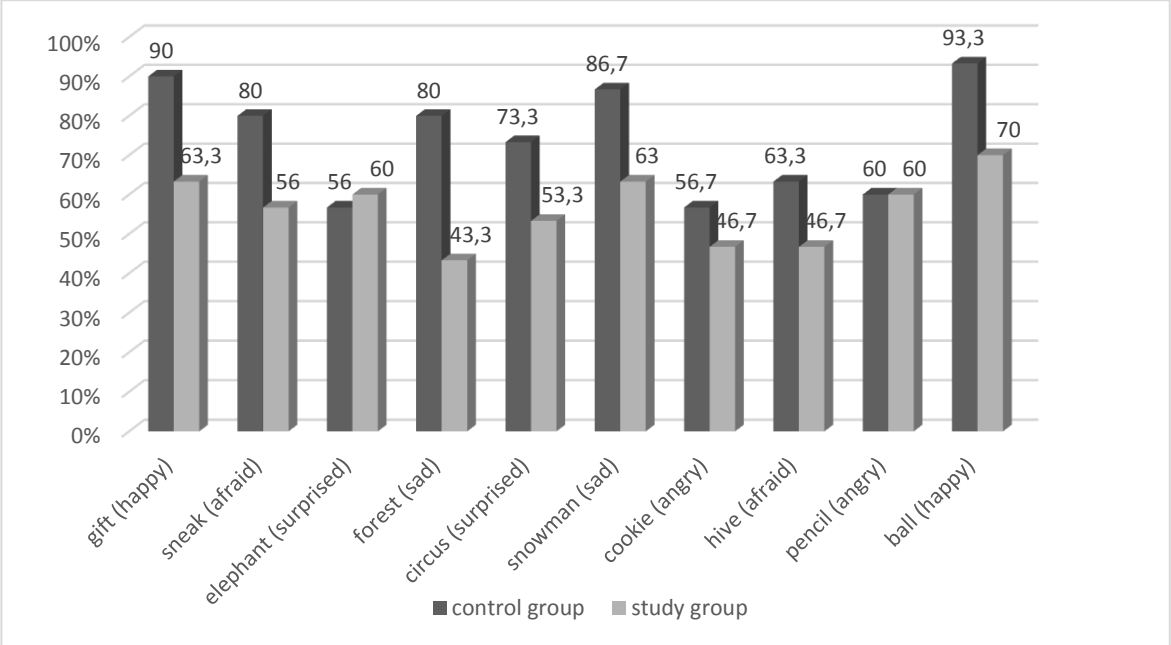
Table 5: Mann-Whitney U results of both group in emotion discrimination from scenario cards

n=60	Mean Rank	Sum of Ranks	Mann-Whitney U	p
Study Group (n=30)	26.08	782.50		
Control Group (n=30)	34.92	1047.50	317.50	.047

Table 6: Mann-Whitney U results of both groups in recognition the emotions from scenario cards

n=60	Mean Rank	Sum of Ranks	Mann-Whitney U	p
Study Group (n=30)	25.85	775.50		
Control Group (n=30)	35.15	1054.50	310.50	.037

Figure 2: Emotion discrimination from scenarios cards



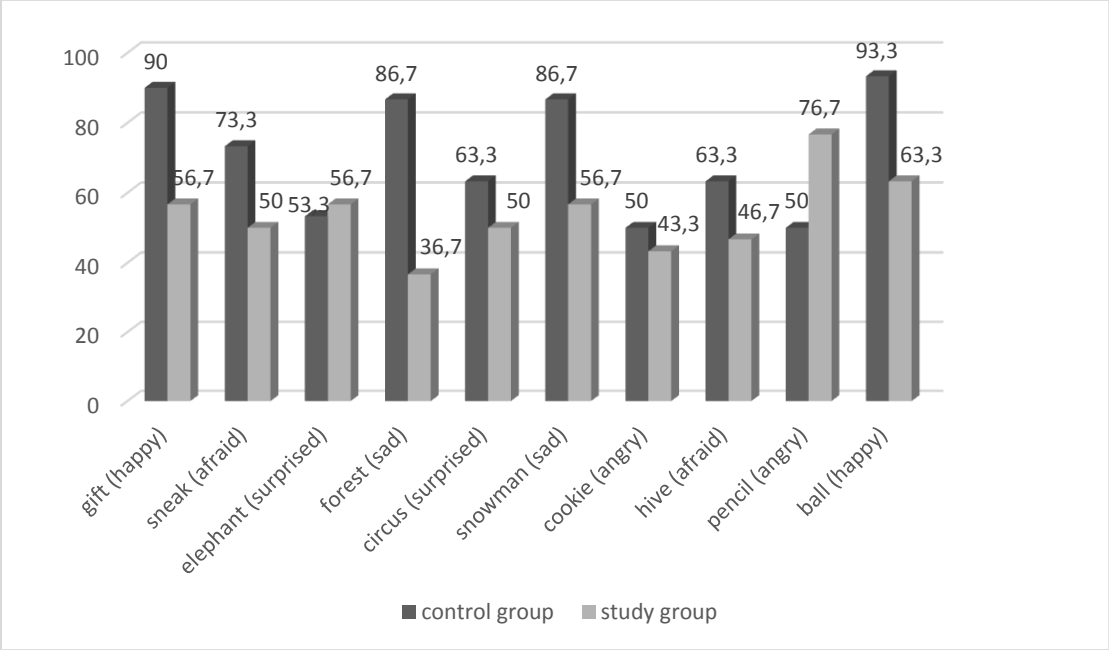
In this study, more than half of the children in the control group discriminated the emotions from scenario cards successfully. The highest proportion belongs to the scenarios related to the emotions "*happy*" and "*sad*". These were followed by "fear", "surprised" and anger".

Expressing the emotions verbally from the scenarios, normal hearing group shows a similar achievement with emotion recognition from the scenario (Figure 3). However, only very few children from CI group gained similar scores in naming task. For instance, CI children get a high scores in recognizing "*anger*" from the scenario while, they couldn't reach same success in expressing the emotions verbally. Additionally, in the study group emotion discrimination and recognition performances were highly correlated in each tasks (Table 7).

Table 7: Correlation between emotion analysis tasks in study group

Study Group (n=30)	**Emotion discrimination from scenario cards (spearman's rho)**	**Emotion recognition from scenario cards (spearman's rho)**
Emotion discrimination from facial expression cards	.670**	.629**
Emotion recognition from facial expression cards	.838**	.864**

Figure 3: Emotion recognition from scenario cards



Relation between Family Assessment Device and emotion analysis performances of children

Family Assessment Device (FAD) was used for evaluating whether family system had any effect on children's emotion recognition skills. In order To eliminate the parents' gender role in the family, the questionnaire was asked to be filled by both parents. Interestingly there

is no significant correlation between emotion recognition performances and FAD scores in study group. However there is a positively significant correlation between emotion recognition skills of children and total FAD scores of parents in control group (Table 8).

Table 8: The correlation between emotion recognition performances of children in control group and FAD total scores of their parents

	Emotion discrimination from scenario cards (Spearman's rho)	**Emotion expression from scenario cards (Spearman's rho)**
Mothers' total FAD scores	-.449*	-.577**
Fathers' total FAD scores	.258	.407*

Relation between emotion recognition skills and temperaments of children

Temperament scale was completed by parents and results were compared with children's emotion recognition tasks in spearman's rho analysis. According to the results there is no significant relation between temperament scale scores and the tasks in the study group and in the control group except for emotionality subtest. Only in the control group mothers' emotionality subtest scores were highly related to emotion discrimination and recognition scores of children from facial expression cards (rho = .404 $p < .05$ in emotion discrimination task; rho = .568 $p < .01$ in emotion recognition task).

Discussion

The current study compared the emotion recognition and discrimination performances of children with cochlear implants and typically developing children. The relation between these performances and temperament of children, and family dynamics were also explored.

Our main hypothesis that children with cochlear implants will perform more poorly than typically developing children in emotion analysis tasks was supported. Children in the cochlear implant group had significantly lower scores in emotion recognition and discrimination tasks. Pons, Harris and De Rosnay gather up the studies in literature on children's emotion understanding skills. According to their study, children in 3-4 years old begin to recognize the emotions from the clues. For example, most of the children in this age group can both recognize and verbally express the words "*happiness*", "*sadness*", "*anger*" and "*fear*" from the facial expressions when they were shown in the pictures (Pons, Harris, &

de Rosnay, 2004; Russell & Widen, 2002). Our study's findings are similar in normal hearing children group. Also similar to the literature findings, our results indicate that 90% of the normal hearing children can both recognize and expressed verbally the emotions "*happy, sad, angry, scared* and *surprised*" from the facial expressions.

On the other hand, in a study which compared the emotion recognition abilities between deaf or hard of hearing and typically developing children, *happiness, sadness, fear,* and *anger* was evaluated via the stories told by the puppets (Rieffe & Terwogt, 2000; Schorr, Fox, & Roth, 2004). 82% of the deaf or hard of hearing children at the age of 6 years old and 90% of age matched normal hearing children predicted the emotions correctly. Whereas 96% of the both groups at 10 years old predicted them successfully. As a result, deaf or hard of hearing children have started to catch up with their normal hearing peers in terms of emotion recognition from the stories along with age. Besides, Rieffe and Terwogt stated that children with hearing loss who didn't attend any specific training program on emotion recognition and expression before 6 years old might affect the difference between two groups (Rieffe & Terwogt, 2000). Hosie et al. divided twenty two children with hearing loss into two groups: younger age group (6 years and 7 months) and older age group (10 years and 9 months) (Hosie et al., 2000). The aim of their study was to evaluate emotion recognition and naming abilities of normal hearing children and children with hearing loss from facial expressions through pictures. "*Happy"* and "*sad"* were the expressions which obtained highest scores in recognition and naming. "*Anger"* was obtained as the emotion which was the latest understood and matched. In addition, "*disgust"* was recognized the latest of all emotions. However, there was not a difference between deaf or hard of hearing children and their normal hearing peers in emotion recognition skills from facial expressions. On the other hand Ludlow demonstrated that chronological and mental age matched control groups were better at identifying emotions than deaf children (Ludlow, Heaton, Rosset, Hills, & Deruelle, 2010). Based on their results they pointed out the effect of the language acquisition and heterogeneity of the groups. Our results were similar and children with cochlear implants performed worse than typically developing peers; although their language test scores were matched.

Emotion recognition abilities of children with severe and profound hearing loss were assessed in two groups according to their ages (Gray, Hosie, Russell, Scott, & Hunter, 2007). The average age of the younger group was between 5.5 and 8.7 years old, and the older group was between 9.5 and 13.2 years old. In both groups, the children with hearing loss show significantly lower performances than their normal hearing peers in the choosing the

appropriate emotion for the main character in the story task, which our study also supports this finding. More than half of the children with normal hearing between 4 and 6 have successfully identified and named the emotions suitable for the scenarios. Children between 2 and 5 years olds used emotion expressions similar to adults, while they might be using the meaning of those expressions in a wrong way(Widen & Russell, 2008). The authors concluded that the reason of the children's failure could be derived from their inexperience, as they have just started to use emotion words. Another study reported that children with hearing loss in 4-6 age group progressed slower than their peers in visual, auditory, and visual-auditory emotion recognition (Most & Michaelis, 2012). This is one of the reason why in our study, children were evaluated with closed set condition which contains picture cards as visual clues.

Children with cochlear implants performed less proficient on emotion recognition tasks than typically developing peers (Wiefferink, Rieffe, Ketelaar, & Frijns, 2012). Expressive language performances of children with cochlear implants were positively related to emotion recognition task performance. According to their findings we controlled the language performances of children with cochlear implants and all of them performed similar as their hearing peers on language tasks. However children in the cochlear implant group struggled in the labeling emotions verbally and understanding emotions from contexts. A Similar study of the authors' demonstrated the relationship between emotion recognition and language development (Wiefferink, Rieffe, Ketelaar, De Raeve, & Frijns, 2013). The remarkable finding of their study was that non-oral language skills might be related to emotion recognition skills of deaf or hard of hearing children. In the future studies pragmatic language abilities and emotion recognition skills should be evaluated and relation between language structures could be identified. The delay in emotion understanding in cochlear implant group should be evaluated with comprehensive expressive vocabulary tests and pragmatic language tests. Maybe these future studies give us more insight about language development and emotion understanding skills of deaf and hard of hearing children.

We also aimed to assess the impact of family dynamics on emotion recognition abilities of children. Our sample is limited to identify the variables which affect the emotion understanding skills of children with cochlear implant. Fisiloglu & Fisiloglu reported similar results in all subtests of FAD, except for problem solving subtest (Fisiloglu & Fisiloglu, 1996). In their study, deaf children's parents performed better at problem solving subtest than typically developing children's parents. The author emphasized that hearing parents of deaf children could cope with the problems and they would have functional family system. This

result could have explained our results that parents in both groups have functional family system and solve the problems successfully. On the other hand parents who have children with hearing loss may show signs of physical and emotional burnout (Morton, 2000). Previous studies showed that having a child with hearing loss can be related with depression in mothers (Sipal & Sayin, 2013); however social support can help them cope with problems (Åsberg, Vogel, & Bowers, 2008).

As a conclusion, we may say that the emotion recognition skills of children with cochlear implants should be supported. In the future studies, the factors related to hierarchical development and emotion recognition development in children with cochlear implants can be studied, as well as typically developing children. We suggest that new educational materials should be developed for improving early emotion recognition skills of children with cochlear implants. The hearing parents of the children with hearing loss must be informed about the importance of expressing their feelings by using appropriate words for clarifying what they feel at that moment while they are communicating with their children.

Conflict Of Interest

Authors have no relevant financial and nonfinancial relationships to disclose.

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