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Chapter 5

Emotion Understanding in Deaf Children with a Cochlear Implant

Carin H. Wiefferink, Carolien Rieffe, Lizet Ketelaar, Leo De Raeve, Johan H.M. Frijns

Submitted
Abstract

The effect of a cochlear implant on emotion understanding is still largely unknown, especially with regard to young children and those who received a cochlear implant at an early age. We examined various indices for emotion understanding and their associations with language development in children aged 2.5-5 years, both normally hearing children (N=52) and deaf children with a cochlear implant (N=57). Two aspects of emotion understanding were tested: i) emotion recognition in facial expressions, and ii) emotion attribution in a situational context. Emotion recognition was assessed by two tasks examining children’s ability to discriminate and identify different facial emotion expressions. An emotion-attribution task examined the extent to which children were able to attribute emotions to a protagonist in prototypical emotion-evoking situations. On all emotion-understanding tasks children with a cochlear implant were less proficient than children with normal hearing. In children with normal hearing performance and language skills were positively associated; in children with cochlear implants language was positively associated only with tasks in which a verbal demand was made on children. These findings indicate that the impairment of children with a cochlear implant affects all aspects of emotion understanding we had measured, including their non-verbal emotion-understanding skills. Auditory input seems essential for non-verbal abilities, such as recognizing facial emotion expressions. On the basis of these outcomes it is not possible to conclude whether emotion understanding development in children with a cochlear implant is merely delayed, or qualitatively different from that in peers with normal hearing. Since the CI children received their implants relatively recently, they may yet catch up with their hearing peers.
Introduction

Emotions play an important role in daily life: the way they are understood and expressed influences social relationships, the way people act in difficult situations, and the way interpersonal conflicts are solved. In children and adults alike, problems in emotion understanding have been shown to be related to developing symptoms of psychopathology or poor social functioning in adults (Eisenberg, Spinrad, & Eggum, 2010). For instance, in children social competence, peer-rated popularity, and academic achievement are strongly related to the ability to recognize the facial expression of emotions in other people, and to understand the causes of these emotions (Denham, McKinley, Couchoud & Holt, 1990).

Because there are also strong indications that language plays an important role in emotion understanding as well (Bosacki & Moore, 2004), the well-documented delays in deaf children’s language development make it particularly difficult for these children to develop proper emotion understanding (Moeller, Tomblin, Yoshinaga-Itano, McDonald Connor & Jerger, 2007; Meerum Terwogt & Rieffe, 2004; Rieffe & Meerum Terwogt, 2000; Rieffe & Meerum Terwogt, 2006). As from the late 1990s deaf children can have access to sound via a cochlear implant (CI), a device that electrically stimulates the auditory nerve, bypassing the damaged part of the ear. Ultimately, signals from the auditory nerve are perceived as sounds by the brain. Today, up to 94% of young, profoundly deaf children receive a CI (De Raeve & Lichtert, 2011). Remarkable results have been obtained with respect to speech and language outcomes, especially in children who received the implant at a young age (Niparko, Tobey, Thal, Wang, Quittner, & Fink, 2010; Colletti, Mandalà, Zoccati, Shannon & Collettie, 2011), and many implanted children are even able to attend mainstream schools (De Raeve & Lichtert, 2011). To date, however, the effect of a CI on children’s emotion understanding has not been examined.

In this study we examined two aspects of the ability to understand emotions in young deaf children with a CI: emotion recognition in facial expressions, and emotion attribution in a situational context. We assessed this
ability for the four basic emotions: happiness, anger, sadness, and fear (Vicari, Reilly, Pasqualetti, Vizzotto & Caltagirone, 2000).

Emotion recognition in facial expressions
An understanding of the facial expression of emotions comes about through the interplay between neurobehavioral maturation and environmental influences (McClure, 2000). Neurobehavioral research has shown that while the amygdala plays a prominent part in the recognition of faces in very early development, later a central role may be played by cortical areas. According to social constructivist theory, social interaction is important for the development of a proper understanding of the facial expression of emotions (McClure, 2000). The most important processes for developing recognition of facial expressions are children’s exposure to, and modeling from adults (McClure, 2000).

In the process of recognizing the facial expression of emotions two phases are distinguished. First, children must be able to discriminate between different facial expressions. In other words, they must be able to see that there is a difference between a drawing of a woman with a happy expression and a drawing of the same woman with a sad expression. However, the ability to discriminate between those two faces does not imply that the child also knows that these differences concern two different emotional states. Second, children must be able to identify and label the facial expressions – they have to associate the facial expression with the corresponding emotion (McClure, 2000).

The development of facial-expression recognition is impaired by deficits in both maturational and experiential factors. While deficits in maturational factors in children include those of Autism Spectrum Disorder (ASD; a neurodevelopmental disorder characterized by deficits in emotional and social interaction) (American Psychiatric Association, 2000), most deaf children have problems with experiential factors, because parent-child interactions are less frequent, shorter and less conversational than they are with hearing children (Gray, 2007). According to Hosie, Gray, Russell, Scott & Hunter (1998), research on the lateralization of face-processing abilities suggests that the emotional development of deaf children may differ from that of hearing children, probably because their exposure to and modeling from adults deviates
from that of hearing children. However, it is unknown how this difference affects deaf children’s recognition of the facial expressions of emotions.

Because deaf children spend less time communicating with their parents and cannot overhear conversations in which they are not directly involved, one possible consequence is that they are more sensitive to the facial expression of emotions (Barker, Quittner, Fink, Eisenberg, Tobey & Niparko, 2009). In general, deaf children are more dependent on visual information than hearing children, for instance because face patterns are essential for sign language, and many words share the same sign but with different facial expressions (Ludlow, Heaton, Rosset, Hills & Deruelle, 2010). Another consequence might be that deaf children have difficulties in acquiring the skills needed to recognize the facial expression of emotions, because this skill usually develops within the auditory and linguistic contexts. Young children with normal hearing not only observe the facial expressions of others, but also listen to others in order to learn how such expressions are interpreted. Deaf children do not get this verbal information. Their lack of exposure to daily conversation deprives them of models who facilitate their development (Rieffe & Meerum Terwogt, 2006).

Nowadays, however, most deaf children in Western countries receive a cochlear implant (CI) before their second birthday (De Raeye, 2010). By giving them access to sound, a CI makes it possible for them to learn spoken language more easily. Since there is a positive relation between language development and emotion understanding (Bosacki & Moore, 2004), these children can be expected to develop a better understanding of emotions than deaf children without a CI. To date, only few studies have examined facial emotion discrimination in CI children (Hopyan-Misakyan, Gordon, Dennis, & Papsin, 2009; Wang, Su, Fang, & Zhou, 2011). Hopyan-Misakyan et.al. (2009) showed that, when asked to match photos with drawings of facial emotion expressions (happiness, anger, sadness, and fear), a group of ten-year-old children who had received their CI prelingually were indeed just as accurate as their hearing peers in discriminating between different facial expressions. However, normally hearing preschool children performed significantly better on facial expression recognition than CI children, suggesting that there is a delayed development in children with CI (Wang et al., 2011).
Emotion attribution in a situational context

The recognition of other people’s emotions does not depend solely on facial expressions. Observers can attribute emotions correctly only when they know the antecedents of the emotion expression – i.e., they can correctly predict an emotion only when they have some knowledge about the situational context in which the emotion is expressed. Therefore, besides the ability to recognize emotions in facial expressions, it is equally important for children to develop knowledge about the kinds of situations that typically evoke a certain type of emotion.

In prototypical situations, most hearing four-year-olds can correctly attribute the basic emotions to a protagonist (Rieffe, Meerum Terwogt, & Cowan, 2005). In contrast, a study by Gray, Hosie, Russell, Scott & Hunter (2007), showed that deaf children aged 5-8 years found it considerably more difficult to assign emotions to prototypical situations than their hearing peers. The ability to understand the basic emotions in a prototypical situational context has not yet been studied in CI children.

This study

The aim of our study was to compare the capacity for emotion recognition and emotion attribution in prototypical situations between young normally hearing (NH) and CI children aged 2.5-5 years. We also examined the relation between emotion recognition/attribution and language development. Today, up to 94% of young, profoundly deaf children are fitted with a CI (De Raeve & Lichtert, 2011), making it difficult to compare CI children with deaf children who did not receive a CI. Therefore, we included in our study NH children and prelingually deaf children with a CI. First, by being asked to match drawings of various facial expressions to counterparts showing a similar expression, all children were required to discriminate between two different emotional facial expressions: 1) positive versus negative facial expressions, and 2) angry versus sad facial expressions. For this task, no language skills were required and children were instructed non-verbally. Second, the children were asked to identify emotions by linking words denoting emotion to facial expressions of happiness, sadness, anger, and fear. Third, they were asked to attribute emotions to a protagonist in various prototypical situations.
We expected CI children to be able to discriminate between different facial expressions as well as NH children could, because no language skills are needed in this task. Moreover, deaf children generally depend more on visual information than do NH children (Ludlow et al., 2010), thus developing more sophisticated nonverbal skills. Hence, we expected CI children to perceive the difference between a happy and a sad face just as well as NH children did.

We also expected CI children to perform less well than NH children in identifying facial emotion expressions and attributing emotions in prototypical emotion-evoking situations. This is because the identification of emotions is related to language development, which in CI children has repeatedly been shown to be delayed in the first few years of life (Colletti, 2009).

Method

Participants

The total sample consisted of 57 CI children (34 males, 23 females, aged 2.5 – 5 years, mean age = 46 months, SD = 8.6) and 52 NH children (30 males, 22 females, aged 2.5 – 5 years, mean age = 47 months, SD = 10.2). All CI children were born to hearing parents, had profound prelingual hearing loss with no other disabling conditions, and all had had their implant before the age of 43 months, with the exception of one child, who had received it at 57 months (range = 6 – 57 months, M = 20, SD = 10.1). At the start of the study, the mean duration of CI use was 25 months; 85% of the children had had their CI for more than 12 months (range = 1 – 44, SD = 11.3).

NH children were recruited through day-care centers, playgroups, and primary schools in the Netherlands. CI children were recruited through hospitals and family counselling services in the Netherlands and the Dutch-speaking part of Belgium. Informed consent was obtained from all parents and the study was approved by the university’s medical ethical committee.

General development was assessed by means of the Dutch version of the Child Development Inventory, a standardized instrument for children aged 15-72 months (Ireton & Glascoe, 1995). As an indication of cognitive development motor development scales were used, since it is impossible to obtain reliable IQ
scores for children this young (Piek, Dawson, Smith, & Gasson, 2008). Because deaf children usually have problems with the organ of balance (Gheysen, Loots, & Van Waelvelde, 2008), situated in the inner ear, five items referring to balancing skills were removed from the gross motor scale. The questionnaires were filled out by parents (N = 36 NH; N = 39 CI). No significant differences were found for fine motor skills, but CI children scored lower on gross motor skills than NH children did (t(71) = 2.45, p = .02).

Materials

Emotion recognition in facial expression. Two tasks were used to assess emotion recognition in facial expression: a discrimination task and an identification task.

First, children’s ability to discriminate between different facial emotion expressions was examined in the Emotion-Discrimination Task, consisting of two conditions, each covering two performance tasks of increasing difficulty. In the first, neutral, condition children were tested on their ability to discriminate between: 1) cars versus flowers, and 2) faces with hats versus faces with glasses. This condition was also used to check whether the children understood what they were expected to do. The second, facial expression condition was designed to test children’s ability to discriminate between different facial emotion expressions: 1) positive versus negative expressions, and 2) angry versus sad expressions. The task was stopped if children did not produce correct responses for the first condition. In both conditions children had a sheet in front of them with a sample drawing of one category in the top left corner (e.g., a car) and a drawing of the other category in the top right corner (e.g., a flower). The children were then handed six cards in fixed order (three drawings of a car and three drawings of a flower) and non-verbally asked to place each card on the correct side of the sheet. The drawings of facial emotion expressions used in this task were all computer-generated, in black and white, and based on photos of three- and four-year-old boys (Figure 1). The cards that were placed correctly were counted, with a maximum of three per category.
Second, in order to examine the children’s ability to link emotion words to the facial expressions accompanying the four basic emotions (happiness, sadness, fear, and anger), they were presented with the Emotion Identification Task, consisting of eight drawings of facial emotion expressions, two for each emotion, designed especially for this study. The researcher asked the children: “Who looks happy?” and they had to point to the drawing with the correct facial expression. Next, the researcher asked: “Is there anybody else who looks happy?” After that, she repeated the same procedure for anger, sadness, and fear.
The number of emotions identified correctly was recorded, with a maximum score of two per emotion. Next, the scores for negative emotions (anger, sadness, fear) were combined into one mean score. The scores for positive and negative valence were used in the analyses.

**Emotion attribution in prototypical situations.** The material for the third task, the *Emotion-Attribution Task*, consisted of eight vignettes depicting prototypical emotion-eliciting situations; these, too, had been designed especially for this study. For each basic emotion (happiness, anger, sadness and fear), two vignettes were designed.

After the children had been asked to look at the drawing and had been offered, either in spoken or in sign language, very simple illustrative words, e.g., “Boy sees dog”, they were first asked to say or sign how the protagonist would feel (verbal condition), and then to point to the drawing with the correct facial expression (visual condition). Their scores were calculated as 1) the proportion of correct verbal predictions, and 2) the proportion of correct visual predictions. A correct answer was achieved when a child predicted an emotion with the intended valence, i.e., negative (anger, sadness, fear) versus positive (happiness).

The children were then asked to explain why the protagonist would feel that emotion (e.g., “Why is boy scared?”). All responses were coded by two raters. Interrater agreement was 98.7% and disagreements were resolved by discussion. Children’s scores were calculated as the proportion of correct emotion explanations.

**Language development.** Language development – spoken and/or sign language - was assessed on the basis of the Dutch version of the Child Development Inventory (Ireton & Glascoe, 1995), which consists of two language scales – an expressive scale and a comprehensive scale – of 50 items each. Examples of items on the expressive scale are “calls/signs you ’mama’ or ‘dada’ or a similar name” and “uses at least five words/signs as names of familiar objects”. Examples of items on the comprehension scale are “usually comes when called” and “follows simple instructions”. Parents answered the items by yes or no.

*Test procedure*
Children were tested individually in a quiet room. CI children who communicated wholly or partly in sign language were tested by a researcher who was familiar with spoken and sign language. More than half of the CI children (53%) were tested by means of some form of spoken Dutch combined with signs, 29% by spoken Dutch, and 18% by sign language. No differences in performance were found on any of the tasks concerning language mode. All sessions were recorded on video and took approximately 20 minutes, including other tasks, which are not presented in this paper. After the sessions, the researcher made transcripts of the tapes.

**Data analysis**

Children who were unable to perform a task received a score 0 for that particular task, because this means that they were not able to correctly recognize facial expressions and attribute emotions. To determine whether accuracies in the recognition of facial expressions and the attribution of emotions in prototypical situations differed between NH children and CI children, all scores were entered in a multivariate analysis of variance. Effect sizes are also reported: Effect sizes around .01 are viewed as small, around .06 as medium and around .14 as large (Cohen, 1988). These analyses were also repeated excluding children who had been unable to perform one or more of the tasks, children who had received their CI after their third birthday, and children who had had their CI for less than one year. There were no differences in outcomes between the analyses including, and those excluding these participants. Furthermore, all analyses were also carried out by gender and age. According to Miller and Chapman (2001) this is only legitimate when the covariates (gender and age) and groups (CI/NH) are independent, and when assignment to group is based on the scores of the covariates. Both assumptions were fulfilled in our study, since CI children were matched with their hearing controls on age and gender. No differences were found in this respect either. For reasons of clarity, these analyses are not included in the analyses presented below.
Results

Emotion recognition in facial expression

Emotion Discrimination. Table 1 presents means and standard deviations of children’s performances on the Emotion-Discrimination Task. Children’s scores for the neutral condition were analyzed with a 2 (Group) x 2 (Difficulty) analysis of variance. A main effect was found for Difficulty ($F(1,107) = 25.50, p < .01$), both groups finding the flower/car task easier than the glasses/hat task. There was no significant difference between NH children and CI children.

Children’s scores for the facial expression condition were analyzed with a 2 (Group) x 2 (Difficulty) analysis of variance; this revealed main effects for Group ($F(1,107) = 5.12, p = .03$) and Difficulty ($F(1,107) = 29.70, p < .01$). First, we found that CI children were not as proficient as NH children at sorting faces that expressed emotion. Second, it was more difficult for children in both groups to distinguish between emotions within the negative domain (sadness and anger) than across valence domains (positive and negative). There were no other significant outcomes. Eight children were unable to perform this task: two NH children and six CI children.

<table>
<thead>
<tr>
<th></th>
<th>CI children (n=57)</th>
<th>NH children (n=52)</th>
<th>partial $\eta^2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flower/car</td>
<td>2.57 (0.88)</td>
<td>2.79 (0.67)</td>
<td>.019</td>
<td>2.67 (0.79)</td>
</tr>
<tr>
<td>Glasses/hat</td>
<td>2.22 (1.02)</td>
<td>2.42 (0.86)</td>
<td>.012</td>
<td>2.32 (0.95)</td>
</tr>
<tr>
<td>Facial-expression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive/negative</td>
<td>1.50 (1.11)</td>
<td>1.89 (0.92)</td>
<td>.037</td>
<td>1.69 (1.04)</td>
</tr>
<tr>
<td>Sad/Angry</td>
<td>1.06 (1.03)</td>
<td>1.47 (0.99)</td>
<td>.040</td>
<td>1.26 (1.03)</td>
</tr>
</tbody>
</table>

Emotion Identification. Table 2 presents the accuracy with which children identified the positive and negative facial-emotion expressions. A 2 (Group) x 2 (Emotion) analysis of variance revealed main effects for Group ($F(1,107)$ =
21.02, \( p = .01 \) and Emotion (\( F(1,107) = 19.73, \ p < .01 \)), which were qualified by an interaction of Group x Emotion (\( F(1,107) = 20.62, \ p < .01 \)). For Positive and Negative emotions alike, NH children performed better than CI children in linking emotion words to facial expressions. Post-hoc \( t \) tests also showed that NH children performed better on Positive emotions than on Negative emotions – a difference that was not found in CI children. Five NH children and 23 CI children were unable to perform this task, which means that they were unable to link emotion words to drawings depicting emotions. Post-hoc \( t \) tests showed that the mean age of children unable to perform the task was younger than for those able to perform the task (\( t(107) = 4.11, \ p < .01 \)). All hearing children unable to perform this task were less than three years old; the age of the CI children varied from 2.5 – 5 year. No other differences were found (Bonferroni correction was applied).

Table 2. Mean score of correct responses and standard deviation for the Emotion-Identification Task and the Emotion-Attribution Task as a function of hearing status (range 0-2)

<table>
<thead>
<tr>
<th></th>
<th>CI children (n=57)</th>
<th>NH children (n=52)</th>
<th>partial ( \eta^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion-Identification Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive facial expression</td>
<td>0.82 (0.93)</td>
<td>1.71 (0.64)</td>
<td>.237</td>
</tr>
<tr>
<td>Negative facial expression</td>
<td>0.83 (0.82)</td>
<td>1.18 (0.62)</td>
<td>.055</td>
</tr>
<tr>
<td>Emotion-Attribution Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal prediction</td>
<td>0.20 (0.31)</td>
<td>0.66 (0.37)</td>
<td>.323</td>
</tr>
<tr>
<td>Visual prediction</td>
<td>0.41 (0.43)</td>
<td>0.71 (0.38)</td>
<td>.113</td>
</tr>
</tbody>
</table>

**Emotion Attribution in prototypical situations**

Children’s scores for the prediction of emotions in prototypical situations were analyzed by means of a 2 (Group) x 2 (Mode: Verbal, Visual) analysis of variance (Table 2). Main effects were found for Group (\( F(1,107) = 31.99, \ p < .01 \)) and Mode (\( F(1,107) = 23.28, \ p < .01 \)), which were qualified by an interaction of Group x Mode (\( F(1,107) = 11.06, \ p < .01 \)). Post-hoc \( t \) tests showed that NH children performed better than CI children on both the verbal condition.
(predicting the emotion using language, either sign or spoken) and the visual condition (pointing to a drawing of the correct facial expression). Whereas CI children performed better on visual than on verbal prediction, there was no difference between the modes of prediction in NH children. Because five NH children and 23 CI children were unable to perform the Emotion-Identification Task, we did not assess the Emotion-Attribution Task in these children, assuming that they would not be able to perform this more complicated task.

A t test was conducted to analyze differences in explanations of the predicted emotion between the two groups. More correct explanations were given by NH children ($M = .62, SD = .39$) than by CI children ($M = .19, SD = .34$), ($t(107) = 6.04, p < .01$). The same outcome was produced by excluding the data for the children who had given no explanation.

**Associations with background variables**

Pearson correlation was used to analyze the relation of language development (both expressive and comprehensive) to the Emotion-Discrimination Task, Emotion-Identification Task, and Emotion-Attribution Task. Table 3 shows that Emotion-Attribution Tasks were significantly correlated with expressive and comprehensive language development. For CI children and NH children alike, expressive and comprehensive language capacities were related to the Verbal Prediction and Explanation parts of this task. CI children differed from NH children in one respect: their expressive and comprehensive language was not related to the Visual Prediction part of the Emotion-Attribution Task. Language development was not significantly associated with emotion identification or emotion discrimination.

The age at which CI children had had their implant did not correlate with any of the emotion-understanding indices. Although the length of time since receiving their CI was correlated with all emotion-understanding measures, none of these significant correlations remained after control for chronological age.
Table 3. Correlations between language skills with all emotion tasks as a function of hearing status

<table>
<thead>
<tr>
<th></th>
<th>NH children</th>
<th>CI children</th>
<th>Emotion-Discrimination Task</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expressive language</td>
<td>Language comprehension</td>
<td>Expressive language</td>
<td>Language comprehension</td>
<td></td>
</tr>
<tr>
<td>Positive/negative</td>
<td>.23</td>
<td>.37*</td>
<td>.06</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td>Sad/Angry</td>
<td>.11</td>
<td>.24</td>
<td>.07</td>
<td>-.05</td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Emotion-Identification Task</th>
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<tbody>
<tr>
<td></td>
<td>Positive facial expression</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.16</td>
<td>.31*</td>
<td>.24</td>
</tr>
<tr>
<td></td>
<td>Negative facial expression</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>.28</td>
<td>.49**</td>
<td>.09</td>
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<table>
<thead>
<tr>
<th></th>
<th>Emotion-Attribution Task</th>
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<tbody>
<tr>
<td></td>
<td>Verbal prediction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.47**</td>
<td>0.59**</td>
<td>0.47**</td>
</tr>
<tr>
<td></td>
<td>Visual prediction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.57**</td>
<td>0.67**</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Explanation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.51**</td>
<td>0.59**</td>
<td>0.40*</td>
</tr>
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</table>

* p<.05; ** p<.01

Discussion

In this study we examined the ability of 2.5 to 5-year-old deaf children with a cochlear implant to recognize and attribute emotions in prototypical situations. We included only the basic emotions (happiness, sadness, anger, and fear), since these are the first that children learn to recognize (Denham, 1998). Overall, CI children performed less well than their normally hearing peers. CI children were less proficient than NH children in emotion recognition in facial expressions, both discriminating and identifying, and in attributing emotions to a protagonist in prototypical situations. Although the use of language in the tasks was kept to a minimum, the results of CI children were impaired on all measures, even when no verbal demands were made on the children.

Some CI and NH children failed to perform certain tasks. In the Discrimination Task, for example, they started playing with the cards instead of
sorting them; in the Attribution Task, there were questions they did not answer they did not answer a question, with more CI than NH children failing to participate. In both groups these children were younger than the children who were able to perform the task. After the scores of the ‘failing’ children had been excluded from the analyses, the differences between CI and NH children remained. While the length of time since receiving the CI was related to all outcomes in CI children, these associations were absent after control for chronological age. In NH children language comprehension was associated with better performance on all tasks, but in CI children only with performance on the two tasks in which the children were expected to respond verbally (either orally or in sign language).

Importantly, CI children fell behind their hearing peers, even in non-verbal tasks. In the Emotion-Discrimination Task, for example – in which children were asked to sort cards showing facial emotion expressions for emotion valence (positive versus negative) and for two emotions within the negative domain (anger versus sadness) – CI children performed less well than NH children. This is not in line with our expectation that both groups of children would perform equally well. However, CI and NH children performed equally well in the neutral, non-emotional condition (sorting cars and flowers, or distinguishing between faces with hats or with glasses), which emphasizes the fact that children did understand the task well. In fact, the discrepancy in outcomes between the two neutral conditions versus the two emotion conditions suggests that it is not understanding the task that is problematic for deaf children – even if they have a CI -, but discriminating between two different facial expressions.

Additionally, in line with our expectations, it was not only the recognition of facial expressions of emotion that was more difficult for CI than NH children, but also the interpretation of the emotional valence in prototypical emotion-evoking situations. Again, this task could be performed non-verbally. When children were shown a drawing displaying an emotion-evoking event, asked (in either oral or in sign language) which emotion the protagonist would feel, and shown pictures of facial emotion expressions they could point to, CI children again were outperformed by their hearing peers. Nevertheless, they did
slightly better when they could point to one of the facial expressions depicting an emotion than when asked to produce the emotion word or sign.

The question is whether the differences we found between CI and NH children indicate delayed emotion understanding due to delayed language skills, or rather stem from a qualitative difference in development. The outcomes on the Discrimination Task may hint at delayed development, since CI children were outperformed by NH children, but both groups were more proficient at discriminating between domains (positive versus negative) than within one emotion-valence domain (anger versus sadness). This is consistent with other research (Vicari et al., 2000; Gao & Maurer, 2009). Conceivably, a positive facial expression can be distinguished from a negative one by its unique mouth pattern; in other words, happiness can be recognized by merely a smile. In contrast, discriminating between negative facial expressions, such as anger, fear, and sadness, is more demanding because it requires the integration of both the upper and lower face (Vicari et al., 2000).

On the other hand, the outcomes on the Emotion-Identification Task do not indicate whether the development of CI children is delayed or qualitatively different. In line with other research, NH children in this study mastered the identification of positive emotions such as happiness before that of negative emotions (Vicari et al., 2000; Gao & Maurer, 2009), but CI children performed equally poorly on both valences. Because professionals and other people dealing with CI children need to know whether or not the development of these children is qualitatively different from normally hearing children, this is an issue that in future studies might be examined more closely. For example, if CI children do indeed develop differently, emotion indices might be expected to have a different adaptive or maladaptive function, and thus to contribute differently to the development of psychopathology symptoms than they do in NH children. Gaining insight into the developmental pattern of emotion understanding in CI children might help professionals in training these children in emotion understanding skills in order to prevent the development of psychopathology.

Taken together, our findings indicate that CI children’s emotion understanding is negatively influenced by their deafness, even when a task does not directly require language skills. The fact that CI children also fell behind their NH peers on a non-verbal task in recognizing emotional expressions in
faces emphasizes that a social context is crucial for children’s emotional development, or so-called “emotion socialization” (Saarni, 1999). The delay in emotion understanding in CI children might be explained by lower exposure and less modeling from adults before they received their CI and had no access to spoken language. By using a longitudinal design, future studies might examine possible developmental pathways, thus shedding more light on the causal relation between language development and children’s emotional functioning. Possibly, CI children “catch up” with their hearing peers when they have had the benefit of their implant for a longer period. Children in this study had been implanted for a relatively short time, due to their young age. This study is only a first step towards increasing our understanding of the effect of deafness and language development on children’s emotional development. This might be relevant not only to the group with a CI, but also to other clinical groups with language or communication impairments, such as children with specific language impairments or an autism spectrum disorder. Future studies could examine the extent to which the outcomes of this study indeed also apply to other groups with language delays.

References


