

REVIEW

# Adaptive psychological structure in childhood hearing impairment: audiological correlations

## *Struttura psicologica adattiva nel deficit uditivo infantile: correlazioni audiologiche*

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### SUMMARY

The present research deals with the clinical and social problems present during linguistic and cognitive development of deaf children. Currently, the development of Theory of Mind represents an important research field in deafness studies. These international studies highlighted a significant alteration in the development of Theory of Mind in deaf children compared to normal hearing children, especially in cases of congenital or preverbal hearing loss. In particular, the research focuses on the skills of deaf children in recognising emotions and desires, through both perceptive and cognitive methods, by evaluation of psycho-cognitive skills of children with severe hearing loss using a set of questions to be administered to hearing loss patients. The experiment was performed on a group composed of 10 children (5 males and 5 females) aged 4 to 9 years and 54 to 108 months, affected by bilateral congenital hearing loss (severe to total), or hearing loss that developed in preverbal children the year before entering elementary school, or during the fourth year of elementary school. The selection criteria were based on: audiologic evaluation, neuro-psychological tests administered to assess general, cognitive as well as praxis and perceptive abilities, and clinical observations performed to assess psychopathology using tests that assess development of both visual perceptive (Coloured Progressive Matrices) and graphic representational abilities (Test of Human Figure Drawings and the Family Drawing Test). The instrument “cognitive” was the “Deaf Children Series”, arranged by us, that consists of a mental status examination (MSE) that evaluates: level of cognitive (knowledge-related) ability, emotional mood, and speech and thought patterns at the time of evaluation. Deaf children show a reduced responsiveness to the expressions of sadness on the perceptive side. Through the test, we observed a psychodynamic defense mechanism considering perceptive understanding performance. On the contrary, in normal hearing children, the emotion ‘fear’ is the most difficult to identify. Deaf children seem to be more susceptible to recognition of visual emotions. Furthermore, deaf children present significant problem-solving skills and emotional recognition skills, possibly as a result of their hearing impairment.

KEY WORDS: Infant hearing loss • Hearing impairment • Cognitive-relational development • Theory of mind • Emotional recognition

### RIASSUNTO

*La presente ricerca affronta i problemi clinici e sociali che riguardano lo sviluppo linguistico e cognitivo nei bambini sordi. Attualmente, lo sviluppo della “Teoria della mente” rappresenta un importante campo di ricerca nello studio della sordità. Questi studi internazionali hanno evidenziato nei bambini sordi una significativa alterazione nello sviluppo della “Teoria della Mente”, soprattutto in caso di perdita congenita o preverbale dell’udito. In particolare, la ricerca si concentra sulle competenze dei bambini sordi nel riconoscere emozioni e desideri, attraverso metodi sia cognitivi che percettivi, per la valutazione delle capacità psico-cognitive attraverso una serie di domande composte da alcuni test adeguati, da somministrare ai pazienti con perdita uditiva. L’esperimento è stato condotto su un gruppo composto da 10 bambini (5 maschi e 5 femmine), di età compresa tra 4 e 9 anni e tra 54 e 108 mesi), affetti da perdita uditiva congenita bilaterale (da grave a cofosi), o da perdita uditiva preverbale sviluppata sia in bambini che attendono l’ultimo anno prima di frequentare la scuola elementare, sia in quelli che frequentano il quarto anno di scuola elementare. I criteri di selezione sono stati basati su: valutazione audiologica, somministrazione di test neuropsicologici al fine di valutare, in generale, le capacità cognitive e percettive e osservazioni cliniche effettuate, al fine di valutare la psicopatologia del campione, attraverso dei test che valutano più facilmente lo sviluppo sia della percettività visiva (Coloured Progressive Matrices), sia della rappresentazione grafica (Test di disegno sulla figura umana e il Test di disegno sulla famiglia). Lo strumento di misurazione “cognitiva” è stato il “Deaf Children Series”, test strutturato da noi, che consiste in un esame dello stato mentale (MSE), capace di valutare: il livello di capacità cognitiva (conoscenza-correlato), l’umore e modelli di discorso e di pensiero di un paziente al momento della valutazione. I bambini sordi mostrano sul lato percettivo una sensibilità ridotta alle espressioni di tristezza. Nel test possiamo osservare un meccanismo di difesa psicodinamico per quanto riguarda la prestazione percettiva. Al contrario, per quanto riguarda i bambini normoudenti, la paura è l’emozione più difficile da identificare. I bambini sordi sembrano essere maggiormente predisposti al riconoscimento di emozioni visive. Inoltre, i bambini sordi presentano notevoli capacità di “problem solving”, capacità di riconoscimento emotivo, probabilmente a causa del loro problema.*

PAROLE CHIAVE: Ipoacusia infantile • Disabilità uditiva • Sviluppo cognitivo-relazionale • Teoria della mente • Riconoscimento delle emozioni

## Introduction

The clinical relevance of the different types of hearing loss in childhood depends on the its impact on psychological and audio communicative aspects of children.

As far as the psychological area is concerned, it is important to understand the different clinical consequences caused by hearing loss affecting children, such as concerns with affection and intelligence, as well as memory and social attitude.

These consequences, which seem not to be related to deafness but to a lack of a good communicative context, can involve serious psychopathological consequences.

The most common developmental problems linked to deafness are:

- attention deficit;
- hyperactivity disorder;
- abnormal behaviour;
- mood disorder.

For this reason, language development skills in deaf children, represents a sub-factor of communicative competence, that should be assessed according to the classification of different types of hearing loss, as well as the specific characteristics of people affected by hearing loss. In particular, disease evaluation depends on several aspects:

- age;
- severity;
- syndromicity;
- therapy;
- rehabilitation method;
- communication characteristics of parents;
- psychiatric comorbidity;
- association with neuropsychological deficits;
- level of education obtained.

International studies recently conducted on Theory of Mind (ToM) in deaf children, showed a remarkable alteration in the development of mentalisation, empathetic and representational skills<sup>1</sup>, compared to normal hearing children, especially in cases of congenital or preverbal hearing loss. The ToM approach specifically deals with the study of specific socio-communicative strategies used for acquiring mentalisation skills, providing the child with pragmatic skills for easing the orientation within the context of daily life.

Identification of sub-factor pragmatic skills, which is a component of the key factor linguistic communicative skills, is the key variable of linguistic development in children. The study focused on the child and the conditions leading to the awareness of the ways of thinking of others. ToM was defined, as a communicative, affective and cognitive special skill, to be understood as a pragmatic ability to recognise the existence of mental representations, both in ourselves and others, not necessarily coinciding with the real world events<sup>2-5</sup>.

Actually, the study on ToM overlaps with mirror neurons theory research<sup>6</sup>. The research program investigating “mirror

neurons” demonstrated the presence of an observation-execution matching system in humans. Studies carried out on the development of ToM in deaf children investigated the most crucial features of this phenomenon, such as deafness severity and age at onset of symptoms. The discriminant variable concerning the age at onset of symptoms is represented by the fundamental difference between prelinguistic and post-linguistic deafness. Another important feature consists of the family context of deaf children, such as family size, order of geniture and the language spoken at home.

For this reason, the presence of deaf or hearing loss parents and their speech or gestures, as well as the sign language, or the oral language, constitutes an important variable that is necessarily linked to therapeutic and educational approaches.

The variables regarding the educational approach are the following: deaf education<sup>7-9</sup>, oral education<sup>6 10 11</sup> and, finally, the investigation including the two previous studies on total communication education<sup>12-15</sup>.

The variables regarding the therapeutic approach comprise auxiliary audio enhancement devices versus the impossibility of using hearing aids.

Recently, a better definition of this factor has been provided after comparing children wearing conventional hearing aids with children who received a cochlear implant with an interior ear module<sup>15 16</sup>.

Considering the last factors, we can easily make a distinction amongst the samples generated by different investigations, such as native signers, those who learned sign language at an early age as a first language<sup>17</sup>; late signers, those who lost their hearing after childhood and have to learn the sign language as a second language<sup>12-15 16</sup>; and oral deaf, those who are able to communicate orally, learning with or without a prosthetic aid, in most cases, with hearing parents<sup>10-11 18</sup>.

The goal of this study is to increase the clinical and social awareness of cognitive and linguistic development of individuals with hearing loss. The study focuses on the perceptive and cognitive ability developed by deaf children in order to identify emotions (happiness, sadness, rage, fear) and desires (fulfilled and failed).

## Materials and methods

The experiment was performed on a group composed by 10 children. The group was matched for gender (5 males and 5 females), and age (54 to 108 months), affected by bilateral congenital hearing loss (severe to total), or hearing loss that developed in preverbal children the year before entering elementary school, or during the fourth year of elementary school. The selection criteria of 10 subjects were based on:

- audiologic evaluation;
- neuro-psychological tests administered to assess general cognitive as well as praxis and perceptive abilities;

- oral exams and clinical observations to assess psychopathology.

The set of questions was composed of suitable tests to be administered to hearing loss patients.

The tests facilitate assessment of development of both visual perceptive and graphic representational abilities:

- Coloured Progressive Matrices 19, for visual perceptive abilities;
- the test of Human Figure Drawings 20, and the Family Drawing Test 21, for graphic and representational abilities.

The average age was 75.33 months (73.00 in girls and 76.66 in boys).

Over the course of a year, all patients were given the same set of tests in the presence of a parent silently sitting behind him/her. If required, a sign language interpreter could translate for the patient. Children's answers can be easily translated into words, signs, or gestures.

The findings of the experimental group were compared to those obtained from a normal hearing control group, composed of 30 healthy subjects investigated to implement the "Deaf Children Series". The control group sample was selected from 6 elementary school classes attending the first or second year in a public school.

Subjects were selected by their teachers according to the following criteria: 5 children without disabilities or behavioural problems, but not excellent in a particular subject, always matched for gender (2-3) and age (54-74 months). Five subjects were selected from each class, so the result was a group composed of 16 females and 14 males, aged between 54 and 74 months. The average age was 64.83 months (65.38 for girls and 64.21 for boys). Each individual was given the same set of tests over the space of a month.

The Deaf Children Series was implemented on the basis of two steps:

- processing answers;
- measuring the correlation between the age and mistakes, for each level of answer.

In order to avoid misinterpretation of findings, four children were not considered, since they failed the test investigating the cognitive capacity of attributing mental states. Thus, the statistical sample is composed of 26 subjects: 13 average underage subjects (64.8 months) and 13 average overage subjects.

The measurement instrument is the "Deaf Children Series", which is a test implemented by us. It consists of a mental status examination (MSE) which assesses the level of cognitive (knowledge-related) ability, appearance, emotional mood, and speech and thought patterns at the time of evaluation in the curriculum for educating individuals on ToM<sup>22</sup>. The Deaf Children Series is composed of 10 tables, and its structure is based on 4 development levels of capabilities to recognise desires and emotions (Table I).

**Table I.** Characteristics of tables.

|                     |   |                          |
|---------------------|---|--------------------------|
| Level 1<br>1 table  | Understanding photos and facial expressions | Perceptive understanding |
| Level 2<br>1 table  | Drawing and facial expression understanding |                          |
| Level 3<br>4 tables | Understanding emotions (situations-based)   | Cognitive understanding  |
| Level 4<br>4 tables | Understanding emotions (desires-based)      |                          |

## Results

As far as deaf children are concerned, the average score in the total sample was 36.00/48.00 (SD: 4.76); in hearing children, the values were 39.97/48.00 (SD: 4.78) (Table II). As far as cognitive recognition of desire and emotion are concerned, the total score in deaf children (level 3 + level 4) was 28.25/36 (SD: 2.87).

In hearing children, the average score in the total sample was 30.93/36.00 (SD: 3.60); in deaf children, for questions (E) (perceptive and cognitive understanding of emotions) the total score was 25.00/36.00 (SD: 4.32), while in hearing children the score was 28.23/36.00 (SD: 4.46). In deaf children, for questions (D), the total score was 11.00/12.00 (SD: 1.15), while in hearing children the score was 11.73/12.00 (SD: 0.82).

For the first level, in deaf children, the total score was 3.50/4.00 (SD: 0.58), while in hearing children it was 2.83/4.00 (SD: 1.26) (Table III).

**Table II.** Average score of the responses in the different levels.

| Answers              | Maximum score | Deaf children | Hearing children |
|----------------------|---------------|---------------|------------------|
| Level 1              | 4             | 3.50          | 2.83             |
| Level 2              | 8             | 4.25          | 6.20             |
| Level 3              | 12            | 9.50          | 9.67             |
| Level 4              | 24            | 18.75         | 21.27            |
| Levels 1+2           | 12            | 7.75          | 9.03             |
| Levels 3+4           | 36            | 28.25         | 30.93            |
| Question E           | 36            | 25.00         | 28.23            |
| Question E (level 4) | 12            | 7.75          | 9.53             |
| Question D           | 12            | 11.00         | 11.73            |
| <b>Total</b>         | <b>48</b>     | <b>36.00</b>  | <b>39.97</b>     |

**Table III.** Average score of the responses to different emotional states at level 1.

| Answers level 1 | Maximum score | Deaf children | Hearing children |
|-----------------|---------------|---------------|------------------|
| Happiness       | 1             | 1.00          | 0.83             |
| Sadness         | 1             | 0.50          | 0.73             |
| Rage            | 1             | 1.00          | 0.70             |
| Fear            | 1             | 1.00          | 0.57             |
| <b>Total</b>    | <b>4</b>      | <b>3.50</b>   | <b>2.83</b>      |

**Table IV.** Average score of the responses to different emotional states at level 2.

| Answers level 2 | Maximum score | Deaf children | Hearing children |
|-----------------|---------------|---------------|------------------|
| Happiness       | 2             | 1.75          | 1.87             |
| Sadness         | 2             | 0.25          | 1.23             |
| Rage            | 2             | 1.75          | 1.83             |
| Fear            | 2             | 0.50          | 1.27             |
| <b>Total</b>    | <b>8</b>      | <b>4.25</b>   | <b>6.20</b>      |

**Table V.** Average score of the responses to different emotional states at level 3.

| Answers level 3 | Maximum score | Deaf children | Hearing children |
|-----------------|---------------|---------------|------------------|
| Happiness       | 3             | 3.00          | 2.70             |
| Sadness         | 3             | 1.50          | 2.37             |
| Rage            | 3             | 2.75          | 1.73             |
| Fear            | 3             | 2.25          | 2.87             |
| <b>Total</b>    | <b>12</b>     | <b>9.50</b>   | <b>9.67</b>      |

For the second level, in deaf children the total score was 4.25/8.00 (SD: 1.71), while hearing children it was 6.20/8.00 (SD: 1.99) (Table IV).

For the third level, in deaf children the total score was 9.50/12.00 (SD: 1.73), while in normal hearing children it was 9.67/12.00 (SD: 1.89) (Table V).

In the fourth level, in deaf children the total score was 18.75/24.00 (SD: 2.50), while in normal hearing children it was 21.27/24.00 (SD: 2.91)

Since there was a substantial average age difference between the two groups, there was a significant decrease in the average score in deaf children for levels 2 and 4.

On the contrary, for level 1 is concerned, deaf children performed better than hearing children.

Deaf children show a reduced responsiveness to the expressions of sadness on the perceptive side. With regards to this specific age range, in the test a psychodynamic defense mechanism regarding perceptive understanding performance was observed. On the contrary, in hearing children, fear was the most difficult emotion to identify (see level 1+2). With regards to level 2, for both samples, fear can be easily mistaken for sadness and vice versa. Paul Harris described his theory in his work on evolution, development and simulation<sup>23</sup>. He embeds the emotion recognition capability into the affective development, as a process much more articulated than the cognitive process. We can easily make a distinction between two specific competences: emotion understanding and emotion control.

Both emotional and cognitive processes are implicated in the successful regulation of thought and behaviour, so the functional relation between these areas provides a biological mechanism for behavioural integration of emotive and cognitive processes in early childhood.

As far as emotional control is concerned, deaf children can easily understand a scared expression, unlike hearing children. Emotional tasks, such as facing sadness involve a defence mechanism among deaf children, rather than facing fear.

As far as level 3 is concerned, the performance on emotion recognition and cognitive understanding was almost the same for both groups, except for sadness, which remains the most difficult emotion to perceptively identify for deaf children, as well as rage for hearing children (unlike fear compared to perceptive understanding). The effects of desires and satisfactions on emotions are investigated in level 4. The unique difference is that deaf children show a reduced responsiveness to the expressions of sadness, so the thesis asserting this difficulty on the cognitive as well as perceptive side, is further bolstered. On the other hand, both samples reveal similarity in the cognitive recognition of desires.

## Discussion

According to the our results, deaf children seem to be better at recognising visual emotions (level 1). Furthermore, deaf children present significant problem-solving and emotional recognition skills, perhaps as a result of their innate problem solving attitude towards peers, or because of the oversimplified contexts of interaction, artificially created in order to facilitate their relational approach. The deaf children, when evaluated in conventional language recognition, showed poor perceptive and cognitive ability in identifying emotions in socio-communicative contexts (level 2). This could be due to a lack of socialisation experiences in various contexts compared to hearing counterparts .

Finally, according to the results of the psychological test, deaf children showed a reduced responsiveness to the expressions of sadness on both the cognitive and the perceptive side.

This could be due to their difficulty in controlling negative emotions such as sadness, unlike fear and rage. As easily observed, the latter are manifested in situations characterised by a high rhythmic and sonorous intensity, unlike sadness<sup>24-27</sup>.

## Conclusions

This study identifies a set of variables that can affect development of psycho-emotional hearing impaired children, distinguishing them from that of the normal hearing child.

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