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THE LINGUISTIC COMPETENCE OF HEARING-IMPAIRED CHILDREN WITH COCHLEAR IMPLANTS: RESULTS FROM A STANDARDIZED COMPREHENSION TEST

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1. Introduction

Modern linguistics (Chomsky, 1981) has been originated from two crucial questions: how did we acquire our native language? And, what does it mean exactly to know a language? Certainly, we can say that language acquisition occurs spontaneously and with ease in the first years of life. However, the linguistic data young children have access to cannot be sufficient to determine grammatical principles they develop. This is sometimes called 'the paradox of language acquisition'. According to Chomsky's nativist theory, language acquisition is possible because of the existence of a genetic endowment, which he calls Universal Grammar (UG), that consists of Principles, common to all human languages, and Parameters, that distinguish one language from another. Crucially, the Parameters of a language have to be 'set' through the contact with the linguistic input within a critical period.

In the case of children who are born deaf or who become deaf very early in life, the natural access to the oral language is denied. Auditory deprivation determines an atypical and delayed language acquisition. Luckily, in the last decades, neonatal screenings allow hearing impairments to be detected very soon. Hearing loss's consequences can thus be limited by appropriate rehabilitative interventions. In particular, recent studies highlighted that many children fitted with a cochlear implant in the first years of their life demonstrate linguistic skills similar to normal hearing peers (Caselli et al., 2012). Furthermore, early implantation seems to be crucial for such good outcomes (Nicholas and Geers, 2006).

The aim of our study is to assess the performances of 13 Italian-speaking children fitted with a cochlear implant in a standardized comprehension test, the TCGB. We will consider whether and how their results differ from typically developing children's one. In particular, we will analyze their responses by comparing them to 2 groups of hearing children matched on linguistic age and auditory age.

In Chapter 2, we will consider the importance of an appropriate exposure to the linguistic input in the first years of life. We will outline the main stages of children linguistic development and then examine Chomsky's nativist theory of language acquisition. Finally, we will introduce the generativist approach to the study of languages that will be the theoretical basis of our analysis of data.

Chapter 3 will describe the nature of hearing-impairments and its consequences on oral language development. We will analyze the types of prosthesis that help deaf individuals to improve the quantity or the quality of their linguistic input and we will consider the variables that seem to positively influence the achievement of their linguistic competence.

In Chapter 4 and 5, we will focus on two linguistic structures that literature reports to be particularly problematic for hearing-impaired individuals: passive and relative clauses. Analyzing their main properties, we will try to identify which factors could be the most problematic ones. Furthermore, we will review most remarkable studies on the acquisition of these linguistic constructions. Then, we will make some predictions on the difficulties that the hearing-impaired children participating to out experiment could meet in the test.

Finally, in Chapter 6 we will first describe the standardized test we used (TCGB, Chilosi et al., 1995, 2006); then we will present the participants and report the results. Responses will be evaluated from both the quantitative and qualitative point of view. Finally, a brief discussion will summarize the experiment outcomes.

2. Language acquisition

2.1 Introduction

According to Pinker (2010:10) “people know how to talk in more or less the same way that spiders know how to spin webs". In fact, native speakers “achieve language not because they are taught, not because they are generally smart, not because it is useful to them, but because they just can't help it". In other words, language seems to be an instinct of human being. Apart from some exceptions[1], every children acquires spontaneously the language he is exposed to in the first years of his life. This happens independently from the modality in which the language is expressed (oral or signed) and it seems to follow the same stages in every child irrespective of the particular language or the environmental variations. In the next sections, we will consider the role of input in language acquisition along with some consideration on the critical period, the temporal window in which acquisition takes place. Afterwards, we will briefly look at the stages that children all across the world follow when acquiring languages focusing on the parallelism between oral and sign languages and on children’s errors (overregularizations, for example) while building their own grammar. Finally, we will present Chomsky’s nativist theory of language acquisition which will inevitably bring us to touch on the linguistic representation laid out by generative grammar which is also the basis of the analysis we will maintain in this study.

2.2 The role of input and the critical period

In order to acquire a language children can benefit from very different stimuli provided by the environment. In any case, despite every linguistic experience can be considered unique (language exposure differs quantitatively and qualitatively depending on the subject) in the first years of life every children reaches the same linguistic competence. Even when children receive an impoverished input their linguistic development seems not to be hampered. For example, the linguistic input provided to the 7 years old deaf child studied by Singleton and Newport (2004) was an imperfect ASL (American sign language) which his deaf parents learnt only during adolescence. Nevertheless, the child developed a sign language much more accurate than his parents’ one and comparable to his hearing-impaired peers’ one who acquired it from their native speakers parents.

[1] We refer here to children with learning disabilities or with neuropsychological impairments or with any other problem that could hinder language development.

Another example is explicated by the birth of the Nicaraguan sign language (NSL) from a system of communication based on domestic gestures (*homesigns*). The second generation of children exposed to this pidgin developed a new language, organic and fully structured (a creole). Also in this case, the output exceeds the input. This seems to suggest children natural instinct to create language and their ability to do it even in case of impoverished input. According to the data in their hand, children seem able to extrapolate structural rules and to build an organic grammar.

Literature provides many examples demonstrating that linguistic deprivation in the first years of life causes the irremediable incapability to reach a native-like proficiency in language development. This phenomenon is known as 'critical period' and were proposed for the first time by Lenneberg (1967). Following Penfield & Roberts (1959), the linguist (and neurologist) argued the existence of age constraints on language acquisition related to neuroplasticity[2]. This assumption has been studied and more clearly demonstrated in animals' visual system where vision hindrance in early life provokes a permanent inability to see. Similarly, Sacks (1995) tells us the story of Virgin, a grown man blind since childhood, who could not develop his functional sight even if after a cataract surgery he was technically able to see. He could still recognize his dog only touching him and even if rehabilitation helped him to learn how to identify the objects around him he rapidly and systematically forgot about them because of the lack of visual memory he never experienced before. This example shows that sensory deficits modify our brain organization in a way that some abilities, if not early stimulated and thus activated, can never develop satisfactorily. The same happens for language. We can think of feral children, for instance. The story of Victor, also known as 'the wild boy of Aveyron', has been described by Itard, the doctor who took care of his linguistic rehabilitation too. Victor was found in the French forests at the end of 1800 when he was approximately 11 years old. Since he presumably grew up in the wild for most of his life he was not able to speak and also after Itard's efforts on teaching him language he still did not succeed in developing speech. The case of Chelsea (Curtiss, 1989) is another meaningful example. Her deafness was diagnosed only when she was 31 years old and for this reason she was never fitted with hearing aids and she had never received a linguistic training. Despite the attempts to teach her language, efforts turned out to be unsatisfactory. That is, she learnt some lexical terms and she became able to communicate with ease but she never developed a grammar. Her biological window for language acquisition was already closed.

It is interesting to add that some researchers criticize the clear-cut time span proposed by the critical period hypothesis suggesting instead the notion of sensitive period which admits a gradual onset and an incomplete offset. In this case, sensory deprivation during the sensory period does not cause

[2] Mayberry (1998).

an irreversible language deficit. Pictures below represent the critical and the sensitive periods (Tomblin, Barker & Hubbs, 2007).

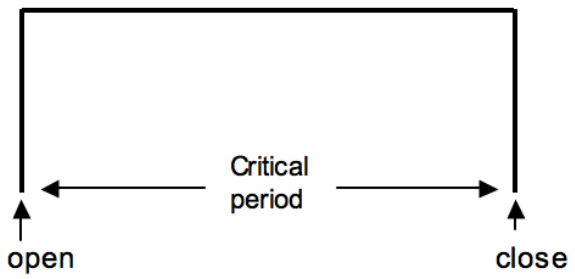


Figure 1. Critical period.

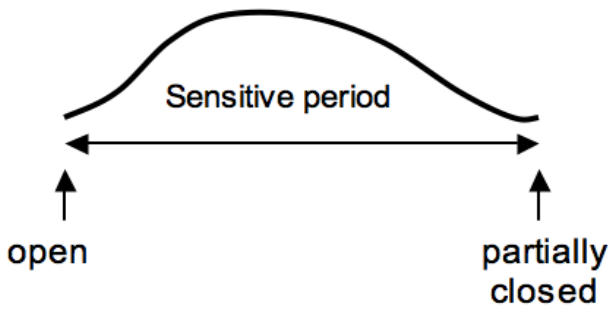


Figure 2. Sensitive period.

In any case, an adequate access to linguistic data within a (more or less constrained) period of time seems essential in order to achieve full native mastery of a language and especially of its grammar. A suitable example may be the case of immigrants who learn a second language as adults and their young children. The former, despite their efforts, never achieve native-speakers levels of competence in the language of the new country. The latter, instead, if appropriately integrated in the linguistic environment, acquire the language perfectly and in a spontaneous way.

In any case, the input has to be adequate. Chesi (2006) studies the linguistic competence of a group of deaf children and adolescents whose access to the linguistic experience had been inevitably limited by their sensory deficit. He observes that their acquisition of crucial functional operators is compromised resulting in their difficulties with subject and verb's agreement, articles and adjectives' determination and case assignment, just to mention a few. Later on we will talk about oral language acquisition by hearing-impaired people. Before that, however, we will consider the main stages of language acquisition in both oral and signed modalities. We will see that through the visual channel deaf children develop a sign language according to the same phases and timing of

typically developing children acquiring an oral language (Morgan and Woll, 2002; Schick, Marshark and Spencer, 2006[3]).

2.3 Stages of language acquisition

Children acquire a language according to specific stages. According to different studies on the topic (we mainly refer to Guasti, 2007; Petitto, 2000; Aglioti and Fabbro, 2006; and Chesi, 2006) the main phases are summarized as follows:

- Pre-linguistic phase: it includes the period from birth to 3 months approximately. Children produce their first vocalizations and guttural sounds.

- Babbling phase: from about 7 months. It concerns the production of sequences of syllables (typically, a reduplicated sound units consisting of consonants and vowels) which seem to be connected to the rhythm of the language (Petitto et al., 2004). Deaf children exposed to a sign language produce manual babbling (Petitto and Marentette, 1991) which, as the oral one, does not carry any linguistic meaning. In both modalities, babbling represents the first intentional productions. Finally, since also oral babbling appears in hearing-impaired children development this phase seems to be biologically determined.

- Holophrastic stage: from 12 to 18 months. The first words/signs appearing in this phase represents whole sentences (such as 'home' for 'I want to go home').

- Telegraphic stage: between 24 and 36 months. It is the period when the combinatory ability develops. Children produce the first sentences but functional elements are still missing (*Sarah want cookie, Where Humpty Dumpty go, Adam write pencil*[4]).

- Complex combinatory structures phase: from 3 to 5 years old. Sentences are progressively more complex since functional elements begin to be produced. Verbs are correctly conjugated and in the same way determinants, nouns and adjectives' agreements are respected.

As Guasti (2007) and other authors argue, both typically developing and deaf children make systematic grammatical errors during acquisition. For example, they make overextensions,

[3] Reference to these works is found in Miceli (2011/2012).
[4] Examples from Stromswold (2000).

overregularizations (such as 'goed' for 'went' and its equivalent error with morphological markers in sign language), they have trouble with negative verbal forms and they confound deictic pronouns of first and second person (i.e. they refer to themselves ('*I*') as '*you*', or to their referent ('*You*') as '*I*'). Since in sign languages personal pronouns are expressed by points whose non-linguistic equivalents are used to communicate very soon, deaf children's error with deictic pronouns is really meaningful. Indeed, signed linguistic systems prove to be separate from prelinguistic communicative gestures (in spite of the ostensible similarities) (Miceli, 2011/2012). It is important to underline that children's errors are the product of their own ability to extract regularities analysing their linguistic data in a distributional way. In other words, they never experience such errors in their lives. This is one of the strongest point against the behaviourist (stimulus-response) theory of language acquisition (Skinner, 1957)[5]. Moreover, we can easily observe that children persist in their errors and they seem not to have no perception of parental corrections (Petitto, 2000). This could express that every single stage is necessary and unavoidable in order to acquire a language.

2.4 The nativist theory of language acquisition

In this section, we will try to resolve the problems raised so far according to Chomsky's theories. His starting point is the poverty of the stimulus argument that underlines the fact that people acquires the abstract linguistic knowledge of their mother tongue despite the limited linguistic experience they are exposed to. Indeed, positive evidence, that is the grammatical sentences the children have access to, seems hardly sufficient to learn the patterns of a language. Moreover, the input is often degenerated since people produces speeches which are fragmentary, full of interruptions and restarts. So, children listen to sentences that are not always well-formed. On the other hand, the so-called negative evidence, which demonstrates what is not grammatical in a language, is not (always) provided and, even when it is, children seem to ignore it (we have seen previously that in spite of parents' corrections, children persist in their errors). In order to explain the gap between the limited linguistic data available and the grammatical knowledge that we acquire in early childhood Chomsky assumes the existence of a genetic endowment which guides us through language acquisition. He calls it Universal Grammar (UG) and it is described as a "system of principles, common to the species and available to each individual prior to experience" (Chomsky, 1981). For example, the fact that every language has nouns, verbs, adjectives and other

[5] Cited in Guasti (2007).

grammatical categories (Baker, 2003)[6] which are related according to structural (instead of linear) dependencies[7], is specified in UG. In addition to absolute universals, UG contains parameters that need to be set and that are responsible for variation between languages. In other words, there is a range of choices which UG makes available. During acquisition, and within a biologically determined period of time (critical period), children make these choices (they set parameters) according to the linguistic input they receive. Parameters have a binary nature, that is, they offer two possibilities of choice only: the *pro*-drop parameter (Rizzi , 1982a, 1986a; Jaeggli and Safir, 1989)[8], for instance, either allow (as in Italian) or forbid (as in English) the omission of the subject. Moreover, comparative linguistics studies have shown that languages typically set clusters of properties in a way that if a language has the parameter *x* it probably has also parameters *y* and *z*. Parameters sharing gathers languages in typologies. For example, the already mentioned *pro*-drop parameter is usually associated to languages with a rich verb inflection since the information on the subject can be recovered through it. On the contrary, languages with isolating characteristics guarantee the information on the subject by the presence of the corresponding pronoun. Examples (1-3) show this difference clearly: in Italian (1) verb inflection identifies the subject explicitly, so there is no need for the presence of the pronoun 'Essi' ('They') – unless it is required for contrastive or pragmatic reasons-. In English, instead, the verb alone does not express its subject (2) which has to be expressed explicitly as in (3).

(1) Dormono[9].

(2) *Sleep.

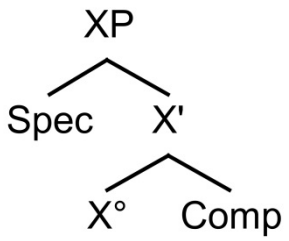
(3) They sleep.

Summarizing, human beings acquire language through an innate predisposition (Universal Grammar) that guide them in developing the specific grammar for their language (Mental Grammar). This proposal is known as the 'Principles and Parameters theory' (Chomsky, 1981). In the next paragraph, we will briefly explain Chomsky's X-bar theory (1994) which proposes a model of syntactic organization which is shared by all languages. Besides, syntactic movement and theta role assignment will be presented. The linguistic analysis I will make in this study follows this theoretical approach.

[6] Cited in Guasti (2007).
[7] It is called 'principle of structural dependency'.
[8] Studies cited in Haegeman (2000).
[9] Items highlighted in red contain the information on the subject.

2.5 Theoretical framework

X-bar theory proposes a system of representation which is able to generate all possible sentences in every language of the world. First of all, it admits that sentences are organized into constituents that are called phrases and which are generated by a hierarchical operation named *Merge*. Among merged elements there is one that projects its categorical feature to the whole phrase and it is called *head*. It can be of any syntactic category: lexical (noun, verb, adjective, adverb, etc.) or functional (inflection, complementizer). Every head, X (minimal projection), is merged with its complement to form the X', or X-bar, constituent (intermediate projection) which in turn is combines with a specifier with whom it forms the XP (maximal projection).



Picture 1. X-bar structure.

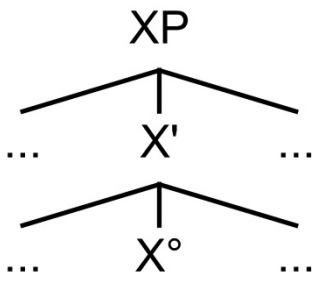
Every constituent has a different role in the sentence. For example, in (4), according to the argumental structure of the verb *to kiss*, the presence of the constituent *Leo* is obligatory (*argument*). Its absence instead would create ungrammaticality. We can represent it as a hierarchical structure where the NP (Noun Phrase) Leo is VP- internal, that is, it is require by the verb. On the other hand, the PP *at the cinema* may be omitted (*adjunct*) without creating any grammatical problem.

(4) Maria kissed Leo (at the cinema).

The so called 'subcategorization frames' define verbs' selectional properties, that is, the number of 'participants minimally involved in the activity or state expressed by the predicate' (Haegeman, 1994: 44). Moreover, depending on the semantic relationship between the verb and its arguments, different thematic-roles (or θ-roles) are assigned to the arguments (agent, patient, experiencer,

beneficiary, etc.). The grammatical component which regulates thematic roles assignment is called thematic theory.

Despite we assumed that sentences are hierarchically organized as in (1), it is necessary to add that the linear order of the constituents in relation to the head of the projection seems not universally determined (by UG). It might derive, instead, from a parametrisation of heads, complements, adjuncts and specifiers' relative order.



Picture 2. Universal X-bar structure.

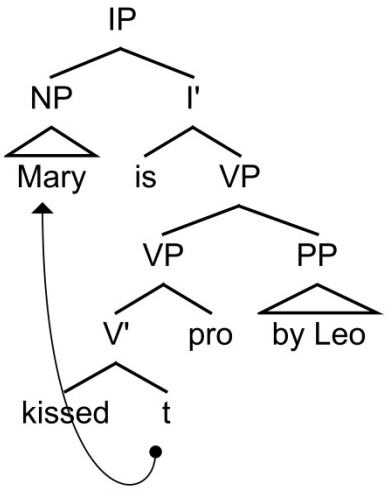
Otherwise, configurations different from Picture 1 might be the result of a later movement: complement-head order would arise from the leftward movement of the complement crossing the head (Haegeman, 2000). In fact, there is another operation in syntax, called *Move α*, which is responsible for the movements of constituents from a base position to a landing site. In relation to this, syntactic structures are considered in two levels of representation: the D(eep)-structure and the S(urface)-structure (their phonetic and semantic realizations occur respectively in the Phonological Form, PF, and Logical Form,LF)[10]. The former represents lexical properties, which are subjected to the Theta-criterion[11] whereas the latter is the result of the sentence after movement. For instance, considering the passive sentence *Mary is kissed by Leo*, in the D-structure the passive verb assigns the theme role to the NP *Mary* (which is VP-internal) whereas at the S-structure level the NP Mary moves into the Spec, IP position in order to receive nominative case [12]and become the subject[13].

[10] In Chomsky's Minimalist Program (1995) the levels of representation are reduced to two interfaces: the PF and the LF.

[11] Theta criterion: Each argument bears one and only one θ-role, and each θ-role is assigned to one and only one argument.

[12] Case filter requires that every lexically realized NP must be assigned abstract Case.(Haegeman, 2000:139).

Movement is signaled by a 'trace[14]' (*t*) of *Mary* which remains in post-verbal position. An A(rgumental)-chain is formed between *Mary* and its antecedent *t*.



Picture 4. S-structure of Mary is kissed by Leo.

In this paragraph, we briefly outlined some theoretical foundation of generative grammar in order to introduce the linguistic analysis we will make in this study. In particular, we will examine passive and relative structures carefully.

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[13] According to 'Burzio's generalization', verbs lacking an external argument cannot assign structural case (case absorption) to their objects (Haegeman, 2000:280-282).

[14] A trace is an empty category whose presence is necessary in order to interpret the sentence correctly. Because of its crucial role on interpretation, it requires some specific structural requirements to be satisfied (Empty Category Principle). In Chomsky's (1995) Minimalist Program the concept of *trace* is replaced by that of *copy*.

3. Hearing-impairment

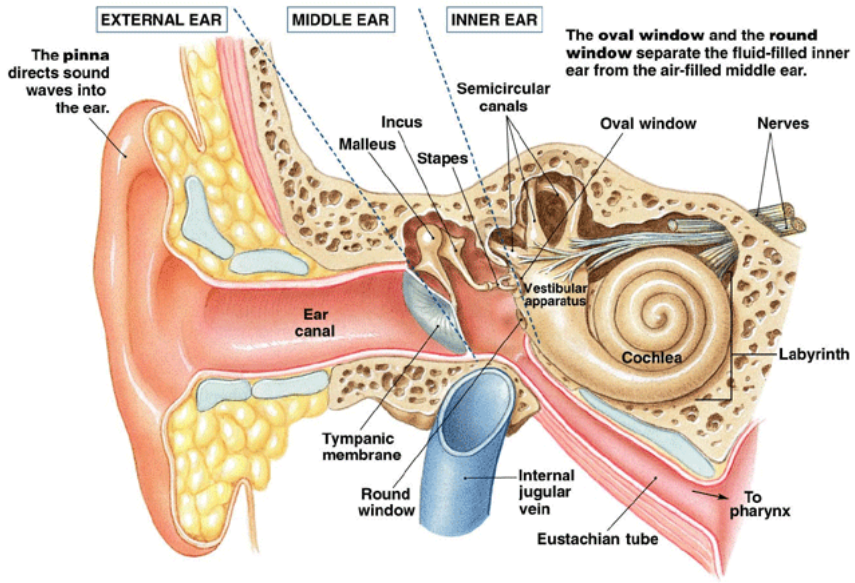
3.1 Introduction

Hearing-impairment is one of the most frequent sensory disabilities of human being. It has been calculated that it affect more than 250 million people in the world to some degree (Mathers et al., 2007). Approximately one out of every 1000 newborns is hearing-impaired (Govaerts et al., 2002; Soi & Brambilla, 2003; Cardoni & Quaranta, 2011). In all these cases, acoustic deprivation reduces drastically the quantity and quality of linguistic input that children need in order to acquire an oral language naturally. As a result, a normal linguistic development is affected. Anyways, hearing-impaired population exhibits a huge inter-subjects variability concerning language competence. The factors that may be responsible for these differences seem to be many and complex; therefore the importance of the role that each of them plays has not been established yet. Nevertheless, early intervention is demonstrated to be crucial for language development: together with an appropriate rehabilitative program and active involvement by families, it seems to help children to 'catch up' with their normal hearing peers. However, in order to comprehend in depth the reasons why hearing-impaired children display such heterogeneous linguistic developments, further investigation are needed.

In this chapter, we will give an overview on the human ear and on the way it perceives sounds. Furthermore different classification of hearing impairments will be analyzed according to the type of damage affecting the auditory system, the degree of the hearing loss and the age of onset. Besides, conventional hearing aids and cochlear implants will be described according to their function and structure. Finally, we will give a short account of the studies on oral language development by hearing impaired population and we will consider the variables that might determine the differences in their linguistic outcomes.

3.2 Anatomy of the ear

The ear is a sophisticated organ which allows to detect sounds. The human ear can be divided into three main sections which are: the external ear, the middle ear and the inner ear (Picture 1).



Picture 1. The ear[15].

The external ear is made up of the ear flap (pinna) and the external auditory canal which is approximately 3 cm in length. The middle ear is formed by the tympanic cavity which starts with a delicate membrane, the eardrum, that vibrates to sound waves. This vibration is transferred to a chain of three small bones which are, in order, the hammer (malleus), the anvil (incus) and the stirrup (stapes). Their movement amplifies vibrations in order to compensate for the loss of energy that occurs in the transition from the air to the fluid of the inner ear. The inner ear includes the vestibular system, which is the responsible for keeping our balance, and the cochlea, which is the sensory organ of the hearing system. It is a 35 mm tube coiled into a spiral and it is divided by the basilar and the Reissner's membranes in scala vestibule, the scala tympani (which contain the perilymph fluid) and the scala media (which contains endolymph fluid). The vibration in the inner ear fluids provokes the movement of the basilar membrane which in turn causes the sensory cells (Inner Hair Cells -IHC- and Outer Hair Cells -OHC-)of the organ of Corti to bent. Sound vibrations are then converted into electric signals which are transmitted through the auditory nerve to the brain where the message is finally interpreted.

In the next sections we will consider the different damages which can occur to the hearing system. In particular, we will provide a description of the types and the different degrees of severity of hearing loss. Then, we will hint at the possible rehabilitative approaches. Finally, we will review

[15] This picture has been downloaded on 26 January 2013 from the following website: http://www.directhearingaids.co.uk/index.php/33/how-hearing-balance-work-together/ .

literature's studies on language development in hearing-impaired children and in particular in cochlear implanted ones.

3.3 Hearing-impairment classifications

Hearing impairments are categorized depending on their type, their severity, and the age of onset. We will discuss these factors in the next paragraphs.

3.3.1 Types

There are four different types of hearing loss depending on which part of the auditory system is damaged:

- Conductive hearing loss: as the name implies, it is due to the impairment or obstruction of the transmission of sound from the external or middle ear to the inner ear. This might be caused by the presence of wax in the ear canal, by a congenitally closed-off ear canal, by the eardrum's perforation or by a problem with the little bones inside the middle ear. Also a tumor in the external or middle ear causes conductive hearing loss. It affects all frequencies of hearing to the same degree and it is usually causes a moderate hearing impairment.
- Sensorineural hearing loss: it is caused by the damage of the hair cells in the inner ear or the nerve that connects the cochlea to the brain stem. This can occur because of aging, exposure to loud, sudden or prolonged noise, ototoxic medications, head trauma or congenital malformations. Since hair cells respond best to different frequencies of sound according to the basilar membrane's tonotopicity[16], depending on which hair cells are damaged specific frequencies will be affected. Severity ranges from mild to profound. The majority of hearing impairments falls under this type (Soy & Brambilla, 2003).
- Mixed hearing loss: it is a combination of the two types discussed above. So, the impairment can affect both the external or middle and the inner ear.
- Central hearing loss: it is rare compared to the conductive or sensorineural types of hearing loss. It results from damage to the brain pathways or to the brain itself. Individuals affected with this type of hearing impairment can hear sounds but they cannot understand or process them.

[16] Physical characteristics of the basilar membrane cause different frequencies to reach maximum amplitudes at different positions: the base of the membrane (near the oval and round windows) vibrates best to high frequencies whereas low frequencies are transduced best at the apex.

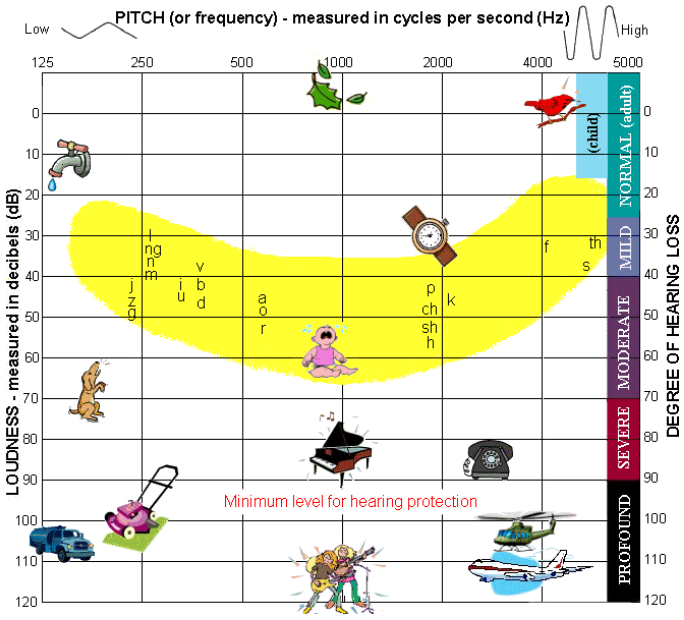
3.3.2 Severity

Sounds are measured according to their intensity (loudness) and frequency (pitch). The former is calculated in logarithmic units called decibel (dB) whereas the latter is measured in hertz (Hz). Hearing is usually measured on a frequency scale from 125 to 8000 Hz and on an intensity scale from -10 to 110 dB. According to the audiometric classification provided by the Bureau International d'Audiophonologie (BIAP), the level of hearing loss distinguishes the following categories:

- 0 – 26 dB normal hearing
- 26 – 40 dB mild hearing loss
- 40 – 70 dB moderate hearing loss
- 70 – 90 dB severe hearing loss
- >90 dB profound hearing loss

Essentially, the degree of hearing loss is measured by the average threshold level which considers the mean values of intensity for the three fundamental frequencies of speech perception, that is, 500, 1000 and 2000 Hz. In the audiogram[17] below, pictures are arranged depending on the typical frequencies and decibels of the related sounds. The yellow banana-shaped region, instead, represents the most typical frequency and loudness for each speech sound. Thus, we can extract information about which sounds can be heard at specific degrees of hearing loss. For example, people with moderate sensorineural hearing loss can hear dogs barking, phone ringing and helicopter sounds but when engaged in a conversation they may not be able to hear high frequency sounds such as /f/ or /s/ which are typically recognized within a normal 20 dB range of hearing.

[17] Downloaded on 27 January 2013 from: http://earcommunity.com/hearing-loss/emotional-support/how-to-explain-hearing-loss/ .



Picture 2. 'Speech banana' audiogram.

3.3.3 Age of onset

Hearing loss can be congenital, that is genetically inherited or acquired during pregnancy, or can arise in the first years of life (approximately before the age of three). In both cases, since it occurs before the acquisition of oral language it is called pre-lingual deafness. On the contrary, when hearing loss occurs after the acquisition of language we speak of post-lingual deafness. The age at onset of deafness is a crucial factor for language acquisition. Indeed, the auditory input that post-lingual deaf individuals can experience in early childhood allows them to access the properties of the oral language they are exposed to and consequently to develop it naturally. In pre-lingual deafness, instead, hearing loss hinders the normal exposition to the oral language. Its acquisition is therefore seriously jeopardized.

In the next paragraph, we will examine the different typologies of prosthesis which hearing-impaired people can employ in order to improve their acoustic perception.

3.4 Types of prosthesis

Depending on the type and severity of hearing loss, hearing-impaired individuals can rely upon different devices. For example, while conventional hearing aids (HA) are generally used in case of moderate and severe hearing losses, cochlear implants (CI) are considered the best solution for severe and profound sensorineural hearing-impairments (that is, when HA provide little or no benefit). Hearing aids and cochlear implants are structurally and functionally different. On the one

hand, HA is an external device which amplifies sound. It is composed by a microphone, which converts the sound waves into an electrical signal, an amplifier, which increases the strength of the electrical signal and the receiver which converts the electrical signal back to tan acoustic signal before it is delivered to the ear. In sum, it helps to detect more sound but it does not really improve frequency resolution. On the other hand, cochlear implant is an electronic device which transforms acoustic stimuli into electric stimuli and sends them directly to the auditory nerve. It is composed by an external component, which is worn on the head or body as an hearing aid, and by an internal component, that is surgically implanted. The former receives and codifies the acoustic signals from the environment and transmits them to the receiver/stimulator of the internal component. Digitally coded sound is then converted into electrical impulses which are sent to an array of electrodes inside the cochlea that stimulate the auditory nerve. Cochlear implant mainly encodes speech information (which are contained in mid and high frequency values) but does not enhance music perception (characterized by high frequency values). In brief, cochlear implantation aims at improving hearing-impaired individuals' auditory abilities for comprehension of speech and for developing of spoken language. However, an improvement of detection and discrimination of sounds does not ensure speech intelligibility. In other words, speech perception does not imply necessarily speech comprehension (Dowell et al., 2002). Therefore, after surgery, cochlear implanted people need to start an extensive rehabilitation program that enables them to develop their auditory, vocal and cognitive skills. According to Fry (1966), in linguistic development the crucial factor is not the hearing itself but rather the way a child makes use of it.

3.5 Oral language development in hearing-impaired children

Most prelingual hearing-impaired children fall significantly behind their hearing peers in their mastery of the oral language. Both lexical-semantic and morpho-syntactic abilities have been shown to be severely delayed. However, it seems that depending on the linguistic domain considered (phonology, lexicon, morpho-syntax, semantics or pragmatics) hearing-impaired children development diverges from typically developing children's one in a qualitatively different way. For example, the stage of babbling is very similar between the two populations. As we have seen before (section 2.3), despite their acoustic deprivation, also hearing-impaired children experience this phase. It appearance is a little delayed though: according to Oller and Eilers (1988)[18] it never begins before 11 months of age. Moreover, deaf infants' babbling does not increase developmentally; on the contrary, it tends to diminish after a few months, probably because of the limited (or even absent) auditory feedback. Finally, during babbling stage hearing-impaired children fitted with

[18] Cited in Volpato (2010).

cochlear implant exhibit "a high rate of development in terms of hearing age"[19]. As a matter of fact, they seem to catch up some of the delay incurred before implantation because of the auditory deprivation. Schauwers et al. (2008)[20], point out cochlear- implanted and typically developing children similarities in babbling. In particular, they found that both groups produce mostly coronal and labial consonants and that the favorite manner of articulation is occlusion. However, cochlear-implanted children display a babbling pattern that is less variegated compared to their hearing peers: in their syllabic productions, they tend to vary vowels and to maintain the same consonants. The Authors suggest this is due to vowels' greater auditory salience.

Hearing-impaired children are at a disadvantage also in learning vocabulary if compared to hearing peers. Their receptive vocabulary scores are shown to be lower and their vocabulary growth rates slower. Besides, the so called 'vocabulary burst', which seems to characterize hearing children's lexical development, is not observed in hearing-impaired children (Ledeberg, 2003). On the other hand, Hayes et al. (2009) found out that early implanted children (by the age of 2 years old) exhibit a substantial vocabulary growth which allows them to achieve receptive vocabulary skills within the average range for typically developing children. Also Geers et al. (2009) report good percentages of cochlear implanted children showing age appropriate development in receptive (50%) and expressive (58%) vocabulary. Finally, Caselli et al. (2012) confirm these results recounting that CI and normal hearing children matched for time since cochlear implant activation performed similarly on lexical production tasks.

Morpho-syntactic domain seems to be the most problematic for hearing impaired individuals. Most studies on Italian[21] hearing-impaired individuals report an overall low-proficiency in syntactically complex sentences. However, also easier structures are neither produced nor comprehended properly by hearing-impaired people. They mostly experience difficulties with functional elements such as determiners, pronouns and auxiliaries as well as prepositions (for Italian, Caselli et al., 1994; Franchi, 2004; Chesi, 2006; Volpato, 2008). For example, Chesi (2006) tests a group of hearing-impaired children with severe and profound hearing loss ranging in age from 6 to 17 years old in order to evaluate their oral and written productions. He founds a significant number of determiners' omission. In particular, productions were short in indefinite and partitive articles whereas a significant amount of definite ones was omitted in post-verbal position (*A me piace ø computer* 'I like ø computer' - instead of *A me piace il computer* 'I like the computer'). Also clitics were often omitted (sometimes participants repeated the lexicalized object in order for the thematic role to be assigned) whereas verbal inflections were substituted: most frequent errors concerned the

[19] Volpato (2010).
[20] Cited in D'alatri et al. (2011).
[21] Most of the results reported by Italian studies are confirmed cross-linguistically.

production of the third person preferred over any other (*Ha vinto* '(He) has won' - instead of *Ho vinto* '(I) have won) in verbal inflections whereas, concerning number, singular person verbs were produced with plural subjects. Besides, relative clauses construction is essentially impaired because of the frequent substitution of the complementizer *che* 'that' with coordinating particles.

Similar 'non-standard' productions were also found by Caselli et al. (1994). In picture-naming and identification tasks, the hearing-impaired participants investigated in this study (age range varied between 2;6 and 11 years old) produced high percentages of articles omission. Also substitution errors were made: children mostly used singular determinants instead of plural ones. Furthermore, plural morphology was found to be problematic both on nouns and verbs. Finally, in a prepositions production task, subjects reported low percentages of accuracy.

Hearing-impaired population's difficulties with free morphology are reported also by Beronesi and Volterra (1986), Volterra and Bates (1989), D'Amico (1991), Emiliani et al. (1994). Studies on syntactically complex structures, such as passives and relative clauses, will be discussed more in depth in the next chapter.

To sum up, the linguistic input deprivation in the first years of life seems to affect drastically language development in hearing-impaired individuals. Anyway, they represent a very heterogeneous group where different linguistic outcomes arise. We will now investigate the role that different variables may play on linguistic development.

3.5.1 Variables in language development

It is generally acknowledged that hearing-impairment can affect language acquisition to different degrees. As a matter of fact, linguistic outcomes of hearing-impaired individuals are very heterogeneous: together with compromised and delayed linguistic profiles there are also cases where a comprehensive linguistic competence develops. Many have been discussed to be the variables of these differences in outcomes. The most considered are the age at onset of hearing loss, age at detection, degree of hearing loss, age of intervention, type and duration of use of prosthesis, family background (presence of hearing or deaf parents; involvement; socio-cultural level) and type of education (oralist, signed, bimodal, bilingual).

According to many studies, the severity of hearing loss does not seem to correlate with the variability of linguistic competence (Blamey et al., 2001; Friedmann and Szterman, 2006). On the contrary, the age of intervention, and in particular *early* intervention ("it consists in the application of hearing aids as soon as the hearing impairment is detected and/or in the application of cochlear

implants in the case of severe or profound hearing losses[22]"), is the variable that seems to play the major role. For example, in Friedmann and Szterman's (2006) study, children whose hearing loss was detected before the age of 8 months and promptly fitted with hearing aids had good performances in a comprehension tasks. Neither the type of hearing aid nor the duration of use of cochlear implant (nor, as we observed before, the degree of hearing loss) were found to be significant variables for syntactic comprehension.

Furthermore, Svirsky et al. (2004), Tomblin et. al. (2005), Connor et al. (2006) and Geers (2006) report that children who are implanted at very young ages achieve spoken language development at similar rates to typically developing children. In these cases, all participants had prolonged cochlear implant experience.

Oller and Eilers (1988), Moeller (2000), Schauwers et al.'s (2005) and Johnson and Goswami. (2010) investigations corroborate the importance of early intervention on linguistic outcomes. Their results claim that it positively influences the achievement of phonological awareness, favours the receptive vocabulary growth and, in general, reduces the linguistic delay.

According to Yoshinaga-Itano et al. (2010), some early implanted children do even learn language more quickly than typically developing children's average. This would be connected to the necessity to 'catch up' the delay which the period of auditory deprivation inevitably caused them. As a matter of fact, the Authors report the hearing-impaired children studied to reach age-appropriate levels of linguistic competence (4 to 7 years old).

Early timing of intervention is sustained also by Nicholas and Geers (2006) and Ledeberg and Spencer (2005) who suggest the existence of a critical period for implantation according to the age-related plasticity of the brain.

Nevertheless, even among early implanted children linguistic development remains highly variable suggesting the existence of further factors to critically affect it (Ouellet and Cohen, 2001). For instance, as observed by Moeller (2000), high levels of family involvement in the intervention programs correlates with positive language outcomes whereas low involvement by families was associated with a child language delay.

Summarizing, many variables are involved in the development of language of hearing impaired children. However, the way they interact with each other is still debated.

In the next chapters, we will focus on two structures that will be analyzed in our experiment and that literature reports to be problematic for hearing-impaired population: passive and relative clauses.

[22] Volpato (2010).

4. The morpho-syntactic properties of passive clauses

4.1 Introduction

Passive sentences are complex structures which seem to be mastered at late developmental stage (Chilosi et al, 1995; 2006). Deaf population seems to have significant problems with passives even after childhood (Rampelli, 1989; Bertone e Volpato, 2009). The difficulty of these structures seems to lie on the fact that the grammatical subject does not coincide with the agent of the action. In passives, in fact, the agent is usually expressed by a PP introduced by the preposition *by* whereas the patient, moving from an internal argument position, occupies the subject position, where it receives the nominative case.

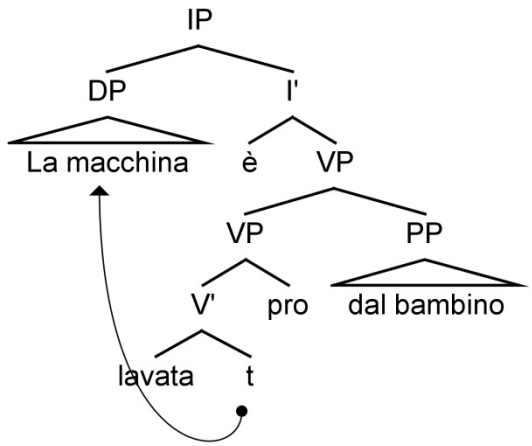
In these chapter we will outline the main properties of passive clauses in order to provide the theoretical basis which support our analysis. Then, we will report some theories and studies on the acquisition of passive structures. Finally, we will make some considerations on the performances that the hearing-impaired children we tested in this study may exhibit.

4.2 Properties of Italian passive clauses

Verbal passive sentences are syntactically represented in structures which contain A-movement. We will explain briefly how and why this movement occurs. First of all, we can easily observe that the grammatical subject of a passive clause is the internal object of the corresponding active clause. On the contrary, the subject of the active clause is either expressed with a PP adjunct headed by the preposition *da* (in Italian) or absent, that is, non-explicitly realized. In particular, the passive morphology of the verb prevents the verb itself from the assignment of the external theta-role to a NP in A-position. Anyway, according to the Theta criterion (Chomsky 1981, 1995) all thematic roles associated with a theta-assigner (the verb in this case) must be assigned to an argument. Thus, Jaeggly (1986) and Roberts (1987) propose that, in these structures, the external theta-role is 'absorbed' by the passive inflection of the verb. Concerning the internal theta-role, instead, it is normally assigned by the verb. However, as we can see from (1), after receiving the *patient* role the internal argument, *la macchina* ('the car'), has to move. This is because the verb cannot assign structural case. Thus, in order to satisfy the Case filter, which postulates that overtly realized NP (or

DP) arguments have to be case marked or associated with a case position, the internal argument moves to Spec, IP[23] where it receives *nominative* case by the auxiliary.

(1) La macchina è lavata dal bambino.



The movement of the internal argument is also due to the need for the phi (Φ)-features of the auxiliary to be checked. Indeed, if the DP, *la macchina,* contains intrinsic Φ-features (gender: feminine; number: singular), the auxiliary, *è* ('is'), has to establish a Spec-Head agreement relation with the closest DP in order to evaluate its relevant features. Finally, we need to notice that in languages such as Italian, the past participle agrees with the grammatical subject in passive clauses. In the example above, for instance, the lexical verb *lavata* contains the features [+singuar] [+feminine] as required by the agreement with the DP *la macchina.* In order to receive subject's features, the verb needs to be associated with a AgrOP[24] (Agreement Object Phrase) projection whose head contains past participle phi-features (Haegeman, 2000). Basically, before occupying the subject position in Spec, IP, the internal argument (*la macchina*) moves to Spec, AgrO, where it leaves a trace. Then, the verb moves to the head of the AgrOP projection where it can enter into a Spec-Head configuration with the trace of the object and receive its number and gender features.

4.3 The acquisition of passive structures

[23] This position is canonically occupied by external arguments. However, in passive constructions it is empty because of the reason explained above.

[24] The definition Agreement Object depend on the fact that the agreement is with the internal argument of the verb that later becomes the grammatical subject of the sentence.

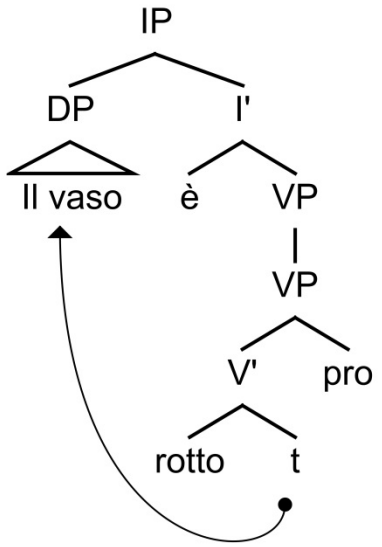
Many studies on typically developing children suggest that passive constructions are acquired late. I will focus here on some of the most representative only. Main results revealed that:

- passive sentences with **actional verbs** are comprehended earlier than passives with **experiential verbs**[25] (i.e. verbs denoting cognitive, emotional and perceptual event). In particular, passives involving non-action verbs seem to be acquired after the age of 5 years old (Maratsos et al., 1985; Hirsch & Wexler, 2006; Fox and Grodzinsky, 1998; Driva and Terzi, 2008; Volpato et al.; in press). Contrasting studies report instead a good comprehension of passives with both actional and non-actional verbs by 3 – 4 years old children (O'Brien et al., 1987; Demuth et al.; 2010).
- **Long** passives, that is those in which the agent is expressed (or *by-phrases*) are acquired later compared to **short** passives (without explicit agent) (Hirsch and Wexler, 2006; Rubin, 2009). Conflicting results are reported by Driva and Terzi (2008) and Volpato et al. (in press) which do not find any difference in long and short passives' performance.
- **Irreversible** passives are acquired before **reversible** ones (Chilosi et al. 2006; Turner and Rommetveit, 1967;).
- Since young children are typically guided by expectations in comprehension, **probable** sentences are easier than **improbable** ones (this holds both for active and passive sentences) (Gowie and Powers, 1972; Hutson and Powers, 1974).

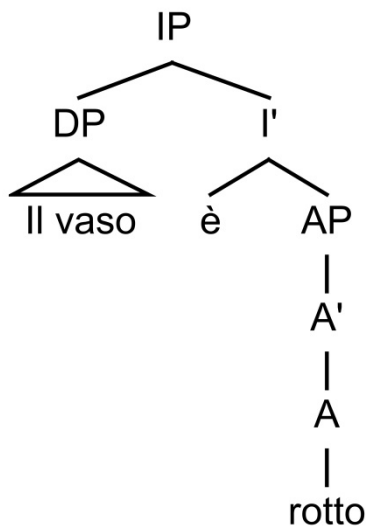
In order to explain the late development of passive structures in children's grammar, Borer and Wexler (1987) propose their *Maturation Hypothesis* which claims that young children are not able to form A(rgument)-chains[26] before 5 years of age. Until then, children analyse passive sentences as adjectival passives. For example, they interpret the verbal passive in (2) as the adjectival passive in (3).

[25] Basically, the difference is that actional verbs select an external argument whose thematic role represents the cause of an action (agent, instrument) whereas non-actional verbs select an external role whose thematic role does not represent the cause of an action (experiencer, goal).
[26] In passives, A-chains are necessary in order to move the verb internal argument into the subject position.

(2) *Il vaso è rotto* (*eventive interpretation*)



(3) Il vaso è rotto (stative interpretation)



In their representations, thus, the complement of I is an Adjectival Phrase, instead of a VP. Furthermore, the *patient* is base-generated in Spec, IP, so no A-movement occurs. Finally, the *agent* role is not represented because the adjectival passive does not include it in its thematic grid (it only needs *theme/patient* role). This hypothesis makes clear previsions on the structures that children will or will not be able to create and comprehend. For instance, passive sentences with

psychological verbs are supposed to be inaccessible to children because of the impossibility to create adjectival passives with such verbs. Moreover, since the representation we analysed in (3) does not allow *agent* role to be present, long passives (that express the *agent* role explicitly) are told to be problematic. Effectively, the results we reported above seem to corroborate this hypothesis. Fox and Grodzinsky (1998), however, found good performances on short passives (with both action and non-action verbs). As a consequence, they admit that children *are* able to form A-chains. Analysing chance performances on long passives involving non-actional verbs, instead, they suggest an inability to assign the theta-role to *by*-phrases. Simplifying, children would be able to assign correctly only '*affector*' theta-roles to *by*-phrases (i.e. agents, instruments, creators/possessors). Hence the chance performance on long passive with non-actional predicates (the assignment of this theta role is felicitous in passives with action verbs only). In a sentence such as *Mary is loved by Leo*, for instance, children would assign the role of *theme* to *Mary* and an *affector* θ-role to *Leo* which would be inconsistent with the thematic structure of the verb (*love* requires *non-affector* θ-roles: experiencers, goals/targets). Semantic interpretation would thus be linked to cognitive strategies which assign a thematic role randomly.

Finally, Hyams et al. (2006) propose that children cannot form A-chains only when associated to a non-canonical alignment between thematic hierarchy and grammatical functions[27]. Hence, children difficulties with passives is due to the non-canonical assignment of the *subject* grammatical function to the *patient*.

Gordon and Chafetz (1990) observe also the possibility that actional passives are easier to understand because they appear more frequently in parental speech compared to non-actional ones.

Concerning reversible and irreversible passive sentences, it is not a surprise that the latter are easier to comprehend. Indeed, irreversible sentences, such as *La mela è mangiata dalla bambina* ('The apple is eaten by the child'), contain semantic clues which definitely help with their interpretation whereas in reversible sentences (*Il bambino è spinto dalla bambina* 'The boy is pushed by the girl') two likely interpretations can be attributed to the sentence (both nouns can potentially be the subject of the sentence), thus children can rely on grammatical features only.

Bertone and Volpato (2009), found that reversible passive sentences are the most problematic structures for the hearing-impaired subjects they tested by TCGB. Participants seem to interpret the sentences on the strength of the knowledge of the world and disregarding functional elements instead. Also Bigoni et al. (2003) report poor performances on passives comprehension in 11 children and adolescents with severe to profound hearing loss. Finally, the 16 hearing-impaired

[27] This theory recalls Bever's (1970) suggestion according to which children rely on a *Canonical Sentence Strategy* that conceives NP-V-NP sequences as agent-action- theme patterns.

adults investigated by Vacca (2011/2012) confirms the asymmetry between passives with agentive and non-agentive verbs found in typically developing children whereas no significant differences are found in long and short passives' performances.

Our experiment will look for new evidences of the difficulties experienced by hearing-impaired children with passive sentences.

4.4 Remarks and test predictions

In our experiment, passive sentences are controlled for the reversibility variable, the presence of an actional or stative verb and the probability of the event they express.

They are all Subject-Verb-Agent sentences but two which are short passives (Subject-Verb). Despite the small number of examples provided for short passives, we will investigate any possible difference with long passives in children performances. Anyway, we have to highlight that these SV passives appear at the negative form.

Concerning children's comprehension of passives with actional and non-actional predicates, probably we will not report any interesting result. As a matter of fact, they are tested in irreversible sentences which are semantically constrained. Indeed, this kind of sentence allows to assign the relevant thematic roles unambiguously. So, good performances are expected by the children of our experiment in irreversible passives, mostly if compared to reversible ones. In the same way, among reversible passives, a good percentage of correct responses is predicted in probable ones. Semantic clues do not help neutral and improbable irreversible sentences, instead. So, it will be possible to find some errors with an incorrect thematic role assignment. Finally, when participle's number and gender features disambiguate the referent who receives the *theme* role, comprehension should be easier.

The hearing-impaired participants of our study are cochlear implanted children between 7;9 and 10;8 years old. Their performances on passives can help us to collect important details for language acquisition studies.

5. The morpho-syntactic properties of relative clauses

5.1 Introduction

In linguistic literature, relative clauses are commonly considered as complex structures which require mastery of movement operations and sufficient processing resources to compute the relevant syntactic dependencies. In particular, object relative clauses are found to be much more problematic than subject relative clauses both in typically developing children (Guasti and Cardinaletti, 2003; Arosio et al., 2005) and hearing-impaired individuals[28] (Friedmann and Sztermann, 2006; Volpato and Adani, 2009; Volpato, 2010).

In this chapter, we will illustrate the morpho-syntactic characteristics of relative clauses with their relevant complexity variables. We will then explore the results reported by studies of relative clauses in typical and atypical acquisition contexts. We will then consider some linguistic and psycholinguistic approaches in order to account for some of the linguistic behaviors observed. Finally, we will briefly consider the results that we expect from the hearing-impaired children of our study.

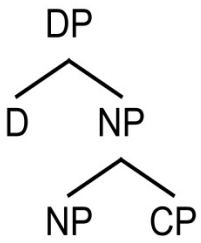
5.2 Properties of Italian relative clauses

As we have seen for passives, also relative clauses involve syntactic movement. In this case, however it is an A'-movement. This movement originates a long-distance dependency between the trace that the moved element leaves in its base-generated position and the moved element itself. In particular, the thematic-role is first assigned to the trace and then transmitted to the moved element via a chain.

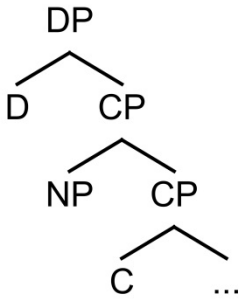
In this study we will investigate restrictive relative clauses. They are subordinate clauses that modify a nominal antecedent in the main clause restricting the number of possible referent for it. Syntactically, they belong to the CP (Complementizer Phrase) (Cinque, 1982; Rizzi, 1997; Bianchi, 1999)[29] and are embedded in a complex DP. However, their representation is still highly debated. In particular, it is still unclear if they should be considered adjuncts (1) or arguments (2) of the DP which contains them.

[28] Object relatives seem to be more complex that subject relatives also for SLI children, agrammatic (aphasic) patients (see section 5.3 for reference to the relevant studies).
[29] The reference to these studies is obtained by Volpato (2010).

(1)

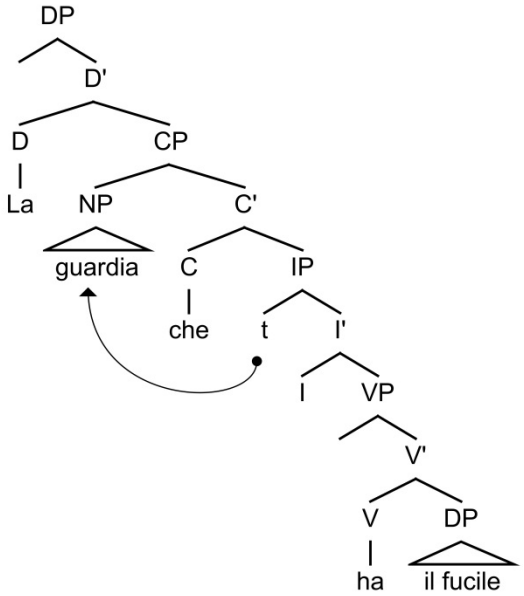


(2)



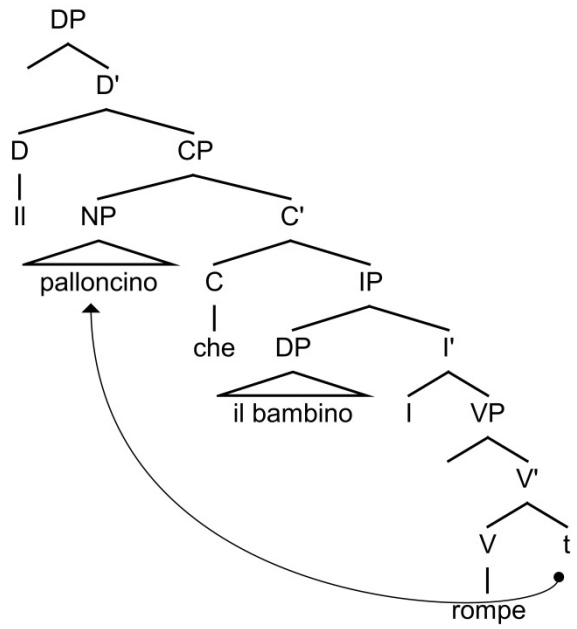
In this study, we will consider the argument analysis proposed, among others, by Kayne (1994). Besides considering the relative clause as a complement of the determiner, it assumes that the subject or object head from the embedded clause is moved to Spec, CP[30]. According to the position from which the head moves we distinguish subject and object relative clauses. In the syntactic trees below we propose examples of both of them (respectively (3) and (4)).

(3) La guardia che <la guardia> [31]ha il fucile.



[30] A previous account assumes the movement of a relative operator, instead (Cinque, 1978; 1981-1982; Chomsky, 1986, 1995).
[31] The < > brakets indicate the head original position.

(4) Il palloncino che il bambino rompe <il palloncino>.



Thus, the head of the DP selects the relative clause whose head raises to Spec, CP leaving a trace in its original position. Furthermore, the head of the relative clause can be either the subject or the object in the main clause. Depending on the case, we distinguish between embedded and clause-final relatives respectively.

5.2.1 Complexity variables in relative clauses

Relative clauses are complex structures whose interpretation implies the ability to build the syntactic representation of A'-movement and the relation between the moved element and its trace. Many studies from different languages, however, report different degrees of complexity in these structures. They seem to depend on both syntactic and lexical-semantic factors. Among the syntactic ones, three linguistic principles seem to be crucial:

- The canonical order of the referents of the sentence[32] (SVO in Italian) ;
- The role of the relative pronoun in respect to the noun it is referred to;

[32] It is important because the verb typically assigns the role of *agent* to the first NP and the *theme* role to the second one. In case of movement, however, it is necessary to build the correct chain in order to retrieve the correct thematic role assignment (which occurs at D-level). In any case, when after movement the canonical order (agent-verb-theme) is respected thematic roles will be assigned more easily (Friedmann and Haddad, in press).

- The minimum-distance principle (which is infringed every time an embedded clause intervenes between the subject and the predicate of a main clause).

According to the respect or violation of each of these principles, every typology of relative clause may be more or less problematic. Chilosi et al. (2006) summarize relative clauses' characteristics according to these principles in Table (1) below:

	SVO sequence	Grammatical role	Minimum distance
Embedded S/S	+	+	-
Clause-final O/O	-	+	+
Embedded S/O	-	-	-
Clause-final O/S	+	-	+

Table 1. Linguistic principles' respect (+) or violation (-) in different typologies of relative clause.

Basically, the more principles are violated, the more complex is the sentence. Therefore, it is clear that embedded S/O relative clauses are expected to be the most demanding in acquisition. According to Chilosi et al., when at least two animated referents occur in a sentence, the order of acquisition (from the easier to the most complex) is the following:

- Clause-final O/O - *Il babbo tiene il palloncino che il bambino rompe*
- Clause-final O/S - *Il bambino rincorre la bambina che è in bicicletta*
- Embedded S/S - *La guardia che ha il fucile ferma il ladro*
- Embedded S/O - *Il topo che il gatto rincorre ha il formaggio in bocca*

We report below, the order of acquisition of each item on relative clauses found by Chilosi and colleagues on TCGB:

Structure/Age	5	5;6	6	6;6	7	8
Relative	Emb SO (69)	Fin OO (72)	Fin OS (31) Fin OO (60)*	Fin OS (41) Emb SS (45)	Emb SS (39)	Emb SO (50)

For every age group, items were considered to be acquired when 85% of the sample responded correctly. (On the item marked by an asterisk, children perform irregularly).

Even if the most difficult item contain an embedded object relative clause, these data seem to suggest that subject relatives are more complex. In the next paragraph, we will see instead that

most of the studies on relative clauses agree that object relatives are more complex than subjective ones.

Also semantic clues play their role. So, when one animated referent only is present, the semantic constraint facilitates the thematic roles assignment regardless of the structure typology. In other words, the irreversible *Il vaso che il bambino dipinge è* sulla sedia 'The bowl that the child paints is on the chair' (which is an embedded S/O relative clause) may be more demanding than the reversible *Il bambino rincorre la bambina che è in bicicletta* 'The child-MASC runs after the child-FEM that rides a bicycle'.

5.3 Typical and atypical acquisition of relative clauses

Unlike Chilosi et al., research in various languages revealed that both typical and atypical populations have more difficulties in comprehending object relative clauses (ORC) than subject relative clauses (SRC) (for typically developing children, see Guasti and Cardinaletti, 2003; Arosio et al., 2006, 2010; Utzeri, 2007; Adani, 2008; Adani et al. 2010, for Italian; Guasti et al., 2008, for Greek; Arnon, 2009; Friedmann et al.. 2009. for Hebrew; Diessel and Tomasello, 2005, for German; for Italian adults, see De Vincenzi, 1990; for SLI children, see Stavrakaki, 2001 for Greek; Friedmann and Novogrodzsky, 2004 for Hebrew; Adani, 2008 for Italian; for aphasic patients, see Garraffa and Grillo, 2007; Grillo, 2008)[33].

Recent investigations confirm the subject/object relative clauses asymmetry in hearing-impaired children (Friedmann and Sztermann, 2006; Volpato and Adani, 2009; Volpato, 2010) and adults too (Vacca, 2011-2012). As suggested by Friedman, Belletti and Rizzi (2009), the reasons can be found in Rizzi's (1990, 2001, 2004) Relativized Minimality (RM) principle. According to this theory, in a configuration like (5), a local relation between X and Y cannot be established if Z intervenes and Z is a potential candidate for the local relation. Same structural type

(5) X … Z … Y

An intervenient element is defined as a potential candidate in terms of 'identity of features' (Rizzi, 2001). In particular, Rizzi (2004) proposes the following feature classes:

- *Argumental*: person, number, gender, case
- *Quantificational*: Wh, Neg, measure, focus …

[33] The reference of these studies is drawn from Volpato and Adani (2009) and Benţea (2012).

- *Modifier*: evaluative, epistemic, Neg, frequentative, celerative, measure, manner ... (the same found in Cinque, 1999)
- *Topic*

According to Cartographic studies (Cinque, 1999, 2002; Rizzi, 2004) each position in the clause structure is associated to a class of morpho-syntactic features.

Argumental features will determine locality of A-chains whereas the other three classes are A'-features.

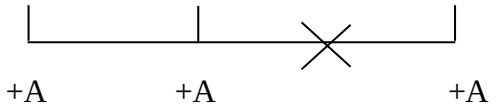
Concerning relative clauses, we first have to consider that in subject relative clauses no intervenient elements occur between the head of the relative and its trace:

(6) *La guardia che <la guardia> ha il fucile.*

Hence, no particular difficulties are observed neither in typical developing children nor in in hearing-impaired population.

In object relative clauses, instead, an embedded DP intervenes between the DP head and its trace. According to Adani (2008) and Volpato and Adani (2009), the former belongs to the Argumental class (A) whereas the latter to the Quantificational class (R). Therefore, since RM effects occur just in case of identity of features, the chain between the moved DP and its trace can be correctly formed. Evidently, however, young children and hearing-impaired individuals, whose linguistic competence is not fully achieved, are not able to attribute the correct class of feature to the two DPs. They do probably identify them as belonging to the same A class[34].

(7) La palla che il bambino colpisce <la palla>.



In this case, the identity of features with the intervening element blocks the long-distance dependency between the moved NP and its trace.

In Friedmann et al. (2009), the authors consider locality effects (between the head of the relative clause and the intervening element) in terms of [+NP] feature sharing (i.e. similarity in lexical NP restrictions).

Finally, psycholinguistic studies suggest that subject/object RCs asymmetry can be related to economy strategies in parsing. In particular, the Minimal Attachment Principle (Frazier, 1987)

[34] According to Garraffa and Grillo, 2007, Adani, 2008 and Grillo, 2008, -cited in Volpato and Adani (2009)- R features are more likely to be compromised or underspecified because of their position in the periphery of the clause which makes them demanding to process.

claims that human sentence processor tends to attach incoming material into the available (previously formed) phrase marker. The syntactic representation is thus constructed using the fewest nodes, accordingly to the well-formedness rules of the language. So, in relatives, the parser tries to close the A' dependency as soon as possible. In detail, the moved-element is assumed to occupy the closest argument position which is the subject position. Hence, if this strategy succeed with SRCs, it does not with ORCs. Indeed, they require a re-analysis that cause an increase in the computational load from which derives the complexity of these structures.

5.4 Remarks and test predictions

In the test we used for our experiment, the number of items on relative clauses is very small (only 8). However, we will observe if the SRC/ORC asymmetry attested by most of the studies on the topic is confirmed by our group of cochlear implanted children. Performances' accuracy is expected to be connected to sentence complexity that, how we explained above, depends on the respect or violation of the word-order, grammatical role and minimum distance principles. Also semantic clues are considered to influence relative clauses' accuracy. The interpretation of both object and subject relative clauses should be facilitated by the irreversibility factor.

Also, we will consider any relevant correlation between performances and both the age of children implantation and the years of use.

6. The experiment

6.1 Introduction

The aim of this study is to verify the linguistic competence of a group of 13 Italian-children fitted with a cochlear-implant assessed by the Test di Comprensione Grammaticale per Bambini (TCGB, Chilosi et al., 1995, 2006). In particular, we investigate the role played by acoustic deprivation in language acquisition. In order to do that, we will focus on any possible difference between hearing-impaired (HI) children's performances and typical developing (TD) children ones.

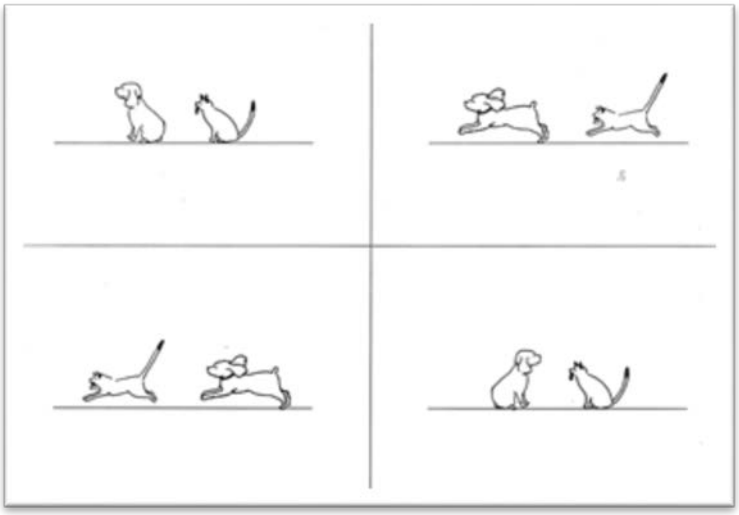
Cochlear-implanted (CI) participants are matched with a group of TD children (control group) with similar linguistic and auditory age. The former matching is determined by TCGB's overall scores whereas the latter correspond to the length of time of language exposure, that for hearing-impaired children is the period of time since the activation of the cochlear implant whereas for hearing children is chronological age.

Results of the picture selection task will be analyzed both quantitatively and qualitatively. In other words, for each sentence presented we will consider if participants fail and how many times and depending on the picture indicated we will examine the strategy used in sentence comprehension.

A complete description of the test is given in the next paragraph together with the explanation on the way in which linguistic abilities are evaluated. Furthermore, we will present the participants and report the results. Finally, we will make a careful analysis of CI children performances by comparing their errors and response strategies with those of the control group.

6.2 TCGB - Test di comprensione grammaticale per bambini

This experiment is based on the Test di Comprensione Grammaticale per Bambini (TCGB, Chilosi et al., 1995, 2006) which is adapted from the Italian versions (Parisi and Pizzamiglio, 1970; Laicardi et al., 1983, 1984) of Fraser, Bellugi and Brown's (1963) test. It assesses children's comprehension abilities through the administration of 76 sentences accompanied by an illustrated album. Children have to select the picture corresponding to the stimulus sentence choosing between 4 options, which contain grammatical and/or lexical distractors. For example, Picture 1 below shows the 4 images combined with the target sentence *'Il gatto rincorre il cane'* (*'The cat chases the dog'*).



Picture 1. 'Il gatto rincorre il cane'

The comprehension of test lexical words is verified before the beginning of the experiment through the presentation of some vocabulary tables that can be proposed at any time, when children seem not familiar with lexical terms. Even though the TCGB is standardized on hearing people and is used to assess 3;6 to 8;0 children's linguistic abilities, it is also used to assess the linguistic competence of subjects with language and hearing impairments.

The test investigates eight different grammatical structures which are presented randomly but according to an increasing order of complexity. In particular, it is composed by:

- *Locative structures* (14 items): according to the characteristics of the locative element contained, they are divided in *topological* and *projective.* In particular, the topological elements included in the test are *sopra, sotto, giù, su, dentro, fuori, vicino, lontano* (8 items). Projective elements, instead, are *davanti, dietro, da-a, tra* (6 items). According to Slobin (1985), topological locative structures are acquired earlier than projective ones. His results are reported in the picture below[35].

[35] This Table reports the results of an elicitation task conducted by Johnston and Slobin (1979:537) with 2;0 to 4;8 years old children. We obtained it from Slobin (1985).

TABLE I.1
Order of Acquisition of Locative Expressions in Four Languages and Percentage of Subjects Producing Each[a]

Scale Point	*English*		*Italian*		*Serbo-Croatian*		*Turkish*	
1	IN	90	IN	91	ON	88	IN	90
2	ON	83	ON	88	IN	84	ON	80
3	UNDER	81	UNDER	84	BESIDE	82	UNDER	79
4	BESIDE	74	BESIDE	77	UNDER	72	BESIDE	79
5	BETWEEN	49	BETWEEN	57	$BACK_f$	31	$BACK_f$	71
6	$FRONT_f$	30	$BACK_f$	42	BETWEEN	26	$FRONT_f$	53
7	$BACK_f$	21	$FRONT_f$	41	$FRONT_f$	19	BETWEEN	50
8	BACK	14	BACK	23	BACK	16	BACK	7
9	FRONT	3	FRONT	18	FRONT	12	FRONT	4
Gutman coefficient of reproducibility		0.93		0.89		0.86		0.91
Number of subjects		86		74		90		70

Indeed, they require a greater number of considerations to be evaluated and even more complex: the resulting computational load makes them more demanding. However, the results of the studies of Chilosi et al. report that this kind of structure is the first to be acquired by children. By the age of 5;6 locative items comprehension reaches the 88% while children of 7;6 years old obtain a score of 96%.

- *Inflectional structures* (16 items): they include both nominal and verbal inflections. The former tests singular/plural (2 items) and masculine/feminine (2 items) contrasts, whereas the latter evaluates number (2 items) and tense (present/past/future: 6 items) ones. Number contrast is considered in possessives too (4 items). According to the creators of the test, nominal inflection is acquired earlier than verbal or adjectival one. Future tense inflection, instead, seems the most complex.
- *Active affirmative structures* (10 items): they test Subject-Verb (SV) (2 items) and Subject-Verb-Object (SVO) sentences with different degrees of complexity. Indeed, reversibility is combined with probable (2 items), neutral (2 items) and improbable (2 items) events. In 2 items the difficulty lies on the inanimate nature of the agent connected with an animate patient. Anyway, in these structures the canonical word order is respected both concerning grammatical functions (i.e. the subject occurs before the object) and thematic hierarchy (i.e. the agent precedes the patient). So, they are considered to be easy for children as confirmed by Chilosi et al.. The only problems could be found in improbable sentences where children

could be tempted to assign the thematic roles according to their experience (that is depending on the relation they are used to gather those elements) or in sentences with inanimate agent where the agent role is more probably assigned to the animate referent regardless of syntactic structure.

- *Negative active structures* (6 items): they include 2 SV structure items and 4 irreversible and reversible SVO ones. Complexity is connected to the way negation is represented: through the absence of the action expressed in the sentence (e.g. *Il gatto non mangia il pesce* 'The cat does not eat the fish'- It is represented as standing still) or though the presence of an alternative object participating in the action (*Il bambino non mangia la minestra* 'The child does not eat the soup'- He is represented while eating an ice-cream). Children are required to have recourse to deductive reasoning and to consider the word order correctly. Chilosi and colleagues observe that negative active structures are acquired approximately at the age of 6;6 and that SV sentences result easier than SVO ones.
- *Affirmative passive structures* (10 items): they are controlled for the reversibility factor (4 irreversible and 6 reversible items), for the kind of verb involved and for cognitive factors such as event probability. According to the observations we made in chapter 4, the semantic constraint implied in irreversible sentences is consider to ease children's interpretation; a similar facilitation is expected by the probability factor (i.e. probable sentences are expected to be easier than neutral or improbable ones) whereas concerning the typology of the verb, sentences with actional verb (which implies an affected object) are expected to be easier than sentences with non-actional verb (non-affected object).
- *Negative passive structures* (6 items): they correspond to 2 SV and 4 SVA (2 irreversible and 2 reversible) structures. According to the studies examined previously short passives (SV) are expected to be easier. Anyway, comprehension may be tangled by the presence of the negation which increases the computational load. In general, the same observations made for active passives are valid here too.
- *Relative structures* (8 items): depending on the position of the relative clause in respect to the main clause, they are divided in embedded and clause-final relatives. A further classification distinguishes them depending on the role that the relative pronoun acquires in the sentence (both in the main and in the embedded clauses). To sum up, there are:
  - Embedded S/S relative clauses (*La guardia che ha il fucile ferma il ladro*),
  - Embedded S/O relative clauses (*Il vaso che il bambino dipinge è sulla sedia*),
  - Clause-final O/O relative clauses (*Il babbo tiene il palloncino che il bambino rompe*),
  - Clause final O/S relative clauses (*Il gatto salta sul topo che è sulla sedia*).

As considered in chapter 5, embedded S/O relatives should be the most complex to compute. In fact, they violate both the canonical SVO order of the nuclear sentence and the minimum distance principle between the referents of the main clause; furthermore, the relative pronoun acquires a grammatical role which is different from the DP it is referring to. Moreover, Chilosi et al. found that embedded S/S relatives are the second structures most complex because of their minimum distance principle infringement.

- *Dative structures* (6 items): they express an agent who executes an action towards a recipient. Their complexity degree varies depending on event probability and on the animate/inanimate feature of the referents. Even if this kind of structures seem to be acquired pretty soon (by 6;6 years, according to Chilosi and colleagues) it is presumable to meet some errors in neutral or improbable contexts, that is in those cases where participants cannot depend on any extra-linguistic clues. Also sentences with three animate referents (the agent, the object and the recipient) might be more problematic than those with both animate and inanimate referents since in the latter the roles assignment is facilitated.

Depending on error patterns, children's processing strategies and possible difficulties in particular linguistic areas are uncovered.

Each correct response is attributed a score of 0. If the participant selects the wrong picture on the first administration, the sentence is proposed again. In this case, a correct response is indicated by a 0,5 scores. If the target picture is missed again, instead, a score of 1,5 is attributed. Hence, the lower the score, the better the performance.

Participants correct comprehension of lexical words occurring in the experimental trials is assessed before beginning the test in order to exclude any possible connection between poor performances and lexical knowledge.

The TCGB manual reports the average of partial (depending on sentence typology) and overall results obtained by 10 groups of typically developing children tested by Chilosi et al.. These normative data can be consulted in order to attribute a linguistic age to the children that participate in the test and to evaluate any possible atypical development.

This study analyzes some of the data obtained by Volpato's (2010) work.

6.3 Participants

This experiment investigates the general linguistic abilities of 13 hearing-impaired children with a cochlear implant. Their age range is between 7;9 and 10;8 years (mean age: 9;0) whereas their age

of cochlear implantation varies between 1;9 and 3;4 years old. In order to verify if and how their verbal language acquisition differs from typically developing children their performance is compared to that of 13 hearing children matched on linguistic age, which is calculated according to TCGB final score. Since HI children accede to the linguistic input later than typically developing children, their linguistic competence is hardly comparable. For this reason, the hearing children group includes younger participants. Their chronological age is between 5;7 and 7;10 (mean: 6;9).
Moreover, in order to verify the correlation between years of cochlear implant use and linguistic development, hearing impaired children are also matched with 13 hearing children on the basis of auditory age[36] (i.e. years of exposition to the linguistic input: it corresponds to the years of cochlear implant use for hearing-impaired children and to the chronological age for hearing children). This group's age range is between 4;11 and 9;4 years old (mean age 7;4) whereas HI children auditory age varies from 4;6 to 8;6 years.

6.4 Results

We will develop the analysis on linguistic age (LA) and auditory age (AA) matching in parallel. In Table 1 below, HI and hearing children's final score on TCGB is shown according to linguistic age matching:

[36] Eight of the typically developing children were used for the matching on both linguistic and auditory age. Obviously, each of them is paired with different hearing impaired children depending on the relevant criterion.

ID	AGE (Y;M)	SCORE	ID	AGE	SCORE
D1	7;9	21	H1	5;7	18,5
D2	10;8	8,5	H2	5;10	9,5
D3	8;10	8,5	H3	6;2	8,5
D4	7;11	6	H4	7;4	6
D5	9;6	4,5	H5	7;6	5,5
D6	9;10	4,5	H6	7;9	4,5
D7	8;2	3,5	H7	7;10	4
D8	8;1	3,5	H8	6;10	3,5
D9	9;5	2	H9	6;1	3
D10	9;3	1,5	H10	7;2	1,5
D11	9;6	1,5	H11	7;3	1,5
D12	9;6	0,5	H12	7;5	1,5
D13	9;9	0,5	H13	7;5	1,5

Table 1. TCGB total score of hearing-impaired (D) and hearing (H) children matched on linguistic age.

The results in Table 1 show that the range score varies between 0,5 and 21 in hearing-impaired children, and between 1,5 and 18,5 in hearing children.

Considering their chronological age, most of the hearing children had normal range scores on the TCGB test (i.e. they were included between the 25° and 75° percentile), but 5 of them (H1, H4, H5, H6 and H7) obtained scores included between the 25° and 10° percentile which represent performances a little lower than the average.

A relevant factor is that hearing-impaired children are approximately two years older than their matching hearing children. D2 is matched with a child 5 years younger. So, as far as implanted children's linguistic competence is concerned it is not comparable to hearing peers' one.

Now, we will compare the performance of HI children with that of control children matched on auditory age (all available clinical data are reported):

ID	AUDITORY AGE (Y;M)	AGE OF CI (Y;M)	SCORE	ID	AGE	SCORE
D1	4,4	3,4	21	H16	4;11	21
D2	8,6	2,2	8,5	H14	9;4	4,5
D3	5,11	2,11	8,5	H18	5;11	6
D4	6,0	1,11	6	H15	6;1	1,5
D5	7,2	2,4	4,5	H17	7;1	7
D6	8,1	1,9	4,5	H7	7;10	4
D7	5,11	2,3	3,5	H2	5;10	9,5
D8	6,3	1,10	3,5	H9	6;1	3
D9	7,2	2,3	2	H10	7;2	1,5
D10	7,6	1,9	1,5	H13	7;5	1,5
D11	7,2	2,4	1,5	H12	7;5	1,5
D12	7,3	2,3	0,5	H11	7;3	1,5
D13	7,1	2,8	0,5	H8	6;10	3,5

Table 2. TCGB total score of hearing-impaired (D) and hearing (H) children matched on auditory age (CI: cochlear implantation).

It is interesting to note that in 7 cases out of 13, children with similar duration of oral language exposure (according to the years of cochlear implant use in HI children and depending on chronological age in TD ones) exhibit similar patterns of performance. In the remaining 6 couples, D2, D3 and D4's score is higher than their matching hearing children with similar linguistic experience's duration. In the D5-H17, D7-H2 and D13-H8 matching, instead, hearing children exhibit worse performances. However, in most of the cases, implanted children developed a linguistic competence in line with their auditory age. The only exceptions is D2 which display a performance comparable to 6 years old children despite he wears the cochlear implant from 8;6 years.

In the next section, will analyze participants' performances quantitatively and qualitatively. In particular, we will investigate the differences between HI and hearing subjects in errors distribution and interpretative strategies choice.

6.4.1 Quantitative analysis: correct responses

Concerning linguistic-age matching, the number and the percentage of correct sentences provided by the two groups on each structure type have been calculated. In order to avoid leaving aside significant results, correct responses were calculated considering 1,5 error score only and both 0,5 and 1,5 errors. Tables 3 and 4 report respectively the number and the percentage of correct items in the hearing-impaired group considering 1,5 error score only.

	D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**
L	13/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14
I	14/16	16/16	16/16	16/16	16/16	16/16	15/16	16/16	16/16	16/16	16/16	16/16	16/16
AA.	9/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10
AN	5/6	5/6	6/6	5/6	5/6	5/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
PA	8/10	10/10	9/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10
PN	5/6	6/6	5/6	6/6	6/6	6/6	6/6	5/6	6/6	6/6	6/6	6/6	6/6
R	7/8	8/8	8/8	8/8	8/8	8/8	7/8	8/8	8/8	8/8	8/8	8/8	8/ 8
D	5/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
TOT.	66/76	75/76	74/76	74/76	75/76	75/76	74/76	75/76	76/76	76/76	76/76	76/76	76/76

Table 3. Number of correct items provided by hearing-impaired children on each sentence type (1,5 error score only).

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	Mean
L	93%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
I	88%	100%	100%	100%	100%	100%	94%	100%	100%	100%	100%	100%	100%	99%
AA.	90%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
AN	83%	83%	100%	83%	83%	83%	100%	100%	100%	100%	100%	100%	100%	93%
PA	80%	100%	90%	90%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%
PN	83%	100%	83%	100%	100%	100%	100%	83%	100%	100%	100%	100%	100%	96%
R	88%	100%	100%	100%	100%	100%	88%	100%	100%	100%	100%	100%	100%	98%
D	83%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
TOT.	**86%**	**98%**	**97%**	**97%**	**98%**	**98%**	**98%**	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**98%**

Table 4. Percentage of correct items provided by hearing-impaired children on each sentence type (1,5 error score only).

Tables 5 and 6 provide the number and the percentage of correct items in the hearing group considering 1,5 error score only.

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13
L	13/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14
I	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16	16/16
AA.	10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10
AN	4/6	5/6	6/6	4/6	6/6	5/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
PA	10/10	10/10	9/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10
PN	6/6	6/6	2/6	5/6	6/6	5/6	5/6	6/6	6/6	6/6	5/6	6/6	6/6
R	8/8	8/8	7/8	8/8	8/8	7/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8
D	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
TOT.	73/76	75/76	69/76	70/76	67/76	72/76	71/76	69/76	76/76	73/76	75/76	73/76	73/76

Table 5. Number of correct items provided by hearing children on each sentence type (1,5 error score only).

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	Mean
L	93%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
I	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AA	100%	100%	90%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
AN	67%	83%	100%	67%	100%	83%	100%	100%	100%	100%	100%	100%	100%	92%
PA	100%	100%	90%	100%	90%	100%	100%	100%	100%	100%	100%	100%	100%	98%
PN	100%	100%	33%	83%	100%	83%	83%	100%	100%	100%	83%	100%	100%	90%
R	100%	100%	88%	100%	100%	88%	100%	75%	100%	100%	100%	100%	100%	96%
D	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TOT.	**95%**	**98%**	**88%**	**94%**	**99%**	**94%**	**98%**	**97%**	**100%**	**100%**	**98%**	**100%**	**100%**	**97%**

Table 6. Percentage of correct items provided by hearing children on each sentence type (1,5 error score only).

Analyzing 1,5 errors only, it emerges that both the HI and the hearing group comprehend correctly 61 items out of 76, that is the 80%. However, as Table 7 shows, common errors are only 7 in 15. The hearing impaired children found difficulties with 8 items which instead were correctly interpreted by hearing children. In the same way, the latter fail to comprehend 8 items that were not problematic for the hearing-impaired children group. In detail, common errors were found in locative, negative (passive and active) and relative structures. Further problems were found in relative and negative passive structures by hearing children. Finally, only cochlear-implanted children make errors in inflectional and dative structures while in active and passive affirmative structures hearing-impaired and typically-developing participants make errors in different items.

	D	C	H
LOCATIVE	0	1	0
INFLECTIONAL	2	0	0
AFF. ACTIVE	1	0	1
NEGAT. ACTIVE	0	2	1
AFF. PASSIVE	4	0	2
NEGAT. PASSIVE	0	2	2
RELATIVE	0	2	2
DATIVE	1	0	0
	8	**7**	**8**

Table 7. Number of wrong items given by deaf participants only (D), by hearing participant only (H) and by both groups (C).

The error analysis in terms of choice of a particular picture instead of the target one will be discussed in the next section.

Now, in order to consider all data, another error analysis will be presented. This time, both 0,5 and 1,5 error scores will be counted. In the following tables, the number and the percentages of correct responses are summarized. Tables 8 and 9 show hearing-impaired children results while Tables 10 and 11 display hearing children data.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13
L	11/14	12/14	13/14	14/14	14/14	14/14	14/14	14/14	14/14	13/14	14/14	14/14	14/14
I	11/16	15/16	15/16	16/16	14/16	14/16	15/16	15/16	15/16	14/16	16/16	15/16	16/16
AA.	8/10	7/10	9/10	10/10	10/10	9/10	9/10	10/10	10/10	10/10	9/10	10/10	10/10
AN	5/6	5/6	6/6	5/6	5/6	5/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
PA	5/10	4/10	5/10	7/10	10/10	9/10	10/10	8/10	8/10	10/10	10/10	10/10	9/10
PN	4/6	4/6	4/6	4/6	4/6	4/6	6/6	5/6	5/6	6/6	5/6	6/6	6/6
R	5/8	8/ 8	7/8	6/8	6/8	8/8	7/8	7/8	8/8	8/8	7/8	8/8	8/8
D	5/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
TOT.	54/76	61/76	65/76	68/76	69/76	69/76	73/76	71/76	72/76	73/76	73/76	75/76	75/76

Table 8. Number of correct items provided by hearing-impaired children on each sentence type (0,5 and 1,5 error scores).

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13
L	79%	86%	93%	100 %	100 %	100 %	100 %	100 %	100 %	93%	100 %	100 %	100 %
I	67%	94%	94%	100 %	88%	88%	94%	94%	94%	88%	100 %	94%	100 %
AA.	80%	70%	90%	100 %	100 %	90%	90%	100 %	100 %	100 %	90%	100 %	100 %
AN	83%	83%	100 %	83%	83%	83%	100 %	100 %	100 %	100 %	100 %	100 %	100 %
PA	50%	40%	50%	70%	100 %	90%	100 %	80%	80%	100 %	100 %	100 %	90%
PN	67%	67%	67%	67%	67%	67%	100 %	83%	83%	100 %	83%	100 %	100 %
R	63%	100 %	88%	75%	75%	100 %	88%	88%	100 %	100 %	88%	100 %	100 %
D	83%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
TOT.	72%	80%	85%	87%	90%	90%	97%	93%	95%	98%	95%	99%	99%

Table 9. Percentage of correct items provided by hearing-impaired children on each sentence type (0,5 and 1,5 error scores).

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13
L	9/14	13/14	13/14	14/14	14/14	14/14	14/14	14/14	13/14	14/14	14/14	14/14	14/14
I	13/16	13/16	13/16	15/16	14/16	15/16	16/16	15/16	15/16	16/16	16/16	15/16	16/16
AA	7/10	9/10	9/10	10/10	9/10	10/10	10/10	10/10	9/10	10/10	10/10	10/10	10/10
AN	4/6	5/6	5/6	4/6	4/6	5/6	5/6	4/6	5/6	5/6	6/6	5/6	6/6
PA	9/10	9/10	8/10	10/10	8/10	10/10	10/10	9/10	9/10	9/10	10/10	9/10	9/10
PN	1/6	6/6	6/6	4/6	5/6	5/6	5/6	5/6	6/6	6/6	5/6	6/6	4/6
R	5/8	4/8	6/8	8/8	7/8	7/8	4/8	6/8	7/8	7/8	8/8	8/8	8/8
D	5/6	4/6	5/6	5/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	5/6
TOT.	53/76	63/76	65/76	70/76	67/76	72/76	70/76	69/76	70/76	73/76	75/76	73/76	72/76

Table 10. Number of correct items provided by hearing children on each sentence type (0,5 and 1,5 error scores).

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13
L	64%	93%	93%	100 %	100 %	100 %	100 %	100 %	93%	100 %	100 %	100 %	100 %
I	81%	81%	81%	94%	88%	94%	100 %	94%	94%	100 %	100 %	94%	100 %
AA	70%	90%	90%	100 %	90%	100 %	100 %	100 %	90%	100 %	100 %	100 %	100 %
AN	67%	83%	83%	67%	67%	83%	83%	67%	83%	83%	100 %	83%	100 %
PA	90%	90%	80%	100 %	80%	100 %	100 %	90%	90%	90%	100 %	90%	90%
PN	17%	100 %	100 %	67%	83%	83%	83%	83%	100 %	100 %	83%	100 %	67%
R	63%	50%	75%	100 %	88%	88%	50%	75%	88%	88%	100 %	100 %	100 %
D	83%	67%	83%	83%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	83%
TOT.	67%	82%	86%	89%	87%	94%	90%	89%	92%	95%	98%	96%	93%

Table 11. Percentage of correct items provided by hearing children on each sentence type (0,5 and 1,5 error scores).

For convenience, we will not report the percentages of correct responses provided by hearing children matched on auditory age. However, their mean percentage of accuracy for each sentence typology is expressed in Table 12 together with those of HI children and hearing children matched on linguistic age.

Sentence structure type	**Mean**		
	Hearing-impaired children	**Hearing children (LA)**	**Hearing children (AA)**
Locative	96%	96%	96%
Inflectional	92%	92%	92%
Act. Aff.	93%	95%	95%
Act. Neg.	93%	**81%**	**84%**
Pass. Aff.	**81%**	92%	85%
Pass. Neg.	**81%**	**82%**	87%
Relative	90%	**82%**	**81%**
Dative	99%	99%	88%
TOT.	91%	90%	89%

Table 12. Mean percentages of correct items for each sentence typology provided by the three groups of participants (0,5 and 1,5 error scores) (LA: matched for Linguistic Age; AA: matched for Auditory Age).

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From these data, we can observe that passives sentences are the most complex for HI children. Low percentages on this structures (81% on both affirmative and negative passives) are shared by AA children in affirmative clauses (85%) and by LA controls in negative clauses (82%). Cochlear implanted children, on the contrary, report better results (90%) than both LA (82%) and AA (81%) children in relative clause comprehension. In the same way, active negative structures do not seem to be fully mastered by the typically developing children of our study yet whereas hearing impaired children show 93% of correct responses.

Comparing the total number of items comprehended correctly by all groups on the first administration, similar results are obtained. In fact, cochlear-implanted children do not make errors in 35 items whereas LA and AA controls respond correctly to 37 and 34 items respectively.

In order to depict participants' developmental profiles accurately we will now study individual performances in detail.

6.4.2 Qualitative analysis: response strategies

In this section, the errors made by participants will be considered carefully.

First of all, we will present number and percentage of correct responses for each item, that we gather according to typology. In the second place, the possible response strategies connectable to the choice of the wrong picture will be studied in the light of the selection of the grammatical or lexical-semantic distractor (or neither). Furthermore, a comparative analysis between hearing and hearing-impaired error types will be conducted in order to highlight any possible significant difference.

6.4.2.1 Locative structures

Table 13 below summarizes the number and percentage of correct responses provided by HI children and LA controls on each item. Responses are considered as an error when participants fail either on the first or on both attempts.

ITEM	Nr HI children giving the correct response	% HI children giving the correct response	Nr LA children giving the correct response	% LA children giving the correct response	Nr AA children giving the correct response	% AA children giving the correct response
1 La palla è sotto il tavolo – SOTTO	12/13	92%	13/13	100%	13/13	100%
2 Il gatto è vicino alla sedia – VICINO	13/13	100%	13/13	100%	13/13	100%
3 La casa è dietro l'albero - **DIETRO**	11/13	85%	12/13	92%	12/13	92%
4 Corre giù – GIU'	13/13	100%	13/13	100%	13/13	100%
5 Il cane è dentro la macchina – DENTRO	13/13	100%	13/13	100%	13/13	100%
6 La palla è tra il tavolo e la sedia - **TRA**	13/13	100%	13/13	100%	13/13	100%
7 Il cane corre dalla casa all'albero – **DA-A**	12/13	92%	9/13	**69%**	9/13	**69%**
8 Il cane è sopra la sedia – SOPRA	13/13	100%	13/13	100%	13/13	100%
9 Il gatto è lontano dalla sedia – LONTANO	13/13	100%	13/13	100%	13/13	100%
10 Vola su – SU	12/13	92%	12/13	92%	12/13	92%
11 Il bambino è fuori – FUORI	13/13	100%	13/13	100%	13/13	100%
12 Il bambino è tra il babbo e la mamma- **TRA**	13/13	100%	13/13	100%	13/13	100%
13 Il cane è davanti alla cuccia – **DAVANTI**	12/13	92%	12/13	92%	12/13	92%
14 L'uccellino vola dalla casa al nido – **DA-A**	12/13	92%	12/13	92%	12/13	92%

Table 13.Number and percentage of hearing-impaired (HI), hearing children matched on linguistic age (LA) and hearing children matched on auditory age (AA) indicating the correct response on the first administration on each item.

Locative structures do not seem to be problematic for our hearing-impaired participants. They display a good performance also in item n.7 which contains a projective element and where both the hearing groups obtain only 69% of accuracy on the first administration.

Now, in Tables 13 and 14 all errors produced by HI and LA participant are presented together with their score[37]. The letters (A, B, C and D) accompanying the error score represent the picture/s indicated by the subject considered. Letters correspond to images as follows:

A	**B**
C	**D**

Hearing-impaired children results are shown below:

	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**
1 La palla è sotto il tavolo		0,5 B											
2 Il gatto è vicino alla sedia													
3 La casa è **dietro** l'albero	0,5 C		0,5 B										
4 Corre giù													
5 Il cane è dentro la macchina													
6 La palla è **tra** il tavolo e la sedia													
7 Il cane corre **da**lla casa **a**ll'albero	0,5 B												
8 Il cane è sopra la sedia													
9 Il gatto è lontano dalla sedia													
10 Vola su	1,5 A C												
11 Il bambino è fuori													
12 Il bambino è **tra** il babbo e la mamma													
13 Il cane è **davanti** alla cuccia										0,5 D			
14 L'uccellino vola **da**lla casa **a**l nido		0,5 D											

Table 13. Error scores for each item obtained by hearing-impaired children in locative structures.

[37] AA subjects' results are not displayed because of redundancy reasons. However, we will report and discuss any relevant detail.

In Table 14 there are hearing (LA) children results:

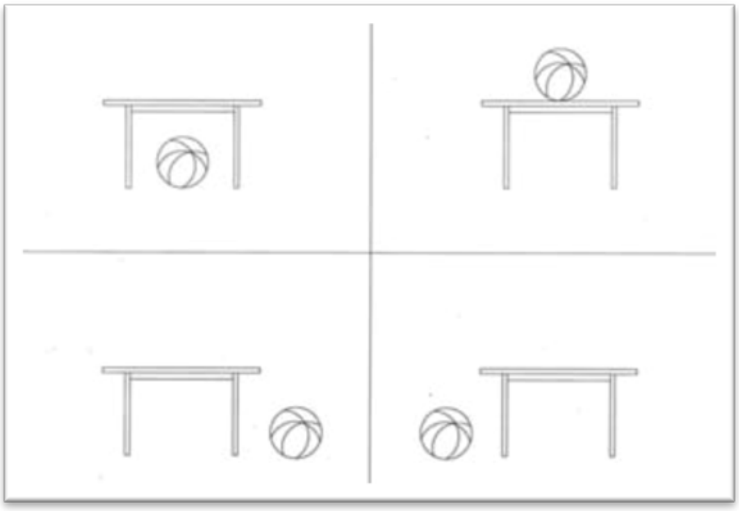
	HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H10**	**H11**	**H12**	**H13**
1 La palla è sotto il tavolo													
2 Il gatto è vicino alla sedia													
3 La casa è **dietro** l'albero	0,5 B												
4 Corre giù													
5 Il cane è dentro la macchina													
6 La palla è **tra** il tavolo e la sedia													
7 Il cane corre **da**lla casa **a**ll'albero	0,5 B	0,5 B	0,5 D						0,5 B				
8 Il cane è sopra la sedia													
9 Il gatto è lontano dalla sedia													
10 Vola su	1,5 A B												
11 Il bambino è fuori													
12 Il bambino è **tra** il babbo e la mamma													
13 Il cane è **davanti** alla cuccia	0,5 A												
14 L'uccellino vola **da**lla casa **a**l nido	0,5 D												

Table 14. Error scores for each item obtained by hearing children in locative structures.

According to premises, only a few errors were made in locative structures. D1, D2 and H1 obtained the highest scores. In particular, D1, who is 7;9, obtains a partial error score of 2,5 which represents the mean achieved by children a few years younger. Besides, the score of D2, the oldest participant (10;8 years old), corresponds to the mean performance of 6;6 years old children.

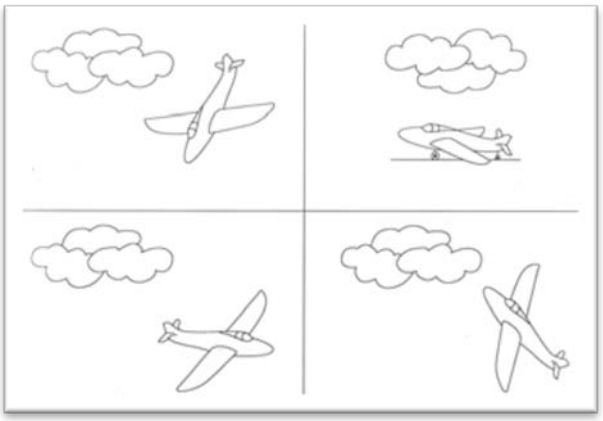
Analysing errors, it results that D1, D2 and H1 fail on two topological structures even if they are supposed to be the simplest sentences of the test. In particular, D2 misses the item n.1 ('*La palla è sotto il tavolo'*- '*The ball is under the table'*) selecting the figure B, that is the one where the ball is *on* the table. He demonstrates thus some uncertainties with prepositions. However, since he corrects his choice on the second administration and he shows no doubts on the contrasting item n.8 ('*Il*

cane è sopra la sedia'- 'The dog is on the chair') we can consider the response as a lack of attention.

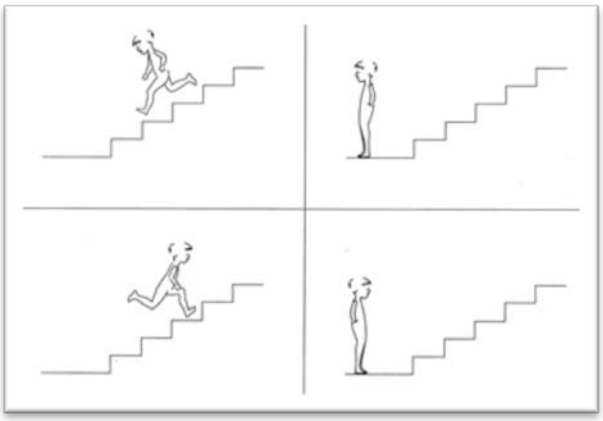


Item n.1 'La palla è sotto il tavolo'

The other error is registered in item n.10 '*Vola su'* ('(*It*) *flies upwards'*) and it is made by D1 and both his LA (H1) and AA (H16) controls. The error is produced twice by all of them. Interestingly, they all indicate picture A, which is the lexical distractor, whereas after that D1 and H16 select picture C, where the plane is flying straight (neither upwards nor downwards), while H1 choses picture B which depicts a steady plane and so it does not even represents the verb 'to fly'. Considering that the lexical comprehension of the terms appearing in the test is verified before or even during the test itself we can only hypothesize distraction or a problem with the codification of the adverb. No mistakes were made in item n.4 ('*Corre giù*'- '(*He*) *runs downwards'*) which tests the same contrast.

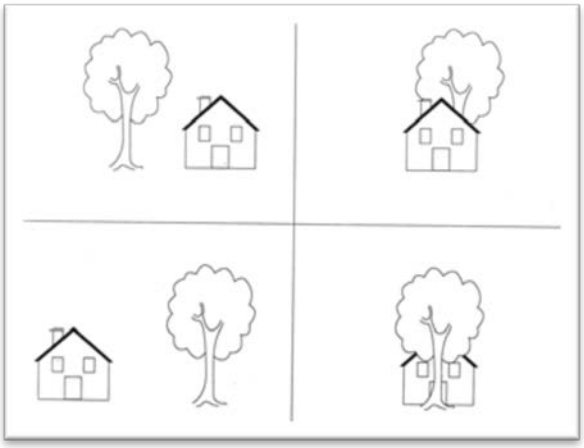


Item n.10 'Vola su'

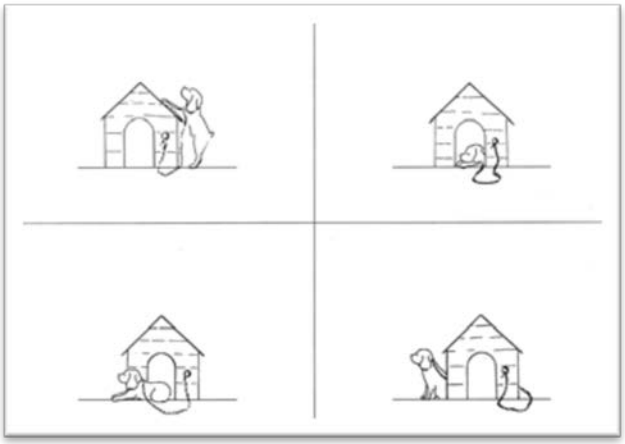


Item n.4 'Corre giù'

All other errors in locative structures concern projective typology and in particular item n. 3, 7, 13 and 14. Interestingly, these errors coincide with the *dietro/davanti* (‘*behind/in front of*’) and *da-a* (‘*from-to*’) contrasts. Concerning item n.3, D3 indicates the grammatical distractor represented in picture B which is the same pointed by H1 and H16. D1, instead, choses picture C. In this case, for the former group it is possible to suggest a comprehension driven by event probability since a tree behind a house is more usual than the opposite while it is probable that D1 interprets the sentence according to the linear order of the words, that is he looks for the graphic correspondence of the elements in the clause (*house – tree)*, ignoring the preposition. However, these errors, as long as D10’s one in item n.13, can be considered as distractions. In fact, the three children correct their response on the second administration.

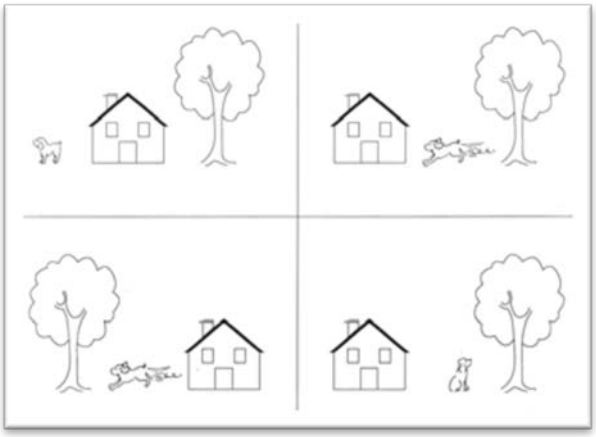


Item n. 3 ‘La casa è dietro l’albero’

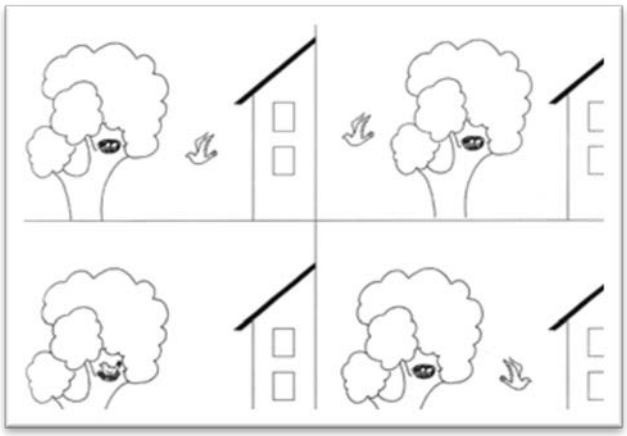


Item n. 13 ‘Il cane è davanti alla cuccia’

Items n.7 (‘*Il cane corre dalla casa all’albero’ – ‘The dog runs from the house to the tree*’) and 14 (‘*L’uccellino vola dalla casa al nido’ – ‘The bird flies from the house to the nest*’), which contain the locative *da-a*, do not seem to be particularly problematic for cochlear-implanted children. In total, they make two errors only in these items and both of them are corrected on the second administration. A greater number of hesitations is found, instead, in typically developing children’s performances which confirm that the two graphic representation of the sentences imply different degree of perceptive clues, as highlighted by Chilosi and colleagues.



Item n.7 'Il cane corre dalla casa all'albero'



Item n.14 'L'uccellino vola dalla casa al nido'

6.4.2.2 Inflectional structures

In Table 16, the number and percentage of correct items scored by hearing-impaired, LA and AA children on each item are presented. Both 0,5 and 1,5 errors are considered.

ITEM	Nr HI children giving the correct response	% HI children giving the correct response	Nr LA children giving the correct response	% LA children giving the correct response	Nr AA children giving the correct response	% AA children giving the correct response
15 Sedie – PLUR. NOM.	13/13	100%	13/13	100%	13/13	100%
16 Bambino – MASC.	13/13	100%	13/13	100%	13/13	100%
18 Cane – SING. NOM.	13/13	100%	13/13	100%	13/13	100%
19 Camminano – PLUR. VERB.	13/13	100%	13/13	100%	13/13	100%
21 Maestra – FEM.	12/13	92%	13/13	100%	13/13	100%
22 Il bambino fa il bagno – PRES.	13/13	100%	13/13	100%	13/13	100%
23 Vola – SING. VERB.	11/13	85%	10/13	**77%**	11/13	85%
24 Il loro cane – POSS. PLUR.	13/13	100%	13/13	100%	13/13	100%
27 Il gatto ha saltato – PAST	10/13	**77%**	10/13	**77%**	12/13	92%
28 La sua mamma – POSS. SING.	12/13	92%	9/13	**69%**	10/13	**77%**
30 Il gatto salta – PRES.	13/13	100%	12/13	92%	12/13	92%
33 Il suo cane – POSS. SING.	12/13	92%	12/13	92%	12/13	92%
35 La loro mamma – POSS. PLUR.	13/13	100%	13/13	100%	12/13	92%
38 Il bambino ha fatto il bagno – PAST	12/13	92%	13/13	100%	13/13	100%
49 Il bambino disegnerà – FUT.	7/13	**54%**	10/13	**77%**	9/13	**69%**
56 Il bambino farà il bagno – FUT.	11/13	88%	12/13	92%	10/13	77%

Table 16. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

HI children exhibit an overall good performance on this sentence typology. Anyway, verbal tense inflection seems to create them some difficulties. In particular, items n. 27 on past tense inflection and n.49 on future tense obtain low levels of accuracy (77% and 54% respectively). Tables 17 and 18 below will help us to investigate the reasons why cochlear- implanted children fail to interpret correctly these structures (and a few more too).

	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D 10**	**D 11**	**D 12**	**D 13**
15 Sedie													
16 Bambino													
18 Cane													
19 Camminano													
21 Maestra	0,5 A												
22 Il bambino fa il bagno													
23 Vola						0,5 A			0,5 A				
24 Il loro cane													
27 Il gatto ha saltato						0,5 D				0,5 D		0,5 D	
28 La sua mamma	1,5 A A												
30 Il gatto salta													
33 Il suo cane	0,5 A												
35 La loro mamma													
38 Il bambino ha fatto il bagno										0,5 D			
49 Il bambino disegnerà	1,5 B B	0,5 D	1,5 B D		0,5 C		1,5 C C	0,5 B					
56 Il bambino farà il bagno	0,5 D				0,5 C								

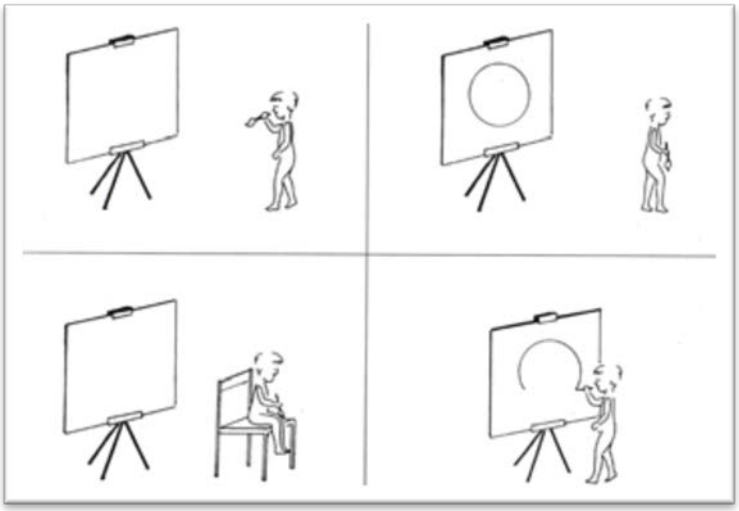
Table 17. Error scores for each item obtained by hearing-impaired children in inflectional structures.

	LA HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H10**	**H11**	**H12**	**H13**
15 Sedie													
16 Bambino													
18 Cane													
19 Camminano													
21 Maestra													
22 Il bambino fa il bagno													
23 Vola		0,5 A	0,5 A		0,5 A								
24 Il loro cane													
27 Il gatto ha saltato	0,5 D		0,5 D	0,5 D									
28 La sua mamma	0,5 A	0,5 D							0,5 D			0,5 A	
30 Il gatto salta						0,5 B							
33 Il suo cane					0,5 A								
35 La loro mamma													
38 Il bambino ha fatto il bagno													
49 Il bambino disegnerà	0,5 B	0,5 D	0,5 D										
56 Il bambino farà il bagno								0,5 D					

Table 18. Error scores for each item obtained by LA hearing children in inflectional structures.

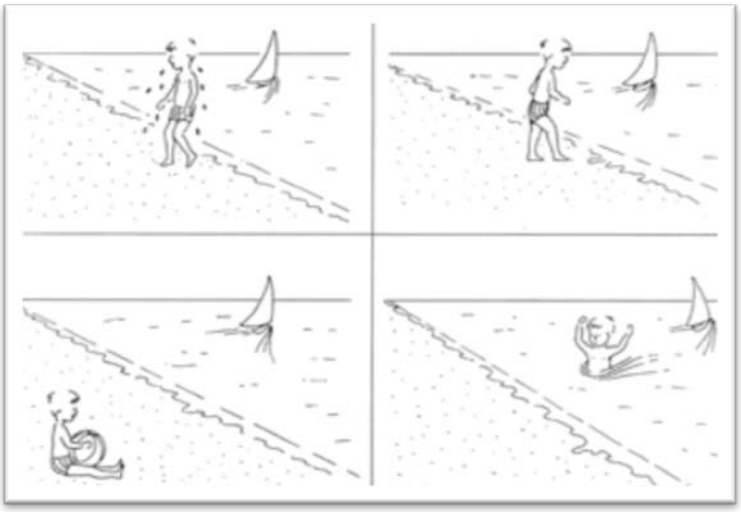
AA children show similar response patterns. The most significant remark concerns H16 obtaining the highest error score (3). His performance is comparable with that of the hearing-impaired children he is matched with (H1). In particular, they both show significant problems with future tense inflection.

In line with Chilosi and Cipriani's results, indeed, the item n.49 on future inflection is the most complex: 6 hearing-impaired and 6 hearing children (from both LA and AA groups) miss it. Interestingly, the overall pattern of response is rather variable insomuch as a specific interpretative strategy is not easy to detect.



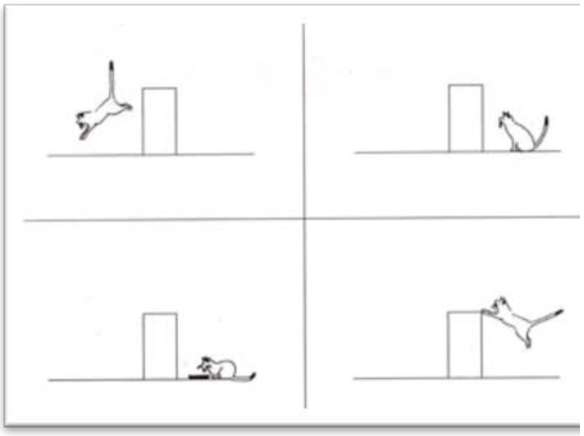
Item n.49 'Il bambino disegnerà'

However, analyzing the verb in item n.49 and the one in item n.56, where only a few errors occurred, it is possible to relate the asymmetry between the two future sentences to the different verbs they contain. In particular, *disegnare* is a monovalent verb (in this case) which, therefore, does not require additional arguments and encompasses a lexical meaning. In *fare*, instead, which is a bivalent verb in this sentence, lexical meaning is expressed by the internal object. The hypothesis, as commented by Grosselle (2008) would be that in verbs as *disegnare* children would focus on the lexical aspect taking no notice of the syntactic one. On the contrary, with the verb *fare*, readers are persuaded to continue the analysis in order to find the internal argument: this would trigger the syntactic analysis that influences the verbal tense comprehension too. Anyway, according to this idea, in item n.49 children should select a picture depending on the presence or not of the drawing action whatever its temporal representation is. Instead, 2 hearing-impaired participants select picture C where no correlations with the drawing action are implied. Interestingly, D5 indicates the picture lacking any temporal connection with the stimulus both in item n.49 and 56: the child stands still on the seashore with a ball in his hands in the former and he is sitting on a chair with a blackboard behind him in the latter. However, since D5 is correcting his choice on the second administration and his overall performance in inflectional structures is good these errors might be due to distraction.

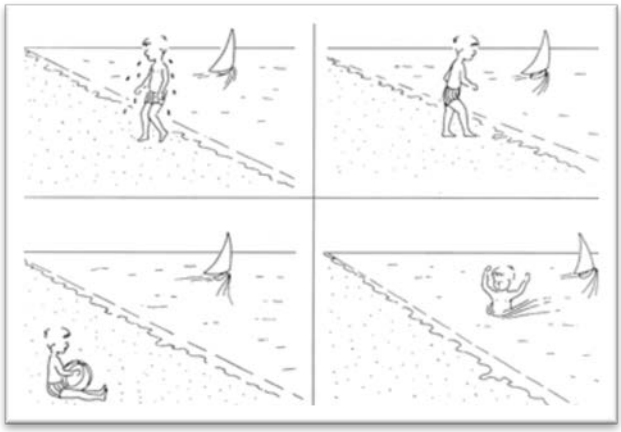


Item n.56 'Il bambino farà il bagno'

It is meaningful that the same asymmetry is found in past sentences too. That is, item n. 27 ('*Il gatto ha saltato'- 'The cat has jumped'*), which contains the intransitive verb *saltare,* results more complex than the transitive verb *fare* in item n.38 ('*Il bambino ha fatto il bagno' – 'The child has had the bath'*). In addition to the considerations we have seen about verb valence, we should contemplate the presence of the auxiliary in past tense forms. In fact, according to Grosselle, children succeed to make the correct temporal interpretation with bivalent verbs (*fare*) despite they do not seem to consider the auxiliary, while in monovalent verbs (*saltare*) the analysis of the auxiliary is crucial to evaluate verbal tenses. Considering that deaf population's difficulties with auxiliary verbs (both in comprehension and production) have been noticed in different studies (Franchi, 2003/2004; Chesi, 2006; Volpato, 2010) errors in sentences with monovalent verbs is therefore predictable in the hearing-impaired group.

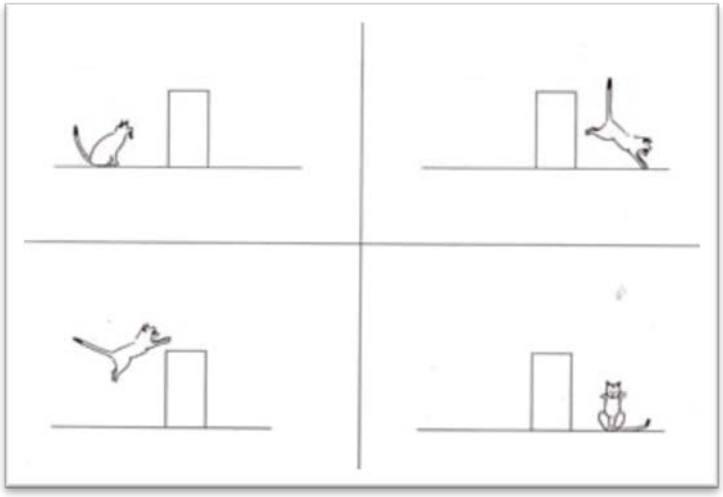


Item n.27 'Il gatto ha saltato'



Item n.38 'Il bambino ha fatto il bagno'

However, since the number of hearing and HI subjects choosing the incorrect picture in this item is the same, an additional account could be useful. For instance, analyzing errors it results that *all* children misinterpreting item n.27 select picture D. Hence, it is possible that subjects fail the right answer for reasons which are not connected to verbal valence. It will be suggested, instead, that the causes for this choice might be due to the pictures' ambiguity or maybe to the semantic features of the verb. Indeed, the pertinence of item n.27's pictures with the sentence has to be found in the fact that the action is accomplishing; in other words, a context where the cat is flooring after the jump is requested. In the traditional analysis of the target picture the cat's movement is conceived as a jump which starts from the floor, it passes the obstacle and it ends again on the floor where the animal is caught just before landing. But, if we would analyse the cat's jump as a movement which starts from the obstacle and finishes on the floor (a downward jump) the participants' choice of picture D would be correct too. Someone could say that the same ambiguity should be found also in item n.30 (*'Il gatto salta'- 'The cat jumps'*) which tests for present tense. In other words, if the picture ambiguity hypothesis is valid, some participants should select picture B where the cat jump from the obstacle- point of departure- to the floor. As a matter of fact, the only two errors (made by H6 and H16) are oriented toward picture B. Anyway, the pictures for item n.30 are a little bit different from item n.27. First of all, the cat in picture B touches the floor with its forelegs: this might drift away tested subjects from a *present* interpretation of the action in favor of a present perfect reading which would indicate a movement which is nearly concluded. Secondly, in the pictures of items n.27 and 30, the feline's movement has different directions (in the pictures where the cat jumps obviously), that is leftward and rightward respectively. It is possible that direction might perceptually affect interpretation. However, these conjectures should be proved.

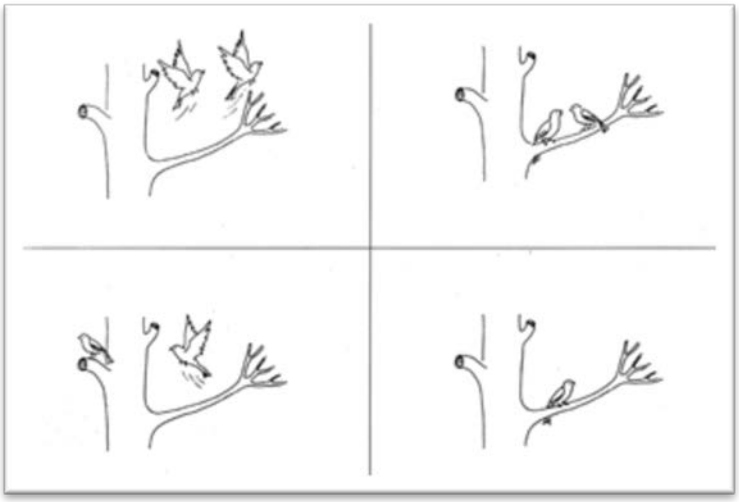


Item n.30 'Il gatto salta'

Even in items testing present tense inflection, no errors with the verb *fare* (item n.22-*'Il bambino fa il bagno' – 'The child has a bath'*) are produced, confirming the simplicity of this kind of structures. Certainly, it would be interesting to compare the performances on present, past and future tense inflections with couples of sentences such as:

Il gatto salta - Il gatto fa un salto	PRESENT
Il bambino disegna - Il bambino fa un disegno	
Il gatto ha saltato - Il gatto ha fatto un salto	PAST
Il bambino ha disegnato - Il bambino ha fatto un disegno	
Il gatto salterà - Il gatto farà un salto	FUTURE
Il bambino disegnerà - Il bambino farà un disegno	

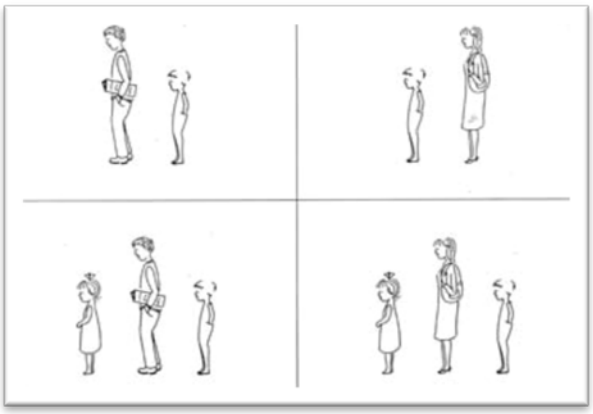
A few errors were made also in item n. 23 '*Vola*' ('(*It*) *flies*), testing singular verbal inflection. Interestingly, all the six subjects (2 from the HI group and 4 from the hearing groups) that misinterpret it, indicate picture A which is the grammatical distractor representing the plural inflection. However, according to Chilosi et al.'s normative data, 8 years old typical developing children reach an accuracy of 85% on this item. Considering both hearing and hearing-impaired groups' mean age we can say that their performances are in accordance with standard results. In any case, it is possible that the difficulty on this item is connected to the target picture, or better to perceptive reasons connected to it. It is just a suspect, actually, but what if the bird flew rightward in picture C? With no elements to analyze this hypothesis we can just forecast that errors are due to an immature competence on verbal inflections or maybe to distraction since all participants correct their choice on the second administration.



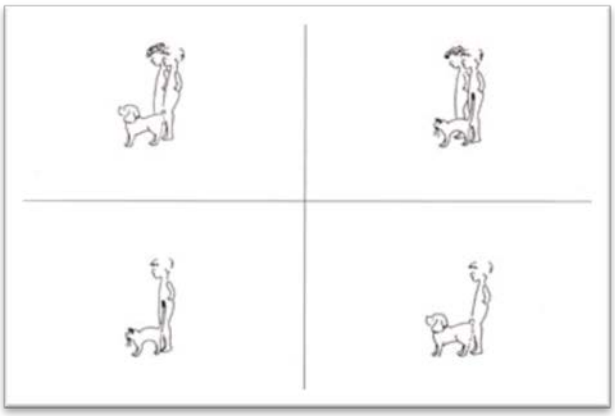
Item n.23 'Vola'

Among inflectional structures, also item n.28 '*La sua mamma*' ('*His mother'*) is found to be problematic for D1. Interestingly, he selects (twice) picture A, which does not reflect uncertainty with singular possessives but with feminine gender instead. Hearing children failing this item pointed either picture A or D.

In Item n.33 *'Il suo cane'* (*'His dog'*), instead, D1 confuses singular and plural possessives: he indicates picture A.

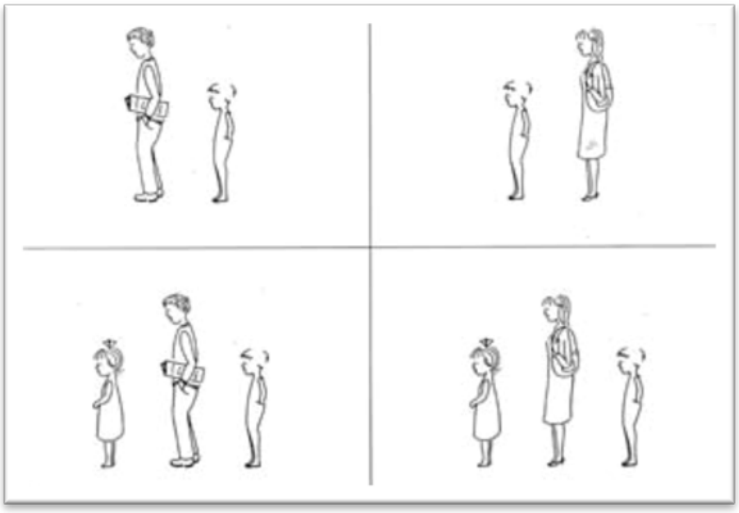


Item n.28 'La sua mamma'



Item n.33 'Il suo cane'

Finally, D1 fails the easy item n.21 '*Maestra*' ('*Teacher-Fem*') too. Since he chooses the picture A where the teacher is represented by a man and not by a woman it is possible to forecast that his gender inflection morphology is rather vulnerable.



Item n.21 'Maestra'

6.4.2.3 Active affirmative structures

In this section, we reports participants' results on active affirmative structures. In Table 19, hearing-impaired and hearing children performances are summarized. We remind that responses are considered correct here only when participants select the target picture on the first administration.

ITEM	Nr HI children giving the correct response	% HI children giving the correct response	Nr LA children giving the correct response	% LA children giving the correct response	Nr AA children giving the correct response	% AA children giving the correct response
17 La mamma lava – SV	12/13	92%	13/13	100%	13/13	100%
20 La bambina si pettina – SV RIFL.	12/13	92%	9/13	**69%**	11/13	85%
25 La mamma pettina la bambina – SVO PROB.	13/13	100%	13/13	100%	12/13	92%
29 Il gatto rincorre il cane – SVO NEUTRAL	9/13	**69%**	13/13	100%	13/13	100%
32 La mamma lava la bambina – SVO PROB.	13/13	100%	13/13	100%	13/13	100%
34 Il bambino imbocca la mamma –SVO IMPR.	12/13	92%	13/13	100%	13/13	100%
37 Il bambino spinge la bambina – SVO NEUTRA	12/13	92%	12/13	92%	13/13	100%
42 La macchina tira il camion – SVO IMPR.	13/13	100%	13/13	100%	13/13	100%
70 La palla colpisce il bambino – SVO I-A	12/13	92%	13/13	100%	12/13	92%
75 La carta brucia il bambino – SVO I-A	13/13	100%	11/13	85%	11/13	85%

Table 19. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

HI children performances are largely good except for item n.29 testing a neutral SVO structure. Even if 69% of accuracy corresponds to first responses only, that is no corrections on the second administration are counted, such a result is unexpected. We will investigate the reasons of these performances in the light of individual picture-selection illustrated in Tables 20 and 21 below.

	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D 10**	**D 11**	**D 12**	**D 13**
17 La mamma lava		0,5 B											
20 La bambina si pettina		0,5 C											
25 La mamma pettina la bambina													
29 Il gatto rincorre il cane	1,5 A C		0,5 C				0,5 C				0,5 C		
32 La mamma lava la bambina													
34 Il bambino imbocca la mamma						0,5 C							
37 Il bambino spinge la bambina	0,5 B												
42 La macchina tira il camion													
70 La palla colpisce il bambino		0,5 C											
75 La carta brucia il bambino													

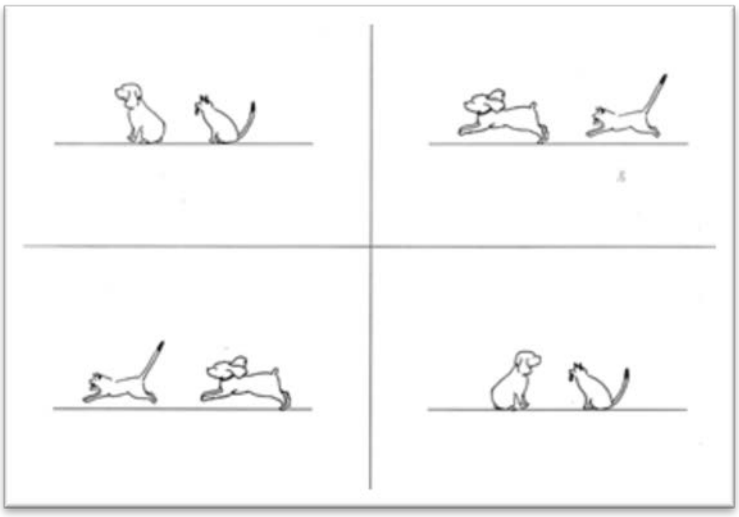
Table 20. Error scores for each item obtained by hearing-impaired children in active affirmative structures.

	HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H 10**	**H 11**	**H 12**	**H 13**
17 La mamma lava													
20 La bambina si pettina	0,5 C	0,5 C			0,5 C				0,5 C				
25 La mamma pettina la bambina													
29 Il gatto rincorre il cane													
32 La mamma lava la bambina													
34 Il bambino imbocca la mamma													
37 Il bambino spinge la bambina	0,5 B												
42 La macchina tira il camion													
70 La palla colpisce il bambino													
75 La carta brucia il bambino	0,5 B		1,5 B B										

Table 21. Error scores for each item obtained by hearing children in active affirmative structures.

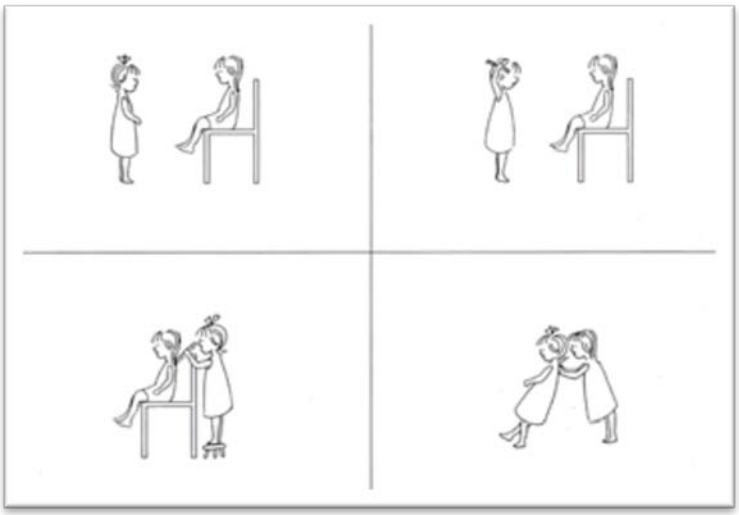
In item n.29 ‘*Il gatto rincorre il cane*’ (‘*The cat chases the dog*’), D1, D3, D7 and D11 indicate picture C where the agent and patient roles are reversed. Since this is a neutral SVO sentence, children cannot rely on event probability clues. Children interpretative strategy, then, is probably based on the linear word order. That is, they seems to read ‘cat’ and ‘dog’ and then look for a graphic correspondence. As a matter of fact, picture C is the only one representing the cat on the left and the dog on the right (we could verify this hypothesis by testing pictures with rightward chasing). Interestingly, only HI children miss this item. However, at the second administration D3,

D7 and D11 answer correctly while D1 indicates picture A where both the cat and the dog are not moving at all.



Item n.29 'Il gatto rincorre il cane'

Unlike many hearing children, HI subjects do not exhibit any difficulties with the reflexive sentence '*La bambina si pettina*' ('*The child*-FEM- *combs herself*') in item n.20. The only exception is D2 who, in the first administration, selects picture C suggesting a transitive interpretation of the reflexive verb.

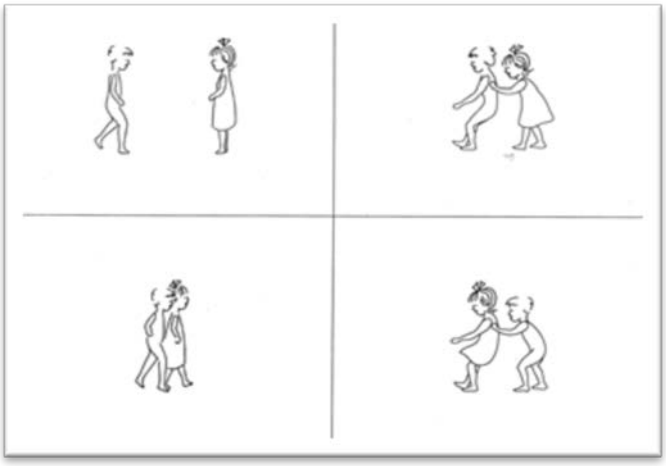


Item n. 20 'La bambina si pettina'

Subject D2, makes an error in item n. 17 too. In this structure the verb *lavare* (*to wash*) occurs without direct object but an argument is necessarily implicit. Anyway, if the correct interpretation considers the mother washing something , the reflexive interpretation is excluded. This is exactly D2's error (picture B).

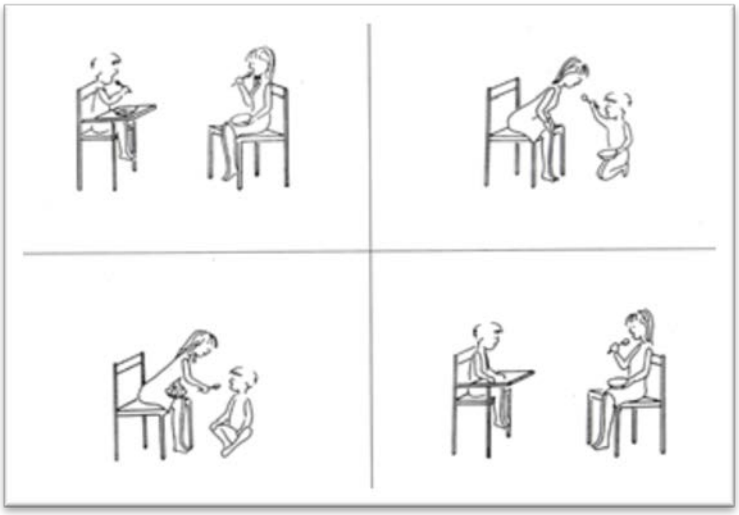
Item n.17 'La mamma lava'

D1 shows uncertainty in the other neutral active affirmative structure too, that is item n.37 '*Il bambino spinge la bambina*' ('*The boy pushes the girl'*). Also in this case his interpretation seems to be guided by the linear order of constituents. The same strategy seems to be adopted by his matching LA control too.



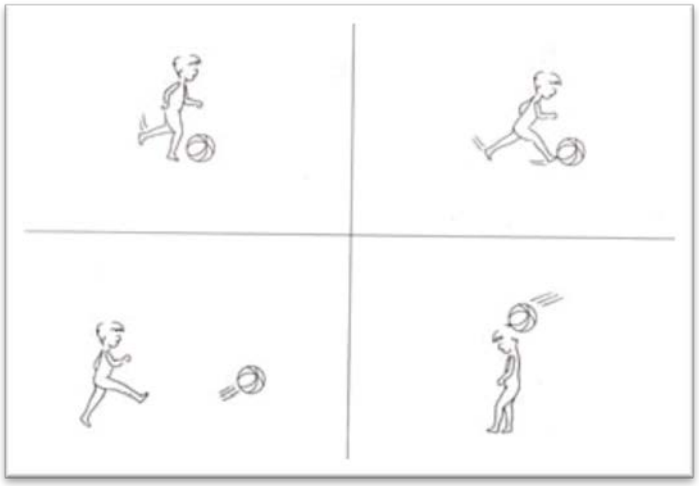
Item n.37 'Il bambino spinge la bambina'

Moreover, one subject, D6, misses the improbable SVO structure '*Il bambino imbocca la mamma*' ('*The child feeds the mother*'). He is probably influenced by logical-deductive factors which address him towards the more 'usual' situation represented in picture C where it is the mother who feeds the child.



Item n. 34 'Il bambino imbocca la mamma'

Finally, SVO structures with inanimate agent do not seem to create problems to cochlear-implanted children . The only error is made by D2 in item n.70 '*La palla colpisce il bambino'* ('*The ball hits the child'*). Since he selects picture C, where the thematic roles are reversed, we can assume that his interpretation is due to a lexical-semantic strategy that associates the role of agent of the action to the animate subject.



Item n. 70 'La palla colpisce il bambino'

6.4.2.4 Active negative structures

Results of active negative clauses are reported in Table 22 below.

ITEM	**Nr HI children giving the correct response**	**% HI children giving the correct response**	**Nr LA children giving the correct response**	**% LA children giving the correct response**	**Nr AA children giving the correct response**	**% AA children giving the correct response**
26 Il bambino non dorme – SV	13/13	100%	13/13	100%	13/13	100%
36 La bambina non corre – SV	13/13	100%	13/13	100%	13/13	100%
44 Il gatto non mangia il pesce – SVO IRR. Abs. act.	13/13	100%	13/13	100%	13/13	100%
48 Il bambino non mangia la minestra – SVO IRR. Obj. alt.	11/13	85%	10/13	**77%**	9/13	**69%**
53 La bambina non spinge il bambino – SVO REV.	10/13	**77%**	8/13	**62%**	10/13	**77%**
68 Il babbo non bacia la mamma – SVO REV.	13/13	100%	6/13	**46%**	8/13	**62%**

Table 22. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

No significant difficulties seem to hinder hearing-impaired children's comprehension on this typology of structures . Anyway, in item n.53, cochlear implanted subjects do not reach the percentage of acquisition considered by Chilosi and Cipriani which requires the 85% of participants responding correctly. Also LA and AA children report low percentages. Moreover, it is interesting to note that HI children's group obtains higher accuracy both in item n.48 and 68 compared to the two groups of hearing controls. Table 23 and 24 tell us more about children responses. They will be analyzed in order to consider the possible decoding strategies and interferences which can affect the correct interpretation.

	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D 10**	**D 11**	**D 12**	**D 13**
26 Il bambino non dorme													
36 La bambina non corre													
44Il gatto non mangia il pesce													
48 Il bambino non mangia la minestra	1,5 D D			1,5 B D									
53 La bambina non spinge il bambino		1,5 B D			1,5 B A	1,5 A B							
68 Il babbo non bacia la mamma													

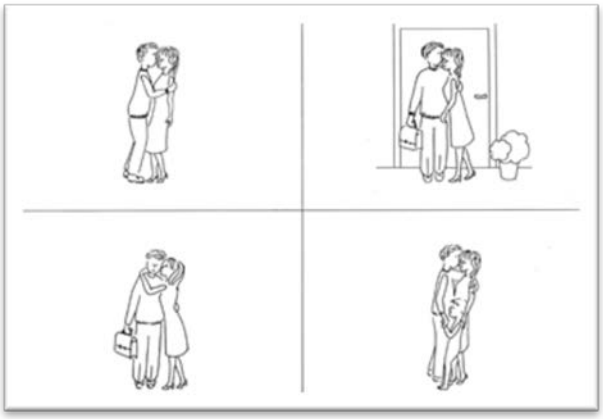
Table 23. Error scores for each item obtained by hearing-impaired children in active negative structures.

	HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H 10**	**H 11**	**H 12**	**H 13**
26 Il bambino non dorme													
36 La bambina non corre													
44Il gatto non mangia il pesce													
48 Il bambino non mangia la minestra	1,5 B D							0,5 A	0,5 A				
53 La bambina non spinge il bambino	1,5 B D			1,5 A D	0,5 B	1,5 B B	0,5 B						
68 Il babbo non bacia la mamma		1,5 B D	0,5 B	1,5 D D	0,5 D			0,5 A		0,5 D		0,5 D	

Table 24. Error scores for each item obtained by hearing children in active negative structures.

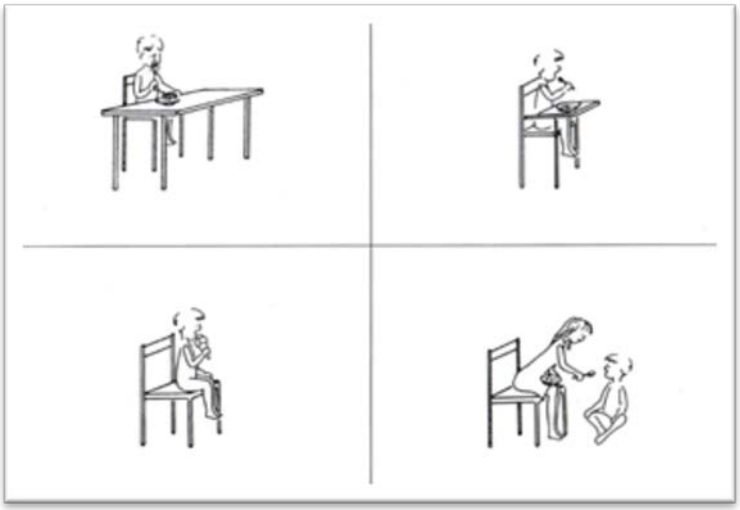
In line with Chilosi et al. data, SV sentences are the easiest and no errors are made by participants. A great amount of errors is found instead on item n.53 'La *bambina non spinge il bambino*' ('*The child-FEM does not push the child-MASC'*) a reversible SVO sentence where the target picture indicates a boy pushing a girl. 3 hearing-impaired children and 5 hearing children reveal a problem with negation. Most of them, in fact, cannot select the correct picture on the second administration neither. Their responses do not show a particular preference towards one picture: all grammatical distractors have been indicated. Apart from negation decoding, participants seem to be unable to identify the thematic roles of the referents, also because of the reversibility of the sentence which does not facilitate their assignment semantically. On the contrary, in item n.68 '*Il babbo non bacia la mamma*' ('*Dad does not kiss mum'*), where the two referents can be clearly identified, HI children do not make any errors. This item is the most problematic for both LA and AA hearing children instead.

Item n. 53 'La bambina non spinge il bambino'



Item n. 68 'Il babbo non bacia la mamma'

In addition to these reversible SVO sentences, some participants meet difficulties with the irreversible sentence of item n.48 *'Il bambino non mangia la minestra'* (*'The boy does not eat the soup'*). Here, the negation is represented graphically by a child eating something different than a soup; in other words, the object of the action is different. Children have to reason deductively in order to select the right picture. However, D1, D4, H1, H8 and H9 demonstrate their difficulty to do it properly.



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Item n.48 'Il bambino non mangia la minestra'

6.4.2.5 Affirmative passive structures

In Table 25, participants' correct responses on the first administration are summarized.

ITEM	Nr HI children giving the correct response	% HI children giving the correct response	Nr LA children giving the correct response	% LA children giving the correct response	Nr AA children giving the correct response	% AA children giving the correct response
40 La macchina è lavata dal bambino – SVA IRR. (actional v.)	13/13	100%	10/13	**77%**	10/13	**77%**
47 La mela è mangiata dalla bambina – SVA IRR. (actional v.)	13/13	100%	13/13	100%	13/13	100%
52 La bambina è vestita dalla mamma – SVA REV. PROB.	10/13	**77%**	13/13	100%	12/13	92%
55 Il cane è tirato dall'uomo – SVA REV. NEUTRAL	9/13	**69%**	11/13	85%	9/13	**69%**
58 Il bambino è spinto dalla bambina – SVA REV. NEUTRAL	9/13	**69%**	12/13	92%	13/13	100%
61 La mamma è presa in braccio dal bambino – SVA REV. IMPR.	10/13	**77%**	13/13	100%	12/13	92%
65 Il libro è letto dal bambino – SVA IRR. (stative v.)	12/13	92%	13/13	100%	13/13	100%
67 La bambina è pettinata dalla mamma – SVA REV. PROB.	11/13	85%	13/13	100%	12/13	92%
71 Il cane è morso dal bambino – SVA REV. IMPR.	6/13	**46%**	10/13	**77%**	11/13	85%
73 Il film è visto dal bambino – SVA IRR. (stative v.)	12/13	92%	12/13	92%	12/13	92%

Table 25. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

As expected, HI participants are not very accurate on passive structures. Reversible sentences result more complex than irreversible ones and the probability factor seems to highly influence interpretation. The reversible improbable passive sentence in item n.71, indeed, reaches 46%

accuracy only. No relevant differences are found instead between passive sentences with actional verb and with stative verb.

HI children's overall and partial performances are definitely worse than hearing controls.

Individual errors are reported in Tables 26 and 27.

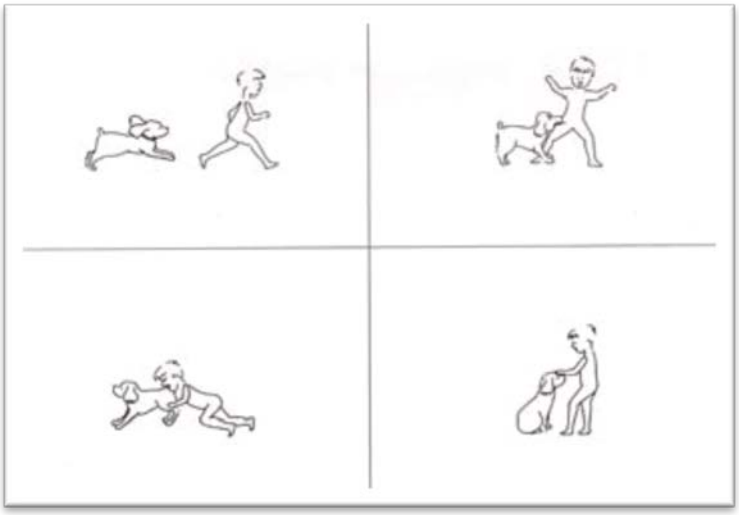
	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D 10**	**D 11**	**D 12**	**D 13**
40 La macchina è lavata dal bambino													
47 La mela è mangiata dalla bambina													
52 La bambina è vestita dalla mamma	1,5 C D	0,5 B	0,5 B										
55 Il cane è tirato dall'uomo		0,5 A	1,5 A B					0,5 A					0,5 A
58 Il bambino è spinto dalla bambina	0,5 D	0,5 D	0,5 D	0,5 D									
61 La mamma è presa in braccio dal bambino	0,5 B			1,5 B C					0,5 B				
65 Il libro è letto dal bambino	1,5 C D												
67 La bambina è pettinata dalla mamma		0,5 C	0,5 C										
71 Il cane è morso dal bambino	0,5 B	0,5 B	0,5 B	0,5 B		0,5 B		0,5 B	0,5 B				
73 Il film è visto dal bambino		0,5 D											

Table 26. Error scores for each item obtained by hearing-impaired children in affirmative passive structures.

	HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H 10**	**H 11**	**H 12**	**H 13**
40 La macchina è lavata dal bambino					0,5 B				0,5 B	0,5 B			
47 La mela è mangiata dalla bambina													
52 La bambina è vestita dalla mamma													
55 Il cane è tirato dall'uomo		0,5 A										0,5 A	
58 Il bambino è spinto dalla bambina	0,5 D												
61 La mamma è presa in braccio dal bambino													
65 Il libro è letto dal bambino													
67 La bambina è pettinata dalla mamma													
71 Il cane è morso dal bambino			0,5 B		1,5 B B			0,5 B					
73 Il film è visto dal bambino			1,5 B B										

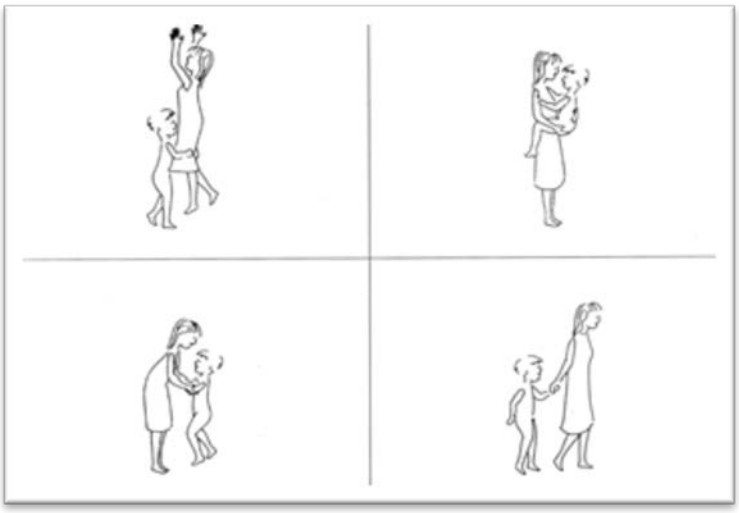
Table 27. Error scores for each item obtained by hearing children in affirmative passive structures.

Item n.71 *'Il cane è morso dal bambino'* (*'The dog is bitten by the child'*) is the most complex sentence among affirmative passives. 7 HI children in 13 and 3 hearing participants indicate picture B, that is the one where the dog bites the child. Essentially, this sentence is interpreted exactly as its active counterpart should be. In line with premises, cognitive expectations seem to strongly influence participants' selection. So, in this case, the probability clue (it is more probable that it is the dog that bites the child) is stronger than any syntactic element and this leads children to opt for the wrong picture.



Item n.71 'Il cane è morso dal bambino'

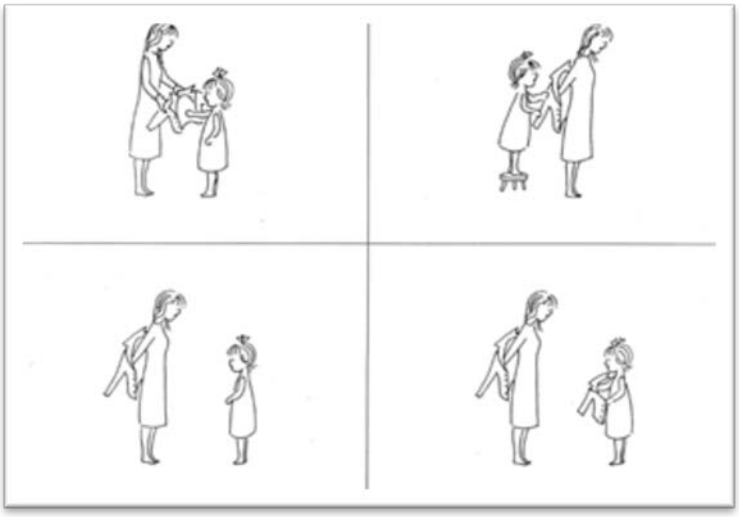
D1, D4 and D9 miss the other reversible improbable too ('*La mamma è presa in braccio dal bambino' – 'The mother is picked up by the child'*). In this case, they all select the picture representing the mother holding the child: this choice underlines a specific problem with the passive verbal construction. D7 misses the target picture on the second administration too. This time, he indicates picture C that represents the active version of the stimulus. Interestingly, no hearing children fail this item.



Item n.61"La mamma è presa in braccio dal bambino'

D1, D2 and D3 provide the wrong response in item n.52 too. It is a reversible probable passive sentence ('*La bambina è vestita dalla mamma*' - '*The child-FEM is dressed by the mum'*) and the

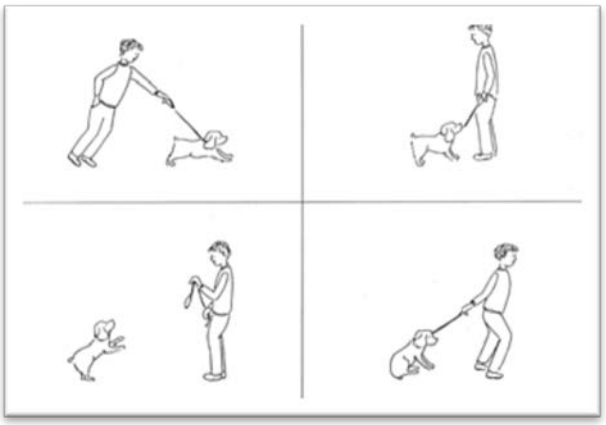
errors are unexpected here because of the semantic clues which supports the correct thematic role assignment. D2 and D3's selection of picture B may be due to its graphic correspondence with the linear order of the words in the sentence, or maybe to children's reliance on the linear default strategy that assign the agent role to the clause-initial NPs, that is the grammatical subject (we discussed of it in relation to children's acquisition of passive clauses in chapter 4, paragraph 3).
Subject D1 indicates pictures C and D which are not even grammatical distractors. It is evident that he is not able to derive the meaning of the sentence using functional words. On the contrary, his interpretation seems to be based on lexical words only.



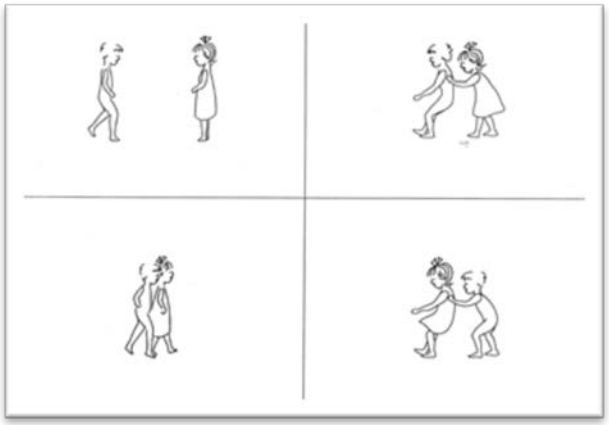
Item n.52 'La bambina è vestita dalla mamma'

Also reversible neutral passive structures create difficulties in comprehension. Item n. 55 ('*Il cane è tirato dall'uomo*' – '*The dog is pulled by the man*') is interpreted by 4 HI children and 4 hearing child as the equivalent active sentence '*The dog pulls the man'* (picture A). Even if the position of the subjects of the sentence respects graphically the linear word order children do not seem to rely upon this clue. Instead, despite the sentence is supposed to lack of any semantic clues, participants are probably guided by their expectancies. However, everyone except D3 choose the correct picture on the second administration.
In item n.58 '*Il bambino è spinto dalla bambina*' ('*The child-MASC is pushed by the child-FEM*'), 5 children (D1, D2, D3, D4 and H1) seem to make the same kind of analysis, that is, they consider the passive sentence as an active one. In fact, they all indicate picture D where agent and patient roles are reversed. Moreover, since in this case past participle disambiguates the patient role through phi-features agreement between the two, we can suggest HI children's lack of attention to

relevant morphological inflections (gender desinences, here). No errors were made on the second administration.



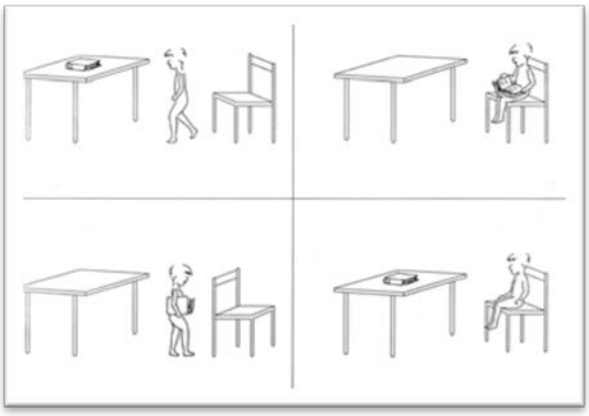
Item n. 55 'Il cane è tirato dall'uomo'



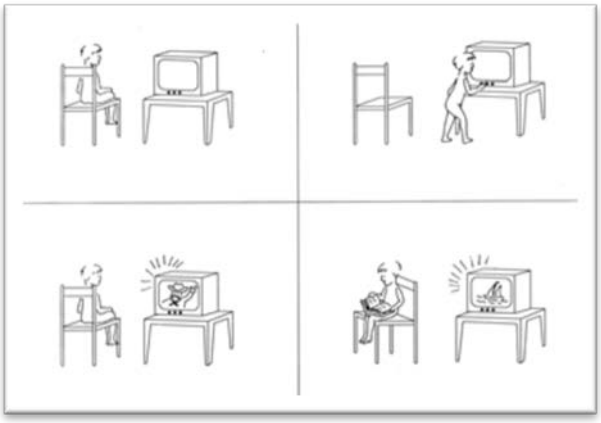
Item n. 58 'Il bambino è spinto dalla bambina'

Comparing children's results on items with action and stative verbs, no significant differences are found. However, a couple of errors are produced in passives with stative predicate. In particular, D1 misses item n.65 *'Il libro è letto dal bambino'* (*'The book is read by the child'*) on both administrations. As observed by Bertone and Volpato (2009), this error may be related to the difficulty (that many HI individuals show) to attribute the correct grammatical category to the inflected form of verbs when homophonic and homographic with other words, such as nouns. In this case, the confusion may originates from the word *letto*, which is both a past participle and a noun ('*bed*').

In item n.73 *'Il film è visto dal bambino'* (*'The movie is watched by the child'*), D2 indicates picture D. The sentence does not seem to be processed at all since the chosen picture is a distractor which does not include any correlation between the child and the movie. Otherwise, we can suppose a resultative reading of the passive (typical from children) which could generate an interpretation such as: the child has already seen the movie, *so*, he is not watching it again but he is reading a book, instead. The error can also be due to a simple lack of attention. The child point to the correct picture on the second administration, indeed.

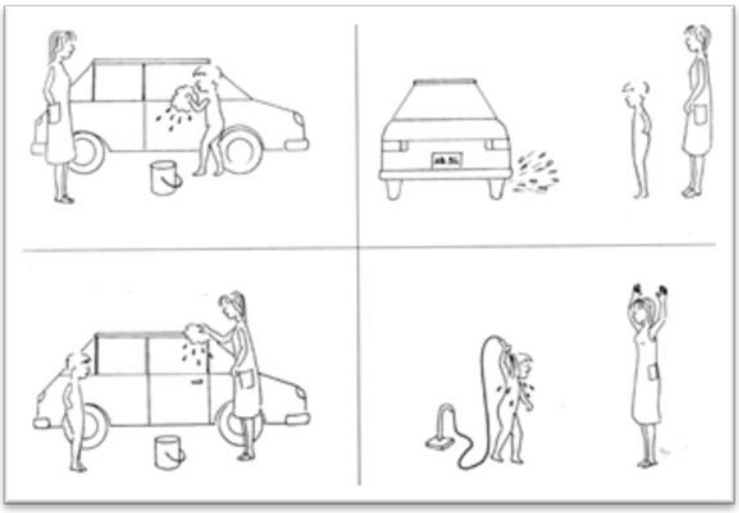


Item n. 65 'Il libro è letto dal bambino'



Item n.73 'Il film è visto dal bambino'

Finally, unlike control children, item n.40 '*La macchina è lavata dal bambino'* ('*The car is washed by the child*') is correctly comprehended by HI participants.



Item n.40 'La macchina è lavata dal bambino'

6.4.2.6 Negative passive structures

Table 28 below summarizes participants' results.

ITEM	Nr HI children giving the correct response	% HI children giving the correct response	Nr LA children giving the correct response	% LA children giving the correct response	Nr AA children giving the correct response	% AA children giving the correct response
57 Il cestino non è stato svuotato – SV	8/13	**62%**	10/13	**77%**	10/13	**77%**
59 Il pianoforte non è suonato –SV	13/13	100%	13/13	100%	13/13	100%
62 Il bambino non è spinto dalla bambina – SVA REV.	8/13	**62%**	9/13	**69%**	10/13	**77%**
63 La pipa non è fumata dall'indiano – SVA IRR. Abs. act.	12/13	92%	12/13	92%	13/13	100%
66 La mela non è presa dalla bambina – SVA IRR. Obj. alt.	12/13	92%	9/13	**69%**	11/13	85%
76 Il cane non è rincorso dal gatto – SVA REV.	10/13	**77%**	11/13	85%	11/13	85%

Table 28. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

Participants' percentages of accuracy on these structures are rather low. Certainly, the fact that sentences are only 6 should not be disregarded; however the difficulties of both groups of children with these items is undeniable. In particular, HI children fail on both reversible passive sentences and on a SV construction. Irreversible sentences, instead, do not cause them particular problems. In Tables 29 and 30 all errors are presented.

	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D 10**	**D 11**	**D 12**	**D 13**
57 Il cestino non è stato svuotato	1,5 B D	0,5 B	1,5 B D						0,5 B		0,5 B		
59 Il pianoforte non è suonato													
62 Il bambino non è spinto dalla bambina			0,5 A	0,5 A	0,5 A	0,5 A		1,5 A D					
63 La pipa non è fumata dall'indiano					0,5 A								
66 La mela non è presa dalla bambina	0,5 A												
76 Il cane non è rincorso dal gatto		0,5 A		0,5 D		0,5 D							

Table 29. Error scores for each item obtained by hearing-impaired children in negative passive structures.

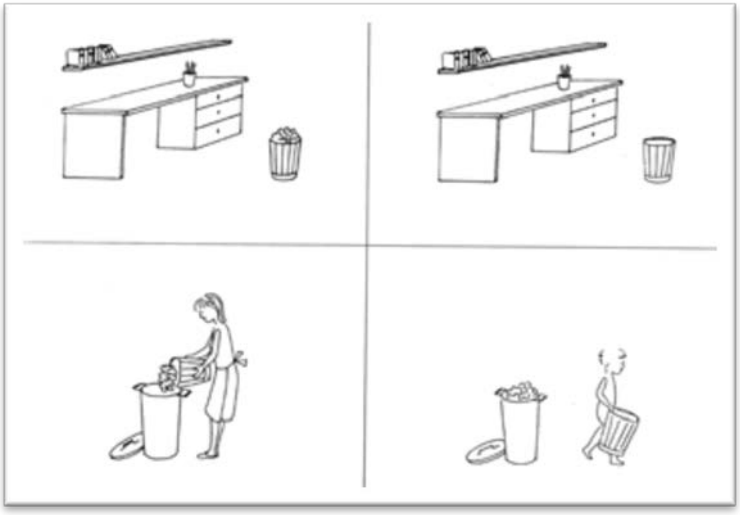
	HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H 10**	**H 11**	**H 12**	**H 13**
57 Il cestino non è stato svuotato	1,5 B C						1,5 B D						0,5 D
59 Il pianoforte non è suonato													
62 Il bambino non è spinto dalla bambina	1,5 C D			1,5 A D		1,5 C C		0,5 D					
63 La pipa non è fumata dall'indiano	0,5 C												
66 La mela non è presa dalla bambina	1,5 B D			0,5 B							1,5 B B		0,5 B
76 Il cane non è rincorso dal gatto	1,5 B D				0,5 B								

Table 30. Error scores for each item obtained by hearing children in negative passive structures.

The most difficult item is n. 62 '*Il bambino non è spinto dalla bambina*' ('*The child-MASC is not pushed by the child-FEM'*) which contains two referents that create difficulties in other structures too, as we have seen before. However, the two groups behave differently on response choice. For example, all implanted children select picture A, that corresponds to the affirmative version of the stimulus whereas hearing children have a more variegated response pattern. Maybe this item requires a cognitive load they are not ready to manage. They need to reason deductively in order to understand that the target picture is the one where the boy is not pushed but he is the actor himself of the action of pushing. 3 out of 4 hearing children and D9 fail this item twice.

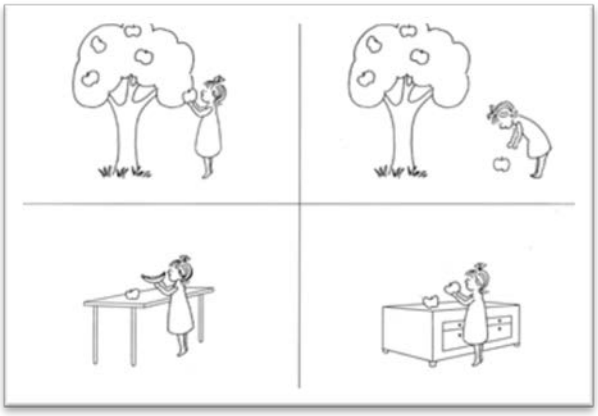
Item n.62 'Il bambino non è spinto dalla bambina'

Also in item n.57 '*Il cestino non è stato svuotato*' ('*The bin has not been emptied'*) many errors occurred: 5 children from the hearing-impaired group fail on the first administration and 2 subjects persist in indicating the wrong picture even on the second trial. In the hearing children group, 2 subjects score 1,5 whereas one child correct his error on the second chance. Within these groups, everyone except H13 indicates picture B, where the bin is empty. D1, D3 and H7 on the second administration and H13 on the first one select picture D, where the bin has just been emptied and finally H1 chooses picture C where the woman is emptying the bin. Evidently, children experience some difficulty to process negation: if the bin has not been emptied it means that it is full. Or, maybe, they completely ignore it.



Item n.57 'Il cestino non è stato svuotato'

Only one error is made in both irreversible sentences by HI children. In particular, D1 fails item n.66 ‘*La mela non è presa dalla bambina*’ (‘*The apple is not taken by the child-FEM’*) while D5 misinterprets item n.63 ‘*La pipa non è fumata dall’indiano’* (‘*The pipe is not smoked by the Indian’*). In the first case, the item is missed by D1’s linguistic-age matching control too. However, D1 and H1 select different pictures: letter A, the former, and both letters B and D, the latter. In all cases negation does not seem to be taken into account during interpretation. The same happens in item n.63 when D5 selects picture A.

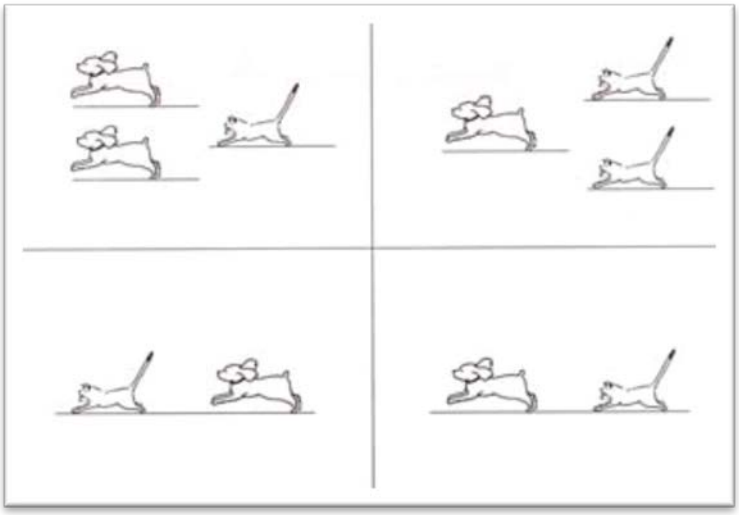


Item n.66 ‘La mela non è presa dalla bambina’

Item n.63 ‘La pipa non è fumata dall’indiano’

Finally, no errors are made by HI participants on item n.76 ‘*Il cane non è rincorso dal gatto*’ (‘*The dog is not chased by the cat*’). Even if (according to the TCGB’s creators) we considered that both cat and dog’s chasing is equally probable, it is possible that children are more tempted to assume that it is the dog that chases the cat. So, maybe the accuracy on this item may be due to its matching with children’s expectations.[38]

[38] On the contrary, the errors found on item n.29 may be due to the target picture’s mismatch with children’s expectations.



Item n.76 'Il cane non è rincorso dal gatto'

6.4.2.7 Relative structures

In Table 31, participants' results are reported.

ITEM	Nr HI children giving the correct response	% HI children giving the correct response	Nr LA children giving the correct response	% LA children giving the correct response	Nr AA children giving the correct response	% AA children giving the correct response
31 Il bambino rincorre la bambina che è in bicicletta – FIN OS	11/13	85%	8/13	**62%**	9/13	**69%**
39 Il bambino che è sul tavolo mangia la marmellata – EMB SS	13/13	100%	12/13	92%	12/13	92%
41 Il gatto salta sul topo che è sulla sedia – FIN OS	13/13	100%	12/13	92%	11/13	85%
45 La guardia che ha il fucile ferma il ladro – EMB SS	11/13	85%	9/13	**69%**	8/13	**62%**
50 Il topo che il gatto rincorre ha il formaggio in bocca – EMB SO	10/13	**77%**	9/13	**69%**	8/13	**62%**
60 Il babbo tiene il palloncino che il bambino rompe – FIN OO	12/13	92%	12/13	92%	13/13	100%
69 Il vaso che il bambino dipinge è sulla sedia – EMB SO	10/13	**77%**	10/13	**77%**	11/13	85%
72 Il cane morde la palla che il bambino colpisce – FIN OO	13/13	100%	13/13	100%	12/13	92%

Table 30. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

Despite relative clauses can be considered among the most complex structures in TCGB, cochlear-implanted children show good levels of comprehension on them. Their performance is more accurate that their linguistic-age and auditory-age matching controls. As expected, the most problematic typology of relative clauses are the SO embedded ones. In all other structures, at least 85% of participants respond correctly.

In Tables 31 and 32, response patterns are shown.

	HEARING-IMPAIRED CHILDREN												
ITEM	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D 10**	**D 11**	**D 12**	**D 13**
31 Il bambino rincorre la bambina che è in bicicletta	1,5 C D			0,5 A									
39 Il bambino che è sul tavolo mangia la marmellata													
41 Il gatto salta sul topo che è sulla sedia													
45 La guardia che ha il fucile ferma il ladro	0,5 A				0,5 A								
50 Il topo che il gatto rincorre ha il formaggio in bocca	0,5 A				0,5 A			0,5 A					
60 Il babbo tiene il palloncino che il bambino rompe			0,5 A										
69 Il vaso che il bambino dipinge è sulla sedia				0,5 A			1,5 A C				0,5 C		
72 Il cane morde la palla che il bambino colpisce													

Table 31. Error scores for each item obtained by hearing-impaired children in relative structures.

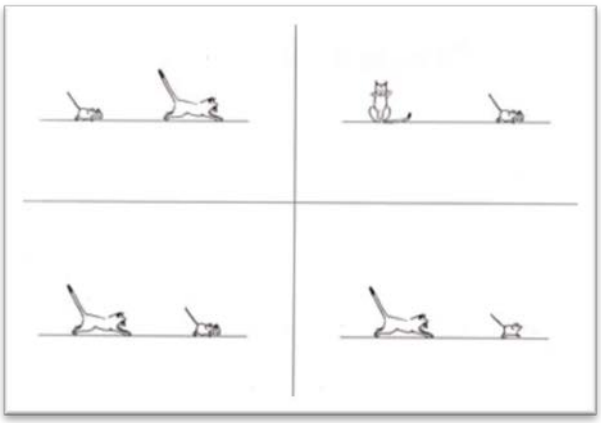
	HEARING CHILDREN												
ITEM	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H 10**	**H 11**	**H 12**	**H1 3**
31 Il bambino rincorre la bambina che è in bicicletta		1,5 C D			0,5 C		0,5 C	0,5 D	0,5 C				
39 Il bambino che è sul tavolo mangia la marmellata			0,5 B										
41 Il gatto salta sul topo che è sulla sedia		1,5 A C											
45 La guardia che ha il fucile ferma il ladro	0,5 A	0,5 D					0,5 A	0,5 D					
50 Il topo che il gatto rincorre ha il formaggio in bocca		0,5 A	1,5 A B				0,5 A			0,5 A			
60 Il babbo tiene il palloncino che il bambino rompe	0,5 A												
69 Il vaso che il bambino dipinge è sulla sedia	0,5 C					1,5 C C	0,5 C						
72 Il cane morde la palla che il bambino colpisce													

Table 32. Error scores for each item obtained by hearing children in relative structures.

As expected, most problematic structures are object relatives. In particular, item n.50 '*Il topo che il gatto rincorre ha il formaggio in bocca*' ('*The mouse that the cat chases has the cheese in its mouth*') is the most complex one. All but one subject misinterpreting this sentence indicate the grammatical distractor (picture A) where the mouse chases the cat. As observed earlier, their interpretation may rely on the correspondence of the word order in the sentence to the graphic position of the corresponding participants. In order to confirm this hypothesis it would be interesting to observe their selection with pictures representing the same subjects (the cat and the mouse) moving leftward. Anyway, everyone except H3 is able to indicate the target picture on the second administration.

Unlike Chilosi and al.'s data, which reported item n.69 ('Il vaso che il bambino dipinge è sulla sedia' – 'The bowl that the child paints is on the chair') to be the easiest among relative structures,

the hearing impaired children we tested do not reach the acquisition threshold in this item. Analysing error patterns, we observe that D7 and D11, as well as all hearing children missing the item, indicate picture C. They seem to ignore the relative clause completely: there are no representations of the verb of the embedded clause (*paints*) in picture C. D4 and D7 on the second administration, instead, select picture A. In this case, the distance between the subject and the verb of the main clause might have caused problems to the interpretation. The presence of one inanimate subject which put semantic restrictions on the interpretation probably helped them to identify the referents' grammatical role of the verb '*dipingere*' ('*to paint*') but the subject of the main clause cannot be inferred anyway. In terms of RM effect (examined in chapter 5), we could observe that in the syntactic representation of these children, the presence of the DP *il bambino* between the DP *il vaso* and its trace blocks the long-distance dependency between these last two elements.



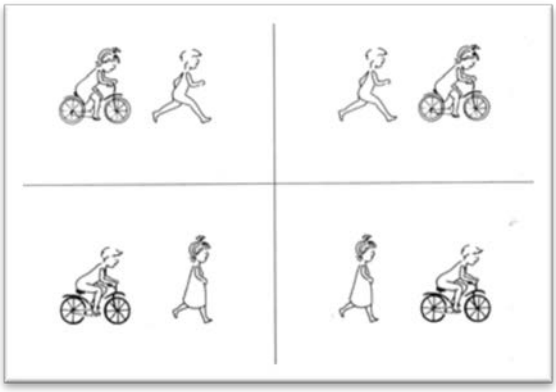
Item n.50 'Il topo che il gatto rincorre ha il formaggio in bocca'.

Item n.69 'Il vaso che il bambino dipinge è sulla sedia'.

Concerning embedded S/S relative sentences, only item n.45, '*La guardia che ha il fucile ferma il ladro*' ('*The guard who has the rifle stops the thief*'), seems problematic. D1 and D5 select the same picture as H1 and H7, that is picture A. They correctly interpret the agent and the patient of the verb *fermare* ('*to* stop') but they show no consideration for the relative clause which indicates that the guard has a rifle.

Item n.45 'La guardia che ha il fucile ferma il ladro'

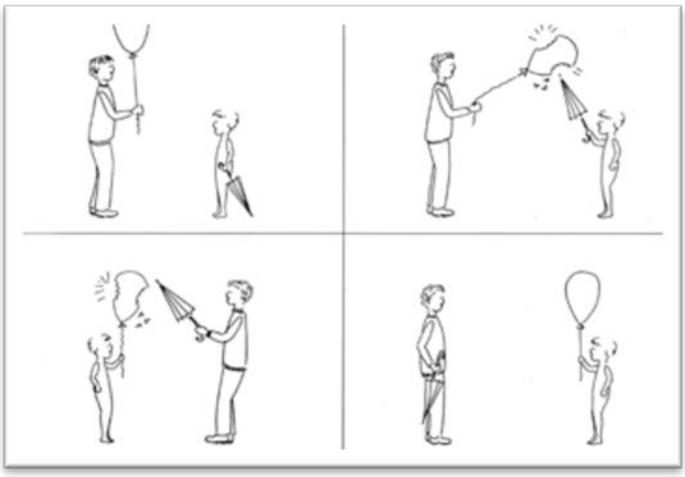
Concerning item n. 31 '*Il bambino rincorre la bambina che è in bicicletta*' ('*The child-MASC runs after the child-FEM who rides a bicycle*'), both D1 and D4 fail it. Anyway, they provide different responses. In particular, the former selects picture C and D (he gets wrong twice) whereas the latter points picture A and then the target one. We can observe that in picture C the boy is considered to be the subject of both the main and the relative clauses. The complementizer *che*, in fact, seems to be interpreted as a coordinate conjunction (i.e. '*The child-MASC runs after the child-FEM* ***and*** *(he) rides a bicycle'*). In picture D, instead, the two referents of the sentence are inverted ('*The child-FEM runs after the child-MASC that rides a bicycle'*). Finally, in picture A the relative clause seems correctly comprehended whereas the main clause is ignored from the analysis.



Item n.31 'Il bambino rincorre la bambina che è in bicicletta'

Finally, O/O relative clauses in final position prove to be the easiest, as expected. Only 2 errors were made in item n.60 '*Il babbo tiene il palloncino che il bambino rompe*' ('*The dad holds the balloon that the child breaks*') and no errors at all were found in item n. 72 '*Il cane morde la palla che il bambino colpisce*' ('*The dog bites the ball that the child hits*'). In item n.60 both D3 and H1

select picture A: they seem to stop reading after completing the main clause. As a result, the picture they chose represent only partially the meaning of the sentence.



Item n.60 'Il babbo tiene il palloncino che il bambino rompe'

6.4.2.8 Dative structures

Finally, participants' performance on dative structures are shown in Table 31:

ITEM	**Nr HI children giving the correct response**	**% HI children giving the correct response**	**Nr LA children giving the correct response**	**% LA children giving the correct response**	**Nr AA children giving the correct response**	**% AA children giving the correct response**
43 La bambina dà la cartella al bambino – AIA NEUTRAL	13/13	100%	12/13	92%	13/13	100%
46 La rondine porta il verme all'uccellino – AAA PROB.	13/13	100%	13/13	100%	12/13	92%
51 Il bambino porta il gatto al topo – AAA IMPR.	13/13	100%	11/13	85%	11/13	85%
54 Il babbo porta le sigarette al bambino – AIA IMPR.	13/13	100%	13/13	100%	13/13	100%
64 Il babbo mette le scarpe al bambino – AIA PROB.	13/13	100%	12/13	92%	9/13	**69%**
74 Il cane porta il maiale alla pecora – AAA NEUTRAL	12/13	92%	11/13	85%	11/13	85%

Table 31. Number and percentage of HI, LA and AA children indicating the correct response on the first administration on each item.

HI's participants comprehension on dative structure is almost perfect. The only error occurs in the sentence with three animate referents. LA and AA children's performance is much lower.

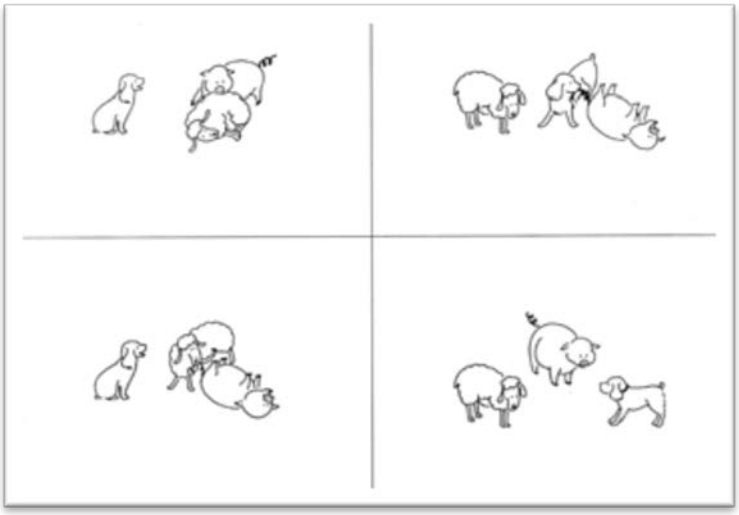
Now, after presenting children's error scores, individual responses will be considered. For convenience, relevant data will be represented together in the same Table[39].

	HEARING-IMPAIRED AND HEARING CHILDREN								
ITEM	**D1**	**H1**	**H2**	**H3**	**H4**	**H13**	**H14**	**H15**	**H16**
43 La bambina dà la cartella al bambino		0,5 D							
46 La rondine porta il verme all'uccellino									1,5 A C
51 Il bambino porta il gatto al topo				0,5 B		0,5 B			0,5 B
54 Il babbo porta le sigarette al bambino									
64 Il babbo mette le scarpe al bambino			0,5 A				0,5 D	0,5 D	0,5 D
74 Il cane porta il maiale alla pecora	1,5 A C		0,5 A		0,5 C				0,5 C

Table 32. Error scores for each item obtained by hearing-impaired and hearing children in active affirmative structures.

Since we are interested to HI children data only, we will analyze the only item that was found as problematic by a member of this group: item n.74 '*Il cane porta il maiale alla pecora*' ('*The dog brings the pig to the sheep*'). D1 associates this sentence to pictures A and C. Also in this case, his interpretation probably rely on linear-word order. That is , according to the order of appearance of the participants in the sentence he look for their representation in the picture, from left to right. Indeed, both in picture A and C the dog appears on the left while the other referents swap the agent and theme roles. Syntactic representation is totally neglected.

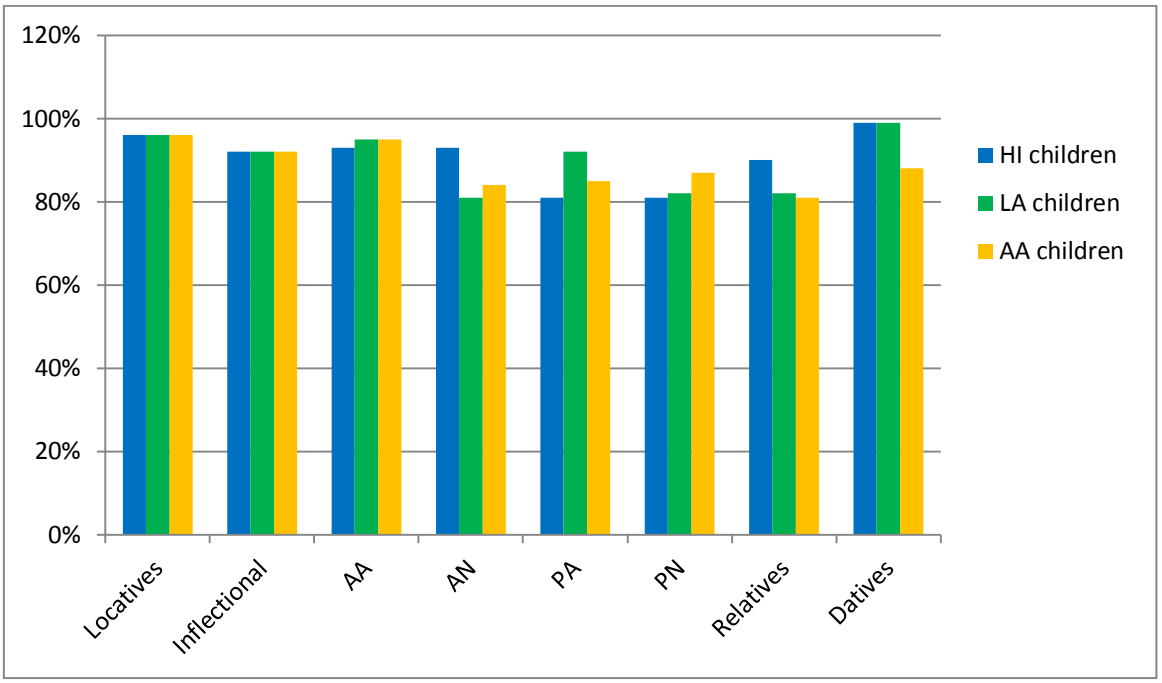
[39] This time all hearing-impaired children's error are displayed.



Item n.74 'Il cane porta il maiale alla pecora'

6.5 Discussion

The graph below summarizes the overall performances on each structure typology.



Graph 1. % of correct responses divided by sentence typology provided by HI children and LA and AA controls.

The present study confirms hearing-impaired children's difficulties to master some aspects of oral languages, Italian in this case. In particular, the cochlear-implanted children we investigated

through TCGB reported similar results to younger typically developing children. Their overall performance, thus, points out an expected delayed language acquisition. In particular, one linguistic construction seems to be the most difficult to master and it is passive construction. HI children's performances on it are even worse than younger controls' ones. On the contrary, they demonstrate better proficiency on relatives and negative active sentences.

HI participants' errors highlight difficulties with inflectional morphology and especially with past and future tense inflections. In sentence comprehension, they often seem to rely on lexical words only: they extrapolate words' meaning taking no notice of functional, semantically empty, elements. This is evident also in sentences which contain referents which can be disambiguated by morphological inflection only as it is the case for *bambino* and *bambina*. In sentences such as '*Il bambino non spinge la bambina'*, indeed, thematic role assignment is made harder both by the presence of the negation and by the attention subjects need to pay on nominal, disambiguating, morphology. In almost every item containing both the noun *bambino* and *bambina*, participants providing the correct response do not reach the 80%.

Most of the time, the hearing-impaired children we tested entrust their comprehension to their world knowledge and its corresponding expectancies. This could be the reason for such several errors committed in improbable sentences ('*Il cane è morso dal bambino'* is mistaken by more than half of implanted children during the first administration) or for the high accuracy on irreversible sentences ('*La mela è mangiata dalla bambina'*). On the contrary, when logical-semantic clues are not present, children make use of linear word order strategies, sometimes. For example, they attribute thematic roles according to their canonical order which is associated to different grammatical functions: in these cases, it is clear that children report poor performances in passive clauses, where the agent and patient/beneficiary order is inverted ('*La bambina è vestita dalla mamma'*). According to the linear word order of the sentences, besides, they sometimes seem to look for a linear graphic correspondence ('*Il gatto rincorre il cane'*).

Low performances in the item '*Il cestino non è stato vuotato*' are probably due to their need for perceptive-cognitive decoding in addition to syntactic analysis, which evidently on the whole is rather demanding.

Finally, embedded S/O relative structures are confirmed to be the most complex among relative clauses. Also in this case, the preferred interpretation strategy seems to concern linear word order.

In general, it is possible to outline a slightly delayed linguistic profile in HI children. However, a huge variability is reported among cochlear-implanted children's performances. As we discussed in chapter 3, this might be due to several factors. In order to help hearing-impaired children to

develop their linguistic competence in the most proficient way as possible is necessary to identify which of these factors are crucial in language acquisition.

7. Conclusions

The purpose of this study was to investigate the comprehension abilities of a group of cochlear implanted children. In order to evaluate whether and to which extent their linguistic development differentiates from typically developing children's one, we compared their performances with 2 control groups: one was matched on linguistic age and the other one on auditory age. In both of these groups, participants were younger than children of the hearing-impaired group.

Overall results reported that HI children's linguistic age is comparable to younger hearing children ones. However, error pattern analysis showed some interesting differences between the two groups. First of all, cochlear-implanted children obtained the lowest accuracy on passive sentences whereas hearing children experienced difficulties with negative (both active and passive) and relative clauses.

Concerning passive sentences, it results that HI children strongly rely on semantic clues during their interpretation. Both irreversibility and probability factors were found to be crucial for participants' performances. It is clear, however, that when a sentence expresses an unrealistic meaning, comprehension is seriously at risk. Syntactic analysis seems subordinated to world knowledge. Furthermore, in those cases where semantic clues are not provided, HI children made use of linear word order strategies to understand the sentence. Finally, no significant differences were found between passive clauses with actional and non actional verbs and no relevant conclusions can be drawn from performances on long and short passives either. Indeed, low accuracy on item n. 57 ('*Il cestino non è stato svuotato*') is probably justifiable with the presence of negation which increased sentence complexity.

As for relative clauses, cochlear-implanted children exhibited high accuracy. The only problems were found in embedded SO relative clauses. About 80% of HI participants fail on both item n.50 and 69. These data contrast with Chilosi and colleagues' results which reported item n.69 ('*Il vaso che il bambino dipinge è sulla sedia*') to be the first one to be acquired among relative structures. On the other hand, they are in line with most of the studies proving object relative clauses to be more complex than subject relatives. This asymmetry could be explained as a Relativized Minimality effect.

In all other structure types, HI children performances were pretty much equivalent to or better than those of matching typically developing children. The most remarkable results suggest difficulties with past and future inflections.

Finally, this study confirms the high variability of linguistic outcomes among cochlear-implanted children.

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