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**THE ACQUISITION OF RELATIVE CLAUSES AND PHI-
FEATURES: EVIDENCE FROM HEARING AND HEARING
IMPAIRED POPULATIONS**

**SETTORE SCIENTIFICO-DISCIPLINARE DI AFFERENZA:
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INTRODUCTION

This study originates from much existing cross-linguistic and psycholinguistic research on the comprehension and production of relative clauses by a variety of populations including children (for Italian, Adani 2008, Arosio, et al. 2005, Guasti & Cardinaletti 2003, Utzeri 2006, 2007; for French, Labelle 1990, Pérez-Leroux, 1995, Guasti & Cardinaletti 2003; for Hebrew, Arnon 2005; for Greek, Varlokosta & Armon-Lotem, 1998), adults (Utzeri 2007), children with specific language impairment (for Italian, Adani 2008; for Greek, Stavrakaki 2001, for Hebrew, Friedmann & Novogrodzky 2004, Håkansson & Hansson, 2000), and agrammatic patients (Garraffa & Grillo 2007). These properties have also been also studied in populations of hearing impaired individuals in Hebrew (Friedmann & Sztermann 2006), English (Quigley & Paul 1984, De Villiers, 1988), and French (Delage 2008). Unfortunately, no data have been found for Italian-speaking hearing-impaired children.

This study contributes to the debate by testing the ability of Italian-speaking hearing-impaired children fitted with a cochlear implant to comprehend and produce restrictive subject and object relative clauses, in order to determine whether and to what extent their performance differs from that of normal hearing children. In order to make the comparison as complete as possible, this study investigated the relevant properties of relative clauses also in other populations, including hearing-impaired adolescents using the Italian Sign Language (LIS, henceforth), and hearing children, adolescents and adults.

A comprehension task and a production task were elaborated following recent experimental research on the investigation of subject and object relatives (Friedmann & Novogrodzky 2004, Arnon 2005, Utzeri 2006, Adani 2008), in order to obtain a picture as detailed as possible of the underlying linguistic knowledge of hearing and hearing-impaired individuals, as far as the acquisition and development of relative clauses are concerned. These tasks developed for this study tested the different conditions in the right-branching relative clauses by manipulating number features on both the head and the embedded DP, thus

succeeding in obtaining a more accurate analysis of the performance of cochlear-implanted children.

Various conditions manipulating the number features on both DPs were created. The DPs were therefore both similar (match condition) and dissimilar (mismatch condition) in terms of number features. Cross-linguistic and psycholinguistic research on the role of phi-features in sentence comprehension showed that the salience of Number influences linguistic performance. Therefore, we will investigate how marked features may modulate the comprehension of relative clauses in the various populations.

The performance on the comprehension and production of relative clauses has been recently explained by approaches based on Relativized Minimality, a principle of locality, occurring in configurations like (55), and postulating that a relation between X and Y cannot be established if the intervening Z represents a potential candidate for the local relation:

(1) ...X...Z...Y...

Grillo (2005, 2008) and Garraffa & Grillo (2007) claimed that, in agrammatic patients, the underspecification of scope-discourse related features due to limited processing capabilities leads to Relativized Minimality effects. Adani (2008) adopted this approach to explain the difficulties experienced by Italian-speaking typically-developing children. For Hebrew-speaking typically-developing children, Friedmann et al. (2009) proposed instead that intervention effects arise when the intervener is lexically restricted (NP).¹

By combining theories on phi-features and these recent approaches based on Relativized Minimality (RM), we will investigate whether and how these approaches can also be adopted to explain the performance by hearing and hearing-impaired participants in the experiments that this work analyses. As we will see these approaches have to be integrated with the theories on phi-features

The organization of the study is as follows.

¹ We will examine these approaches in the course of the dissertation.

Chapter 1 offers a general overview of what hearing impairment is and which its implications are for the acquisition of an oral language by hearing-impaired individuals. This impairment is of sensory nature, and it drastically reduces the quantity and quality of linguistic input available to the hearing-impaired individual, hindering him/her from acquiring an oral language naturally. The level of linguistic competence they achieve depends on the interaction of a variety of clinical and personal factors, namely degree of hearing loss, prosthetic device used, age of intervention, parents' linguistic background, etc.

Chapter 2 presents the relevant properties of the structures proposed in the production and comprehension tasks. Restrictive subject and object relative clauses are complex structures that are derived through long-distance movement from the embedded subject and object positions. Stemming from much linguistic and psycholinguistic research on phi-features, the use of different combinations of number features in the elaboration of relative clauses was taken into consideration, in order to test how these morphosyntactic cues modulate the comprehension of relative clauses.

Chapter 3 shows how the experiment was constructed, namely the choice for administering both comprehension and production tasks, alongside with repetition tasks. All the various tasks included in the experiment are presented in detail, also including the tests investigating memory, which were adopted in order to verify whether the performance on the comprehension task may be influenced by low memory resources.

Chapter 4 presents the scores achieved by the different populations in the repetition (memory) tasks. The comparison between the various groups will be presented. These data will be used in the following chapter, in order to detect whether some correlations exist between memory and performance on the comprehension task.

Chapter 5 investigates in detail the comprehension of relative clauses by presenting three distinct comparisons. The first study compares the performance of the cochlear-implanted participants with that of language-matched hearing controls. The second study compares the performance of the LIS signers with that of a group of language-matched hearing children and a group of age-matched

hearing adolescents. The third study compares the performance of hearing children with that of hearing adolescents and adults. The analysis of data shows that in all groups, an asymmetry between subject and object relatives is detected. Hearing-impaired individuals (both cochlear-implanted children and LIS signers) significantly differ from younger hearing children in the comprehension of relative clauses. The type of responses provided in the different sentence conditions shows that the source of difficulty is different for the group of hearing-impaired individuals, as opposed to hearing participants. Attraction phenomena in terms of Kayne (1989) and the failed specification of number features on verbal morphology explained the performance of hearing-impaired children on object relatives. The recent proposal by Friedmann et al. (2009) is used instead to account for the performance of hearing children in the different combinations of number features. Following Guasti & Rizzi (2002) and Franck et al. (2006), we explain the difficulties found with some object relatives, namely those with post-verbal embedded subject, in terms of fragility of agreement between the sentence constituents.

The difficulties experienced by hearing children are also attributed to limited memory resources, resulted from correlation analyses between the performance in each sentence condition and repetition tasks.

Chapter 6 analyses the production of relative clauses by presenting two distinct comparisons. The first study compares the group of cochlear-implanted children with the group of language-matched hearing children. The second study compares the groups of hearing children, adolescents and adults. The use of two main strategies in the production of targeted object relative is investigated and is explained in terms of developmental processes involved in language acquisition.

Much research on relative clause comprehension demonstrated that children experience difficulties in correctly interpreting object relatives. Despite that, they do produce object relatives in eliciting production tasks (Utzeri 2006). On the other hand, adolescents and adults tend to turn the targeted object relatives into passive relatives (Carpenedo 2009, Utzeri 2006). By adopting an approach combining recent linguistic proposals in terms of locality and agreement by Collins 2005 (Smuggling), Guasti & Rizzi (2002), and Franck et al. (2006), we

will try to account for the performance of hearing and hearing-impaired participants.

CHAPTER 1

HEARING IMPAIRMENT AND ITS IMPLICATIONS

1.1 Introduction

Children acquire language spontaneously and effortlessly. They do this in a surprising way, and they are able to master completely the language to which they are exposed within a period of few years.

Children have innate language-specific abilities that allow language acquisition to take place in the first years of life during which environmental exposure is fundamental to stimulate this innate proclivity (Chomsky 1975, Pinker 1994). It is therefore necessary for this innate component to be stimulated within a period of time known as ‘critical period’¹, at the end of which it becomes more difficult to acquire a language naturally (Lenneberg 1967). Some cases of late exposure to the linguistic input have indeed confirmed the existence of such a sensitive period, as demonstrated by the story of Chelsea (Curtiss 1989). Chelsea was born deaf from hearing parents in a town in California, but doctors and clinicians did not recognize her disability and they diagnosed her as mentally retarded. Only when she was thirty-one her hearing loss was finally diagnosed, she was fitted with hearing aids and began linguistic training. However, despite the hard rehabilitation period she endured, linguistically, she was compared to a ten-year-old child: even if she acquired the vocabulary of the language she was exposed to and developed communication skills easily, her mental grammar remained quite underdeveloped, allowing her to produce only ungrammatical sentences.

Hearing impairment inevitably affects the normal development of speech and language acquisition, because of the drastically reduced quantity and quality of linguistic input available and accessible to the deaf person (Furth 1966). The

¹ Lenneberg (1967) posited the existence of a critical period, namely a span of time in which our brain is predisposed to build mental grammars, beginning around the age of two and ending with puberty. However, some researchers have recently proposed the existence of a ‘sensitive period’, for which the onset is gradual and the offset is incomplete (Tomblin et al. 2007). Actually, there appears to be more than one sensitive period, also depending on the linguistic component considered (morphology, phonology or syntax) (Guasti 2007).

difficulties that hearing-impaired people experience are essentially circumscribed to the domain of language and are accompanied by a normal development of all the other cognitive abilities.

Statistical analyses found that hearing impairment is among the most common disabilities of human beings. It has been estimated that over 70 million individuals in the world are hearing impaired with moderate to profound hearing loss. Approximately one out of 1000 children is born deaf (Maragna 2000, Govaerts et al. 2002, Fabbro 2003) and one out of 300 children is affected by hearing impairment to a different degree. Over half of early onset hearing loss and at least one third of late onset hearing loss are attributable to genetic factors (Nadol & Merchant 2001).

Hearing impairment is contemplated by Italian law (Law n. 381/1970 – Law n. 95/2006). Through these laws, the Italian state recognizes hearing impairment as the status of a person that suffers from hearing loss occurring at birth or in the course of age development, which compromises normal language development.

This chapter will introduce some general issues on hearing and hearing impairment. It further gives an overview on how the ear works and how some peculiarities of hearing impairment may affect language. A survey on how language is acquired in hearing impaired people will also be offered, with particular attention to the issue of language development by Italian hearing-impaired individuals.

1.2. The human ear

The functioning of the human ear is a complicated mechanism. The anatomy of the human ear is shown in the following figure.

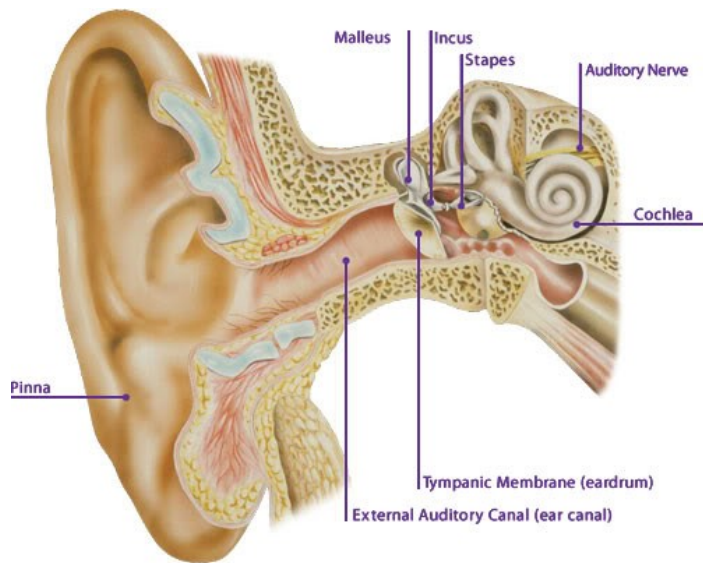


Figure 1: the ear²

The three main sections of the human ear are: the outer ear, the middle ear and the inner ear. Sound, which is transmitted as sound waves (vibration of the air), enters the outer ear (*pinna*), and reaches the eardrum after travelling through the external auditory canal. The eardrum is a delicate membrane that vibrates to sound waves, thus also causing the vibration of the three small bones behind it in the middle ear: the hammer (*malleus*), the anvil (*incus*) and the stirrup (*stapes*). The vibration waves in the inner ear fluid causes the sensory (hair) cells in the inner ear (*cochlea* - a snail-shaped organ) to bend. The hair cells convert sound vibrations into electrical signals. These electrical signals are transmitted through the auditory nerve up to the brain, where they are interpreted.

When lesions or damages to the ear occur, a person may suffer from hearing impairment, with strong consequences on the development of linguistic abilities. Basically, the factors that influence deaf individuals' language development are numerous and complex; among them are the age of onset of deafness and its detection, the severity of hearing loss, the age of first intervention, the parents' linguistic background and their choice on the approach

² This figure has been taken from the following website (downloaded on 11 October 2009): <http://media.photobucket.com/image/how%20the%20ear%20works/goodsires/ear2.jpg>

which makes it possible for the child to access linguistic input. In the next sections, we will examine in detail these factors.

1.3. Types of hearing impairment

Four types of hearing loss are identified, depending on the site where the lesion or the damage is localized:

1. Conductive hearing loss – it is caused by diseases or obstructions in the outer or middle ear. It usually affects all frequencies of hearing to the same degree and typically hearing impairment is moderate.
2. Sensorineural hearing loss – it results from damage to the sensory hair cells of the inner ear or the nerves which supply it. Hearing impairment may range from mild to profound. It does not affect all frequencies in the same way, namely certain frequencies are less affected than others.
3. Combined hearing loss – it is attributed to a combination of conductive and sensorineural losses and therefore the hearing deficit occurs in both the outer or middle and the inner ear.
4. Central hearing loss – it is the rarest type and it results from damage either along the pathways to the brain or in the brain itself.

Among the four types of hearing impairment, the most frequent form is the sensorineural one (Soi & Brambilla 2003).

1.4. Degree of hearing loss

Sound is measured by its loudness or intensity on a logarithmic unit called decibels (dB). Its frequency or pitch is measured in units called hertz (Hz).

Hearing is usually measured across a range of frequencies from 125 to 8000 Hz. It can be measured from -10 to 110 dB.

Hearing thresholds refer to audiological measurement of unaided hearing in the better hearing ear. According to the B.I.A.P. (Bureau International d'Audiophonologie), normal hearing and degree of hearing loss fall into the following categories:

- 0 dB – 26 dB normal hearing

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

The hearing threshold level (HTL) for each ear is graphed on an audiogram by plotting an individual's response threshold for each measured frequency. Here are two examples of audiograms, one for a person with normal hearing and one for a person with profound hearing loss³:

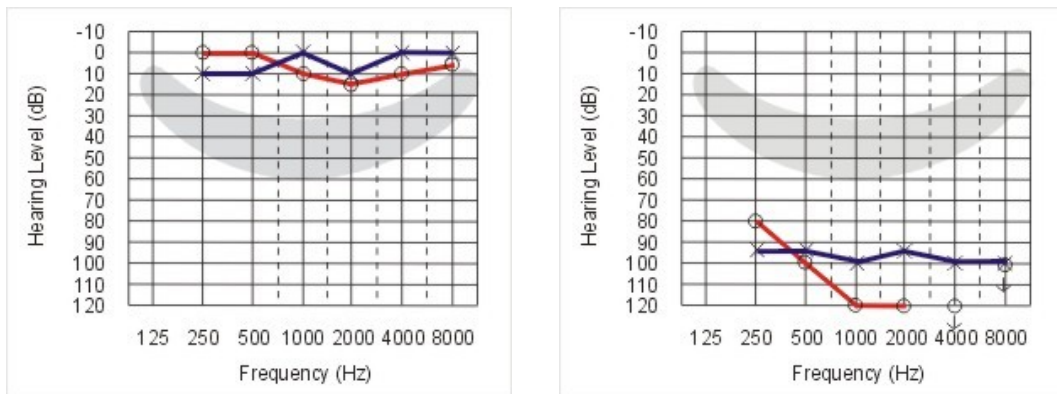


Figure 2: audiograms of a normal-hearing person (left) and of a hearing-impaired one (right)

The degree of hearing impairment is often represented as the average of the HTL for the three frequencies considered to be the most important for the reception of speech: 500, 1000 and 2000 Hz.

1.5. Types of prosthesis

Two prostheses are available for hearing impaired individuals in order to restore hearing: conventional hearing aids and cochlear implants. These two devices are different in their functions and use, also depending on the type and degree of hearing loss affecting the hearing-impaired individual. Conventional hearing aids are external devices helping hearing-impaired people to exploit their residual hearing. The cochlear implant is instead an auditory device that is surgically

³ The two audiogram examples are taken from: http://www.schooltrain.info/deaf_studies/audiology2/levels.htm. The blue line (x) identifies the left ear and the red line (o) identifies the right ear ((downloaded on 11 October 2009).

implanted in the inner ear (in the cochlea) and is activated by an external device, worn outside the ear. Conventional hearing aids and cochlear implants have different functions. The former usually amplifies sounds and performs much better in the coding of low sound frequencies, which contain mainly information related to tonality, musicality, timbre, etc. (temporal content). The latter stimulates the auditory nerve, thus allowing deaf individuals to receive sounds, and is mainly conceived to code the mid and high sound frequencies (spectral content), since speech information is mainly contained in these frequencies, but it is not suitable for music perception.

Individuals with sensorineural hearing loss may be fitted with either classical hearing aids (exploiting acoustic stimulation) or cochlear implants (exploiting electric stimulation). Classical hearing aids represent the best solution for hearing impaired individuals suffering from moderate and severe hearing losses, whereas cochlear implants are best suited for profound hearing impairment. Cochlear implants are argued to be the solely device making it possible for profoundly hearing-impaired individuals to “hear language”, reaching high levels of speech intelligibility. Various studies addressing the important issue of language acquisition in hearing-impaired individuals found that language in hearing-impaired children with a cochlear implant develops faster than in children without the cochlear implant (Blamey et al. 2001, Miyamoto et al. 1999, Svirsky et al. 2000, and Tye-Murray et al. 1995), in some cases, with linguistic performance comparable to that of normal-hearing children (Tomblin et al. 1999, Svirsky et al. 2000). For first language acquisition by English-speaking pre-lingually deafened children, cochlear implants have been proven to be much more efficient than hearing aids to enhance production skills (Kirk & Hill-Brown 1985; Parsier & Chute 1991; Chin & Pisoni 2000).

Steady acoustic and linguistic training is required for both the application of conventional hearing aids and cochlear implants

1.6. Age at onset of deafness

Onset of hearing loss is another important factor that may have consequences on the development of linguistic abilities.

Hearing impairment which is due to pre-birth causes is referred to as congenital and it can be genetically inherited or acquired during pregnancy. Hearing impairment may also occur after birth. In this case, if it occurs before the age of three, namely before oral language is acquired, it is referred to as pre-lingual. If it occurs after that period of time, it is defined as post-lingual. The distinction between pre-lingual and post-lingual deafness is crucial for the acquisition of the oral language. Although a child deafened, for instance, at the age of six and suffering from profound sensorineural hearing loss has the same degree of impairment as a child who suffers a congenital profound impairment, consequences on language development and communication are very different. Indeed, differently from pre-lingually deaf children, a child deafened after the age of three (in the case in point at the age of six) has had some auditory experience enabling him/her to access most properties of the oral language in a natural way. Therefore, post-lingual deafness makes it possible to develop oral first language normally.

1.7. The parents' background and approaches for language development

The hearing status of parents is a crucial factor that influences the form of language or communication to which the deaf child is exposed during infancy and early childhood. Depending on the linguistic background and on the educational philosophy of his/her parents, a hearing-impaired child may be exposed to linguistic input consisting of oral speech, sign language and/or some form of manually-coded language. At present, some possibilities available to make language accessible to deaf people are:

- the oralist method
- the sign language
- the bimodal method
- bilingual education

Hearing-impaired children born to hearing parents are mainly oriented towards an oralist approach. This approach exploits exclusively written and oral language modalities, without any use of signs. It aims at developing acoustic

training and lip-reading, by means of conventional hearing aids or cochlear implants.

Sign language is a visual-gestural language, which is considered a full-fledged linguistic system (Newport & Supalla 1999). It has the same degree of expressiveness and grammatical complexity as any other language in the world (Klima & Bellugi 1979). The development of grammar rules in sign language follows the same processes as acquisition of an oral language by hearing children. Indeed, hearing-impaired individuals who are exposed to sign language only at adulthood never perform as well as those who acquired it at very early stages of acquisition. Sign languages are the most natural languages of deaf communities. In Italy, hearing-impaired children born to hearing-impaired parents (only 5-10%) are exposed to the Italian Sign Language (LIS, henceforth) and can learn it naturally from their parents. On the other hand, deaf children born to hearing parents are hardly exposed to LIS and for them the oral education is mainly preferred. They might learn LIS from other deaf children when they enter school education.

The bimodal approach combines the oral and the visual-gestural modalities, but it fundamentally follows the grammar rules of the oral language (in the case in point, Italian) (Beronesi et al. 1991). Thus, words are accompanied by signs, keeping the word order of the oral language. Some invented signs supported by the fingerspelling alphabet are used to mark those functional elements that do not have an equivalent sign (i.e. articles, prepositions, plural markers, inflected morphemes).

The bilingual education involves the simultaneous exposure to both oral and sign language. Bilingualism is the knowledge and regular use of two or more languages. In the case of deaf children, it involves the simultaneous exposure to both oral and sign languages. The main assumption of this kind of approach is that deaf children acquire the sign language very easily, unlike what happens with an oral language. Bilingualism constitutes a great resource for hearing children speaking two oral languages. It is an even bigger richness for children with hearing loss. Indeed, it represents the only way for a deaf child to satisfy his/her own needs, that is, to be able to communicate early with his/her parents, develop

his/her cognitive abilities, acquire knowledge of the world, communicate and interact with both hearing and deaf people. The role and necessity of bilingualism is highlighted by a study carried out by Bertone & Volpato (2009), focussing on the linguistic competence and morpho-syntactic abilities of four hearing-impaired groups: a group of cochlear-implanted children, a group of native LIS signers, a group of non-native LIS signers and a group of foreign students speaking Italian as second language. The group of cochlear implanted children achieved the highest scores in comparison with the other three groups. However, among the other three groups, native LIS signers showed the best performance. An educational system combining both an oral and a signed approach would make it possible for a hearing-impaired child to fully develop the grammar of his/her own language.

1.8. The role of ‘clinical’ variables in language acquisition

Hearing-impaired children constitute a very heterogeneous group, with consistent inter-individual differences. As shown in the preceding sections, the factors that might influence hearing-impaired children’s language acquisition and development are numerous and complex; among them the age of onset of hearing impairment, age at detection of hearing loss, the severity of hearing loss, early intervention, the application of cochlear implants and/or conventional hearing aids and the duration of use of these devices, the use of sign language, the family background, etc... Many studies have often tried to explain whether a relationship exists between the level of linguistic competence a deaf person achieves and his/her clinical data. However, how all these variables interact with each other and influence the development of language is still highly debated.

Although it is generally acknowledged that hearing impairment may hinder the development of normal linguistic abilities (Davis et al 1986), the role of the degree of hearing loss in language acquisition is still unclear. Various studies investigating the relationship between the degree of hearing loss and oral language receptive or productive skills across different languages have not yet found any correlation between the two factors (Blamey et al. 2001, Friedmann &

Szterman 2006, Fry 1966, Gilbertson & Kahmi 1995, Norbury et al. 2001 & 2002, Tuller & Jakubowicz 2004, Wolgemuth et al. 1998).

Blamey et al. (2001) investigated linguistic competence and speech perception in a group of 87 children with moderate, severe and profound hearing loss, in order to identify whether the degree of hearing loss and the age at which the loss occurs might influence performance. The degree of hearing loss only correlates with speech perception, but not with language scores.

Similar findings were also offered by Norbury et al. (2001, 2002) for English-speaking children with mild-to-moderate hearing loss. These authors demonstrated that a relation could be established between age and language performance (older children performed better than younger children), but again no correlation was shown to exist between language scores, degree of hearing loss and age of hearing loss detection.

For French, Tuller & Jakubowicz (2004) explored the comprehension and production skills of 20 children with hearing losses ranging from 37 to 64 dB. Different properties and grammatical aspects of French were investigated, namely the use of determiners, clitic pronouns, verbal morphology. High inter-subject variability was found. Hence, in the hearing-impaired individuals tested, some properties were deficient and some others were less or not at all affected, but these phenomena were not correlated with the degree of hearing loss, nor with the age of detection of hearing loss, nor with the age of fitting of hearing aids. Only an age effect was found, therefore younger children showed more difficulties in mastering their language than older children.

All these studies demonstrated high variability in linguistic competence which cannot be ascribed to the degree of hearing loss alone (Blamey et al. 2001).

Friedmann & Sztermann (2006) investigated the comprehension and production of relative clauses and OVS topicalization sentences in moderate, severe and profound hearing-impaired children ranging from age 7;7 to 11;3. Results demonstrated that hearing impaired children failed to understand object relatives and topicalization sentences. Similarly to the other studies, Friedmann and Sztermann also found that the difficulty experienced in the syntactic comprehension of these sentences did not correlate with the degree of hearing

loss. Interestingly, a positive relationship could be established between early detection of hearing loss, early intervention and fitting of hearing aids and performance on comprehension tasks.

Much recent research showed that many English-speaking children with hearing loss may achieve both in receptive and expressive language skills comparable to those of their hearing peers, if inclusive intervention programs are provided very early, by 6 months of age (Apuzzo & Yoshinaga-Itano (1995), Yoshinaga-Itano et al. 1998).

Moeller (2000) investigated the relationship between age of enrollment in intervention and linguistic competence (vocabulary skills) at the age of 5 in a group of 112 prelingually deaf and hard-of-hearing children with mild to profound sensorineural hearing loss. She found a significant negative correlation between the two factors, namely children undergoing early intervention programs demonstrated better language scores at 5 years of age as opposed to children enrolled later (e.g. after 11 months of age). The level of vocabulary development was comparable to that of their hearing peers. Family involvement and age of enrollment significantly contributed to explaining a large amount of variance in the linguistic competence at 5 years of age.

The role of early intervention was also put forth by Oller & Eilers (1988) and Schauwers et al. (2005). Indeed early intervention favours a more normal pre-lexical vowel development and might contribute to reduce the linguistic delay. 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. About 43% of children implanted at the age of 2 manage to develop language at the age of 8-9, whereas only 16% of children implanted before the age of 4 manage to attain a good linguistic competence (Boothroyd et al. 1991). The existence of a critical period for the efficacy of cochlear implants has been suggested by Nicholas & Geers (2005) Ledeberg & Spencer (2005). Implantation occurring before the age of 2 may contribute to develop language (including syntax) at more normal rates, as opposed to implantation occurring after that age (Schauwers et al. 2005).

Background variables, such as family factors, also proved to have strong consequences on the outcome of intervention. Parents involved in the intervention program were found to communicate better with their children and to contribute more to the child's progress than parents who did not participate in the program (Moeller 2000).

1.9. Language development in hearing impaired individuals

When faced with both comprehension and production tasks, past and recent research conducted by Pressnell (1973), Sarachan-Deily & Love (1974) Brannon (1966), Geers & Moog (1978) for English, and Tur-Kaspa & Dromi (2001) for Hebrew demonstrated that hearing-impaired children showed a different developmental pattern when compared to hearing children.

As a matter of fact, in comparison to hearing children, language acquisition and development in hearing impaired children show three types of patterns. Some phenomena (e.g. babbling) develop equally in deaf and hearing children (see section 1.9.1). Other aspects (e.g. vocabulary) are delayed in hearing-impaired children but exhibit developmental pathways similar to those in younger language-matched hearing children (see section 1.9.2). On the opposite side, some aspects (morphosyntax) are qualitatively different and widely deviate from the characteristics found among hearing children (see section 1.9.3). Cross-linguistic research demonstrated that hearing impairment might lead to deficits in different domains of language acquisition (phonology, lexicon, semantics, morphosyntax and pragmatics).

In the next paragraphs, we will examine the acquisition of the different linguistic domains cross-linguistically, also analysing the very early stages of language acquisition, namely babbling. Then, in paragraph... we will focus on language acquisition by Italian-speaking hearing-impaired children.

1.9.1 Babbling development

The first form of linguistic production is represented by babbling, "precursor to language" (Guasti 2002). In normal hearing children, babbling appears in the first months of life, when they start producing simple combinations of vowel and

consonant sounds in well-formed syllables (papapa, dadada), at approximately 6 to 10 months of age. Hearing-impaired children begin to babble not earlier than 12-25 months (Oller & Eilers, 1988). The first babbles produced by hearing-impaired children seem to suggest that babbling is an innate behaviour, developing in all children regardless of their hearing status. However, if early vocalizations occurring in hearing-impaired children appear to sound like those of normal-hearing children, after few months, they tend to decrease, clearly differing from those of hearing children (Marschark 2009). In cochlear implanted children, although delayed in terms of chronological age, this linguistic stage seems to show a high rate of development in terms of hearing age, namely of length of time since the activation of the cochlear implant.

The relation between babbling and the development of later language abilities is however not so clear. On the one hand, the quality of children's canonical babbles seems to be an indicator of phonological knowledge (Oller & Eilers, 1988). On the other hand, babbling does not appear to be predictive or necessary for the development of linguistic skills.

1.9.2 Vocabulary development

In the lexical domain, hearing-impaired children show poor receptive and productive vocabulary, when compared to their normal hearing peers, and difficulties in the comprehension of words with more than one meaning.

A study conducted by Ledeborg (2003) on English speaking deaf children, showed that they have a lower rate of acquisition of words than that of hearing children, even when the children wear cochlear implants or have consistent amplification and high-quality programming.

Some deaf children possessing a vocabulary of over 100 words learn new words very slowly, adding only a few words in a month, and this is a phenomenon which is not observed among hearing children. Moeller et al. (1986) showed that deaf children aged 13 through 20 years remain at an age equivalent of hearing 9-year-olds on the PPVT (Peabody Picture Vocabulary Test).

Mayne et al. (2000) found that children with hearing loss may come to develop lexicon easily if exposed early during infancy to the linguistic input,

regardless of the communication methods (either sign or speech) adopted to develop language.

Overall, children fitted with cochlear implants experience develop vocabulary faster than children with traditional hearing aids.

1.9.3 Morpho-syntactic development

If compared to vocabulary learning, syntactic development is even more delayed. Although there are wide individual differences, deaf children and adolescents frequently have reduced lexicons and poor syntactic knowledge, especially in the area of morphosyntax and complex sentences. Hearing-impaired adolescents show difficulties with syntactic rules and structures even after long exposure to the “oral” language. Normally, acquisition of syntax seems to depend on the input from ‘face-to-face’ interactions, but the grammatical elements that are necessary to learn functional categories are unstressed and carry minimal semantic information (De Villiers et al. 1994). Markers such as inflectional morphemes, determiners and pronouns are less perceptually salient in the speech stream than content words.

In the morphosyntactic domain, hearing-impaired individuals avoid producing complex structures, preferring short sentences, and experience difficulties in the use of prepositions and functional elements, such as determiners, auxiliaries, and pronouns, the presence of which is of primary importance in order to correctly interpret a sentence (for English, see Quigley & Paul 1984, De Villiers 1988, De Villiers et al. 1994; for French, see Tuller 2000, Tuller & Jakubowicz 2004, Delage & Tuller 2007, Delage 2008; for Italian, see Volterra & Bates 1989, Caselli et al. 1994, Fabbretti et al. 1998, Franchi 2004, Ajello et al. 2001, Volterra et al. 2001, Chesi 2006, Fabbretti 2000, Fabbretti & Tomasuolo 2006). The competence in the pragmatic domain, which basically makes it possible to distinguish between the literal and the figurative meaning of some linguistic expressions, idiomatic expressions and proverbs, is mainly precluded to hearing-impaired children, these abilities being acquired through acoustic repetitiveness, to which they have difficult access (Maragna 2000).

Similar to hearing children, deaf children acquire lexical categories – nouns, verbs, adjectives, prepositions – before they acquire functional categories. Berent (1996) and De Villiers et al. (1994) found that among deaf adolescents and adults, knowledge of functional categories is poor and incomplete. Such incomplete knowledge causes these individuals to make errors in morphosyntactic constructions and complex sentences.

Deaf children acquiring their oral language experience particular difficulties with functional categories, including derivational and inflectional markers, and the determiner and auxiliary systems. The most frequent errors for English-speaking hearing impaired individuals are omissions of tense inflections (present, past or present progressive) in obligatory contexts (Berent 1996, De Villiers & Pomerantz 1992, Schauwers et al. 2005). Unlike hearing children, deaf children rarely overgeneralized the regular past tense (-ed) to irregular verbs. Therefore deaf children may have a prolonged period of memorization of verb forms. English deaf children make few errors with English plurals and possessives and show age-related performance. Therefore, order of acquisition of these morphemes differs from that of hearing children.

German oral deaf children fitted with cochlear implant performed very similarly to hearing children in acquiring plurals and verb inflectional morphology (Szagun 2004). On the other hand, these children made many errors in grammatical agreement. Hebrew-speaking hearing-impaired children made errors in number and gender agreement between verbs and nouns and between adjectives and nouns (Tur-Kaspa & Dromi 1998). German children using cochlear implants also experienced difficulties with case and gender agreement between articles and nouns (Szagun 2004).

As for Italian, 11- to 15-year olds made a lot of errors of agreement between determiners and nouns (Taeschner et al. 1988). These subjects seem to frequently select the determiner on the basis of the final vowel or letter of the noun, an error never seen in hearing children (e.g. *i notti*, instead of *le notti* ‘the.MAS.PL. nights, *le fucile*, instead of *il fucile*).

1.9.4 Language acquisition by Italian-speaking hearing-impaired children

In this section, we will focus on the development of linguistic abilities by Italian-speaking hearing impaired individuals. Studies investigating the linguistic competence of Italian hearing-impaired children, adolescents and adults are mainly concerned with the assessment of lexical and morphosyntactic skills in individuals fitted with conventional hearing aids (Taeschner et al. 1988, Rampelli 1989, Volterra & Bates 1989, Caselli et al. 1994, Emiliani et al. 1994, Fabbretti 2000, Ajello et al. 2001, Volterra et al. 2001, Bigoni et al. 2003, Franchi 2004, Chesi 2006, Rinaldi & Caselli 2009, Volpato 2002, Volpato 2008, submitted,). Linguistic research assessing the acquisition of some properties of the Italian language in hearing-impaired children using cochlear implants is just emerging (Volpato & Adani 2009). Basically, all the above mentioned studies show that hearing-impaired children experience difficulties with receptive and productive vocabulary, and morphosyntactic properties of simple items as well as with complex sentences including passive sentences and relative clauses. They omit and substitute determiners, prepositions, auxiliary verbs and clitic pronouns, they incorrectly add determiners, and they omit copulas. They frequently make gender and number agreement errors, and they show difficulties with verbal inflections, thus producing agreement errors between the subject and the finite verb (Maragna 2000, Caselli et al. 1994).

Detailed analyses of performance and non-standard forms produced by Italian hearing-impaired children are offered by Caselli et al. (1994), Chesi (2006) and Rinaldi & Caselli (2009).

Caselli et al. (1994) investigated the linguistic competence/lexical and morphosyntactic abilities of 25 hearing-impaired children with different degrees of hearing loss (mild, severe and profound), ranging in age from 2;6 to 11 years and attending nursery and primary schools in Rome. Linguistic abilities were assessed by using lexical tasks of figure naming and identification; grammar tasks investigating morpho-syntactic properties of nouns and verbs, sentence repetition tasks including sentences of variable length and syntactic difficulty (Devescovi et al. 1992): simple sentences (e.g. *il bimbo piange* ‘the child cries’), sentences containing the lexical verbs *be* and *have* (*il nonno ha il cappello* ‘the grandfather has the hat’, *la macchina è rossa* ‘the car is red’), sentences containing adjectival

or adverbial modifiers (*il cane guida la macchina rossa* ‘the dog drives the red car’) and sentences containing negation (*la bambina non mangia la pappa* ‘the child does not eat the food’).

In the youngest group, the percentage of correct determiner-noun agreement between the article and the noun was 42% and the percentage of incorrect agreement was 19%. The percentage of omissions was 30%, and 9% was the percentage of substitution of the definite article with an indefinite one. As for instances of incorrect agreement, in most cases (50%) the errors regarded incorrect number agreement (singular is used instead of plural, mainly for feminine) and incorrect gender agreement (33% - feminine is used instead of masculine). In the task investigating the use of singular or plural morphology on nouns, children produced 60% of correct responses. The performance oldest children showed a higher percentage of accuracy. Correct responses ranged between 88% and 100% for singular nouns and between 85% and 100% for plural nouns. The percentage of correct selection of definite articles is between 74% and 98% for singular nouns and between 73% and 91% for plural nouns. Children experienced some difficulties mainly in the use of plural features on nouns, especially on those ending in *e*. Indeed, singular nouns ending in *e* were treated as plurals (for instance the word *fiore* was produced instead of *fiori*). The use of number (plural) morphology is also often problematic on verbs, and the third person plural marker is substituted by the correspondent singular (for instance, the word *dorme* ‘(he) sleeps’ for *dormono* ‘(they) sleep’).

In the sentence repetition task, the percentage of correct responses for the youngest group was 52%. Incorrect responses contained both omission (90%) and substitution (10%) errors in the use of determiners, nouns, verbs, auxiliaries, prepositions and negation particles. Prepositions were the most omitted categories (33%), while the elements showing the lowest percentage of omission were nouns (11%). The highest percentage of substitutions concerned verbs (80%).

The percentage of correct repetitions for the oldest hearing-impaired group was also quite low (67%), considering that younger normal-hearing children repeat these items correctly when they are 3;6 year old (Devescovi et al. 1992). Both omissions (74%) and substitutions (26%) were found. Again most errors

concerned the use of ‘free morphology’, especially the production of determiners and prepositions.

For a more in depth investigation of the use of prepositions, a comprehension and a production task were administered to the oldest hearing-impaired children. As for the production task, 66% of sentences contained the correct preposition. In 9% of the sentences, the children omitted the preposition or substituted the correct one with an incorrect one. 25% of responses did not correspond to the target sentence and did not contain any preposition. In the comprehension task, the hearing-impaired group showed a percentage of correct responses of 87%, whereas the percentage of accuracy in the normal hearing group is 99%. The most problematic preposition was *da* (from) (17% of errors), and the less problematic was *dentro* (in) (4% of errors).

Data collected on normal-hearing children showed that on the whole, the performance of the hearing-impaired children was comparable, both from a qualitative and a quantitative point of view, to that of hearing children ranging in age from 2;6 to 4-5 years (Caselli et al 1993, Caselli et al. 1994).

Chesi (2006) investigated the oral and written production of a group of 13 hearing-impaired children with severe and profound hearing loss ranging in age from 6 to 17 years.

He also investigated the use of articles and accusative, dative and reflexive clitic pronouns and found that the main tendency for all participants was to systematically omit these elements. The percentage of correct clitic forms was 48% in oral productions and 52% in written productions. Enclitic pronouns were omitted more than proclitic ones, confirming a tendency also found in Taeschner et al. (1988) and Fabbretti (2000). The best strategy in order to avoid the use of a clitic pronoun was to repeat the lexical object or to omit altogether the clitic and the lexical object. However, when the clitic pronoun was produced, correct agreement between the clitic and its antecedent/referent and correct case assignment were often attested. Although problematic, the use of clitic pronouns in proclitic and enclitic position made it possible to infer that some children were nonetheless able to distinguish between finite and non-finite verb forms.

As for articles, definite forms were more frequently produced than indefinite or partitive ones. The highest percentage of omissions was in the post-verbal position (95%) (*Tom scivola e rompe ø piatti* ‘Tom slips and breaks \emptyset dishes’ Target: *Tom scivola e rompe i piatti* ‘Tom slips and breaks *the* dishes’). The most problematic article form was masculine plural (41%), followed by masculine singular (35%), feminine singular (18%) and feminine plural (6%).⁴ Although the productions showed a high percentage of errors and non-standard forms, interestingly, the different constituents of the determiner phrase followed the restrictions fixed by their hierarchical order, and consequently their linear order (e.g. *tre ragazze sorda* ‘three girls deaf.FEM.SG’ meaning ‘three deaf girls’, but never *ragazze tre sorda* ‘girls three deaf.FEM.SG’).

In the verbal domain, failed agreement between subject and verb was found. Errors mainly concerned person (the third person was the most used *Dove va tu?* ‘Where is you going?’) and number features (singular used instead of plural – *È mio carte* ‘(it) is mine.MASC.SG papers.FEM.PL). Compound verbs were only attested in a small number of productions. Auxiliary verbs were correctly used, although some substitutions of the verb *essere* ‘to be’ with *avere* ‘to have’ were attested. Optional infinitives were used instead of the finite form, and temporal and agreement verbal morphology were sometimes expressed by other elements, namely lexical subjects, pronominal subjects, adverbs (*poi dopo mettere così* ‘then to put so’, *dopo fare i compiti io* ‘then to do homework I’).

Some attempts to produce more complex sentences, namely relative clauses, were identified, although the complementizer ‘che’ was often substituted by coordinating particles (as was also noticed for English by Quigley & Paul 1984): e.g. (*il formaggio*) *lo butta verso un vetro del comodino e si rompe* ‘(He) throws it (the cheese) against a bedside table glass and it breakes.’ TARGET: (*il formaggio*) *lo butta verso un vetro del comodino che si rompe* ‘(He) throws it (the cheese) against a bedside table glass, which breakes’.

Interestingly, Chesi (2006) found a close correlation between mean length of utterance (MLU) and grammar development. Children who had the lowest

⁴ That feminine plural is the most preserved form is also demonstrated in Volpato (2008), who investigated the elicited production of clitic pronouns in HI adults and found that the feminine plural clitic pronoun *le* has the highest percentage of correct responses.

MLU (about 4.6) showed the highest use of simple sentences, avoiding producing subordinate sentences. Articles were omitted post-verbally, but sometimes also in pre-verbal position. The production of clitic pronouns was mainly avoided by omitting it or by repeating the lexical object. Number and/or gender agreement errors were found in constituents containing more than one nominal modifier (article, quantifier, adjective and noun). Both in main and subordinate clauses, infinitival verbs or past participial forms were preferred over the required finite form. The third person singular forms of the verbs were preferred when other forms were required. Children with higher MLU (15.9) showed a lower number of atypical productions, mainly concentrated in sentences requiring the presence of clitic pronouns. Indeed, an evident asymmetry between the use of articles and that of clitic pronouns is attested. The former showed a lower percentage of omissions than the latter.

Rinaldi & Caselli (2009) assessed the language development of 20 hearing-impaired pre-schoolers wearing conventional hearing aids (5 with moderate hearing loss, 5 with severe hearing loss and 10 with profound hearing loss), comparing their performance to that of 40 normal hearing children, 20 matched on chronological age and 20 matched on “hearing age” (i.e. the time of formal exposure to the oral language). Early grammar skills and comprehension and production of spoken vocabulary were assessed by using the Italian short version of the MacArthur-Bates CDI questionnaire (Fenson et al. 1993, Caselli et al. 2007) to be filled in by the children’s parents. The questionnaire included a “Vocabulary” and a “Sentences” section. The lexical section investigated the comprehension and production of both nominal and verbal content words (*cane* ‘dog’, *dormire* ‘to sleep’), and function words (*perché* ‘why’, *ancora* ‘more’). The morphosyntactic section investigated the child’s ability to produce sentences and the level of completeness he/she managed to achieve in the sentence production/construction. The results demonstrated that hearing-impaired children showed a significant delay both in vocabulary and in grammar, if compared to same-age children. The hearing-impaired group produced fewer and shorter sentences, and in most cases they omitted functional elements, thus showing a

pattern of performance comparable to that of younger normal hearing children, namely those matched on duration of language experience.

The effect of the hearing loss degree in the language development was investigated by Emiliani et al. (1994), who analysed lexical and morphosyntactic abilities in eight children with severe hearing loss and in five profoundly hearing-impaired children, by using the Peabody Picture Vocabulary Test and 24 tasks of a test of grammatical comprehension, elaborated by Cipriani et al. (1988). Results proved that in lexical comprehension, children with severe hearing loss performed quite well, whereas children with profound hearing loss performed very poorly. Also in grammatical comprehension, the former group achieved higher scores than the latter group. For both groups, most errors were identified in the comprehension of closed class words, while fewer errors were detected in the domain of inflectional morphology.

Beronesi & Volterra (1986), Rampelli (1989) and Volterra & Bates (1989) analysed the linguistic competence of hearing-impaired adolescents and adults. Beronesi & Volterra (1986) analysed the written and spoken production of five hearing-impaired adolescents, and Volterra & Bates (1989) that of a congenitally hearing-impaired woman with profound hearing loss. They all found that the hearing-impaired individuals had poor vocabulary and tended to use short and syntactically simple structures. These subjects experienced difficulties in the use of free morphology, namely in the use of determiners, pronouns and prepositions, which were mostly omitted or replaced by other elements thus making the sentence ungrammatical. Similar results were reported by Rampelli (1989) on comprehension skills of a group of hearing-impaired adults. These individuals proved to have poor receptive lexical abilities and, from a morphosyntactic point of view, difficulties in the interpretation of passive and reversible sentences. The reason for the difficulties encountered by hearing-impaired individuals was reported to lie on the necessity to have a normally-developing phonetic-phonological system in order to correctly comprehend and use closed class words in oral languages (Volterra & Bates 1989).

Volpato & Adani (2009), to our knowledge, is the first study investigating the linguistic competence of specific syntactic properties of Italian in cochlear

implanted children. This study assessed the comprehension of relative clauses in 8 hearing-impaired children (age range: 6;9-9;3; mean age 7;9), by using an agent selection task. Their performance was compared to that of three groups of typically-developing children: a group of 8 children matched on morpho-syntactic abilities (age range: 3;6-5;11), a group of 8 children matched on receptive vocabulary (age range: 5;4-7;0) and a group of 8 children matched on chronological age (age range: 7;1-7;8). Subject and object right-branching relative clauses were tested in order to detect whether hearing impaired children pattern with normal hearing children as far as the comprehension of this structure is concerned, and in what and to what extent the two groups differ from each other. This experiment and its theoretical implications will be presented in detail in chapter 5.

CHAPTER 2

THE MORPHO-SYNTACTIC PROPERTIES OF RELATIVE CLAUSES

2.1 Introduction

This chapter is devoted to the presentation of the main properties concerning relative clauses. In order to understand the construction of stimuli in the present experiment, we have to examine some properties, namely the morphology of the cues marking grammatical functions, and word order patterns in the main clause and in the relative clause.

2.2 Properties of Italian relative clauses

Relative clauses are at the core of a great deal of studies both from a linguistic and psycholinguistic point of view across numerous and different languages.

Debate is however very controversial on how relative clauses are syntactically represented. The types of relative clauses at issue in this experimental investigation are the restrictive ones. In restrictive relative clauses, the head (which can be either the subject or the object in the main clause) delimits the range of possible referents and is extracted either from the subject or from the object position in the embedded clause.

Subject and object restrictive relative clauses are subordinate clauses modifying a nominal element. They modify the antecedent, restricting the number of possible referents for it. They belong to the syntactic category labelled as CP (Cinque 1982, Vergnaud 1985, Rizzi 1997, Bianchi 1999, Zwart 2000) and are embedded in a complex nominal expression (DP). They are introduced by the complementizer “che” (the equivalent of English “that”) and contain a gap in the subordinate clause marking the initial position of the element that has been relativized. Examples of relatives extracting from subject and object positions are provided in (2) and (3), respectively¹²:

¹ According to Rizzi (2006), and Rizzi & Shlonsky (2007), the subject does not move from the preverbal position, but presumably from the base position (see chapter 6, footnote 10). Since the base subject position is higher than the object position, the object does not cause any minimality effect. For the sake of simplicity, we place the subject in the preverbal position.

² The constituents in <> identify the original position from which the head is extracted.

- (2) la tigre che <la tigre> colpisce gli elefanti
 ‘the tiger that <the tiger> hits the elephants’
- (3) il cane che la tigre bacia <il cane>
 ‘the dog that the tiger kisses <the dog>’

Early accounts on relative clauses argue that these sentences are derived by *wh*- movement of a relative operator (Cinque 1978, 1982). The relative operator moves from the embedded position in which it is originated to a position in the high part of the sentence, namely Spec/CP, where it is coindexed with the relative head. A chain between the operator and the relative head is thus created. According to this theory, a subject relative is derived as in (4):

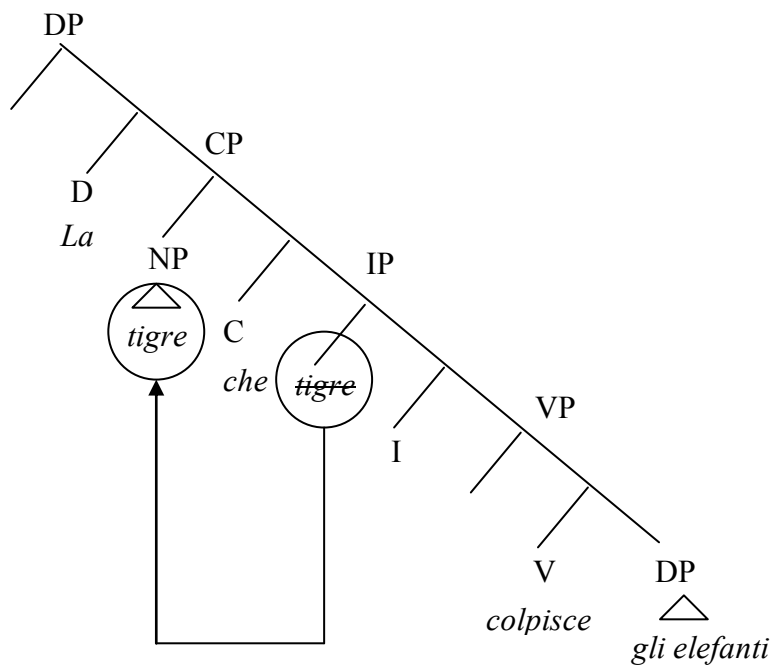
- (4) a. La tigre che <la tigre> colpisce gli elefanti.
 b. [_{DP} la [_{NP} tigre_i [_{CP} OP_i che [_{IP} t_i colpisce gli elefanti]]]]

An object relative is instead derived as in (5):

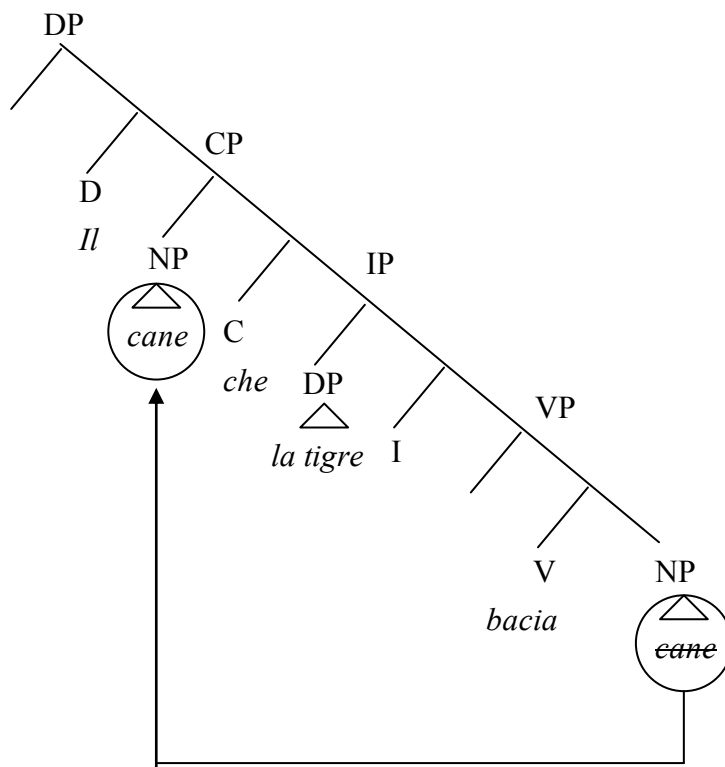
- (5) a. Il cane che la tigre bacia <il cane>
 b. [_{DP} Il [_{NP} cane_i [_{CP} OP_i che [_{IP} la tigre bacia t_i]]]

Much recent research (Vergnaud 1985, Kayne 1994, Guasti & Shlonsky 1995, Bianchi 1999, Cinque in preparation) challenged this proposal by hypothesizing a head-raising analysis of relative clauses. According to this proposal what moves in subject and object restrictive relative clauses, is not a relative operator, but the relative head itself. This type of movement analysis from the subject and object embedded positions is represented in (6) and (7), respectively:

- (6) a. La tigre che <la tigre > colpisce gli elefanti.
 b. [_{DP} la [_{CP} [_{NP} tigre_i] che [_{IP} [_{NP} t_i] colpisce gli elefanti]]]]



- (7) a. Il cane che la tigre bacia <il cane>
 b. [DP Il [CP [NP cane_i] che [IP la tigre bacia [NP t_i]]]]



The relative clause is selected by the head of the DP, an external D°, and the relative head, the lexical NP, generated in the relativization site, raises to the position Spec/CP.

Relative clauses involve A'-movement. The position from which movement takes place is marked by a *t* (trace) or it is considered as a silent copy of the moved element (Chomsky 1995). Depending on the analysis adopted, either the trace of the moved element or the silent copy and the element itself form a chain.

2.3 Relative clauses and the *pro-drop* parameter

Italian is a *pro-drop* language, namely a language in which the subject of a finite sentence can be omitted. The setting of the *pro-drop* parameter on a positive value involves the possibility for the overt subject to occur either in the preverbal or in the post-verbal position:

- (8) a. Gianni ha telefonato.
John has phoned
b. Ha telefonato Gianni.
has phoned John
'John has phoned.'

The *pro-drop* parameter also accounts for the occurrence of the embedded subject in post-verbal position in relative clauses like the example shown in (9):

- (9) Il gelato che ha mangiato Gianni
The ice-cream that has eaten John.SUBJ
'The ice-cream that John has eaten'

A consequence for the setting of the *pro-drop* parameter on a positive value is that a relative clause containing semantically reversible verbs, such as the one shown in example (10), may result ambiguous between a subject and an object interpretation:

- (10) Il bambino che bacia il nonno
 the child that kisses the grandfather

In Italian, the sentence in (10) is ambiguous because both DPs, either *il bambino* ‘the child’ or *il nonno* ‘the grandfather’, could be the subject of the embedded verb. A subject reading implies that the child is kissing the grandfather and the gap is therefore in preverbal embedded subject position, marked by the ‘greater than’ and ‘less than’ pair of signs:

- (11) Il bambino che <il bambino> bacia il nonno
 The child that <the child> kisses the grandfather

In the object reading, the grandfather is kissing the child and the gap is in the post-verbal embedded object position:

- (12) il bambino che bacia il nonno <il bambino>
 The child that kisses the grandfather <the child>

In Italian, in order to make an object relative clause unambiguous, two different strategies are possible, a morphological and a syntactic strategy.

When the two DPs show mismatched number features, namely when one DP is singular and the other is plural, disambiguation may occur through a morphological cue (number feature) on verbal morphology. Indeed, since in Italian the verb agrees in number with the subject, agreement number features on the embedded verb make it possible to attribute either a subject (13)-(14) or an object reading (15)-(16) to the sentence:

- (13) Il bambino_i [che <il bambino> bacia_i i nonni]
 the child_i [that <the child> kisses_i the grandfathers]

- (14) I bambini_i [che <i bambini> baciano_i il nonno]

the children_i [that <the children> kiss.3.PL_i the grandfather]

- (15) Il bambino [che baciano_i i nonni_i <il bambino>]
the child [that kiss.3PL_i the grandfathers_i <the child>]
'the child that the grandfathers kiss'

- (16) I bambini [che bacia_i il nonno_i <i bambini>]
the children [that kiss.3SG_i the grandfather_i <the children>]
'the children that the grandfather kisses'

Alternatively, when both DPs share the same number features, it is possible to place the subject of the embedded clause in the preverbal position, as it obligatorily happens for object relatives in *non-pro-drop* languages (syntactic cue):

- (17) Il bambino [che il nonno bacia <il bambino>]
the child [that the grandfather kisses <the child>]

Both the morphological and the syntactic cues may also be combined, when the embedded subject DP is placed in the preverbal position and the number features are mismatched:

- (18) Il bambino [che i nonni_i baciano_o <il bambino>]
the child [that the grandfathers_i kiss_i <the child>]

- (19) I bambini [che il nonno_o bacia_i <i bambini>]
the children [that the grandfather_i kisses_o <the children>]

Summing up, examples (17)-(19) account for the fact that speakers may decide for an object reading by relying either on syntactic cues (the presence of the embedded subject DP after the complementizer) or on morphological cues (mismatching number features and number morphology on the embedded verb).

When these specific cues are missing, and both DPs share the same number feature, the subject reading is also possible.

2.4 The role of phi-features

As shown in the previous section, number features on nominal and verbal morphology are crucial in Italian for the interpretation of a relative clause, namely for the correct assignment of theta-roles in subject and object relatives.

At the heart of much linguistic debate and experimental work on phi-features is the account of the role and representation of number features in opposition to gender features. Much linguistic and psycholinguistic research conducted across different languages has contributed over the years to the description of the way number features and gender features are encoded by the human parser (for English, Nicol (1988); for Italian, De Vincenzi & Di Domenico (1999), Carminati (2005); for Spanish, Anton-Mendez et al. (2002)), and represented in clause structure from a phonological and morphosyntactic point of view (Di Domenico (1997), Ferrari (2005), Lampitelli (2008), Thornton (2001); for Spanish, Harris (1991) Picallo (1991, 2005, 2007); for Hebrew, Ritter (1995)) in order to determine which features are salient and relevant to a syntactic stage and which are instead associated to some other head.

The experiment run on cochlear-implanted children in the present study is mainly devoted to investigate the role of number features in the acquisition of relative clauses. However, it is worth pointing out that previous investigations in language acquisition and development by hearing-impaired subjects focussed on the role of both number and gender features, crucially contributing to the current debate on phi-features (Volpato 2008, Volpato submitted). For this reason, this section will offer a brief state-of-the-art situation of the research on phi-features.

2.4.1 The role of number: evidence from experimental studies

The salience of number is highlighted by much recent linguistic and psycholinguistic research.

Nicol (1988) investigated the role of number features and their relation with gender using a cross-modal priming technique. Participants were presented

with pairs of sentences, each containing a personal pronoun. The two pronouns differed either in number or in gender/displayed differences in gender and/or number features. In each pair of stimuli, the pronoun was preceded by two lexical referents and the disambiguation between the two antecedents could be achieved through either number or gender features. The following examples show two pairs of sentences (20)-(21), and (22)-(23), respectively, in which the decision concerns number and gender features:

- (20) The landlord told the janitors that the fireman with the gas-mask would protect **him** if it became necessary.
- (21) The landlord told the janitors that the fireman with the gas-mask would protect **them** if it became necessary.
- (22) The ballerina told the skier that the doctor would blame **him** for the injury.
- (23) The ballerina told the skier that the doctor would blame **her** for the injury.

The sentences were visually presented and after the pronouns, a target word appeared on the screen for lexical decision. Results showed that number was used earlier than gender information to select the appropriate pronoun antecedent.

For Italian, De Vincenzi & De Domenico (1999) carried out a similar experiment, in which they tested the following conditions for number (24) - (25) and gender features (26) - (27):

- (24) Lo sposo disse agli alunni che il vecchio generale in pensione voleva salutare **lui** quanto prima.
'The bridegroom told the pupils that the old retired general wanted to greet **him** as soon as possible.'
- (25) Lo sposo disse agli alunni che il vecchio generale in pensione voleva salutare **loro** quanto prima.

‘The bridegroom told the pupils that the old retired general wanted to greet **them** as soon as possible.’

- (26) Lo zio disse alla laureanda che l’ingegnere conosciuto in vacanza poteva ricevere **lei** nel pomeriggio.

‘The uncle told the doctorand(F) that the engineer known during vacation could receive **her** in the afternoon.’

- (27) Lo zio disse alla laureanda che l’ingegnere conosciuto in vacanza poteva ricevere **lui** nel pomeriggio.

‘The uncle told the doctorand(F) that the engineer known during vacation could receive **him** in the afternoon.’

Replicating the results by Nicol (1998), this study demonstrated once again that number information is crucial and is retrieved earlier than gender information. Number is a cognitively salient feature.

The salience of number from a syntactic, morphological and psycholinguistic point of view was also demonstrated by Volpato (2008). This study investigated the use of the four third-person accusative clitic pronouns *lo*, *la*, *li*, *le*, in left-dislocation sentences by hearing-impaired LIS signers through an eliciting production task. The tested conditions are shown in the following examples³:

- (28) Tu e tuo fratello, la luce l(a)’avete accesa, perché la stanza era al buio.
You and your brother, the light.FEM.SG_i, it.FEM.SG_i have turned-on.FEM.SG_i,
because the room was at dark.
‘You and your brother turned on the light (it), because the room was at dark.’

- (29) Il ladro, i poliziotti l(o)’hanno arrestato ieri sera.

³ The words that are underlined are those produced by the participants.

The thief.MAS.SG_i, the policemen.MAS.PL him have arrested.MAS.SG_i last night.

'The policemen arrested the thief (him) yesterday night.'

(30) Il giardiniere, gli alberi, li pota ogni anno.

The gardener.MAS.SG, the trees.MAS.PL_i them.MAS.PL_i prunes every year.

The gardener prunes trees (them) every year.

(31) Le mele, lei le mangia tutti i giorni.

The apples.FEM_i, she them.FEM_i eats every day.

She eats apples (them) every day.

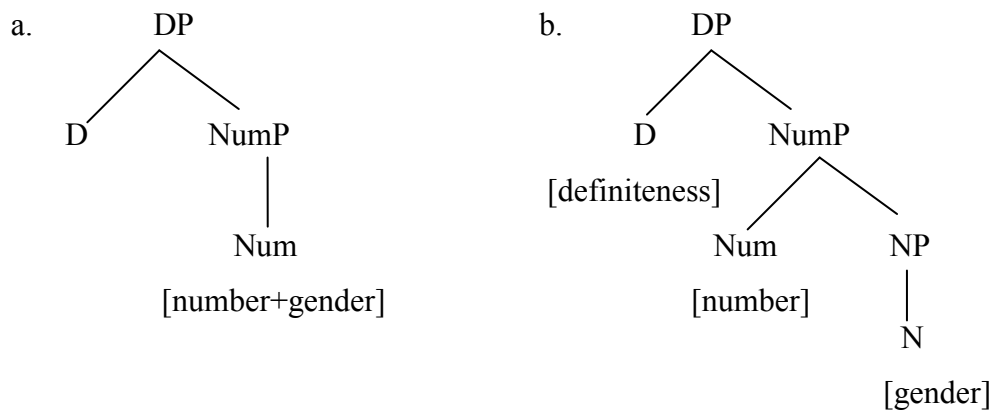
Results showed that participants performed significantly better on plural clitic pronouns, which are more complex from a morphological, phonological and syntactic point of view, than on singular ones. This is consistent with a modular theory of language processing, according to which individuals find it easier to produce the structure that is syntactically more complex, with the greatest number of checked visible (plural) features, because they have more overt evidence of it, thus confirming a triggering force for plural number features with respect to singular ones.

Although still highly debated, the salience of number has been attributed to the fact that number features project their own syntactic head, differently from gender features (Ritter 1995, Di Domenico 1997, De Vincenzi & Di Domenico 1999).

Ritter (1995) for Hebrew and Di Domenico (1997) for Italian argue that in the nominal system, number information is encoded differently from gender information and consequently it is represented structurally in a different manner. Both authors postulate the existence of a number projection above NP in the DP structure. Number heads its own projection, also hosting semantic gender (Di Domenico 1997). Grammatical gender is instead hosted under another projection, namely under N, being in fact considered as part of the lexical entry. Similarly, highlighting the relevance of number features, Ritter (1995) suggested that

number projects its own syntactic head, also hosting gender. The noun phrase has a plural denotation only when Number heads a distinct functional projection. Differently from nouns, pronouns lack the NP projection. Hence gender is specified on and projected with number. (32a) and (32b) provide a representation of the projections for pronouns and full noun phrases, respectively:

(32)



In sum, number is a syntactic head, separately represented in the lexicon and autonomously projected in syntax, in some cases hosting gender features. Gender is projected in syntax either with the noun (32b), when present, or with number (32a).

Ferrari (2005), analysing the Italian nominal system, strongly corroborates the structure proposed by Ritter, by convincingly arguing that plural features are realized by Merge of a further projection (NumP) into clause structure. In Ferrari's proposal, Number is projected only in the plural and not with singular features. In addition, Ferrari also claims, in line with other linguistic studies (Picallo 1991, 2005, 2007, Lampitelli 2008, Volpato submitted), that number and gender features head two distinct projections in the syntactic structure.

The presence of a more prominent structural element, namely the Number projection, somehow facilitates linguistic performance. In this way, the prominence attributed to Number confirms previous findings in linguistic and psycholinguistic research.

This discussion is crucial for our research in order to understand some aspects underlying the construction of the experimental stimuli, which will be presented in the next chapter.

2.5 Feature checking and agreement phenomena

In this section, we will analyze how phi-features realize agreement in clause structure within the Principle & Parameter framework and the Minimalist Program (Chomsky 1995, 2000).

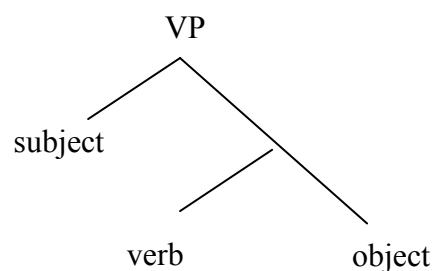
Linguistic theory considers the syntactic structures as derived by stepwise successive building up operations of MERGE, AGREE and MOVE of sentence constituents, until the final representation is derived.

MERGE is the operation providing two natural relations, stringing two elements together, in order to form a minimal phrase:

(33) Merge $(\alpha, \beta) \rightarrow K(\alpha, \beta)$

The skeleton of the syntactic structure is derived through merge of a head with a complement, and the successive merge of the head-complement with the specifier. The thematic nucleus of the sentence is thus formed by merge of the verb with its arguments inside VP:

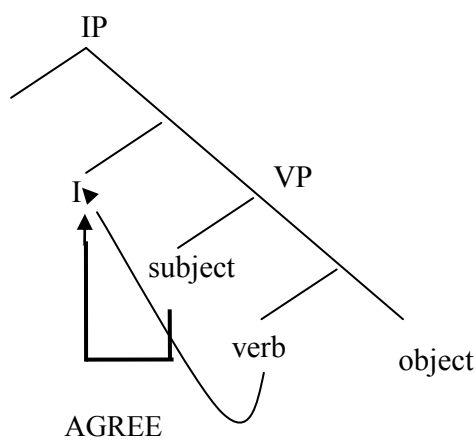
(34)



Following the VP-internal Subject Hypothesis (Sportiche 1988, Koopman & Sportiche 1991), the subject is merged in the specifier position of the lexical verb, where it receives its theta-role.

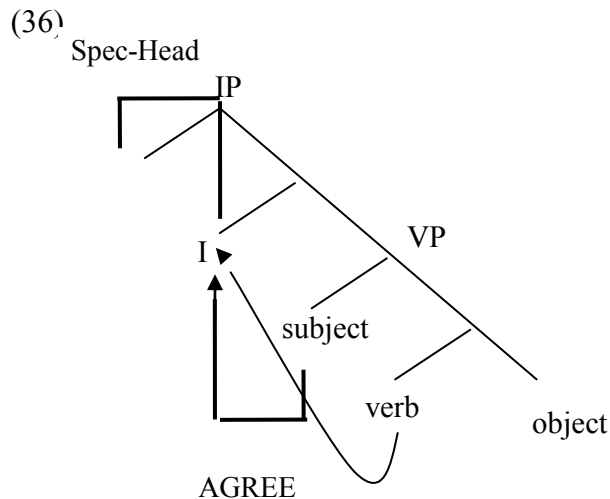
Successive merging operations introduce the functional structure of the sentence, also containing the IP projection, which provides the syntactic configuration in which the subject-verb relationship is established. This syntactic node (I) enters into an AGREE relationship with the subject, when it is still in its base position within the VP projection, in order to be valued. Therefore, number and person features of the subject are imported onto I:

(35)



Endowed with the relevant features, I acts as a *probe* seeking a *goal* with identical phi-features in its c-command domain. After I has been valued for number and person features, the displacement of the verb (MOVE) occurs in order to collect the relevant morphological specifications. Subsequently, the subject within VP moves to the specifier of I.

Within this projection, the subject enters a Spec-Head relationship with the verb, thus allowing local checking to occur (Franck et al. 2006, Guasti & Rizzi 2002).



Spec-Head agreement verifies that the subject in the specifier of I and the verb in I bear the same features, which were previously attributed through AGREE.

In this respect, Franck et al.'s (2006) proposal slightly differs from Chomsky's (1995, 2000, 2001) assumptions, according to which the agreement relation is established only through a single feature checking operation, either in a Spec-Head configuration as in Chomsky (1995), or under AGREE as in Chomsky (2000, 2001). The proposal for a robust double checking operation comes from the observation of cross-linguistic data in French, English (Frank et al. 2006) and Italian (Guasti & Rizzi 2002), in which the presence of a SV structure obligatorily implies agreement, while agreement does not occur in a VS configuration:

(37) C'est les filles / Ce sont les filles
 It is the girls / It are the girls

(38) Many books are/*is on the table
 There are/'s many book on the table

(39) Viene le ragazze / *Le ragazze viene
 Comes the girls / the girls comes

In Subject/Verb configurations, the morphological manifestation of agreement is more stable when AGREE is also associated with MOVE (Spec-Head), and is more fragile when only one derivational step occurs.

CHAPTER 3

TEST CONSTRUCTION

3.1 Introduction

The aim of this study is to provide insights into the mechanisms underlying the comprehension and production of restrictive relative clauses by hearing impaired individuals alongside with hearing populations. In order to achieve such a goal, an experimental protocol has been elaborated.

This chapter provides a detailed description of all tasks included in the experiment, with the aim to show how it was constructed and which variables are considered in the realization of the comprehension and production tasks.

3.2 The choice for a comprehension and a production task

Children's knowledge of relative clauses may be investigated through comprehension and elicited production tests by using picture selection, act-out and preference tasks (Crain & Thornton, 1998, McKee et al. 1998). Both comprehension and production tasks may help to understand which syntactic representation individuals assign to relative clauses. Language comprehension sheds light on the language acquisition process making it possible to account for the comprehension of structures that are not yet produced and to identify whether children assign them the same interpretation as adults do. Comprehension is essential in order to uncover the full extent of children's grammatical knowledge. On the other side, the production analysis gives a more accurate picture of the content of the child's emerging language system. Arguably, by the time children are producing a particular structure, they have already acquired it.

However, in the course of typical language development, Italian- and Greek-speaking children begin to produce relative clauses by the age of 3;0 (Crain et al. 1990, Varlokosta & Armon-Lotem 1998). Conversely, studies conducted on English, Italian and Swedish children showed that they appear to master the comprehension of relative clauses at a later stage, when they are about six (Sheldon 1974, de Villier et al. 1979, Tavakolian 1981, Goodluck & Tavakolian

1982, Hakansson & Hansson 2000, Guasti 2002). Production seems therefore to precede comprehension. This unique phenomenon led us to investigate the acquisition of relative clauses through both comprehension and production tasks, in order to detect how the performance varies according to the modality adopted (comprehension or production).

3.3 Making the stimuli

Many variables were taken into consideration when constructing the experimental test battery, such as structural embeddedness, sentence ambiguity and the role of word order in disambiguation, the effect of morphological (number) and syntactic cues (embedded preverbal subject) in the interpretation of object relatives.

3.3.1 Embeddedness

A crucial classification concerning relative clauses and affecting child language as well as adult language is the distinction between centre-embedding and right-branching relative clauses. A sentence like (40) displays the relative clause on the right of the matrix clause:

(40) He watched the child that the mother kisses.

The main clause occurs before the relative clause and can be closed off once the relative pronoun has been identified.

In a sentence like (41), the relative clause is instead embedded in the centre of the matrix clause:

(41) The child that the mother kisses is very tall.

For adults and children, right-branching relative clauses are easier to understand and to process, and are acquired at an earlier stage than centre-embedded relative clauses (Correa 1995, de Villiers et al. 1979, Kidd & Bavin 2002, Sheldon 1974, Stavrakaki 2001).

The participants included in the experimental investigation are hearing impaired children ranging in age from 7;11 to 10;8 years. Hearing-impaired children, who show a delayed acquisition, experience great difficulties in using specific properties of Italian, also including relative clauses (see chapter 1, section 1.9.4), and mastery of relative clauses in typically-developing children is problematic even after the age of six. The use of right-branching relative clauses was preferred over the use of centre-embedded ones, because the use of less complex structures would relieve the processing system of these young children from too much overload.

3.3.2 Ambiguity

As we have seen in chapter 2, section 2.3, in Italian restrictive relative clauses, when both DPs display the same phi-features (number), the sentence might be ambiguous between a subject and object reading. Utzeri reported that, when presented with such stimuli, children proved to be sensitive to the ambiguity and to recognize that both readings were possible (Utzeri 2006). Adults showed instead a different reaction, by always interpreting the head DP *il bambino* as the subject of the embedded clause.¹ According to much linguistic and psycholinguistic research, the subject reading might be preferred over the object reading, because the human parser tends to postulate a gap immediately after the complementizer, in the embedded subject position (Minimum Chain Principle – De Vincenzi 1991). Starting from these premises, the present experiment also includes ambiguous stimuli with either singular or plural DPs. This would make it possible to detect the mechanisms underlying the preference behaviour of the different populations towards either a subject or an object reading, also verifying whether and how the use of plural or singular feature may influence their choice. The behaviour of the participants in the selection of a subject or object reading may also provide interesting hints for understanding the performance on comprehension of unambiguous relative clauses.

¹ In my study, participants showed the opposite trend, namely adults were often sensitive to the ambiguity, while children were not (see section 5.6.4.1, chapter 5.)

3.3.3 Disambiguating cues

When interpreting complex sentences and conveying information about theta-roles, cross-linguistically, individuals rely on different cues (Bates et al. 1999). English-speaking individuals heavily rely on word order, whereas Italian-speaking ones are more sensitive to morphological cues, namely to number features on the embedded verb. A positive cue from the verb is expected when number features on it disambiguate the role of the main subject as the object of the relative clause. In addition, Italian-speaking individuals might also be sensitive to the position of the constituents in the sentence (Arosio et al. 2005).

In this experimental study, alongside with ambiguous sentences, unambiguous subject and object relative clauses will also be administered. Object relatives will be disambiguated by using either a structural strategy, namely the embedded subject will be placed before the embedded verb, or by using a morphological strategy, namely mismatching DPs and number agreement between the embedded verb and the post verbal NP subject. These choices would test the strength and the reliability of the structural and/or the morphological cue in relative clauses processing by hearing impaired children.

3.3.4 The lexicon and the sentences

All experimental sentences are semantically reversible, namely they contain verbs in which thematic roles could be compatible with both DPs. This means that the meaning of the sentence cannot be derived by relying on semantic or pragmatic cues.

Experimental trials were also interspersed with filler sentences, which were not reversible and contained either intransitive verbs or transitive verbs with inanimate objects. Fillers are easier than experimental trials for children (Goodluck and Tavakolian, 1982) and were included in order to renew the child's confidence and interest in the task. All nouns and verbs are included in the high-frequency lexicon of children (Marconi et al. 1993) and are controlled for length and familiarity.

All the experimental sentences had the same length in terms of words and syllables.

3.4 The main tasks

3.4.1 The production task

Production was investigated by using the elicited production technique. Elicited production makes it possible to “evoke sentences with complex structures that only rarely occur in spontaneous speech and enables to control the meaning that is to be associated with the targeted utterance” (McKee et al.1998). The model adopted to test relative clause production in Italian hearing-impaired children was the preference task elaborated by Friedmann & Sztermann (2006) to test Hebrew-speaking hearing impaired children, also used by Utzeri (2007) to test production in Italian-speaking children and adults.

This production task satisfies the felicity condition pointed out by Hamburger & Crain (1982). Hamburger & Crain (1982) found that felicity conditions in the elicitation of relative clauses are met when at least two instances for the head of the sentence are placed in the experimental context. When these felicity conditions are satisfied, children’s performance on relative clauses significantly improves.

Moreover, through a preference task, the child’s interest in the task is stimulated by the possibility of choosing the picture in which he/she can identify himself/herself. Although some choices might appear unusual to the child, he/she was asked to express anyway a preference for one of the two options.

The task was composed of thirty-six stimuli, 12 eliciting a subject relative, 12 eliciting an object relative and 12 filler sentences. Fillers have the function to divert the attention of the tested participant from the real aim of the investigation, to keep children’s attention high and to encourage them, since the answer is very easy. The presentation of filler sentences required the production of a simple SV or SVO word order sentence. Both singular and plural head DPs were used. In twelve sentences, the head was singular and in twelve, the head was plural.

Two examples of items eliciting a subject and an object relative clause with singular head DP are shown respectively in figure (3) and figure (4):

Elicitation of subject relatives – Ci sono due disegni. Nel primo disegno, un bambino pettina la mamma. Nel secondo, un bambino pettina il cane. Quale

bambino ti piace (di più)?² Inizia con “Mi piace il bambino...” oppure “Il bambino...” Target: “(Mi piace) il bambino che pettina la mamma/il cane”.

[There are two pictures. In the former, a child is combing the mother. In the latter, a child is combing the dog. Which child do you like? Start with “I like the child...” or “The child...” Target answer: (I like the child) that is combing the mother /the dog]

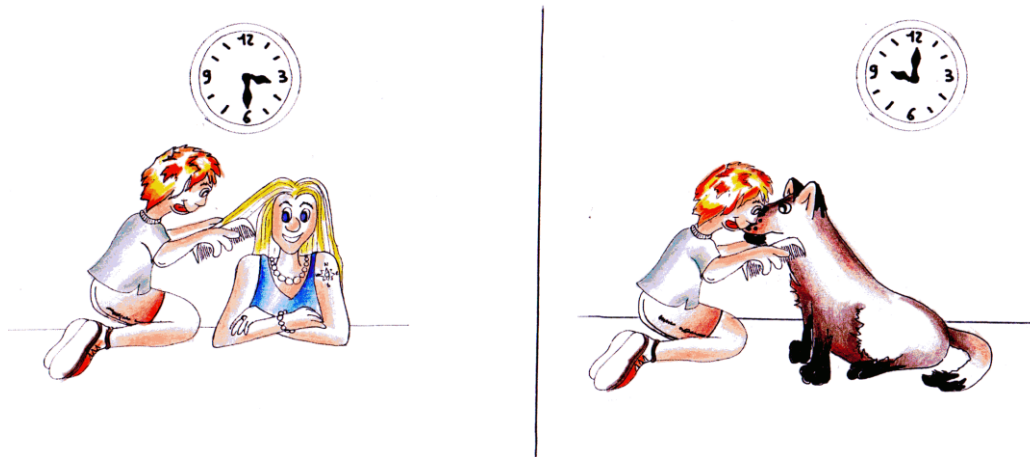


Figure 3: elicitation of a subject relative (singular head)

Elicitation of object relatives – Ci sono due disegni. Nel primo disegno, il papà colpisce un bambino. Nel secondo, il papà bacia pettina un bambino. Quale bambino ti piace? Inizia con “Mi piace il bambino...” oppure “Il bambino...” Target: “(Mi piace) il bambino che il papà colpisce/bacia”.

[There are two pictures. In the former, the father is hitting a child. In the latter, the father is kissing another child. Which child do you like? Start with “I like the child...” or “The child...” Target answer: (I like) the child that the father is hitting/ kissing.]

² In the original tasks (Friedmann & Szterman 2006, Utzeri 2007), the question by the experimenter was: “Which child would you rather be?”. In the stimuli presented in this experiment, the final question was “Which child/children do you like (the most)?”. The final question was changed because for hearing-impaired individuals the use of the conditional mood could have caused some trouble. Therefore, in order to avoid incorrect responses due to the incorrect use of conditional mood, the use of simple indicative tense sentences was preferred.

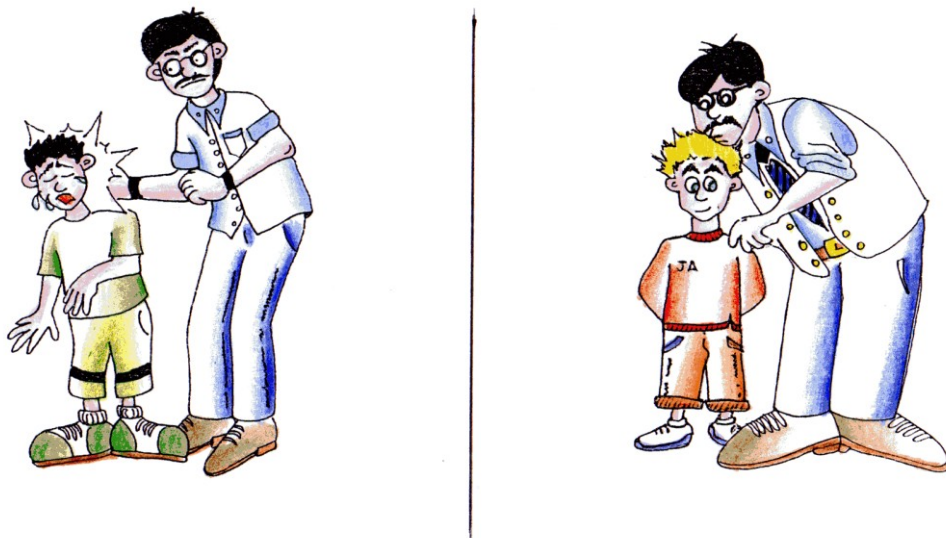


Figure 4: elicitation of an object relative (singular head)

Two examples of items eliciting a subject and an object RC with plural head NP are shown respectively in figure (5) and figure (6):

Elicitation of subject relatives – Ci sono due disegni. Nel primo disegno, i bambini accarezzano il gatto. Nel secondo, i bambini colpiscono il gatto. Quali bambini ti piacciono (di più)? Inizia con “Mi piacciono i bambini...” oppure “I bambini...” Target: “(Mi piacciono) i bambini che accarezzano/ colpiscono il gatto”.

[There are two pictures. In the former, the children stroke the cat. In the latter, the children hit the cat. Which children do you like? Start with “I like the children...” or “The children...” Target answer: (I like) the children that stroke/hit the cat.]

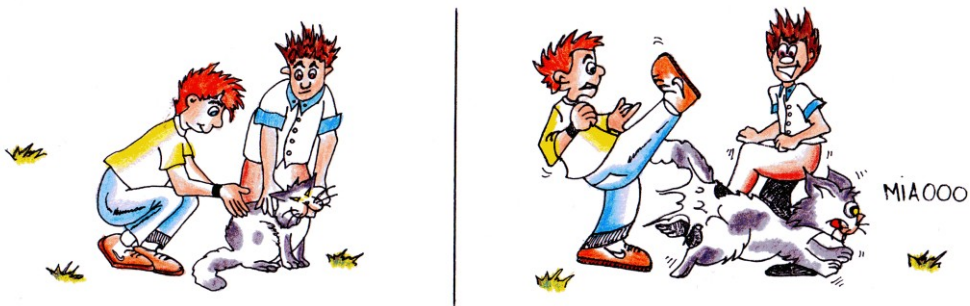


Figure 5: elicitation of a subject relative (plural head)

Elicitation of object relatives – Ci sono due disegni. Nel primo disegno, il papà pettina i bambini. Nel secondo, il barbiere pettina i bambini. Quali bambini ti piacciono? Inizia con “Mi piacciono i bambini...” oppure “I bambini...” Target: “(Mi piacciono) i bambini che il papà/barbiere pettina”.

[There are two pictures. In the former, the father is combing a child. In the latter, the barber is combing another child. Which child do you like? Start with “I like the child...” or “The child...” Target answer: (I like) the child that the father/hairdresser is combing.]

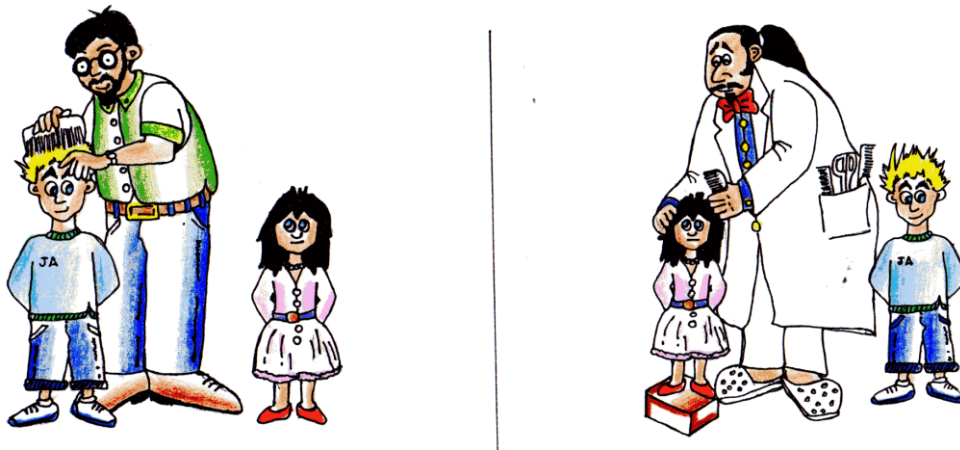


Figure 6: elicitation of an object relative (plural head)

An example of item eliciting a filler sentence is shown in Figure (7):

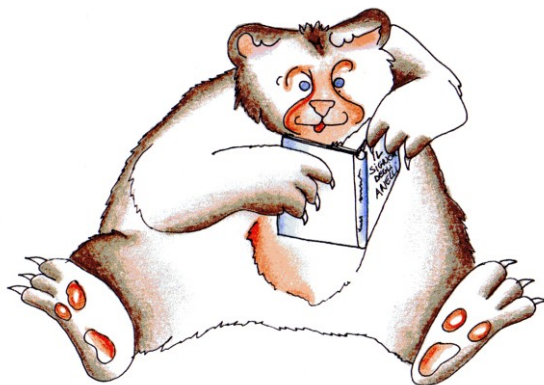


Figure 7: elicitation of a filler sentence

Experimental items were randomized and proposed in the same order to all participants. Only animate nouns were used, belonging to early vocabulary. All verbs were transitive, taking a direct object as a complement, and were used in the present tense, in order to avoid difficulties deriving from the presence of auxiliaries and past participle morphology, which are often problematic for hearing impaired children (Chesi 2006). The verbs used in the experimental task are: *lavare* (to wash), *colpire* (to hit), *inseguire* (to chase), *portare* (to bring), *tirare* (to pull), *spingere* (to push), *pettinare* (to comb), *fermare* (to stop), *baciare* (to kiss), *guardare* (to look at), *mordere* (to bite), *seguire* (to follow), *salutare* (to greet), *rincorrere* (to run after), *visitare* (to visit).

Before beginning the task, children were familiarized with the nouns and verbs presented in the task. A training part preceded the experimental part, in order to familiarize children with the items and the experimental setting, and to make sure that they had correctly understood the instructions.

3.4.2 The comprehension task

Children's failure to produce a particular linguistic element or structure does not automatically mean that they do not perceive or represent them (Fraser et al. 1963). For this reason, a comprehension task was also administered to the participants of this experiment. The comprehension task made it possible to infer the nature of children's morphosyntactic underlying representations, by examining the types of comprehension errors children make during the performance.

Previous experiments investigating relative clause comprehension adopted picture matching tasks (Friedmann and Novogrodzky 2004, Friedmann & Sztermann 2006) and agent selection tasks (Arnon 2005, Adani 2008). What differentiates these two task typologies is that the former implies the choice between two pictures and the latter between three (Adani 2008) or four characters (Arnon 2005). Presenting children with two pictures on each trial would set chance performance at 50%, but it would reduce the processing load deriving from the keeping in mind a long sentence and detecting the correct response. On the other hand, presenting children with four pictures on each trial would offer

some statistical advantages and show that chance performance is 25% or 33%, thus increasing the experimenter's ability to detect non-random behaviour. In this task, the participant listens to a sentence and has to select a referent from a set of characters, choosing the one that correctly matches the sentence. The problem of identifying non-random behaviour was overcome in this experiment by using an offline agent selection task, following the proposals by Friedmann & Novogrodzky (2004)/ Friedmann & Sztermann (2006) and Arnon (2005)³, in which the child was presented with two pictures but he/she has to detect the correct referent among four proposed characters (chance performance is 25%).

In the present experiment, two opposed scenarios are shown to the child, one in which two characters perform an action and one in which the same characters perform the same action but with the reversed thematic roles. In this way, felicity conditions showing two instances for each DP head were fulfilled (Hamburger & Crain 1982).

Figure 8 shows an example of an experimental sentence:

³ What differentiates Arnon's administration method from that of the other studies cited here, is that in Arnon (2005), experimental trials were introduced by the request "put a sticker on...".

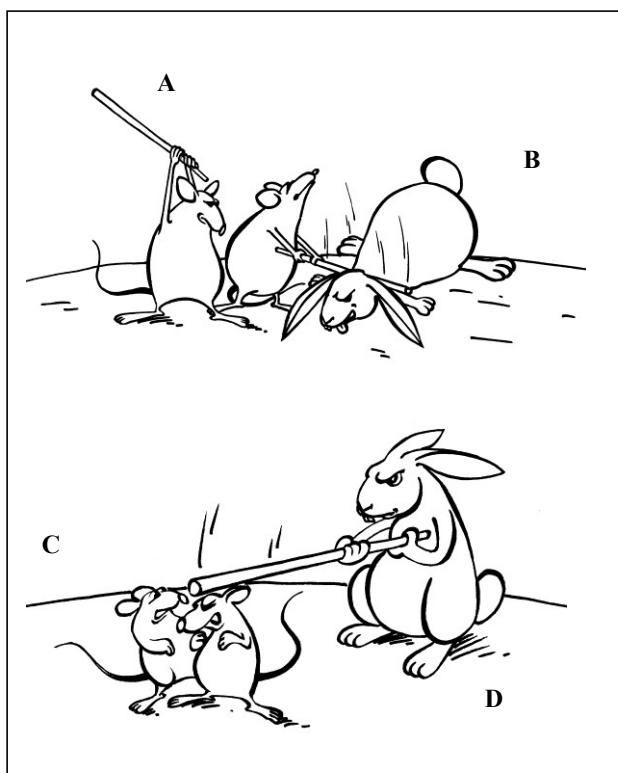


Figure 8: experimental sentence ‘Tocca il coniglio che colpisce i topi’ (touch the rabbit that hits the mice)

In this trial, one picture depicts a rabbit hitting the mice and the other depicts the mice hitting the rabbit. The experimenter read the sentence *Tocca il coniglio che colpisce i topi* ‘Touch the rabbit that hits the mice’ and the participant had to select the referent that correctly matched the sentence (the rabbit in the lower picture).

The battery included eighty items distinguished between sixty experimental trials and twenty filler sentences. The experimental trials distinguished ten different sentence typologies, each including six items⁴:

⁴ In the following examples, the first three letters indicate the type of relative clause: SVO is a subject relative with subject-verb-object word order (the head of the main clause is the subject of the embedded one); OSV is an object relative with object-subject-verb word order (the head of the main clause is the object of the embedded one and the embedded subject is in preverbal position); OVS is an object relative with object-verb-subject word order (the head of the main clause is the object of the embedded one and the embedded subject is in the post-verbal position). The abbreviations SG, standing for ‘singular’, and PL, standing for ‘plural’, indicate respectively the number of the head DP and the number of the embedded DP. For example, the abbreviation SVO_SG_PL indicates that the sentence is a subject relative, in which the first DP is singular and the second DP is plural.

Ambiguous trials (AMB):

SVO_SG_SG:	La mucca che spinge l'elefante The cow that pushes the elephant (expected SVO order)
SVO_PL_PL	Le mucche che spingono gli elefanti The cows that pull the elephants (expected SVO order)

Unambiguous subject relatives (OS):

SVO_SG_PL	La mucca che spinge gli elefanti The cow that pushes the elephants
SVO_PL_SG	Le mucche che spingono l'elefante The cows that push the elephant

Object relatives with embedded subject in preverbal position (OO):

OSV_SG_SG	La mucca che l'elefante spinge The cow that the elephant pushes
OSV_PL_PL	Le mucche che gli elefanti spingono The cows that the elephants push
OSV_SG_PL	La mucca che gli elefanti spingono The cow that the elephants push
OSV_PL_SG	Le mucche che l'elefante spinge The cows that the elephant pushes

Object relatives with embedded subject in post-verbal position (OOp):

OVS_SG_PL	La mucca che spingono gli elefanti The cow that push the elephants
OVS_PL_SG	Le mucche che spinge l'elefante The cows that pushes the elephant

Filler sentences (F)

SVO	La capra che mangia il gelato The goat that eats the ice-cream
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An example of filler sentence is shown in the following picture:

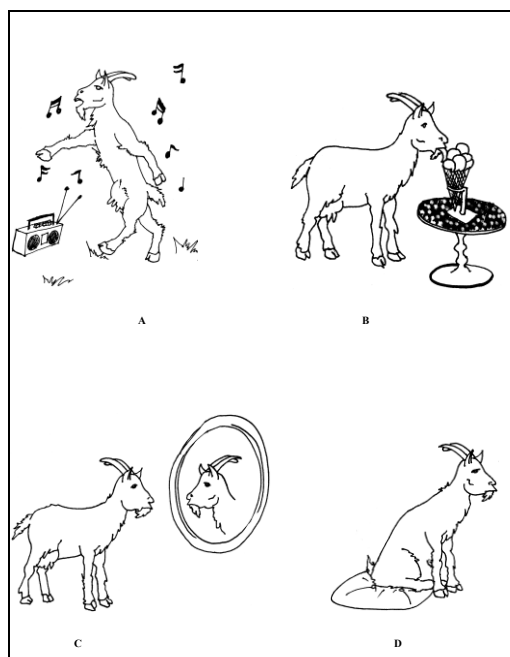


Figure 9: filler sentence ‘Tocca la capra che mangia il gelato’ (touch the goat that eats the ice-cream)

The presentation of four referents made it possible to obtain from the child one out of four responses, thus being able to gain a representation as detailed as possible of the underlying grammar of children. The answer possibilities varied according to the type of sentence proposed.

For subject relatives (SVO order – *Tocca il coniglio che colpisce i topi* ‘Touch the rabbit that hits the mice’), it was possible to obtain the following answers (see Figure 8):

- the correct answer: referent D
- the reversed answer: referent B
- other error: referent A - C

For object relatives (OSV – *Tocca il coniglio che i topi colpiscono* ‘Touch the rabbit that the mice hit’ and OVS order – *Tocca il coniglio che colpiscono i topi* ‘Touch the rabbit that hit the mice’ meaning again ‘Touch the rabbit that the mice hit’), still considering Figure (8), it was possible to obtain the following answers:

- the correct answer: referent B

- the reversed answer: referent D
- the agent error (selection of the agent instead of the head): referent A
- other error: referent C

The reversal error suggests that individuals are able to understand that the relative clause modifies a referent. However, they are unable to correctly assign the thematic role to the head DP. The agent error suggests that children are not able to process the whole sentence correctly and to detect the modifying nature of the relative clause, namely that the subordinate sentence adds information on the head DP. They are however able to correctly assign the thematic roles to the DPs.

For ambiguous sentences, such as *Tocca la pecora che lava il cavallo* ‘Touch the sheep that washes the horse’, it was possible to obtain only two answers. In this case, both the sheep in the upper picture and that in the below picture could have been the correct answers.

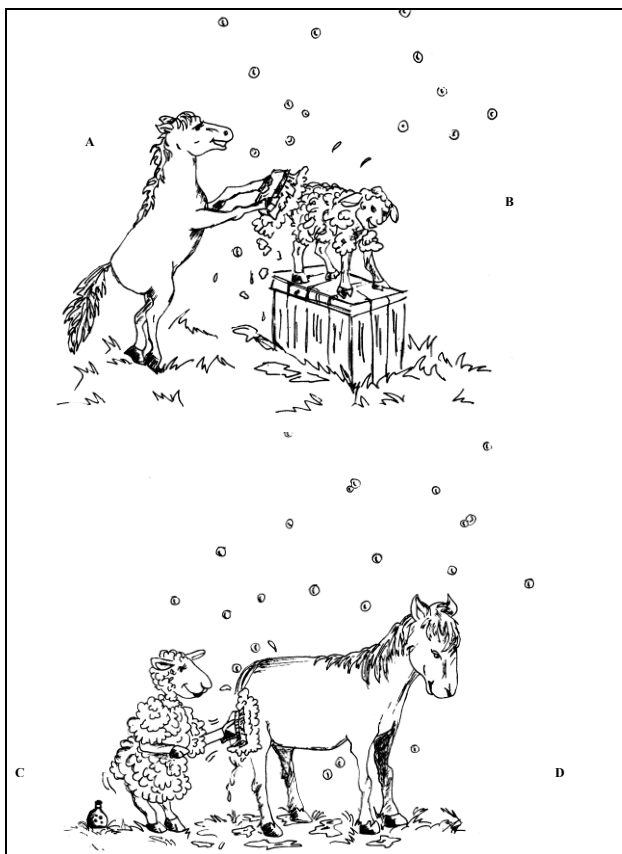


Figure 10: picture matched to the ambiguous sentence *Tocca la pecora che lava il cavallo* ‘touch the sheep that washes the horse’

In this case, it was possible to obtain the following responses:

- the correct answer (referent A and D)
- other error (referent B and C)

Only animate nouns were used in the experimental trials. All verbs were transitive and in the present tense, in order to avoid troubles deriving from the presence of auxiliaries and past participle morphology, which are often source of difficulty for hearing impaired children. Each trial began with *Tocca* (touch)⁵. The verbs used in the experimental task are: *lavare* (to wash), *colpire* (to hit), *inseguire* (to chase), *portare* (to bring), *tirare* (to pull), *beccare* (to peck), *spingere* (to push), *spaventare* (to scare), *toccare* (to touch), *pettinare* (to comb), *fermare* (to stop), *baciare* (to kiss), *guardare* (to look at), *mordere* (to bite), *seguire* (to follow), *salutare* (to greet), *rincorrere* (to run after) All sentences were semantically reversible.

The experimental trials were controlled for length (both considering the number of syllables and the number of words). All sentences were composed of 11 syllables and 6 words⁶. Experimental items were randomized and proposed in the same order to all participants.

The correct referents were well balanced across the four different positions. Indeed, the correct response appeared the same number of times in each of the four positions. Some pictures were presented twice but the children were instructed to listen carefully to the experimental sentence.

Before beginning the task, children were familiarized with the lexicon presented in the task. The experimental part was preceded by a training part, giving the possibility to children to familiarize children with the items and the experimental setting, and to make sure that the instructions were correctly understood.

3.5 General linguistic abilities assessment

The experimental part investigating the comprehension and production of relative clauses was preceded by the administration of a task assessing the general

⁵ Some sentences contained the verb ‘touch’ in the embedded clause (ex: la giraffa che tocca il coniglio ‘the giraffe that is touching the rabbit’). In such cases (4 stimuli), the sentence read by the experimenter began with *Indica* ‘point-to’, in order not to cause confusion to the child.

⁶ Only one sentence contained 12 syllables.

linguistic abilities of hearing-impaired and hearing children. This standardized test is known as Test di Comprensione Grammaticale per Bambini (Test of Grammatical Comprehension for children – TCGB, henceforth; Chilosi et al 1995).

TCGB is used to assess the development of children's comprehension abilities from 3;6 to 8 years and it is a useful tool providing a picture of language evolution in terms of linguistic age.

The test includes 76 sentences. After the experimenter had read the sentence, participants were invited to point to the picture that correctly matches the sentence, out of the four possible choices. Eight different sentence typologies were investigated: items containing locative complements (e.g. *La palla è tra il tavolo e la sedia* 'the ball is between the table and the chair'), items testing verbal and nominal inflectional morphology (e.g. *camminano* '(they) walk', *bambino* 'child.masc'), affirmative active sentences (e.g. *la mamma lava* 'the mum washes'), negative active sentences (e.g. *il bambino non dorme* 'the child does not sleep'), affirmative passive sentences (e.g. *il cane è morso dal bambino* 'the dog is bitten by the child'), negative passive sentences (e.g. *la mela non è presa dalla bambina* 'the apple is not taken by the child'), relative clauses (e.g. *il babbo tiene il palloncino che il bambino rompe* 'the dad holds the balloon that the child breaks'), sentences containing dative complements (e.g. *il babbo porta le sigarette al bambino* 'the dad brings the cigarettes to the child'). Scores were attributed to each response in the following way. Each correct response was attributed 0 scores. If after the first administration, the participant failed to provide the correct response, the sentence was proposed again. When at the second administration, the participant pointed to the correct picture, a score of 0.5 was assigned. When they pointed again to the incorrect picture, a score of 1.5 was attributed. The final total score was obtained by summing all partial scores. The higher the score, the poorer the performance.

For each of the sentence typologies as well as for the overall performance, the TCGB manual provides normative data collected from typically-developing children. On the basis of the final score, it was possible to attribute a linguistic age to the hearing-impaired individuals, and assign them a control hearing individual.

On the basis of the scores obtained in the standardized tests, the performance of hearing-impaired children was compared to that of hearing children matched for linguistic age to the hearing-impaired group. Since the delayed access to the linguistic input involves a delayed language acquisition, hearing impaired children are linguistically hardly comparable to typically developing children of the same chronological age. For this reason, the control group included samples of younger hearing children with normal language development attending nursery school and/or the first years of primary school.

3.6 Memory assessment

In addition to tasks investigating syntactic comprehension and production, some tasks assessing memory abilities were administered to the hearing-impaired and hearing young participants in order to get a more accurate and detailed profile of the individuals tested.

Memory is a basic function which exerts an influence on all other cognitive abilities (Quigley & Paul 1984). Hence, memory tasks were administered in order to check possible effects of memory limitations in the relative clauses processing and comprehension. Memory tests included some verbal repetition tasks, in order to test digit and word span, non-word repetition and sentence recalling.

3.6.1 Word repetition task

The word repetition task consisted in the repetition of stimuli assembled into sequences of increasing length, ranging from 2 to 6 items, and presented at the rate of one item per second. Only singular words were selected for the word-repetition task. They corresponded to disyllabic high frequency words in elementary Italian (Marconi et al. 1993) and were chosen among common nouns. Each series was arranged so that adjacent items did not form meaningful units and did not show phonological similarities. Every participant was presented with four sequences for each series.

The word span was assessed in the oral modality. Appendix A1 provides the list of words used in the word repetition task.

3.6.2 Forward and backward digit span task

The forward (subtest 7) and backward (subtest 13) digit span tasks were included in the TEMA (Test di Memoria e Apprendimento, Reynolds & Bigler, 1995). They consisted in the immediate serial recall of sequences of digits (1-10) of increasing length. Stimuli were assembled into sequences ranging from 2 to 10 numbers for the forward digit span and from 2 to 9 for the backward digit span. They were read aloud at the rate of 1 second per item, and the individual was required to recall and immediately repeat the digits in the same order as they were presented by the experimenter. For backward digit span, individuals were required to recall numbers in the reversed order with respect to that of the presentation by the experimenter. Testing proceeded until the children incorrectly repeated less than 4 digits in two consecutive trials. One point was assigned for each number recalled in the correct position. The higher the score, the better the performance. The manual provides normative data for each age range and makes it possible to transform raw scores into standard scores. Children obtaining a standard score included between 8 and 12 showed mean performance. Those who achieve lower scores perform below mean, and those who achieve higher scores perform above mean.

The list of stimuli is shown in Appendix A3.

3.6.3 Non-word repetition task

This task was included in a battery for assessing linguistic abilities in children from 4 to 12 years, known as “Batteria della valutazione del linguaggio in bambini dai 4 ai 12 anni” (Fabbro 1999), the Italian adaptation of the “Batterie d’évaluation du langage oral de l’enfant aphasique” (De Agostini et al. 1998).

In the non-word repetition task, children cannot rely on a pre-existing phonological representation to repeat the non-word, as it happens with word repetition. Basically, children have to build a new phonological representation after hearing the novel auditory stimulus and then translate or reassemble the newly formed representation into an articulatory output in speech production.

The non-word repetition task consisted in the repetition of 15 non-existing words of different length, ranging from one to four syllables. The task was composed of the following stimuli:

- four monosyllabic non-words
- five bisyllabic non-words
- five trisyllabic non-words
- one four-syllable non-words

For this task, also data collected from typically-developing children ranging in age from 4 to 11 years were provided.

The list of stimuli is shown in Appendix A2.

3.6.4 Sentence recall

The task of sentence repetition has often been used in some experimental studies on child language development by Fraser et al. (1963), Slobin & Welsh (1973), Radford (1990), and is suitable for vulnerable linguistic areas to be identified. The underlying assumption is that the model sentence cannot be kept in the short-term memory but the child will interpret its semantic content and reconstruct it according to his/her own grammar.

The experimenter said each sentence aloud and the children were required to recall the sentence immediately. Sentences of different length and difficulty were elaborated. The difficulty of sentences ranged from simple active structures with SVO order to sentences with more complex syntactic structures, namely relative clauses, passive sentences, coordination sentences and clitic left-dislocation sentences.

Children's responses were tape recorded. Performance on the sentence recall task was scored following Alloway & Gathercole (2005). A way to calculate the accuracy of sentence recall could have been to consider that a sentence had an error if one or more syntactical or lexical errors occurred in the sentence. However, such a method does not take into account the variability in syntactic complexity or sentence length. Hence, to attribute a score percentage to each participant, the accuracy of recall was determined using a criterion according

to which a word was considered as correct if it was recalled in its original position within the sentence.

The list of stimuli is shown in Appendix A4.

3.7 Preliminaries

Before beginning the experiment, a written consent was distributed to all parents (both for hearing and hearing-impaired participants), together with a short presentation of the experiment. Only those who gave the consent form back duly signed were included in the experiment. Adults were also asked to sign the written consent.

In addition, in order to make sure that children included in the studies were monolingual Italian-speakers, parents were asked to inform us about the language mainly spoken in their family, by choosing among four options:

- Italian
- Italian and dialect
- Italian and a foreign language
- Mainly a foreign language

Only those who used Italian, and Italian and dialect in their family were finally included in the experiment. Children belonging to other bilingual or multilingual contexts were tested as well, but they were not included in this analysis.⁷

3.8 Participants

The tests presented in the previous sections were run on five different populations: hearing-impaired children with a cochlear implant, hearing-impaired adolescent LIS signers, hearing children, hearing adolescents, and hearing adults⁸.

These populations were compared in three different studies:

- study one compares hearing impaired children with a cochlear implant and language-matched hearing children, in the repetition, comprehension, and production tasks

⁷ The production by these children was investigated by Lunardi (2009)

⁸ Adults were administered only the comprehension and production task.

- study two compares LIS signers, hearing children, and hearing adolescents, in the repetition and comprehension tasks
- study three compares hearing children, hearing adolescents and hearing adults, in the repetition, comprehension and production tasks.

In this section, the groups of participants included in the experiment are presented in detail. The analysis of the different studies will be presented in the next chapters.

3.8.1 Hearing-impaired children using a cochlear implant

The group of hearing-impaired participants using a cochlear implant is composed of 13 children ranging in age from 7;9 to 10;8, (mean age 9;2)⁹. All of them had profound hearing loss (≥ 90 dB), classified accordingly to B.I.A.P (Bureau International d’Audiophonologie – see Chapter 1, section 1.4). All children were hearing-impaired since birth. All children are born to hearing parents and use a cochlear implant.

Nine children were recruited at the hospital of Rovereto, “Presidio Ospedaliero S. Maria del Carmine”, in Trento and three were recruited at the ‘Centro Medico di Foniatria’ in Padua. They had bilateral, sensorineural hearing loss. They have grown up in families where Italian is habitually spoken, and none of them has ever used the Italian Sign Language. They have been exposed exclusively to the oral language. As soon as they were diagnosed as hearing-impaired, they were immediately fitted with hearing aids. For all of them, fitting with hearing aids occurred within the second year of life (from 0;5 to 1;8 years) and the age of cochlear implantation varied between 1;9 and 3;4 years. The cochlear implant use duration varied from 4;5 to 8;6 years. All children had been trained orally and all of them received speech-language therapy from two to three times per week. They had normal IQ. They did not show any other associated disabilities. At the time of testing, they were attending primary schools in hearing classes.

⁹ Actually, we tested 14 hearing-impaired children, but one of them had to be excluded from the analysis because her performance strongly deviated from that of the other children. Moreover, differently from the other children, she had great difficulties even to correctly comprehend and repeat nouns in the word repetition task.

Table 1 provides a summary of personal data and clinical data for each hearing-impaired participant.

ID	Age (Y;M)	Age of HA (Y;M)	Age of CI (Y;M)	CI Use Duration (Y;M)	HL (dB)	HL with HA (dB)	HL with CI (dB)
201	10;8	0;9	2;2	8;6	90	85	30
202	7;11	1;2	1;11	6;0	>90	75	25
203	7;9	1;0	3;4	4;5	>90	85	30
205	9;6	1;6	2;4	7;2	>90	85	30
206	9;6	1;6	2;3	7;3	>90	55	30
207	9;6	1;6	2;4	7;2	>90	85	30
208	8;10	1;0	2;11	5;11	90	65	30
209	9;5	1;8	2;3	7;2	>90	85	30
210	9;9	0;9	2;8	7;1	>90	85	30
211	9;10	0;5	1;9	8;1	>90	85	30
212	9;3	0;10	1;9	7;6	>90	85	30
213	8;1	1;0	1;10	6;3	>90	85	25
214	8;2	1;4	2;3	5;11	>90	75	25

Table 1: identification number and data of the hearing-impaired children (HL: Hearing loss; HA: Hearing aids; CI: cochlear implantation)

3.8.2 Hearing-impaired LIS signers

The hearing-impaired group is composed of six adolescent native LIS signers, ranging in age from 15;5 to 17;6. Identification numbers and age of each participant are shown in the following table:

ID	AGE
85	15;5
83	15;9
82	16;1
80	16;11
84	16;5
81	17;6

Table 2: identification number and age of the LIS signers

They were profoundly deaf since birth, born to deaf parents. They were hosted in a residential school for deaf people, at the “Istituto Magarotto” in Padua. They had severe and profound hearing loss. Two of them habitually used conventional hearing aids (IDs 80 and 84). Unfortunately, it was not possible to obtain all personal and clinical details of each participant. Therefore, correlation analyses in order to determine whether and how hearing impairment could have influenced the performance were not possible. The list of the LIS signers is showed in the following table:

3.8.3 Hearing children

The group of hearing children included in this work is composed of 22 children ranging in age from 5;3 to 7;10 (mean age: 6;8). They were recruited in a nursery and two primary schools of the Istituto Comprensivo “A. Gramsci” of Campalto - Venice. All of them were monolingual speakers of Italian. They did not have any language impairment or any hearing or mental disabilities. Some of them were also exposed to dialect in their families. Identification numbers and age of each participant are shown in the following table:

ID	AGE	ID	AGE
8	5;3	59	6;10
16	5;3	48	7;1
10	5;7	46	7;2
19	5;8	53	7;2
13	5;10	49	7;3
22	6;1	43	7;4
30	6;1	42	7;5
20	6;2	58	7;5
21	6;7	54	7;6
26	6;7	50	7;9
31	6;9	52	7;10

Table 3: identification number and age of the hearing children

3.8.4 Hearing adolescents

The group of hearing adolescents was composed of 16 participants. They were recruited at the High-school I.T.C.S. “Leon Battista Alberti” in San Donà di Piave (Venice). They ranged in age from 15;1 to 17;5 years (mean age 15;5) and were enrolled in the second and third class of the school. They did not have any language impairment or any hearing or mental disabilities. All students were monolingual speakers of Italian and came from the North-East of Italy. Identification numbers and age of each participant are shown in the following table:

ID	AGE	ID	AGE
74	14;1	63	15;3
62	14;2	69	15;3
64	14;3	78	15;6
61	14;5	71	16;5
67	14;9	65	16;7
68	14;11	79	16;7
60	15;2	66	16;8
75	15;2	70	17;5

Table 4: identification number and age of the hearing adolescents

3.8.5 Hearing adults

The group of hearing adults included 16 participants ranging in age from 19;11 and 33;9 (mean age 24;11). Some of them were attending university at the time of testing, and some others had already finished it. Only one of them interrupted university attendance after the first year. In any case, for all of them, the age of schooling was at least 13 years. Some of them were students recruited at the Language Sciences Department of the University of Venice. All of them live in North-East of Italy, in the region of Veneto or near the border with Friuli-Venezia-Giulia. Some hearing participants habitually use the dialect variety spoken in their area both in family and with their friends. The list of all adult participants is showed in the following table:

ID	AGE	ID	AGE
99	19;11	91	22;11
97	20;1	89	24;9
100	20;1	98	25;9
87	20;2	93	26;4
101	20;11	94	27;11
95	21;11	92	31;9
90	22;3	86	33;1
96	22;10	88	33;9

Table 5: identification number and age of the hearing adults

3.9 Procedure

The tasks were administered in more than one session, in such a way that in each session both memory ability and either comprehension or production skills were assessed. The repetition tasks always preceded the comprehension or production tasks.

The order of task administration for all participants is the following:

1. First session:

- Forward and backward digit span (Reynolds & Biegler 1995)
- Non-word repetition (Fabbro 1999)
- Test di Comprensione Grammaticale per Bambini (TCGB – Chilosi et al. 1995/2006)

2. Second session:

- Word repetition
- Production task

3. Third session:

- Sentence repetition
- Comprehension task

Typically-developing children were tested at their infancy or primary schools. The experiment was preceded by a familiarization session with the whole class and the teachers, during which the experimenters introduced themselves and the puppets (the hippo “Filippo” in the nursery school and in the first class of the primary school and the snail “Camilla” in the second class of the primary school) to the children. The two puppets wanted to learn Italian, but they were too

frightened to talk to adults and therefore they asked children to help them in this learning purpose. After this preliminary session, hearing children were tested individually in a quiet room.

Hearing adolescents were tested individually at their high school during school time. Adults were tested individually in a quiet room at the University of Venice.

Hearing-impaired children were tested by the speech therapist and the experimenter during their individual speech therapy sessions. With them, the puppets were not used.

Hearing-impaired signers were tested at their residential school, in afternoon hours.

All tasks were administered through the oral modality. For hearing-impaired children, the tasks were administered without the experimenter's mouth hidden by his hands, in order for the children to eventually rely on lip-reading.¹⁰ When the stimuli were not perfectly heard, they were read again. To LIS signers, the test was administered in the written modality and items were presented on separate strips of paper, since these participants are not trained to lip-reading and oral-administration would have been extremely problematic.

Test instructions were signed by the experimenter for LIS signers and presented orally for all other participants. LIS was never used to support the administration of experimental trials.

¹⁰ This choice was due to the fact that exercises performed with the experimenter's mouth hidden by his hands mainly assess hearing competence. We wanted instead to assess linguistic competence.

CHAPTER 4

THE EXPERIMENT: THE REPETITION TASKS

4.1 Introduction

This section will present the scores that each participant achieved in each repetition task. The scores achieved in these tasks will be used to investigate whether the performance in the comprehension task is related to memory skills, in both hearing and hearing-impaired individuals. Correlation analyses with performance on the different conditions of the comprehension task will be shown in the next chapter. The aim of this study is neither to analyse the processes involved in working memory, nor to detect problems in the working memory system of the investigated individuals, but to analyse the comprehension and production of relative clause, also investigating whether any correlation exists between comprehension and memory resources. It would also be interesting to know how the different measures assessing working memory interact with each other. However, these questions go far beyond the scope of this study. Therefore, we will leave these issues open for future psycholinguistic research.

4.2 The role of working memory

The term ‘working memory’ refers to the ability of the individual to store and manipulate information in his/her mind for a short period of time (Gathercole & Alloway 2004). Working memory capacity varies across individuals and age, especially in childhood (Gathercole et al. 2004, cited in Gathercole & Alloway 2006). Performance on working memory begins to level off more or less at adolescence, when it becomes comparable to the levels reached by adults.

Working memory plays an important role in learning and in the development of language skills (Gathercole & Baddeley 1993, Baddeley et al 1998, Alloway & Gathercole 2005). Scores on complex memory span tasks are predictive of different general academic abilities, such as literacy, mathematics (Gathercole & Pickering 2000), and language comprehension (Seigneuric et al. 2000).

The role of working memory in linguistic performance is shown by Gathercole et al. (2004), who found that poor linguistic abilities in English-speaking children are accompanied by low working memory scores. Close links between working memory and learning attainments were also shown by Gathercole et al. (2003), in a longitudinal study in which working memory skills were measured shortly after school entry.

Linguistic performance is correlated with different measures of memory abilities (forward and backward digit span, non-word repetition, sentences recall). Findings on the relation between sentence recall and the development of learning skills (Alloway & Gathercole 2005) have demonstrated that sentence recall tasks represent an important diagnostic tool for identifying learning difficulties. Memory span for words in sentences was found to be almost twice as big as the span for unrelated sequences of words (Baddeley et al. 1987). However, “the gist of the sentence is preserved” (Saffran & Martin 1975). Sentence recall positively relies on the representation of the meaning of sentence, even though, sometimes, “due to spreading activation to semantically associated items, related words may be erroneously selected” (Potter and Lombardi 1990, 1998).

In this investigation, we collected data from different tasks investigating the role of memory resources, in order to determine whether working memory limitations may influence the comprehension of complex syntactic structures, as relative clauses are. Papagno et al. (2007), for instance, investigated the role of memory in processing sentences of increasing difficulty (also including relative clauses), in a 35-year-old woman with a selective memory deficit. They found that, due to this deficit, the woman experienced consistent difficulties in comprehending centre-embedded, object cleft, and object right-branching relative clauses, performing significantly lower than controls.

Limitations of verbal working memory have negative consequences on language processing (Bishop et al. 1996, Ellis Weisner et al. 2000) by English-speaking SLI children, and language comprehension of complex sentences by French-speaking SLI children (Jakubowicz 2005, Jakubowicz & Tuller, 2008). Low memory resources also affect the development of language skills by hearing-

impaired children (Pisoni & Geers 2000, Cleary et al. 2002, Dillon et al.2004, Szagun 2004).

4.3 The relation between memory and language abilities in hearing-impaired individuals

Much research has turned its attention to the analysis of whether memory abilities play a significant role in linguistic performance in hearing-impaired children (Pisoni & Geers 2000, Cleary et al. 2002, Dillon et al. 2004, Szagun 2004). Various studies investigating the role of working memory in the development of linguistic abilities have demonstrated that LIS signers showed to have a limited working memory system (Geraci et al. 2008), and also children using cochlear implants have shorter memory spans if compared to their normal-hearing peers (Dawson et al. 2002).

Szagun (2004) suggests that due to auditory deprivation during early development, processing deficits in working memory of hearing-impaired children may cause syntactic difficulties. Indeed, these children may experience difficulties in the acquisition of elements that require processing and storing of information across elements in the sentence, such as gender and case agreements.

Pisoni & Geers (2000) analysed the role of working memory in 43 hearing-impaired children with profound hearing loss and found a correlation between auditory digit span and four sets of outcome measures (speech intelligibility, speech perception, language comprehension, reading), thus proving that the working memory may influence the performance outcomes. They observed enormous individual differences among cochlear-implant users. Nonetheless, since spoken language and working memory “share a common set of processing resources” (Gathercole et al. 1997), a close interrelation between these two variables was found in cochlear-implanted children.

Non-word repetition also appears to be a crucial measure to determine the outcomes of linguistic performance. The non-word repetition task is an extremely complex task involving the fast execution and coordination of several underlying linguistic processing skills. The processes necessary to the child to repeat a non-word stimulus are complex. First of all, the child has to perceive a completely

novel sound pattern only relying on the auditory modality without the aid of speech reading, pragmatic context or semantic content. Then he/she has to hold and verbally rehearse this novel sound pattern in immediate phonological memory. Finally, he/she has to rehearse and transform the perceived sound into an articulatory output.

The participant's ability to rehearse a non-word stimulus depends on two subcomponents of the phonological working memory, namely the "temporary storage system", holding in memory traces for few seconds, and the "subvocal rehearsal system", in order to rehearse and produce the stimulus (Baddeley 2001, 2003).

Dillon et al. (2004) investigated the relation between non-word repetition performance and scores on vocabulary, speech and linguistic abilities in 76 children using a cochlear implant and found that children had variable performances, repeating correct non-word stimuli for 75% to 100% of all stimuli. A previous study carried out by Cleary et al. (2002) found that non-word repetition was strongly correlated with other independent measures of spoken word recognition, language comprehension, working memory, speech intelligibility and speech rate. Results showed that children with a sufficient experience with cochlear implants are able to accurately repeat non-word stimuli.

The importance and the need to collect data from auditory memory tasks by cochlear-implanted children have been emphasized by Pisoni (2000). The analysis of the role of memory and perceptual learning in children who use cochlear implants is crucial, because the errors that they make may be due to the incorrect perception of the proposed stimuli (Dawson et al. 2002).

In this chapter, however, we will only check whether significant differences exist between the performances of the groups included in the different comparisons, without investigating the mechanisms involved in memory storage.

4.4 Study one: hearing-impaired children with a cochlear implant and hearing children

In study one, we compare the performance on repetition tasks by a group of hearing-impaired children using a cochlear implant with that of a group of

younger hearing children, selected on the basis of comparable general morpho-syntactic abilities (TCGB, Chilosi et al. 1995/2006)

4.4.1 Participants

Two groups of Italian monolingual children are included in this study. A group of 13 hearing impaired children using a cochlear implant (CI group, age range 7;9-10;8, mean age 9;2) and a group of 13 typically-developing children (LA group, age range 5;7-7;9, mean age 6;7), matched to the hearing impaired group on linguistic age and scores on the TCGB test.¹

Language-matched children were selected among those who had normal range scores on the TCGB test, by being included between the 25^o and 75^o percentile. No significant difference was found between the TCGB scores of the two groups (Mann Whitney U=74.5 p=.606).

The following table shows the list of participants:

CI GROUP		LA GROUP	
ID	AGE	ID	AGE
201	10;8	13	5;10
202	7;11	43	7;4
203	7;9	10	5;7
205	9;6	50	7;9
206	9;6	58	7;5
207	9;6	42	7;5
208	8;10	20	6;2
209	9;5	59	6;10
210	9;9	49	7;3
211	9;10	54	7;6
212	9;3	53	7;2
213	8;1	52	7;10
214	8;2	22	6;1

Table 6: Participants of study one. Each hearing-impaired child is matched to a hearing child on morphosyntactic abilities (TCGB)

For details on the participants of this study, see chapter 3 sections 3.8.1 and 3.8.3.

¹ In this experiment, hearing impaired children were matched only to linguistic-age peers. We plan to compare hearing-impaired children with children matched on chronological age in future work.

4.4.2 Results

Results are shown separately for each task in the following sections.

4.4.2.1 Word-repetition task

In this task, children were required to repeat different sequences of two-syllable unrelated words immediately after the experimenter had read them (see chapter 3, section 3.6.1). For each individual in each group, table (7) and (1) report the results (number and percentage of correct words repeated in the correct position) in two-, three-, four-, five- and six-word sequences:

CI ID	2		3		4		5		6		Mean words
	nr	%	nr	%	Nr	%	nr	%	nr	%	
201	7/8	88%	11/12	92%	2/16	13%	2/20	10%	0/24	0%	40%
202	8/8	100%	12/12	100%	10/16	63%	7/20	35%	6/24	25%	65%
203	8/8	100%	12/12	100%	4/16	25%	0/20	0%	1/24	4%	46%
205	8/8	100%	12/12	100%	12/16	75%	2/20	10%	1/24	4%	58%
206	8/8	100%	12/12	100%	16/16	100%	14/20	70%	14/24	58%	86%
207	8/8	100%	12/12	100%	15/16	94%	15/20	75%	6/24	25%	79%
208	8/8	100%	12/12	100%	15/16	94%	13/20	65%	1/24	4%	73%
209	8/8	100%	12/12	100%	9/16	56%	4/20	20%	5/24	21%	59%
210	7/8	88%	11/12	92%	10/16	63%	4/20	20%	5/24	21%	57%
211	8/8	100%	10/12	83%	13/16	81%	8/20	40%	3/24	13%	63%
212	8/8	100%	12/12	100%	14/16	88%	11/20	55%	6/24	25%	74%
213	8/8	100%	12/12	100%	16/16	100%	6/20	30%	4/24	17%	69%
214	8/8	100%	12/12	100%	16/16	100%	9/20	45%	3/24	13%	72%
mean											
group		98%		97%		73%		37%		18%	
sd		5%		5%		29%		24%		15%	

Table 7: nr. and % of correctly repeated words by hearing-impaired children (CI group)

LA	2		3		4		5		6		Mean words
	nr	%	nr	%	Nr	%	nr	%	nr	%	
13	8/8	100%	12/12	100%	16/16	100%	17/20	85%	5/24	21%	81%
43	8/8	100%	12/12	100%	8/16	50%	6/20	30%	5/24	21%	60%
10	8/8	100%	12/12	100%	9/16	56%	8/20	40%	2/24	8%	61%
50	8/8	100%	12/12	100%	16/16	100%	11/20	55%	2/24	8%	73%
58	8/8	100%	12/12	100%	13/16	100%	14/20	70%	10/24	42%	82%
42	8/8	100%	11/12	92%	13/16	81%	14/20	70%	8/24	33%	75%
20	8/8	100%	12/12	100%	16/16	100%	17/20	85%	4/24	17%	80%
59	8/8	100%	12/12	100%	16/16	100%	17/20	85%	3/24	13%	80%
49	8/8	100%	12/12	100%	16/16	100%	18/20	90%	11/24	46%	87%
54	8/8	100%	12/12	100%	13/16	81%	12/20	60%	2/24	8%	70%
53	8/8	100%	12/12	100%	16/16	100%	20/20	100%	6/24	25%	85%
52	8/8	100%	12/12	100%	16/16	100%	15/20	75%	2/24	8%	77%
22	8/8	100%	12/12	100%	16/16	100%	10/20	50%	8/24	33%	77%
mean group	100%		99%		90%		69%		22%		
Sd	0%		2%		18%		21%		13%		

Table 8: nr. and % of correctly repeated words by hearing children (LA group)

To compare the performance between the two groups, we carried out a statistical analysis using the Mann-Whitney test for independent samples.

Data show that hearing children achieved higher scores on the repetition of each sequence. Overall, the analysis identified a significant difference between the two groups ($U=35.5$ $p=.012$). By comparing the performance between the two groups in each word sequence, we detected a significant difference only in the repetition of series from four ($U=48$ $p=.048$) and five words ($U=27$ $p=.003$).

4.4.2.2 Non-word repetition task

In the non-word repetition task, children were asked to repeat immediately after the experimenter 15 non-words (see chapter 3, section 3.6.3). The following table shows the numbers and percentages of correct non-words repeated by each individual in each group:

CI GROUP			LA GROUP		
<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>	<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>
201	13/15	87%	13	9/15	60%
202	13/15	87%	43	15/15	100%
203	12/15	80%	10	15/15	100%
205	13/15	87%	50	15/15	100%
206	15/15	100%	58	15/15	100%
207	13/15	87%	42	15/15	100%
208	14/15	93%	20	15/15	100%
209	15/15	100%	59	15/15	100%
210	15/15	100%	49	15/15	100%
211	13/15	87%	54	15/15	100%
212	13/15	87%	53	15/15	100%
213	15/15	100%	52	15/15	100%
214	15/15	100%	22	15/15	100%
Mean	92%		Mean	97%	
sd	7%		sd	11%	

Table 9: nr. and % of correctly repeated non-words by CI and LA groups

This task is included in a battery, which also reports some normative data on the mean of non-words repeated by typically-developing children at the different age ranges:

	4;0-4;6	4;7-5;0	5;0-5;6	5;7-6	6	7	8	9	10
Mean	10	12	12	12	13	14	14	14	14
1 sd	8	9	10	10	11	12	12	12	13
2 sd	6	7	8	9	10	11	11	11	12

Table 10: normative data for the non-word repetition task (Fabbro 1999)

We remind that hearing-impaired children range in age from 7;9 to 10;8, while hearing children range from 5;7 to 7;9. One hearing child (age 5;10) performed two standard deviations below the mean, while the others performed at ceiling. In the hearing-impaired group, most children performed at ceiling, while six of them performed one standard deviation below the mean. The highest number of errors in the hearing-impaired group also resulted in a significantly lower performance of this group as opposed to that of the hearing group (Mann-Whitney, $U=43$ $p=.011$). That hearing impairment may contribute to low scores on working memory tasks, especially those involving the repetition of non-words, was also found by Briscoe et al. (2001).

4.4.2.3 Forward & Backward Digit Span

These tasks are two subtests (Subtest 7 for forward digit span, and Subtest 13 for backward digit span) included in the TEMA (Reynolds & Bigler 1995) (see chapter 3, section 3.6.2).

This task consisted in the immediate serial recall of sequences of digits of increasing length. Children had to repeat the digit in same exact order as presented by the experimenter (forward digit span) and in the reversed order (backward digit span). One point was attributed for each digit correctly repeated in the exact sequence. The following tables report the scores obtained by summarizing all scores in each sequence. For this task, normative data collected from typically-developing individuals are also available.

For each child, the table shows the raw score (left column) and the corresponding standard score (right grey column). The standard scores have been attributed considering the age of the children, on the basis of the tables contained in the TEMA, which provide the relevant standard scores for each age range:

	Forward		Backward	
	Raw Score	Standard Score	Raw Score	Standard Score
201	20	4	12	8
202	21	7	13	10
203	29	9	10	9
205	43	10	18	10
206	52	11	11	8
207	35	9	21	11
208	36	10	17	11
209	29	7	21	11
210	24	6	17	10
211	27	7	22	11
212	28	7	8	7
213	37	10	11	9
214	39	10	17	11
<i>Mean</i>	31		16	
<i>Sd</i>	8		6	

Table 11: digit span score in cochlear-implanted children

	Forward		Backward	
	Raw Score	Standard Score	Raw Score	Standard Score
13	43	14	4	8
43	17	5	14	11
10	29	10	1	7
50	22	7	18	12
58	27	8	14	11
42	49	12	11	10
20	49	13	9	10
59	36	11	23	14
49	43	12	23	13
54	20	6	14	11
53	38	11	22	13
52	36	10	12	10
22	46	13	13	11
Mean	34		15	
sd	11		7	

Table 12: digit span score in normal-hearing children

The children who obtained standard scores between 8 and 12 show mean performance; children obtaining higher scores are above the mean and children obtaining lower scores are below the mean. The child who achieved 5 standard scores is definitely below the mean.

In both subtests, the Mann-Whitney did not detect any significant difference between the two groups.

4.4.2.4 Sentence Repetition Task

In this task, children were required to repeat twenty sentences of different length and syntactic difficulty (see chapter 3, sections 3.6.4). The table shows the percentages of accuracy obtained in this task, following the scoring methods proposed by Alloway & Gathercole (2005):

CI			LA		
<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>	<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>
201	81/146	55%	13	135/146	92%
202	120/146	82%	43	118/146	81%
203	124/146	85%	10	114/146	78%
205	131/146	90%	50	138/146	95%
206	145/146	99%	58	133/146	91%
207	143/146	98%	42	138/146	95%
208	129/146	88%	20	133/146	91%
209	134/146	92%	59	143/146	98%
210	101/146	69%	49	146/146	100%
211	132/146	90%	54	129/146	88%
212	140/146	96%	53	141/146	97%
213	138/146	95%	52	141/146	97%
214	137/146	94%	22	144/146	99%
Mean	87%		Mean	92%	
sd	12%		sd	7%	

Table 13: accuracy scores in the sentence repetition task by CI and LA groups

Both groups experienced some difficulties in the repetition of long and/or complex sentences, namely coordinated structures and relative clauses. Sometimes, sentences containing clitic pronouns also proved to be difficult. Clitic pronouns were avoided and simple SVO sentences were produced instead. Common errors include additions, deletions and substitutions of the target words. In any case, no significant difference was attested between the two groups.

4.5 Study two: LIS signers, hearing children and hearing adolescents

In this study, we compare the performance of a small group of LIS signers (LIS group) with that of two hearing control groups.

4.5.1 Participants

The hearing-impaired group is composed of six adolescent LIS signers (LIS group – see Grosselle 2008, age range: 15;5-17;6) who were matched to six normal-hearing young children (age range: 5;3-7;5) on the basis of morphosyntactic

abilities (LA group), and to six normal-hearing adolescents (age range: 15;3-17;5) on the basis of chronological age (CA group).

The following table summarizes some details of participants of the three groups:

LIS GROUP		LA GROUP		CA GROUP	
ID	AGE	ID	AGE	ID	AGE
80	16;11	31	6;9	66	16;8
81	17;6	42	7;5	70	17;5
82	16;1	13	5;10	71	16;5
83	15;9	16	5;3	78	15;6
84	16;5	59	6;10	79	16;7
85	15;5	19	5;8	69	15;3

Table 14: participants of study two (each LIS signer is matched on language age – LA – and to and chronological age –CA – to a hearing participant)

In the normal-hearing children group, children were selected among those who had normal range scores on the TCGB test (25°-75° percentile). No significant difference was found between the scores of the TCGB test of the LIS signers and the children (Mann Whitney U=8 p=.107). No significant difference was found between the ages in months of the LIS signers and the hearing adolescents (Mann Whitney U=16.5 p=.808).

For details on the participants of this study, see chapter 3 sections 3.8.2 3.8.3, and 3.8.4.

To LIS signers, all stimuli were presented in the written modality, while to hearing participants, the task was administered through the oral modality.

4.5.2 Results

Results are shown separately for each task in the following sections.

4.5.2.1 Word repetition task

The following table report the results in two-, three-, four-, five- and six-word sequences (number and percentage of correct words repeated in the correct position) for each individual included in each group (see chapter 3, section 3.6.1):

ID	2		3		4		5		6		Mean words
	nr	%	nr	%	nr	%	nr	%	Nr	%	
83	8/8	100%	9/12	75%	5/16	31%	4/20	20%	6/24	25%	50%
82	8/8	100%	12/12	100%	12/16	75%	9/20	45%	10/24	42%	72%
80	8/8	100%	11/12	92%	12/16	75%	12/20	60%	11/24	46%	75%
85	8/8	100%	12/12	100%	11/16	69%	10/20	50%	12/24	50%	74%
84	8/8	100%	12/12	100%	13/16	81%	18/20	90%	8/24	33%	81%
81	8/8	100%	12/12	92%	4/16	25%	2/20	10%	2/24	8%	47%
mean group	100%		93%		59%		46%		34%		
sd	0%		10%		25%		29%		15%		

Table 15: nr. and % of correctly repeated words by LIS signers (LIS group)

ID	2		3		4		5		6		Mean words
	nr	%	nr	%	nr	%	nr	%	nr	%	
16	8/8	100%	12/12	100%	14/16	88%	6/20	30%	1/24	4%	64%
13	8/8	100%	12/12	100%	16/16	100%	17/20	85%	5/24	21%	81%
31	8/8	100%	12/12	100%	15/16	94%	13/20	65%	7/24	29%	78%
19	8/8	100%	12/12	100%	12/16	75%	4/20	20%	0/24	0%	59%
59	8/8	100%	12/12	100%	16/16	100%	17/20	85%	3/24	13%	80%
42	8/8	100%	11/12	92%	13/16	81%	14/20	70%	8/24	33%	75%
Mean group	100%		99%		90%		59%		17%		
Sd	0%		3%		10%		28%		13%		

Table 16: nr. and % of correctly repeated words by hearing children (LA group)

ID	2		3		4		5		6		Mean words
	nr	%	nr	%	nr	%	nr	%	nr	%	
78	8/8	100%	12/12	100%	16/16	100%	18/20	90%	13/24	54%	89%
71	8/8	100%	12/12	100%	16/16	100%	18/20	90%	4/24	17%	81%
66	8/8	100%	12/12	100%	16/16	100%	17/20	85%	14/24	58%	89%
69	8/8	100%	12/12	100%	16/16	100%	14/20	70%	15/24	63%	87%
79	8/8	100%	12/12	100%	16/16	100%	17/20	85%	15/24	63%	90%
70	8/8	100%	12/12	100%	16/16	100%	18/20	90%	19/24	79%	94%
mean group	100%		100%		100%		85%		56%		
sd	0%		0%		0%		8%		21%		

Table 17: nr. and % of correctly repeated words by hearing adolescents (CA group)

Adolescents performed at ceiling in the repetition of two-, three-, and four-word-series. Percentages are quite high also for five-word series. More problematic is instead the repetition of six-word-series. They achieved higher scores than each of the other two groups. For LIS signers, percentages are high only for series of two and three words. For the other series the percentages are definitely low.

The CA group performed significantly better than both LA and LIS groups. Overall, the analysis identified a significant difference between the CA group and both the LIS and the LA group ($U=5$ $p=.005$ in both cases). By comparing the performance between pairs of groups in each word sequence, no significant difference was found for the repetition of series of three words. A significant difference between the LIS group and the LA group was found in the repetition of series from four words ($p=.012$). Significant differences between the LIS group and the CA group, and between the LA group and the CA group were found in the repetition of series of four words ($p=.002$ and $p=.022$, respectively), five words ($p=.027$ and $p=.026$, respectively), and six words ($p=.037$ and $p=.016$, respectively).

4.5.2.2 Non-word repetition task

The non-word repetition task was not administered to the hearing adolescents, but only to the group of LIS signers and to the language-matched hearing group.

LIS			LA		
<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>	<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>
83	15/15	100%	16	13/15	87%
82	15/15	100%	13	9/15	60%
80	14/15	93%	31	13/15	87%
85	15/15	100%	19	12/15	80%
84	15/15	100%	59	15/15	100%
81	15/15	100%	42	15/15	100%
Mean	99%		Mean	86%	
sd	3%		sd	15%	

Table 18: nr. and % of correctly repeated non-words by the LIS and LA groups

Normative data do not include any analysis on adolescents. Nonetheless, we collected data from the adolescent LIS signers, in order to check whether the performance might be influenced by low phonological memory.

The LIS signers performed nearly at ceiling, only one error was detected in one participant. They performed significantly better than hearing children ($p=.049$).

For hearing children, the mean percentage is quite high, although some children placed behind the threshold level for their age.

	4;0-4;6	4;7-5;0	5;0-5;6	5;7-6	6	7	8	9	10
Mean	10	12	12	12	13	14	14	14	14
1 sd	8	9	10	10	11	12	12	12	13
2 sd	6	7	8	9	10	11	11	11	12

Table 19: normative data on the non-word repetition task (Fabbro 1999)

4.5.2.3 Forward & Backward Digit Span

A direct comparison between the groups is not possible, since only in hearing children, memory skills were assessed by using the subtests of the TEMA test. For hearing adolescents, unfortunately, it was not possible to get any data on this repetition task. For LIS signers, memory skills were collected when the experimental protocol was not completely defined. Since by that moment, only the CESPEE B test (Bruni 2002) was available, we adopted this tool to assess memory abilities.

By using the scoring method proposed by the TEMA test, we nonetheless attributed a score to each participant. We will therefore show their scores on the following table, but no statistical comparison will be carried out.

	Forward		Backward	
	Raw Score	Standard Score	Raw Score	Standard Score
83	51	8	27	9
82	46	7	33	10
80	49	7	36	10
85	49	7	34	10
84	51	8	36	10
81	53	8	38	10
Mean	49,8		34,0	
sd	2,4		3,8	

Table 20: digit span score in the group of LIS signers

	Forward		Backward	
	Raw Score	Standard Score	Raw Score	Standard Score
13	41	13	1	7
43	43	14	4	8
10	20	7	11	10
50	17	7	15	13
59	36	11	23	14
42	49	12	11	10
Mean	36,5		11,5	
sd	12,2		9	

Table 21: digit span score in normal-hearing children

Children achieving a score include between 8 and 12 showed mean performance. Those achieving lower scores showed below mean performance, and those achieving higher scored showed above mean performance.

4.5.2.4 Sentence Repetition Task

The sentence repetition task was administered to all groups. Table (22) shows the percentages of correct words repeated in the correct position within the sentence:

LIS			LA			CA		
ID	Nr. Corr	% Corr	ID	Nr. Corr	% Corr	ID	Nr. Corr	% Corr
83	103/157	66%	13	124/146	98%	78	146/146	100%
82	135/157	86%	43	135/146	95%	71	146/146	100%
80	115/157	73%	10	119/146	82%	66	146/146	100%
85	92/157	59%	50	117/146	80%	69	146/146	100%
84	141/157	90%	59	143/146	85%	79	146/146	100%
81	126/157	80%	42	138/146	92%	70	146/146	100%
Mean	76%		Mean	89%		Mean	100%	
sd	12%		Sd	7%		sd	0%	

Table 22: nr. and % of correctly repeated non-words by LIS, LA and CA groups

Hearing adolescents performed at ceiling. LIS signers and hearing children achieved instead lower scores. In the group of LIS signers, a high inter-individual variability was found. Also in this study, LIS and LA groups experienced some difficulties in the repetition of long and/or complex sentences, namely coordinated structures and relative clauses, and sometimes also in the repetition of left-dislocation sentences. Clitic pronouns were avoided and simple SVO sentences

were produced instead. Common errors included additions, deletions and substitutions of the target words. By running a between-group analysis, significant differences were attested between the CA group and both the LIS and the LA groups ($p=.002$, in both cases).

4.6 Study three: hearing children, adolescents and adults

Study three includes the comparison between three hearing populations, namely children, adolescents and adults. However, the repetition tasks were not administered to adults. Hence, in the following sections, only the comparison between children and adolescents will be shown.

4.6.1 Participants

The group of hearing children included 16 participants ranging in age from 5;3 and 7;5 years (mean age 6;5). This group of hearing children was larger and more homogenous than those of the previous studies, including five 5-year-olds children attending the third class at the nursery school, five 6-year-old and six 7-year-old children attending the first and second class at the primary school, respectively.

The group of hearing adolescents was composed of 16 participants. They ranged in age from 15;1 and 17;5 years (mean age 15;5).

The group of hearing adults included 16 participants ranging in age from 19;11 and 33;9 (mean age 24;11).

For further details on the participants of this study, see chapter 3 sections 3.8.3, 3.8.4, and 3.8.5.

4.6.2 Results

Results are shown separately for each task in the following sections.

4.6.2.1 Word repetition task

The following tables show the percentages of accuracy of these two populations in the word repetition task.

ID	2		3		4		5		6		Mean words
	nr	%	nr	%	nr	%	Nr	%	nr	%	
19	8/8	100%	12/12	100%	12/16	75%	4/20	20%	0/24	0%	59%
13	8/8	100%	12/12	100%	16/16	100%	17/20	85%	5/24	21%	81%
8	8/8	100%	12/12	100%	11/16	69%	13/20	65%	1/24	4%	68%
16	8/8	100%	12/12	100%	14/16	88%	6/20	30%	1/24	4%	64%
10	8/8	100%	12/12	100%	9/16	56%	8/20	40%	2/24	8%	61%
21	8/8	100%	12/12	100%	16/16	100%	20/20	100%	11/24	46%	89%
22	8/8	100%	12/12	100%	16/16	100%	10/20	50%	8/24	33%	77%
26	8/8	100%	12/12	100%	16/16	100%	20/20	100%	12/24	50%	90%
31	8/8	100%	12/12	100%	15/16	94%	13/20	65%	7/24	29%	78%
30	8/8	100%	12/12	100%	12/16	75%	1/20	5%	0/24	0%	56%
42	8/8	100%	11/12	92%	13/16	81%	14/20	70%	8/24	33%	75%
48	8/8	100%	12/12	100%	11/16	69%	6/20	30%	3/24	13%	62%
49	8/8	100%	12/12	100%	16/16	100%	18/20	90%	11/24	46%	87%
53	8/8	100%	12/12	100%	16/16	100%	20/20	100%	6/24	25%	85%
58	8/8	100%	12/12	100%	13/16	81%	14/20	70%	10/24	42%	79%
46	8/8	100%	12/12	100%	16/16	100%	10/20	50%	1/24	4%	71%
mean											
group	100%		99%		87%		61%		22%		
sd	0%		2%		15%		30%		18%		

Table 23: nr and % of correctly repeated words by children

ID	2		3		4		5		6		Mean words
	nr	%	nr	%	nr	%	Nr	%	nr	%	
60	8/8	100%	12/12	100%	16/16	100%	12/20	60%	15/24	63%	85%
61	8/8	100%	12/12	100%	16/16	100%	20/20	100%	18/24	75%	95%
62	8/8	100%	12/12	100%	15/16	94%	14/20	70%	12/24	50%	83%
63	8/8	100%	12/12	100%	16/16	100%	13/20	65%	12/24	50%	83%
64	8/8	100%	12/12	100%	16/16	100%	20/20	100%	19/24	79%	96%
65	8/8	100%	12/12	100%	16/16	100%	18/20	90%	15/24	63%	91%
66	8/8	100%	12/12	100%	16/16	100%	17/20	85%	14/24	58%	89%
67	8/8	100%	12/12	100%	16/16	100%	19/20	95%	8/24	33%	86%
69	8/8	100%	12/12	100%	16/16	100%	14/20	70%	15/24	63%	87%
70	8/8	100%	12/12	100%	16/16	100%	18/20	90%	4/24	17%	81%
71	8/8	100%	12/12	100%	16/16	100%	18/20	90%	19/24	79%	94%
74	8/8	100%	12/12	100%	16/16	100%	16/20	80%	5/24	21%	80%
75	8/8	100%	12/12	100%	16/16	100%	16/20	80%	13/24	54%	87%
77	8/8	100%	12/12	100%	16/16	100%	17/20	85%	9/24	38%	85%
78	8/8	100%	12/12	100%	16/16	100%	18/20	90%	13/24	54%	89%
79	8/8	100%	12/12	100%	16/16	100%	17/20	85%	15/24	63%	90%
mean											
group	100%		100%		100%		83%		54%		
sd	0%		0%		0%		12%		19%		

Table 24: nr. and % of correctly repeated words by adolescents

Adolescents performed at ceiling in the repetition of two-, three-, and four-word-series. Percentages were quite high also for five-word series. More problematic was instead the repetition of six-word-series.

Hearing children performed at ceiling in the repetition of two- and three-word-series. Also for four-word-series, percentages are quite high. More problematic is the repetition of five-word-series and for six-word-series, for which percentages are indeed very low. By running a between group analysis, overall, adolescents performed significantly better than children ($p=.001$). Significant differences between the two groups were found in the repetition of series of four words ($p=.002$), five words ($p=.035$), and six words ($p=.000$).

4.6.2.2 Non-word repetition task

This task was administered only to hearing children, since only for them a comparison with normative data was possible. The following table shows the number and the percentage of correctly repeated non-words by each participant:

Children		
<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>
19	12/15	80%
13	9/15	60%
8	9/15	60%
16	13/15	87%
10	15/15	100%
21	14/15	93%
22	15/15	100%
26	15/15	100%
31	13/15	87%
30	12/15	80%
42	15/15	100%
48	15/15	100%
49	15/15	100%
53	15/15	100%
58	15/15	100%
46	15/15	100%
mean	90%	
sd	14%	

Table 25: nr. and % of correctly repeated non-words by children

We report once again below the table containing normative data for children ranging in age from 4;0 to 10;0 years. Two children (13 and 8) were two standard

deviations below the mean. The others showed a level of performance corresponding to their age peers.

	4;0-4;6	4;7-5;0	5;0-5;6	5;7-6	6	7	8	9	10
Mean	10	12	12	12	13	14	14	14	14
1 sd	8	9	10	10	11	12	12	12	13
2 sd	6	7	8	9	10	11	11	11	12

Table 26: normative data on the non-word repetition task (Fabbro 1999)

4.6.2.3 Forward & Backward Digit Span

These tasks were only administered to hearing children.² The following tables report the scores obtained by summarizing all scores obtained in each sequence. For this task, normative data collected from typically-developing individuals are also available.

For each child, the table shows the raw score (left column) and the corresponding standard score (right grey column):

ID	Forward		Backward	
	Raw Score	Standard Score	Raw Score	Standard Score
19	17	7	15	13
13	43	14	4	8
8	39	13	0	6
16	41	13	1	7
10	29	10	1	7
21	67	16	9	10
22	46	13	13	11
26	56	14	9	10
31	20	7	11	10
30	23	8	11	10
42	49	12	11	10
48	23	7	15	11
49	43	12	23	13
53	38	11	22	13
58	27	8	14	11
46	32	10	13	10
Mean	35,6		11,9	
sd	11,6		7,0	

Table 27: digit span score in children

² See study two, section 4.5.2.3 for remarks on hearing adolescents.

Children obtaining standard scores between 8 and 12 show mean performance; children obtaining higher scores are above the mean and children obtaining lower scores are below the mean. Some children showed quite high performance. Most children showed performances comparable to that of their age peers.

4.6.2.4 Sentence Repetition Task

The following table shows the scores attributed to each participant in the sentence repetition task:

CHILDREN			ADOLESCENTS		
<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>	<i>ID</i>	<i>Nr. Corr</i>	<i>% Corr</i>
19	117/146	80%	60	146/146	100%
13	135/146	92%	61	146/146	100%
8	133/146	91%	62	146/146	100%
16	124/146	85%	63	146/146	100%
10	114/146	78%	64	146/146	100%
21	145/146	99%	65	146/146	100%
22	144/146	99%	66	146/146	100%
26	142/146	97%	67	146/146	100%
31	119/146	82%	69	146/146	100%
30	115/146	79%	70	146/146	100%
42	138/146	95%	71	146/146	100%
48	134/146	92%	74	141/146	97%
49	146/146	100%	75	146/146	100%
53	141/146	97%	77	146/146	100%
58	133/146	91%	78	146/146	100%
46	143/146	98%	79	146/146	100%
mean	90,9%		mean	99,8	
Sd	7,8%		sd	0,9	

Table 28: accuracy scores in the sentence repetition task by hearing children and adolescents

Hearing adolescents performed at ceiling. Only one participant made some errors. In particular, he failed to correctly repeat one relative clause, and in some cases, he replaced the target lexical words with other words, semantically associated to the target words. Hearing children achieved lower scores than adolescents. Nonetheless the overall percentage of accuracy is quite high, above 90%. In line with the performance detected in study one and study two, hearing children experienced some difficulties in the repetition of long and/or complex sentences, namely coordinated structures and relative clauses, and sometimes also in the

repetition of left-dislocation sentences. Clitic pronouns were avoided and simple SVO sentences were produced instead. Common errors included additions, deletions and substitutions of the target words. By running a between group analysis, a significant difference was attested between the two groups ($p=.000$).

4.7 Final remarks

The analysis carried out in this section showed that overall, cochlear-implanted children performed lower than hearing controls in the different repetition tasks. LIS signers also scored lower than the hearing control groups. In the same way, hearing children showed lower performance than hearing adolescents. Leaving the analysis of the mechanisms involved in the working memory system open for future research, we will use data collected from the repetition tasks in order to investigate whether a correlation exists between these measures of memory span and the comprehension of relative clauses. Results for all groups will be presented in the next chapter (see section 5.9).

CHAPTER 5

THE EXPERIMENT: THE COMPREHENSION TASK

5.1 Introduction

Comprehension of restrictive relative clauses by different populations across different languages has been at the core of much linguistic and psycholinguistic research since the seventies. Early studies on the comprehension of relative clauses date back at the beginning of the seventies (Sheldon 1974), and proved that even after six years of age, children's mastery of these structures is still problematic.

Children's poor performance (Tavakolian 1981) was explained by arguing that children lack adults' competence to comprehend relative clauses, because they do not have access to recursive rules for building embedded structures. Hence, a relative clause like (42) is interpreted like the conjoined structure in (43):

(42) The pig bumps into the horse that <the horse> jumps over the giraffe

(43) The pig bumps into the horse and <the horse> jumps over the giraffe

Goodluck & Tavakolian (1982) and Hamburger & Crain (1982) rejected this hypothesis, by arguing that children do have adult competence and do have recursion rules, since they produce relative clauses even at early stages of language acquisition. They instead attributed the difficulty to processing and pragmatic factors. In particular, Goodluck & Tavakolian (1982) attributed the source of difficulty to the intrinsic complexity of relative clauses and to the number of arguments receiving a thematic role in the sentence. They claimed that by simplifying the sentence, for example through the use of intransitive verbs, as in (44), accuracy would increase:

(44) The pig bumps into [the horse that hops up and down]

When felicity conditions are met and disturbing factors are removed from the experimental setting, children's performance improves significantly. Bearing these aspects in mind, a great deal of researchers has turned their attention to the elaboration of new tools for adequately testing relative clauses in children and adults showing typical and atypical language development.

5.2 The comprehension of relative clauses in typical and atypical populations

A great number of studies have been carried out on typically-developing children (Friedmann & Novogrodzky 2004, Arnon 2005 for Hebrew; Arosio et al. 2005, Adani 2008 for Italian), children affected by specific language impairment (Stavrakaki 2001 for Greek, Friedmann & Novogrodzky 2004, 2007 for Hebrew, Adani et al. 2007 for English, Adani 2008 for Italian), aphasic patients (Garraffa & Grillo, 2007, Grillo, 2008 for Italian) and adults (De Vincenzi 1991, for Italian). All these studies brought to light a common pattern of response, namely that subject relatives are easier to process and to comprehend than object relatives.

Arosio et al. (2005) investigated the comprehension of three types of restrictive relative clauses in 5- to 11-year-old monolingual typically-developing children, by using a picture selection task. They tested three conditions: subject relatives (45), object relatives with preverbal embedded subject (46) and object relatives with post-verbal embedded subject (47), like those shown in the following examples¹:

- (45) Fammi vedere lo gnomo che <lo gnomo> dipinge i bambini (OS)
'Show me the dwarf that <the dwarf> is painting the children'
- (46) Fammi vedere lo gnomo che i bambini dipingono <lo gnomo> (OO)
'Show me the dwarf that the children are painting <the dwarf>'

¹ As pointed out in chapter 2, subject and object relative clauses differ with respect to the position from which movement has taken place. In subject relatives, the head moves from the embedded subject position (cf. 45) whereas in object relatives, it moves from embedded object position (cf. 46 and 47). The constituents in <> identify the original position from which the head is extracted.

- (47) Fammi vedere lo gnomo che dipingono i bambini <lo gnomo> (OOp)
show me the dwarf that are painting the children <the dwarf>
'Show me the dwarf that the children are painting <the dwarf>'

The analysis of responses demonstrated that most difficulties were experienced on sentences shown in (47) (OOp). In 5-year-old children, the comprehension of (46) (OO) is above chance (70%), whereas (47) (OOp) is below chance (25%). Only by the age of 11, the comprehension of RCs with post-verbal subject seems to reach a level comparable to adult performance.

Adani (2008) tested the same sentence typologies by adopting an agent selection task in which children were asked to point to the correct referent out of three characters². By testing 3-to-7-year-old monolingual Italian children, she replicated the gradient of accuracy (OS > OO > OOp) found by Arosio et al. (2005). Children were more accurate in this task: whereas subject relatives were at ceiling from the age of 3, OO are 83% correct at the age of 4 and OOp are 70% correct at the age of 7.

For Hebrew, Friedmann & Novogrodsky (2004) tested the comprehension of subject and object relative clauses by young monolingual speakers (mean age 4;7) using a picture selection task, similar to that used by Arosio et al. (2005). Children were asked to select the picture correctly matching a sentence read by the experimenter, by choosing between two options. In one picture, the thematic roles correctly matched the sentence and in the other picture thematic roles were reversed. The authors reported chance performance on object relatives as opposed to subject relatives, which were correctly interpreted.

By using a modified version of Friedmann & Novogrodzsky (2004), Arnon (2005) tested the comprehension of relative clauses in Hebrew-speaking monolingual children ranging in age from 4;5 to 5;2. Differently from the previous study, children were administered an agent selection task and they were invited to select one out of four referents. In line with previous studies on relative clauses, Arnon (2005) reported the typical asymmetry, namely subject relatives (95% of correct responses) are more accurate than object relatives (51% of correct

² For a detailed presentation of the test see chapter 3, section 3.4.2.

responses). However, the author challenged the previous explanations which attributed to movement the difficulties raised by object relatives. She focussed instead on the presence of an interfering NP in object relatives (*the granny that the girl is kissing*), causing troubles in the assignment of the thematic role to the head.

The interfering role of the NP as source of difficulty had already been offered by previous studies focussing on the processing of long-distance dependencies (Gibson, 1998; Gordon et al. 2001).

The same structures also proved to be difficult for children showing atypical language development, like for example SLI children (Stavrakaki 2001, Friedmann & Novogrodzsky 2004).

Stavrakaki (2001) tested the comprehension of relative clauses by Greek-speaking SLI children ranging in age from 5;4 to 9;3. She tested both centre-embedded and right-branching relative clauses and found a subject/object asymmetry in relative clause comprehension. She also found that the level of accuracy of SLI children was lower than either language-matched or age-matched typically-developing controls. She posited that for Greek-speaking SLI children, a deficit in the linguist competence causes much trouble in the comprehension of sentences with non-canonical word order.

Friedmann & Novogrodzsky (2004) investigated the comprehension of subject and object relative clauses by 10 Hebrew-speaking SLI children, comparing their performance with 20 typically-developing children. SLI children ranged in age between 7;3 and 11;2, an age at which normal developing children perform well on relative clauses. They were matched to 10 control children selected on the basis of the age at which children appear to comprehend relative clauses well (age range: 5;11-6;5) and 10 younger control children who did not yet completely mastered relative clauses and still experienced difficulties in comprehending them (age range: 4;0-5;0). The percentage of accuracy on subject and object relatives was 98,5% and 62%, respectively, for SLI children, 95% and 86%, respectively, for the older group of control children, and 85,5% and 58%, respectively, for the younger group of controls. The three groups performed above chance on subject relative clause. On object relatives, SLI children and the group

of younger controls behaved at chance level, while the older group was significantly better than SLI children in comprehending object relatives.

Further evidence of the difficulties experienced in the interpretation of object relatives as opposed to subject relatives is offered by Garraffa & Grillo (2007) and Grillo (2008), who tested long-distance dependencies in agrammatic patients and found a high level of accuracy on subject relatives and only chance levels on object relatives.

5.3 The comprehension of relative clauses by hearing-impaired individuals

Studies investigating the comprehension of relative clauses in hearing-impaired individuals with different degrees of hearing loss have been conducted for many languages, but to our knowledge, relative clauses have not been investigated for Italian-speaking hearing-impaired children until recently. The first attempt to investigate these syntactic properties in this population was Volpato & Adani (2009).

Past and recent research employed different tools to investigate the comprehension of restrictive relative clauses by children with hearing impairment in English (Quigley et al. 1974 and Engen & Engen 1983), and in Hebrew (Friedmann & Szterman 2006 for Hebrew, Friedmann et al. 2008), identifying that comprehension of complex sentences is often problematic for this population. These studies focussed on the linguistic competence of hearing aid users. Only Friedmann & Szterman (2006) tested both hearing aid users and a small sample of children fitted with a cochlear implant.

Past research by Quigley, Smith and Wilbur (1974) investigated the comprehension of relative clauses by deaf subjects ranging in age from 10 to 18 years. The task consisted in judging some items containing relative clauses, namely assessing the acceptance of sentences containing copies (resumptive DPs or resumptive pronouns), in sentences like (48):

(48) the man saw the boy who the boy kicked the ball

Results proved that overall hearing-impaired individuals experience difficulties in understanding relative clauses. Hearing impaired individuals performed better on right-branching relative clauses, namely those modifying the object in final position, with a gap in the object position (OO – *I saw the boy whom the dog chased*), followed by those with a gap in the subject position (OS – *I saw the boy who went home*).³ These researchers raised the question as to whether deaf individuals generate the same syntactic structures as hearing individuals but at a delayed rate, or they generate some structures that never appear in the language of hearing individuals. Results showed that the errors that deaf individuals made were also made by some hearing students, and therefore they put forward the hypothesis that for deaf students, learning English is similar to a second language acquisition process.

Much more recently, Friedmann & Szterman (2006) investigated the comprehension of subject and object relative clauses in Hebrew hearing-impaired children ranging in age from 7;7 to 11;3 and found that overall hearing-impaired children performed significantly poorer than typically-developing peers (68% vs. 86%). However, whereas their performance on subject relatives was quite intact (117 correct responses out of 130), their performance on object relatives was significantly poorer. Friedmann & Szterman (2006) attributed the difficulty experienced by hearing-impaired children to the several operations necessary to interpret long distance dependencies, namely the creation of a trace, subsequent to movement, the assignment of a thematic role to the trace, and the formation of a chain between the trace and the moved constituent. Furthermore, Friedmann & Szterman (2006) also found a strong correlation between linguistic performance and age of first intervention: children wearing hearing aids before the age of eight months performed significantly better than the other children, regardless of the type of hearing device used to access the oral language (hearing aid or cochlear implant).

³ Quigley et al. (1974) also tested centre-embedded relative clauses, which appeared to be more problematic than right-branching ones. However, the use of the former type of relative replicated the same pattern of performance found on the comprehension of the latter, namely relative clauses with a gap in the subject position (SS – *The boy who went home is my friend*) were easier than those with a gap in the object position (SO – *The boy whom I saw is John*).

In the following sections, we will analyse the comprehension of relative clauses by different populations of hearing and hearing-impaired populations. Section 5.4 will present the pilot study conducted by Volpato & Adani (2009) on the comprehension of right-branching relative clauses by Italian-speaking hearing-impaired children fitted with a cochlear implant, to identify whether and to what extent their performance differs from that of hearing children.

5.4 The comprehension of relative clauses by Italian hearing-impaired children with cochlear implants: a pilot study

This pilot study represents the first study investigating the linguistic competence of specific syntactic properties of Italian, namely the comprehension of relative clauses, in hearing-impaired children using a cochlear implant (Volpato & Adani 2009).

5.4.1 Participants

This study assessed the comprehension of restrictive relative clauses in 8 hearing-impaired children ranging in age between 6;9 and 9;3 years (mean age 7;9). Their performance was compared to that of three groups of typically-developing children: a group of 8 children matched on morpho-syntactic abilities (age range: 3;6-5;11), a group of 8 children matched on receptive vocabulary (age range: 5;4-7;0) and a group of 8 children matched on chronological age (age range: 7;1-7;8). The hearing impaired participants were recruited at the Centro per le Disabilità Sensoriali in Venice (four children) and at the Centro per Otologopatici of the ASL 16 in Padua (four children). Children became part of this experiment only after their parents signed the consent form. In the hearing impaired group, all participants were hearing impaired since birth, born to hearing parents. Only one participant had parents with hearing loss. None of them had ever used LIS. In their family, they had been exclusively exposed to the oral language. Age of hearing loss detection varied from birth to 1;6. Application of hearing aids occurred within the second year of life. Age of cochlear implantation varied between 2;1 to 4;4 years. All children had been trained orally and all of them had received speech-language therapy from two to three times per week. Among the

selection criteria, normal IQ and no other associated disabilities were required. At the time of testing, they were attending primary schools in hearing classes. The following table summarizes the main clinical data of each child:

ID	Age (Y:M)	Age of HL Diagnosis	Age of HA	Age of CI	CI Use Duration	HL (dB)	HL with CI (dB)	Sign language
101	6;10	1;2	1;3	2;5	4;5	>90	25	no
102	7;11	1;0	1;1	2;1	5;10	>90	30	no
103	7;4	1;6	1;7	2;10	4;6	>90	30	no
104	6;11	0;4	0;6	3;4	3;7	>90	25	no
105	7;4	0;0	0;3	4;4	3;0	>90	30	no
106	9;3	0;7	0;9	2;7	6;8	>90	30	no
107	8;7	1;5	1;5	3;2	5;5	>90	30	no
109	7;1	0;9	0;10	3;2	3;11	>90	25	no

Table 29: Clinical data of HI participants (HL: Hearing loss; HA: Hearing aids; CI: cochlear implantation).

The hearing children were recruited at the primary school ‘Rovani’ and at the infancy schools ‘Vittorino’ and ‘Primavera’ in Sesto San Giovanni near Milan. Language-matched children were selected among those who had normal range scores on the TCGB test.

5.4.2 Materials

General morpho-syntactic abilities were assessed by using the TCGB test (Chilosi et al., 1995/2006), and receptive vocabulary was assessed by using the Peabody test (Stella et al., 2000). A test assessing memory abilities (CESPEE B, Bruni 2002) was also administered to the hearing-impaired participants, in order to measure forward and backward digit span. To investigate the comprehension of relative clauses, we used the agent selection task by Adani (2008). We tested subject relatives (OS), object relatives with preverbal embedded subject (OO), and

object relatives with post-verbal embedded subject (OOp)⁴. The three conditions we tested are shown in the following example:

- (49) ...il cavallo [che <il cavallo> sta inseguendo i leoni] OS
 ‘...the horse [that <the horse> is chasing the lions]’
- (50) ...il cavallo [che i leoni stanno inseguendo <il cavallo>] OO
 ‘...the horse [that the lions are chasing <the horse>]’
- (51) ...il cavallo [che *pro* inseguono i leoni <il cavallo>]⁵ OOp
 ‘...the horse [that *pro* are chasing the lions <the horse>]’

The relative noun head was always singular whereas the embedded noun was always plural. Number morphology on the verb (either singular or plural) was the relevant cue disambiguating the sentence between the subject and the object reading. The singular verb always agreed with the relative head (as in 49), and the plural verb always agreed with the embedded noun (as in 50 and 51). All relative clauses were preceded by the instruction ‘Indica’ (‘point at’).

The test was composed of 24 experimental trials, with 8 sentences for each condition. Each sentence was matched to a different picture. A sample of an experimental picture is shown in Figure 5:



Figure 11: Sample of experimental picture (Adani 2008)

⁴ In the three examples, the first letter (‘O’) refers to the fact that the relative clause head is the object of the main clause, whereas the second letter indicates its grammatical role within the embedded clause (either subject ‘S’ or object ‘O’). The final ‘p’ indicates when the subject of the embedded clause is in post-verbal position.

⁵ In this typology, a null pronoun (*pro*) is postulated in embedded preverbal subject position.

Figure 5 was matched with one of the structures in (49), (50) and (51). Each picture displayed the same structure: animal X on the left, a pair of animals Y in the middle and animal X on the right. In this figure, a horse is chasing two lions that are chasing another horse.

Correct responses were always either the rightmost or the leftmost character. The task also included 12 filler sentences. In filler sentences, containing either intransitive verbs or transitive verbs with inanimate objects, the correct response always corresponds to the character in the middle.

5.4.3 Procedure

Hearing children were tested at their school or kindergarten. The testing session was preceded by a preliminary meeting with the whole class, in order to introduce ourselves and our puppet Camilla to the children. Camilla was a little snail who wanted to learn Italian and asked children to help her in this purpose. The puppet was necessary to introduce the experiment as a game, in order to obtain responses as spontaneous as possible, and in order to avoid frustration deriving from the idea of being tested. After this preliminary session, children were assessed individually in a quiet room.

Hearing impaired children were tested by the experimenter in collaboration with the speech therapist during their speech therapy sessions. With hearing impaired children, the puppet was not used. The experimenter read aloud the sentence and the children had to point to the correct character matching the sentence. For hearing children, sentences were instead uttered by a voice played on a laptop connected to loudspeakers.

The comprehension task was preceded by a pre-experimental part, in order to make sure that all children were familiar with the lexical verbs used in the test, and by a training part to make sure that children had understood the task correctly. Furthermore, the characters were introduced to the children before reading the experimental trial, in order to make sure that participants did not have difficulties in recognizing them. This preamble made it possible to introduce the whole experimental setting to the child, minimize lexical access just before the

experimental sentence was uttered, and make both relative head candidates salient in the reference context.

Children's responses were recorded on the response sheet by the experimenter. One point was attributed for each correct response.

5.4.4 Results and Data Analysis

The percentages of correct responses for each group on each sentence typology are presented in the following table:

	HI	GC	VC	AC	<i>Sentence type Mean</i>
OS	89	100	97	97	96
OO	55	81	83	92	78
OOp	22	45	53	67	47
Group Mean	55	76	78	85	

Table 2: Correct response % for each condition in each group.

The data were analysed by using the software program SAS. Following Jaeger (2008) and Dixon (2008), a repeated-measure logistic regression analysis was conducted in order to explore the variation of errors (Non-Target) and correct (Target) responses. Logistic regression is used to predict the probability of occurrence of an event over a non-event. It is used when the dependent variable is dichotomous and the independent variable(s) is/are of any type. It can be used when the data are categorical to predict the behaviour of the dependent variable on the basis of continuous and/or categorical variables, to determine how the dependent variable varies as in relation to the independent variables, and to assess interaction effects. In our experiments, the dependent variable was the accuracy scores obtained in the experimental stimuli, while the independent variables were sentence typologies and group types.

We found significant main effects of Group [$\chi^2(3)= 8.59$, $p=0.035$] and Sentence [$\chi^2(2)= 24.02$, $p<0.001$]. As for the main effect of Group, the HI group (mean accuracy: 55%) resulted less accurate than the GC group (mean accuracy 76%, $p= 0.01$), than the VC group (mean accuracy: 78%, $p= 0.007$) and than the

AC group (mean accuracy: 85%, $p < 0.001$). No significant differences were attested among control groups.

As for the main effect of Sentence, OS (mean accuracy: 96%) were more accurate than OO (mean accuracy: 78%, $p < 0.001$) and than OOp (mean accuracy: 47%, $p < 0.001$). OO resulted more accurate than OOp ($p < 0.001$). No significant interaction effects Sentence per Group were attested.

In addition, by using the binomial distribution, we detected the number of children who performed above chance in each sentence type. Children were considered above chance if they answered correctly at least 5 (out of 8) items for each condition. By setting chance level at 33%, the number of subjects in each group who were performing at above chance level is reported in the following table:

	HI	GC	VC	AC
OS	8	8	8	8
OO	3	6	8	7
OOp	1	4	3	4

Table 3: Number of children for each group performing above chance

All children performed above chance on OS. On object relatives, the number of children performing above chance was quite low. On OO, 3 hearing-impaired children out of 8 scored above chance, whereas on OOp only one performed above chance.

Correlation analyses were also carried out in order to check whether language performance in hearing impaired children could also be linked to one or more of the following factors:

- (a) age at the time of testing;
- (b) age at fitting with hearing aids,
- (c) age of the children at cochlear implantation;
- (d) duration of use of cochlear implants;
- (e) forward and backward digit span.

No significant correlations were found between sentence comprehension and age at the time of testing, age at fitting with hearing aids, age of the children at cochlear implantation and duration of use of cochlear implants. A significant positive correlation was found instead between performance on OOp sentences and memory span.

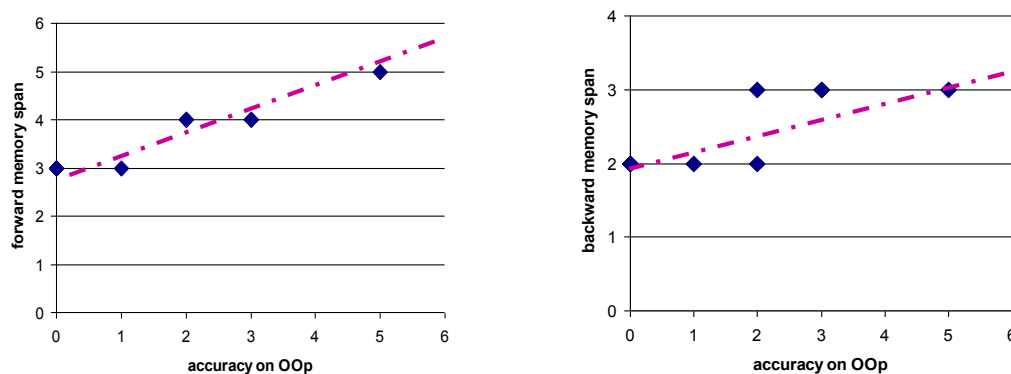


Table 30: Correlations between linguistic performance and forward (left table) and backward (right table) digit span

Specifically, comprehension of OOp correlated with both forward ($r_s = .941$, $p < .001$) and backward span ($r_s = .9$, $p < .004$).

5.4.5 Discussion

The performance of the hearing-impaired children in the comprehension task shows a typical gradient of difficulty, namely OS are easier to interpret than OO and OO are easier than OOp.

Children's performance on subject and object relatives and difficulties experienced with object relatives are predicted by both processing and grammatical approaches. These approaches are discussed in the following sections.

5.4.5.1 The Minimal Chain Principle

The responses of hearing impaired children show a typical gradient of difficulty, namely subject relatives (OS) are easier to comprehend than object relatives with embedded preverbal subject (OO), and OO are easier than object relatives with embedded postverbal subject (OOp). The asymmetry between OS and OO is

explained by the Minimal Chain Principle (De Vincenzi, 1991). The syntactic parser tries to place a gap as soon as possible, in order to build the shortest chain between the moved element and its trace. As a consequence, shorter dependencies are less demanding than longer ones.

- (52) Indica la tartaruga [che <e> sta inseguendo i pesci]
 Point to the turtle [that <e> is chasing the fish.PL]
short chain: <head DP, e>

- (53) Indica la tartaruga [che i pesci stanno inseguendo <e>]
 Point to the turtle [that the fish.PL are chasing <e>]
long chain: <head DP, e>

The human parser is led to the shortest dependency analysis. Therefore it seems to show preference for a subject reading. A subject relative is easier to compute since the gap is in embedded subject position and therefore the chain between the relative head and the gap is very short. In object relatives, instead, the presence of an intervening NP brings on increasing load on the processing system (Arnon 2005) and forces the parser to abandon the subject reading and start the analysis again. In OOp, the trace with which the relative head is coindexed is placed in the embedded post-verbal object position, thus establishing a longer relation than in subject relatives (Rizzi, 1986):

- (54) Indica la tartaruga [che *pro* stanno inseguendo i pesci <e>]
 Point to the turtle [that *pro* are chasing the fish.PL <e>]
I chain: <head DP, e> **II chain: <pro, subject DP>**

The presence of two distinct relations requires the simultaneous computation of the relative clause and the inverted thematic roles, placing an even heavier load on the interpretive system.

5.4.5.2 The grammatical approach

By assuming Chomsky's (1995) Copy Theory of Traces⁶ and the Relativized Minimality principle (Rizzi, 1990, 2004a, Starke 2001), Volpato & Adani (2009) explained that the asymmetry between subject and object relatives is to be attributed to intervention effects involved in sentences containing long-distance dependencies. Relativized Minimality (RM, henceforth) is a principle of locality, occurring in configurations like (55):

(55) ...X...Z...Y...

This principle states that the local relation between X and Y is blocked when an intervener, Z, represents a potential candidate for the local relation.

In subject relatives, RM is not at play. The high percentage of correct responses in these structures in all groups is predicted by the absence of an intervening element blocking the relation between the moved subject (relative head) and the original embedded position. In this type of sentences, no Z-type element occurs between the two positions:

(56) Indica il cavallo [che < il cavallo > sta inseguendo i leoni]
 Point to the horse [that <the horse> is chasing the lions]

The asymmetry between subject relatives (OS) and object relatives with pre-verbal subject (OO) is explained by the occurrence of RM effects due to an intervening element between the moved object, namely the relative clause head, and its gap in the embedded clause. RM effects arise when the intervener is structurally similar to the element that has moved (Rizzi 2000), namely when the attractor and the intervener share the same featural specification. Recent Cartographic studies, drawing detailed maps of syntactic configuration (Cinque 1999, 2002, Rizzi 2004b), help clarify the concept of "sameness" in featural specification. Indeed, each position in clause structure is associated to a set of morphosyntactic features, as (57) shows:

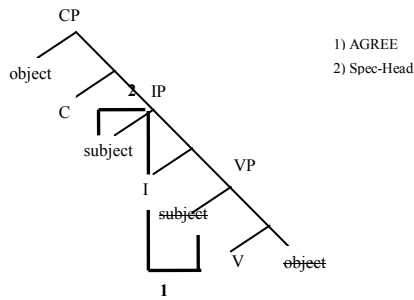
⁶ In this theory, Chomsky (1995) claims that traces are full (silent) copies of their antecedents.

would be expected to be similar. On the contrary all groups (especially the HI group) achieved lower scores on OOp than on OO.

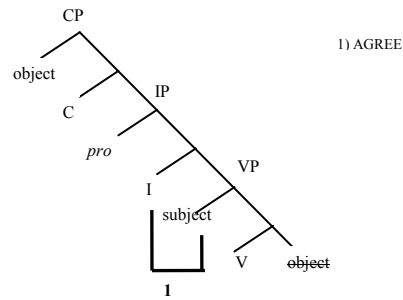
Friedmann et al. (2009) argued that the source of difficulty for the comprehension, as well as for the production of Hebrew object relatives by typically-developing children was the presence of the lexical NP (lexical restriction). Indeed, they found that by manipulating the referential properties of the intervening element, the difficulty associated with object relatives decreased. They found, for instance, that the presence of *pro* did not cause any RM effect, and the sentence was correctly interpreted. Our OOp also contained a null pronoun *pro*. The nature of the two *pros* is undoubtedly different. In Friedmann et al. (2009), it is arbitrary, whereas in our experiment, it is an expletive null pronoun. Despite this difference, we claim that, in the same way as arbitrary *pro*, expletive *pro* in our experimental trials is not problematic per se. The source of the difficulty must be found in the presence of a post-verbal subject in the low area of clause structure and to the way agreement between the subject and the verb takes place.

By adopting the minimalist theory of Agreement (Chomsky 1995, 2000, 2001), and following Guasti & Rizzi (2002) and Franck et al. (2006), in OO, agreement checking occurs both under AGREE and in the Spec-Head configuration (62a) (see chapter 2, section 2.5). Hence, subject-verb agreement is robust in syntactic configurations in which the derivation involves both AGREE and Spec-Head checking, because agreement is checked twice. Agreement is instead more fragile in Verb-Subject configurations, in which this relation is established exclusively under AGREE and no local checking in Spec-head takes place. Indeed, in the case of OOp, only long-distance AGREE is established between the verb in I and the subject in the low portion of the clause structure. This agreement is not strengthened by Spec-Head checking (62b):

(62) a. OO



b. OOp



Volpato & Adani (2009) suggest that the difficulties in the interpretation of OOp are related to the fragility of agreement between verbs and post-verbal subjects, based on AGREE only (Guasti and Rizzi, 2002, Frank et al., 2006). They claim that this phenomenon is easily found in early child grammar systems, but consequences are even stronger in the presence of immature systems and especially in hearing-impaired children.

Fragility of agreement places heavy processing load in the interpretation of these structures, since memory is forced to keep plural morphology on the verb suspended, until the post-verbal subject is encountered. Since the plural features displayed on the verb needs to be checked against the subject in post-verbal position, the human parser presumably forces the syntactic reanalysis of OOp clauses, which are interpreted as OS. Interestingly, Volpato & Adani found a significant correlation between performance on OOp and both forward and backward digit spans in hearing-impaired children.

As already seen in chapter 4, section 4.2 and 4.3, low memory resources may affect the development of language skills by hearing-impaired children typical and atypical language acquisition and development. In particular, limitations in short-term memory and working memory have consequences on the comprehension of syntactically complex sentences (Papagno et al. 2007).

5.5 The new experiment

The pilot study discussed in the previous sections represented the starting point for the elaboration and development of a further and more complete experiment, presented in detail in chapter 3. The aim of this new study was to investigate even

more in depth the role of grammatical cues, namely number features, in the comprehension of relative clauses by a larger sample of cochlear-implanted children, also extending the analysis to other hearing and hearing-impaired populations.

In this experiment, in order to determine which feature combinations facilitate the establishment of a grammatical relation, different hearing and hearing-impaired populations were tested. Three different studies were carried out (see chapter 3, section 3.8). In the first study, a group of hearing-impaired children using a cochlear implant was compared to a group of hearing children matched on morpho-syntactic abilities (TCGB). In the second study, a group of hearing-impaired adolescents, native signers of LIS was compared to a group of hearing children matched on morpho-syntactic abilities and to a group of hearing adolescents matched on chronological age. Finally, in the third study, a group of hearing children was compared to a group of hearing adolescents and a group of hearing adults. We will analyse in detail the different comparisons in the next sections.

For the group of hearing-impaired children, we will investigate whether some correlations exist between performance on comprehension and the following data (age at the time of testing, age at fitting with hearing aids, age at activation of cochlear implants, duration of use of cochlear implants). In addition, for all populations (both hearing and hearing-impaired participants), we will investigate whether some correlations exist between relative clause comprehension and memory scores achieved in the repetition tasks.

5.6 Study one: hearing-impaired children with a cochlear implant and hearing children

In study one, we compare the group of hearing-impaired children using a cochlear implant with the group of younger hearing children, selected on the basis of comparable general morpho-syntactic abilities.

5.6.1 Participants

In this study, a group of 13 hearing impaired children using a cochlear implant (CI group, age range 7;9-10;8, mean age 9;2) was compared to a group of 13 typically-developing children (LA group, age range 5;7-7;9, mean age 6;7), matched to on morpho-syntactic abilities.⁹

Control children were matched to the hearing-impaired group on the basis of linguistic age and scores on the TCGB test. Language-matched children were selected among those who had normal range scores on the TCGB test, by being included between the 25^o and 75^o percentile. No significant difference was found between the TCGB scores of the two groups (Mann Whitney U=74.5 p=.606).

For further details on the participants see chapter 3, section 3.8.1 and 3.8.3.

5.6.2 Materials

To test relative comprehension, we used an agent selection task, in which participants were asked to select the correct referent out of four possible choices, after listening to a sentence read by the experimenter. For a detailed description of the task see chapter 3, section 3.4.2.

5.6.3 Procedure

Each participant was presented with some pictures and was asked to point to the correct character after listening to the test sentence. For all children, the sentences were read by the experimenter. The session started with a pre-test, in order to make sure that all children were familiar with the lexical words used in the test. Then a training part including two practice sentences followed, in order to make sure that participants had understood the task. After that, the experimental task began.

Children's responses were transcribed on the response sheet by the experimenter. One point was attributed for each correct response.

⁹ In this experiment, hearing impaired children were matched only to linguistic-age peers. We plan to compare hearing-impaired children with CA in future work.

5.6.4 Results

This section presents the results on the comprehension task.

Table (31) shows the number of participants who behaved above chance in each group in each sentence type. We carried out this analysis by using the binomial distribution. The probability of responding correctly to relative clauses with SVO order in the mismatch number condition, to relative clauses with OSV and OVS order was 25%. A child was considered above chance when he/she answered correctly at least 4 items for each type of relative clauses ($p=0.03$). The following table summarizes the results¹⁰:

	CI (N=13)		LA (N=13)	
	No.	%	No.	%
SVO_SG_PL	12	92%	11	85%
SVO_PL_SG	11	85%	12	92%
OSV_SG_SG	9	69%	9	69%
OSV_PL_PL	9	69%	11	85%
OSV_SG_PL	7	54%	11	85%
OSV_PL_SG	8	62%	11	85%
OVS_SG_PL	3	23%	9	69%
OVS_PL_SG	3	23%	6	46%

Table 31: number and percentage of children behaving above chance in non-ambiguous sentences (CI = cochlear-implanted children; LA= language-matched children)

We note that on subject relatives, almost all hearing-impaired performed above chance. Object relatives were more problematic than subject relatives. The number of hearing-impaired children performing above chance is lower on OSV than in SVO. On OVS types, only three hearing-impaired children performed above chance. OVS types were also problematic for hearing children. However, the number of hearing children performing above chance is higher.

To compare the performance between the two groups in the ten sentence types (between-group and within-group analysis), a repeated-measure logistic regression was adopted by using the software ‘R’. As pointed out in section 5.4.4, when the dependent variables are of any type, the logistic regression calculates the

¹⁰ The abbreviations for the different conditions are explained in chapter 3, section 3.4.2.

occurrence probability of the event over the non-event, in the case in point the probability of the occurrence of target responses over non-target ones.

The number and percentage of correct answers for each group in each sentence type are shown in the following table:

		CI		LA		<i>Mean Sentence Type</i>	
AMB	SVO_SG_SG	77/78	99%	73/78	94%	150/156	96%
	SVO_PL_PL	78/78	100%	76/78	97%	154/156	99%
OS	SVO_SG_PL	71/78	91%	71/78	91%	142/156	91%
	SVO_PL_SG	68/78	87%	73/78	94%	141/156	90%
OO	OSV_SG_SG	58/78	74%	60/78	77%	118/156	76%
	OSV_PL_PL	56/78	72%	62/78	79%	118/156	76%
	OSV_SG_PL	46/78	59%	66/78	85%	112/156	72%
	OSV_PL_SG	51/78	65%	63/78	81%	114/156	73%
OOp	OVS_SG_PL	29/78	37%	56/78	72%	85/156	54%
	OVS_PL_SG	19/78	24%	47/78	60%	66/156	42%
	Mean group	71%		83%			

Table 32: percentage of correct answers for each group in each sentence type (the abbreviation of the different conditions are explained in chapter 3, section 3.4.2)

By comparing the group of hearing impaired children with that of children matched on linguistic age, we found a significant effect of group, since the hearing group performed significantly better than the cochlear implanted group [$\chi^2(1) = -2.230$, $p = 0.02$], and an effect of Sentence Type [$\chi^2(3) = -14.81$, $p = 0.000$]. Ambiguous sentences (AMB) are significantly more accurate than subject relatives (OS), than object relatives with both preverbal (OO) and post-verbal embedded subject (OOp) ($p = 0.033$, $p < 0.001$, $p < 0.001$, respectively). OS are significantly more accurate than OO and OOp ($p < 0.001$ and $p < 0.001$, respectively). OO were significantly more accurate than OOp ($p < 0.001$). We also observed a significant interaction effect of Sentence Type per Group ($p = 0.000$). The performance on each main sentence type and interaction effects will be analysed separately in the next sections.

5.6.4.1 Ambiguous sentences

In ambiguous sentences, either the first or the second DP could have been interpreted as the subject of the embedded verb (also cf. chapter 2, sections 2.3, and 3.3.2). Both the hearing and the hearing impaired group performed nearly at ceiling in ambiguous sentences. The number and percentage of correct responses are shown again in the following table:

	CI		LA		<i>Mean Sentence Type</i>	
SVO_SG_SG	77/78	99%	73/78	94%	150/156	96%
SVO_PL_PL	78/78	100%	76/78	97%	154/156	99%
Mean group	99%		96%			

Table 33: number and % of correct responses in ambiguous relative clauses

In ambiguous sentences, percentages of accuracy are slightly higher in hearing-impaired children than in hearing children. However, no significant difference was found between the two groups and no significant difference was found between the two sentence types in each of the two groups. Interaction effects were also non significant.

For ambiguous sentences, for which the probability of answering correctly was 50%, a child was considered above chance when he/she answered correctly to all 6 items. The following table is summarizing the results:

	CI (N=13)		LA (N=13)	
	No.	%	No.	%
SVO_SG_SG	13	100%	11	85%
SVO_PL_PL	13	100%	11	85%

Table 34: number and percentage of children behaving above chance in ambiguous sentences

Ambiguous sentences were tested to check whether a subject or an object reading was preferred by Italian speakers and whether hearing impaired children could be significantly sensitive to a potential subject in the embedded post-verbal position. Therefore, by considering only correct responses, we could calculate the percentages for the subject reading and those for the object reading in each of the two ambiguous types for each group. Results are shown in the following table:

	SVO_SG_SG		SVO_PL_PL	
	<i>SR</i>	<i>OR</i>	<i>SR</i>	<i>OR</i>
IC	90%	10%	73%	27%
LA	96%	4%	87%	13%

Table 35: percentage of subject and object interpretation for each type of ambiguous sentence

From the above table it is evident that both hearing and cochlear-implemented children mainly selected the first DP as the subject of the embedded clause both when DPs were singular and when they were plural. In the former case (singular DPs), as far as the hearing impaired group was concerned, the subject reading was accepted in 69 items out of 77 correct responses (90%), while the object reading was accepted in 8 items out of 77 (10%). In the case of plural DPs, the subject reading was accepted in 57 out of 78 correct responses (73%), while the object reading was accepted in 21 items (27%). None of the children appeared to be sensitive to the ambiguity.

Summing up, singular features significantly force a subject reading more times than plural features.

5.6.4.2 Subject relatives

Numbers and percentages of correct responses in each unambiguous subject relative types are shown in the following table:

	CI		LA		<i>Mean Sentence Type</i>	
SVO_SG_PL	71/78	91%	71/78	91%	142/156	91%
SVO_PL_SG	68/78	87%	73/78	94%	141/156	90%

Table 36: number and % of correct responses in subject relatives

In subject relatives, the percentages of correct responses are quite high for both groups in both sentence types. In the hearing group, they are above 90% in both mismatch conditions, while in the hearing-impaired group, correct responses are 87% when the head is plural, and 91% when the head is singular. Despite the lower percentage of accuracy in sentence type SVO_PL_SG in the hearing-

impaired group, no significant difference is attested either between the two groups or between the two sentence types.

5.6.4.3 Object relatives with preverbal embedded subject

The number and percentage of correct responses in object relatives with preverbal embedded subject are shown in the following table:

	CI		LA		<i>Mean Sentence Type</i>	
OSV_SG_SG	58/78	74%	60/78	77%	118/156	76%
OSV_PL_PL	56/78	72%	62/78	79%	118/156	76%
OSV_SG_PL	46/78	59%	66/78	85%	112/156	72%
OSV_PL_SG	51/78	65%	63/78	81%	114/156	73%

Table 37: number and % of correct responses in object relatives with preverbal embedded subject

Object relatives with preverbal embedded subject appear to be more problematic than subject relatives, since the percentages of correct responses are lower for both groups. Percentages for the CI group are even lower than for the LA group. In the hearing impaired group, no significant difference was found between the performance on OSV_SG_SG and that on OSV_PL_PL and OSV_PL_SG, between OSV_PL_PL and both OSV_SG_PL and OSV_PL_SG, between OSV_SG_PL and OSV_PL_SG. A significant difference was attested only between OSV_SG_SG and OSV_SG_PL ($p=0.023$).

In the hearing group, no significant differences were found within the OO class, between any of these sentence types.

By examining whether some sentence types were significantly more difficult for one of the two groups (interaction effects Sentence Type per Group), the analysis highlighted that in OSV_SG_PL, the hearing impaired group achieved lower accuracy scores (59%) as opposed to the hearing group (85%). Indeed, a significant difference was attested between the two groups ($p=0.008$).

5.6.4.4 Object relatives with post-verbal embedded subject

The number and percentage of correct responses in object relatives with preverbal embedded subject are presented once again in the following table:

	CI		LA		<i>Mean Sentence Type</i>	
OVS_SG_PL	29/78	37%	56/78	72%	85/156	54%
OVS_PL_SG	19/78	24%	47/78	60%	66/156	42%

Table 38: number and % of correct responses in object relatives with post-verbal embedded subject

In these sentence types, both groups obtained the lowest scores as opposed to all the other sentence types. Within each of the two groups, no significant difference was found between the two sentence types.

The lower percentage of accuracy of the hearing impaired group as opposed to the hearing group also resulted in a significant difference in performance between the two groups. Indeed, hearing impaired children performed significantly lower than hearing children both in OVS_SG_PL ($p=0.004$) and in OVS_PL_SG ($p=0.005$).

5.6.5 Response type analysis

In each experimental trial, participants' responses could fall in one out of four possibilities, among which only one was correct. When the correct referent was not selected, the choice could fall in one out of three following incorrect responses: reversible, agent and other error.

The following tables summarize the responses provided by the hearing-impaired (table 39) and the hearing (table 40) groups in each sentence type:

	Correct		Reversible		Agent		Other	
SVO_SG_SG	77/78	98,7%					1/78	1,3%
SVO_PL_PL	78/78	100%					0/78	0%
SVO_SG_PL	71/78	91,0%	5/78	6,4%			2/78	2,5%
SVO_PL_SG	68/78	87,2%	7/78	9,0%			3/78	3,8%
OSV_SG_SG	58/78	74,4%	14/78	17,9%	6/78	7,6%	0/78	0%
OSV_PL_PL	56/78	71,8%	8/78	10,3%	14/78	17,8%	0/78	0%
OSV_SG_PL	46/78	59,0%	17/78	21,8%	14/78	17,8%	1/78	1,3%
OSV_PL_SG	51/78	65,4%	11/78	14,1%	16/78	20,5%	0/78	0%
OVS_SG_PL	29/78	37,2%	38/78	48,7%	8/78	10,1%	3/78	3,8%
OVS_PL_SG	19/78	24,4%	50/78	64,1%	7/78	8,9%	2/78	2,5%

Table 39: responses provided by hearing-impaired children in each sentence type

	Correct		Reversible		Agent		Other	
SVO_SG_SG	73/78	93,6%					5/78	6,4%
SVO_PL_PL	76/78	97,4%					2/78	2,6%
SVO_SG_PL	71/78	91,0%	3/78	3,8%			4/78	5,1%
SVO_PL_SG	73/78	93,6%	0/78	0%			5/78	6,4%
OSV_SG_SG	60/78	76,9%	8/78	10,3%	9/78	11,5%	1/78	1,3%
OSV_PL_PL	62/78	79,5%	7/78	9,0%	7/78	9,0%	2/78	2,6%
OSV_SG_PL	66/78	84,6%	5/78	6,4%	7/78	9,0%	0/78	0%
OSV_PL_SG	63/78	80,8%	6/78	7,7%	9/78	11,5%	0/78	0%
OVS_SG_PL	56/78	71,8%	15/78	19,2%	6/78	7,7%	1/78	1,3%
OVS_PL_SG	47/78	60,3%	26/78	33,3%	5/78	6,4%	0/78	0%

Table 40: responses provided by hearing children in each sentence type

Descriptively, we can see that the distribution pattern of incorrect responses varies according to the type of group and to the type of sentence considered.¹¹

In ambiguous sentences, the response could have only been either “correct” or “other”. In these types of sentence, the responses provided were mainly correct for both groups. Only a very small percentage of (incorrect) responses fell into the category “other”. The other error was mainly attested in the hearing group. Overall, in both groups, for all sentence types, the percentage of responses falling in the category ‘other’ is very low, therefore they will not be taken into consideration in this analysis.

Most interesting results were detected on object relatives with preverbal embedded subject. For hearing impaired children, the percentages of accuracy varied between 59% and 74%, with better scores on items bearing the same number features (74% in OSV_SG_SG and 72% in OSV_PL_PL) as opposed to items which were dissimilar in terms of number features (59% in OSV_SG_PL and 65% in OSV_PL_SG). When the noun head was singular, they mainly selected the reversible error (18% in OSV_SG_SG and 22% in OSV_SG_PL). When the noun head was plural, children more occurrences of the agent error selection were attested (18% in OSV_PL_PL and 21% in OSV_PL_SG). The pattern is completely reversed for hearing children, who performed slightly better

¹¹ With the statistical softwares used, it was not possible to carry out an analysis based on a multinomial logistic regression with repeated-measure. Hence, only a descriptive analysis will be provided as far as the type and pattern of incorrect responses are concerned.

on trials displaying different number features (the percentage of accuracy is 81% and 85% respectively for OSV_SG_PL and OSV_PL_SG), as opposed to trials in which the DPs displayed the same features (76,9% in OSV_SG_SG and 79,5% in OSV_PL_PL). Despite the fact that the percentages falling into the agent and reversible categories were very low, it seems possible to detect a different trend according to the presence of match or mismatch conditions. In the match conditions (OSV_SG_SG and OSV_PL_PL), children seemed to randomly select either the agent or the reversible error. In the mismatch conditions (OSV_SG_PL and OSV_PL_SG), children seemed to show a trend towards the agent error. However percentages were very low. It will be interesting to compare these data with those observed in the studies presented in the following sections.

In object relatives with post-verbal embedded subject, the percentages of correct responses were the lowest for both groups. Both hearing and hearing-impaired group largely selected the reversible error.

5.7 Study two: LIS signers, hearing children, hearing adolescents

In the second study, the performance of a small group of hearing-impaired adolescent LIS signers was compared to that of two hearing groups

5.7.1 Participants

The hearing-impaired group is composed of six adolescent LIS signers (LIS group – see Grosselle 2008, age range 15;9-17;6) who were matched to six monolingual normal-hearing young children (age range: 5;3-7;5) on the basis of morphosyntactic abilities (LA group) and to six monolingual normal-hearing adolescents (age range 15;3-17;5) on the basis of chronological age (CA group).

The following table shows the participants of the three groups:

LIS GROUP		LA GROUP		CA GROUP	
ID	AGE	ID	AGE	ID	AGE
80	16;11	31	6;9	66	16;8
81	17;6	42	7;5	70	17;5
82	16;1	13	5;10	71	16;5
83	15;9	16	5;3	78	15;6
84	16;5	59	6;10	79	16;7
85	15;5	19	5;8	69	15;3

Table 41: participants in study two (each LIS signer is matched on language age – LA – and to and chronological age –CA – to a hearing participant)

In the normal-hearing children group, children were selected among those who had normal range scores on the TCGB test (25°-75° percentile). No significant difference was found between the scores of the TCGB test of the LIS signers and the children (Mann Whitney U=8 p=.107). No significant difference was found between the ages in months of the LIS signers and the hearing adolescents (Mann Whitney U=16.5 p=.808).

5.7.2 Procedure

The participants were tested following the procedure showed chapter 3, section 3.9.

5.7.3 Results

The following table shows the number of participants who performed above chance in the different sentence conditions. A subject showed above chance performance when he/she answered correctly at least 4 items:

	LIS (N=6)		LA (N=6)		CA (N=6)	
	No.	%	No.	%	No.	%
SVO SG PL	4	67%	6	100%	6	100%
SVO PL SG	3	50%	6	100%	6	100%
OSV SG SG	2	33%	2	33%	6	100%
OSV PL PL	1	17%	4	67%	6	100%
OSV SG PL	1	17%	5	83%	6	100%
OSV PL SG	2	33%	4	67%	6	100%
OVS SG PL	1	17%	2	33%	6	100%
OVS PL SG	1	17%	2	33%	6	100%

Table 42: number and percentage of participant who behaved above chance on each unambiguous sentence type

The adolescents performed at ceiling on all conditions. In the group of LIS signers, few participants performed above chance. While in subject relatives, all participants of the LA and CA groups performed above chance, four LIS signers performed above chance on the SVO_SG_PL type, and three on the SVO_PL_SG type. In object relatives, the number of LIS signers performing above chance is very low.

For each group, the numbers and percentages of correct responses on each sentence type were calculated. The following table summarizes the results:

		LIS		LA		CA		<i>Mean Sentence Type</i>	
AMB	SVO_SG_SG	26/36	72%	35/36	97%	36/36	100%	97/108	90%
	SVO_PL_PL	29/36	81%	35/36	97%	36/36	100%	100/108	93%
OS	SVO_SG_PL	22/36	61%	35/36	97%	36/36	100%	93/108	86%
	SVO_PL_SG	20/36	56%	36/36	100%	36/36	100%	92/108	85%
OO	OSV_SG_SG	15/36	42%	17/36	47%	33/36	92%	65/108	60%
	OSV_PL_PL	15/36	42%	23/36	64%	33/36	92%	71/108	66%
	OSV_SG_PL	10/36	28%	26/36	72%	35/36	97%	71/108	66%
	OSV_PL_SG	12/36	33%	23/36	64%	35/36	97%	70/108	65%
OOp	OVS_SG_PL	14/36	39%	19/36	53%	34/36	94%	67/108	62%
	OVS_PL_SG	5/36	14%	13/36	36%	34/36	94%	52/108	48%
Mean group		47%		73%		97%			

Table 43: percentage of correct answers for each group in each sentence type

By comparing the group of LIS signers with language-matched hearing (LA) children and age-matched hearing adolescents (CA), the LIS signers achieved the lowest accuracy percentages, as opposed to both hearing groups. Indeed, we found a significant effect of Sentence Type [$\chi^2(3) = -10.562, p = 0.000$] and a significant effect of Group [$\chi^2(2) = -5659, p = 0.000$]. The group of hearing adolescents performed significantly better than adolescent LIS signers ($p = 0.000$) and than hearing children ($p = 0.000$). The group of hearing children performed significantly better than LIS signers ($p < 0.001$). Ambiguous sentences (AMB) were significantly more accurate than subject relatives (OS) and object relatives with both preverbal (OO) and post-verbal embedded subject (OOp) ($p = 0.03, p < 0.001, p < 0.001$, respectively). OS were significantly more accurate than OO and OOp ($p < 0.001$ and, $p < 0.001$, respectively). OO were significantly more accurate than OOp ($p < 0.001$). As for the difference in performance between the three groups across

the various sentence types, as well as interaction effects, we will analyse them in the relevant sections.

5.7.3.1 Ambiguous sentences

The percentage of correct responses for each group in each sentence type is shown in the following table:

	LIS		LA		CA		<i>Mean Sentence Type</i>	
SVO SG SG	26/36	72%	35/36	97%	36/36	100%	97/108	90%
SVO PL PL	29/36	81%	35/36	97%	36/36	100%	100/108	93%

Table 44: number and % of correct responses in ambiguous relative clauses

For each group, we calculated the percentages for subject and object reading in each of the two ambiguous types, when participants provided the correct response. Results are shown in the following table:

	SVO SG SG		SVO PL PL	
	<i>SR</i>	<i>OR</i>	<i>SR</i>	<i>OR</i>
LIS GROUP	77%	23%	73%	27%
LA GROUP	100%	0%	77%	23%
CA GROUP	97%	3%	100%	0%
<i>Mean Sentence</i>	93%	7%	83%	16%

Table 45: percentage of subject and object interpretation for each type of ambiguous sentence

From the above table, a clear tendency towards a subject reading for both typologies of ambiguous relative clauses emerges for all groups. When a relative clause contains two DPs bearing the same number features, in most cases, the first DP is interpreted as the subject of the embedded sentence. When features are singular, in the LIS group, out of 26 correct responses, 20 sentences were interpreted as subject relatives (77%); in the LA group, all 35 sentences were interpreted as subject relatives (100%); and in the CA group, 35 out of 36 correct responses had a subject reading (97%). In ambiguous sentences with plural DPs, the tendency to provide a subject reading decreased, although percentages were in any case very high.

For ambiguous sentences, for which the probability of answering correctly was 50%, we also calculated the number of subjects who performed above chance, using the binomial distribution. A subject was considered above chance when he/she answered correctly all items, i.e. 6, for each sentence typology. The following table is summarizing the results:

	LIS (N=6)		LA (N=6)		CA (N=6)	
	No.	%	No.	%	No.	%
SVO_SG_SG	1	17%	6	100%	5	83%
SVO_PL_PL	2	33%	6	100%	5	83%

Table 46: number and percentage of subjects behaving above chance in ambiguous sentences

As table 44 and 46 show, for the group of LIS signers, ambiguous sentences with both singular and plural DPs were problematic. Age-matched and language-matched controls (LA group) performed at ceiling (100% and 97%, respectively). The repeated-measure logistic regression revealed that a significant difference was attested between the group of LIS signers and the group of hearing children on both ambiguous sentence types ($p=0.0062$ in presence of singular DPs and $p=0.0184$ in presence of plural DPs). No significant difference was attested between the hearing adolescents and the other two groups.¹²

5.7.3.2 Subject relatives

Numbers and percentages of correct responses in each unambiguous subject relative type are shown in the following table:

	LIS		LA		CA		<i>Mean Sentence Type</i>	
	No.	%	No.	%	No.	%	No.	%
SVO_SG_PL	22/36	61%	35/36	97%	36/36	100%	93/108	86%
SVO_PL_SG	20/36	56%	36/36	100%	36/36	100%	92/108	85%

Table 47: number and % of correct responses in subject relative clauses

¹² This result is unexpected, since a significant difference exists between LIS signers and hearing children. In the present and the following analyses, when a population performed at ceiling (100%) in one or more conditions, the program did not detect any significant difference. This might depend on the high values of variance, and on the reduced number of participants.

The percentage of accuracy was very high for the two hearing groups, both children and adolescents. For LIS signers, these sentences were instead problematic. Indeed, as opposed to both hearing groups, the percentage of correct responses in the LIS group was definitely lower.

For hearing-impaired individuals, subject relatives caused much trouble. Indeed, a significant difference was attested between LIS signers and hearing children as far as the performance on these structure types is concerned. Actually, a between-group analysis showed that the problematic structure was the sentence type SVO_SG_PL, in which the percentage of accuracy is significantly higher for hearing children as opposed to the hearing impaired group ($p=0.0017$). The sentence type SVO_PL_SG did not show any significant variation when the two groups were compared.

By comparing LIS signers and hearing adolescents, no significant difference is attested between them in any of the two types of subject relatives.

5.7.3.3 Object relatives with preverbal embedded subject

Numbers and percentages of correct responses in each object relative with the embedded subject in the preverbal position are shown in the following table:

	LIS		LA		CA		<i>Mean Sentence Type</i>	
OSV_SG_SG	15/36	42%	17/36	47%	33/36	92%	65/108	60%
OSV_PL_PL	15/36	42%	23/36	64%	33/36	92%	71/108	66%
OSV_SG_PL	10/36	28%	26/36	72%	35/36	97%	71/108	66%
OSV_PL_SG	12/36	33%	23/36	64%	35/36	97%	70/108	65%

Table 48: number and % of correct responses in object relatives with preverbal embedded subject

A between-group analysis comparing the performance of LIS signers and that of hearing children, proved that the only significant difference was in the sentence type OSV_SG_PL ($p=0.0061$), replicating the results found on this sentence type when comparing cochlear implanted children and their language-matched control (see section 5.6.4.3)

By comparing instead adolescent LIS signers and hearing adolescents, a significant difference in performance was found between the two groups, namely

hearing adolescents performed better than hearing-impaired ones in all object relatives (in OSV_SG_SG $p=0.0038$, in OSV_PL_PL $p=0.0038$, in OSV_SG_PL $p=0.0002$, in OSV_PL_SG $p=0.0006$).

5.7.3.4 Object relatives with post-verbal embedded subject

Numbers and percentages of correct responses in each object relative with the embedded subject in the post-verbal position are shown in the following table:

	LIS		LA		CA		<i>Mean Sentence Type</i>	
OVS_SG_PL	14/36	39%	19/36	53%	34/36	94%	67/108	62%
OVS_PL_SG	5/36	14%	13/36	36%	34/36	94%	52/108	48%

Table 49: number and % of correct responses in object relatives with post-verbal embedded subjects

In these sentence types, LIS signers achieved lower scores than each of the other hearing group. A between-group analysis detected a significant difference between the group of adolescent LIS signers and the group of hearing adolescents. The latter group performed better than the former group in both types of object relatives with post-verbal embedded subject ($p=0.0014$ in OVS_SG_PL and $p=0.0000$ in OVS_PL_SG). No significant difference was instead attested between the group of hearing-impaired and that of hearing children in either of the two sentence types. What is somehow surprising is that they achieved higher scores in the sentence type OVS_SG_PL (OOp), than in some OO sentences, namely those displaying mismatched number features (OSV_SG_PL and OSV_PL_SG)

5.7.4 Response type analysis

Table (50), table (51) and table (52) summarize the responses provided, respectively by adolescent LIS signers, hearing adolescents and hearing children in each sentence type:

	Correct		Reversible		Agent		Other	
	Nr.	%	Nr.	%	Nr.	%	Nr.	%
SVO SG SG	26/36	72%					10/36	28%
SVO PL PL	29/36	81%					7/36	19%
SVO SG PL	22/36	61%	5/36	14%			9/36	25%
SVO PL SG	20/36	56%	4/36	11%			12/36	33%
OSV SG SG	15/36	41,7%	11/36	30,6%	7/36	19,4%	3/36	8,3%
OSV PL PL	15/36	41,7%	9/36	25,0%	9/36	25,0%	3/36	8,3%
OSV SG PL	10/36	27,8%	10/36	27,8%	9/36	25,0%	7/36	19,4%
OSV PL SG	12/36	33,3%	9/36	25,0%	10/36	27,8%	5/36	13,9%
OVS SG PL	14/36	38,9%	10/36	27,8%	5/36	13,9%	7/36	19,4%
OVS PL SG	5/36	13,9%	23/36	63,9%	3/36	8,3%	5/36	13,9%

Table 50: responses by LIS signers in each sentence type

	Correct		Reversible		Agent		Other	
	Nr.	%	Nr.	%	Nr.	%	Nr.	%
SVO SG SG	35/36	97%					1/36	3%
SVO PL PL	35/36	97%					1/36	3%
SVO SG PL	35/36	97%	1/36	3%			0/36	0%
SVO PL SG	36/36	100%	0/36	0%			0/36	0%
OSV SG SG	17/36	47,2%	9/36	25,0%	10/36	27,8%	0/36	0%
OSV PL PL	23/36	63,9%	7/36	19,4%	6/36	16,7%	0/36	0%
OSV SG PL	26/36	72,2%	2/36	5,6%	8/36	22,2%	0/36	0%
OSV PL SG	23/36	63,9%	3/36	8,3%	10/36	27,8%	0/36	0%
OVS SG PL	19/36	52,8%	11/36	30,6%	4/36	11,1%	2/36	5,6%
OVS PL SG	13/36	36,1%	20/36	55,6%	1/36	2,8%	2/36	5,6%

Table 51: responses by hearing children in each sentence type

	Correct		Reversible		Agent		Other	
	Nr.	%	Nr.	%	Nr.	%	Nr.	%
SVO SG SG	36/36	100%					0/36	0%
SVO PL PL	36/36	100%					0/36	0%
SVO SG PL	36/36	100%	0/36	0%			0/36	0%
SVO PL SG	36/36	100%	0/36	0%			0/36	0%
OSV SG SG	33/36	91,7%	3/36	8,3%	0/36	0,0%	0/36	0,0%
OSV PL PL	33/36	91,7%	3/36	8,3%	0/36	0,0%	0/36	0,0%
OSV SG PL	35/36	97,2%	1/36	2,8%	0/36	0,0%	0/36	0,0%
OSV PL SG	35/36	97,2%	0/36	0,0%	1/36	2,8%	0/36	0,0%
OVS SG PL	34/36	94,4%	1/36	2,8%	0/36	0,0%	1/36	2,8%
OVS PL SG	34/36	94,4%	2/36	5,6%	0/36	0,0%	0/36	0,0%

Table 52: responses by hearing adolescents in each sentence type

In sentences displaying number disambiguation, hearing adolescents did not show any problem. When only disambiguation through displacement of the

embedded subject in the preverbal position, and the two DPs displayed the same number features, relative clauses proved to be more problematic for this population.

In the group of hearing adolescents, the percentages of correct responses were very high. Their performance was almost at ceiling. For a small number of items, they chose the incorrect referent, namely the reversible character. This occurred with object relatives with preverbal embedded subject, mainly with those displaying the same number features on both DPs. As a matter of fact, in such conditions, a subject reading is also possible, in which the object is topicalized.¹³

As opposed to hearing adolescents, hearing children experienced greater difficulties in the interpretation of relative clauses, as we also showed in the first study. Subject relatives were comprehended without any difficulty. Problems arose with object relatives, for which significant differences are attested between the two groups in all conditions. In object relatives with preverbal embedded subject, the type of errors varies depending on the number features displayed on the two DPs. When sentences displayed the same number on both DPs (either singular or plural), children seem to randomly select either the reversible or the agent character. Both characters indeed agree in number with the embedded verb. In this sense, both DPs can potentially agree with the verb. In sentences disambiguated by verbal morphology, children correctly assigned thematic roles to the referents, but they selected in most cases the agent character, namely the character entering a strong agreement relationship with the verb (both under AGREE in Chomsky's 1995, 2000, 2001 terms and in a Spec-Head configuration) (see chapter 2, section 2.5, and this chapter, section 5.4.5.2). Object relatives with post-verbal subject showed the highest percentage of incorrect responses, replicating results of the previous study, as well as of Volpato & Adani (2009). On both sentence types (OVS_SG_PL and OVS_PL_SG), when the response was incorrect, the participants selected the character mainly corresponding to the reversible error. Therefore, following Volpato & Adani (2009), we claim that the difficulties experienced with these sentences rely on the presence of the embedded subject in the post-verbal position and to the fragility of agreement between the

¹³ This explanation was also provided by more than one adult participant.

two constituents, occurring under AGREE only (Guasti & Rizzi 2002, Franck et al. 2006).

What is worth being underlined is that in the group of hearing controls, the pattern of performance strongly corresponded to that identified for the hearing children in the first study.

Different remarks need to be made for the group of adolescent LIS signers, for whom the interpretation of relative clauses was extremely problematic. Ambiguous and subject relatives were the sentences on which the LIS signers showed the highest accuracy, although the percentages of correct responses were definitely lower than in all the other populations. Object relatives were more problematic than subject ones. In this respect, it seems that the pattern of performance of LIS signers corresponded to that of the other groups considered either in these studies, or in previous studies on typical and atypical populations. However, the overall pattern of response was quite different since participants seemed to choose responses quite randomly. This is suggested by the selection of the 'other' error in a quite high amount of items in all types of sentences. It was thus not possible to detect a clear trend for this group.

Different phenomena and different aspects have to be taken into consideration in assessing the performance of LIS signers. First of all, the group was small and not homogenous, i.e., it was not selected according to strict criteria. In addition, their linguistic age suggests that they experienced strong difficulties with a considerable number of linguistic properties of Italian, among which relative clauses.

The difficulty experienced with relative clauses might be attributed to some properties of relative clauses in LIS. The status of relative clauses in LIS is controversial and highly debated. Actually, to translate Italian relative clauses, LIS uses a construction labelled *prorel* clause, which is syntactically and semantically different from the Italian relativization structure (Cecchetto et al. 2004). We will not examine this issue in detail. However, it is possible that the different status of relative clauses in the two languages makes it difficult for LIS signers to properly master Italian relative clauses. The significant difference between hearing children and LIS signers in ambiguous and subject relatives is

explained by the fact that in the course of language development, hearing children manage to acquire and master these sentences. For LIS signers, these structures remain anyway problematic even at later stages of language development.

5.8 Study three: hearing children, hearing adolescents and hearing adults

In this study, we compared the performances of three hearing populations: a group of hearing children, a group of hearing adolescents, and a group of hearing adults. In Utzeri (2007), adolescents were included in the adult group. However, a production study conducted by Carpenedo (2009) demonstrated that in some cases, acquisition at adolescence does not fully pattern with that of adults, still presenting some characteristics typical to younger children. This comparison was necessary in order to determine whether and to what extent the performance of adolescents was different from that of hearing children and hearing adults.

The group of hearing adults included 16 participants ranging in age from 19;11 and 33;9 (mean age 24;11). The group of hearing adolescents was composed of 16 participants ranging in age from 15;1 and 17;5 years (mean age 15;5). The group of hearing children included 16 participants ranging in age from 5;3 and 7;5 years (mean age 6;5).

5.8.1 Procedure

The participants were tested following the procedure described in sections 3.9.

5.8.2 Results

The number and percentage of correct responses for the three groups are shown in the following table:

		Adults		Adolescents		Children		Mean Sentence	
AMB	SVO_SG_SG	96/96	100%	95/96	99%	91/96	95%	282/288	98%
	SVO_PL_PL	96/96	100%	93/96	97%	93/96	97%	282/288	98%
OS	SVO_SG_PL	96/96	100%	96/96	100%	89/96	93%	281/288	98%
	SVO_PL_SG	96/96	100%	96/96	100%	88/96	92%	279/288	97%
OO	OSV_SG_SG	95/96	99%	80/96	83%	57/96	59%	232/288	81%
	OSV_PL_PL	96/96	100%	87/96	91%	60/96	63%	243/288	84%
	OSV_SG_PL	96/96	100%	92/96	96%	70/96	73%	258/288	90%
	OSV_PL_SG	96/96	100%	93/96	97%	62/96	65%	251/288	87%
OOp	OVS_SG_PL	96/96	100%	93/96	97%	47/96	49%	236/288	82%
	OVS_PL_SG	96/96	100%	86/96	90%	37/96	39%	219/288	76%
Mean Group		99,9%		94,9%		72,3%			

Table 53: percentage of correct answers for each group in each sentence type

The group of adults performed at ceiling. The groups of adolescents and children made instead some errors. The group of children appears to be the group experiencing the greatest difficulties in the interpretation of some sentence types. Analysis of responses revealed a significant effect of Group [$\chi^2(2)=-9.212$, $p<0.001$] and a significant Sentence Type effect [$\chi^2(3)=-12.09$, $p<0.001$]. The group of adults performed significantly better than the group of adolescents ($p<0.001$) and that of children ($p<0.001$). Ambiguous sentences (AMB) were significantly more accurate than object relatives with both preverbal (OO) and post-verbal embedded subject (OOp) ($p<0.001$, $p<0.001$, respectively). OS were significantly more accurate than OO and OOp ($p<0.001$ and, -9.732 $p<0.001$, respectively). OO were significantly more accurate than OOp ($p<0.001$). No significant difference was attested between AMB and OS. As for the difference in performance between the three groups across the various sentence types, we will analyse them in the next sections. Significant interaction effects (Sentence Type x Group) were also found ($p<0.001$).

5.8.2.1 Ambiguous sentences

The percentage of correct responses for each group in each sentence type is shown in the following table:

	Adults		Adolescents		Children		Mean Sentence	
SVO SG SG	96/96	100%	95/96	99%	91/96	95%	282/288	98%
SVO PL PL	96/96	100%	93/96	97%	93/96	97%	282/288	98%

Table 54: number and % of correct responses in ambiguous relative clauses

The percentages of correct responses are very high for all groups. Adults showed a ceiling performance. Children and adolescents also achieved high percentages of accuracy, although lower than adults did.

These sentences were ambiguous between a subject and an object reading. For each group, we calculated the percentages of interpretation of the head as the subject or the object of the embedded clause in each of the two ambiguous sentence types, when participants provided the correct response. Results are shown in the following table:

	SVO SG SG			SVO PL PL		
	<i>SR</i>	<i>OR</i>	<i>AMB.</i>	<i>SR</i>	<i>OR</i>	<i>AMB.</i>
Adults	96%	0%	4%	92%	4%	4%
Adolescents	98%	1%	1%	96%	1%	3%
Children	98%	2%	0%	85%	15%	0%
Mean Sentence	97%	1%	2%	91%	7%	2%

Table 55: percentage of subject (SR) and object (OR) interpretation for each type of ambiguous sentence

From this table, it is evident that when a relative clause contained two DPs bearing the same number features, in most cases, the first DP was interpreted as the subject of the embedded sentence, replicating results found in previous studies. The head was also interpreted as the object of the embedded clause, but percentages were very low. Differently from children, both adults and adolescents perceived the ambiguity of some sentences, but then, when asked to make a choice between the two options, the subject reading was always preferred.

As a confirmation of previous analyses, once again for ambiguous sentences with plural DPs, the percentage of subject reading is lower than the percentage of object reading.

5.8.2.2 Subject relatives

Numbers and percentages of correct responses in each unambiguous subject relative types are shown in the following table:

	Adults		Adolescents		Children		Mean Sentence	
SVO_SG_PL	96/96	100%	96/96	100%	89/96	93%	281/288	98%
SVO_PL_SG	96/96	100%	96/96	100%	88/96	92%	279/288	97%

Table 56: number and % of correct responses in subject relative clauses

The performance on subject relatives shows very high percentages of accuracy. Adolescents and adults performed at ceiling, while children made some errors. Nonetheless percentages were very high, above 90%, and between-groups analyses did not reveal any significant difference.

5.8.2.3 Object relatives with preverbal embedded subject

Numbers and percentages of correct responses in each object relative with the embedded subject in the preverbal position are presented again in the following table:

	Adults		Adolescents		Children		Mean Sentence	
OSV_SG_SG	95/96	99%	80/96	83%	57/96	59%	232/288	81%
OSV_PL_PL	96/96	100%	87/96	91%	60/96	63%	243/288	84%
OSV_SG_PL	96/96	100%	92/96	96%	70/96	73%	258/288	90%
OSV_PL_SG	96/96	100%	93/96	97%	62/96	65%	251/288	87%

Table 57: number and % of correct responses in object relatives with preverbal embedded subject

These types of relative clauses were not problematic for adults. Both adolescents and children made some errors, but the lowest percentages of accuracy were attested in the group of children. A repeated-measure logistic regression analysis revealed that children significantly differed from adolescents in the comprehension of all object relatives with preverbal embedded subject (in OSV_SG_SG, $p=0.012$, in OSV_PL_PL, $p=0.0012$, in OSV_SG_PL, $p=0.024$ and in OSV_PL_SG, $p=0.000$).

5.8.2.4 Object relatives with post-verbal embedded subject

Numbers and percentages of correct responses in each type of object relative with the embedded subject in the post-verbal position are shown in the following table:

	Adults		Adolescents		Children		Mean Sentence	
OVS_SG_PL	96/96	100%	93/96	97%	47/96	49%	236/288	82%
OVS_PL_SG	96/96	100%	86/96	90%	37/96	39%	219/288	76%

Table 58: number and % of correct responses in object relatives with post-verbal embedded subjects

In these sentence types, children achieved the lowest scores when compared with all the other sentence types. A between-group analysis detected a significant difference between the group of adolescents and the group of children. Interaction effects found indeed that these sentence types are more difficult for children than for adolescents ($p < 0.001$ for both structures).

5.8.3 Analysis of response types

Table (59), table (60) and table (61) summarize the responses provided, respectively by adults, adolescents and children in each sentence type:

	Correct		Reversible		Agent		Other	
SVO_SG_SG	96/96	100%					0/96	0%
SVO_PL_PL	96/96	100%					0/96	0%
SVO_SG_PL	96/96	100%	0/96	0%			0/96	0%
SVO_PL_SG	96/96	100%	0/96	0%			0/96	0%
OSV_SG_SG	95/96	99%	1/96	1%	0/96	0%	0/96	0%
OSV_PL_PL	96/96	100%	0/96	0%	0/96	0%	0/96	0%
OSV_SG_PL	96/96	100%	0/96	0%	0/96	0%	0/96	0%
OSV_PL_SG	96/96	100%	0/96	0%	0/96	0%	0/96	0%
OVS_SG_PL	96/96	100%	0/96	0%	0/96	0%	0/96	0%
OVS_PL_SG	96/96	100%	0/96	0%	0/96	0%	0/96	0%

Table 59: responses by adults in each sentence type

As already pointed out in the above sections, adults performed at ceiling in all items. Only one participant gave an incorrect answer, by choosing the reversible referent in the OSV_SG_SG condition.

	Correct		Reversible		Agent		Other	
SVO_SG_SG	95/96	99%					1/96	1%
SVO_PL_PL	93/96	97%					3/96	3%
SVO_SG_PL	96/96	100%	0/96	0%			0/96	0%
SVO_PL_SG	96/96	100%	0/96	0%			0/96	0%
OVS_SG_SG	80/96	83%	13/96	14%	3/96	3%	0/96	0%
OVS_PL_PL	87/96	91%	7/96	7%	2/96	2%	0/96	0%
OSV_SG_PL	92/96	96%	2/96	2%	2/96	2%	0/96	0%
OSV_PL_SG	93/96	97%	0/96	0%	3/96	3%	0/96	0%
OVS_SG_PL	93/96	97%	1/96	1%	1/96	1%	1/96	1%
OVS_PL_SG	86/96	90%	7/96	7%	3/96	3%	0/96	0%

Table 60: responses by adolescents in each sentence type

Adolescents achieved high scores in all sentence types, although they experienced some difficulties with some sentence types, namely with those involving movement from the embedded object position. The sentence type OVS_SG_SG appeared to be the most problematic. In most cases, students selected the reversible referent, as also happened for the participant in the adult group. The same trend was also identified in sentence type OVS_PL_PL, where participants selected the reversible referent in a small percentage of items. The reversible error was also detected in sentence type OVS_PL_SG. The “other” error was selected in a small amount of items, and the same could be noted for the “agent” error.

	Correct		Reversible		Agent		Other	
SVO_SG_SG	91/96	95%					5/96	5%
SVO_PL_PL	93/96	97%					3/96	3%
SVO_SG_PL	89/96	93%	4/96	4%			3/96	3%
SVO_PL_SG	88/96	92%	2/96	2%			6/96	6%
OSV_SG_SG	57/96	59%	20/96	21%	18/96	19%	1/96	1%
OSV_PL_PL	60/96	63%	18/96	19%	17/96	18%	1/96	1%
OSV_SG_PL	70/96	73%	7/96	7%	18/96	19%	1/96	1%
OSV_PL_SG	62/96	65%	8/96	8%	26/96	27%	0/96	0%
OVS_SG_PL	47/96	49%	31/96	32%	13/96	14%	5/96	5%
OVS_PL_SG	37/96	39%	48/96	50%	9/96	9%	2/96	2%

Table 61: responses by children in each sentence type

In the group of children, there is higher variability in the pattern of response than in the other two groups. On a par with adolescents’ performance,

children experienced more difficulties with relatives involving movement from the embedded object position. Confirming the results found in study one and two, in OSV sentence types, children performed slightly better on trials in which the DPs were dissimilar in term of number features (OSV_SG_PL and OSV_PL_SG), as opposed to trials in which the DPs displayed the same features (OSV_SG_SG and in OSV_PL_PL). The pattern of response found in study one and study two is much more distinct in this study. In the match conditions (OSV_SG_SG and OSV_PL_PL), children seemed to randomly select either the agent or the reversible error. In the mismatch conditions (OSV_SG_PL and OSV_PL_SG), instead children showed a clear preference for the agent error.¹⁴

5.9 Correlation analysis

Memory places strong limitations to the correct interpretation of complex sentences (Papagno et al.2007), as relative clauses are. In order to determine whether the performance in the comprehension task depended on reduced memory abilities, we correlated each repetition task with the relative clause comprehension task. In addition, for cochlear-implanted children, we also correlated comprehension in each sentence condition with age at testing, age at first intervention, age at implantation, degree of hearing loss, and duration of use of the cochlear implant. In the following sections, the analysis for each group is presented.

5.9.1 Hearing-impaired children with cochlear implant

We did not find any correlation between measures on working memory and scores on the comprehension of any specific type of sentence. We found instead a significant positive correlation between mean sentence comprehension and word repetition ($r_s = .615$ $p = .025$). In addition, we also found a positive correlation between age at testing and both types of unambiguous subject relatives (SVO_SG_PL: $r_s = .556$ $p = .049$ and SVO_PL_SG: $r_s = .619$ $p = 0.24$).

¹⁴ It is worth pointing out is that when such an error is made, assignment of thematic roles is correct and thematic relationship is preserved and correctly interpreted.

5.9.2 Hearing children

In hearing children, we found that comprehension of relative clauses correlated with a variety of working memory measures. A significant positive correlation between mean sentence comprehension and the following measures:

- backward memory span ($r_s = .611$ $p = .003$)
- non-word repetition scores ($r_s = .727$ $p = .000$)
- age (in months) ($r_s = .783$ $p = .000$)

We also found correlations between scores on memory abilities and specific sentence types. Specifically, we found significant correlations between scores on sentence repetition task and performance on the comprehension of the following sentence conditions:

Sentence type	r_s	p
OSV_PL_SG	.433	.044
OSV_SG_PL	.486	.022
OSV_SG_SG	.515	.014
OVS_PL_SG	.468	.028
OVS_SG_PL	.497	.019

Positive correlations were also detected between backward digit span and performance on the following sentence types:

Sentence type	r_s	p
OSV_PL_SG	.782	.000
OSV_SG_PL	.712	.000
OSV_SG_SG	.512	.015
OSV_PL_PL	.767	.000
OVS_PL_SG	.555	.007
OVS_SG_PL	.627	.002
SVO_PL_PL	.679	.001
SVO_SG_PL	.506	.016
SVO_SG_SG	.570	.006

Positive correlations were also found between the non-word repetition task and performance on the following sentence types:

Sentence type	r_s	p
OSV_PL_SG	.668	.001
OSV_SG_PL	.597	.003
OSV_SG_SG	.699	.000
OSV_PL_PL	.701	.000
OVS_PL_SG	.590	.004
OVS_SG_PL	.638	.001
SVO_PL_PL	.499	.018

The scores on the word repetition task positively correlated only with the sentence type OVS_SG_PL ($r_s = .484$ $p = .022$).

Finally, scores on the comprehension task also correlated with the age at the moment of testing:

Sentence type	rs	p
OSV_PL_SG	.803	.000
OSV_SG_PL	.700	.000
OSV_SG_SG	.666	.001
OSV_PL_PL	.801	.000
OVS_PL_SG	.602	.003
OVS_SG_PL	.650	.001
SVO_PL_PL	.571	.006
SVO_SG_SG	.500	.018

5.9.3 LIS signers

In LIS signers, repetition of words positively correlated with performance on SVO_PL_PL ($r_s = .907$ $p = .013$), while backward digit span negatively correlated with performance on OVS_SG_PL ($r_s = -.898$ $p = .015$).

5.9.4 Hearing adolescents

In adolescents, scores in the sentence repetition task correlated with performance on the sentence condition SVO_PL_PL ($r_s = .537$ $p = .032$).

5.10 General discussion

Confirming the results by previous studies on typical and atypical populations (Arosio et al. 2005, Adani 2008, Volpato & Adani 2009), the asymmetry between subject relatives and object relatives is also replicated in this study, both for the hearing and the hearing-impaired group. Subject relatives are performed significantly better than object relatives. Furthermore, also the gradient of difficulty is replicated in this study, namely subject relatives (OS) are easier than object relatives with preverbal subject (OO), and OO are easier than object relatives with post-verbal subject (OOp).

5.10.1 The performance on subject relatives

Following the analysis proposed in Volpato & Adani (2009) (see sections 5.4.5.1 and 5.4.5.2), we claim that the asymmetry between subject relatives and object relatives is easily captured by the short relation between the relative head and the position from which it has moved:

- (63) le tigri [_{CP} che [_{IP} <le tigri> mordono il cavallo]
the tigers [_{CP} that [_{IP} <the tigers> bite the horse]

In addition, no intervention (Relativized Minimality) effects are at work, because no interfering elements block the relationship between the two positions.

5.10.2 The performance on object relatives

In Volpato & Adani (2009), we claimed that the difficulty that children experienced with object relatives is to be attributed to Relativized Minimality (RM, henceforth) due to the presence of an intervening element between the object head of the matrix clause and the position from which it is extracted.

Since also in this work, object relatives are significantly more difficult than subject relatives, we might hypothesize that the same phenomenon is also at play for the data collected through this experiment. In a sense, this is the case. However, we claim that other phenomena are also at play, and we will account for them later in this section. If we consider RM as the only eligible explanation, we

would not expect any difference between the two groups in the use of the four types of OO. Instead, one sentence type in which the two DPs dissimilar in terms features (namely the head DP is singular and the embedded DP is plural – OSV_SG_PL) was significantly more difficult for hearing-impaired children than for hearing children. In addition, although without any significant difference, the pattern of performance of hearing-impaired children, also in terms of the nature of the errors, seems to slightly depart from that of hearing ones. In particular, number features either on the two DPs or on verbal morphology influence in a different way the outcomes of the performance within the two groups.¹⁵

Before proceeding with the analysis, let us examine some issues on how number features are morpho-syntactically realized on verbs.

5.10.3 The number feature on verbal morphology

The verbs presented in the comprehension task are either in the third-person singular (third form of the paradigm), or in the third-person plural (sixth form of the paradigm):

(64) La giraffa che pettina gli orsi
‘the giraffe that combs the bears’

(65) Le giraffe che pettinano l’orso
‘the giraffes that comb the bears’

From this example, we can see that the plural form of the verb (*pettinano*) is derived by adding the morpheme *-no* to the singular form (*pettina*).

Thornton (1999) and Salvi & Vanelli (2004) highlighted the particular status of the sixth (third-person plural) form, as opposed to the other plural persons of the paradigm. Indeed, as opposed to the fourth and fifth (plural) persons, in the verbal inflectional Italian system, the sixth person is constructed as

¹⁵ In Volpato & Adani (2009), using the test by Adani (2008), all sentences had the same combination of number features, namely a singular head and a plural embedded DP. For this reason, there was no possibility to investigate the different match and mismatch conditions.

a true plural of the singular by adding the plural morpheme *-no* agglutinated to the third person singular:

- (66) a. [[*pettina*]+no] [[comb.3.SG]+PL]

Differently from the sixth person which displays the (real) plural morpheme on the verbal root, the third-person singular does not display any agreement morpheme. The vowel appearing on the root in the singular is a thematic vowel. The verbal form *pettina* '(he/she) combs' is therefore a bare form, created by the root *pettin* + the thematic vowel *a*.¹⁶ This vowel is not the singular agreement suffix, as opposed to the suffix *-no*, which marks the plural (sixth) form of Italian verbs. Hence, in Italian, plural is the marked form, and singular is the bare unmarked one. In this respect, Italian presents the mirror image of the agreement system of English, in which third-person singular is the marked form, composed of the bare form of the verb + the singular marker *-s*, while third-person plural is the bare (unmarked) form.

The distinction between marked and unmarked (bare) forms is important to understand a linguistic phenomenon in an English variety, where a singular subject can co-occur with a verb not marked for singular features (*think*, for instance), when the head of the relative/*wh*- phrase is in the plural (Kayne 1989):

- (67) the people who Clark think are in the garden
- | | | |
|----|----|----|
| PL | SG | PL |
|----|----|----|

¹⁶ This proposal is based on verbs belonging to the first conjugation, like *pettinare*. With verbs belonging to the second or third conjugation, the vowel preceding the plural marker in the sixth form is *o*, while it is *e* in the 3rd person singular:

- (i) a. vede vedono
 see.3.SG see.3.PL
 b. dorme dormono
 sleep.3.SG sleep.3.PL

Thornton (1999) suggests that in this case, the plural morpheme *-no* is added to the first person forms rather than to the third person:

- (ii) a. [[vedo]+no] [[see.1. SG]+PL]
 b. [[dormo]+no] [[sleep.1. SG]+PL]

While this proposal accounts for the morphological form of the third-person plural, it is somehow controversial with respect to the semantic features involved. We leave the exact status of *o* as an open issue.

This attraction phenomenon does not occur in the reversed situation. Namely, the plural embedded subject cannot co-occur with the marked form of the verb (bearing the marked singular feature $-s$), when the relative head is in the singular:

(68) *the man who the girls likes
 SG PL SG

Agreement and attraction phenomena as those shown in (67) are possible because the verb form is bare, and consequently it appears that it is not specified to agree with a specific DP. On the other hand, the third-person singular, representing the marked form (by being specified for the marked value [+singular]) cannot co-occur with a plural DP because the verb is specified for singular features.

The Italian verbal system is opposite to the English one, in that in Italian, the marked form is specified for the value [+plural], bearing the plural agreement morpheme $-no$.

5.10.4 The role of number features in hearing-impaired children

We claim that similar agreement/attraction phenomena in the sense of Kayne (1989), and as shown in (67), are at work when hearing-impaired children interpret object relatives with preverbal embedded subject. Before explaining how they operate, some further remarks are necessary.

First of all, let us repeat the four OO conditions with an example:

OSV_SG_SG: Il pulcino che la gallina becca
 ‘The chick that the hen pecks’

OSV_PL_PL: I pulcini che le galline beccano
 ‘The chicks that the hens peck’

OSV_SG_PL: Il pulcino che le galline beccano
 ‘The chick that the hens peck’

OSV_PL_SG: I pulcini che la gallina becca
'The chicks that the hen pecks'

Linguistic and psycholinguistic studies proposed that number features play a significant role in the interpretation of a sentence (cf. chapter 2, sections 2.4 and 2.4.1). Indeed, when the Num projection is present in clause structure, sentence comprehension is facilitated. Therefore, we would expect a different positive behaviour when the two DPs display different number features, and verbal morphology unambiguously shares number features with the embedded DP (OSV_SG_PL and OSV_PL_SG).

Instead, hearing-impaired children did not appear to be sensitive to number cues on the embedded verb in the disambiguation and interpretation of a sentence. Indeed in the mismatch conditions, when plural (marked) agreement occurred both on the embedded DP and the embedded verb, hearing-impaired children showed a significant less accurate performance than hearing children in the sentence type OSV_SG_PL. In addition to a between-group difference, also within the hearing-impaired group, percentages of accuracy in mismatch conditions are lower than those in the matched ones.

We claim that number features play an important role in hearing children, but in the hearing-impaired group, they are problematic, because they might be inaccessible or underspecified on verbal plural forms, as often happens in atypical populations (Chesi 2006, Chinellato 2004). Chesi (2006) found that in some hearing-impaired individuals singular is preferred over plural on verbs, mainly when referred to the third person. Chinellato (2004), instead, found that in agrammatic patients, plural number features seem to be more expensive in terms of computation.¹⁷

¹⁷ Indeed, Chinellato (2004) found that a patient LC substituted in most cases (57%) the sixth person with the third one (in present tenses, the form 'va' replaced the form 'vanno' and in past tenses, the form 'aveva preso' ((he/she) had.3.SG taken) replaced the correct form 'avevano preso' ((they) had.3.PL taken). The explanation is that the feature checking operation brought the syntactic derivation to crash (Chomsky 1995), since some person features are inaccessible or underspecified. In agrammatic patients, the plural feature seems to be more expensive in terms of computation (and in some cases inaccessible) during syntactic derivation, and consequently the sixth person is produced with more difficulties.

5.10.5 Attraction and agreement phenomena to account for performance

Generally, when interpreting a sentence, children always prefer starting with a subject interpretation and positing a gap as soon as possible (De Vincenzi 1991). This claim is also strengthened by the data collected from the interpretation of ambiguous sentences, namely sentences in which the relative head may be interpreted either as the subject or the object of the embedded verb (see section 5.6.4.1, this chapter). The subject reading was attributed significantly more often when number features were singular, than when they were plural (Wilcoxon, $Z=-2.357$ $p=0.018$). This means that when two DPs are in the singular, the subject reading is more easily available than when the two DPs are in the plural. Although numerically high in both cases, the subject reading is highly favoured with singular features. This phenomenon also has strong consequences for the interpretation of the results for object relatives with preverbal subject (OO).

Undoubtedly, the presence of an interfering DP places some further load to the computation of a sentence (Arnon 2005). However, it is not the solely responsible factor since we claim that attraction errors are also at play¹⁸, which besides justifying the percentage variability in OO, help justify the type of responses children provided in the task, namely the choice of reversible or agent errors.

Mismatch conditions seem to cause some trouble to hearing-impaired children, above all when the head is singular and the embedded DP subject is plural, namely for the sentence type OSV_SG_PL. Following the assumption by Chesi (2006) and Chinellato (2004), we claim that in the sentence type OSV_SG_PL, reported as (69), plural features are not specified, and the morpheme *-no* does not enter the computation, as (70) shows:

(69)	La gallina	che	i pulcini	beccano
	the hen	that	the chicks	peck
	DPO[-pl]		DPS[+pl]	V[+pl] ¹⁹

¹⁸ In linguistic theory, attraction refers to the force that drives movement, in order for an element to check its features in the relevant projections. Here, the term attraction is referred in a more general sense as ‘looking for agreement’.

¹⁹ DPO indicates that the DP is the object of the matrix clause, DPS that the DP is the subject of the embedded clause and V the verb. The abbreviation in square brackets indicates number

- (70) La gallina che i pulcini beccano
 the hen that the chicks peck
 DPO[-pl] DPS[+pl] V[-pl]

Following Kayne (1989), in Italian, it is possible for a head bearing the unmarked form (singular features [-pl]) to attract a verb bearing unmarked singular features [-pl]²⁰:

- (71) La gallina che i pulcini becca(no)
 DPO[-pl] DPS[+pl] V[-pl]
 SG PL SG
 |-----↑

The DP *la gallina* looks for a verb bearing the same number feature for agreement purposes, regardless of the position in which the verb might occur. Since plural features are not accessible in the computation, the plural morpheme –*no* on the verb is deleted, thus leaving the bare form *becca*. The only constituent available for agreement is *la gallina*, and the embedded DP is interpreted as a topicalized object.

The incorrect agreement between the DP *la gallina* and the verb *becca* leads hearing-impaired children to select the incorrect referent, namely the reversible character, in a considerable number of experimental trials.


The same principles may also explain the incorrect responses provided in the sentence types OSV_SG_SG, OSV_PL_PL, and OSV_PL_SG. For instance, in the sentence type OSV_SG_SG (72), the object head is again singular. Also the embedded subject and the verb bear singular features:

features associated to each constituent. [-pl] means that the element bears singular features, and [+pl] indicates that it bears plural features.

²⁰ What we obtain is the opposite pattern of English

- (72) La gallina che il pulcino becca
 the cock that the chick pecks
 DPO[-pl] DPS[-pl] V[-pl]

Also in this sentence, an agreement relation is established between the DP *la gallina* and the verb, regardless of the position occupied by the embedded verb and the hierarchical structure. The DP *il pulcino* is interpreted, in this case, as a topicalized object:

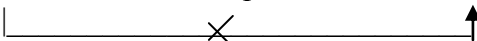
- (73) La gallina che il pulcino becca


Following the same line of reasoning as in (71), the choice of the reversible (error) character is immediately captured.

We would expect that the same phenomena occurring in (73) are also at play in the case in which all constituents are marked for plural features. However, differently from unmarked features, marked features cannot act as attractors for the verb (Kayne 1989):

- (74) Le galline che i pulcini beccano
 the cocks that the chicks peck
 DPO[+pl] DPS[+pl] V[+pl]

Non-interpretable plural features on the verb are more fragile and may remain underspecified. Hence, the plural verbal morphology *-no* does not enter computation and hearing-impaired children interpret the verb *beccano* '(they) peck' as *becca* '(it) pecks'. In addition, an agreement relation between the DP *le galline* and the verb cannot be established, because the verb is unspecified for number features:

- (75) Le galline che i pulcini becca(∅)


The strength of this relation, as opposed to that in (76), may also be confirmed by the higher percentage (although probably not significant) of selection of the agent character in this case (21% in OSV_PL_SG vs. 18% in OSV_PL_PL).

5.10.6 The role of number features in hearing children

In object relatives, the patterns of performance of hearing children tend to differ from that of hearing-impaired children. For hearing children of study one, the percentage of accuracy in object relatives with preverbal subject (OO) is quite high, almost 80%. Nonetheless, the performance accuracy is lower than in subject relatives (OS).

As opposed to hearing-impaired children, in OO, hearing participants showed higher percentages of accuracy in the mismatch conditions (OSV_SG_PL and OSV_PL_SG) with respect to the match ones (OSV_SG_SG and OSV_PL_PL), performing significantly better than the hearing-impaired group in the sentence type OSV_SG_PL.

While in cochlear-implanted children, number features do not appear to play any role, the markedness of plural agreement on the verb (above all in the mismatch condition) appears to be the relevant cue helping hearing children performance, thus confirming results from both linguistic and psycholinguistic studies on the significant role played by the Number projection in clause structure (Ritter, 1995, Di Domenico 1997, De Vincenzi & Di Domenico 1999, Carminati 2005, Adani 2008, Volpato 2008, Volpato submitted). This is evident in study one, but also in the other studies in which the performance of hearing children was analysed, namely study two and study three. If we consider comprehension data by hearing children across the three studies (study one, two and three), we see that the pattern of performance is the same in all studies.

The sentences with match conditions (OSV_SG_SG and OSV_PL_PL) showed lower percentages of accuracy than those with mismatch conditions (OSV_SG_PL and OSV_PL_SG).

The pattern of performance of hearing children when compared to that of hearing-impaired children suggests that the source of difficulty is different in the

two groups. This claim is also supported by the type of (incorrect) responses (either reversible or agent) provided in the comprehension of OO by the two groups.

Friedmann et al. (2009) accounted for the difficulties experienced by Hebrew-speaking children in object relatives in terms of intervening effects (lexical restriction) due to the presence of the subject NP blocking the relation between the moved head and its copy in the embedded object position (see section 5.4.5.2). If we consider hearing children's performance in all three studies, we would expect that performance does not change across the four types of OO. Despite the fact that no significant differences are attested within the four sentence types, higher percentages of correct responses are found in the mismatch conditions. Following the same line of reasoning of Friedmann et al. (2009), we claim that disjoint number features on the DPs favour sentence comprehension:

(80) La gallina che i pulcini beccano <la gallina>

The hen that the chicks peck <the hen>

[-pl]	[+pl]	[-pl]
ok		

(81) Le galline che il pulcino becca <le galline>

The hens that the chick pecks <the hens>

[+pl]	[-pl]	[+pl]
ok		

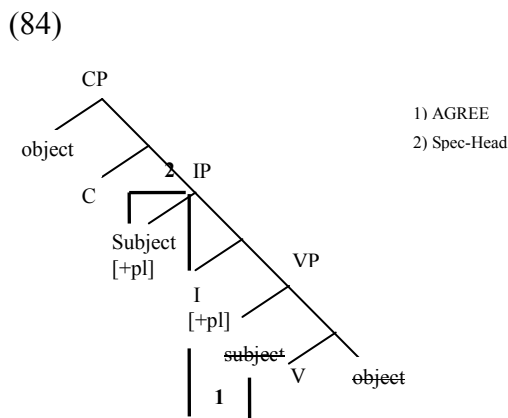
The presence of disjoint number features increases accuracy. In the mismatch condition OSV_SG_PL (80), in which hearing children performed better than hearing-impaired children, comprehension is facilitated because more cues are available, thus the agreement relation is stronger. Two plurals are linearly close to each other, the embedded subject and the verb, and the NumP projection is present in the (embedded) clause structure (Ferrari 2005, Volpato 2008, submitted):

(82) la gallina che i pulcini beccano <la gallina>
 [-pl] [+pl] [-pl]
 [CP... [DP... [NumP... [NP...] VP]]

(83) le galline che il pulcino becca <le galline>
 [+pl] [-pl] [+pl]
 [CP... [DP... [NP...] VP]]

Hence, a double plural markedness implies more visibility. Plurality appears to drive correct interpretation

As we can see from the following figure, when the embedded subject is plural, children find redundancy of information as opposed to the other conditions (Agree + Spec-Head agreement + [+pl(ural)] markedness in the Spec-Head configuration), and interpret correctly the sentence:



In a disjunction situation, the rich configuration of agreement and the salience of Number features favour the correct interpretation of thematic roles. However, unfortunately, the limited resources of the memory system block the parsing of the whole sentence and somehow force children to choose the agent referent. The role of memory in the performance of the different types of OO has been highlighted by different measures assessing memory abilities. The relation between low memory resources and performance on object relatives has also been pointed out by Papagno et al. (2007) (see chapter 4, section 4.2).

When we have disjunction in number features as in (80) and (81), the sentence is comprehended better than in the conditions in which disjunction does not occur and the relation is blocked, as in (85) and (86):

- (85) La gallina che il pulcino becca <la gallina>
 The cock that the chick pecks <the hen>
 [-pl] [-pl] [-pl] [-NumP]
 |-----no-----|

- (86) Le galline che i pulcini beccano <le galline>
 The cock that the chicks peck <the hen>
 [+pl] [+pl] [+pl] [+NumP]
 |-----no-----|

When disjunction does not occur, children seem to randomly select either the reversible error or the agent error, since both can potentially (numerically) act as antecedents. However, when the Number projection is present in clause structure, the performance improves.

In the course of language development, performance significantly improves. Indeed, with adolescent subjects, the percentages of correct responses increase. Most importantly, there seems to be a sort of continuity between the performance of children and that of adolescents. Indeed, for both of them, the match conditions are problematic, but the insertion of NumP in clause structure favours a more accurate performance.

5.10.7 The performance on object relatives with post-verbal subject

On object relatives, both hearing and hearing-impaired participants achieved lower scores than on all the other structures. These structures were extremely problematic for hearing-impaired children, and indeed a significant difference was attested between the two groups in both types of sentences, replicating the results found in Volpato & Adani (2009), which were presented in section 5.4.4.

Also hearing children experienced strong difficulties in interpreting these sentences, and indeed, a significant difference was found between this group and the group of adolescents. For adolescents, percentages of correct responses are quite high, although some errors are attested in both sentence types included in the OOp class.

Study one confirms once again that the difficulty of children, and especially of cochlear-implanted subjects, is due to the fragility of agreement occurring between the sentence constituents, namely between the verb and the post-verbal subject. By adopting Guasti & Rizzi's (2002) and Franck et al.'s (2006) assumptions, in OVS, agreement is realized only under AGREE, but it is not strengthened by further agreement in the Spec-Head configuration. Checking of features only under AGREE is extremely fragile and taxing for hearing-impaired children (see section 5.4.5.2). The higher percentages achieved in the sentence type OVS_SG_PL prove that the presence of NumP in (embedded) clause structure facilitates the comprehension by all populations.

CHAPTER 6

THE EXPERIMENT: THE PRODUCTION TASK

6.1 Introduction

This analysis inserts at the core of much recent linguistic research focussed on the production of relative clauses by different populations across different languages. Recent cross-linguistic research demonstrated that in English, French, Italian and Greek, relative clauses are produced by typically-developing children very early, around 3 years of age (Crain et al. 1990; McKee et al. 1998; Pérez-Leroux, 1995; Varlokosta & Armon-Lotem, 1998).

Recent research is devoted to the analysis of elicited speech production of relative clauses in Italian (Guasti & Cardinaletti 2003, Utzeri, 2007), in French (Labelle 1990, Guasti & Cardinaletti 2003), in Hebrew (Novogrodzky & Friedmann 2006), across populations with typical and atypical language development (typically-developing children, adults, SLI children).

Elicited production of relative clauses in hearing-impaired populations with different degrees of hearing loss was investigated in English by Quigley and Paul (1984) and De Villiers (1988), in Hebrew by Friedmann & Szterman (2006), in French by Delage (2008). These authors mainly tested individuals fitted with conventional hearing aids. Only Friedmann & Szterman (2006) included in their experimental sample a small group of hearing-impaired individuals using a cochlear implant. Common to all these studies is the widely attested asymmetry between subject and object relatives. In all populations across different languages, subject relatives are more accurate than object relatives. The relativization of the object is avoided through strategies turning object relatives into subject relatives. To our knowledge, no study on the production of relative clauses has been conducted for Italian-speaking hearing-impaired children yet.

This study investigates the production of subject relatives and object relatives by hearing-impaired children using a cochlear implant in order to verify whether they differ from normal hearing children in the development of specific

properties of Italian, namely relativization, when using an eliciting production task.

In addition, in order to have a more detailed picture on relative clause production, a comparison between normal hearing children, adolescents and adults was carried out so as to detect the performance variations in the course of language acquisition and development.

6.2 The production of relative clauses: Previous studies

This section presents the studies on the production of relative clauses by hearing and hearing-impaired individuals.

6.2.1 The production of relative clauses by hearing individuals

Elicitation of relative clauses in Italian has been carried on typically-developing children (Guasti & Cardinaletti 2003, Utzeri 2007) and adults (Utzeri 2007). Utzeri (2007) investigated the production of relative clauses by Italian-speaking hearing children and adults. She tested 41 children aged between 6 and 11 years and 30 adults ranging from 15 to 73 years of age. She elicited subject and object relative clauses by using a picture description task (PDT) and a preference task (PT), previously adopted by Novogrodsky & Friedmann (2006) and Friedmann & Sztermann (2006) to test these structures in different Hebrew-speaking typical and atypical populations. Utzeri (2007) found that both children and adults produced the targeted subject relatives without any problem. As for object relatives, children produced 22% of the elicited target sentences. Actually, in child production three types of object relatives were found: with gaps (either with pre-verbal or post-verbal embedded subject – 15 in the PDT and 42 in the PT), with resumptive pronouns (19 in PDT and 49 in PT) and with resumptive DPs. In adults, instead, object relatives are almost absent. Indeed, adults produced less than 1% of the targeted sentences. Children and adults adopted various strategies turning the targeted object relatives into subject relatives. The strategies she identified were passivization (87), causative constructions (88), use of ‘receive+DP (89), change of the verb (90) (examples from Utzeri 2007):

- (87) Target: il bambino che la mamma copre
the child that the mother wraps up
Production: il bambino che è coperto dalla mamma
the child that is wrapped up by the mother
- (88) Target: Il bambino che il re pettina
The child that the king combs
Production: Il bambino che si fa pettinare dal re
The child that himself makes comb by the king
'The child that makes himself comb by the king'
- (89) Target il bambino che la mamma bacia
the child that the mother kisses
Production il bambino che riceve un bacio dalla mamma
the child that receives a kiss by the mother
- (90) Target Il bambino che il nonno ascolta
The child that the granddad listens-to
Production Il bambino che legge al nonno
The child that read to the granddad

What is crucial in Utzeri (2007) is that children produced a considerable number of object relatives, whereas in adults object relatives are nearly absent and passivization is the prevailing strategy.

In Guasti & Cardinaletti (2003), a group of Italian-speaking children (age range 5;1-10;0) and a group of French-speaking children (age range 4;5-7;3) participated in an experiment eliciting different types of relative clauses (subject relatives, direct object relatives, indirect object relatives, locative relatives, genitive relatives). Results demonstrated that both subject and direct-object relatives produced by children were consistent with adult performance, namely they were introduced by the complementizer and rarely contained resumptive pronouns. Subject relatives were always correctly produced and were also used

when other types of relatives were targeted. In the same way as in Utzeri (2007), object relatives were sometimes turned into subject relatives through passivization of the verb, as in the following examples:

- (91) a. Tocca il cammello che il bambino ha comprato (9;3)
 ‘Touch the camel that the child has bought.’
 b. Tocca il cammello che è stato comprato dal bambino
 ‘Touch the camel that has been bought by the child.’

Direct-object relatives rarely contained resumptive pronouns, both in Italian and in French. In French direct-object relatives, the complementizer *que* was sometimes replaced by *où* and a resumptive pronoun also occurred (62% of cases).

- (92) a. Touche le cochon que le monsieur est en train de laver
 ‘Touch the pig that the man is washing.’
 b. Touche le cochon qui était lave.
 ‘Touch the pig that was washed.’ (6;4)

In only one case, in Italian, the relative operator *dove* replaced the complementizer in object relatives. In the same way as in French, the child also inserted a resumptive pronoun in the embedded sentence:

- (93) Target: Tocca il panda che il bambino sta accarezzando
 ‘Touch the panda that the child is striking’
 Production Tocca il panda dove il bambino lo sta accarezzando
 ‘Touch the panda where the child it is striking’ (9;3)

The paradigm adopted by Utzeri (2007) was firstly elaborated by Novogrodsky & Friedmann (2006), who tested the production of subject and object relative clauses in 18 Hebrew-speaking SLI children, by comparing their performance to that of a group of 28 typically-developing children. The group of

SLI children, ranging in age from 9;3 to 14;6 was compared to a group of younger children, ranging in age from 7;6 to 11;0. Results proved that children in the control group produced subject and object relatives without difficulty. On the other hand, for SLI children, the production of the targeted sentence was quite problematic. In subject relatives, the number of non-target responses was quite limited and mainly consisted in the production of simple sentences, avoiding the production of a relative clause:

- (94) ha-xayelet ha-zot malbisha et ha-axot
the-(female)-soldier the-this dresses ACC the-nurse
‘‘This soldier dresses the nurse.’’

Other errors in subject relatives involved the presence of doubling elements in embedded subject position, either resumptive pronouns or doubled DPs:

- (95) *ze ha-leican she-hu soxev ta-dubi
this the-clown that-he carries ACC-the-teddy-bear
‘*This is the clown that he carries the teddy bear.’
- (96) *ze ha-yeled she-ha-yeled roxec et ha-aba
this the-boy that-the-boy washes ACC-the-father
‘*This is the boy that the boy washes the father.’

Novogrodzsky & Friedmann (2006) also found that SLI children produced object relatives with resumptive pronouns (which are licit in Hebrew and were also attested in control children), subject relatives with reflexive verbs, verb changes and, surprisingly for this language, passive sentences. Actually, passive sentences are rarely used in Hebrew, sometimes attested only in academic or journalistic texts. Differently from SLI children, control children did not produce any passive construction. The reduced number of object relatives from the corpus of these children was interpreted as a sign of linguistic deficit. Errors made by SLI

children were mainly attributed to movement and to the difficulty in the correct assignment of thematic roles to moved constituents.

6.2.2 The production of relative clauses by hearing-impaired individuals

The elicitation task used by Novogrodzky & Friedmann (2006) to test SLI children was also used to test a group of 14 Hebrew-speaking hearing impaired children with moderate to profound hearing loss, ranging in age from 7;7 to 11;3 years (Friedmann & Sztermann 2006). The group included children with different degrees of hearing loss, using either conventional hearing aids or a cochlear implant. Results demonstrated that these children crucially showed significant difficulties with both subject and object relative clauses, although non-target responses are more attested in the latter type of sentences. They produced correctly about 80% of subject relatives. Most errors concerned the production of ungrammatical sentences and avoidance of relative clause by producing a sentential complement instead:

- (97) hayiti roce she-safta texabek yeled exad
Would-1sg-past want that-grandma hug-future boy one
'I would want that grandma would hug one boy'.

They experienced instead great difficulties in producing object relatives. They refrained from the production of an object relative either by turning it into a subject relative or by producing a sentence without a relative clause. In some cases, they ended up with producing an ungrammatical sentence. In 19% of responses, children produced a grammatical object relative without resumptive pronouns; 42% of responses were grammatical object relatives with a resumptive pronoun, 6% of object relatives were turned into grammatical subject relatives. In 24% of cases, children produced an ungrammatical relative clause, and in 10% they did not produce a relative clause. In the same way as for SLI children in Novogrodzky & Friedmann (2006), Friedmann & Sztermann (2006) interpreted such avoidance as a sign of a linguistic deficit.

The responses produced by the hearing-impaired group were different from those produced by the control group. The problematic production of object relative clauses documented a difficulty in using movement-derived constructions.

Among the different strategies adopted to avoid targeted object relatives, children produced grammatical subject relatives by changing the verb. In some cases, they produced object relatives either with resumptive pronouns or with full DPs, they omitted either the relative head or the complementizer. Furthermore, the hearing-impaired group produced a significantly higher number of ungrammatical sentences than the control group ($p=.0001$).

The acquisition of subject and object relative clauses in hearing-impaired individuals was also investigated for English by De Villiers (1988). This study presented data collected from orally-trained hearing-impaired individuals wearing conventional hearing aids, and ranging in age from 11 to 18 years, by using an eliciting spoken production task. The subjects were required to verbally pick out one referent among others for a listener who could not see the scenario, by producing restrictive relative clauses like those shown in the following examples:

- (98) SS. The cowboy who brushed the horse is washing the cow
OS. The policeman is grabbing the man who broke the window
OO. The farmer is kicking the pumpkin that the racoon licked
SO. The cat that the boy brushed is chasing the mouse

Normal hearing children aged from four to six years produced sentences like those in (98) without any difficulty, but hearing impaired subjects made several types of errors, among which the introduction of resumptive pronouns, mistakes in the relative pronoun, and relativization of the incorrect noun phrase. These phenomena led the author to the conclusion that relative clauses were extremely delayed in hearing-impaired individuals. Nonetheless their performance patterned with that of much younger hearing children.

On a par with Hebrew and English, Delage (2008) found some asymmetries in the production of relative clauses (pseudo-relatives) by French-speaking hearing-impaired individuals. She tested 29 children with mild-to-

moderate hearing loss ranging in age from 7;11 to 13;11 years, by using an eliciting production task (using the paradigm by Friedmann & Sztermann 2006). The group of hearing-impaired participants was split into two subgroups, distinguishing young from older individuals. In the former group, the mean age was 9;8 years, and in the latter, it was 12;6 years. The control group was composed of younger children, whose mean age was 6;4. Subject relatives show higher percentages of correct responses than object relatives in all three groups (84% for the hearing group, 73% for the young hearing-impaired group and 93% for the older one). In the hearing-impaired group, errors in the production of subject relative clauses included, for instance, the use of simple SVO sentences, thus avoiding relativization, and the use of *où* 'where' as replacing filler for the complementizer.

For object relatives, the percentages of target responses are 41% for the hearing group, 23% for the young hearing-impaired group, and 0,7% in the older group. Two young participants with hearing loss produced 100% of target object relatives. In order to avoid relativization of the object, most participants turned object relatives into subject relatives, by using causative and passive constructions. The use of passive relatives was the strategy prevailing in the group of older hearing-impaired participants. Some participants also produced simple SVO sentences, sentences in which the complementizer was missing, and sentences in which the complementizer was replaced by the filler '*où*'.

6.2.3 Resumptive pronouns in relative clauses

Among the strategies adopted by typical and atypical populations in order to simplify the production of object (and sometimes of subject) relatives, resumption is largely used. Much linguistic research has demonstrated that in some languages children and adults rely heavily on resumptive pronouns when producing relative clauses. This tendency is widely attested across different languages, but while in some of them the presence of resumptive pronouns is licit, as in Hebrew or in Modern Greek, in others the massive use of resumptive pronouns in relative

clauses is only attested in child language (French, Italian) and in informal speech and spoken colloquial language.¹

Labelle (1990) reports that three-to-six French-speaking children largely use relatives containing resumptive pronouns:

- (99) celle-là que le papa lui montre un dessin (JF, 5;0)
that-one there that the father to-her shows a drawing
'that one there whose father shows her a drawing'²

In French relative clauses, subject resumptive pronouns may also be found, as the following example shows:

- (100) Voici le courrier qu'il est arrivé ce soir
'here-is the mail that it is arrived tonight'
(Zribi-Herz, 1984)

Many other studies investigating early grammar systems, confirmed the use of resumptive pronouns also in Spanish (Pérez-Leroux 1995), in Serbo-Croatian (Goodluck and Stojanovic 1996), and in a more limited number of cases also in English (Pérez-Leroux 1995).

For Italian, Utzeri (2007) detected the same massive use of resumption in child language when producing object relatives (cf. section 6.2.1). However, in Italian, as well as in other Romance varieties (Spanish, northern Italian dialects), resumptive pronouns are also used in other types of relatives (Mulas 2001):

- (101) Indirect object relative:
Sono un tipo che gli piace rischiare
(I) am a fellow that to-him 'pleases' [to] risk

¹ Resumptive relatives are reported to be non-standard forms to be distinguished by conventional relatives, i.e. object relatives with gaps. Resumptive relatives are largely found in spoken colloquial language by people of different socio-economic backgrounds. Conventional relatives are found in written texts and in more formal contexts (for Italian, see Cinque 1988).

² This example is taken from Guasti 2002.

(102) Locative relative:

E' una libreria che ci vado ogni tanto

(It) is a bookstore that (I) there go from time to time

The heavy reliance on resumptive strategies has been reported as evidence in favour of the hypothesis that movement is the source of syntactic deficit.

The use of resumption has been identified as an important cue offering interesting insights into the nature of grammar and language acquisition, supporting the recent proposals by Chomsky (1995, 2000, 2001), according to which movement involves the creation of copies of the displaced constituent and deletion of the copies, but one. The use of resumption provides instances of sentences in which more than one copy is pronounced. Actually, Belletti (2005) accounted for this phenomenon in children's relative clauses by proposing that movement consists of two steps, copy + deletion. By adopting a raising analysis according to which all object relatives are derived through movement of the object head to a position in the CP projection (see chapter 2), different deletion degrees take place. Deletion is *total* in object relatives with gap, *partial* in object relatives containing resumptive pronouns, and *absent* in those containing resumptive DPs.

6.3 The experiment

We are now examining two different studies. Study one compares the population of hearing-impaired children fitted with cochlear implants with that of hearing children. Study three compares the group of hearing children, adolescents, and adults. Study two was not carried out, because no data were collected on the LIS signers' production. We will analyse how the performances by different populations and the strategies adopted differ according to the type of group considered and to the linguistic level achieved by individuals.

6.4 Study one: Hearing-impaired children with a cochlear implant and hearing children

6.4.1 Participants

In study one, 13 monolingual Italian-speaking hearing-impaired children were compared to a group of language-matched hearing children. For the description of the groups and the data of the participants see chapter 3, section 3.8.1 and 3.8.3.

6.4.2 Materials and procedure

The production of subject and object relatives was investigated by using a preference task, through which the children were forced to produce a relative clauses. A detailed description of the task and of the type of stimuli is offered in chapter 3, section 3.4.1. The list of stimuli is shown in Appendix C.

All participants' productions were recorded. For further details on the procedure adopted to test production, see chapter 3, section 3.9.

6.4.3 Results

First of all, we carried out a quantitative analysis, by calculating whether for each experimental trial, the child managed to produce the target sentence or not, regardless of the number of attempts and of the type of response provided for each trial.

The percentages of target subject relatives and object relatives produced are shown in following table and figures:

	CI		NH	
SR	138/156	88%	154/156	99%
OR	9/156	6%	22/156	14%
Group mean	47%		57%	

Table 62: percentages of target responses in each type of sentence in each group (CI: cochlear-implanted children; NH: normal hearing children)

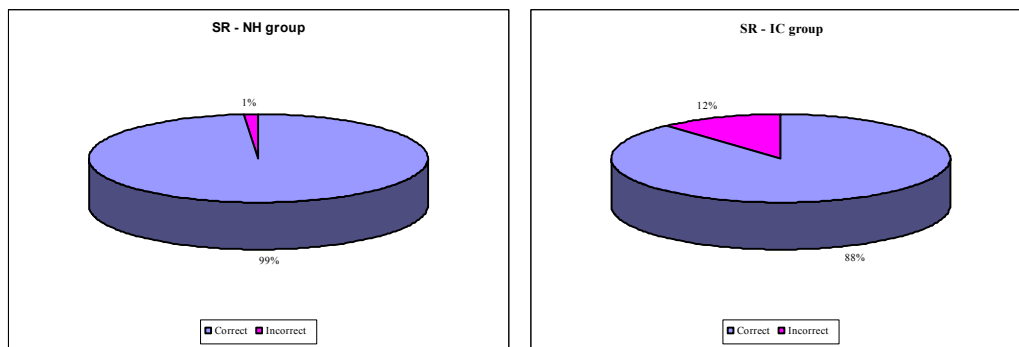


Figure 12 and 13: percentages of target and non-target responses in subject relatives in the hearing (left) and hearing-impaired (right) groups

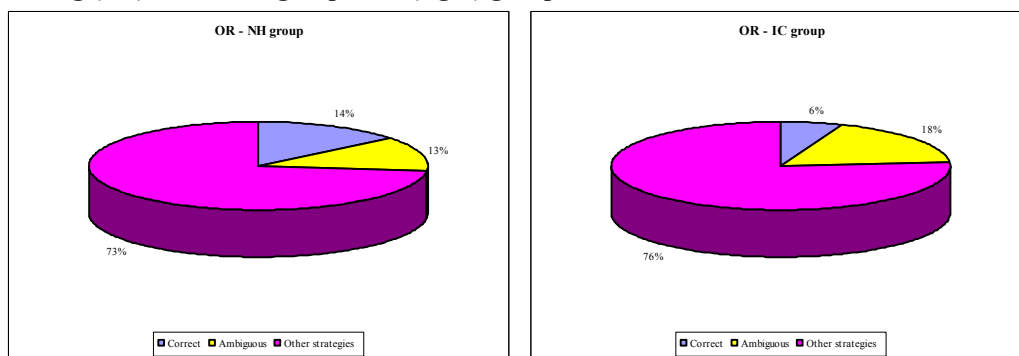


Figure 14 and 15: percentages of target and non-target responses in object relatives in the hearing (left) and hearing-impaired (right) groups

The discrepancy between the number of targeted subject relatives and that of targeted object relatives produced is very evident. The table and the figures show that for subject relatives, percentages of accuracy are very high (88% for cochlear-implemented children and 99% for hearing children). For object relatives, the percentage of correct responses is lower for both groups (6% for hearing-impaired children and 14% for hearing children). However, the pattern of performance is the same for both groups, namely subject relatives are more accurate than object relatives, replicating the results reported in the previous studies. A chi-square test for independent samples showed the contingency between the performance in subject and object relative clause production as a function of the type of group considered, either hearing or hearing impaired ($\chi^2=4.44$ $p=.035$).

By comparing the means of the two groups on subject and object relatives together, the hearing group performed significantly better than the hearing-impaired group ($z=-2.51$ $p=.006$). As for subject relatives, results showed that

although these sentences are largely produced by cochlear-implanted children, the level of accuracy of this group is significantly lower than that of the normal-hearing group ($z=-3.78$ $p=0.000$). A significant difference between the two groups was also attested for object relatives ($z=-2.48$ $p=0.0065$).

Sometimes, when an object relative was targeted and both DPs displayed the same number features, children produced ambiguous sentences, namely sentences in which either a subject or an object reading was possible:

- (103) Target: Mi piacciono i bambini che i vigili salutano.
 I like the children that the policemen greet.
 Production: Mi piacciono i bambini che salutano i vigili.
 I like the children that greet the policemen.

Despite the fact that Italian allows for a subject to occur in the embedded post-verbal position, we are not sure that the children were actually using an object construction. For this reason, sentences like those in example (103) were kept separated from both subject and unambiguous object relatives.

In table (7) and in figures (14) and (15), an object relative was considered as correctly produced when the head correctly moved from the embedded object position, the embedded subject was either in the preverbal or post-verbal position, and no other resumptive element was present in the sentence (object relatives with gap). However, when a child was required to produce an object relative, he/she sometimes produced it by adding a resumptive element, which could be either a pronoun or a full DP³. As show in section 6.2.3 (this chapter), this phenomenon is frequently attested in child and colloquial Italian and in other languages, as for example Hebrew, French, and Greek.

If we also count as correct object relatives those containing resumption strategies, the percentages of correct productions increases for both groups, although the significant difference between them remains. The normal-hearing group significantly produced a higher number of target object sentences than the

³ These elements may also appear together, they do not necessarily appear in complementary distribution.

hearing-impaired group ($z=-2.49$ $p=.0063$). The following figures show the modified percentages of correct and incorrect responses:

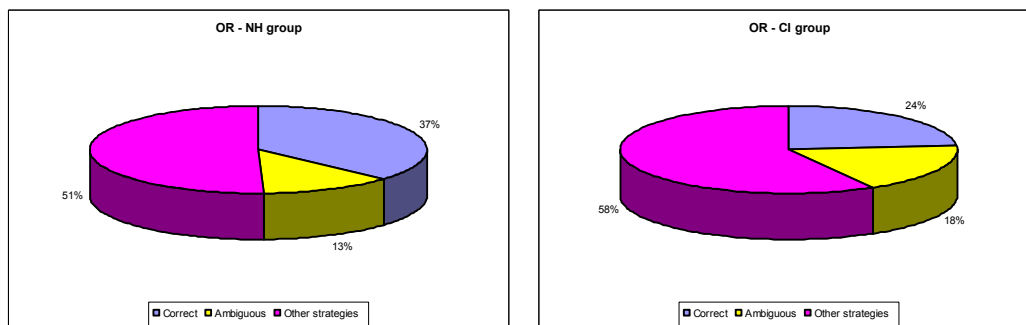


Figure 16 and 17: percentages of target and non-target responses in object relatives in the hearing (left) and hearing-impaired (right) groups, also including resumptive object relatives among the target ones

The pattern of performance of both groups remains the same. Normal hearing children produced more object relatives than hearing-impaired ones. Both groups produced object relatives with gaps, with resumptive pronouns, and with resumptive DPs, as table 71 shows:

	OR with gap	OR with RP	OR with RDP
CI	9/37	16/37	12/37
NH	22/57	27/57	8/57

Table 63: number of object relatives with gap, resumptive pronoun (RP), and resumptive DP (RDP) produced by each group

An example for each sentence type is shown here below:

(104) *OR with gap:*

I bambini che il papà pettina
The children that the father combs

(105) *OR with resumptive pronouns:*

Il bambino che l'orso lo accarezza.
The child that the bear him caresses

(106) *OR with resumptive DPs:*

Il bambino che l'orso accarezza *il bambino*

The child that the bear caresses the child

A preference for resumptive object relatives clearly emerges from this table, for both groups. When producing object relatives with gaps, children had two options available, either placing the embedded subject in the preverbal position, or placing it after the embedded verb, namely in the post-verbal position. The following table shows the distribution of embedded subjects in object relatives:

	OR with gap	preV-subj	postV-subj
CI	9	6	3
NH	22	21	1

Table 64: Distribution of embedded subjects in object relatives (preverbal or post-verbal position)

Despite the difference in the number of object relatives produced, children showed a preference for placing subjects in the embedded preverbal position.

6.4.4 The analysis of responses: relativization strategies

This section is devoted to offer a more detailed qualitative analysis of the whole range of responses provided by the participants. It was in fact observed that children enjoying and feeling involved in the game sometimes provided more than one response to each experimental stimulus.

When subject or object relatives were targeted, children avoided producing the target sentence by adopting different strategies. Since most interesting remarks are detectable in the production of object relatives, we begin by identifying the type of responses provided when these structures were targeted. Then, subject relatives will follow.

6.4.4.1 Object relatives

Object relative clauses were produced by both hearing and hearing impaired children. However, since children's fantasy has no limit, in a great amount of

trials, both groups, and especially the hearing-impaired one, adopted a large number of strategies in order to avoid producing object relative clauses, most of them confirming previous findings by Friedmann & Sztermann (2006), Utzeri (2007), and Delage (2008). In most cases, they turned object relatives into subject relatives. The following table summarizes all the different strategies:

	CI		NH		TOT	
Object relatives (gap and resumptive)	37	22%	57	38%	94	30%
Passivisation	41	25%	21	14%	62	20%
Use of <i>wh</i> - 'fillers'	18	11%	0	0%	18	6%
Use of causative verbs	5	3%	32	21%	37	12%
SVO sentence (no RC)	16	10%	1	1%	17	5%
SR (head becomes embedded subject)	12	7%	2	1%	14	4%
SR (embedded subject becomes head)	8	5%	24	16%	32	10%
Verb change	10	6%	12	8%	22	7%
Various strategies	19	11%	2	1%	21	7%
<i>Total</i>	<i>166</i>		<i>151</i>		<i>317</i>	

Table 65: relativization strategies for OR adopted by each group (CI=cochlear implant users, NH= normal hearing children)

In the category ‘various strategies’, we included sentences displaying very low percentages of occurrence, such as ungrammatical sentences, incomplete sentences, use of reflexive verbs. Examples will be provided below in (70)-(85).

As we can see from the table, the strategies adopted by the children in order to avoid producing the targeted object relatives are numerous, and some interesting asymmetries between the two groups emerge.

By considering the whole number of responses, object relatives (either with gap, with resumptive pronoun or with full DP) were produced in 22% of cochlear-implanted children’s trials and in 38% of hearing children’s ones.

To avoid production of object relatives, in many cases participants turned the targeted sentences into subject relatives. Among the different strategies, passivization of the verb was the most frequently adopted, as the following example shows:

- (107) Target: Mi piace il bambino che il papà lava
 I like the child that the father washes

Production: Mi piace il bambino che è lavato dal papà
I like the child that is washed by the father

By comparing the percentages of produced passive relatives, we see that the pattern of performance is reversed, namely hearing-impaired children produced subject relatives with passives more often than normal hearing children (25% in the former group and 14% in the latter). As far as the production of object relatives and the use of passivization are concerned, there seems to be a sort of mirror use of these two answering strategies.

Apart from the use of these two strategies, which correspond to most non-target responses, there is a wide range of strategies with lower percentages of occurrence, in which the performance of the two groups differs. A second strategy adopted to turn object relatives into subject relatives consisted in the use of causative constructions (*farsi* + *verb* ‘to make oneself+verb’), as the following example shows:

(108) Target: Mi piace il bambino che il papà pettina
I like the child that the father combs
Production: Mi piace il bambino che si fa pettinare dal papà
I like the child that himself makes comb by the father
‘I like the child that makes himself comb by the father’

Causative constructions were used instead of object relatives in 3% of the sentences by hearing-impaired children and in 21% of the sentences in hearing children. In these structures, the presence of the functional verb *fare* ‘to make’ involves the assignment of an additional thematic role. For this reason, these structures are rarely produced by hearing-impaired children.

In the corpus of hearing-impaired children, we also found a considerable number of sentences in which the complementizer ‘che’ is replaced by other *wh*-fillers, such *dove* ‘where’, in (109):

(109) Target: I bambini che i vigili salutano

the children that the policemen greet
 Production: I bambini dove i vigili li salutano
 the children where the policemen them greet
 ‘the children where the policemen greet them’

This strategy was not adopted by hearing children. However, it is a strategy well attested in other studies investigating French and Italian child productions (Mulas 2001, Guasti & Cardinaletti, 2003, Labelle 1990 and cf. section 6.2.3).

A strategy largely adopted by hearing children as opposed to hearing-impaired children is the transformation of object relatives into subject relatives by turning the embedded subject into the relative head, as in the following example:

(110) Target: I bambini che il papà pettina
 the children that the father combs
 Production: Il papà che pettina i bambini
 The father that combs the children

Hearing children used this strategy in 24% of productions. Although such a response does not correspond to the target one, it significantly shows that thematic roles are correctly assigned.

Numerous other response strategies are attested, but they are less frequent in children’s corpora. For these strategies, we cite some examples of children’s productions:

(111) Use of reflexive ‘si’:
 Target: I bambini che il barbiere pettina
 the children that the hairdresser combs
 Production: I bambini che si pettinano dal barbiere
 the children that themselves comb by the hairdresser
 ‘the children that comb themselves by the hairdresser’

(112) Omission of the complementizer:

Target: Mi piace il bambino che il dottore guarda
 I like the children that the doctor watches
Production: Mi piace il bambino... guarda il dottore
 I like the child... watches the doctor

(113) Avoidance of relative clause – production of simple SVO sentences:

Target: I bambini che il papà pettina
 the children that the father combs
Production: il papà pettina i bambini
 the father combs the children

(114) Production of subject relatives in which the head becomes the embedded subject:⁴

Target: I bambini che i cani baciano
 the children that the dogs kiss
Production: I bambini che baciano il cane
 The children that kiss the dog

(115) Verb change:

Target: Il bambino che il cane segue
 The child that the dog follows
Production: Il bambino che porta a spasso il suo cane
 The child that take his dog for a walk

Some strategies were adopted only by the hearing-impaired group:

(116) Production of incomplete sentences (SV or VO):

Target: I bambini che la maestra premia
 the children that the teacher praises

⁴ Differently from what happens in (86) note that here theta roles are not assigned correctly.

Production: Premia i bambini
Praises.3.SG. the children

(117) Production of ungrammatical sentences:

Target: Il bambino che il cane segue
The child that the dog follows

Production: Mi piace il bambino così cammina e così il cane insegue
I like the child so walks and so the dog follow.SUBJ.MOOD

The presence of a large number of sentences containing different types of errors in the hearing-impaired child production, as opposed to that of hearing children, is also attested by Chesi (2006) for Italian, Delage (2008) for French, and Friedmann & Szterman (2006) for Hebrew.

6.4.4.2 Subject relatives

Subject relative clauses appear to be quite preserved in both groups, although a higher percentage of accuracy is attested in the hearing group as opposed to the hearing-impaired one.

When considering all responses provided by the participants, thirty-five incorrect responses were detected in the corpus of cochlear-implanted children, while only three were found in hearing children's productions. Among the errors produced by the former group, we mention the production of simple SVO sentences without relativization (72), incomplete sentences (119), use of a different *wh*- filler instead of the complementizer 'che'(120):

(118) Target: Il bambino che rincorre l'orso
The child that runs after the bear

Production: Il bambino rincorre l'orso
The child runs after the bear

(119) Target: Il bambino che pettina il cane
The child that combs the dog

Production: Mi piace il cane...
I like the dog

(120) Target: Il bambino che alza l'elefante
The child that lifts the elephant

Production: Mi piace il bambino quello dove alza l'elefante
I like the child that where (he) lifts the elephant

6.5 Study three: hearing children, hearing adolescents and hearing adults

In the previous study, we compared a group of hearing-impaired children with a group of hearing children matched on linguistic age (morpho-syntactic abilities).

Some interesting findings showed that hearing children produced some object relatives, while hearing-impaired children produced a higher number of passive sentences instead of the target object relatives. Children, either belonging to the hearing-impaired group or to the hearing one, displayed a wide range of strategies available to overcome the difficulties deriving from the production of object relative clauses, the same as Utzeri (2007) found in her study. She also found that adults, ranging in age from 15 to 73 years, performed differently from children, namely object relatives were almost absent (less than 1%), and most responses fell into the category of passive relatives.

Study three made it possible to check how the performance of children differs from that of older individuals. The group of adolescents was also included in the analysis, in order to detect whether their performance was fully comparable to that of adults, or they still showed some different pattern of performance. This latter possibility might suggest that some syntactic properties are not yet fully available even at adolescence.

6.5.1 Participants

In this study, 16 monolingual Italian-speaking hearing children were compared to a group of adolescents and a group of adults.⁵ A detailed description of the groups involved in this study is provided in chapter 3, sections 3.8.3, 3.8.4, and 3.8.5.

6.5.2 Materials and Procedure

The production of subject relatives and object relatives was investigated by using a preference task (Friedmann & Szterman 2006), through which the participants were forced to produce a relative clause. A detailed description of the task and of the type of stimuli is offered in chapter 3, section 3.4.1. The list of stimuli is shown in Appendix C.

All participants' productions were recorded. For further details on the procedure adopted to test production, see chapter 3, section 3.9.

6.5.3 Results

Like in the case of the first study, we considered a response as correct when the child managed to produce the target subject or object relatives, even when the target response may have not been provided at the first attempt. The percentages of target subject relatives and object relatives correctly produced are shown in following table:

	Children		Adolescents		Adults	
SR	176/192	92%	192/192	100%	189/192	98%
OR	34/192	18%	0/192	0	0/192	0

Table 66: number and percentages of target responses for each group on each sentence type

The table shows that for subject relatives, percentages of accuracy are very high for all groups. Adolescents performed at ceiling (100%), and adults were very close to 100%. Children made some errors in subject relatives. Despite this fact, the percentage of correct responses is very high (92%). By carrying out pair

⁵ It would have been interesting to select a higher number of children for each age range (5-6-7-years), but it was not possible to create three homogeneous groups, therefore a single larger group with children belonging to the three age ranges was formed in order to avoid quantity unbalancing.

comparisons, adolescents performed significantly better than both children and adults ($p=0.0000$ and $p=0.04$, respectively), and adults performed significantly better than children ($p=0.0009$). As for object relatives, adolescents and adults never produced any of them, preferring instead the production of subject relatives. On the other hand, children produced a small amount of object relatives, confirming previous findings by Utzeri (2007). The asymmetry between subject and object relatives found in the previous studies is also replicated in this one.

6.5.3.1 Subject relative clauses

As we have seen in the previous section, subject relatives were not problematic and were produced without any trouble.

In adults, only three sentences did not match the target ones. Actually, one participant did produce a subject relative, but she selected some intransitive verbs instead of transitive ones. Another participant produced an object relative clause instead of the subject relative.

Children produced the highest number of non-target responses, and in order to overcome the difficulties deriving from the use of a complementizer and the production of a relative clause, they adopted various strategies. They used other filling *wh*- elements instead of the complementizer (121), they produced incomplete sentences (122), they produced simple SVO sentences, preceded by *Mi piace che* 'I like that' (123) and in one case, a participant repeated the copy of the head in the embedded subject position (124):

(121) Target: Il bambino che bacia il cane
 The child that kisses the dog
 Production: Il bambino perché bacia il cane
 The child because he kisses the dog

(122) Target: I bambini che salutano il papà
 The children that greet the father
 Production: salutano il papà
 [they] greets the father

- (123) Target: Mi piacciono i bambini che lavano il cane
 I like the children that wash the dog
 Production: Mi piace che i bambini lavano il cane.
 I like that the children wash the dog
- (124) Target: Il bambino che pettina il cane
 The child that combs the dog
 Production: Il bambino che il bambino pettina il cane
 The child that the child kisses the dog

6.5.3.2 Object relative clauses

Target object relatives were much more problematic than subject relatives for all groups. An object relative was counted as correctly produced when the head moved from embedded object position, the embedded subject appeared in preverbal or post-verbal position, and no resumptive element was present (see table 66). Neither adolescents nor adults produced any object relative. Only children produced object relative clauses. Some children produced object relatives and at the same time placing a resumptive element in the embedded clause. These sentences also are largely found in colloquial Italian (see section 6.2.3).

The strategies adopted to overcome the difficulties deriving from object movement are different and vary according to the group considered. For some items, when an object relative was targeted, participants produced an ambiguous sentence, since the two DPs displayed the same number features.

In the qualitative analysis, all responses provided by the children will be considered. The strategies adopted when an object relative was targeted are summarized in the following table:

	Children		Adolescents		Adults	
Object relatives (gap and resumptive)	84	37%	0	0%	0	0%
Ambiguous sentences	30	13%	21	11%	3	2%
Passivization	6	3%	158	82%	189	97%
Various strategies	6	3%	3	2%	0	0%
Use of <i>wh</i> - 'fillers'	5	2%	0	0%	0	0%
Use of causative verbs	18	8%	7	4%	0	0%
SVO sentence (no RC)	18	8%	0	0%	0	0%
SR (head becomes embedded subject)	5	2%	1	1%	0	0%
SR (embedded subject becomes head)	40	18%	2	1%	2	1%
Verb change	15	7%	0	0%	0	0%
<i>Total</i>	<i>227</i>		<i>192</i>		<i>194</i>	

Table 67: relativization strategies for OR adopted by each group

Children produced 227 sentences when object relatives were targeted. As opposed to adolescents and adults, children adopted a wide variety of strategies, although some trends can be identified, and interesting remarks can be made. Children produced 84 object relatives, 34 with gaps, 13 with resumptive pronouns and 37 with resumptive DPs. To avoid relativization of the object, in most cases, they turned the object relative into a subject relative. When avoiding beginning the sentence with the required hint “*Mi piace il bambino*”, in 40 stimuli, they turned the embedded subject into the head of the relative clause, as in the following example⁶:

- (125) Target: I bambini che il papà pettina
The children that the father combs
Production: Il papà che pettina i bambini
The father that combs the children

In other sentences, they correctly began with the required hint, but they nonetheless produced a subject relative by using a causative construction:

- (126) Target: I bambini che i cani baciano

⁶ In this case, thematic roles were correctly assigned.

The children that the dogs kiss

Production: I bambini che si fanno baciare dai cani

The children that make themselves kiss by the dogs

In some cases, they avoided producing the correct relative clause, by placing the complementizer *che* ‘that’ immediately after *Mi piace* ‘I like’ (see also example (123) on subject relatives). In this way, a simple SVO sentence was uttered, in which the object became the subject of the sentence, as the following example shows:

(127) Target: I bambini che il cane rincorre

The children that the dogs run-after

Production: Mi piace che il cane rincorre i bambini

I like that the dog run-after the children

Some relatives were produced by modifying the verb and/or providing a more detailed description of the picture in order to avoid relativizing the object, as in the following example:

(128) Target: I bambini che il cane rincorre.

The children that the dogs run-after.

Production: Quelli che stanno correndo e il cane li insegue.

Those that run and the dog run-after them.

A wide variety of other response strategies are attested, however with lower percentages. Some examples are provided below.:

(129) Use of subject relative through passivization:

Target: I bambini che la maestra premia.

The children that the teacher prizes.

Production: i bambini che vengono premiati

the children that are prized.

(130) Use of *wh*- fillers:

Target: il bambino che la mamma bacia
 The child that the mother kisses.

Production: (Mi piace) questo bambino, perchè la mamma bacia lui...
 (I like) this one because the mother kisses him

(131) Use of reflexive *si*:

Target: il bambino che il papà lava
 The child that the father washes.

Production: Il bambino che si fa la doccia
 Il bambino that himself has a shower
 ‘the child that is having a shower’

(132) Production of SR in which the head became the embedded subject

Target: il bambino che il cane insegue
 The child that the dog runs-after.

Production: I bambini che inseguono il cane
 The children that run after the dog

Adolescents differed a lot from children as far as the types of answering strategies are concerned. They did not produce any object relative clauses, which were replaced by subject relatives. They produced a very high percentage of passive relatives (92%), thus showing a trend towards adult-like performance. Nonetheless a small percentage of causative constructions (4%) was found, replicating a behaviour identified in younger participants. In one sentence, they incorrectly considered the head as the subject of the embedded clause, and in two sentences, they comprehended thematic roles correctly, but in order to avoid the production of an object relative, they turned the embedded object into the head of the main clause.

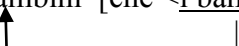
The performance of adults patterns that of adolescents, as far as the lack of object relatives is concerned. Indeed, adults did not produce any object relative

clause, producing instead only subject relatives, in most cases through passivization of the verb. Only in the case of two items, participants produced a subject relative by turning the embedded subject into the head of the matrix clause, as that produced by a hearing child in example (125).

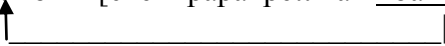
6.6 General discussion of both studies (study one and study three)

The asymmetry between subject and object relatives is confirmed once again in both study one and study three. In subject relatives, the percentages of target responses are very high for all participants, while object relatives show very low percentages of occurrence. Processing-based and grammatical approaches (see chapter 5, sections 5.4.5.1 and 5.4.5.2) explain this asymmetry by pointing out that in subject relatives, a short (local) movement of the subject from its original position to the landing site in the CP domain occurs (133), as opposed to object relatives, in which the movement takes place from the embedded object position (134), involving the establishment of a longer relation between the two positions:

(133) Mi piacciono [i bambini [che <i bambini> accarezzano il gatto]



(134) Mi piacciono [i bambini [che il papà pettina <i bambini>]



When producing object relatives, children adopted a high number of strategies in order to avoid object relativization. It is nonetheless important to point out that, despite the difficulty of these structures, both hearing and hearing-impaired children do produce object relatives, also replicating data collected by Utzeri (2007) on other Italian-speaking children.

Children in both study one and study three produced a considerable number of object relative clauses. In the first study, hearing children produced 38% of object relatives on the total number of responses, whereas in the hearing impaired group, the percentage of target responses was 22%. Similarly, in the second study, a huge number of object relatives were produced by children (37%), as opposed to the other populations. Conversely, adult and adolescent did not produce any target object relative, preferring to produce subject relatives through

passivization of the verb (passive relative clause) rather than relativizing the object. Adults produced 97% of passive relative clauses, whereas the percentage of production of these structures in adolescents was 82%. We remind that the high percentage of passive relatives in adults replicates data collected by Utzeri (2007) on this type of population (see section 6.2.1). In children, the percentages of passive structures produced are low, as opposed to older participants. They are 3% in the hearing group of the second study, 14% in the hearing group of the first study, 25% in the hearing-impaired group.

Apart from passivization a wide range of answering strategies are adopted in order to avoid object relativization. Among them, causative constructions are used by hearing children in the first study, but are less frequent in all the other populations.⁷ However, since the main trend featuring both studies is that passive relatives appear to consistently increase and object relatives to finally disappear with linguistic maturation, we will focus our discussion on the use of these two options, leaving aside all the other strategies. Therefore, we will try to account for the presence of object relatives in early stages of language acquisition and the switch from these structures to passive constructions at a later stage of language development.

To explain the performance of hearing impaired children and hearing populations, we discuss the recent proposal by Collins (2005) on the representation of passive relatives and those in Belletti (2008) and Friedmann et al. (2009) on the source of difficulty in the acquisition of object relative clauses.

By analysing the comprehension of relative clauses in Hebrew-speaking young children (age range: 3;7-5;5), and by adopting a raising analysis of relative clauses, Friedmann et al. (2009) accounted for the difficulties with object relatives in terms of locality and intervention effects (Relativized Minimality) due to the presence of an intervening lexically restricted noun phrase between the head in the

⁷ Causative constructions, which yield a 'fare da' structure, are structurally related to passive sentences, since a *by*-phrase introduces the external argument within the complement of the causative verb (Burzio 1986). However, causative constructions, differently from passive relatives, contain the functional verb *fare* 'to make', which assigns an additional thematic role. For this reason, they were counted and analysed separately here.

main clause and its trace in the embedded object position.⁸ Adults do not have this problem, because their grammar is able to operate a disjunction between the features of the head and those of the intervener, thus permitting the extraction of the object over the intervening NP *the* (see chapter 5, section 5.4.5.2).

The analysis on the comprehension of relative clauses is also extended to production.

Belletti (2008) suggests that the source of difficulty for the production of object relative clauses is that the derivation of such a construction is blocked and disfavoured in children by the intervention of the DP in the embedded subject position. But, if this assumption is correct and RM is at play in immature grammars, why do young children also correctly produce object relative clauses, which at first sight appear to be more difficult than subject relatives, just like passive relatives are? This is unexpected. Indeed, children produce 25% of object relatives. Conversely, if RM is a source of difficulty in comprehension especially for children, why do we not find any object relatives in the adults' production corpus?

We would suggest that children's and adults' performance does not have to be traced back to RM but to some other linguistic property operating in the derivation of these construction together with developmental phenomena. We will discuss these aspects in the next sections.

6.7 Analysis of the production of passive sentences

Passivization involves the transformation of a targeted object relative into a subject relative. Since subject relatives are easier than object relatives, we would expect that children use more often the former strategy instead of the latter. However, the construction deriving passive sentences appears far from being fully mastered at early stages of language development. How can this be explained? To answer this question and to account for the performance of hearing and hearing-impaired individuals, we will first analyse some syntactic properties of passive sentences.

⁸ Whenever the lexical restricted intervening element is no longer present (namely in non-headed free object relatives and in object relatives the subject of which is a null impersonal arbitrary *pro*), object relative clauses are correctly comprehended.

6.7.1 The passive construction

The active sentence in (135) may be passivized as in (136):

(135) Il papà pettina il bambino.
The father combs the child.

(136) Il bambino è pettinato dal papà.
The child is combed by the father.

Turning an active sentence into a passive sentence involves the reorganization of grammatical functions. Indeed, the object (internal argument) of the active sentence, *il bambino* ‘the child’, becomes the grammatical subject of the passive sentence. The subject of the active sentence (external argument), *il papà* ‘the father’, becomes the oblique object in the passive sentence introduced by the preposition *by*. Passive sentences represent problematic structures that are acquired late and fully mastered at late developmental stage (Chilosi et al. 1995/2006). For instance, for Italian, Ciccarelli (1998)⁹ investigated the comprehension of passive sentences in young typically-developing children. This study, in which passive sentences also containing the PP “by+NP” were tested, showed that at the age of 4, the percentage of correct responses is 57%, at the age of five, it is 72% and at the age of 6, it is 80%. Despite the higher percentage of correct comprehension by the age of six, passive constructions are not completely mastered by that age.

In early accounts, passive sentences involved A-movement and were derived through direct raising of the object DP to the specifier of IP. The internal argument receives the thematic role by the trace in the original position, with which it is coindexed. By reaching this position, the object triggers agreement on the inflected verb.

Recent theories (Collins 2005) proposed that the derivation of passive sentences is slightly different and a little more complex, because it involves more

⁹ Cited in Guasti (2007).

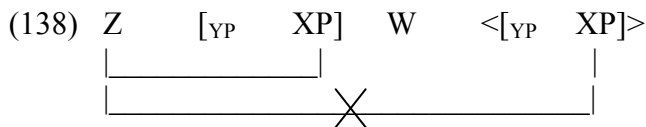
derivational steps. To account for the representation of passive sentences in English, he has recently proposed the theory of Smuggling.

Smuggling occurs when the movement of the internal argument over an external argument is required, but minimality effects arising between elements of the same featural class, block the relationship between the original object position and its final landing site.

Taking the definition by Collins (2005), smuggling is defined as follows:

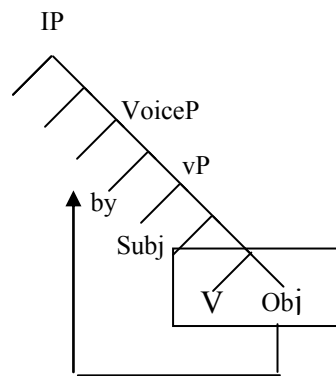
- (137) Suppose a constituent YP contains XP. Furthermore, XP is inaccessible to Z because of the presence of W, some kind of intervener blocking any syntactic relation between Z and XP. If YP moves to a position c-commanding W, YP smuggles XP past W.

This definition is illustrated as follows:



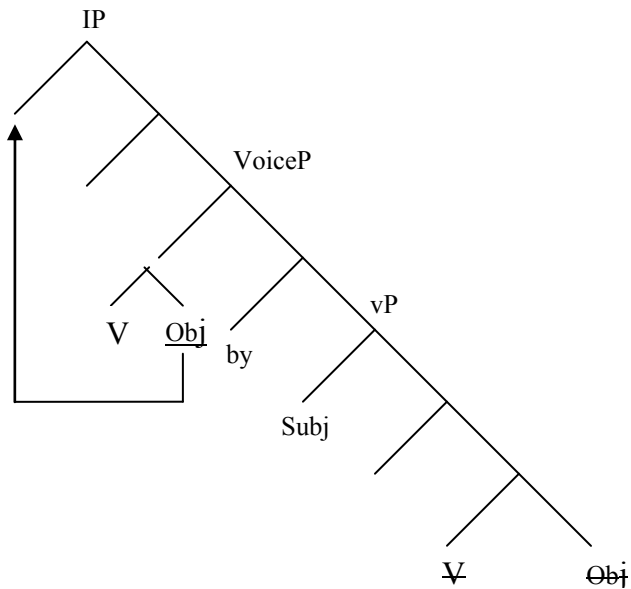
Smuggling is the operation which avoids intervention in a passive sentence. Indeed, the external argument, the subject in Spec/vP, represents a blocking element for the movement of the VP-internal direct object to a position higher than vP. For this reason, smuggling of the Verb+Object (VP) projection makes it possible for the object to cross over the external argument and land in a higher projection, namely the specifier of the Voice/P projection, whose head is the preposition *by*.

(139)



From there, the object alone moves to a still higher position, the specifier of IP, without producing any RM violation:

(140)

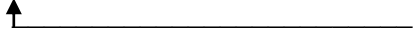


6.7.2 The derivation of object relatives and passive relatives


Now let us come back to the types of structure produced by the participants and to the way they are derived.

As we remember from chapter 2, in object relatives the head (object) moves from a low position inside the VP, as a complement of the verb, and raises to a higher position in the CP node. Then, object relatives are derived through A'

(long) movement of the VP-internal object to the left-peripheral position, CP, as the following example shows:

- (141) DP [_{CP} NP_{obj} *che* [_{IP} DP_{subj} [_{vP} V <NP_{obj}>]]

 Il bambino *che* il papà pettina <il bambino>
 ‘the child that the father combs <the child>’

As for passive subject relatives, in the same way as passive sentences, they are derived through smuggling and subsequent object extraction to perform relativization in a higher position (Belletti 2008)¹⁰:

- (142) DP [_{CP} NP_{obj} *che* [_{IP} *pro* aux [V <DP_{obj}>] *by*... [_{vP} DP_{subj} <[V NP_{obj}]>]]]]

 il bambino *che* è pettinato <il bambino> dal papà <pettinare il bambino>
 the child that is combed <the child> by the father <comb the child>

A first step is necessary for the VP, containing the verb and the object, to smuggle the subject in the vP-internal position, and a second step is necessary for the object to reach the head position inside CP. The preverbal embedded subject position is filled in with the expletive pronoun *pro*. As (142) shows, differently from passive sentences, in passive relatives the object reaches an A’ position, namely the specifier of CP. Hence, differently from object relatives, in passive relatives, both A and A’ movements occur in the final derivation. Therefore, the presence of two chains is involved.

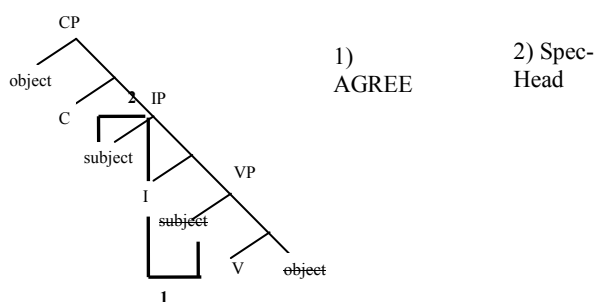
The correct production of target object relatives leads us to exclude relativized minimality as the source of difficulty. The early use of object relatives could instead be explained in terms of a preference for the lowest number of steps required in the sentence derivation. Indeed, object relatives are derived through a unique (long) step (141), as opposed to passive relatives, in which more local steps are necessary to build up the syntactic structure (142). The preference for a

¹⁰ Following Rizzi (2006) and Rizzi & Shlonsky (2007), we assume that in passive subject relatives, movement does not occur from the EPP preverbal subject position, because this is a criterial position (Belletti 2008).

unique chain is also predicted by the Derivational Complexity Metric (Jakubowicz 2005, to appear, Jakubowicz & Strik, 2008, Jakubowicz & Tuller, to appear). In the course of language development, children replace the preference for the unique long-distance relationship with the preference for more local relations.

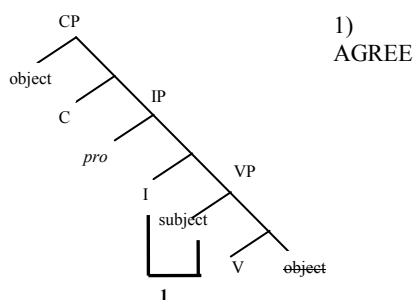
A further difference between object relatives and passive relatives is explained in terms of Agreement relationships, as conceived in Chomsky's minimalist theory (Chomsky 1995, 2000, 2001). Following Guasti & Rizzi (2002), we assume that Agreement is composed of two separate components: AGREE and Spec-Head checking as a result of the displacement of elements (MOVE). As already discussed in chapter 5, section 5.4.5.2, in object relatives both agreement configurations are present:

(143)



In object passive relatives, instead, the agreement relationship takes place only through the AGREE configuration, on a par with object relatives with embedded subject in the post-verbal position:

(144)



Object relatives are therefore more accessible since the agreement relationship occurs both under AGREE and in the Spec-Head configuration (see (143)). On the other hand, in passive relatives this relationship is more fragile since no local checking in a Spec-head configuration takes place (144).

The preference for object relatives in the early stages of language acquisition is explained by the presence of a unique step in the structural derivation, strengthened by the robustness of agreement between the embedded subject and the verb, occurring both under AGREE and in the Spec-Head configuration. In passive relatives, in which more local steps are involved, the delayed access to smuggling depends on the fragility of agreement based on AGREE only (Franck et al. 2006). When smuggling becomes available and fully acquired, local movement steps constitute the most economical solution and are therefore highly preferred over one unique long relationship.

There is not an exact moment in which this property becomes available. Indeed, as we have seen, also children produce passive relatives. Children seem to have a wide range of possible strategies available in their grammar to convey meaning. Then, depending on the level of linguistic maturation and on the linguistic resources available at a specific stage, they will opt for either a structure or the other.

6.8 The asymmetry object relatives/passive relatives in hearing and hearing impaired children

The analyses so far conducted both on hearing and hearing-impaired individuals have pointed out some interesting aspects that are summarized here briefly. For all participants, the pattern of performance is the same, namely subject relatives are produced without any difficulty as opposed to object relatives. However, the strategies adopted by hearing and hearing-impaired children are different.

Proportionally, hearing children both in the first and in the second study produced a considerable number of object relatives (37% and 38%, respectively), replicating the findings by Utzeri (2007). Hearing-impaired children produced instead a lower number of object relatives (22%) and a higher number of passive

relatives (25%), replicating the behaviour of the group of older hearing-impaired participants in Delage (2008) (see section 6.2.2). In this respect, the performance of hearing-impaired children is the reverse of that of hearing children: the main strategies adopted by the former group correspond to an opposite pattern of occurrence in the latter.

In addition to passive relatives, the hearing-impaired group produced some sentences that were not found in the corpus produced by the hearing control group, namely sentences containing *wh*- elements replacing the complementizer and ungrammatical sentences. Such *wh*- fillers are not specific to hearing-impaired individuals. They were attested in studies investigating relative clause production in young French- and Italian-speaking children (Labelle 1990, Mulas 2001, Guasti & Cardinaletti 2003).

The presence of both passive relatives and relatives introduced by different *wh*- fillers shows that there is high individual variability of performance within the cochlear-implanted group. The low number of object relatives and the high percentage of passive relatives produced by some hearing-impaired children are presumably linked to their chronological age and to the good cognitive and linguistic development somehow related to it. Indeed, hearing-impaired children ranging in age from 7;11 to 10;8 are older than hearing controls (5;3-7;10). In hearing individuals, the tendency to produce passive relatives instead of object relatives increases with age and is higher in adolescents and adults than in children (Carpenedo 2009, Utzeri 2007).

On the other hand, the tendency of other hearing-impaired children to produce higher percentages of sentences in which *wh*- fillers replaced the complementizer, or ungrammatical sentences, as opposed to hearing children, is to be related to the linguistic delay associated to hearing loss. However, these productions are attested in young hearing children (Guasti & Cardinaletti 2003). Moreover, Chesi (2006), Delage (2008) and Friedmann & Szterman (2006) also found that ungrammatical productions are frequent in individuals with hearing impairment.

CONCLUSIONS

The main aim of this work was to investigate the comprehension and production of restrictive relative clauses by a variety of hearing and hearing-impaired populations. A group of cochlear-implanted children was compared with a group of younger hearing children matched on general morphosyntactic abilities (TCGB). A group of adolescent LIS signers was compared to a group of younger children matched on morphosyntactic abilities, and to a group of adolescents matched on chronological age. A group of young children was compared to a group of adolescents and a group of adults.

Cochlear-implanted children were selected on the basis of a number of criteria, in order to create a group as homogeneous as possible. The criteria of selection were: birth year included between 1998 and 2001, fitting with hearing aids within the second year of life, and cochlear implantation within 3;6 years.

Following much experimental research on this topic, a comprehension task and a production task were elaborated. The comprehension task tested ambiguous sentences, subject relatives, object relatives with a preverbal embedded subject (disambiguated either by placing the embedded subject in the preverbal position, or by manipulating number features on the two DPS, or by both cues), and object relatives with the embedded subject in the post-verbal position. In total, we tested 10 conditions. Differently from Volpato & Adani (2009), this task tested the different conditions in the right-branching relative clauses by manipulating number features on both the head and the embedded DP, thus succeeding in obtaining a more accurate analysis of the performance of cochlear-implanted children. The production task tested subject and object relative clauses in which the head and the embedded DPs were either in the singular or in the plural. The experiment also included a number of repetition tasks, checking for participants' memory resources. The inclusion of these tasks was necessary in order to verify whether the difficulties experienced in the comprehension task may be attributed to limited resources of working memory.

Let us now summarize the most important findings for each task.

The hearing-impaired children's ability to comprehend relative clauses was found to be significantly lower than that of control children. Despite the significant difference in performance, a within-group analysis revealed that hearing-impaired children pattern with hearing children as far as the relative clauses gradient of difficulty is concerned. In both groups, an asymmetry between subject and object relatives was found, replicating previous results on the comprehension of these structures by other typical and atypical populations. OS were more accurate than OO, and OO were more accurate than OOp. The higher accuracy on OS is explained by the short relation between the relative head and the site from which it has been extracted. In OO, the performance of the two groups is qualitatively and quantitatively different, especially as far as the type of incorrect responses provided is concerned, and the source of difficulty was attributed to a different reason. Hearing children showed higher percentages of correct responses in those conditions in which the DPs were dissimilar in terms of number features (OSV_SG_PL and OSV_PL_SG) rather than when the two DPs displayed the same features (OSV_SG_SG and OSV_PL_PL), and performed significantly better than the hearing-impaired group in the sentence type OSV_SG_PL. This phenomenon has to be traced back to the role played by number features in the two populations. While for hearing-impaired children, number features did not play any role, and failed to enter sentence computation, sentences containing the NumP projection strongly facilitated hearing children in the correct interpretation of the sentence. The difficulties found in hearing children with object relatives displaying the same number on both DPs were explained by a sort of intervention effects, recalling Friedmann et al.'s (2009) proposal. Sentences containing disjoint specification of number features favour the selection of the correct response. In addition, when the embedded subject is plural, the presence of redundancy of information (AGREE + Spec-Head agreement + [+pl(ural)] markedness in the Spec-Head configuration), led children to the correct interpretation of the sentence.

For hearing-impaired children both attraction phenomena in the sense of Kayne (1989) and failed computation of the plural verbal morpheme help to explain the performance and the difficulties experienced by this population.

In the course of language development, namely at adolescence, the number of correct responses increases, although some errors still occur. This is interpreted as a sort of continuity with children's pattern of performance, since the structures that are difficult for children are also problematic (to a less extent) for adolescents.

We explained the difficulty experienced with OOp by using an approach that combines recent linguistic proposals in terms of locality and agreement. Indeed, for all groups the difficulty is explained by the fragile subject-verb agreement occurring with post-verbal subjects, which is only based on the AGREE relation, and is not strengthened by Spec-Head agreement (Guasti & Rizzi, 2002, Franck et al. 2006).

The fact that the source of the deficit is different in the two groups may be further emphasized by the different results obtained from a correlation analysis between memory and comprehension.

The production task was elaborated following the paradigm by Friedmann & Novogrodzky (2004), in order to force children to produce either a subject or an object relative clause. Interesting results were found by analysing the data from this task.

First of all, the asymmetry between subject relatives and object relatives found in the comprehension task was also found in the production task, replicating previous studies on typical and atypical populations' production of relative clauses.

However, despite the difficulties experienced in the comprehension task with object relatives, we noted that both hearing and hearing-impaired children did produce object relatives. Hearing children produced 38% of target object relatives, while the group of hearing-impaired children produced a lower percentage, 22%. On the other hand, neither adolescents nor adults produced any object relative clause.

When object relatives were not produced, all populations adopted strategies turning the target sentence into a subject relative. The most frequently used strategy consisted in the production of passive relatives, largely adopted by adults and adolescents. Hearing-impaired children also produced a quite high

percentage of passive relatives. In this respect, a sort of reversed pattern in the performance of the two groups was observed. Hearing children produced a high percentage of object relatives, as opposed to passive relatives, while hearing-impaired children produced a high number of passive relatives, as opposed to object relatives. Hearing-impaired children adopted the passive strategy which was largely used by older individuals, namely adolescents and adults (Carpenedo 2009, Utzeri 2007). This phenomenon seems to be linked to an age factor. Since hearing-impaired children are older than hearing children, some of them, namely those with a more mature linguistic system and who had reached high levels of linguistic competence, showed a performance comparable to age peers.

We tried to investigate the reason for which passive relatives are acquired later than object relatives, considering that they are structures involving subject extraction and consequently should be easily produced. Passive relative clauses involve the presence of two chains. They are derived through Smuggling (Collins 2005) and subsequent extraction to perform relativization (Belletti 2008). Object relatives are instead derived through a long movement of the VP-internal object DP to the left-peripheral position. The higher number of object relatives produced by younger children is explained in terms of a preference for the lowest number of steps necessary in the derivation, as opposed to passive relatives, which require more local steps and are therefore produced at a later linguistic developmental stage.

Moreover, the delayed production of passive relatives is also explained by adopting the minimalist theory of Agreement (Chomsky 1995). Following Guasti & Rizzi (2002), we assume that Agreement is more robust when it occurs both under AGREE and in the Spec-Head configuration. The delayed access to smuggling depends on the fragility of agreement based on AGREE only (Frank et al. 2006).

The most interesting aspect emerging from the analysis of both comprehension and production skills is that, in child grammar, robustness of agreement favours better performance in both tasks. However, one point still needs to be clarified, namely the fact that production seems to precede comprehension. Indeed, children produce structures that they sometimes fail to

correctly comprehend. This is somewhat surprising, although previous studies, showed that the production of relative clauses occurs at an earlier age as opposed to comprehension (Tavakolian 1981, Goodluck & Tavakolian 1982, Crain et al. 1990). We may hypothesize that when producing a sentence, all features are available to the child, and the whole structure is built up step by step. In comprehension, however, children sometimes tend to hypothesize_simplified structures. Therefore, comprehension may be driven by particular strategies, as for instance interpreting the first DP as the subject. When a DP intervenes in the object position, reanalysis of the sentence is necessary.

The findings of such an accurate research may contribute to focus on some specific properties that can be useful in defining new rehabilitation strategies.

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APPENDIX A: REPETITION TASKS

A1 Word repetition

1	cane	filo				
2	monte	cerchio				
3	foglia	fata				
4	pioggia	topo				
5	festa	neve	collo			
6	pesca	orso	mamma			
7	dente	capra	frutto			
8	scarpa	rana	piatto			
9	latte	sole	mucca	mano		
10	zebra	moto	fame	cuore		
11	sedia	acqua	dito	letto		
12	scimmia	libro	auto	testa		
13	dado	nave	bocca	salto	pesce	
14	mela	gamba	tigre	gioco	mare	
15	nonno	sale	piede	colla	barca	
16	fiore	naso	palla	carta	pasta	
17	terra	ramo	scala	chiave	erba	luna
18	porta	cigno	foglio	lana	sasso	onda
19	gallo	occhio	nano	botte	vaso	pane
20	torta	uomo	oca	gonna	passo	gatto

A2 Non-word repetition (Fabbro 1999)

1	bro
2	cla
3	spe
4	sce
5	gelco
6	stalmo
7	nespa
8	permo
9	cargia
10	lovaba
11	virtallo
12	almera
13	gilvane
14	qualerco
15	citrallèsco

A3 Forward and backward digit span (TEMA - Reynolds & Bigler 1995)

Subtest 7 (forward)

- 1 8-5
- 2 3-10
- 3 6-8-3
- 4 2-1-5
- 5 4-6-1-9
- 6 3-2-4-10
- 7 6-9-1-3-5
- 8 10-6-8-5-9
- 9 6-4-9-2-1-8
- 10 4-3-5-1-6-4
- 11 1-3-9-6-8-3-10
- 12 6-5-10-1-8-3-1
- 13 4-2-1-3-9-8-3-9
- 14 9-4-10-1-2-8-10-3
- 15 1-4-9-2-8-10-2-9-3
- 16 9-1-3-10-5-2-8-4-6
- 17 8-5-6-10-4-1-3-9-2-5
- 18 2-1-5-3-8-4-9-2-6-10

Subtest 13 (backward)

- 1 1-4
- 2 6-2
- 3 1-8-5
- 4 8-1-4
- 5 9-5-1-8
- 6 3-7-4-10
- 7 4-8-9-1-3
- 8 1-9-4-8-5
- 9 9-6-4-8-10-1
- 10 5-2-9-4-8-3
- 11 6-3-9-4-10-1-8
- 12 1-6-5-9-8-3-10
- 13 2-5-3-6-10-1-4-9
- 14 3-5-6-8-2-6-1-10
- 15 1-6-5-9-8-3-6-4-8
- 16 4-9-8-3-5-10-8-2-1

A4 Sentence repetition

- 1 Le giraffe seguono l'uomo
- 2 L'autobus è tirato dalla moto
- 3 Il cane segue le scimmie che mangiano la banana
- 4 Il cigno tira i cavalli
- 5 I gatti, la bambina li accarezza
- 6 L'elefante spinge le tigri e bacia le rane
- 7 Il nonno è fermato dai vigili
- 8 La mamma guarda il papà e saluta il nonno
- 9 I gatti sono colpiti dal topo
- 10 La mamma bacia la bambina
- 11 Il pesce spinge l'elefante che il leone rincorre
- 12 Il bambino, il latte lo beve al mattino
- 13 Le capre lavano le oche e spingono i topi
- 14 Le volpi sono portate dai lupi
- 15 L'auto che le moto inseguono corre molto forte
- 16 I pinguini lavano i cani
- 17 La torta, lo zio la mangia a colazione
- 18 Le nonne che guardano le mucche bevono il tè
- 19 Gli orsi seguono la zebra e mordono il topo
- 20 Le scarpe il papà le pulisce ogni giorno

APPENDIX B: RELATIVE CLAUSE COMPREHENSION

		TOCCA
AMB	SVO_SG_SG	La pecora che lava il cavallo
AMB	SVO_SG_SG	Il cammello che pettina il cigno
AMB	SVO_SG_SG	La moto che segue la macchina
AMB	SVO_SG_SG	La giraffa che tocca il coniglio
AMB	SVO_SG_SG	Il cane che spaventa il coniglio
AMB	SVO_SG_SG	L'orso che saluta la tartaruga
AMB	SVO_PL_PL	I pesci che tirano i pinguini
AMB	SVO_PL_PL	I topi che spingono le galline
AMB	SVO_PL_PL	I gattini che guardano le capre
AMB	SVO_PL_PL	Le galline che portano i lupi
AMB	SVO_PL_PL	Gli asini che lavano gli orsi
AMB	SVO_PL_PL	Le macchine che tirano i camion
OS	SVO_SG_PL	Il coniglio che colpisce i topi
OS	SVO_SG_PL	Il pesce che segue le tartarughe
OS	SVO_SG_PL	Il cavallo che insegue i leoni
OS	SVO_SG_PL	La giraffa che pettina gli orsi
OS	SVO_SG_PL	Il bambino che lava le bambine
OS	SVO_SG_PL	La pecora che colpisce i gatti
OS	SVO_PL_SG	I leoni che guardano l'elefante
OS	SVO_PL_SG	Le scimmie che fermano il pinguino
OS	SVO_PL_SG	I cani che toccano il ragazzo
OS	SVO_PL_SG	Le tigri che mordono il cavallo
OS	SVO_PL_SG	I pinguini che lavano il nonno
OS	SVO_PL_SG	Le zebre che tirano la giraffa
OO	OSV_SG_SG	La gallina che il pulcino becca
OO	OSV_SG_SG	L'elefante che l'uccellino porta
OO	OSV_SG_SG	La lepre che la giraffa saluta
OO	OSV_SG_SG	Il bambino che la nonna pettina
OO	OSV_SG_SG	Il leone che la tartaruga tira
OO	OSV_SG_SG	L'elefante che la scimmia insegue
OO	OVS_PL_PL	Le moto che le macchine spingono
OO	OVS_PL_PL	Le oche che i pinguini fermano
OO	OVS_PL_PL	Gli asini che i cani lavano.
OO	OVS_PL_PL	Le mucche che i cammelli tirano
OO	OVS_PL_PL	I serpenti che le tigri guardano
OO	OVS_PL_PL	Le rane che le ragazze seguono
OO	OSV_SG_PL	Il pinguino che i gatti guardano
OO	OSV_SG_PL	Il nonno che i pinguini lavano
OO	OSV_SG_PL	La giraffa che le zebre tirano

OO	OSV_SG_PL	Il ragazzo che i cani toccano
OO	OSV_SG_PL	Il pinguino che le scimmie fermano
OO	OSV_SG_PL	Il cavallo che le tigri mordono
OO	OSV_PL_SG	Le scimmie che l'elefante insegue
OO	OSV_PL_SG	Le tartarughe che l'orso saluta
OO	OSV_PL_SG	Le bambine che il bambino lava
OO	OSV_PL_SG	I gatti che la pecora colpisce
OO	OSV_PL_SG	I leoni che l'elefante guarda
OO	OSV_PL_SG	Gli orsi che la giraffa pettina
OOp	OVS_SG_PL	La pecora che tirano le scimmie
OOp	OVS_SG_PL	Il cammello che lavano gli orsi
OOp	OVS_SG_PL	L'uccellino che guardano i cani
OOp	OVS_SG_PL	Il cigno che beccano i pulcini
OOp	OVS_SG_PL	La macchina che seguono i camion
OOp	OVS_SG_PL	La tigre che baciano le bambine
OOp	OVS_PL_SG	I conigli che tira la gallina
OOp	OVS_PL_SG	I nonni che tocca la tartaruga
OOp	OVS_PL_SG	Le ragazze che ferma il vigile
OOp	OVS_PL_SG	I bambini che insegue il cavallo
OOp	OVS_PL_SG	I gattini che guarda il pinguino
OOp	OVS_PL_SG	Le pecore che colpisce la gallina
FILLER	F	Il cane che ha l'osso in bocca
FILLER	F	Il topo che legge un libro.
FILLER	F	La bambina che corre in bicicletta.
FILLER	F	Il nonno che guarda la televisione.
FILLER	F	La scimmia che è in acqua
FILLER	F	Il gatto che suona la chitarra.
FILLER	F	L'elefante che piange
FILLER	F	Il leone che gioca con la palla.
FILLER	F	La mucca che suona la tromba
FILLER	F	Il bambino che fa il bagno
FILLER	F	La bambina che salta la corda
FILLER	F	La rana che salta.
FILLER	F	Il coniglio che legge
FILLER	F	La capra che mangia il gelato.
FILLER	F	Il coniglio che beve
FILLER	F	Il bambino che dorme
FILLER	F	Il papà che scrive.
FILLER	F	La zebra che balla.
FILLER	F	La bambina che tiene il palloncino
FILLER	F	Il bambino che ha il cane

APPENDIX C: RELATIVE CLAUSES PRODUCTION TASK

Subject relatives:

Ci sono 2 disegni. Nel primo un bambino pettina la mamma e nel secondo un bambino pettina il cane. Quale bambino ti piace di più? “(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo i bambini inseguono le farfalle. Nel secondo, i bambini inseguono le api. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo un bambino rincorre il gatto e nel secondo un bambino rincorre l'orso. Quale bambino ti piace di più? “(Mi piace) il bambino...

Ci sono due disegni. Nel primo un bambino guarda la tigre e nel secondo un bambino guarda la zebra. Quale bambino ti piace di più? “(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo i bambini guardano i cavalli. Nel secondo, i bambini guardano le scimmie. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo disegno, i bambini salutano il papà. Nel secondo, i bambini salutano l'amico. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono 2 disegni. Nel primo i bambini tirano le mucche. Nel secondo, i bambini tirano i topi. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo un bambino bacia il cane e nel secondo un bambino bacia la bambina. Quale bambino ti piace di più? “(Mi piace) il bambino...

Ci sono due disegni. Nel primo un bambino rincorre l'amico e nel secondo un bambino rincorre il cane. Quale bambino ti piace di più? “(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo i bambini lavano il cane. Nel secondo, i bambini lavano la tigre. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono 2 disegni. Nel primo un bambino alza l'elefante. Nel secondo un bambino guarda l'elefante. Quale bambino ti piace di più? “(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo i bambini accarezzano il gatto. Nel secondo, i bambini colpiscono il gatto. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Object relatives:

Ci sono 2 disegni. Nel primo i cani baciano i bambini. Nel secondo, i nonni baciano i bambini. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo l'orso morde un bambino. Nel secondo l'orso accarezza un bambino. Quale bambino ti piace di più? "(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo, il padre pettina i bambini. Nel secondo, il barbiere pettina i bambini. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo la mamma abbraccia un bambino. Nel secondo la mamma bacia un bambino. Quale bambino ti piace di più? "(Mi piace) il bambino...

Ci sono due disegni. Nel primo il dottore visita un bambino. Nel secondo il dottore saluta un bambino. Quale bambino ti piace di più? "(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo la maestra sgrida i bambini. Nel secondo, la maestra premia i bambini. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo il leone segue un bambino. Nel secondo il cane segue un bambino. Quale bambino ti piace di più? "(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo i vigili fermano i bambini. Nel secondo, i vigili salutano i bambini. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono 2 disegni. Nel primo i leoni inseguono i bambini. Nel secondo, i leoni tirano i bambini. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Ci sono due disegni. Nel primo il papà lava un bambino. Nel secondo il papà sporca un bambino. Quale bambino ti piace di più? "(Mi piace) il bambino...

Ci sono due disegni. Nel primo il papà colpisce un bambino. Nel secondo il papà bacia un bambino. Quale bambino ti piace di più? "(Mi piace) il bambino...

Ci sono 2 disegni. Nel primo un cane morde i bambini. Nel secondo, un cane insegue i bambini. Quali bambini ti piacciono di più? (Mi piacciono) i bambini...

Fillers:

Cosa fa il bambino in questa foto? Il bambino...

Cosa fa il coniglio? Il coniglio...

Cosa fa il vigile? Il vigile...

Cosa fa l'orso? L'orso...

Cosa fa il leone? Il leone...

Cosa tiene in mano la bambina? La bambina...
Cosa mangia la scimmia? La scimmia...
Cosa fa l'elefante? L'elefante...
Cosa fanno i bambini? I bambini...
Cosa fa la bambina? La bambina...
Cosa fa il bambino? Il bambino...
Dov'è il gatto? Il gatto...

Estratto per riassunto della tesi di dottorato

Studente: Francesca Volpato *matricola:* 955301

Dottorato: Scienze del Linguaggio

Ciclo: 22°

Titolo della tesi : *THE ACQUISITION OF RELATIVE CLAUSES AND PH-
FEATUES: EVIDENCE FROM HEARING AND HEARING IMPAIRED
POPULATIONS*

Abstract:

Questo studio indaga la produzione e la comprensione delle frasi relative restrittive sul soggetto (OS) e sull'oggetto (OO) in diverse popolazioni di individui sordi (bambini con impianto cocleare e adolescenti segnanti LIS) e udenti (bambini, adolescenti e adulti), per mezzo di un task di produzione elicitata e di un task di selezione d'agente. L'analisi della comprensione ha mostrato una differenza significativa tra i sordi e gli udenti nell'uso delle combinazioni dei tratti di numero. Tuttavia, per tutti i partecipanti è stato individuato un tipico gradiente di difficoltà: le OS sono risultate più facili delle OO, e le OO sono risultate più facili delle relative sull'oggetto con soggetto postverbale (OOp). Anche nella prova di produzione, le OS sono state prodotte con più facilità rispetto alle OO. Diverse sono state invece le strategie di risposta quando una OO era elicitata, e pattern di performance diversi sono stati identificati a seconda della maturazione linguistica raggiunta. La performance dei partecipanti è stata spiegata tramite fenomeni di "attraction" e proposte linguistiche recenti sulle relazioni di località e di accordo.

The aim of this study is to investigate the production and comprehension of subject (OS) and object (OO) restrictive relative clauses in various hearing and hearing-impaired populations (cochlear-implanted children, adolescent LIS signers, hearing children, hearing adolescents, and hearing adults). An agent selection task and an elicited production task were adopted to test the individuals' competence. The analysis of the comprehension showed that a significant difference between hearing-impaired and hearing subjects was attested in the

different combinations of number features. In any case, for all participants a typical gradient of difficulty was found. OSs are easier than OOs, and OOs are easier than object relatives with a postverbal subject (OOp). In the production task, the asymmetry between OSs and OOs was replicated. OSs were produced more easily than OOs. Different response strategies were adopted when an OOs was targeted; the pattern of response varied according to the linguistic maturation achieved. The performance of the participants was explained by attraction phenomena and recent linguistic proposals on locality and agreement.

Firma dello studente
