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Evidence from Populations with Normal Hearing and Hearing Impairment

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Relative Clauses, Phi Features, and Memory Skills
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Francesca Volpato

Abstract

This book discusses important issues concerning the comprehension and the production of right-branching subject and object relatives in populations of children, adolescents, and adults with normal hearing and populations of individuals with hearing impairment (children with cochlear implants and LIS signers).
Starting from much existing crosslinguistic research on the acquisition of relative clauses in populations with typical and atypical language development, new linguistic tools were developed in order to assess sentences in which number features are manipulated on both the relative head and the embedded DP. This made it possible to investigate how marked features modulate the comprehension and production of relative clauses in the different populations.
In comprehension, a typical gradient of difficulty was found for all participants. Subject relatives are easier than object relatives, and object relatives with preverbal subjects are easier than object relatives with postverbal subjects. However, the participants with hearing impairment showed lower scores than normal hearing participants.
The asymmetry between subject and object relative clauses was also found in the production task, namely the former were produced more easily than the latter. Different response strategies were adopted when object relatives were targeted; the pattern of response varied according to the linguistic maturation achieved.
The performance is explained by attraction phenomena and recent linguistic proposals on locality and agreement.
The book contains 5 chapters. Chapter 1 offers a general overview on hearing impairment and the consequences of hearing loss on the acquisition of an oral language. Chapter 2 presents the characteristics of the relative clauses proposed in the comprehension and production tasks. Chapter 3 and chapter 4 focus on the comprehension and the production of relative clauses in the different populations with normal hearing and hearing impairment. Chapter 5 focuses on memory resources and discusses the relationship between memory skills and acquisition of relative clauses.

Keywords Relative Clauses. Comprehension. Production. Phi features. Memory. Hearing impairment. Normal hearing. Children. Adolescents. Adults.

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Relative Clauses, Phi Features, and Memory Skills
Evidence from Populations with Normal Hearing and Hearing Impairment

Francesca Volpato

Table of Contents

Introduction

This volume is a revised version of my PhD thesis (Volpato 2010b) and discusses important aspects of the acquisition of complex structures by populations with hearing impairment compared to populations with normal hearing. It presents data on Italian children with hearing impairment fitted with cochlear implants, whose language competence has been investigated only very recently. The research conducted during my PhD was the first study on their syntactic competence.

After that, some research has been devoted to investigating different linguistic aspects, using standardized tests (Caselli et al. 2012; Chilosi et al. 2013) and experimental tests on clitic pronouns (Guasti et al., 2014). Much research is still needed to understand the difficulties that children with cochlear implants encounter with language and with syntax in particular.

The research carried out during my PhD (2006-2009) and in the following years has attempted to fill in the gap focusing on the comprehension and production of complex syntactic structures, specifically restrictive right-branching relative clauses, by deaf children with cochlear implants. The choice of this research topic depended, on the one hand, on the fact that no data were available at the time on the syntactic abilities of Italian-speaking children with cochlear implants (and more generally, individuals with hearing impairment). On the other hand, the wide body of literature on the syntactic description of relative clauses and their acquisition made it possible to understand the difficulties with these complex structures in case of hearing impairment.

A long-lasting debate exists on how relative clauses are processed, comprehended, and produced across a variety of languages and populations: children (for English, Sheldon 1974; Hamburger, Crain 1982; Crain, McKee, Emiliani 1990; Kidd, Bavin 2002; Contemori, Marinis

2012; for Italian, Guasti, Cardinaletti 2003, Arosio, Adani, Guasti al. 2005, 2009; Utzeri 2006, 2007; Adani 2008; Adani et al. 2010; Volpato 2010b; for French, Labelle 1990; Pérez-Leroux 1995; Guasti, Cardinaletti 2003; for Hebrew, Arnon 2005; for Greek, Varlokosta, Armon-Lotem 1998), adults (for English, Contemori, Marinis 2012; for Italian, Utzeri 2006, 2007; Belletti, Contemori 2010; Contemori, Belletti 2013), children with specific language impairment (for English, Adani et al. 2014; for Italian, Adani 2008; for Greek, Stavrakaki 2001; for Hebrew, Friedmann, Novogrodsky 2004; for Swedish, Håkansson, Hansson 2000), and agrammatic patients (for Italian, Garraffa, Grillo 2008; for Hebrew, Friedmann 2008).

Cross-linguistic research on the acquisition of relative clauses by individuals with hearing impairment exists: for English (Quigley, Smith, Wilbur 1974; Engen, Engen 1983; Quigley, Paul 1984; De Villiers 1988; De Villiers, De Villiers, Hoban 1994), Hebrew (Friedmann, Szterman 2006; Friedmann et al. 2008; Szterman, Friedmann 2014; 2015), Palestinian Arabic (Friedmann, Haddad-Hanna 2014), French (Delage 2008), and German (Ruigendijk, Friedmann 2017). The first data on Italian-speaking children with hearing impairment fitted with cochlear implants were presented in Volpato and Adani (2009) and Volpato (2010b).

The aim of the study is to obtain a picture as detailed as possible of the underlying linguistic knowledge of individuals with normal hearing and individuals with hearing impairment, as far as the acquisition and development of relative clauses are concerned.

The investigation on relative clauses was also enriched with data collected on other populations, including adolescents with hearing impairment using Italian Sign Language (LIS, henceforth), and hearing children, adolescents, and adults. This is the first study which presents data from Italian hearing adolescents.

The comprehension task and the production task used to investigate the syntactic representation of relative clauses in these populations have been developed following previous experimental research by Friedmann and Novogrodsky (2004), Arnon (2005), Utzeri (2006, 2007), and Adani (2008).

What makes my tools different from all previous experimental research is the manipulation of number features on both the head and the embedded DP in right-branching relative clauses. Several conditions were presented with all possible combinations: both conditions in which the two DPs are similar (*match* condition) and conditions in which the DPs are dissimilar (*mismatch* condition) in terms of number features. I focused on number features because cross-linguistic studies on the representation of number (and gender) features in clause structure (e.g. Ferrari 2005) and cross-psycholinguistic research on the role of phi features in sentence processing (e.g. Nicol 1998; De Vincenzi, Di Domenico 1999) show that the salience of Number ex-

erts an important influence on linguistic performance.

In the tasks developed during my PhD, the use of singular and plural DPs made it possible to investigate how marked features modulate the comprehension of relative clauses in the various populations, and especially in individuals with hearing impairment. Due to the delayed access to the linguistic input, plural markers on verbs are underspecified in these individuals (Chesi 2006), and consequently, their linguistic competence may be compromised.

The performance on the comprehension and production of relative clauses, and in particular the asymmetry found between subject (*the rabbit that hits the mice*) and object relative clauses (*the rabbit that the mice hit*), has been addressed by combining theories on phi features and approaches based on Relativized Minimality (Rizzi 1990; 1997; 2004a; Friedmann, Belletti, Rizzi 2009). Relativized Minimality is a principle of locality postulating that a relation between two positions (the first merge position and the landing site of movement) cannot be established if an intervening element represents a potential candidate for the local relation.

Proposals based on Relativized Minimality and on evidence coming from (young) typically developing children (Friedmann, Belletti, Rizzi 2009) suggested that intervention effects arise in object relatives when the intervener is lexically restricted, namely when a full NP moves across another full NP. Further refinements of this hypothesis suggested that other DP-features such as Number may be crucial for the correct interpretation of (object) relative clauses by participants with typical language development (for centre-embedded relatives, see Adani et al. 2010; for right-branching relatives, see Volpato 2010b; 2012). Although Relativized Minimality effects may also be at play in children with hearing impairment, other linguistic phenomena must be assumed to explain their different performance on object relatives with preverbal subjects in the different match and mismatch conditions tested. These phenomena include attraction phenomena along the lines of Kayne (1989) and the failed or damaged processing of number features on plural verbal morphology.

For all participants, the lower performance with object relatives with postverbal subjects, as opposed to object relatives with preverbal subjects, is explained in terms of fragility of agreement between the sentence constituents, following Guasti and Rizzi (2002) and Franck et al. (2006).

Interesting findings are also observed in the production task. Although children do not seem to be able to comprehend object relatives because of minimality effects arising in immature grammars, they do produce object relatives in elicited production tasks (Utzeri 2006; 2007; Volpato 2010b; 2011; Volpato, Vernice 2014). As children grow older, they opt for structures containing the passive voice. In adolescents and adults, the use of passive relatives is indeed the prevailing

strategy, while object relatives are almost never produced. Although these results have been replicated by much research on Italian typically developing children and adults, they are nonetheless surprising, since a structure that is comprehended at ceiling by adults, is never produced by them, and a structure that is problematic for children is among the most used strategies by these young participants. The explanation for such a behaviour, proposed by Volpato (2010b) and Volpato and Vernice (2014), combines recent linguistic proposals on locality (*Smuggling* mechanism, Collins 2005) and agreement phenomena (Guasti, Rizzi 2002; Franck et al. 2006). The analysis of the different strategies used by typically developing populations also help accounting for the inter-subject variability found in the performance of children with cochlear implants.

Another important issue that is addressed in the last chapter of this book concerns the assessment of memory skills and the relationship between comprehension of relative clauses and memory resources in children with cochlear implants and normal hearing children. Different memory measures are used to assess memory skills and investigate possible relationships with relative clause comprehension: nonword repetition, forward and backward digit span recall, sentence and word repetition.

The volume is organised as follows.

Chapter 1 offers a general overview on hearing impairment, its implications for the acquisition of an oral language, and the variables that characterize the populations with hearing impairment and may influence their language acquisition. This impairment is of sensory nature. It drastically reduces the quantity and quality of linguistic input available, hindering children from acquiring an oral language naturally. The level of linguistic competence they achieve may depend on the interaction of a variety of clinical and personal factors, namely degree of hearing loss, hearing device used, age of intervention, parents' linguistic background, etc. A section is devoted to show the difficulties that Italian-speaking children encounter when acquiring their oral language.

Chapter 2 presents the relevant syntactic properties of the structures assessed in the production and comprehension tasks. Restrictive subject and object relative clauses are complex structures derived through long-distance (A') movement from the embedded subject and object positions, respectively. Stemming from much linguistic and psycholinguistic research on phi features, I discuss the use of different combinations of number features in the creation of the experimental trials, in order to test how these morphosyntactic cues modulate the comprehension of relative clauses.

Chapter 3 provides an overview of the research on the comprehension of relative clauses in Italian-speaking populations as well as on the comprehension of these complex structures by Italian individu-

als with hearing impairment. The new data collected during my PhD concern the comparison between a group of children, a group of adolescents, and a group of adults. For the first time in the research investigating the comprehension of relative clauses by typically developing individuals, adolescents' performance is distinguished from that of adults. Interestingly, some differences between the two populations indeed emerge from data analysis. In addition, the studies carried out on the comprehension of relative clauses by children with cochlear implants compared to normal hearing children are presented (Volpato, Adani 2009; Volpato 2012). I also present data on the performance of a small group of adolescent LIS signers.

In all groups (except adults), an asymmetry between subject and object relatives is detected. All participants with hearing impairment (both children with cochlear implants and LIS signers) significantly differ from younger hearing children in the comprehension of relative clauses. In particular, their responses differ from those of hearing children in the different number conditions in which object relatives have been tested. We suggest that the source of difficulty for the group of participants with hearing impairment is different from that of normal hearing participants. While a refinement of the proposal by Friedmann, Belletti, and Rizzi (2009) is used to account for the performance of hearing children, for children with hearing impairment attraction phenomena (in the sense of Kayne 1989) and computational difficulties with plural verbal morphemes are also at play. For all populations, the difficulties with object relatives with postverbal subjects are explained in terms of fragility of agreement (Franck et al. 2006).

Chapter 4 focuses on the production of relative clauses. A literature review is offered at the beginning of the chapter in order to present the main strategies adopted by Italian-speaking individuals in relative clause production. The production task and the results observed on the populations of children, adolescents, and adults are presented and discussed. The discussion focuses on two main strategies used when object relatives are elicited, namely the production of target object relatives and passive relatives. The use of these two strategies is explained in terms of developmental processes involved in language acquisition (*smuggling* and agreement phenomena). In the second part of the chapter, I turn my attention to the production of relative clauses in populations with hearing impairment. The performance of children with cochlear implants is compared with that of different groups of normal hearing children. The results of this comparison have appeared in Volpato (2011) and Volpato and Vernice (2014); some strategies (namely the use of resumptive elements and passive relatives) have been discussed in Volpato and Cardinaletti (2015).

Chapter 5 discusses the possibility that the scores obtained in the

comprehension task are due to low memory resources in both hearing children and children with cochlear implants. The first part of the chapter presents an overview of the studies focusing on memory skills of typically developing children and children with cochlear implants. It also shows the results of these populations in the different memory measures. The second part of the chapter discusses the relationship between memory skills and scores on language measures in both hearing populations and participants with hearing impairment. Different results are found in the different populations. Most interestingly, the difficulties experienced by hearing children in the comprehension of relative clauses may also be attributed to limited memory resources, resulting from correlation analyses between the performance in each sentence condition and repetition tasks. As we will see, this hypothesis cannot be extended to the other populations.

1 Hearing impairment and language acquisition

Summary 1.1 Introduction. – 1.2 The hearing loss and the variables influencing language development. – 1.2.1 The human ear and the site of lesion. – 1.2.2 Degree of hearing loss. – 1.2.3 Types of hearing devices . – 1.2.4 Age at onset of deafness. – 1.2.5 Parental background and approach to language development. – 1.3 The relationship between clinical variables and linguistic outcomes. – 1.4 Language development in individuals with hearing impairment. – 1.5 Language development by Italian-speaking individuals with hearing impairment.

1.1 Introduction

Children acquire language spontaneously and effortlessly and can completely master 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 time window known as 'critical period', which as Lenneberg (1967) pointed out, extends from early infancy until puberty, when it becomes more difficult to acquire a language naturally. In this time window, children's brain is predisposed to build mental grammars.

As a matter of fact, several studies after Lenneberg revealed the existence of many time windows depending on the linguistic component considered (e.g. Ruben 1997; Meisel 2013; Friedmann, Rusou 2015). Moreover, the acquisition process was proven to start from birth, or even in the last months of pregnancy, and it is not clear at what age the critical period(s) should be considered closed.

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Friedmann and Rusou (2015) pointed out that different language components have different critical periods. New words can be learned at any age, even in adulthood, while for syntax, the input accessed during the first year of life is fundamental to adequately set the parameters of the language(s) to which each child is exposed. It is during this period that infants use the information they obtain from prosody, phonology, and words frequency to build up their syntax.

Some cases of late exposure to the linguistic input have indeed supported the existence of such a critical/sensitive period, as demonstrated by the children who lived socially isolated, who have grown in socially compromised conditions, or who were not diagnosed as hearing impaired (Friedmann, Rusou 2015). Two well-known examples of late exposure to the linguistic input are the cases of Genie (Curtiss 1977) and 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 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 only produce 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 accessible to individuals with hearing impairment (Furth 1966). The difficulties that these people experience are essentially limited to the language domain.

Hearing impairment is among the most common disabilities of human beings. In 2018, the World Health Organization estimated that about 5.3% of the world's population was affected by hearing impairment. In our country, the number of Italians who was suffering from hearing loss at different degrees were about 8 million (about 12% of the country's population).

Approximately one child out of 1000 newborns is born with hearing impairment (Maragna 2000; Govaerts, Schauwers, Gillis 2002; Fabbro 2003), which seriously interferes with language acquisition and speech development, and hinders the full integration in school and society. Over half of early onset hearing loss and at least one third of late onset hearing loss, are to be attributed to genetic factors (Nadol, Merchant 2001).

This chapter introduces some general issues on hearing and hearing impairment. It gives an overview on how the ear works and how some peculiarities of hearing impairment may affect language acqui-

sition. A survey on how language is acquired in people with hearing impairment is also offered, with a focus on language development by Italian individuals with hearing impairment.

1.2 The hearing loss and the variables influencing language development

When damage occurs to the ear, individuals may suffer from hearing loss, sometimes with strong consequences on the development of linguistic abilities. The population of individuals with hearing impairment is extremely heterogeneous. Basically, the factors that influence language development in individuals with hearing impairment are numerous and complex: among them are the site of lesion, the age of onset of deafness and age of diagnosis, the severity of hearing loss, the age of first intervention, the parents' linguistic background and their choice on the educational approach to adopt in intervention in order for the child to access linguistic input. In the following sections, a brief description of all these variables will give the possibility to better understand hearing impairment and its consequences on language acquisition.

1.2.1 The human ear and the site of lesion

One of the variables that may influence language development is the area where the auditory damage is localized. For a better understanding of the damage localization, it is important to briefly sketch the structure of the human ear.

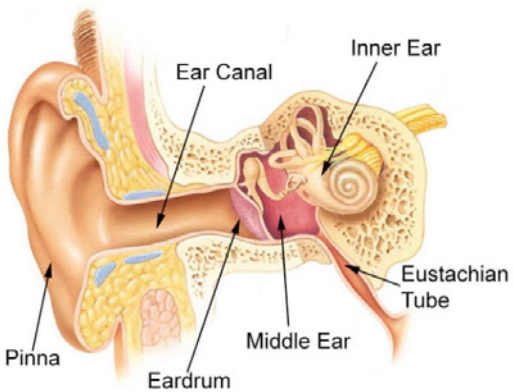

Figure 1 The human ear (https://slocountyhearingaids.com/how-the-ear-works/) (2019-10-07)

The human ear can be divided into three main sections: 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 (tympanic membrane) after travelling through the external auditory canal. The eardrum is a delicate membrane that separates the outer ear from the middle ear and 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 mechanical sound vibrations into electrical signals. These electrical signals are transmitted through the auditory nerve up to the brain, where they are interpreted as sounds.

Four types of hearing loss are identified, depending on the site where the lesion or the damage is localized (Quigley, Paul 1984):

- 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.
- 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. Certain frequencies are less affected than others.
- Combined hearing loss: it is attributed to a combination of conductive and sensorineural losses; therefore, the hearing deficit occurs in both the outer or middle and the inner ear.
- Central hearing loss: 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), while the central hearing loss is the rarest type.

1.2.2 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 can be measured from -10 to 120 dB. It is usually measured across a range of frequencies from 125 to 8000 Hz. Hearing thresholds refer to audiological measurement of unaided hearing in the better hearing ear. According to the BIAP (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 for each ear is reported 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 loss:[1]

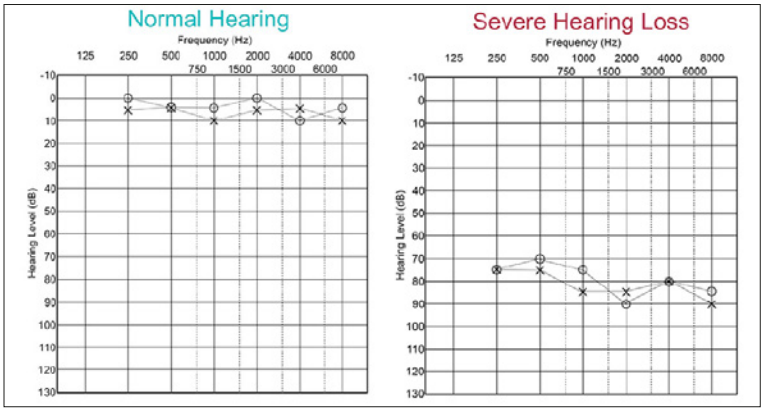

Figure 2 Audiograms of a person with normal hearing (left) and of a person with severe hearing impairment (right) (https://www.babyhearing.org/what-is-an-audiogramon, 2019-10-07)

The degree of hearing impairment is often represented as the average of the hearing thresholds for the four frequencies considered to be the most important for the reception of speech: 500, 1000, 2000 and 4000 Hz.

1.2.3 Types of hearing devices

Conventional hearing aids and cochlear implants are the devices available to individuals with hearing impairment in order to get access to the acoustic and linguistic input. These two hearing devices are different in their functions and use.

Conventional hearing aids (either analog or digital) usually amplify

1 The two audiogram examples are taken from: `http://www.schooltrain.info/deaf_studies/audiology2/levels.htm`. The line with 'x' identifies the left ear and the line with 'o' identifies the right ear.

sounds and perform much better in the coding of low sound frequencies, which contain mainly information related to tonality, musicality, timbre (temporal content). Conventional hearing aids are external devices helping people with hearing impairment to exploit their residual hearing and are more suitable for treating mild-to-moderate and severe hearing loss.

Cochlear implants are instead auditory devices that are surgically implanted in the inner ear (in the cochlea) and are activated by an external device, worn outside the ear. They stimulate the auditory nerve, thus allowing individuals with hearing impairment to perceive sounds, and are mainly conceived to code the mid and high sound frequencies (spectral content), since speech information is mainly contained in the range of these frequencies. Cochlear implants are more intended for children and individuals who suffer from severe to profound hearing loss (De Filippis Cippone, 2002; Govaerts 2004). Cochlear implants make it possible to reach high levels of speech intelligibility. They are however 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) depending on the degree of hearing loss.

Various studies addressing the important issue of language acquisition in individuals with hearing impairment found that in children with cochlear implants, language develops faster than in deaf children without the cochlear implant (Tye-Murray, Spencer, Woodworth 1995; Miyamoto et al. 1999; Svirsky et al. 2000; Blamey et al. 2001), 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 deaf 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).

Regardless of the type of hearing device that individuals with hearing impairment receive, steady acoustic and linguistic training sessions are necessary for language development.

1.2.4 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 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 span

of time, it is defined as post-lingual. The distinction between pre-lingual and post-lingual deafness is crucial for the acquisition of oral languages. Although a child whose hearing impairment is diagnosed, for instance, at the age of six or seven and suffers from profound sensorineural hearing loss has the same degree of hearing impairment as a child who suffers from a congenital profound impairment, consequences on language development and communication are very different. Indeed, differently from pre-lingually deaf children, a child deafened at the age of six has had enough auditory experience to access linguistic input and fix most properties of the oral language in a natural way. Therefore, in most cases, post-lingual hearing impairment makes it possible to develop oral first language normally.

1.2.5 Parental background and approach to 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 person with hearing impairment may be exposed to linguistic input consisting of oral speech, sign language, and/or some form of manually coded language. The possibilities available to make language accessible to people with hearing impairment are:

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

For children with hearing impairment born to hearing parents, the oralist approach is most frequently chosen. This approach exclusively exploits 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 languages are visual-gestural languages, which are considered full-fledged linguistic systems (Caselli et al. 1994; Newport, Supalla 1999). They have 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 languages follows the same processes as acquisition of oral languages by children with normal hearing. Indeed, individuals with hearing impairment who are exposed to a 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, children born to parents with hearing impairment (only 5-10%) are exposed to Italian Sign Language (LIS, henceforth) and can ac-

quire it naturally from their parents. On the other hand, children with hearing impairment born to hearing parents are hardly exposed to sign language from birth, and for them the oral education is mainly preferred. They might acquire the sign language later.

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, Massoni, Osella 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).

Bilingual education involves the simultaneous exposure to both the sign language and the oral language (in its written and oral modalities). Bilingualism is the knowledge and regular use of two (or more) languages. In the case of individuals with hearing impairment, it involves the simultaneous acquisition of both the oral and the sign language. The main assumption of this kind of approach is that children with hearing impairment acquire the sign language spontaneously, unlike what happens with a spoken language. Bilingualism must be considered a great resource for children with normal hearing who speak two oral languages. It is an even bigger richness for children with hearing loss. Indeed, it represents the only way for a child with hearing impairment 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 people with either normal hearing or hearing impairment.

The importance of a bilingual approach has been highlighted by different studies (a.o., Wie et al. 2007; Bertone, Volpato 2009; Jiménez, Pino, Herruzo, 2009; Grosjean 2010; Davidson, Lillo-Martin, Chen Pilcher 2014; Rinaldi, Caselli 2014). Wie et al. (2007) showed that Norwegian-speaking children with hearing impairment who were exposed to both sign and oral language had very good outcomes in activities assessing oral language speech perception. A study carried out on Spanish-speaking children directly compared children with cochlear implants who exclusively received an oralist education and children who followed a bilingual approach. The group of bilingual children obtained significantly higher scores than the other group of children in verbal fluency favoured by the easy access to lexicon thanks to the use of sign language (Jiménez, Pino, Herruzo 2009). Davidson, Lillo-Martin, Chen Pilcher (2014) compared 5 children with cochlear implants born to deaf signing parents with a group of hearing children born to deaf parents and exposed to both American Sign Language (ASL) and English. The children with cochlear implants were exposed to ASL from birth, and to English after implantation. The group of children with cochlear implants and the group of nor-

mal hearing children showed comparable performance on different standardized language measures. Improvement in vocabulary skills was observed for an Italian-speaking deaf child exposed to Italian Sign Language and spoken Italian (Rinaldi, Caselli 2014). The number of signs and words used by the child increased as the child progressively grew older, showing a level of lexical development comparable to that of hearing peers. Bertone and Volpato (2009) focused on the linguistic competence and morpho-syntactic abilities in Italian of four groups of participants with hearing impairment: a group of children with cochlear implants, a group of adolescents who are native LIS signers, a group of non-native LIS signers, and a group of foreign students who arrived in Italy at a later stage of language acquisition. The group of children with cochlear implants obtained the highest scores in comparison with the other three groups. However, among the other three groups, native LIS signers showed the best performance. Results confirmed that an educational system combining both an oral and a signed approach would make it possible for a child with hearing impairment to fully develop the grammar of the oral language.

The coexistence of both experiences, although much debated, does not hinder the development of the oral language (as people which favour an oralist approach would point out); instead, it facilitates children's development of linguistic, cognitive, and communication skills.

1.3 The relationship between clinical variables and linguistic outcomes

The population of individuals with hearing impairment is very heterogeneous, with consistent inter-individual differences. Linguistic outcomes of individuals with hearing impairment are very heterogeneous. In some cases, atypical and delayed linguistic profiles are identified; in other individuals, language skills develop normally and comparably to age peers. As shown in the preceding sections, many variables may interact with each other and explain the variability of linguistic outcomes, among them age of hearing-loss onset, age of diagnosis, degree of hearing loss, age of intervention, type and length of use of the hearing device, family background, and type of education, mainly depending on the family background. Many studies have tried to find out whether a correlation exists between the level of linguistic competence attained by individuals with hearing impairment and their clinical data. However, which factors predict accuracy in language skills and how all these variables interact with each other and influence language development is still highly debated.

Although it is generally acknowledged that hearing impairment may hinder the development of normal linguistic abilities, 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 receptive or productive skills across different oral languages have not yet found any correlation between the two factors (Fry 1966; Gilbertson, Kahmi 1995; Wolgemuth, Kamhi, Lee 1998; Blamey et al. 2001; Norbury, Bishop, Briscoe 2001, 2002; Tuller, Jakubowicz 2004; Friedmann, Szterman 2006).

Blamey et al. (2001) investigated speech perception and linguistic skills 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 hearing impairment occurs might influence performance. The degree of hearing loss only correlates with abilities in speech perception, but not with language scores. Similar findings were also offered by Norbury, Bishop, Briscoe (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 observed between language scores, degree of hearing loss, and age of hearing loss detection.

For French, Tuller and Jakubowicz (2004) explored the comprehension and production skills of 20 children with degrees of hearing loss ranging from 37 to 64 dB. Different grammatical aspects of French were investigated, namely the use of determiners, clitic pronouns, and verbal morphology. High inter-subject variability was found. Hence, in the individuals with hearing impairment, 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.[2]

Friedmann and Szterman (2006) investigated the comprehension and production of relative clauses and topicalization sentences in Hebrew-speaking children with moderate, severe and profound hearing loss ranging from age 7;7 to 11;3. Results demonstrated that children with hearing impairment failed to understand object relatives and topicalization sentences, but, as in other studies, these difficulties were not associated to the degree of hearing loss. Interestingly, a positive relationship was observed between early detection of hearing loss, early intervention and fitting of hearing aids and performance on comprehension tasks.

Different findings were obtained by Delage and Tuller (2007), who explored the relationship between hearing loss and language out-

2 In Tuller and Jakubowicz (2004), only an age effect was found, therefore younger children showed more linguistic difficulties than older children.

comes measured using standardized and non-standardized tasks. Difficulties with the French language were found especially in the domain of phonology and grammar. The scores obtained by the adolescents with mild-to-moderate hearing impairment significantly correlated with degree of hearing loss.

Much recent research showed that many English-speaking children with hearing loss may achieve skills comparable to those of their hearing peers in both receptive and expressive language, 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 enrolment in intervention and vocabulary skills at the age of 5 in a group of 112 children with mild to profound sensorineural hearing loss. She found a significant negative correlation between the two factors, namely children undergoing early intervention programs (before 11 months of age) 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. Another variable that significantly contributed to explaining a large amount of variance in the linguistic competence was the involvement of family. 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.

While severity of hearing loss was not found to correlate with linguistic results, age of intervention, and especially early intervention is the variable that seems to play the major role. Boothroyd et al. (1991) observed that about 43% of children who received the cochlear implant at the age of 2 managed to reach a good level of linguistic competence at the age of 8-9, whereas only 16% of children fitted with a cochlear implant before the age of 4 manage to attain a good linguistic competence. Friedmann and Szterman (2006) pointed out that children (either wearing conventional hearing aids or using a cochlear implant) whose hearing loss was detected before the age of 8 months showed good performance in the comprehension of complex syntactic structures.

Focusing primarily on individuals using a cochlear implant, early intervention and early activation of this device are two factors that contribute to account for the variability observed in this population as far as linguistic outcomes are concerned. Some studies report that children who received a cochlear implant early in their life and had prolonged experience with cochlear implants achieve spoken language abilities comparable to those of normal hearing children (Svirsky et al. 2005; Connor et al. 2006; Geers 2006). The importance of early intervention and early device application was confirmed by Oller and Eilers (1988), Moeller (2000), Schauwers, Gil-

lis, and Govaerts (2005), and Johnson and Goswami (2010). These authors show that early intervention favours the achievement of phonological awareness and receptive vocabulary growth, and in general reduces the linguistic delay of individuals with cochlear implants. According to Yoshinaga-Itano, Baca, Sedey (2010), some early implanted children do even learn language more quickly than typically developing children. Hammes et al. (2002) showed that children who received a cochlear implant before 18 months of age showed spoken language skills comparable to age-peers. The need for early intervention is also supported by Ledeberg and Spencer (2005) and Nicholas and Geers (2006), who suggest the existence of a critical period for implantation according to the age-related plasticity of the brain. Spencer (2004) claims that such plasticity must be exploited before the age of three years and a half.

There is no agreement on what "early" means, since different ages for implantation are identified depending on the domain and the linguistic properties investigated (Guasti et al. 2014). Using a perception test, Fryauf et al. (1997) found that children implanted before five years of age performed better than children who received the implant after that age. Hayes et al. (2009) found that children receiving early cochlear implantation, namely by the age of two years, show a substantial vocabulary growth which allows them to achieve receptive lexical skills within the average range for normal hearing children. Similar good outcomes in vocabulary development are reported by Geers et al. (2009).

Miyamoto et al. (2008) concluded that implantation occurring before the age of 2;6 years has positive effects on the development of general language abilities. Using spontaneous speech collections and a standardized test investigating expressive and receptive language, Nicholas and Geers (2007) found that children implanted between the age of 12 and 16 months were more likely to achieve spoken languages skills comparable to hearing age-peers. Children who receive a cochlear implant at the age of three may experience great difficulties in obtaining results comparable to normal hearing age-peers. Manrique et al. (2004) investigated lexical and general grammar skills and observed that children implanted before 2 years developed language more easily than those implanted after that age. Using a standardized comprehension test, Nikopoulos et al. (2004) found that children with hearing impairment showed levels of performance comparable to hearing peers if they received a cochlear implant before the age of 4, as opposed to those who underwent cochlear implantation later.

As for Italian, Caselli et al. (2012) investigated lexical-phonological and morpho-syntactic skills in children ranging in age from 3;9 to 5;5. They showed that cochlear implant activation has positive consequences for the lexical domain as it can promote the rapid ini-

tial acquisition and development of vocabulary. They found that children whose cochlear implant was activated in the second year of life showed very good language skills, even though comprehension abilities were not comparable to same-age peers, and some difficulties in the phonological and morphosyntactic areas can still be observed. Guasti et al. (2014) tested a group of children (age range: 4;2-6;10) who received their cochlear implants between the age of 1;0 and 4;8 years and found a correlation between age of implantation and accuracy scores in the production of clitic pronouns.

Other studies (Hodges et al. 1999; Connor et al. 2000; Tobey et al. 2000; Geers 2002; Geers et al. 2002; Osberger, Zimmerman-Phillips, Koch 2002; Geers, Brenner, Davidson 2003; Tobey et al. 2003) have shown that other factors (e.g., duration of cochlear implant use, amount of rehabilitation, device technology, educational setting) explained the variability in children with cochlear implants in different speech and language measures.

In the research carried out during my PhD, in addition to investigate whether and to what extent children with cochlear implants differed from normal hearing children in relative clause comprehension and production, it was verified whether the clinical variables investigated in previous studies (duration of cochlear implant use, age of hearing aid fitting, age of implantation) are predictors of performance in these tasks. The analysis of results is presented in chapters 3 and 4.

1.4 Language development in individuals with hearing impairment

Cross-linguistic research demonstrated that individuals with hearing impairment might show deficits in different domains of language acquisition (phonology, lexicon, semantics, morphosyntax and pragmatics) in comparison to hearing controls. Differences between children with hearing impairment and children with normal hearing may be already observed during the babbling stage.

Babbling represents the first form of linguistic production, which appears in the first months of life in children with normal hearing. At approximately 6 to 10 months of age, they start producing simple combinations of vowel and consonant sounds in well-formed syllables (papapa, dadada). Children with hearing impairment also babble, although they begin to babble with some delay compared to normal hearing children (Oller, Eilers 1988; Eilers, Oller 1994; Moeller et al. 2007). The first babbles produced by these children seem to suggest that this behaviour occurs in all children, regardless of their hearing status. However, if early vocalizations observed in children with hearing impairment appear to sound like those of normal hearing chil-

dren, after few months, they tend to decrease, clearly differing from those of children with normal hearing (Marschark 2009). The characteristics of babbles in children with hearing impairment seem to depend on the degree of hearing loss. Indeed, children with mild levels of hearing loss were observed to develop babbling differently from children with severe or profound hearing loss (Rvachew et al. 1999; Moeller et al. 2007). This is probably due to better perception of the speech signal in the case of low levels of hearing loss. Moreover, in children who received their cochlear implant between the age of 5 and 20 months, babbling started few months after the device activation (Schauwers et al. 2004; Colletti et al. 2005; Schauwers, Gillis, Govaerts 2008). This proves that these children start babbling at an age comparable to normal hearing peers, and from a qualitative point of view, their vocalizations are also very similar to those of age peers.

As for the investigation of vocabulary skills in individuals with hearing impairment, results are very controversial. Much research carried out on populations with hearing impairment showed that vocabulary is reduced in these participants in comparison to normal hearing peers. Early exposure to the linguistic input (either signed or spoken) during infancy was found to be fundamental for individuals with hearing impairment to develop lexicon adequately and easily, and to develop language (Mayne, Yoshinaga-Itano, Sedey 2000). However, in most cases, vocabulary knowledge is low, vocabulary acquisition is delayed, receptive and productive vocabulary is poor, and new words are acquired at slower rates (Moeller, Osberger, Eccarius 1986; Schirmer 2000; Lederberg, Spencer 2001; Lederberg 2003; Paul 2009; Lund 2016). Moeller, Osberger, and Eccarius (1986) showed that children with hearing impairment aged 13 to 20 years were comparable to 9-year-old children with normal hearing in receptive vocabulary. Ledeberg (2003) found that English-speaking children with hearing impairment have a lower rate of acquisition of words than hearing children, even when they wear cochlear implants or have consistent amplification and high-quality programming. Some children learn new words very slowly, differently from normal hearing children, for whom the vocabulary size increases very rapidly. In some cases, the lexical skills of children with cochlear implants were found to be comparable to those of normal hearing children (Caselli et al. 2012; Young, Killen, 2002). Caselli et al. (2012) found that young Italian-speaking children with cochlear implants performed comparably to normal hearing age peers in lexical production. Lexical comprehension was instead more problematic. In a different study on Italian children with cochlear implants, Chilosi et al. (2013) showed different findings. In these participants, expressive vocabulary was delayed, when related to chronological age. However, when related to the length of exposure to the language, expressive vocabulary showed faster development than receptive vocabulary.

If compared to vocabulary learning, morpho-syntactic development is even more delayed. Overall, individuals with hearing impairment frequently show poor syntactic knowledge, especially in the morphosyntax domain and, particularly, in the use of complex syntactic structures. Adolescents with hearing impairment show difficulties with syntactic rules 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, De Villiers, Hoban 1994). Markers such as inflectional morphemes, determiners, and pronouns are less perceptually salient in the speech stream than content words.

Cross-linguistically, much research has found that individuals with hearing impairment avoid producing complex structures, preferring short and simple sentences, and experience difficulties in the comprehension of complex syntactic structures, in the use of derivational and inflectional markers, noun and verb agreement, and functional elements, such as prepositions, determiners, auxiliaries, and pronouns, the presence of which are crucial to correctly interpret a sentence (a.o., for Dutch, Hammer 2010; Verbist 2010; Hammer et al. 2014; for English, Quigley, Paul 1984; De Villiers, Pomerantz 1992; De Villiers, De Villiers, Hoban 1994; Berent 1996; Spencer, Barker, Tomblin 2003; Geers et al. 2009; for French, Tuller 2000; Tuller, Jakubowicz 2004; Delage, Tuller 2007; Delage 2008; for German, Szagun 2004; Ruigendijk, Friedmann 2017; for Hebrew, Tur-Kaspa, Dromi 1998, 2001; Friedmann, Sztermann 2006; 2011; for Italian, Caselli et al. 1994; Taeschner, Devescovi, Volterra 1988; Volterra, Bates 1989; Fabbretti, Volterra, Pontecorvo 1998; Fabbretti 2000; Ajello et al. 2001; Volterra, Capirci, Caselli 2001; Franchi 2004; Chesi 2006; Fabbretti, Tomasuolo 2006; Bertone, Volpato 2009; Caselli et al. 2012; Guasti et al. 2014).

In English, among the most frequent errors for individuals with hearing impairment are omissions of tense inflections (present, past, or present progressive) in obligatory contexts (De Villiers, Pomerantz 1992; Berent 1996). Hebrew-speaking children with hearing impairment made errors in number and gender agreement between verbs and nouns and between adjectives and nouns (Tur-Kaspa, Dromi 1998). In German, Szagun (2004) showed that the use of articles is problematic, as shown by the frequent omission of these functional elements, as well as by the recurrent gender mistakes. German children using cochlear implants also experienced difficulties with case and gender agreement between articles and nouns (Szagun 2004). Verbist (2010) observed that Dutch-speaking children with a cochlear implant show a deficit in the use of weak pronouns in comparison to normal hearing children.

1.5 Language development by Italian-speaking individuals with hearing impairment

Focusing on Italian, most studies were mainly concerned with the assessment of linguistic skills in individuals fitted with conventional hearing aids (a.o., Taeschner, Devescovi, Volterra 1988; Rampelli 1989; Volterra, Bates 1989; Caselli et al. 1994; Emiliani et al. 1994; Fabbretti 2000; Ajello et al. 2001; Volterra, Capirci, Caselli 2001; Bigoni et al. 2003; Chesi 2006; Franchi 2004; Volpato 2008; Rinaldi, Caselli 2009; Volpato 2010a). Basically, all the above-mentioned studies show that children with hearing impairment experience difficulties with receptive and productive vocabulary, and morphosyntactic properties of simple structures 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 (Caselli et al. 1994; Maragna 2000).

Caselli et al. (1994) investigated lexical and morphosyntactic abilities of 25 children with hearing impairment 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. Their linguistic abilities were assessed by using lexical tasks of picture naming and identification, and grammar tasks investigating morpho-syntactic properties of nouns and verbs. For the youngest participants, 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 (feminine is used instead of masculine 33% of times). In the task investigating the use of number morphology on nouns, children produced 60% of correct responses. The performance by the 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 al-

so 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').

A sentence repetition task including sentences of variable length and syntactic difficulty (Devescovi et al. 1992) was administered to a group of participants with hearing impairment to investigate 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 this task, the rate of correct responses for the youngest participants 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 rate of omission were nouns (11%). The highest percentage of substitutions concerned verbs (80%). The percentage of correct repetitions for the group of older participants with hearing impairment was also quite low (67%), considering that younger normal hearing children repeat these items correctly when they are 3;6 years 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 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 group with hearing impairment showed a rate 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). The performance of the children with hearing impairment 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 children with severe and profound hearing loss ranging in age from 6 to 17 years. He 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 rate 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, Devescovi, Volterra (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 the clitic pronoun altogether. However, when the clitic pronoun was produced, correct agreement between the clitic pronoun and its antecedent, correct case assignment, and correct placement were observed. Although problematic, the use of clitic pronouns in proclitic and enclitic position made it possible to infer that 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 rate of omissions was in the postverbal position (95%) (*Tom scivola e rompe ø piatti* 'Tom slips and breaks *ø* dishes', instead of *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%).[3] 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 form – *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 tenses 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 forms, and tense 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 replaced by coordinating particles (as was 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' instead of: *(il formaggio) lo butta verso un*

3 That feminine plural is the most preserved form is also shown in Volpato (2008). In the elicited production of clitic pronouns by adults with hearing impairment, the feminine plural clitic pronoun *le* 'them' has the highest percentage of correct responses.

vetro del comodino che si rompe '(He) throws it (the cheese) against a bedside table glass, *which* breaks'.

Rinaldi and Caselli (2009) assessed language development in 20 pre-schoolers with hearing impairment fitted with 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 children with normal hearing, 20 matched on chronological age and 20 matched on time of formal exposure to the oral language. Early grammar skills and comprehension and production of spoken vocabulary were assessed by using a questionnaire 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 section assessing morphosyntax investigated the child's ability to produce sentences and the level of completeness in sentence production. The results demonstrated that children with hearing impairment showed a significant delay in both vocabulary and grammar, if compared to same-age children. The group of children with hearing impairment 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 hearing experience.

Emiliani et al. (1994) found that in grammatical comprehension, most errors were identified in the comprehension of closed class words, while fewer errors were detected in the domain of inflectional morphology.

Beronesi and Volterra (1986), Rampelli (1989), and Volterra and Bates (1989) analysed the linguistic competence of adolescents and adults with hearing impairment. Beronesi and Volterra (1986) analysed the written and spoken production of five adolescents, and Volterra and Bates (1989) that of a congenitally deaf woman with profound hearing loss. The participants with hearing impairment had poor vocabulary and tended to use short and syntactically simple structures. They experienced difficulties in the use of free morphology, namely 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 the comprehension skills of a group of adults with hearing impairment. 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 lack of a normally developing phonetic-phonological system was claimed to be the reason for the difficulties the individuals with hearing impairment had in the comprehension and use of closed class words in oral languages (Volterra, Bates 1989).

As said above, the studies presented so far were mainly concerned with participants with conventional hearing aids. In addition, the participants involved in all these studies were assessed using standardized measures, or in some cases, questionnaires filled in by parents.

More recent linguistic research has focused on the assessment of language competence by children with cochlear implants. In addition to studies in which the overall lexical and grammatical abilities were assessed using standardized tasks (e.g. Volpato 2010b; Caselli et al. 2012; Chilosi et al. 2013), a number of studies have developed experimental tasks to investigate the competence of specific complex structures of Italian in children with cochlear implants (Volpato, Adani 2009; Volpato 2010b; Volpato 2011; Volpato 2012; Guasti et al. 2014; Volpato, Vernice 2014).

Volpato and Adani (2009) is the first study investigating the competence of specific syntactic properties of Italian in children with cochlear implants. As I show in detail in chapter 3, this study assessed the comprehension of subject and object right-branching relative clauses by 8 children with cochlear implant (age range: 6;9-9;3; mean age 7;9). Their performance was compared to that of younger children matched on morpho-syntactic abilities, younger children matched on receptive vocabulary, and age-matched children. Volpato (2012) used a similar task but different materials to investigate the role of number features in the comprehension of right-branching relative clauses in 13 children with cochlear implant, older than in the previous study (age range: 7;9-10;8), comparing their performance with a group of younger children of comparable linguistic age. In the same group of children with cochlear implants, Volpato (2011) and Volpato and Vernice (2014) also investigated the production of relative clauses. Guasti et al. (2014) used a non-standardized measure to test the production of sentences containing accusative clitic pronouns in a group of young children with cochlear implants (age range: 4;2-6;10). These children showed lower performance than age-matched peers. In most cases, they omitted the clitic pronouns or produced sentences in which the lexical object was used instead of the clitic pronouns.

For Italian, studies on the assessment of the linguistic competence of children with cochlear implants are still scarce, especially as far as the production and comprehension of complex syntax. This volume aims at presenting in detail the recent research that has been carried out on the acquisition of complex structures, in particular relative clauses, by children with cochlear implants, and by adolescent LIS signers.

2 The experiment: linguistic structures and materials

Summary 2.1 Introduction. – 2.2 The characteristics of relative clauses. – 2.3 Relative clauses and the *pro-drop* parameter . – 2.4 The role of phi features . – 2.5 The role of number: evidence from experimental studies. – 2.6 Feature checking and agreement phenomena. – 2.7 Why testing both production and comprehension. – 2.8 Preparing the trials. – 2.8.1 Embeddedness: centre-embedded vs. right-branching relative clauses. – 2.8.2 Ambiguity. – 2.8.3 Disambiguating cues. – 2.8.4 The lexicon and the sentences. – 2.9 The experiment: materials for the assessment of linguistic competence. – 2.9.1 The relative clause comprehension task. – 2.9.2 The relative clause production task. – 2.9.3 Memory assessment: the repetition tasks. – 2.9.4 The assessment of general linguistic abilities. – 2.10 Participants. – 2.10.1 Children with cochlear implants. – 2.10.2 LIS signers with hearing impairment. – 2.10.3 Children with normal hearing. – 2.10.4 Adolescents with normal hearing. – 2.10.5 Adults with normal hearing. – 2.11 Procedure. – 2.12 Conclusion.

2.1 Introduction

The previous chapter presented an overview of the difficulties that individuals with hearing impairment encounter in oral language acquisition. Although several studies have been conducted on this topic over the years, much research is still needed in the different linguistic domains, particularly in syntax. Since this volume is concerned with the analysis of a specific syntactic structure, namely restrictive relative clauses, this chapter is devoted to the presentation of the linguistic properties of these structures and the rationale behind the construction of the comprehension and the production tasks.

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2.2 The characteristics of relative clauses

The experimental investigation presented in this book regards subject and object restrictive relative clauses.

Relative clauses are subordinate clauses modifying a nominal element, the so-called antecedent or head of the relative. Restrictive relative clauses restrict the number of possible referents for the nominal element they modify. 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). Subject and object relative clauses are introduced by the complementizer *che* (the equivalent of English 'that') and contain a gap in the merge position of the element that has been relativized. Examples of relatives extracting from subject and object positions are provided in (1) and (2), respectively:[4]

(1) la tigre che ___ colpisce gli elefanti
'the tiger that hits the elephants'

(2) il cane che la tigre bacia ___
'the dog that the tiger kisses'

Early accounts proposed that relative clauses are derived by *wh*-movement of a relative operator (OP) (Chomsky 1977; Cinque 1978, 1982). The relative operator moves from the embedded position in which it is originated to a position in the high portion of the structure, namely Spec/CP, where it is coindexed with the relative head. A chain between the operator and the relative head is thus created. The derivation of a subject relative is provided in (3):

(3) a. La tigre che 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 (4):

(4) a. Il cane che la tigre bacia
b. $[_{DP}$ Il $[_{NP}$ cane$_i$ $[_{CP}$ OP$_i$ che $[_{IP}$ la tigre bacia t$_i$]]

Much subsequent research (Vergnaud 1985, Kayne 1994, Guasti, Shlonsky 1995, Bianchi 1999, Cinque 2013) challenged this proposal by suggesting a head-raising analysis of relative clauses. According to this proposal, what moves in subject and object restrictive relative

4 According to Rizzi (1982) (also see Rizzi 2006, and Rizzi,Shlonsky 2007, the subject does not move out of the embedded preverbal position, but from its base position (see ch. 4 fn 32). For the sake of simplicity, I place the subject gap in preverbal position.

clauses is not a relative operator, but the relative head itself. This type of analysis is represented in (5) and (6) for subject and object relatives, respectively:[5]

(5) a. La tigre che <la tigre > colpisce gli elefanti.
b. [$_{DP}$ la [$_{CP}$ [$_{NP}$ tigre] che [$_{IP}$ [$_{NP}$ ~~tigre~~] colpisce gli elefanti]]]]

(6) a. Il cane che la tigre bacia <il cane>
b. [$_{DP}$ Il [$_{CP}$ [$_{NP}$ cane] che [$_{IP}$ la tigre bacia [$_{NP}$ ~~cane~~]]]

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. Given the landing position of the relative head, relative clauses involve A'-movement. The position from which movement takes place is marked by a *t* (trace) or is filled by 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 (Rizzi 1982). The setting of the *pro-drop* parameter on a positive value involves the possibility for the overt subject to occur in either the preverbal or the postverbal position:

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

The two possibilities in (7) are also found in relative clauses, as shown in (8):

(8) a. Il gelato che Gianni ha mangiato
The ice-cream that John has eaten
b. 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 positive setting of the *pro-drop* parameter is

5 The constituent in < > identifies the original position from which the head is extracted.

that relative clauses containing semantically reversible verbs, such as the one in (9), may result ambiguous between a subject and an object interpretation:

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

In (9), either *il bambino* 'the child' or *il nonno* 'the grandfather' can 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:

(10) 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 postverbal object position:

(11) 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 available, a morphological strategy and a syntactic strategy.

When the two DPs show different number features, namely when one DP is singular and the other is plural, disambiguation may occur through the morphological cue (number marking) on verbal morphology. Since the verb agrees in number with the subject, number agreement on the embedded verb unambiguously mark either a subject (12)-(13) or an object relative clause (14)-(15):

(12) Il bambino$_i$ [che <il bambino> bacia$_i$ i nonni]
the child$_i$ [that <the child> kisses$_i$ the grandfathers]

(13) I bambini$_i$ [che <i bambini> baciano$_i$ il nonno]
the children$_i$ [that <the children> kiss.3.PL$_i$ the grandfather]

(14) 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'

(15) 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'

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

(16) a. Il bambino [che il nonno bacia <il bambino>]
the child [that the grandfather kisses <the child>]
b. I bambini [che i nonni baciano <i bambini>]
the children [that the grandfathers kiss <the children>]

The morphological and the syntactic disambiguating cues may also co-occur, when the embedded subject DP is placed in preverbal position and the number features are in a mismatch condition:

(17) Il bambino [che i nonni$_i$ baciano$_i$ <il bambino>]
the child [that the grandfathers$_i$ kiss$_i$ <the child>]

(18) I bambini [che il nonno$_i$ bacia$_i$ <i bambini>]
the children [that the grandfather$_i$ kisses$_i$ <the children>]

Summing up, the sentences in (16)-(18) are examples of relative clauses made unambiguous through the syntactic strategy (preverbal subject DP, (16)) or through the morphological strategy (when number features are different on the two DPs, number marking on the embedded verb favours disambiguation, (17) and (18)).

2.4 The role of phi features

As shown in the previous section, number features on nominal and verbal morphology may be crucial in Italian for correct theta-role assignment in subject and object relatives.

In this section, I show that number features play a significant role in clause structure representation. Much linguistic and psycholinguistic research conducted across different languages has contributed over the years to highlight this aspect.

Several studies have addressed the issue of the way number features, especially in opposition to 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, Nicol, Garrett 2002) and represented in clause structure from a phonological and morpho-syntactic point of view (for Italian, Di Domenico 1997; Ferrari 2005; Lampitelli 2010; Thornton 2001; for Spanish, Harris 1991; Picallo 1991, 2005, 2008; for Hebrew, Ritter 1995). These studies aimed at determining which features are salient and syntactically relevant in that they project an autonomous head, and which are instead associated to some other head.

The experiment run on children with cochlear implants in the present book is mainly devoted to investigating the role of number features in the acquisition of relative clauses. Previous investigations in language acquisition and development by individuals with hearing impairment focused on the role of both number and gender features, crucially contributing to the current debate on phi features (Volpato 2008; Volpato 2010b). For this reason, this section will offer a brief state-of-the-art of the research on phi features.

2.5 The role of number: evidence from experimental studies

The salience of number features in clause structure is highlighted by much recent linguistic and psycholinguistic research. Nicol (1988) investigated the role of number features and their relationship with gender using a cross-modal priming technique. Participants were presented with pairs of sentences, each containing a personal pronoun. The two pronouns differed in either number or gender features. In each pair of trials, the pronoun was preceded by two lexical referents, and the disambiguation between the two potential antecedents occurred through either number or gender features. The following examples show two pairs of sentences in which the decision concerns number (19)-(20) and gender features (21)-(22), respectively:

(19) The landlord told the janitors that the fireman with the gas mask would protect him if it became necessary.

(20) The landlord told the janitors that the fireman with the gas mask would protect them if it became necessary.

(21) The ballerina told the skier that the doctor would blame him for the injury.

(22) The ballerina told the skier that the doctor would blame her for the injury.

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

For Italian, De Vincenzi and Di Domenico (1999) carried out a similar experiment, in which they tested the following conditions for number (23)-(24) and gender features (25)-(26):

(23) 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.'

(24) 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.'

(25) 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.'

(26) 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 helps the retrieval of the correct antecedent earlier than gender information. This led the researchers to claim that Number is a cognitively salient feature.

The salience of number was also investigated by Volpato (2008) by using a sentence completion task. This study investigated the use of the four third-person accusative clitic pronouns (*lo, la, li, le*) in left-dislocation sentences in a small group of adult LIS signers. The participants were presented with different sentences and for each sentence, they had to fill in the correct clitic pronoun and the verb in the correct tense (the verb was given in brackets in the infinitive form). The four tested conditions are shown in the following examples. The experimental sentences are provided in a., the answers by the participants (the underlined words) are provided in b.:

(27) a. Tu e tuo fratello, la luce _____ (accendere), perché la stanza era al buio.
b. Tu e tuo fratello, la luce l(a)'avete accesa, perché la stanza era al buio.
You and your brother, the light.FEM.SG, it.fem.sg have turned-on.fem.sg, because the room was at dark.
'You and your brother turned on the light (it), because the room was at dark.'

(28) a. Il ladro, i poliziotti _____ (arrestare) ieri sera.
b. Il ladro, i poliziotti l(o)'hanno arrestato ieri sera.
The thief.MAS.SG, the policemen.MASC.PL him have arrested.masc.sg last night.
'The policemen arrested the thief (him) last night.'

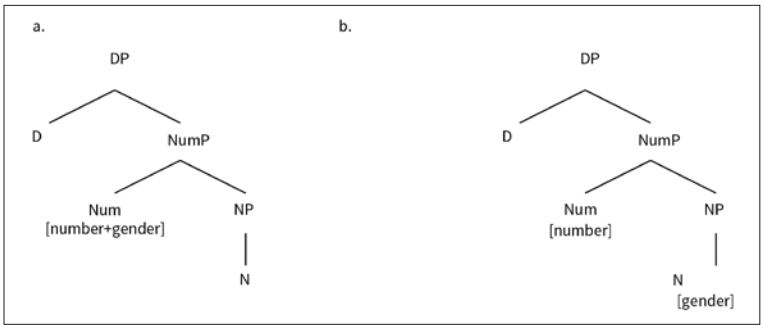
(29) a. Il giardiniere, gli alberi, _____ (potare) ogni anno.
b. Il giardiniere, gli alberi, li pota ogni anno.
The gardener.MAS.SG, the trees.MAS.PL them.MASC.PL prunes every year.
'The gardener prunes trees (them) every year.'

(30) a. Le mele, lei _____ (mangiare) tutti i giorni.
b. Le mele, lei le mangia tutti i giorni.
The apples.FEM.PL, she them.FEM.PL eats every day.
'She eats apples (them) every day.'

Results showed that the three participants with hearing impairment 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 highest number of checked visible (plural) features, because they have more overt evidence of it, thus confirming a triggering force for plural number features rather than for singular ones (Nicol 1998; De Vincenzi, Di Domenico 1999).

Although the issue is 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. Both authors postulate the existence of a number projection (NumP) above NP in the DP structure. Ritter (1995) proposes that for languages such as Hebrew, gender is a feature of N (31b) appearing on the noun stem at all representational levels, while for Romance Languages gender is projected under NumP (31a). Di Domenico's (1997) proposal for Italian is slightly different. Number heads its own projection, whereas gender may be hosted either under N or under NumP. Grammatical gender is projected under N (31b) being considered as part of the lexical entry N. Semantic gender is instead projected together with number under NumP (31a).

(31)



In sum, gender is projected in syntax either with the noun (31b), when present, or with number (31a). However, what is relevant to some issues raised in this book is that number is a syntactic head autonomously projected in syntax.

Analysing the Italian nominal system, Ferrari (2005) strongly corroborates the hypotheses put forward by Ritter (1995), 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.[6]

The presence of a more prominent structural element, namely Number, somehow facilitates linguistic performance (Volpato 2008). The prominence of Number features confirms previous findings in linguistic and psycholinguistic research.

This discussion is crucial for the experimental research presented in this book. It helps understanding important aspects underlying the construction of the experimental trials and the choice of manipulating number features on both DPs in the relative clause.

2.6 Feature checking and agreement phenomena

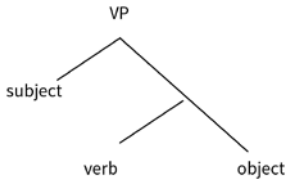
Another aspect that is relevant for the description of relative clauses concerns the way in which phi features realize agreement in clause structure. The discussion is built within the Principle and Parameter framework and the Minimalist Program (Chomsky 1995; 2000).

A syntactic structure is derived by stepwise successive building up operations of MERGE and MOVE of sentence constituents, until the final representation is derived. MERGE is the operation stringing two elements together, in order to form a minimal phrase; MOVE is the operation that accounts for the displacement of an element from the position in which it is interpreted to the position in which it is finally pronounced.

6 Ferrari (2005), as well as other studies (Picallo 1991, 2005, 2007; Lampitelli 2010, Volpato 2010a), claim that number and gender features head two distinct projections in the syntactic structure. However, since this work is mainly focused on number features, I will not provide here any further details on the representation of gender features.

The thematic nucleus of the sentence is formed by merge of the verb with its arguments inside VP:

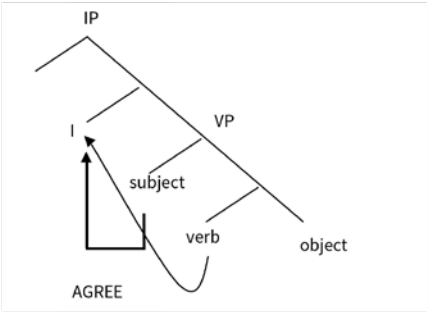
(32)



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.

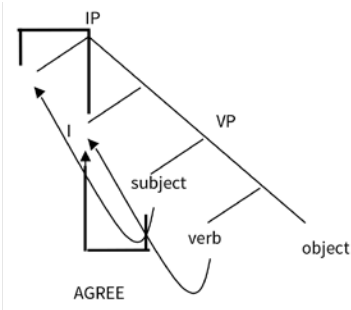
Successive merging operations introduce the functional structure of the sentence, namely the IP projection, which provides the syntactic configuration in which the subject-verb relationship is established. In addition to Merge, another important operation contributing to sentence derivation is AGREE. The syntactic node I enters an AGREE relationship with the subject when it is still in its base position within the VP projection, in order to be valued. In this way, number and person features of the subject are imported onto I:

(33)



After the head of IP, i.e. I, has been valued for number and person features, the displacement of the verb (MOVE) occurs in Italian in order for the verb to collect or check the relevant morphological specifications (Belletti 1990). Subsequently, the subject moves to the specifier position of IP. 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).

(34)



Spec-Head agreement guarantees 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 relationship 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 analysis of cross-linguistic data in French, English (Franck et al. 2006), and Italian (Guasti, Rizzi 2002). The generalization is that in the presence of a SV configuration, morphological number agreement is obligatory, as in (36a) and (37a), while morphological number agreement does not necessarily occur in a VS configuration, (35), (36b) and (37b):

(35) C'est les filles / Ce sont les filles
it is the girls / it are the girls

(36) a. Many books are/*is on the table
b. There are/'s many books on the table

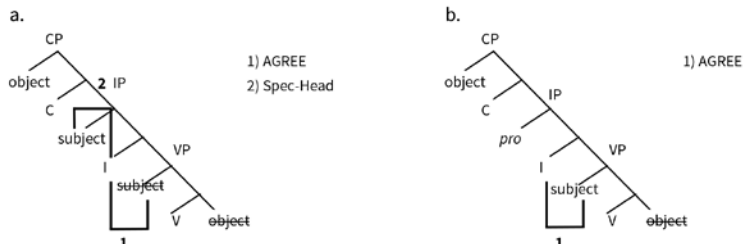
(37) a. Le ragazze vengono/*viene.
the girls come / comes
b. Vengono / Viene le ragazze
come / comes the girls

In Subject/Verb configurations, agreement is morphologically more robust and stable since AGREE is associated with MOVE (Spec-Head), while it is more fragile when only one operation occurs.

By applying the minimalist theory of Agreement by Chomsky (1995; 2000; 2001) and the refinement by Guasti and Rizzi (2002) and Franck et al. (2006) to the derivation of relative clauses, in ob-

ject relatives in which the subject linearly precedes the verb (OR), agreement is checked both under AGREE and in the Spec-Head configuration (38a). In the case of object relatives in which the subject occupies the postverbal position (ORp), only long-distance AGREE is established between the verb in I and the subject in the low portion of the clause structure (38b):

(38)



As we will see below in chapters 3 and 4, these properties of relative clauses are crucial to account for the better performance in ORs as opposed to ORps.

2.7 Why testing both production and comprehension

This book aims at providing insights into the mechanisms underlying both the comprehension and the production of restrictive relative clauses in groups of individuals with hearing impairment alongside with hearing populations. Both comprehension and production tasks are important tools to understand which syntactic representation individuals assign to relative clauses.

Language comprehension sheds light on the acquisition process making it possible to assess the competence of structures that are not yet produced and to identify whether children assign them the same interpretation as adults. Comprehension is essential in order to uncover the full extent of children's grammatical knowledge.

The analysis of production gives a more accurate picture of the content of the child's emerging language system. When children start producing a particular structure, they have already acquired it.

In order to fully master a language, an individual must be able to both comprehend and produce the structures of that language. Using both comprehension and production tasks may be helpful to provide a more detailed picture of children's competence in the use of relativization. Indeed, studies investigating different linguistic properties reported the existence of an asymmetry between production

and comprehension, and the relationship between the two modalities is still unclear.

In the course of typical language development, Italian- and Greek-speaking children were found to start producing relative clauses by the age of 3;0 (Crain, McKee, Emiliani 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; Håkansson, Hansson 2000; Guasti 2002). Production thus seems to precede comprehension.

Clark (1993) instead pointed out that comprehension precedes production. This is also confirmed by Contemori and Garraffa (2010), in a study on children with developmental language disorders.

In order to accurately explore the development of relative clauses in both typically developing populations and individuals with hearing impairment, it is crucial to test not only comprehension but also production.

2.8 Preparing the trials

In both the comprehension and the production tasks, the experimental trials were created taking into account all the characteristics of relative clauses presented in this chapter, 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. The choice of lexicon, in terms of frequency and reversibility of nouns and verbs was carefully studied.

2.8.1 Embeddedness: centre-embedded vs. Right-branching relative clauses

The research presented in this book is only concerned with right-branching relative clauses, like (39), in which the relative clause is on the right of the matrix clause. The reason for that choice (and for the avoidance of centre-embedded sentences like (40)) mainly depends on the degree of difficulty of the latter in comparison to the former.

(39) Touch the child that the mother kisses.

(40) 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 earlier than centre-em-

bedded relative clauses (Sheldon 1974; de Villiers et al. 1979; Correa 1995; Stavrakaki 2001; Kidd, Bavin 2002). The use of right-branching relative clauses in this research experiment was preferred over the use of centre-embedded ones in order to exclude potential factors of difficulty deriving from the interpretation of a sentence in which the main clause is broken up by the embedded clause. This allows me to focus on the role of number features in relative clause comprehension without overloading the processing system of young children with normal hearing and individuals with hearing impairment.

2.8.2 Ambiguity

Another important issue that was not considered in previous studies but has been taken into account in the development of the experimental sentences of this study is ambiguity in relative clauses. As we have seen in the previous sections, when both DPs share the same number features and the subject occurs in the post-verbal position in the relative clause due to the *pro-drop* property of Italian, the sentence is ambiguous between a subject and an object reading. According to much linguistic and psycholinguistic research (e. g. De Vincenzi 1991), the subject reading might be preferred over the object reading, because the human parser tends to postulate a gap immediately after the complementizer, i.e., in the subject position (Minimum Chain Principle). Starting from these premises, the present experiment also includes ambiguous trials with either singular or plural DPs. This makes 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 selection of the subject or object reading may also provide interesting hints to understand the performance in the comprehension of unambiguous relative clauses.

2.8.3 Disambiguating cues

In this experimental study, alongside with ambiguous sentences, unambiguous subject and object relative clauses were also administered. Object relatives are disambiguated by using either the structural strategy, i.e., the subject is placed before the embedded verb, or by using the morphological strategy, namely mismatching DPs and number agreement between the embedded verb and the postverbal subject. These choices allow us to test how the structural strategy and the morphological strategy modulate the comprehension and favour the production of relative clauses in different populations of individuals with normal hearing and hearing impairment.

2.8.4 The Lexicon and the sentences

For both production and comprehension, all experimental sentences are semantically reversible, that is, they contain verbs in which thematic roles are compatible with both DPs present in the clause. Consequently, the meaning of the sentence cannot be derived by relying on semantic or pragmatic cues. Experimental trials were also interspersed with filler sentences, which are not reversible and contain either intransitive verbs or transitive verbs with inanimate objects. Fillers sentences are easier than experimental trials for children (Goodluck, Tavakolian 1982) and were included in order to renew the child's confidence and interest in the task. Fillers have the function to divert the attention of the participants from the real aim of the investigation, to keep children's attention high, and to encourage them, since the answer is very easy.

All nouns and verbs are included in the high-frequency lexicon of children (Marconi et al. 1993) and are controlled for length and familiarity. In the comprehension task, all the experimental sentences have the same length in terms of words and syllables.

2.9 The experiment: materials for the assessment of linguistic competence

The experiment consisted in the administration of different tasks. In addition to a comprehension task and a production task assessing relative clauses, some repetition tasks were also proposed to the participants to assess memory skills, and a standardized test assessed general morpho-syntactic abilities. The comprehension, production, and repetition tasks are briefly sketched in the following sections and are presented in detail in the relevant chapters.

2.9.1 The relative clause comprehension task

Relative clause comprehension was assessed using a referent selection task, which was developed following the models proposed by Friedmann and Novogrodsky (2004), Adani (2008), and Arnon (2005). In this task, participants listened to a sentence and had to select a referent from a set of characters, choosing the one that correctly matches the sentence read by the experimenter. A detailed description of the comprehension test is offered in chapter 3.

2.9.2 The relative clause production task

Relative clause production was investigated by using the elicited production technique. Elicited production makes it possible to evoke sentences with complex structures that only rarely are produced spontaneously and enables to control the meaning that is to be associated with the targeted utterance (McKee et al. 1998).

Relative clause production was assessed using the preference task, which was developed following the model proposed by Friedmann and Szterman (2006) for Hebrew and the adaptation to Italian by Utzeri (2006; 2007).

A detailed description of the comprehension test is offered in chapter 4.

2.9.3 Memory assessment: the repetition tasks

In order to get a more accurate and detailed linguistic and cognitive profile of the individuals included in the experiment, tasks assessing memory abilities were administered to the participants with hearing impairment and to the young participants with normal hearing. Memory is a basic function which exerts an influence on all other cognitive abilities (Quigley, Paul 1984) and may also influence language acquisition. Indeed, poor linguistic abilities may be often accompanied by low memory skills. Hence, memory tasks were administered in order to check possible effects of memory limitations in relative clause comprehension.

For the assessment of memory resources, the following tasks were administered to the participants:

- a word repetition task consisting in the repetition of words assembled into sequences of increasing length (from 2 to 6 items). Only singular words were selected for the word repetition task;
- a nonword repetition task, included in the "Batteria della valutazione del linguaggio in bambini dai 4 ai 12 anni" (Battery for the assessment of language in children from 4 to 12 years, Fabbro 1999). It consisted in the repetition of 15 non-existing words of different length (one, two, three, and four syllables);
- a forward digit span task and a backward digit span task included in the TEMA (Test di Memoria e Apprendimento, *Test of Memory and Learning*) (subtest 7 and subtest 13, respectively), developed by Reynolds and Bigler (1995). They consisted in the immediate serial recall of sequences of digits (1-10) of increasing length. For forward digit span, participants were required to immediately repeat the digits in the same order as they were presented by the experimenter. For backward digit span, they were required to recall numbers in reverse order;

- a sentence recall task, consisting in the repetition of sentences of different length and difficulty (simple active structures with subject-verb-object word order, relative clauses, passive sentences, coordination sentences, and clitic left-dislocation sentences).

A more detailed description of the tasks assessing memory skills is provided in chapter 5.

2.9.4 The assessment of general linguistic abilities

In addition to the tasks assessing relative clause comprehension and production and the repetition tasks, a test assessing the general linguistic abilities was also administered to participants with hearing impairment and children with normal hearing. This standardized measure is known as Test di Comprensione Grammaticale per Bambini (Test of Grammatical Comprehension for Children – TCGB, henceforth; Chilosi, Cipriani 2006). This test is used to assess the development of children's comprehension abilities from 3;6 to 8 years and 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, the participants were invited to point to the picture that correctly matches the sentence, out of four possible choices. Eight different sentence types are 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. A score of 0 was assigned if the answer was correct. If the participant failed to provide the correct response after the first reading, the sentence was proposed again. When at the second reading, the participant pointed to the correct picture, a score of 0.5 was assigned. When he/she pointed again to the incorrect picture, a score of 1.5 was assigned. The final total score was obtained by summing all partial scores. The higher the score, the poorer the performance.

For each sentence type as well as for the overall performance, the TCGB manual provides normative data collected from Italian-speaking

typically developing children. The final score made it possible to detect whether the participant's performance was within the normal range for his/her age and to attribute a linguistic age to the individuals with hearing impairment. Based on this score, it was also possible to individually match participants with hearing impairment to control hearing participants (matching them on language age). Since children with hearing impairment access the linguistic input with delay as opposed to children with normal hearing, in most cases their performance is hardly comparable to that of typically developing children of the same chronological age. For this reason, the control group included samples of younger hearing children with typical language development.

2.10 Participants

Five populations participated in this experiment: children with cochlear implants, adolescent LIS signers with hearing impairment, children, adolescents, and adults with normal hearing.

2.10.1 Children with cochlear implants

The group of participants with cochlear implants is composed of 13 children ranging in age from 7;9 to 10;8, (mean age 9;2).[7] All of them have profound hearing loss (≥90 dB), classified accordingly to B.I.A.P (Bureau International d'Audiophonologie). All children were hearing-impaired from birth. All children were born to hearing parents. Nine children were recruited at the hospital of Rovereto, "Presidio Ospedaliero S. Maria del Carmine", in Trento, one was recruited at the "IRCSSE Medea Associazione La Nostra Famiglia" in Conegliano (Treviso), and three were recruited at the 'Centro Medico di Foniatria' in Padua. They have bilateral, sensorineural hearing loss. They have grown up in families where Italian is habitually spoken, and none of them had ever used 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 at which they received a cochlear implant varied between 1;9 and 3;4 years. The

7 Actually, data were collected from 14 children with cochlear implants, but one of them (S4) 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, and she probably also had a phonological impairment.

duration of cochlear implant use varied from 4;5 to 8;6 years. All children have been trained orally, and all of them received speech-language therapy from two to three times per week. They have normal IQ. They did not show any other associated disabilities. At the time of testing, they were attending primary schools in mainstream classes.

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

Table 1 Identification number and data of the children with cochlear implant (HL: Hearing loss; HA: Hearing aids; CI: cochlear implant)

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)
S1	10;8	0;9	2;2	8;6	90	85	30
S2	7;11	1;2	1;11	6;0	>90	75	25
S3	7;9	1;0	3;4	4;5	>90	85	30
S5	9;6	1;6	2;4	7;2	>90	85	30
S6	9;6	1;6	2;3	7;3	>90	55	30
S7	9;6	1;6	2;4	7;2	>90	85	30
S8	8;10	1;0	2;11	5;11	90	65	30
S9	9;5	1;8	2;3	7;2	>90	85	30
S10	9;9	0;9	2;8	7;1	>90	85	30
S11	9;10	0;5	1;9	8;1	>90	85	30
S12	9;3	0;10	1;9	7;6	>90	85	30
S13	8;1	1;0	1;10	6;3	>90	85	25
S14	8;2	1;4	2;3	5;11	>90	75	25

2.10.2 LIS signers with hearing impairment

This group is composed of six adolescent native LIS signers ranging in age from 15;5 to 17;6 (mean age: 16;4, SD=0.9). They are profoundly deaf from birth, born to parents with hearing impairment. They were hosted in a residential school for students with hearing impairment, the "I.S.I.S.S. Istituto Magarotto" in Padua. They have severe and profound hearing loss. Two of them habitually used conventional hearing aids. Unfortunately, for these participants, it was not possible to obtain all personal and clinical details.

2.10.3 Children with normal hearing

The group of children with normal hearing includes Italian-speaking 22 children ranging in age from 5;3 to 7;10 (mean age: 6;8, SD=0.96). They were recruited in a nursery and two primary

schools of the Istituto Comprensivo "A. Gramsci" of Campalto (Venice). They do not have any language impairmen or mental disabilities. Some of them were also exposed to dialect in their families.

2.10.4 Adolescents with normal hearing

The group of hearing adolescents is composed of 16 Italian-speaking participants. They all attended 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, SD=12) and were enrolled in the second and third class of high school. They do not have any language impairment or mental disabilities. All students come from the North-East of Italy.

2.10.5 Adults with normal hearing

The group of hearing adults includes 16 Italian-speaking participants ranging in age from 19 and 33 (mean age 24; SD=4.7). 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. 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 lived in North-East of Italy, in the region of Veneto or near the border with Friuli-Venezia-Giulia. Some participants habitually used the dialect variety spoken in their area both with their family and their friends.

2.11 Procedure

The tasks were administered in more than one session, in such a way that in each session, both memory abilities 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 was the following:

1. First session:
   - Forward and backward digit span (Reynolds, Biegler 1995)
   - Nonword repetition (Fabbro 1999)
   - Test di Comprensione Grammaticale per Bambini (TCGB – Chilosi, Cipriani 2006)
2. Second session:
   - Word repetition
   - Relative clause production

3. Third session:
    - Sentence repetition
    - Relative clause comprehension

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" at 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 their purpose. After this preliminary session, children with normal hearing 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.

Children with cochlear implants were tested by their speech therapists and the author during their individual speech therapy sessions. With them, the puppets were not used.

LIS signers with hearing impairment were tested at their residential school, in afternoon hours.

All tasks were administered through the oral modality to all participants, except to LIS signers since these participants were not trained to lip-reading and oral administration would have been extremely problematic. To LIS signers, all tasks were administered in the written modality by presenting each trial on separate strips of paper. For children with cochlear implants, the tasks were administered without the experimenter's mouth concealed by his/her hands. In this way, children could also rely on lip-reading.[8] When the trials were not perfectly heard, they were read once again.

Test instructions were presented orally to all participants, except to LIS signers. To LIS signers, instructions were signed by the experimenter. However, LIS was never used to support the administration of experimental trials.

Several comparisons were carried out between the different populations of individuals with hearing impairment and individuals with normal hearing. Children with cochlear implants were compared to children with normal hearing matched on language and grammar abilities in the repetition, comprehension, and production tasks. LIS signers were compared with children and adolescents with normal hearing in the repetition and comprehension tasks; children, ado-

8 This choice was due to the fact that exercises performed with the experimenter's mouth hidden by his hands mainly assess hearing and acoustic skills. My aim was instead to assess linguistic competence.

lescents, and adults with normal hearing were compared in relative clause comprehension and production. Children and adolescents were also compared in the repetition tasks.

Before beginning data collection, a short presentation of the experiment and a written consent were distributed to the parents of all participants (for both participants with hearing impairment and participants with normal hearing). Participants who had reached the age of majority were also asked to sign the written consent. Only the participants for whom we received the consent form back duly signed were included in the experiment.

In addition, in order to make sure that the 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 analysis.

2.12 Conclusion

In this chapter, the rationale behind the construction of the tasks and the development of the experiment has been offered through the presentation of the characteristics of relative clauses and the characteristics of the trials used to assess relative clauses, a short description of all the tasks proposed to the participants, the different populations that were involved in the experiment, and the way in which data were collected.

These pieces of information will be helpful to better understand the following chapters, in which a detailed analysis of comprehension, production, and repetition are offered for the different populations.

3 The comprehension of relative clauses

Summary 3.1 Introduction. – 3.2 The comprehension of relative clauses by Italian-speaking populations. – 3.3 Number Feature manipulation and intervention effects in relative clause acquisition. – 3.4 The comprehension of right-branching relative clauses. – 3.4.1 The comprehension task. – 3.4.2 Results. – 3.4.3 The comprehension of ambiguous sentences: subject vs. object reading. – 3.4.4 The distribution of incorrect responses in the comprehension task. – 3.4.5 The manipulation of number features in object relatives: discussion of results. – 3.4.6 The asymmetry between ORs and ORps. – 3.5 The comprehension of relative clauses by individuals with hearing impairment. – 3.6 The comprehension of relative clauses in Italian-speaking children with cochlear implants. – 3.6.1 The pilot study. – 3.6.2 The manipulation of number features in the comprehension of relative clauses: a new study on children with cochlear implants. – 3.6.3 Discussion of findings on children with cochlear implants.

3.1 Introduction

This chapter discusses data on the comprehension of relative clauses and the results obtained from the different populations of children, adolescents, and adults with normal hearing and populations of children and adolescents with hearing impairment.

The comprehension of restrictive relative clauses has been at the core of much linguistic and psycholinguistic research since the seventies across different languages and different populations: typically developing children (a.o., for English, De Villiers et al. 1979; Kidd, Bavin 2002; Sheldon 1974; Tavakolian 1981; for Italian: Arosio, Adani, Guasti 2005, 2009; Adani 2011; Adani et al. 2010; Volpato 2010b; 2012; Contemori, Belletti 2013; for Hebrew: Friedmann, Novogrodsky 2004; Arnon 2005; Friedmann, Belletti, Rizzi 2009; for German:

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Adani et al. 2012), children with developmental language disorders (a.o., for English: Adams 1990; Adani et al. 2014; for Italian: Contemori, Garraffa 2010; for Greek: Stavrakaki 2001; Stavrakaki, Tasioudi, Guasti 2015; for Hebrew: Friedmann, Novogrodsky 2004; 2007), aphasic patients (Grillo 2008; Garraffa, Grillo 2008, for Italian), and individuals with hearing impairment (a.o., for English: Quigley, Smith, Wilbur 1974; Engen, Engen 1983; for Italian, Volpato 2010b, 2012, Volpato, Adani 2009, D'Ortenzio 2019; for German: Ruigendijk, Friedmann 2017; for Hebrew, Friedmann, Szterman 2006; for Palestinian Arabic, Friedmann, Haddad-Hanna 2014). All these studies brought to light a common pattern of performance; namely subject relatives are easier to comprehend than object relatives.

The earliest studies on the comprehension of relative clauses by typically developing children date back to mid-seventies (Sheldon 1974), and proved that at the age of six, children's mastery of these structures is still problematic. Children lack adults' competence to comprehend relative clauses, because they do not have access to the recursive rules necessary for building embedded structures and, for this reason, they mainly interpret relative clause like conjoined structures, in which the relative operator *that* (the pig bumps into the horse ***that*** jumps over the giraffe) was considered a conjunction (The pig bumps into the horse ***and*** jumps over the giraffe) (Conjoined-clause analysis, Tavakolian 1981).

Subsequent studies (Goodluck, Tavakolian 1982; Hamburger, Crain 1982) argued instead that children do have adult competence and do have recursion rules, and emphasized the need to create proper experimental settings to adequately measure the acquisition of relative clauses. Relative clauses are intrinsically complex due to the presence of long-distance dependencies between sentence constituents and to the number of arguments that receive a thematic role in the sentence. The presence of transitive verbs and animate referents may increase the processing load. Simplifying the sentence, for example using intransitive verbs (*The pig bumps into the horse that hops up and down*), accuracy increases. Indeed, when felicity conditions are met and disturbing factors are removed from the experimental setting, children's performance may improve significantly.

Bearing these suggestions in mind, a number of studies have focused on the development of new tools to adequately test relative clauses in children and adults with typical and atypical language development. In the next section, I present the relevant literature on the acquisition of relative clauses in Italian.

3.2 The comprehension of relative clauses by Italian-speaking populations

Using a binary picture selection task, Arosio et al. (2009) investigated the comprehension of subject and object right-branching relative clauses in 5-7-9-11 year-old Italian-speaking typically developing children. They tested three conditions which yield an unambiguous reading: subject relatives (41), object relatives with preverbal subjects (42), and object relatives with postverbal subjects (43):[9]

(41) Fammi vedere lo gnomo che <lo gnomo> dipinge i bambini (SR)
'Show me the dwarf that <the dwarf> is painting the children'

(42) Fammi vedere lo gnomo che il bambino dipinge <lo gnomo> (OR)
'Show me the dwarf that the child is painting <the dwarf>'

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

Object relatives were disambiguated by either the preverbal position of the embedded subject (same (singular) number features on both the head and the embedded DPs) or number agreement between the embedded verb and the postverbal DP subject (singular features on the head DP and plural features on the embedded DP). Subject relatives were almost at ceiling already at the age of 5. The comprehension of object relatives with preverbal subjects was around 70% at the age of 5 and accuracy gradually increased with increasing age. At the age of 11, accuracy approached 100%. The lowest accuracy scores for all age groups were found on object relatives with postverbal subjects. At the age of 5, the percentage of correct answers was between 25% and 30%. The percentage approached 50% at the age of 7 and 9, and significantly increased at the age of 11 (about 80%), age at which the comprehension of this relative clause conditions almost reached a level comparable to adult performance.

Adani (2008; 2011) tested the three same conditions in right-branching relative clauses through a referent selection task, in which children were asked to point to the correct referent out of

9 As pointed out in chapter 2, subject and object relative clauses differ with respect to the position from which movement takes place. In subject relatives, the head moves from the embedded subject position (cf. (41)) whereas in object relatives, it moves from embedded object position (cf. (42) and (43)). The constituents in < > occupy the original position from which the head is extracted.

three possible choices.[10] In addition to the type of task, the study by Adani (2008; 2011) is different from Arosio et al. (2009) in the characteristics of the trials proposed to the participants. In Adani (2008; 2011), the relative clause head DP is always singular, and the embedded DP is always plural for all sentence conditions: SR (44), OR (45), and ORps (46):

(44) Indica il cavallo che sta inseguendo i leoni — SR
'Point to the horse that is chasing the lions'

(45) Indica il cavallo che i leoni stanno inseguendo — OR
'Point to the horse that the lions are chasing'

(46) Indica il cavallo che stanno inseguono i leoni — ORp
point to the horse that are chasing the lions
'Point to the horse that the lions are chasing'

In Adani (2008; 2011), object relative clauses with preverbal embedded subjects (ORs) were disambiguated through both syntactic (position) and morphological (agreement) cues. By testing 3-to-7-year-old monolingual Italian-speaking children, she replicated the gradient of accuracy (SR>OR>ORp) found by Arosio et al. (2009). However, children were more accurate in this task: SRs were almost at ceiling (91%) by the age of 4; ORs were 53% correct between the age of 3 and 4, then accuracy increased to 83% between the age of 4 and 5 and 89% between the age of 7 and 7;9; ORp are problematic for all age groups (from 3;4 to 6;11, with accuracy between 36% and 55%); only for children ranging in age from 7 to 7;9, accuracy was 70%.

Contemori and Belletti (2013) focused on the comprehension of object relatives in Italian-speaking children aged between 6;5 and 8;10, using a different task, namely the adapted version of the binary picture matching task developed by Friedmann and Novogrodsky (2004) to test relative clauses in Hebrew-speaking children. Specifically, they investigated the comprehension of the different answering strategies that children provide when relative clauses are elicited (see chapter 4). The different test conditions they investigated are summarized in (47)-(51):

(47) Mostrami la bambina che la giraffa lava
"Show me the child that the giraffe is washing"

10 This same task was used to test the comprehension of relative clauses by children with hearing impairment wearing cochlear implants (Volpato, Adani 2009). A detailed presentation of the test along with the results from these participants are offered in section 3.6.1.

(48) Mostrami la bambina che la giraffa *la* lava
Show me the child that the giraffe her-CL is washing
Show me the child that the giraffe is washing her

(49) Mostrami la bambina che si fa lavare dalla giraffa
"Show me the child that makes herself wash by the giraffe"

(50) Mostrami la bambina che è lavata dalla giraffa
"Show me the child that is washed by the giraffe"

(51) Mostrami la bambina lavata dalla giraffa
"Show me the child washed by the giraffe"

In this task, the two DPs displayed the same number features. In addition to relative clauses with the causative (49) and the passive constructions (50)-(51), only object relatives with preverbal subjects were considered, with either gaps (47) or resumptive clitic pronouns (48).[11]

The authors found that accuracy in object relatives with gaps in children aged 6;5 and 8;10 is 64%. Object relatives with resumptive clitic pronouns are more accurate than object relatives with gaps (between 66% and 77%), especially between the age of 8 and 9.

Different approaches were used to explain the asymmetry between subject and object relatives. Among them is the Minimal Chain Principle (De Vincenzi 1991), according to which the syntactic parser tries to place a gap as soon as possible, in order to build the shortest possible chain between the position in which the moved element is pronounced and the position in which it is interpreted (where it leaves a trace, marked by <e>). As a consequence, shorter dependencies (52) are less demanding than longer ones (53).

(52) Indica la tartaruga$_1$ [che <e>$_1$ sta inseguendo i pesci]
Point to the turtle$_1$ [that <e>$_1$ is chasing the fish.PL]

(53) Indica la tartaruga$_1$ [che i pesci stanno inseguendo <e>$_1$]
Point to the turtle$_1$ [that the fish.PL are chasing <e>$_1$]

The human parser is led to the shortest dependency analysis. Therefore, a subject reading is more immediate than an object reading. A subject relative is easier to compute since the gap is in subject position, and therefore the chain between the relative head and the gap

11 As we will see in chapter 4, when we analyse the production data, children sometimes produce object relatives containing resumptive clitic pronouns. Resumptive relatives are reported to be non-standard forms to be distinguished from 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).

is very short. In object relatives, instead, the chain is long, and the presence of the embedded subject forces the parser to abandon the subject reading and start re-analysis. In object relatives with postverbal subjects (54), the trace with which the relative head is coindexed is placed in the embedded postverbal position, thus establishing a longer relation than in subject relatives. In this case, a second chain is present, the one between the postverbal subject and the empty category in the canonical subject position (Rizzi 1982; 1986):

(54) Indica la tartaruga$_1$ [che *pro*$_2$ stanno inseguendo i pesci$_2$ <e>$_1$]
Point to the turtle$_1$ [that *pro*$_2$ are chasing the fish.PL$_2$ <e>$_1$]
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.

More recent approaches (Grillo 2008; Garraffa, Grillo 2008; Friedmann, Belletti, Rizzi 2009) explained the asymmetry between subject and object relatives in terms of the Relativized Minimality principle (Rizzi 1990; 2004a; Starke 2001). Relativized Minimality (RM, henceforth) is a principle of locality which rules relationships in configurations like (55):

(55) …X…Z…Y…

Considering Y as the first merge position and X as the position in which the constituent is finally uttered, this principle states that the local relation between X and Y is blocked because an intervening constituent, Z, represents a more local candidate for the relation. RM effects arise when the intervener is structurally similar to the element that has moved (Rizzi 2001), namely when they 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 (56) shows:

(56) a. *Argumental:* person, gender, number, case
b. *Quantificational: wh-*, Neg, measure, focus
c. *Modifiers:* evaluative, epistemic, Neg, frequentative, manner, etc.
d. *Topic*

To the aim of the present discussion, only Argumental and Quantificational features are considered. Following Adani (2008) and Volpato and Adani (2009), the R feature relevant for relative clauses is added to the set of Quantificational features.

The following example showing the non-extractability of certain *wh-* elements out of indirect questions can help make the RM principle clear:

(57) *How do you wonder who behaved <how>?
Q/wh Q/wh Q/wh
X Z Y

In (57), it is not possible to establish a relationship between Y and X, because the element Z (*who*) displays the same features (*wh-* feature) as X and Y. Movement is therefore blocked. Now let us consider the following grammatical sentence:

(58) How do you think John behaved <how>?
Q/wh A/NP Q/wh
X Z Y

In (58), the intervening element *John* has a featural specification different from the element that moves. The constituents belong to different structural classes and, consequently, movement of *how* to the left-periphery is not hindered.

In object relative clauses, the relative head, which is endowed with the R and NP features, can be extracted from the original merge position, as the grammaticality of the example in (59) shows:

(59) Show me the horse that the lions are chasing <the horse>
R+NP NP R+NP

Based on data from Hebrew-speaking children, Friedmann, Belletti, and Rizzi (2009) suggested that in adult and mature grammars, the different (although partially overlapping) specification of features in the different sentence constituents is a sufficient condition to correctly interpret object relatives. In child and immature grammars, a more rigid version of RM is at play. Indeed, even a partial feature overlap (the NP lexical restriction) may cause difficulties to the correct interpretation of object relatives. A configuration which is comprehended without difficulties is the one in which the element which moves and the element which intervenes do not share any features:

(60) Tare li et mi she-ha-yeled menadned.
Show to-me ACC who that-the-boy swings
'Show me the one that the boy is wetting.'

By manipulating the referential properties of the intervening element, the difficulty associated with object relatives decreases.

In subject relatives, as the sentence shown in (61), RM is not at play.

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

In subject relative clauses, RM effects do not occur given the absence of an intervening element blocking the relation between the position occupied by the moved subject (relative head) and the original embedded position.

The proposal by Friedmann, Belletti, and Rizzi (2009) has been further explored and refined by several studies dealing with different populations and different languages. In particular, the role of different linguistic features (among them, number, gender, and animacy) was investigated in order to determine to what extent these features modulate the comprehension and the production of relative clauses (for Italian, Adani et al. 2010; Arosio, Guasti, Stucchi 2011; Belletti et al. 2012; Volpato 2012; Adani et al. 2014). In the next section, I focus on the studies highlighting the role of number features.

3.3 Number Feature manipulation and intervention effects in relative clause acquisition

Friedmann, Belletti, and Rizzi (2009) proposed that the nominal feature NP present in both the target position and the intervener position in object relatives with preverbal subjects may be difficult for a child grammar, for which even a partial featural overlap may hinder the correct computation of object relatives. Building on Friedmann, Belletti, and Rizzi (2009) and following theoretical proposals on the way number features are projected in clause structure, a more refined version of the intervention approach was proposed in Adani et al. (2010) and Volpato (2010b; 2012).

As for the representation of number information, several studies (Ritter 1991; 1993; 1995; Picallo 1991; 2008; Bernstein 2001; Ferrari 2005) have assumed the presence of a functional head where Number features are checked (NumP) (see chapter 2). Following these proposals, Adani et al. (2010) proposed a picture matching comprehension task assessing centre-embedded object relatives in which number features were manipulated on both DPs of the relative clause.[12] Italian-speaking typically developing children aged 5, 7 and 9 years were tested. The conditions that were tested are shown in (62): sen-

12 Adani et al. (2010) also investigated the comprehension of object relatives through the manipulation of gender features. However, for the sake of this work, only research concerning number features is considered.

tences in which the DPs were matched in terms of number features (match condition (62a-b)) and sentences in which the DPs displayed different number features (mismatch condition (62c-d)).

(62) a. Il leone che il gatto sta toccando è seduto per terra.
'the lion-SG that the cat-SG is touching is sitting-SG
b. I coccodrilli che i cammelli stanno toccando sono seduti per terra.
'the crocs-PL that the camels-PL are touching are sitting-PL
c. Il leone che i coccodrilli stanno toccando è seduto per terra.
'the lion-SG that the crocs-PL are touching is sitting-SG'
d. I coccodrilli che il leone sta toccando sono seduti per terra.
'the crocs-PL that the lion-SG is touching are sitting-PL'

Table 2 summarizes the results for each age group in the match and mismatch conditions.

Table 2 Percentages of accuracy by age group and number condition (M=Match, MM= Mismatch). (adapted from Adani et al. 2010)

Number condition	G5 (N=15)	G7 (N=18)	G9 (N=17)
M	41%	79%	85%
MM	64%	88%	95%

In Adani et al. (2010), accuracy is much higher when object relatives are proposed in the mismatch condition. Accuracy increases with increasing age, and at the age of 9, the comprehension of object relatives in the mismatch condition is almost at ceiling. Based on these results, Adani et al. (2010) have claimed that it is the feature set associated to the DPs that modulates the comprehension of object relative clauses. When the DPs are different in terms of number features (mismatch condition), intervention is reduced, and comprehension improves:

(63) a. D[Num+pl [NP]] that (R) D[Num-pl]] <D[Num+pl [NP]]>
b. D[Num-pl [NP]] that (R) D[Num+pl]] <D[Num-pl [NP]]>

In the presence of similar number features (match condition), intervention effects occur, and accuracy is reduced:

(64) a. D[Num-pl [NP]] that (R) D[Num-pl]] <D[Num-pl [NP]]>
b. D[Num+pl [NP]] that (R) D[Num+pl]] <D[Num+pl [NP]]>

The same conclusion for object relative clauses with preverbal subjects was drawn by Volpato (2010b) from the results obtained by groups of typically developing children, adolescents, and adults on a task in which

the comprehension of right-branching relative clauses was assessed. In the next sections, I present the comprehension task and the results of the comparison between children, adolescents, and adults in detail.

3.4 The comprehension of right-branching relative clauses

Whereas Adani et al. (2010) tested centre-embedded object relative clauses with preverbal subjects, Volpato (2010b) investigated the comprehension of right-branching relative clauses. In addition to object relatives with preverbal subject DPs, number features were also manipulated in subject relatives and in object relatives with postverbal subjects. The following sections present a detailed description of the material developed for relative clause assessment in Volpato (2010b) and the rationale behind the choice of a task designed in such a way.

3.4.1 The comprehension task

The comprehension task was inspired by previous studies that adopted picture matching tasks (Friedmann, Novogrodsky 2004; Friedmann, Szterman 2006) and referent selection tasks (Arnon 2005; Adani 2008) to investigate relative clause comprehension. What differentiates a picture matching task from a referent selection task is that the former implies the choice between two pictures while the latter between three (Adani 2008) or four characters (Arnon 2005).

Presenting children with two pictures on each trial (as Friedmann, Novogrodsky 2004 and Friedmann, Szterman 2006 did) sets chance performance at 50%, but it reduces the processing load deriving from keeping in mind a long sentence and detecting the correct response. Presenting children with three or four pictures on each trial offers some statistical advantages since chance performance is 33% or 25%, respectively, thus increasing the experimenter's ability to detect non-random behaviour. The processing load is however very high.

In a referent selection task, the participant listens to a sentence and must 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 my experiment by using an offline referent selection task, following the proposals by Arnon (2005),[13] 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%).

13 In Arnon (2005), experimental trials were introduced by the request "put a sticker on…".

In the comprehension task, two opposed scenes 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 reversed thematic roles. In this way, felicity conditions showing two instances for each DP head were fulfilled (Hamburger, Crain 1982). Figure 3 shows an example of an experimental sentence:

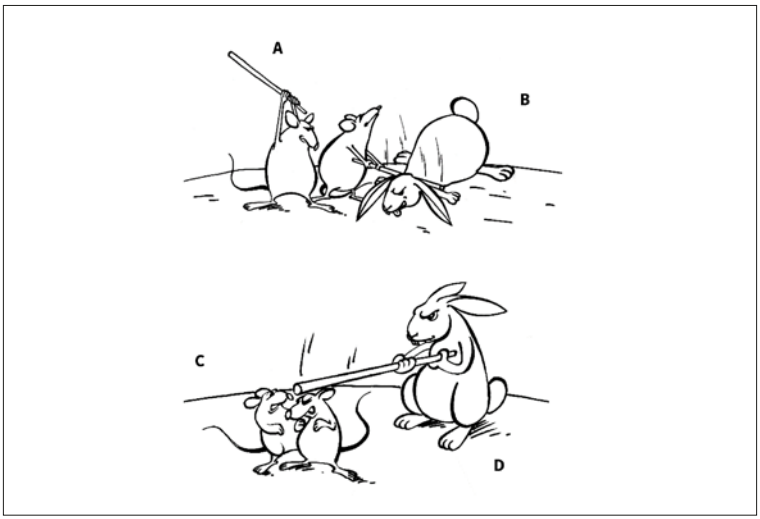


Figure 3 Experimental sentence 'Tocca il coniglio che colpisce i topi' (touch the rabbit that hits the mice)

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 80 items, namely 60 experimental trials and 20 filler sentences. The experimental trials presented 10 different sentence conditions, each including 6 items:[14]

14 In the examples, the first letters indicate the type of relative clause: AMB identifies ambiguous sentences, in which both a subject and an object reading are possible. SR is a subject relative with subject-verb-object word order (the head of the main clause is the subject of the embedded one); OR 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 subject is in preverbal position); ORp 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 subject is in the post-verbal position. The abbreviations SG, standing for 'singular', and PL, standing for 'plural', indicate the number features of the head DP and the number features of the embedded DP, respectively. For example, the abbreviation SR_

Ambiguous trials (AMB):

AMB_SG_SG	La mucca che spinge l'elefante 'The cow that pushes the elephant'
AMB_PL_PL	Le mucche che spingono gli elefanti 'The cows that pull the elephants'

Unambiguous subject relatives (SR):

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

Object relatives with preverbal subjects (OR):

OR_SG_SG	La mucca che l'elefante spinge 'The cow that the elephant pushes'
OR_PL_PL	Le mucche che gli elefanti spingono 'The cows that the elephants push'
OR_SG_PL	La mucca che gli elefanti spingono 'The cow that the elephants push'
OR_PL_SG	Le mucche che l'elefante spinge 'The cows that the elephant pushes'

Object relatives with postverbal subjects (ORp):

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

Filler sentences (F)

SVO	La capra che mangia il gelato 'The goat that eats the ice-cream'

SG_PL indicates that the sentence is a subject relative, in which the first DP is singular and the second DP is plural.

An example of filler sentence is shown in the following picture:

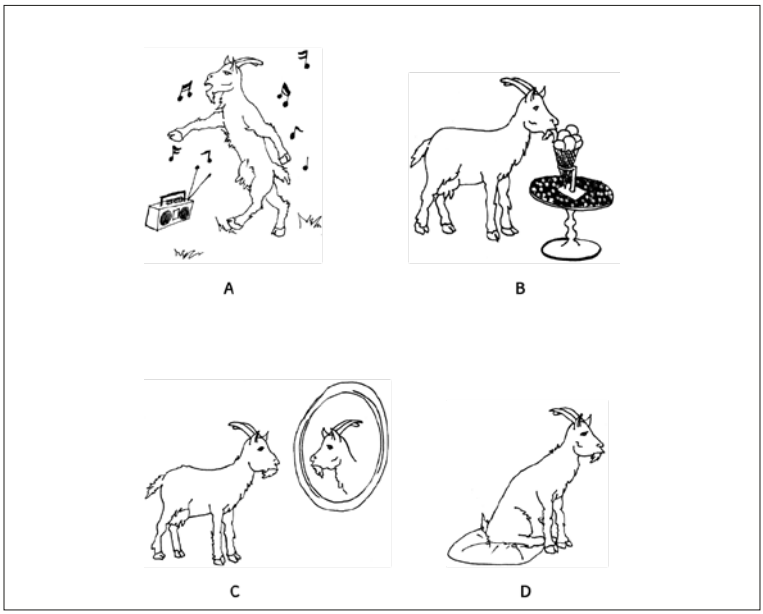


Figure 4 Filler sentence 'Tocca la capra che mangia il gelato' (touch the goat that eats the ice-cream)

The presentation of four referents made it possible to obtain from the participant one out of four responses, thus giving the possibility to gain a representation as detailed as possible of his/her underlying grammar. The answer possibilities varied according to the type of sentence proposed.

For subject relatives (SR – *Tocca il coniglio che colpisce i topi* 'Touch the rabbit that hits the mice'), it was possible to obtain the following answers (see Figure 3):

- the correct referent: D
- the reverse referent: B
- the 'other' referents: A and C

For object relatives (OR – *Tocca il coniglio che i topi colpiscono* 'Touch the rabbit that the mice hit' and ORp – *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 3, it was possible to obtain the following answers:

- the correct referent: B
- the reverse referent: D
- the agent referent (selection of the agent instead of the head): A
- the 'other' referent: C

The selection of the reverse referent suggests that the participant can understand that the relative clause modifies a referent (DP). However, he/she is unable to correctly assign the thematic role to the head DP. The agent error suggests that the participant is 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. He/she is however able to correctly assign thematic roles to the DPs.

For ambiguous sentences, such as *Tocca la pecora che lava il cavallo* 'Touch the sheep that washes the horse', both the sheep in the upper picture and the sheep in the below picture can be considered as correct answers.

Figure 5 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 referent: A and D
- the 'other' referent: B and C

In all trials, verbs are 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 individuals with hearing impairment. Each trial begins with *Indica* (point-to). 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 are semantically reversible. The experimental trials were controlled for length (both considering the number of syllables and the number of words). Most sentences are composed of 11 syllables and 6 words.[15] 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 appears 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 used in the task. The experimental part was preceded by a training part, to familiarize children with the items and the experimental setting, and to make sure that the instructions were correctly understood.

This referent selection task was administered to three groups of typically developing participants in order to compare their performance: 16 typically developing children (age range 5;3-7;5, mean age 6;5), 16 adolescents (age range 15-17;5, mean age: 15;5), and 16 adults (age range 19-33, mean age: 24). What is important to highlight in this comparison is that adolescents represent an independent group. In previous studies on the acquisition of relative clauses (Utzeri 2006; 2007), adolescents were considered as competent as adults, and were therefore included in the group of adult participants. However, the study conducted by Carpenedo (2009) demonstrated that in some cases, the competence of adolescents does not fully pattern with that of adults, still presenting some characteristics typical of 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 in comprehension.

15 Five sentences contained 12 syllables.

3.4.2 Results

The number and the percentage of correct responses for the three groups of typically developing participants are shown in Table 3:

Table 3 Percentage of correct answers for each group in each sentence condition

		Groups						
Sentence conditions		**Children**		**Adolescents**		**Adults**		**Mean**
AMB	AMB_SG_SG	91/96	95%	95/96	99%	96/96	100%	**98%**
	AMB_PL_PL	93/96	97%	93/96	97%	96/96	100%	**98%**
SR	SR_SG_PL	89/96	93%	96/96	100%	96/96	100%	**98%**
	SR_PL_SG	88/96	92%	96/96	100%	96/96	100%	**97%**
OR	OR_SG_SG	57/96	59%	80/96	83%	95/96	99%	**80%**
	OR_PL_PL	60/96	63%	87/96	91%	96/96	100%	**85%**
	OR_SG_PL	70/96	73%	92/96	96%	96/96	100%	**90%**
	OR_PL_SG	62/96	65%	93/96	97%	96/96	100%	**87%**
ORp	ORp_SG_PL	47/96	49%	93/96	97%	96/96	100%	**82%**
	ORp_PL_SG	37/96	39%	86/96	90%	96/96	100%	**76%**
Mean		**72,3%**		**94,9%**		**99,9%**		

Generalized linear mixed-effect (GLME) models employing the statistical software R (R Development Core Team 2018) were used to carry out between-group and within-group analyses. Results are presented in the following subsections.

3.4.2.1 Between-group analysis

The group of adults performed at ceiling. The groups of adolescents and children sometimes selected the incorrect referent. Overall, the group of children appears to be the group experiencing the greatest difficulties in the interpretation of the different sentence conditions. A significant difference is observed between the group of children and the groups of both adolescents (Wald $Z=5.836$, $p<.001$) and adults (Wald $Z=6.247$, $p<.001$). The difference between adolescents and adults is also significant (Wald $Z=3.960$, $p<.001$).

In ambiguous sentences (AMB), the percentages of correct responses are very high for all groups. Adults showed a ceiling performance. Children and adolescents also showed high percentages of accuracy, although lower than adults did. However, no significant differences were observed between the groups in this sentence type.

In subject relatives (SR), percentages of accuracy are very high as well. Adolescents and adults performed at ceiling, while children

made some errors. Despite some few errors, between-groups analyses did not reveal any significant difference between the groups.

Object relatives with preverbal subjects (OR) were not problematic for adults. Both adolescents and children made some errors, but the lowest percentages of accuracy were found in the group of children. The analysis showed that children performed significantly worse than adolescents in the comprehension of object relatives with preverbal subjects (in OR_SG_SG, p=.012, in OR_PL_PL, p=.001, in OR_SG_PL, p=.024, and in OR_PL_SG, p<.001).

In object relatives with postverbal subjects (ORp), children achieved the lowest scores. A between-group analysis detected a significant difference between the group of adolescents and the group of children for both sentence conditions (p<.001).

3.4.2.2 Within-group analysis

Within-group analyses were carried out within each group of typically developing participants.

In the group of children, the variable Sentence Type contributed to the fit of the model ($\chi^2(3) = 82.072$, p<.001). Estimated coefficients, standard errors, Z-values and associated p-values for the Sentence Condition factor are summarized in Table 4.

Table 4 Estimated coefficients, standard errors, Z-values and associated p-values for the Sentence Condition factor in the group of children

Sentence Type	Estimate	SE	Z	p
AMB – SR	-0.749	0.5492	-1.364	.173
AMB – OR	-3.196	0.4779	-6.688	<.001
AMB – ORp	-4.449	0.5243	-8.486	<.001
SR – OR	-2.447	0.4072	-6.010	<.001
SR – ORp	-3.700	0.4592	-8.058	<.001
OR – ORp	-1.253	0.3175	-3.946	<.001

No significant difference was found between ambiguous sentences (AMB) and subject relatives (SR). AMB were significantly more accurate than object relatives with both preverbal (OR) and postverbal subject (ORp). SR were significantly more accurate than OR and ORp. OR were significantly more accurate than ORp.

Considering the OR sentence type, lower accuracy is observed in the match conditions as opposed to the mismatch conditions. However, no significant difference is observed between match and mismatch conditions.

In the group of adolescents, the variable Sentence Type contrib-

uted to the fit of the model ($\chi^2(3)$ =17.743, p<.001). Estimated coefficients, standard errors, Z-values and associated p-values for the Sentence Condition factor are summarized in Table 5.

Table 5 Estimated coefficients, standard errors, Z-values and associated p-values for the Sentence Condition factor for the group of adolescents

Sentence Type	Estimate	SE	Z	p
AMB – SR	0.744	1.0221	0.728	.47
AMB – OR	-1.434	0.7065	-2.030	<.04
AMB – ORp	-1.177	0.7877	-1.487	<.137
SR – OR	-2.186	0.8705	-2.511	<.01
SR – ORp	-1.921	0.9369	-2.051	<.04
OR – ORp	0.2631	0.5752	0.457	<.65

No significant difference was found between ambiguous sentences (AMB) and subject relatives (SR). AMB were significantly more accurate than SR, object relatives with both preverbal (OR) and postverbal embedded subjects (ORp). SR were significantly more accurate than OR and ORp. OR were significantly more accurate than ORp.

Considering the OR sentence type, lower accuracy is observed in the match conditions as opposed to the mismatch conditions, and a significant difference is observed between match and mismatch conditions (Wald Z= 2.170, p=.03).

In the group of adults, percentages are at ceiling in all sentence types and therefore the variable sentence type did not contribute to the fit of the model ($\chi^2(3)$ = 3.2231, p<.3585).

3.4.3 The comprehension of ambiguous sentences: subject vs. object reading

For each ambiguous condition, I calculated the percentages of sentences interpreted either as subject or object relatives by each group, when participants provided the correct response. Results are reported in Table 6:

Table 6 Percentage of subject (SR) and object (OR) interpretations for each ambiguous sentence condition

	AMB_SG_SG			AMB_PL_PL		
	SR	***OR***	***AMB.***	***SR***	***OR***	***AMB.***
Children	98%	2%	0%	85%	15%	0%
Adolescents	98%	1%	1%	96%	1%	3%
Adults	96%	0%	4%	92%	4%	4%
Mean	**97%**	**1%**	**2%**	**91%**	**7%**	**2%**

From Table 6, 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, confirming the tendency to posit a gap as soon as possible, hence in embedded subject position (De Vincenzi 1991). In some cases, the head was 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. For ambiguous sentences with plural DPs, once again the percentage of subject interpretations is higher than the percentage of object interpretations.

3.4.4 The distribution of incorrect responses in the comprehension task

Tables 7-9 show the type of incorrect responses that children, adolescents, and adults, respectively, provided in each sentence condition:

Table 7 Type of incorrect responses provided by children in each sentence condition

	Reversible		Agent		Other	
AMB_SG_SG					5/96	5%
AMB_PL_PL					3/96	3%
SR_SG_PL	4/96	4%			3/96	3%
SR_PL_SG	2/96	2%			6/96	6%
OR_SG_SG	20/96	21%	18/96	19%	1/96	1%
OR_PL_PL	18/96	19%	17/96	18%	1/96	1%
OR_SG_PL	7/96	7%	18/96	19%	1/96	1%
OR_PL_SG	8/96	8%	26/96	27%	0/96	0%
ORp_SG_PL	31/96	32%	13/96	14%	5/96	5%
ORp_PL_SG	48/96	50%	9/96	9%	2/96	2%

Table 8 Type of incorrect responses provided by adolescents in each sentence condition

	Reversible		Agent		Other	
AMB_SG_SG					1/96	1%
AMB_PL_PL					3/96	3%
SR_SG_PL	0/96	0%			0/96	0%
SR_PL_SG	0/96	0%			0/96	0%
OR_SG_SG	13/96	14%	3/96	3%	0/96	0%
OR_PL_PL	7/96	7%	2/96	2%	0/96	0%
OR_SG_PL	2/96	2%	2/96	2%	0/96	0%
OR_PL_SG	0/96	0%	3/96	3%	0/96	0%
ORp_SG_PL	1/96	1%	1/96	1%	1/96	1%
ORp_PL_SG	7/96	7%	3/96	3%	0/96	0%

Table 9 Type of incorrect responses provided by adults in each sentence condition

	Reversible		Agent		Other	
AMB_SG_SG					0/96	0%
AMB_PL_PL					0/96	0%
SR_SG_PL	0/96	0%			0/96	0%
SR_PL_SG	0/96	0%			0/96	0%
OR_SG_SG	1/96	1%	0/96	0%	0/96	0%
OR_PL_PL	0/96	0%	0/96	0%	0/96	0%
OR_SG_PL	0/96	0%	0/96	0%	0/96	0%
OR_PL_SG	0/96	0%	0/96	0%	0/96	0%
ORp_SG_PL	0/96	0%	0/96	0%	0/96	0%
ORp_PL_SG	0/96	0%	0/96	0%	0/96	0%

In the group of children, there is more 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, as already shown in the section 3.4.2. In the match conditions (OR_SG_SG and OR_PL_PL), children seemed to randomly select either the 'Agent' or the 'Reversible' referent. In the mismatch conditions (OR_SG_PL and OR_PL_SG), they showed a clear preference for the agent error.[16] Most incorrect responses were found in the ORp sentence conditions, for which the 'Reversible' character showed the highest percentage of selections in most cases.

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

The adolescents achieved high scores in all sentence conditions, although they experienced some difficulties with the conditions involving movement from the embedded object position. The OR_SG_SG sentence condition appeared to be the most problematic one; in most cases, the adolescent students selected the 'Reversible' referent. The 'Reversible' referent was also the preferred choice in the OR_PL_PL and ORp_PL_SG sentence conditions.

The group of adults performed at ceiling in all sentence conditions. The only incorrect response was found in the OR_SG_SG condition, for which one participant selected the 'Reversible' referent.

3.4.5 The manipulation of number features in object relatives: discussion of results

In the previous sections, I have presented data and analyses on the comprehension of right-branching relative clauses in Italian-speaking typically developing children, adolescents, and adults.

The first aspect that is worth mentioning is that differently from previous studies (e.g. Utzeri 2006; 2007), data from typically developing adolescents are kept separate from adults' results. In most studies, adolescents are considered as competent as adults, but the analysis shown above makes it evident that their performance is not yet adult-like. For both children and adolescents, the typical asymmetry between subject and object relatives can be explained along the lines suggested by Friedmann, Belletti, and Rizzi (2009).

Furthermore, the manipulation of number features has made it possible to highlight that in right-branching ORs, the mismatch conditions have higher percentages of accuracy than the match conditions, replicating the results by Adani et al. (2010) for centre-embedded relative clauses.[17]

Based on these findings and following the same line of reasoning as Friedmann, Belletti, and Rizzi (2009), Volpato (2010b; 2012) claimed for right-branching relative clauses that it is the feature set associated to the DPs that modulates the comprehension of object relative clauses. When the DPs are different in terms of number features (mismatch condition), intervention is reduced, and comprehension is facilitated.[18]

17 In the group of adults, only one incorrect selection was observed, and it occurred in the match condition.

18 The abbreviation in square brackets indicates number features associated to each constituent. [-pl] means that the element bears singular features, and [+pl] indicates that it bears plural features.

(65) La gallina che i pulcini beccano <la gallina>
The hen that the chicks peck <the hen>
[-pl] [+pl] [-pl]
|_____ok_____|

(66) Le galline che il pulcino becca <le galline>
The hens that the chick pecks <the hens>
[+pl] [-pl] [+pl]
|_____ok_____|

Not only different number features increase accuracy. Overall (and especially in the group of children), comprehension in the mismatch condition OR_SG_PL (65) is even more facilitated because more cues are available. Two plural forms are linearly close to each other, namely the embedded subject and the agreeing verb, and the NumP projection is present in the (embedded) clause structure (Ferrari 2005; Volpato 2008; 2010a):[19]

(67) La gallina che i pulcini beccano <la gallina>
the hen that the chicks peck <the hen>
[-pl] [+pl] [-pl]
[$_{CP}$… [$_{DP…}$ [$_{NumP…}$ [$_{NP…}$]] verb]]

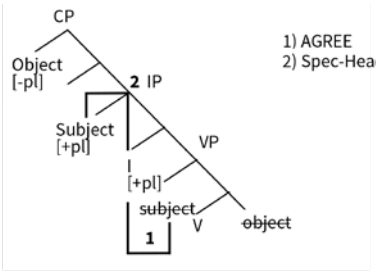
(68) Le galline che il pulcino becca <le galline>
the hens that the chick pecks <the hens>
[+pl] [-pl] [+pl]
[$_{CP}$… [$_{DP…}$ [$_{NP…}$]] verb]]

A double plural markedness, as that occurring in (65) and (67), implies more visibility. Plurality appears to drive correct interpretation.

Adopting the minimalist theory of Agreement (Chomsky 1995; 2000; 2001), and following Guasti and Rizzi (2002) and Franck et al. (2006), in ORs with plural subjects, redundancy of information is available for sentence interpretation as opposed to the other OR conditions, namely AGREE + Spec-Head agreement + [+pl(ural)] markedness in the Spec-Head configuration, as (69) shows:

19 As Ferrari (2005) and Volpato (2008; 2010a) have pointed out, the NumP projection is present only with plural features (see Chapter 2).

(69)



In the mismatch situation represented in (69), the rich configuration of agreement and the salience of Number features facilitate the correct assignment of thematic roles. However, the limited resources of the memory system may sometimes hinder the parsing of the whole sentence and somehow force children to choose the agent referent. As we will see in chapter 5, a positive significant correlation between comprehension of relative clauses and memory was found for typically developing children.

When number features are the same, a Minimality violation may occur, as in (70) and (71):

(70) La gallina che il pulcino becca <la gallina>
The hen that the chick pecks <the hen>
[-pl] [-pl] [-pl] [-NumP]
|_____no_____|

(71) Le galline che i pulcini beccano <le galline>
The hens that the chicks peck <the hen>
[+pl] [+pl] [+pl] [+NumP]
|_____no_____|

Interestingly, however, in the condition in which the NumP projection is present in the embedded subject DP (71), the percentages of accuracy are higher than when this projection is absent (70). When number 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.

In the course of language development, performance significantly improves. Comparing the three populations, it is evident that accuracy increases with increase in age. The percentages of correct responses provided by adolescent participants increase, although the performance is not adult-like yet. Most importantly, there seems to be a sort of continuity between the performance of children and that of

adolescents. Indeed, for both groups, the match conditions are problematic, but the insertion of NumP in the nominal structure implies more accurate performance.

3.4.6 The asymmetry between ORs and ORps

As shown in Table 3, typically developing children experienced considerable difficulties in interpreting object relatives with postverbal subjects (mean percentage: 44%), as opposed to object relatives with preverbal subjects (mean percentage 65%). In addition to that, the group of children significantly differed from the group of adolescents, showing poor performance in the ORp sentence conditions. For adolescents, the percentages of correct responses are quite high, although some errors are present in the ORp sentence conditions.

Consider now ORps from the point of view of RM. The sentence in (72):

(72) La gallina [che *pro*$_i$ beccano **i pulcini**$_i$ <la gallina>]
the hen [that *pro*$_i$ peck the chicks$_i$ < the hen>]
'The hen that the chicks peck'

involves a long chain between the expletive *pro* and the postverbal subject DP (Rizzi 1982; 1986). Preverbal *pro* intervenes between the relative head and the postverbal object DP. Hence, based on RM predictions, we might argue that *pro* causes the same intervention effects as those provoked by the preverbal embedded subject in ORs. The performance on the two types of object relatives would be expected to be similar, but on the contrary, children obtained lower scores on ORps than on ORs.

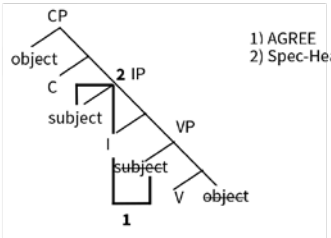
Friedmann, Belletti, and Rizzi (2009) argued that the source of difficulty for the comprehension of object relatives by Hebrew-speaking typically developing children was the presence of the lexical NP (lexical restriction) between the position from which the head is interpreted and the position in which it is pronounced. Indeed, they found that by manipulating the referential properties of the intervening element, the difficulty associated with object relatives decreased (see 3.2). For instance, the presence of *pro* did not cause any RM effect, and the sentence was correctly interpreted. ORps in Italian also contain a null pronoun *pro*. The nature of the two *pro*s is undoubtedly different. In Friedmann, Belletti, and Rizzi (2009), *pro* has an arbitrary interpretation, whereas in sentences like (72), *pro* is an expletive null pronoun. Despite this difference, expletive *pro* in (72) is not problematic per se and does not cause any RM effects. The source of the difficulty must be found elsewhere.

I suggest that the difficulty with ORps is due to the fragility of

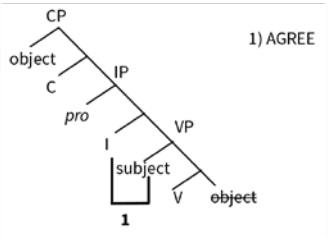
agreement occurring between the verb and the subject. By adopting the minimalist theory of Agreement (Chomsky 1995, 2000, 2001) and following Guasti and Rizzi's (2002) and Franck et al.'s (2006) assumptions (see chapter 2), in ORs, agreement checking occurs both under AGREE and in the Spec-Head configuration (73a). In these configurations, subject-verb agreement is robust because agreement is checked twice. In ORps, agreement is realized exclusively under (long-distance) AGREE (73b), and it is not strengthened by further agreement in the Spec-Head configuration. Checking of features only under AGREE is extremely fragile and especially taxing for young children. The higher percentages achieved in the ORp_SG_PL sentence condition with respect to the ORp_PL_SG sentence condition prove once again that the presence of NumP in the embedded subject facilitates the comprehension by all populations.

(73)

a. OR



b. ORp



Fragility of agreement places heavy load on the processing system, since the human parser is forced to keep plural morphology on the verb suspended, until the postverbal subject is encountered. Since the plural features displayed on the verb needs to be checked against the subject in postverbal position, the human parser presumably forces the syntactic reanalysis of ORp clauses, which are interpreted as SRs.

3.5 The comprehension of relative clauses by individuals with hearing impairment

Research on the comprehension of restrictive relative clauses has also been carried out on individuals with hearing impairment across different languages, showing that comprehension of these complex sentences is often problematic for this population. Most studies are concerned with hearing aid users or with more heterogeneous

groups, which included both hearing aid and cochlear implant users (Quigley, Smith, Wilbur 1974; Engen, Engen 1983; Friedmann, Szterman 2006; Friedmann et al. 2008; Friedmann, Haddad-Hanna 2014; Szterman, Friedmann 2014; 2015; Ruigendijk, Friedmann 2017). The first studies on the comprehension of relative clauses by a homogeneous group of (Italian-speaking) children with cochlear implants are Volpato and Adani (2009) and Volpato (2010b; 2012).

The early study carried out by Quigley, Smith, Wilbur (1974) investigated the comprehension of relative clauses by a group of individuals with hearing impairment ranging in age from 10 to 18 years. The task consisted in judging grammatical and ungrammatical items containing relative clauses and assessing the acceptance of sentences containing copies (resumptive DPs or resumptive pronouns), in sentences like (74):

(74) The man saw the boy who the boy kicked the ball

Results proved that overall, individuals with hearing impairment experienced difficulties in understanding relative clauses. They performed better on right-branching relative clauses, namely those modifying the object in final position, than on centre-embedded ones. However, in both cases, relative clauses with a gap in the subject position were easier than those with a gap in the object position. These researchers raised the question as to whether deaf individuals generate the same syntactic structures as hearing individuals do but at a delayed rate, or they generate some structures that never appear in the language of hearing individuals.

Friedmann and Szterman (2006) investigated the comprehension of right-branching subject and object relative clauses in 20 Hebrew-speaking children with hearing impairment ranging in age from 7;8 to 9;9 comparing their performance with a group of 10 younger normal hearing children (5;11-6;5). Overall the children with hearing impairment performed significantly worse than typically developing peers (68% vs. 86%). However, whereas their performance on subject relatives was quite intact, their performance on object relatives was significantly poorer than on subject relatives. Friedmann and Szterman (2006) attributed the difficulty experienced by children with hearing impairment to movement and to the several operations necessary to interpret long distance dependencies, namely the creation of a trace, the assignment of a thematic role to the trace, and the formation of a chain between the trace and the moved constituent. To find further support to the hypothesis that movement is problematic for children with hearing impairment, an experiment included in this study investigated relative clauses containing resumptive pronouns in the embedded object position (75), which is a possibility exploited by the Hebrew language in order to build grammatical

object relatives.

(75) Show me the girl that the nurse is photographing *her*.

The high percentage of accuracy in the comprehension of relative clauses containing resumptive pronouns is predicted by the proposal that the insertion of a resumptive pronoun involves the creation of a chain between the relative head position and the embedded object position without resorting to movement (Shlonsky 1992). Furthermore, Friedmann and Szterman (2006) found a strong correlation between linguistic performance and age of first intervention: children wearing a hearing device 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).

The asymmetry between subject and object relatives is also observed in a heterogeneous group of 24 Palestinian Arabic-speaking individuals with hearing impairment (age range 9;6-21) whose performance was compared with the performance of 10 normal hearing children aged 6 to 8 years (Friedmann, Haddad-Hanna 2014). The comprehension of relative clauses which maintain the canonical, unmarked order of constituents (agent-verb-theme) is more accurate than that of relative clauses with non-canonical word orders for the group of participants with hearing impairment. Importantly, differently from subject relatives, Palestinian-Arabic object relatives obligatorily include a resumptive pronoun in object position in both orders which are possible in this language, as the examples in (76) and (77) show.

(76) Show me the girl that the nurse is photographing-*her*.

(77) Show me the girl that is photographing-*her* the nurse.

For children with normal hearing, both subject and object relatives (in both orders) are at ceiling. In the group of participants with hearing impairment, accuracy is significantly lower in all structures. However, much difficulty is found in the comprehension of object relatives, which are significantly less accurate than subject relatives. The most problematic type of object relative is the one in which the embedded subject is postverbal. Differently from Hebrew-speaking children with hearing impairment, the Palestinian Arabic participants do not rely on resumptive pronouns in the interpretation of (object) relatives.

The different behaviour of the two populations of individuals with hearing impairment speaking Hebrew and Palestinian Arabic must be traced back to some linguistic properties of the two languages.

Both languages allow the use of resumptive pronouns in object relatives. However, resumption is an optional strategy in Hebrew, exploited by children but not by adults, who instead prefer a structure without resumptive elements. In Palestinian Arabic, resumptive pronouns must be obligatorily expressed when producing an object relative. Furthermore, resumptive pronouns have a different status in the two languages. Whereas they are strong pronouns in Hebrew, they are clitic pronouns in Palestinian Arabic. In Hebrew, they are inserted in clause structure to rescue the derivation of sentences in which movement is blocked. The hypothesis for this language is that the presence of resumptive (strong) pronouns does not imply movement, whereas clitic pronouns in Palestinian Arabic are functional elements that bear a theta-role and obligatorily involve movement. Since individuals with hearing impairment have difficulties with sentences involving movement, they cannot rely on resumptive clitic pronouns when interpreting object relatives (Friedmann, Costa 2011).

As we will see in 4.12, Italian-speaking children with hearing impairment and cochlear implant (as well as children with normal hearing) also use the resumptive strategy, by adding clitic pronouns when producing object relatives.

Using the task developed for Hebrew and Palestinian Arabic, Ruigendijk and Friedmann (2017) tested the comprehension of subject and object relative clauses in 19 German-speaking children with hearing impairment (age range 9;5-13;6), in comparison with a group of age-matched children with normal hearing. Both the experimental and the control groups were further divided into two subgroups, one including 9- and 10-year-old children and the other including 11-year-old and older children. The interesting aspect is that in German, DPs are case-marked. Case markers are important cues to correctly assign thematic roles to sentence constituents and should therefore assist German speakers in the comprehension of relative clauses. Results showed that for both the experimental and the control groups, subject relatives were more accurate than object relatives, confirming the well-known typical asymmetry between the two structures. In addition, in the comprehension of object relatives, the experimental group was significantly less accurate than the control group. The group of children with normal hearing at the age of 9-10 still show difficulties with object relatives, for which the percentage of accuracy is 52%, and a considerable improvement is observed starting from the age of 11 (83%). Both subgroups with hearing impairment lag far behind the control subgroups (accuracy is about 40% for 9- and 10-year-old children and about 60% for 11-year-old and older children). It thus emerges that children with hearing impairment do not rely on case markers to interpret object relatives, and consequently they are not able to correctly compute thematic roles, thus interpreting sentences on the basis of the linear order of the two DPs, namely the DP rel-

ative head is considered the subject of the embedded clause.

Relative clauses have also been investigated in Italian-speaking children with hearing impairment, more specifically in children with cochlear implants, using tasks different in important respects from those used in previous studies on populations with hearing impairment. The experiments (including detailed description of participants, materials, methods, and results) are presented in the next sections.

3.6 The comprehension of relative clauses in Italian-speaking children with cochlear implants

3.6.1 The pilot study

Volpato and Adani (2009) is the first study that investigated the comprehension of restrictive relative clauses in Italian-speaking children with hearing impairment who received a cochlear implant.

Four groups participated in this experiment, one experimental group and three control groups. The performance of eight children with cochlear implant (CI group, age range: 6;9-9;3, mean age 7;9) was compared to that of eight children matched on morpho-syntactic abilities (GC group, age range: 3;6-5;11), eight children matched on receptive vocabulary (VC group, age range: 5;4-7;0) and eight children matched on chronological age (CA group age range: 7;1-7;8).

The participants with cochlear implant were selected at the "Centro per le Disabilità Sensoriali" in Venice (four children) and at the "Centro di Riabilitazione Uditiva" of the ULSS 16 (Local Health and social care services) in Padua (four children). All participants were profound deaf from 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 implant fitting varied between 2;1 to 4;4 years. All children have been trained orally, and all of them have received speech-language therapy from two to three times per week. All participants have normal IQ, and no other associated disabilities were diagnosed. At the time of testing, they were attending primary schools in mainstream classes. The following table summarizes the main clinical data of the children with cochlear implants:

Table 10 Clinical data of participants with CI (HL: Hearing loss; HA: Hearing aids; CI: cochlear implantation).

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

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, belonging to the GA group, were selected among those who had normal range scores on the TCGB (Chilosi, Cipriani 2006). Normal hearing children matched on vocabulary (included in the VC group) were selected among those who had normal range scores on the PPVT-R test (Stella, Pizzoli, Tressoldi 2000).

In addition to tests assessing general morpho-syntactic abilities and receptive vocabulary, a test assessing memory skills (CESPEE B, Bruni 2002) was also administered to the children with cochlear implants, in order to measure forward and backward digit span. To investigate the comprehension of relative clauses, the referent selection task developed by Adani (2008; 2011) was used, in which subject relatives (78), object relatives with preverbal subjects (79), and object relatives with postverbal subjects (80) were assessed.

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

(79) Indica il cavallo [che i leoni stanno inseguendo <il cavallo>] OR
'Point to the horse [that the lions are chasing <the horse>]'

(80) Indica il cavallo [che stanno inseguendo i leoni <il cavallo>] ORp
point to the horse [that are chasing the lions <the horse>]

In the three conditions, 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 78), and the plural verb always agreed with the embedded noun (as in 79 and 80). The task was composed of 24 experimental trials (8 sentences per condition) and 12 filler sentences, each matched to a different picture. A sample of an experimental picture is shown in Figure 6:

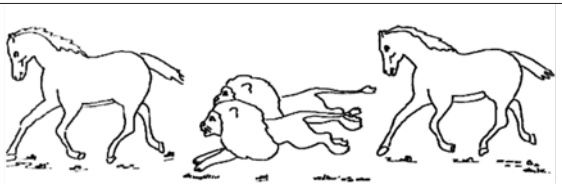


Figure 6 Sample of experimental picture (Adani 2008)

All pictures displayed the same structure as in Figure 6. Correct referents were always either on the right or on the left. In filler sentences, containing either intransitive verbs or transitive verbs with inanimate objects, the correct response always corresponded to the character in the middle. Some pictures were chosen among those included in the task by De Vincenzi (1996), which was used to assess Italian subject and object *wh*-questions. Some other pictures were modified by Adani (2008; 2011) to test subject and object relative clauses.

The children with normal hearing were tested at their school or kindergarten. The testing session was preceded by a preliminary meeting with the whole class, in order to introduce the experimenters and the 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. The children with cochlear implants were tested during their speech therapy sessions and 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 each experi-

mental trial, in order 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 reported on the response sheet by assigning one point for each correct response. Table 11 shows the percentages of correct responses for each group on each sentence typology.

Table 11 Correct response % for each condition in each group.

Sentence Types	**CI**	**GC**	**VC**	**AC**	***Sentence type Mean***
SR	89	100	97	97	*96*
OR	55	81	83	92	*78*
ORp	22	45	53	67	*47*
Group Mean	*55*	*76*	*78*	*85*	

The analysis highlighted significant main effects of Group [$\chi^2(3) = 8.59$, p=.035] and Sentence Types [$\chi^2(2) = 24.02$, p<.001]. As for the main effect of *Group*, the CI group was less accurate than the GC group (p= 0.01), the VC group (p=.007), and the AC group (p<.001). No significant differences were attested among control groups. As for the main effect of *Sentence*, SRs were more accurate than ORs (p<.001) and ORps (p<0.001). ORs were more accurate than ORps (p<.001). No significant interaction effects were observed.

In addition to a group analysis, Volpato and Adani (2009) performed individual analyses investigating the number of children who performed above chance in each sentence type using the binomial distribution and results are reported in Table 12. Children were considered above chance if they answered correctly at least 5 (out of 8) items for each condition.

Table 12 Number of children for each group performing above chance

	CI	**GC**	**VC**	**AC**
SR	**8**	**8**	**8**	**8**
OR	**3**	**6**	**8**	**7**
ORp	**1**	**4**	**3**	**4**

As is evident from Table 12, all children performed above chance on SRs. On ORs, 3 children with cochlear implant out of 8 scored above chance, whereas on ORp, only 1 performed above chance.

The study by Volpato and Adani (2009) was the starting point to further investigate relative clauses in children with cochlear im-

plants. Starting from the task developed by Adani (2008; 2011), the new and improved comprehension task used to compare typically developing children, adolescents, and adults (see section 3.4.1) was also proposed to a sample of children with cochlear implants. Most results were published in Volpato (2012) and are presented in the next sections alongside with some unpublished data, which were part of Volpato (2010b), concerning the comprehension of ambiguous sentences and children's individual performance.

3.6.2 The manipulation of number features in the comprehension of relative clauses: a new study on children with cochlear implants

As pointed out in chapter 2, the new comprehension task made it possible to investigate the role of grammatical cues, in particular number features, in the comprehension of relative clauses, in order to determine which feature combination(s) may facilitate the establishment of grammatical relationships between sentence constituents. The performance of children with cochlear implants was compared to the performance of hearing children matched on morpho-syntactic abilities (TCGB).

3.6.2.1 The experiment: Participants

In Volpato (2010b; 2012), a group of 13 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). Each child with cochlear implant was individually matched to a child with normal hearing based on the scores obtained in the TCGB. Language-matched children were selected among those who had normal range scores on the TCGB test (see chapter 2), by being included between the 25° and 75° 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 section 2.10.

3.6.2.2 Materials

The comprehension of relative clauses was assessed using the referent selection task presented in section 3.4.1, in which participants were asked to select the correct referent out of four possible choices, after listening to a sentence read aloud by the experimenter. The session started with a pre-test, in order to make sure that all chil-

dren 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 reported on the response sheet by the experimenter. One point was attributed for each correct response.

3.6.2.3 Results

Table 13 summarizes the results on each condition for each group. The results on SR, OR, and ORp sentence types are taken from Volpato (2012). The results on AMB sentence types are included in Volpato (2010b).

Table 13 Percentage of correct answers for each group in each sentence type

Sent.types	Conditions	CI		LA		Mean sentence type	
AMB	AMB_SG_SG	77/78	99%	73/78	94%	**150/156**	**96%**
	AMB_PL_PL	78/78	100%	76/78	97%	**154/156**	**99%**
SR	SR_SG_PL	71/78	91%	71/78	91%	**142/156**	**91%**
	SR_PL_SG	68/78	87%	73/78	94%	**141/156**	**90%**
OR	OR_SG_SG	58/78	74%	60/78	77%	**118/156**	**76%**
	OR_PL_PL	56/78	72%	62/78	79%	**118/156**	**76%**
	OR_SG_PL	46/78	59%	66/78	85%	**112/156**	**72%**
	OR_PL_SG	51/78	65%	63/78	81%	**114/156**	**73%**
ORp	ORp_SG_PL	29/78	37%	56/78	72%	**85/156**	**54%**
	ORp_PL_SG	19/78	24%	47/78	60%	**66/156**	**42%**
	Mean group	**71%**		**83%**			

Overall, the CI group showed a significant difference from the LA group (Wald Z=-2.230, p=.02). Volpato (2012) also reported the statistical difference between the two groups in each sentence condition. The results of the analysis are shown in Table 14.

Table 14 Percentage of correct responses for each condition in each group (Volpato 2012)

		CI	LA	Significance
		Mean (SD)	**Mean (SD)**	**CI vs. NH**
AMB	AMB_SG_SG	99% (5%)	94% (13%)	N.S.
	AMB_PL_PL	100% (0%)	97% (6%)	N.S.
SR	SR_SG_PL	91% (15%)	91% (19%)	N.S.
	SR_PL_SG	87% (19%)	94% (16%)	N.S.
OR	OR_SG_SG	74% (29%)	77% (22%)	N.S.
	OR_PL_PL	72% (30%)	79% (26%)	N.S.
	OR_SG_PL	59% (25%)	85% (32%)	p=.008*
	OR_PL_SG	65% (36%)	81% (20%)	N.S.
ORp	ORp_SG_PL	37% (35%)	72% (30%)	p=.004*
	ORp_PL_SG	24% (27%)	60% (29%)	p=.005*

Within-subject analyses investigated the effect of sentence type within each of the two groups. In ambiguous sentences (AMB), both the CI and the LA groups performed almost at ceiling. Although the percentages of accuracy are slightly higher in the former group than in the latter, no significant difference was found between the two groups, and no significant difference was found between the two sentence types within each group.

The statistical analysis for all the other sentence types (SR, OR, and ORps) is taken from Volpato (2012). Subject relatives (SR) are significantly more accurate than object relatives with both preverbal (OR) (Wald Z=5.159 p<.001 for the CI group, and Z=3.763, p<.001 for the LA group) and postverbal subjects (ORp) (Wald Z=9.506 p<.001 for the CI group and Wald Z=5.710, p<.001 for the LA group). Object relatives with preverbal subjects (OR) are significantly more accurate than object relatives with postverbal subjects (ORp) (Wald Z=7.912 p<.001 for the CI group, and Wald Z=3.914, p<.001 for the LA group).

In object relatives with preverbal subjects, the CI group performed significantly better in match than in mismatch conditions (p=.02). In particular, the performance in sentence type OO_SG_SG was significantly more accurate than in sentence type OO_SG_PL (p=.001). The comparisons between all the other conditions were not significant. The LA group showed better performance when the two DPs were dissimilar in terms of number features, although no significant difference is found between match and mismatch conditions (p=.24). Within this group, the comparisons between the various conditions did not yield any significant difference.

In addition to the data presented in Volpato (2012), further analyses are concerned with the interpretation of ambiguous sentences. In ambiguous sentences, either the first (relative head) or the sec-

ond DP (embedded constituent) could be interpreted as the subject of the embedded verb. Ambiguous relative clauses were included in the experimental item list to check the participants' sensitivity to a potential subject in the embedded postverbal position. Therefore, by considering only correct responses, I calculated, for each group, the percentages for subject reading and those for object reading in each of the two ambiguous conditions. The results of this analysis are shown in Table 15:

Table 15 Percentage of subject and object interpretation for each condition of the ambiguous sentence type

	AMB_SG_SG		AMB_PL_PL	
	Subj. Reading	**Obj. Reading**	**Subj. Reading**	**Obj. Reading**
CI	90%	10%	73%	27%
LA	96%	4%	87%	13%

Both children with cochlear implants and children with normal hearing mainly selected the first DP (relative head) as the subject of the embedded clause both when the DPs were singular and when they were plural. In the former case (singular DPs), the CI group chose the subject reading 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 cases (27%). None of the children appeared to be sensitive to the ambiguity by explicitly stating that both interpretations were possible. Overall, singular features forced a subject reading more times than plural features.

3.6.2.4 Individual performance and correlation analyses

In addition to group analyses, an individual performance analysis was carried out within each group. In this analysis, I counted the number of participants who behaved above chance in each group and in each condition (Table 16). This analysis was performed by using the binomial distribution. The probability of responding correctly to subject relatives (SR), to object relatives with preverbal (OR) and postverbal subject (ORp) was 25%. A child was considered above chance when he/she answered at least 4 items for each relative clause condition correctly (p=.03). In ambiguous sentences, the probability of answering correctly was 50%, hence, a child was considered above chance when he/she answered correctly to all 6 items. The following table summarizes the results:

Table 16 Number and percentage of children above chance in each sentence condition (CI = children; LA= language-matched children)

Sent. type	Condition	CI (N=13)		LA (N=13)	
		No.	%	No.	%
AMB	**AMB_SG_SG**	13	100%	11	85%
	AMB_PL_PL	13	100%	11	85%
SR	**SR_SG_PL**	12	92%	11	85%
	SR_PL_SG	11	85%	12	92%
OR	**OR_SG_SG**	9	69%	9	69%
	OR_PL_PL	9	69%	11	85%
	OR_SG_PL	7	54%	11	85%
	OR_PL_SG	8	62%	11	85%
ORp	**ORp_SG_PL**	3	23%	9	69%
	ORp_PL_SG	3	23%	6	46%

In ambiguous sentences (AMB), all children with CI performed above chance, while in the LA group, two children performed at chance level. In subject relatives (SR), almost all children performed above chance. In object relatives (OR), the children with cochlear implants who performed above chance were fewer than normal hearing children. Especially in object relatives with postverbal subjects (ORp), an extremely low number of children with cochlear implants performed above chance. In almost all conditions, the number of children performing above chance is higher in the LA group than in the CI group, especially in the ORp conditions.

In addition to individual performance analyses, correlation analyses were run to investigate whether a relationship exists between comprehension of relative clauses and some clinical variables (age of hearing aid fitting, age of cochlear implant activation, and duration of cochlear implant use). These analyses showed that none of these factors was associated to comprehension. This might be attributed to the fact that the group was small and quite homogeneous in terms of clinical characteristics.

3.6.2.5 Response type analysis

In this section, I report the analysis of the answers provided by the two groups, when the children did not select the correct referent. The data are taken from Volpato (2012).

In each experimental trial, there were four possible choices among which the participant could select the correct one. When the participant did not select the correct referent, the choice fell into one of the following incorrect referents: reversible referent, agent referent, and

other referent (see section 3.4.1 for the detailed presentation of the task and the possible errors). Table 17 and Table 18 summarize the incorrect responses provided in each condition by the children with cochlear implants and the children with normal hearing, respectively.

Table 17 Percentage of incorrect responses (Reversible, Agent, and Other) provided by children with cochlear implants in each condition

	Reversible		Agent		Other	
	No. %		No. %		No. %	
AMB_SG_SG					1/78	1.3%
AMB_PL_PL					0/78	0%
SR_SG_PL	5/78	6.4%			2/78	2.5%
SR_PL_SG	7/78	9%			3/78	3.8%
OR_SG_SG	14/78	17.9%	6/78	7.6%	0/78	0%
OR_PL_PL	8/78	10.3%	14/78	17.8%	0/78	0%
OR_SG_PL	17/78	21.8%	14/78	17.8%	1/78	1.3%
OR_PL_SG	11/78	14.1%	16/78	20.5%	0/78	0%
ORp_SG_PL	38/78	48.7%	8/78	10.1%	3/78	3.8%
ORp_PL_SG	50/78	64.1%	7/78	8.9%	2/78	2.5%

Table 18 Percentage of incorrect responses (Reversible, Agent, and Other) provided by children with normal hearing in each condition

	Reversible		Agent		Other	
	No. %		No. %		No. %	
AMB_SG_SG					5/78	6.4%
AMB_PL_PL					2/78	2.6%
SR_SG_PL	3/78	3.8%			4/78	5.1%
SR_PL_SG	0/78	0%			5/78	6.4%
OR_SG_SG	8/78	10.3%	9/78	11.5%	1/78	1.3%
OR_PL_PL	7/78	9.0%	7/78	9%	2/78	2.6%
OR_SG_PL	5/78	6.4%	7/78	9%	0/78	0%
OR_PL_SG	6/78	7.7%	9/78	11.5%	0/78	0%
ORp_SG_PL	15/78	19.2%	6/78	7.7%	1/78	1.3%
ORp_PL_SG	26/78	33.3%	5/78	6.4%	0/78	0%

The distribution pattern of incorrect responses varies according to the group and to the relative clause condition considered.

In ambiguous trials, two types of responses were possible: the correct referent or the "other" referent. In these conditions, the responses were in most cases correct for both groups. Only a very small percentage of (incorrect) responses fell into the category "other". This phenomenon was more frequent in the hearing group. Overall, in

both groups, for all sentence conditions, the percentage of responses falling in the category 'other' is very low, therefore they are not taken into consideration in this analysis.

The most interesting results were observed in the conditions testing object relatives with preverbal subject (OR), in which the CI group showed a trend different from the control group. For children with cochlear implants, the percentages of accuracy varied between 59% and 74%, with better scores in match conditions as opposed to mismatch conditions (see Table 13). When the noun head was singular, they mainly selected the reversible error. When the noun head was plural, more occurrences of the agent error selection were observed. The pattern is different for hearing children, who performed slightly better in the mismatch conditions, as opposed to the match conditions. Although the percentages of selection of the agent and the reversible referents were very low, it seems possible to detect a different behaviour depending on the presence of match or mismatch conditions. In the match conditions (OR_SG_SG and OR_PL_PL), normal hearing children seemed to randomly select either the agent or the reversible referent. In the mismatch conditions (OR_SG_PL and OR_PL_SG), they seemed to select the agent referent more frequently than in the match condition. However, percentages were very low. In object relatives with postverbal subjects (ORp), the percentages of correct responses were the lowest for both groups. Both children with cochlear implants and children with normal hearing largely selected the reversible referent.

To account for the accuracy and incorrect responses of children with cochlear implants and children with normal hearing, Volpato (2012) suggests that while mismatch conditions and number features are fundamental for children with normal hearing to correctly assign thematic roles to sentence constituents, children with cochlear implants are not particularly sensitive to number features, which in most cases do not help comprehension.

In the next sections, a detailed explanation of the groups' performance is provided for each sentence type (subject relatives, object relatives with preverbal subjects, and object relatives with postverbal subjects).

3.6.3 Discussion of findings on children with cochlear implants

This section discusses the findings of both studies investigating the comprehension of relative clauses in children with cochlear implants (Volpato, Adani 2009; Volpato 2012) compared to normal hearing children.

3.6.3.1 The asymmetry between subject and object relatives

Volpato and Adani (2009) and Volpato (2012) found the asymmetry between subject relatives and object relatives in both the children with cochlear implants and the children with normal hearing, confirming the results by previous studies on several typical and atypical populations. In both studies, subject relatives are comprehended significantly better than object relatives. Subject relatives (SR) are easier than object relatives with either preverbal (OR) or postverbal subjects (ORp), and OR are easier than ORp. The better performance on SR is easily captured by De Vincenzi's (1991) principle, on the basis of which, individuals always start with a subject interpretation when interpreting a sentence, and try to posit a gap as soon as possible, namely in subject position.[20] In SRs, the relation between the relative head and the position from which it has moved is short, in contrast to object relatives, and the canonical SVO word order is kept:

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

Moreover, both Volpato and Adani (2009) and Volpato (2012) claimed that the difficulty that children experience with object relatives has to be attributed to RM effects due to the presence of an intervening element between the object head of the matrix clause and the position from which it has been extracted. However, Volpato (2012), which investigated relative clauses with all possible combinations of number features on the head and the embedded DP, claimed that some other phenomena must be at play given the qualitatively different behaviour of the children with cochlear implants compared to that of the language-matched controls. The condition in which the two DPs are dissimilar in terms of number features (namely the head DP is singular, and the embedded DP is plural – OR_SG_PL) was significantly more difficult for children with cochlear implants than for language-matched children with normal hearing. In addition, although without any significant difference, the pattern of performance of children with cochlear implants seemed to slightly depart from that of hearing ones in terms of errors types. In particular, number features on either

20 This claim is also strengthened by the data on the interpretation of ambiguous sentences, namely sentences in which the relative head may be interpreted as either the subject or the object of the embedded verb. The subject reading was attributed significantly more often when number features were singular than when they were plural (Wilcoxon, Z=-2.357 p=.018). This means that when two DPs were in the singular, the subject reading was more easily available than when the two DPs were in the plural. Although numerically high in both cases, the subject reading is highly favoured with singular features.

the two DPs or verbal morphology were found to influence in a different way the outcomes of the performance within the two groups.[21] To account for the behaviour of the children with cochlear implants, Volpato (2012) discussed some important issues on how number features are morpho-syntactically realized on verbs and computed. First of all, the verbs presented in the comprehension task are either in the third-person singular (82) or in the third-person plural (83):

(82) La giraffa che pettina gli orsi
'the giraffe that combs the bears'

(83) Le giraffe che pettinano l'orso
'the giraffes that comb the bear'

It is evident from the examples that the plural form of the verb (*pettinano*) is derived by adding the morpheme *-no* to the singular form (*pettina*). Thornton (1999) and Salvi and Vanelli (2004) highlighted the particular status of the third-person plural form in the verbal inflectional Italian system, in contrast to the other plural persons of the paradigm. Indeed, only the third-person plural form is constructed as a true plural of the singular by agglutinating the plural morpheme *–no* to the third person singular:

(84) [[pettina]+no] [[comb.3.SG]+PL]

Differently from the third-person plural 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*.[22] This vowel is not the singular agreement suffix, as opposed to the suffix *–no*, which marks the third-person plural form of Italian

21 As said above, Volpato and Adani (2009) used the test by Adani (2008), in which 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.

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

(i) a. vedevedono
see.3.SGsee.3.PL
b. dormedormono
sleep.3.SGsleep.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]

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.

A second important issue discussed in Volpato (2012) concerns the distinction between marked and unmarked (bare) forms in attraction phenomena. This distinction is important to understand a linguistic phenomenon found in an English variety, where a singular subject can co-occur with a verb not marked for singular features (e.g. *think* in (83)), when the relative head is in the plural (Kayne 1989):

(85) the people who Clark think are in the garden
PL SG PL

This attraction phenomenon is excluded in the reversed situation (86). 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:

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

Attraction phenomena as in (85) are possible because the verb form is bare, and consequently it is not specified to agree with a specific DP. In (86), the third-person singular, namely the marked form cannot co-occur with a plural DP because the verb is specified for singular features.

The Italian verb system is opposite to the English one. Indeed, in Italian, the marked form is specified for the value [+plural], bearing the plural agreement morpheme *–no*. Therefore, in Italian, attraction is expected to go in the opposite direction.

A third important issue concerns the inaccessibility or underspecification of number features on verbal plural forms that has often been observed in populations displaying atypical language acquisition (Chesi 2006) or loss of language abilities due to brain damages (Chinellato 2004). Chesi (2006) found that in some individuals with hearing impairment, singular is preferred over plural on verbs, mainly in the third person. Chinellato (2004) found that in agrammatic patients, plural number features seem to be more expensive in terms of computation.[23]

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.

23 Chinellato (2004) found that the patient LC substituted the third-person plural with the third-person singular in most cases (57%) (in present tenses, the form 'va' ((he/she) goes.3.SG) replaced the form 'vanno' ((they) go.3.PL), and in past tenses,

Volpato (2012) suggested that the interaction of these different phenomena (RM, agreement/attraction phenomena in the sense of Kayne (1989), and failed computation of plural features) modulate the comprehension of ORs by children with cochlear implants and explain not only their different performance from typically developing children, but also the performance in the different OR conditions (OR_SG_SG, OR_PL_PL, OR_SG_PL, and OR_PL_SG). Among the different conditions, the most problematic ones for children with cochlear implants are those displaying mismatch number features, and especially the structure in which the head is singular and the embedded DP is plural (OR_SG_PL). Following Chesi (2006) and Chinellato (2004), Volpato (2012) claims that in this sentence condition, reported as (87), the plural morpheme *–no* does not enter the computation, as (88) shows, thus leaving the bare form *becca*:

(87)	La gallina	che	i pulcini	beccano
	the hen	that	the chicks	peck
	DPO[-pl]		DPS[+pl]	V[+pl][24]

(88)	La gallina	che	i pulcini	becca~~no~~
	the hen	that	the chicks	peck
	DPO[-pl]		DPS[+pl]	V[-pl]

Following Kayne's (1989) analysis of attraction, it is possible for a head bearing the unmarked form (singular features [-pl]) to attract a verb bearing unmarked singular features [-pl]:

(89)	La gallina	che	i pulcini	becca(~~no~~)
	DPO[-pl]		DPS[+pl]	V[-pl]
	SG		PL	SG

For Italian, the pattern opposite to English is obtained. Since the plural morpheme *–no* on the verb is deleted, plural features are not accessible in the computation. The only constituent available for agreement is *la gallina*, while the embedded DP is interpreted as a topicalized object. The incorrect agreement between the DP *la gallina* and the verb *becca* leads the children with cochlear implants to

the form 'aveva preso' ((he/she) had.3.SG taken) replaced the correct form 'avevano preso' ((they) had3.PL taken). 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 third-person plural is produced with more difficulties.

24 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.

select the incorrect referent, namely the reversible character, in a considerable number of experimental trials (21.8%).

Following the same reasoning, the performance observed in the other OR sentence conditions (OR_SG_SG, OR_PL_PL, and OR_PL_SG) can be easily explained. For instance, in the sentence condition OR_SG_SG, reported in (90), the relative head is again singular. The embedded subject and the verb also bear singular features:

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

In this sentence, an agreement relation can be established between the DP *la gallina* and the verb, regardless of the position occupied by the embedded verb and the hierarchical structure. As above, the DP *il pulcino* is interpreted as a topicalized object:

(91) La gallina che il pulcino becca
|_____▲

As in (89), the choice of the reversible (error) character is immediately captured.

The same phenomena occurring in (89) are expected to also be at play in the case in which all constituents are marked for plural features. However, differently from unmarked features, marked features, as in (92), cannot act as attractors for the verb (Kayne 1989):

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

As above, the plural verbal morphology *–no* is not correctly computed, and children with cochlear implants interpret the verb *beccano* '(they) peck' as *becca* '(it) pecks'. In this case, the agreement relationship between the DP *le galline* and the verb cannot be established, because the verb is unspecified for number features:

(93) Le galline che i pulcini becca(~~no~~)
|_____✕_____▲

When children are not able to establish such a relation, the next cue available for interpretation is agreement between the subject and the verb in the embedded clause, conceived in terms of a Spec-Head configuration, regardless of the features specified on the DP and on the verb:

(94) Le galline che i pulcini becca(~~no~~)
|__Spec/head_▲

This leads children with hearing impairment to select the agent error more times on this sentence type than in the previous sentence types. This same phenomenon also explains the occurrence of the agent error in the sentence type in which the relative head is again plural, but both the embedded subject and the embedded verb are singular (OR_PL_SG):

(95)	Le galline	che	il pulcino	becca
	The hens	that	the chick	pecks
	DPO[+pl]		DPS[-pl]	V[-pl]

As in (92), children with hearing impairment look for a verb potentially agreeing with the DP *le galline* 'the hens', but the agreement relation cannot be established because the verb is specified for singular features:

(96) Le galline che il pulcino becca
|_____X_____▲

The impossibility to (incorrectly) establish this type of relation between the two elements (relative head and embedded verb) leads children with hearing impairment to rely on Spec-Head agreement between the embedded subject and the embedded verb, which is even stronger than in (92), since both elements share the same number features:

(97) Le galline che il pulcino becca
|__Spec/head_▲

The strength of this relation, as opposed to that in (92), may also be suggested by the higher percentage of selection of the agent character in this case (21% in OR_PL_SG vs. 18% in OR_PL_PL).

Summing the results, it is evident that children with hearing impairment do not appear to be sensitive to number cues on the embedded verb in the disambiguation and interpretation of relative clauses (Volpato 2012). Indeed, in the mismatch condition in which plural (marked) agreement occurred on the embedded DP and the embedded verb (OR_SG_PL), they showed a significant less accurate performance than the hearing children. In addition to a between-group difference, also within the group of participants with hearing impairment, percentages of accuracy in the mismatch conditions are lower than those in the matched ones.

While in children with cochlear implants, number features do not appear to play any role, for the group of language-matched hearing

children, results replicate the pattern of performance observed in the comparison between typically developing children, adolescents, and adults (see section 3.4.2). The language-matched hearing children seem to prefer the mismatch conditions and to rely on plural markers on the embedded verb to correctly interpret ORs. The presence of disjoint number features increases the percentages of correct responses. In the mismatch condition OR_SG_PL (*La gallina che i pulcini beccano* "The hen that the chicks peck"), in which hearing children performed better than children with cochlear implants, comprehension is facilitated because more cues are available. Two plural forms are linearly close to each other, the embedded subject and the verb, and the NumP projection is present in the subject DP. In the match conditions, children are often unable to assign thematic roles properly, since both the first and the second DP can potentially (numerically) act as subject of the embedded verb.

3.6.3.2 The performance on object relatives with postverbal subjects

In both Volpato and Adani (2009) and in Volpato (2012), object relatives with postverbal subjects showed the highest percentage of incorrect responses, replicating previous results observed for other populations (Arosio et al. 2005; 2009; Adani et al. 2010; see section 3.2).

By adopting the minimalist theory of Agreement (Chomsky 1995; 2000; 2001), and following Guasti and Rizzi (2002) and Franck et al. (2006), Volpato and Adani (2009) and Volpato (2012) suggested that the difficulties experienced with ORps are due to the presence of the subject in the postverbal position and to the fragility of agreement between the two constituents, occurring under AGREE only. In ORs, agreement is robust because it is checked twice: both under AGREE and in the Spec-Head configuration.

Since the plural features displayed on the verb need to be checked against the subject in postverbal position, the human parser presumably forces the syntactic reanalysis of ORp clauses, which are interpreted as SRs. Indeed, while providing incorrect responses in both sentence conditions (ORp_SG_PL and ORp_PL_SG), the participants selected the character corresponding to the reversible error. Low performance due to fragility of agreement is easily observed in early child grammar systems, but consequences are even stronger in the presence of compromised systems, and especially in children with cochlear implants.

In addition, fragility of agreement places heavy processing load in the interpretation of ORps, since memory is forced to keep plural morphology on the verb suspended, until the postverbal subject is

encountered. As is discussed in chapter 5, Volpato and Adani (2009) found a significant correlation between performance on ORp and both forward and backward digit spans in children with cochlear implants. Low memory resources may affect the development of language skills by children with hearing impairment.

Comparing the performance of children with cochlear implants with that of normal hearing children, all results showed that the former performed much worse than the latter. The higher difficulties of children with cochlear implants are to be attributed to the fact that they are strictly instructed to the SVO order, the unmarked word order of Italian, during their rehabilitation sessions (Chesi 2006). Consequently, for children with cochlear implants, a postverbal subject is even more unexpected than for children with normal hearing. The reanalysis based on the canonical word order (SVO), that is, as a subject relative, is immediately captured.

3.7 The comprehension of relative clauses in LIS signers: a comparison with children and adolescents with normal hearing

In addition to children with cochlear implants, the task investigating the comprehension of relative clauses was also proposed to another population of individuals with hearing impairment, namely adolescent LIS signers (LIS group).

The LIS group included a small sample of six participants ranging in age from 15;9 to 17;6 who were individually matched to six monolingual young children with normal hearing (age range: 5;3-7;5) on the basis of morphosyntactic abilities (LA group) and to six adolescents with normal hearing (age range 15;3-17;5) on the basis of chronological age (CA group). The participants with hearing impairment were all born to deaf parents and had acquired the sign language naturally from their parents. In the LA 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 belonging to the CA group (Mann Whitney U=16.5 p=.808).

The participants were tested following the procedure discussed in chapter 2, section 2.11.

3.7.1 Results

For each group, the numbers and percentages of correct responses on each sentence condition are summarized in Table 19:

Table 19 Percentage of correct answers for each group in each sentence condition

		LIS		LA		CA		Mean Sentence Type	
AMB	AMB_SG_SG	26/36	72%	35/36	97%	36/36	100%	**97/108**	**90%**
	AMB_PL_PL	29/36	81%	35/36	97%	36/36	100%	**100/108**	**93%**
SR	SR_SG_PL	22/36	61%	35/36	97%	36/36	100%	**93/108**	**86%**
	SR_PL_SG	20/36	56%	36/36	100%	36/36	100%	**92/108**	**85%**
OR	OR_SG_SG	15/36	42%	17/36	47%	33/36	92%	**65/108**	**60%**
	OR_PL_PL	15/36	42%	23/36	64%	33/36	92%	**71/108**	**66%**
	OR_SG_PL	10/36	28%	26/36	72%	35/36	97%	**71/108**	**66%**
	OR_PL_SG	12/36	33%	23/36	64%	35/36	97%	**70/108**	**65%**
ORp	ORp_SG_PL	14/36	39%	19/36	53%	34/36	94%	**67/108**	**62%**
	ORp_PL_SG	5/36	14%	13/36	36%	34/36	94%	**52/108**	**48%**
	Mean group	**47%**		**73%**		**97%**			

3.7.1.1 Between-group analysis

By comparing the group of LIS signers with the group of language-matched hearing (LA) children and age-matched hearing adolescents (CA), overall the group of LIS signers showed the lowest accuracy percentages, as opposed to both hearing groups. Indeed, a significant difference is found between the LIS group and both children (Wald Z=-5.658, p=.008) and adolescents with normal hearing (Wald Z=-3.244, p<.001).

For the group of LIS signers, ambiguous sentences with both singular and plural DPs were problematic. Age-matched and language-matched controls performed at ceiling. A significant difference was observed between the group of LIS signers and the group of LA controls on both ambiguous sentence conditions (p=.006 with singular DPs and p=.02 with plural DPs). No significant difference was found between the hearing adolescents and the other two groups.[25]

In subject relatives, the percentage of accuracy was very high for the two hearing groups, both children and adolescents. Instead,

25 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, on the reduced number of participants, and on the lack of variability within the CA group.

the percentage of correct responses in the LIS group was definitely lower. For the group of LIS signers, subject relatives caused much trouble. Indeed, a significant difference was observed between this group and children with normal hearing as far as the performance on these structure types is concerned. Actually, a between-group analysis showed that the problematic structure was the SR_SG_PL sentence condition, in which the percentage of accuracy is significantly higher for hearing children as opposed to the participants with hearing impairment (p=.002). The SR_PL_SG sentence condition did not show any significant variation when the two groups were compared.

Comparing the three groups in the comprehension of object relatives with preverbal subjects, the only significant difference was found in the sentence type OR_SG_PL (p=.006), replicating the results found on this sentence type when comparing children with cochlear implants and their language-matched control (section 3.6.2.3). By comparing adolescent LIS signers and hearing adolescents, the latter performed significantly better than the former in all conditions (in OR_SG_SG p=.004, in OR_PL_PL p=.004, in OR_SG_PL p<.001, in OR_PL_SG p<.001).

In object relatives with postverbal subjects (ORp), the LIS signers achieved lower scores than each of the hearing groups. A significant difference was found between the group of adolescent LIS signers and the group of hearing adolescents. The latter group performed better than the former group in both conditions (p=.0014 in ORp_SG_PL and p<.001 in ORp_PL_SG). No significant difference was instead found attested between the group of LIS signers and the group of hearing children in either of the two sentence conditions.

3.7.1.2 Within-group analysis

The within-group analysis showed that sentence type is a variable that influences performance, although to a different extent in each of the three groups.

In the LIS group, ambiguous sentences (AMB) were significantly more accurate than subject relatives (SR) (Wald Z=2.413, p=.02), and object relatives with both preverbal (OR) (Wald Z=5.157, p<.001) and postverbal subjects (ORp) (Wald Z= 5.505, p<.001). SR were significantly more accurate than OR (Wald Z=2.825, p=.005) and ORp (Wald Z= 3.367, p<.001). No significant difference was found between OR and ORp (Wald Z=1.415, p>.05).

In the group of language-matched children with normal hearing (LA group), for ambiguous (AMB) and subject relatives (SR) percentages of accuracy were very high, and indeed no significant difference was found between the two sentence types (Wald Z= 0.587, p>.05). Percentages were lower in both ORs and ORps. Both AMB and

SR relatives were significantly more accurate than object relatives with ether preverbal (OR) (Wald Z=4.660, p<.001 and Wald Z=4.281, p<.001, respectively) or postverbal subjects (ORp) (Wald Z= 5.564, p<0.001 and Wald Z=5.101, p<.001, respectively). A significant difference was also found between ORs and ORps (Wald Z= 2.897, p=.004).

In the group of adolescents with normal hearing, ambiguous and subject relatives are at ceiling, while the percentages in the other sentence conditions are very high and approaching 100%. In this group, no significant difference is observed between any of the sentence types (p>.05).

3.7.1.3 The ambiguous sentences: subject vs. object reading

For ambiguous sentences, I calculated the percentages for subject interpretation and object interpretation in each of the two conditions for each group, when participants provided the correct response. Results are shown in Table 20:

Table 20 Percentage of subject and object interpretations for each ambiguous sentence condition

	AMB_SG_SG		**AMB_PL_PL**	
	Subj.Read.	**Obj.Read**	**Subj.Read.**	**Obj.Read.**
LIS GROUP	77%	23%	73%	27%
LA GROUP	100%	0%	77%	23%
CA GROUP	97%	3%	100%	0%
Mean Sentence	93%	7%	83%	16%

From Table 20, a clear tendency towards a subject reading emerges for both ambiguous conditions for all groups. When a relative clause contains two DPs with 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, 20 sentences (out of 26 correct responses) 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 showed a clear preference for a subject reading (97%). In ambiguous sentences with plural DPs, the tendency to prefer the subject interpretation decreased, especially in the LIS and in the LA groups, although percentages were in any case very high.

3.7.1.4 Individual performance

At the individual level, a further analysis was carried out in order to calculate the number of participants who performed above chance in each of the different sentence conditions using the binomial distribution. A participant performed above chance when he/she answered correctly at least 4 out of 6 items in the unambiguous sentence conditions. For ambiguous sentences, for which the probability of answering correctly was 50%, a participant was considered above chance when he/she answered correctly all items for each sentence condition (6 out of 6 items). The results of this analysis are shown in Table 21.

Table 21 Number and percentage of participants for each group who behaved above chance on each condition

	LIS (N=6)		LA (N=6)		CA (N=6)	
	No.	**%**	**No.**	**%**	**No.**	**%**
AMB_SG_SG	1	17%	6	100%	5	83%
AMB_PL_PL	2	33%	6	100%	5	83%
SR_SG_PL	4	67%	6	100%	6	100%
SR_PL_SG	3	50%	6	100%	6	100%
OR_SG_SG	2	33%	2	33%	6	100%
OR_PL_PL	1	17%	4	67%	6	100%
OR_SG_PL	1	17%	5	83%	6	100%
OR_PL_SG	2	33%	4	67%	6	100%
ORp_SG_PL	1	17%	2	33%	6	100%
ORp_PL_SG	1	17%	2	33%	6	100%

All adolescents with normal hearing performed above chance on all conditions. In the group of LIS signers, very few participants performed above chance. While in SRs, all participants of the LA and CA groups performed above chance, a low number of LIS signers performed above chance even on these two sentence conditions. In object relatives, the number of LIS signers performing above chance is extremely low, and in most cases only one participant showed above chance performance. As for the group of hearing children, few participants showed above chance performance especially in the ORp conditions.

3.7.1.5 Analysis of incorrect responses

Table 22, Table 23, and Table 24 show the type of incorrect responses that adolescent LIS signers, hearing adolescents, and hearing children, respectively, provided in each sentence condition:

Table 22 Type of incorrect responses provided by LIS signers in each sentence condition

Type of incorrect response						
Sentence Condition	**Reversible**		**Agent**		**Other**	
	No.	**%**	**No.**	**%**	**No.**	**%**
AMB_SG_SG	/	/	/	/	10/36	28%
AMB_PL_PL	/	/	/	/	7/36	19%
SR_SG_PL	5/36	14%	/	/	9/36	25%
SR_PL_SG	4/36	11%	/	/	12/36	33%
OR_SG_SG	11/36	30.6%	7/36	19.4%	3/36	8.3%
OR_PL_PL	9/36	25%	9/36	25%	3/36	8.3%
OR_SG_PL	10/36	27.8%	9/36	25%	7/36	19.4%
OR_PL_SG	9/36	25%	10/36	27.8%	5/36	13.9%
ORp_SG_PL	10/36	27.8%	5/36	13.9%	7/36	19.4%
ORp_PL_SG	23/36	63.9%	3/36	8.3%	5/36	13.9%

Table 23 Type of incorrect responses provided by hearing children in each sentence condition

Type of incorrect response						
Sentence Condition	**Reversible**		**Agent**		**Other**	
	No.	**%**	**No.**	**%**	**No.**	**%**
AMB_SG_SG	/	/	/	/	1/36	3%
AMB_PL_PL	/	/	/	/	1/36	3%
SR_SG_PL	1/36	3%	/	/	0/36	0%
SR_PL_SG	0/36	0%	/	/	0/36	0%
OR_SG_SG	9/36	25%	10/36	27.8%	0/36	0%
OR_PL_PL	7/36	19.4%	6/36	16.7%	0/36	0%
OR_SG_PL	2/36	5.6%	8/36	22.2%	0/36	0%
OR_PL_SG	3/36	8.3%	10/36	27.8%	0/36	0%
ORp_SG_PL	11/36	30.6%	4/36	11.1%	2/36	5.6%
ORp_PL_SG	20/36	55.6%	1/36	2.8%	2/36	5.6%

Table 24 Type of incorrect responses provided by hearing adolescents in each sentence condition

Type of incorrect response						
Sentence Condition	**Reversible**		**Agent**		**Other**	
	No.	**%**	**No.**	**%**	**No.**	**%**
AMB_SG_SG	/	/	/	/	0/36	0%
AMB_PL_PL	/	/	/	/	0/36	0%
SR_SG_PL	0/36	0%	/	/	0/36	0%
SR_PL_SG	0/36	0%	/	/	0/36	0%
OR_SG_SG	3/36	8.3%	0/36	0%	0/36	0%
OR_PL_PL	3/36	8.3%	0/36	0%	0/36	0%
OR_SG_PL	1/36	2.8%	0/36	0%	0/36	0%
OR_PL_SG	0/36	0%	1/36	2.8%	0/36	0%
ORp_SG_PL	1/36	2.8%	0/36	0%	1/36	2.8%
ORp_PL_SG	2/36	5.6%	0/36	0%	0/36	0%

The interpretation of relative clauses was extremely problematic for the LIS group. Indeed, the percentages of incorrect responses are definitely higher than in all the other populations. Considering the data in Table 22, that relative clauses are difficult to comprehend for the adolescent LIS signers is highlighted by the fact that it is not even possible to detect a pattern in the choice of incorrect responses by the participants included in this group. Especially in ORs, the participants seem to randomly select the 'Reversible' and the 'Agent' character, without following any specific strategy in the identification of the requested referent. It was thus not possible to detect a clear trend for this group. The random selection of relative clause referents is also suggested by the number of times the 'Other' response was chosen in a quite high number of cases. A similar behaviour was not found in the other groups of participants.

In both the LA group (hearing children) and the CA group (hearing adolescents), the percentage of selection of the 'Other' referent was very low. In the group of hearing children, most errors are found in the comprehension of object relatives. In ORs, the type of errors varies depending on the Number features specified on the two DPs. In the match conditions (same number on both DPs), children seem to randomly select either the reversible or the agent character. Since both DPs bear the same number as the embedded verb, both DPs can potentially agree with the verb. In mismatch conditions, children were able to correctly assign thematic roles to the referents, but they selected the 'Agent' character in most cases. This group of hearing children replicates the pattern of performance found in the hearing children compared to children with cochlear implants (section 3.6.2.5).

In the group of adolescents with normal hearing, the level of accuracy was very high. Their performance was almost at ceiling and only for a small number of items, they chose the incorrect referent. The most frequently selected referent was the 'Reversible' character. This choice occurred with ORs, especially with the sentences displaying the match condition. This is probably because, in such conditions, a subject reading might also be possible in which the object is topicalized.[26]

In ORps, all participants with normal hearing (both children and adolescents) tended to select the 'Reversible' referent in incorrect responses. It seems therefore that they interpret the embedded DP subject as the object of the embedded verb, as if the sentence were a subject relative clause, as expected under the Minimal Chain Principle (De Vincenzi 1991, see section 3.2).

The data presented for the group of LIS signers show that these participants had considerable difficulties with relative clause comprehension. However, it is important to point out that the group of LIS signers (and consequently the language-matched and age-matched groups) is very small and not homogenous, and therefore the results must be treated with cautions. It is interesting to note that some findings and trends observed for the populations involved in this comparison were also found in the other populations assessed using this same task (and presented in the previous sections). Overall, the group of LIS signers, on a par with the language- and age-matched controls, showed the typical pattern of performance in the comprehension of relative clauses: ambiguous and subject relatives were more accurate than object relatives with either preverbal or postverbal subjects. However, the experimental group had considerable difficulties with relative clauses and was hardly comparable even to very young hearing children. On the one hand, this could be attributed to the delay with which they accessed the linguistic input, on the other hand, to the fact that LIS signers could not rely on the competence of their mother tongue to interpret relative clauses in Italian. To translate Italian relative clauses, LIS uses a construction labelled *prorel* clause, which is syntactically and semantically different from the Italian relativization structure (Cecchetto, Geraci, Zucchi 2006, Branchini 2014). It is possible that the different status of relative clauses in the two languages does not allow any positive transfer and makes it difficult for LIS signers to properly master Italian relative clauses.

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

3.8 Conclusion

In this chapter, the comprehension of restrictive right-branching relative clauses has been studied in populations with hearing impairment and in populations with normal hearing. The aim was to investigate to what extent, the delayed access to the linguistic input has influenced language acquisition (comprehension) in populations with hearing impairment.

Although the different groups followed the same performance pattern in terms of raw scores, namely ambiguous sentences and subject relatives are less problematic than object relatives with either preverbal or postverbal subjects, the level of accuracy varied depending on the group considered. Children with cochlear implants performed lower than language-matched controls, but in the group of adolescent LIS signers, percentages of accuracy are even lower than those of children with cochlear implants and language-matched normal hearing children. The results showing that the comprehension of relative clauses is more problematic in individuals with hearing impairment (also including children with cochlear implants) than in normal hearing controls replicate previous findings on other languages, such as English (Quigley, Paul 1984; De Villiers, De Villiers, Hoban 1994), French (Delage 2008), Hebrew (Friedmann, Szterman 2006), Palestinian Arabic (Friedmann, Haddad-Hanna 2014), and German (Ruigendijk, Friedmann 2017).

Interestingly, within-group analyses showed that both children with cochlear implants and adolescent LIS signers are less sensitive to number cues in object relatives than normal hearing children. For both groups, the match conditions are more accurate than the mismatch ones. It seems that individuals with hearing impairment mainly need the syntactic cue (preverbal subject) to assign correct thematic roles in object relatives. Conversely, for normal hearing children, number features are crucial for correct theta-role assignment. Individuals with normal hearing seem to need the combination of syntactic (subject position) and morphological (number marking) cues when asked to interpret an object relative clause.

4 The production of relative clauses

Summary 4.1 Introduction. – 4.2 The production of relative clauses by typically developing individuals. – 4.3 The production of relative clauses: the task. – 4.4 The comparison between typically developing children, adolescents and adults. – 4.4.1 Participants. – 4.4.2. Results. – 4.4.3 Answering strategies in subject relative clauses. – 4.4.4 Answering strategies for targeted object relative clauses. – 4.5 The asymmetry between subject and object relatives. – 4.6 The asymmetry between object relatives and passive relatives. – 4.7 The production of passive constructions. – 4.8 The production of relative clauses: further studies. – 4.9 The production of relative clauses in individuals with hearing impairment. – 4.10 The production of relative clauses in children with cochlear implants: the first results for Italian. – 4.11 Answering strategies for targeted subject relatives. – 4.12 The use of resumption in target object relatives. – 4.13 Answering strategies in target object relatives. – 4.14 The use of causative constructions in children with cochlear implants. – 4.15 The inter-individual variability in the CI group.

4.1 Introduction

This chapter focuses on the elicited production of relative clauses by typically developing individuals and children with cochlear implants.

The comparison between children, adolescents, and adults has been carried out to detect the variations in performance in the course of language acquisition and development until the attainment of full adult linguistic competence.

Elicited production of relative clauses in populations with different degrees of hearing loss was investigated in English (Quigley, Paul 1984; De Villiers 1988), Hebrew (Friedmann, Szterman 2006), Palestinian-Arabic (Friedmann, Haddad-Hanna 2014), and French (Delage 2008). These authors mainly tested individuals fitted with conventional hearing aids. Only Friedmann and Szterman (2006) included

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in their experimental sample a small group of individuals with hearing impairment using cochlear implants.

Volpato (2010b) was the first study on the production of relative clauses by (Italian-speaking) children with cochlear implants.

In this chapter, I present the existing literature on the production of relative clauses by typically developing individuals, especially as far as the Italian language is concerned, and the study carried out during my PhD on different typically developing populations (Volpato 2010b). Then I focus on the production of relative clauses by individuals with hearing impairment, presenting the data on Italian-speaking children with cochlear implants published in Volpato (2011), Volpato and Vernice (2014), and Volpato and Cardinaletti (2015).

In Volpato (2011), the data of children with cochlear implants are compared with those of a language-matched control group of hearing children. In the study by Volpato and Vernice (2014), two additional control groups are included in the analysis. Children with cochlear implants are compared to three groups of children with normal hearing: a language-matched group, an age-matched group, and a group of children matched for time from cochlear implant activation. The aim of these analyses was to verify whether and to what extent children with cochlear implants differ from children with normal hearing in the development of relativization, when using an elicited production task, and the strategies they adopt to avoid object relativization.

4.2 The production of relative clauses by typically developing individuals

The research in Volpato (2010b) is at the heart of much linguistic research focused on the production of relative clauses by populations with typical and atypical language development across different languages. Much 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 (Pérez-Leroux 1995; Crain, McKee, Emiliani 1990; McKee, McDaniel, Snedeker 1998; Varlokosta, Armon-Lotem 1998). Much research was also devoted to the elicited production of relative clauses (e.g. for English, Hamburger, Crain 1982; for Italian, Guasti, Cardinaletti 2003; Utzeri 2006, 2007; Re 2010; for French, Labelle 1990; Guasti, Cardinaletti 2003; for Hebrew, Novogrodsky, Friedmann 2006).

The earliest studies focusing on the elicitation of relative clauses in Italian by typically developing individuals were Guasti and Cardinaletti (2003) and Utzeri (2006, 2007). In Guasti and Cardinaletti (2003), a group of Italian-speaking children (age range 5;1-10;0) participated in an experiment eliciting different types of relative claus-

es (subject relatives, direct object relatives, indirect object relatives, locative relatives, genitive relatives). The elicitation task was an adaptation to Italian of the test used by Hamburger and Crain (1982). Results demonstrated that in the production of both subject and direct object relatives, children showed adult-like performance: the sentences were introduced by the complementizer *che* and rarely contained resumptive pronouns. Subject relatives were always correctly produced and were also used when other types of relatives were targeted. Target object relatives were sometimes avoided and turned into subject relatives through passivization of the verb, as in the following example:

(98) 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.'

In one case, in Italian, the relative operator *dove* replaced the complementizer in object relatives, and the child also inserted a resumptive pronoun in the embedded sentence:[27]

(99) 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)

Utzeri (2006; 2007) investigated the production of subject and object relative clauses by 41 Italian-speaking children aged between 6 and 11 years and 30 adults from 15 to 73 years of age. She elicited subject and object relative clauses by using a picture description task and a preference task, previously adopted by Novogrodsky and Friedmann (2006) and Friedmann and Szterman (2006) to test these structures in Hebrew-speaking typical and atypical populations. The DPs included in the experimental sentences of the task were all singular. Utzeri (2006; 2007) found that both children and adults correctly produced the targeted subject relatives. As for object relatives, children produced 22% of the elicited target sentences. Three types of object relatives were found in the corpus: with gaps (*La bambina che la mamma copre* 'The child that the mother wraps up'), with resumptive pronouns (*La bambina che la mamma la copre*

27 The study by Guasti and Cardinaletti (2003) also investigated the performance of a group of French-speaking children (age range 4;5-7;3). As in Italian, French direct-object relatives rarely contained resumptive pronouns. In French direct-object relatives, the complementizer *que* was sometimes replaced by *où*, and a resumptive pronoun also occurred (62% of cases).

'The child that the mother her wraps up'), and with resumptive DPs (*La bambina che il nonno bacia la bambina* 'The child that the granddad kisses the child').

Among the strategies adopted in order to simplify the production of object (and sometimes subject) relatives, resumption is largely used. Much research has demonstrated that children heavily rely on resumptive pronouns when producing relative clauses (for Italian, Belletti, Contemori 2010; Guasti, Cardinaletti 2003; Pivi 2014; Pivi, Del Puppo 2015; Utzeri 2006, 2007; Volpato 2010b; for French, Labelle 1990; Guasti, Cardinaletti 2003; for English, De Villiers 1988; Pérez-Leroux 1995; for Serbo-Croatian, Goodluck, Stojanovic 1996; for Spanish, Ferreiro et al. 1976; Pérez-Leroux 1995; for Hebrew, Friedmann, Szterman 2006). While in some languages the presence of resumptive pronouns is licit (e.g., Hebrew), in others, the massive use of resumptive pronouns in relative clauses is only attested in child language (e.g., French and Italian) and in informal speech and spoken colloquial language by people of different socio-economic backgrounds (Cinque 1988).[28]

Conversely, object relatives with resumptive DPs are frequent in young children's language (Pivi, Del Puppo 2015; Utzeri 2006, 2007; Volpato 2010b) but are not found in adults' productions.

The use of resumption has been identified as an important cue offering insights into the nature of grammar and language acquisition. Chomsky (1995; 2000; 2001) proposed that movement involves the creation of copies of the displaced constituent and deletion of all copies, but one. The use of resumption provides instances of sentences in which more than one copy is pronounced. 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.

Note that while object relatives are frequent in child productions, they are almost absent in adults. Indeed, adults produced less than 1% of the targeted sentences. Children and adults adopted various

28 In Italian, as well as in other Romance varieties (Spanish, northern Italian dialects), resumptive pronouns are also used in other types of relatives (Cinque 1988):
(i) Indirect object relative:
Sono un tipo che gli piace rischiare
(ii) am a fellow that to-him 'pleases' [to] risk
(ii)Locative relative:
È una libreria che ci vado ogni tanto
(It) is a bookstore that (I) there go from time to time

strategies turning the targeted object relatives into subject relatives. The strategies that Utzeri (2006; 2007) identified were passive constructions (100) (also see (98)), causative constructions (101), use of 'receive+DP' (102), verb change (103):

(100) 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

(101) 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'

(102) Target il bambino che la mamma bacia
the child that the mother kisses
Productionil bambino che riceve un bacio dalla mamma
the child that receives a kiss by the mother

(103) Target Il bambino che il nonno ascolta
The child that the granddad listens-to
ProductionIl bambino che legge al nonno
The child that read to the granddad

What is crucial in Utzeri (2006; 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 (93%).

In addition to object relatives, children produced 23% of causative constructions. In the group of adults, this strategy shows a low percentage of occurrence (3%). Causative constructions are thus frequent in child's productions, but at some point, they tend to decrease (on a par with object relatives) with increase in age.

The materials included in Utzeri's (2006; 2007) task showed some limits. Subject relatives contained animate subjects and inanimate objects. Instead, in object relatives, both referents were animate. This fact may have some consequences on the type of sentences that the participants have produced. Indeed, since in object relatives, the embedded singular DP may occur postverbally, and since the head DP is also singular, the produced sentences might be ambiguous between a subject and an object reading.

Another limit of the study by Utzeri (2006; 2007) is the fact that adolescent participants are included in the group of adults. As pointed out in chapter 3, the linguistic competence of some adolescents is not adult-like yet, and the performance is, in some respects, simi-

lar to that of younger participants. For this reason, adolescents' performance should be analysed separately from adults' one (and from children's one).

The research I carried out during my PhD aimed at contributing to the debate on the production of relative clauses, taking into consideration all these aspects, namely the use of animate referents for both subject and object relatives, and the creation of a group of adolescent students to be compared with a group of young children and a group of adults. The detailed description of the task and the results obtained are presented in the following sections.

4.3 The production of relative clauses: the task

The production task was inspired by the studies carried out by Friedmann and Szterman (2006) and Utzeri (2006; 2007), but with important improvements.

The task was composed of thirty-six trials, 12 eliciting a subject relative, 12 eliciting an object relative, and 12 filler sentences. In experimental items, all DPs have animate referents, and number was manipulated: both singular and plural head DPs were used. In twelve sentences, the head was singular, and in twelve, the head was plural, thus allowing the production of sentences with match or mismatch conditions. The presentation of filler items required the production of simple SV or SVO word order sentences. The list of trials is shown in Appendix C.

Two examples of items eliciting a subject and an object relative clause with singular head DP are shown respectively in Figure 7 and Figure 8:[29]

29 In the original tasks (Friedmann, Szterman 2006; Utzeri 2006; 2007), the question by the experimenter was: "Which child would you rather be?" (Italian: *quale bambino vorresti essere*?). In the trials presented in this experiment, the question by the experimenter was "Which child/children do you like (the most)?". The question was changed because for individuals with hearing impairment, the use of the conditional mood may cause troubles in the interpretation of the question (*vorresti*) and/or in the targeted production (*vorrei*). In order to avoid incorrect responses due to the incorrect use of the conditional mood, the use of simple indicative tense sentences was preferred.

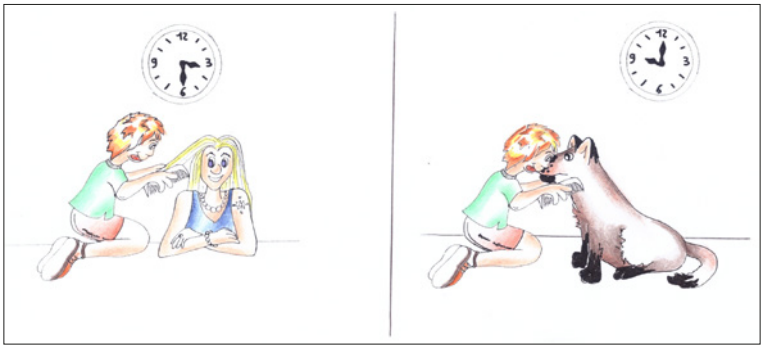


Figure 7 Elicitation of a subject relative (singular head)

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)? 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 first, a child is combing the mother. In the second, 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.

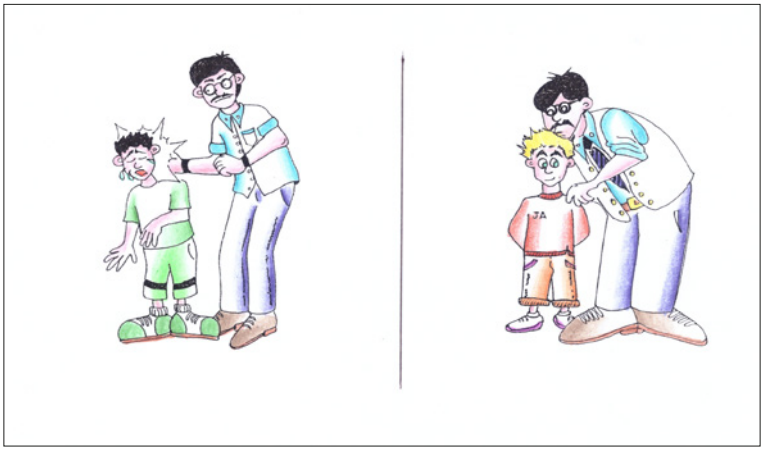


Figure 8 Elicitation of an object relative (singular head)

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 first, the father is hitting a child. In the second, 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.*

Two examples of items eliciting a subject and an object relative clause with plural head NP are shown respectively in Figure 9 and Figure 10:

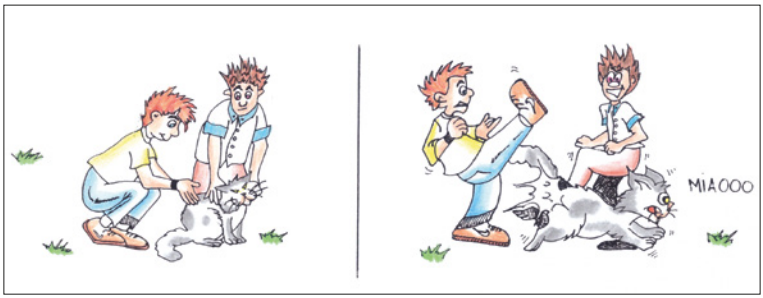


Figure 9 Elicitation of a subject relative (plural head)

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 first, the children stroke the cat. In the second, 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.

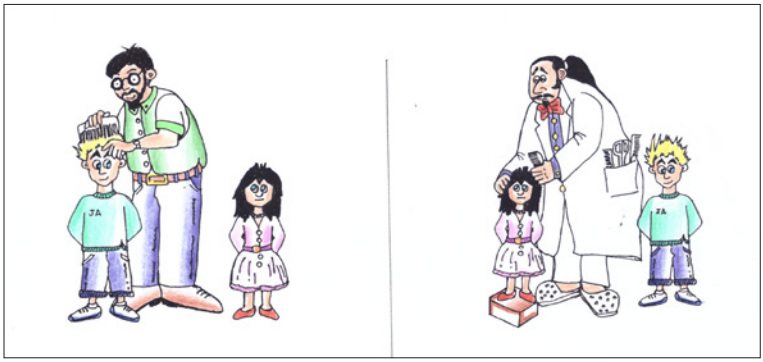


Figure 10 Elicitation of an object relative (plural head)

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 first, the father is combing a child. In the second, 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.

An example of item eliciting a filler sentence is shown in Figure 11:

Figure 11 Elicitation of a filler sentence

Cosa fa l'orso? Target: L'orso legge (un libro).
What is the bear doing? The bear is reading (a book).

The production task satisfies the felicity conditions pointed out by Hamburger and Crain (1982). Hamburger and 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 anyway express a preference for one of the two options.

Experimental trials 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 children with hearing impairment (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, all participants were familiarized with the nouns and verbs presented in the task. A training part preceded the experimental part, in order to familiarize participants with the items and the experimental setting, and to make sure that they had correctly understood instructions.

All participants' productions were audio-recorded and then transcribed for the analysis. For further details on the procedure adopted to test production, see chapter 2, section 2.11.

In the following sections, I present the results obtained comparing typically developing children, adolescents, and adults.

4.4 The comparison between typically developing children, adolescents and adults

The aim of this analysis is 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 investigate 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 developed at adolescence.

4.4.1 Participants

In this study, 16 monolingual Italian-speaking hearing children were compared to a group of 16 adolescents and a group of 16 adults.[30] A detailed description of the groups involved in this study is provided in chapter 2.

30 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.

4.4.2 Results

The percentages of target subject relatives and object relatives correctly produced are shown in Table 25:

Table 25 Number and percentages of target responses for each group on each sentence type

	Children		Adolescents		Adults	
SR	174/192	91%	192/192	100%	190/192	99%
OR	34/192	18%	0/192	0	0/192	0

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%. The group of children made some errors in subject relatives. Despite this, the percentage of correct responses is very high, above 90%. However, children performed significantly lower than both adolescents and adults ($p<.001$ for both comparisons). As for object relatives, adolescents and adults never produced any of them, preferring instead the production of different types of subject relatives. Children produced a small amount of object relatives, replicating the findings by Utzeri (2006; 2007). The asymmetry found in previous studies between subject and object relatives is replicated.

4.4.3 Answering strategies in subject relative clauses

As we have seen in the previous section, in most cases subject relatives were correctly produced. In few cases, target (correct) subject relatives were replaced by incorrect productions.

In adults, only 2 sentences (out of 192) did not correspond to the target ones. One participant did produce a subject relative, but she used an intransitive verb instead of the target transitive (*Mi piace il bambino che corre dietro all'orso* instead of: *Mi piace il bambino che rincorre l'orso*). Another participant produced a passive relative instead of the target subject relative *(Il bambino che viene guardato dalla zebra* instead of: *Il bambino che guarda la zebra*).

Children produced the highest number of non-target responses, and in order to overcome the difficulties deriving from the production of a relative clause, they resorted to various strategies. They used other filling *wh-* elements instead of the complementizer (104), they produced incomplete sentences (105), they produced simple SVO sentences, preceded by *Mi piace che* 'I like that' (106) and in one case, a participant used a resumptive DP in the embedded subject posi-

tion (107):

(104) 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

(105) Target: I bambini che salutano il papà
The children that greet the father
Production salutano il papà
[they] greets the father

(106) 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

(107) 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

Table 26 summarizes the answering strategies used by each group and the number and percentage of occurrence of the different types of responses.

Table 26 Answering strategies for targeted subject relatives

	Children		**Adolescents**		**Adults**	
	No.	**%**	**No.**	**%**	**No.**	**%**
SR	174	90%	192	100%	190	99%
DP resumption	1	1%	0	0%	0	0%
Incomplete sentence	5	2%	0	0%	0	0%
wh- filler	6	3%	0	0%	0	0%
SR>OR	1	1%	0	0%	1	1%
SVO sentence	4	2%	0	0%	0	0%
Other strategies	1	1%	0	0%	2	1%

4.4.4 Answering strategies for targeted object relative clauses

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 postverbal position, and no resumptive element was produced (*Il bambino che il papà bacia* 'the child that the dad is kissing'). Neither adolescents nor adults pro-

duced any object relative. Only children produced object relatives. Some children produced object relatives with gap and with resumptive elements in the embedded clause. As already pointed out in section 4.2, object relatives containing resumptive clitic pronouns are found in colloquial Italian.

The strategies adopted to overcome the difficulties deriving from object movement are different. For some items in which the two DPs displayed the same number features, the participants produced ambiguous sentences (108).

(108) Target I bambini che i cani baciano
The children that the dogs kiss
Production I bambini che baciano i cani
The children that kiss the dogsor
The children that the dogs kiss

To avoid relativization of the object, in some cases, the participants used other strategies that are appropriate for the context, namely they turned the object relative into a subject relative producing causative constructions (109) and passive relatives (110).

(109) Target I bambini che i cani baciano
The children that the dogs kiss
Production I bambini che si fanno baciare dai cani
The children that make themselves kiss by the dogs

(110) Target I bambini che la maestra premia.
The children that the teacher prizes.
Production I bambini che vengono premiati
The children that are prized.

When avoiding beginning the sentence with the required hint "*Mi piace il bambino*", the participants turned the embedded subject into the head of the relative clause (head inversion), as in the following example:[31]

(111) 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 some cases, the correct relative clause was avoided by placing the complementizer *che* 'that' immediately after *Mi piace* 'I like' (see al-

31 In this case, thematic roles were correctly assigned.

so example (106) on subject relatives). In this way, a SVO clause is the subject of *piacere*, as the following example shows:

(112) Target: Mi piacciono 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

A variety of other strategies are found, however with lower percentages of occurrence: use of different *wh-* fillers (113), use of reflexive *si* (114), and production of subject relatives with theta role inversion (115):

(113) Target: Il bambino che la mamma bacia
The child that the mother kisses.
Production: (Mi piace) questo bambino, perché la mamma bacia lui…
(I like) this one because the mother kisses him

(114) 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'

(115) Target: Il bambino che il cane insegue
The child that the dog chases.
Production: I bambini che inseguono il cane
The children that chase the dog

Some relatives were produced by modifying the verb and/or paraphrasing the sentence to avoid relativizing the object, and they were coded as 'other strategies' as in the following example:

(116) 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.

The strategies adopted by each group when an object relative was targeted are summarized in the following table:

Table 27 Answering strategies for targeted ORs by each group (out of 192 expected responses for each group)

	Children		Adolescents		Adults	
	No.	**%**	**No.**	**%**	**No.**	**%**
Object relatives with gap (target)	34	18%	0	0%	0	0%
Object relatives with resump. clitic pronoun	37	19%	0	0%	0	0%
Object relatives with resump. DP	11	6%	0	0%	0	0%
Ambiguous sentences	22	11%	21	11%	3	2%
Passive relatives	6	3%	158	82%	189	97%
Causative constructions	18	9%	7	4%	0	0%
Ungramm. sentences/various errors	2	1%	3	2%	0	0%
Use of different *wh-* 'fillers'	5	3%	0	0%	0	0%
Use of reflexive 'si'	2	1%	0	0%	0	0%
Simple SVO sentence (no RC)	11	6%	0	0%	0	0%
Theta-role inversion	3	2%	1	1%	0	0%
Head inversion	29	15%	2	1%	0	0%
Other strategies	12	6%	0	0%	0	0%

As opposed to adolescents and adults, children adopted a wide variety of strategies. They produced a high number of object relatives (considering both target relatives and relatives with resumptive elements) as opposed to the older age groups. Conversely, the older participants (adolescents and adults) largely produced passive relatives. Sometimes the group of children produced subject relatives with causative constructions to avoid object relativization, replicating previous findings by Utzeri (2006; 2007). In some cases, due to the difficulty to handle object relatives, children produced subject relatives by turning the embedded subject into the relative head (15% of occurrences) or totally avoided the relative clause producing a simple SVO sentence instead.

Adolescents differed from children as far as the types of answering strategies are concerned. They never produced object relatives, which were replaced by subject relatives. Instead, they produced a very high percentage of passive relatives (92%), thus showing a trend towards adult-like performance. Nonetheless, many ambiguous sentences (11%) and a small percentage of causative constructions (4%) and ungrammatical sentences (2%) were found, replicating a linguistic behaviour found in younger participants. In 1 sentence, they incorrectly considered the head as the subject of the embedded clause (Theta role inversion), and in 2 sentences, they comprehended the-

matic 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 (head inversion).

Adults, like adolescents, avoided the production of object relatives. They only produced subject relatives, in almost all cases, through passivization of the verb. Only in three trials, the adult participants produced ambiguous structures.

What is worth pointing out is that in the group of children some causative constructions are found. Then, this strategy starts being avoided with increase in age, and in adolescents the percentage of occurrence is very small. In the group of adults, the causative construction is no longer found.

In sum, these data replicate previous findings on children and adults, and most interestingly, show that the performance of adolescents differs to some extent from that of adults. These findings suggest that adolescent students must be kept separate from adults in studies on language acquisition and that it is important to also investigate the linguistic behaviour of this population, as it can provide interesting insights into the process of language development.

Based on the results and on the answering strategies used by participants, the following sections are devoted to the discussion of the results, focusing on the asymmetry between subject and object relative clauses, and on the asymmetry between object relatives and passive relatives.

4.5 The asymmetry between subject and object relatives

The first important finding of the comparison between children, adolescents, and adults is that the percentages of target subject relatives are very high for all participants, while object relatives show very low percentages of occurrence. This result replicates previous studies on Italian (as well as other languages). Processing-based and grammatical approaches (see chapter 2 and 3) 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 (117), as opposed to object relatives, in which the movement takes place from the embedded object position (118), involving the establishment of a longer relation between the two positions:

(117) Mi piacciono [i bambini [che <i bambini> accarezzano il gatto]
▲ _____|

(118) Mi piacciono [i bambini [che il papà pettina <i bambini>]
▲_____|

Several studies highlighted that syntactic complexity and long-distance relations place a heavy load on performance systems (De Vincenzi 1991; Gibson 1998; Jakubowicz, Tuller 2008; Contemori, Garraffa 2010; Jakubowicz 2011; Tuller et al. 2011).

Friedmann, Belletti, and Rizzi (2009) discussed the asymmetry between subject and object relatives in terms of locality and intervention (RM) effects due to the presence of an intervening lexically restricted noun phrase in object relatives between the head in the main clause and its trace in the embedded object position.

Belletti (2009) and Friedmann, Belletti, and Rizzi (2009) suggested that in object relatives, the derivation is blocked and disfavoured for children due to the intervention of the full DP in the embedded subject position. Hence, a rigid version of RM is at play in child grammars.

However, these findings raise some important questions. If this assumption is correct and RM is at play in immature grammars, why do young children also correctly produced object relative clauses? This is unexpected. Conversely, if RM is a source of difficulty especially for children, why do we not find any object relatives in the adults' production corpus?

In what follows, I suggest that children's and adults' performance does not have to be traced back to RM but to some other linguistic phenomenon occurring in the derivation of object relatives together with developmental processes. I will discuss these aspects in the next sections.

4.6 The asymmetry between object relatives and passive relatives

When object relatives were targeted, children adopted a high number of strategies in order to avoid object relativization. Despite the difficulty of these structures, typically developing children do produce object relatives, replicating data collected by Guasti and Cardinaletti (2003), Carpenedo (2009) and Utzeri (2006; 2007) on other Italian-speaking children.

Typically developing children produced a considerable number of object relative clauses (36%). Adults and adolescents did not produce any target object relative and preferred producing subject relatives through passivization of the verb (passive relative clauses). Adults produced 97% of passive relative clauses, whereas the percentage of production of these structures by adolescents was 82%. The high percentage of passive relatives in adults replicates the data collected by Utzeri (2006, 2007) on this population (93%). In children, the percentage of passivized structures is very low (3%), as opposed to older participants.

Since the main trend is that passive relatives consistently increase and object relatives finally disappear with increase in age, the discussion focuses on the use of these two options, leaving aside all the other strategies. I 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 behaviour of typically developing children, adolescents, and adults, the recent proposal by Collins (2005) on the representation of passive sentences and those in Belletti (2009) on the source of difficulty in the acquisition of object relative clauses are discussed.

4.7 The production of passive constructions

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 the former strategy more often than the latter. However, passive sentences appear far from being fully mastered at early stages of language development. How can this be explained? To answer this question, it is necessary to proceed step by step, first analyzing the syntactic properties of passive sentences.

The active sentence in (119) may be passivized as in (120):

(119) Il papà pettina il bambino.
The father combs the child.

(120) 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. The object (internal argument) of the active sentence, *il bambino* 'the child', becomes the grammatical subject of the passive sentence. The subject (external argument) of the active sentence, *il papà* 'the father', becomes the oblique object of the passive sentence introduced by the preposition *by.* Passive sentences represent problematic structures because they contain movement and long-distance dependencies between the sentence constituents.

Early accounts (Jaeggly 1986) suggested that passive sentences involve A-movement and are derived through direct raising of the object DP to the specifier of IP. The internal argument receives the thematic role from the trace in the original position, with which it is coindexed. By reaching the subject position, the internal argument triggers agreement on the inflected verb.

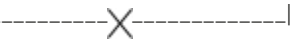
More recent theories (Collins 2005), based on data from English, proposed that the derivation of passive sentences is slightly more complex, because more derivational steps are involved. Collins proposed that passive sentences are derived through *smuggling*. *Smuggling* occurs when the movement of the internal argument over an external argument is required, but minimality effects arising between elements of the same featural class (Rizzi 2004b, see section 3.2) block the relationship between the original object position and its final landing site.

Smuggling is defined by Collins (2005, 97) as follows:

(121) 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.

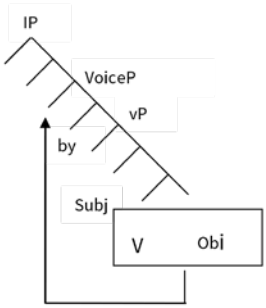
This definition is illustrated as follows:

(122) Z [$_{YP}$ XP] W <[$_{YP}$ XP]>



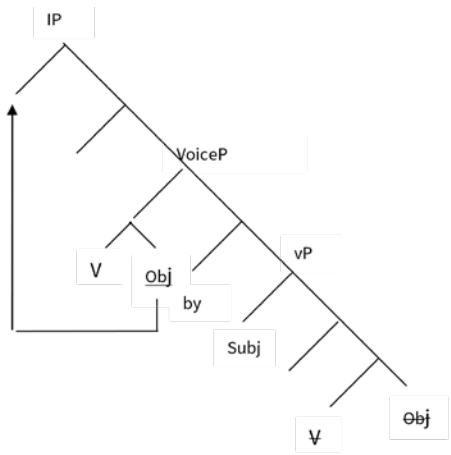
Smuggling is the operation which avoids intervention in passive sentences. The external argument, the subject in Spec/vP, represents a blocking element for the movement of the VP-internal direct object to a position higher than vP. For this reason, *smuggling* of the Verb+Object (VP) projection makes 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*.

(123)



From there, the object alone moves to a still higher position, the specifier of IP, without producing any RM violation:

(124)



In the same way as (simple) passive sentences, passive relatives are derived through *smuggling* and subsequent object extraction to perform relativization in a higher position (Belletti 2009):[32]

(125) DP [$_{CP}$ NP_{obj} che [$_{IP}$ *pro* aux [V <NP_{obj}>] *by*… [$_{vP}$ DP_{subj} < [V NP_{obj}]>]]]]

il bambino che è pettinato <il bambino> dal papà <pettinato il bambino>
the child that is combed <the child> by the father <combed 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 subject position is filled with the expletive pronoun *pro*. As (125) 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

32 Following (Belletti 2009), we assume that in passive subject relatives, subject movement does not occur through the EPP preverbal subject position, because this is a criterial position and movement would be blocked there (Rizzi 2006; Rizzi, Shlonsky 2007).

and A' movements occur in the derivation. Therefore, the presence of two different chains is involved.

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. Therefore, object relatives are derived through A' (long) movement of the VP-internal object to the left-peripheral position, CP, as the following example shows:

(126) 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>'

The correct production of target object relatives by (young) children 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 (126), as opposed to passive relatives, in which more local steps are necessary to build up the syntactic structure (125).

Belletti (2009) suggested that the use of passive relatives represents the most economical solution to realize the structure, since intervention effects are no longer present. The availability of *smuggling* makes it possible for children to shift from object relatives to passive relatives when they grow older. There is not an exact moment in which this property becomes available. Indeed, as we have seen, children also produce passive relatives. Children seem to have a wide range of possible strategies available in their grammar to convey meaning. Then, depending on the linguistic resources available at a specific stage, they will opt for either a structure or the other.

Importantly, it is not possible to argue that maturation is at stake here. If *smuggling* were not available at all in early grammars, passive sentences should never be comprehended or produced by very young children. Evidence to the contrary has however accumulated over the years across different languages (a.o., for English, O'Brien, Grolla, Lillo-Martin 2006; Bencini, Valian 2008; Messenger et al. 2009; for Sesotho, Demuth, Moloi, Machobane 2010; for Italian, Verin 2010; Tagliaferro 2011; Manetti 2013; Volpato et al. 2013; Volpato, Verin, Cardinaletti 2014; 2016).

The higher percentage of object relatives than passive relatives in child language can be explained in terms of agreement relations between sentence constituents. Along the lines of Franck et al. (2006) and Guasti and Rizzi (2002), in object relatives with SV word order, the agreement relationship is established both under AGREE and in the local Spec-Head configuration, as shown in the following repre-

sentation:

(127) [$_{DP}$ I bambini [$_{CP}$ che [$_{IP}$ il papà [$_{t}$ pettina] [$_{vP}$ ~~il papà~~ [$_{VP}$ ~~pettina~~ <~~i bambini~~>]]]]]
|Spec-Head||_AGREE|

In passive relatives, which display a VS word order, the agreement relation between the inflected verb and the internal argument, the patient only occurs under AGREE (after *smuggling* has taken place):

(128) [$_{DP}$ Il bambino [$_{CP}$ che [$_{IP}$ è [pettinato <il bambino>] dal [$_{vP}$ papà [$_{VP}$ ~~pettinato~~ <~~il bambino~~>]]]]]
|___AGREE____|

Object relatives are therefore more accessible than passive relatives since the agreement relationship occurs both under AGREE and in the Spec-Head configuration (see (127)). On the other hand, in passive relatives this relationship is more fragile since no local checking in a Spec-head configuration takes place (128) (cf. Franck et al. 2006).

Summing up, 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. When *smuggling* becomes fully available, local movement steps constitute the most economical solution and are therefore highly preferred over one unique long relationship.

The preference for a unique (long) chain is also predicted by the Derivational Complexity Metric, which states that "merging α n times gives rise to a less complex derivation than merging α (n+1) times" (Jakubowicz, Strik 2008, 106; see also Jakubowicz 2011).

In the course of language development, children replace the preference for the unique long-distance relationship (as in object relatives) with the preference for more local relationships (as in passive relatives).

4.8 The production of relative clauses: further studies

In the same years as my PhD (Volpato 2010b), the study by Belletti and Contemori (2010) also investigated the strategies that Italian-speaking typically developing children and adults adopt when object relatives are elicited.

Belletti and Contemori (2010) tested 48 children (age range: 3;4-6-5), who were compared to 28 adults (age range: 20-30 years). As in

Utzeri (2006; 2007), a preference task was used to test 10 subject and 10 object relatives. The items eliciting subject relatives contained animate subjects and inanimate objects, while in the items eliciting object relatives both the subject and the object were animate. Since a condition in which both referents are singular may cause the production of ambiguous sentences in Italian (see the discussion in chapter 2, section 2.8.2), 6 trials were added in which the agent was plural and the patient singular in order to elicit the production of unambiguous structures. A second preference task assessed the production of unambiguous object relatives in which the head was plural, and the embedded DP was singular. The analysis of all results confirmed previous findings. The percentage of subject relatives produced by the children approached (or was above) 90% by the age of 4, while the percentage of unambiguous object relatives produced at the age of 4 to 6 years is around 50%. In adults, subject relatives were at ceiling, while the percentage of object relatives was about 10%. Once again, the prevailing strategy consisted in the production of passive relatives (88%). This structure occurred at lower rates in 5- to 6-year-old children. The authors attributed the low percentage of passive relatives in the group of children until the age of 6;5 to the fact that the passive voice starts being acquired by that age. However, this cannot be the case, since, as pointed out in section 4.7, Italian children are able to produce and comprehend passive sentences already at a younger age.

In the following years, Contemori and Belletti (2013) investigated the elicited production of subject and object relatives in a larger sample of children, including 97 participants aged 3;4-8;10 years. The results confirmed the trend observed in the study by Belletti and Contemori (2010) and the behaviour observed in the data collected during my PhD and presented in the previous sections. As children grow older, the percentage of passive relatives increases more and more, while object relatives decrease and are almost avoided in adulthood, as the following table (adapted from Contemori and Belletti 2013) shows.

Table 28 Percentage of object relatives and passive relatives produced at the different ages (adapted from Contemori and Belletti 2013)

Task	Conditions	Age					
		3	4	5	6	8	Adults
Elicitation task 1	Object relatives	26%	55%	44%	39%	40%	3%
	Passive relatives	0%	5%	12%	15%	40%	97%
Elicitation task 2	Object relatives	39%	52%	52%	65%	32%	10%
	Passive relatives	0%	0%	11%	10%	55%	88%

4.9 The production of relative clauses in individuals with hearing impairment

The preference task presented in section 4.3 was also used to test a group of Italian-speaking children with cochlear implants. This part of the research was inspired by the study carried out by Friedmann and Szterman (2006), who tested a group of 14 Hebrew-speaking children with hearing impairment, ranging in age from 7;7 to 11;3 years. The group was quite heterogeneous, since it included children with different degrees of hearing loss (from moderate to profound), 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 were more attested in the latter type of sentences. They produced correctly about 80% of subject relatives. The majority of errors concerned the production of ungrammatical sentences and the avoidance of relative clause by producing a sentential complement (129) instead:

(129) 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'.

The Hebrew-speaking children with hearing impairment experienced 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 (10% of productions). In many cases, they ended up with producing ungrammatical sentences (24% of cases). Ungrammatical sentences included the use of resumptive object DPs (*This is the girl that grandma is combing the girl*), resumptive subject DPs (*This is the teddy bear that the teddy bear is hugging the clown*), and resumptive subject pronouns in subject relatives (*This is the boy that he is washing the father*). In 19% of responses, children produced grammatical object relatives without resumptive pronouns (target object relatives); instead, 42% of responses were grammatical object relatives with resumptive pronouns (*I would like to be a boy that grandma dresses him*), 6% of object relatives were turned into grammatical subject relatives (Target: *This is the girl that the nurse is photographing;* produced: *This is the girl that is looking at the camera).* Friedmann and Szterman (2006) interpreted the avoidance of object relativization and the use of the different strategies as a sign of a linguistic deficit. Indeed, the responses produced by the children with hearing impairment were different from those produced by the controls. The conclusion the authors draw was that the problematic production of object relative clauses documented a significant difficulty in

using movement-derived constructions, due to delayed and reduced access to the linguistic input.

The acquisition of subject and object relative clauses was previously investigated in English-speaking individuals with hearing impairment by De Villiers (1988). This study presented data collected from 36 orally trained adolescents with hearing impairment wearing conventional hearing aids and ranging in age from 11 to 18 years. They were compared to 20 5-to-6-year-old children. The task was an elicitation task through which the participants were forced to produce restrictive subject and object relative clauses like those shown in the examples in (130):

(130) 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 4 to 6 years produced sentences like those in (130) without any difficulty, but the participants with hearing impairment made several types of errors, among which the introduction of resumptive pronouns, mistakes in the relative pronoun, and relativization of the incorrect noun phrase. Although the performance of the participants with hearing impairment patterned with that of much younger hearing children as far as the gradient of difficulty of the four types of relative clauses, the type of sentences they produced (e.g. *the girl that petted the dog, her father is feeding the dog the food*, Target: *the girl is petting the dog that the man fed*) led the author to the conclusion that relative clauses were extremely delayed in these participants. In a later study, De Villiers, De Villiers, and Hoban (1994) suggested that the CP node is impaired in individuals with hearing impairment.

On a par with Hebrew and English, some asymmetries in the production of relative clauses (pseudo-relatives) was found in French-speaking children with mild-to-moderate hearing loss ranging in age from 7;11 to 13;11 years (Delage 2008). The group of participants with hearing impairment 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. Replicating previous results, subject relatives showed higher percentages of correct responses than object relatives in all groups (84% for the hearing group, 73% for the younger group of children with hearing impairment and 93% for the older one). In the experimental group, errors in the production of subject relative clauses included the use of simple SVO sentences, thus avoiding relativization, and the use of

où 'where' as replacing filler for the complementizer.[33]

For object relatives, the percentages of target responses were 41% for the hearing group, 23% for the young experimental group, and 0.7% in the older group. Two young participants with hearing loss produced 100% of target object relatives. However, in order to avoid object relativization, 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 participants with hearing impairment. 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'*.

Starting from these findings on other languages, my research also focused on the production of subject and object relative clauses by Italian-speaking children with hearing impairment fitted with cochlear implants. As said in section 4.2, this study was the first one in which both referents were always animate (for both subject and object relatives) and reversible, and in which the head and the embedded DP were both in the plural and in the singular, thus yielding sentences in both match and mismatch conditions. The next sections present the results of the study.

4.10 The production of relative clauses in children with cochlear implants: the first results for Italian

This section will present the results of the study carried out on Italian children with cochlear implants.

The group of 13 Italian-speaking children with cochlear implants (CI, age range 7;9-10;8) presented in section 2.10.1 was compared to a group of 13 language-matched hearing children (LA, age range 5;7-7;9) (Volpato 2010b; 2011; Volpato, Vernice 2014), to a group of 13 children matched on the length of exposure to the oral language through cochlear implants (AA, age range 4;11 to 9;4) and a group of 13 age-matched children (CA, age range 7;5 to 10;3) (Volpato, Vernice 2014). The children with hearing impairment were tested at the clinical centres where they went for their follow-up visits. Normal hearing children were tested at their schools during school hours. For further details on the procedure adopted to test production, see chapter 2, section 2.11.

The production of subject and object relatives was investigated by using the preference task presented in section 4.3. Through this task, children were forced to produce a relative clause. The list of trials is shown in Appendix C.

33 For the use of *où* in French typically developing children, see Labelle (1990) and Guasti and Cardinaletti (2003).

All participants' productions were audio-recorded and then transcribed for the analysis. In coding the responses provided when both subject and object relatives were targeted, a wide number of strategies was observed in all groups. Subject and object relatives were considered as target when they had the structure as shown in (131) and (132), respectively:

(131) I bambini che lavano la tigre
'The children that wash the tiger'

(132) I bambini che (il papà) pettina (il papà)
'The children that (the dad) combs (the dad)'

In object relatives with DP number mismatch (as in 132), the embedded subject was considered as correct when it was placed either in pre-verbal or postverbal position. In object relatives with DP number match, the structure was considered as target when the embedded subject was placed in preverbal position, in order to avoid ambiguous structures.

The percentages of target subject relatives (SR) and object relatives (OR) produced by each of the four groups are shown in the following table, taken from Volpato and Vernice (2014):

Table 29 Number (No.), Mean (M), and Standard Deviation (SD) of target responses in each type of sentence (SR: subject relative; OR: object relative) in each group (CI: children with cochlear implants; LA: language-matched hearing children; AA: children matched on auditory age; CA: age matched hearing children)

	SR			OR			TOT		
	No.	M	SD	No.	M	SD	No.	M	SD
CI (7;9-10;8)	138/156	88%	6%	10/156	6%	8%	148/312	47%	5%
LA (5;7-7;9)	154/156	99%	0.1%	22/156	14%	29%	176/312	56%	2%
AA (4;11-9;4)	150/156	96%	5%	29/156	19%	30%	179/312	57%	3%
CA (7;5-10;3)	156/156	100%	0%	21/156	13%	27%	177/312	57%	2%

Overall, results showed that for all groups (both the experimental and the control groups), accuracy is higher in subject relatives than in target object relatives. Although the pattern of performance is the same for all groups, in the group of children with cochlear implants, the percentages of accuracy of subject and object relatives is lower than in each of the control groups.

In Volpato and Vernice (2014), data were statistically analysed following Dixon (2008) and Jaeger (2008). Repeated-measure logistic regression analyses were carried out in order to analyse accuracy data, using the statistical software R (R Development Core Team 2008). Comparing the CI and LA groups, no significant difference was found

between the groups. A significant predictor was sentence type (subject vs. object relatives): $\chi^2(1) = 73.12$, $p < .001$. Overall, subject relatives are easier to produce than object relatives (Wald Z=13.02, $p < .001$). Analyses within the CI and the LA groups showed that subject relatives were more accurate than object relatives (CI: Wald Z=10.04, $p < .001$; LA: Wald Z=6.50, $p < .001$). In the comparison between the CI and the CA groups, the latter was found to perform better than the former (Wald Z= 1.93, $p < .05$). Moreover, overall, subject relatives were significantly easier than object relatives (Wald Z=11.14 $p < .001$).

In the comparison between the CI and AA groups, on overall performance, the AA group was found to perform better than the CI group (Wald Z= 1.92, $p < .05$). A significant main effect of sentence type as well was found, namely subject relatives are easier to produce than object relatives (Wald Z= 13.64, $p < .001$).

The asymmetry between subject and object relatives found in both the group of children with cochlear implants and the three groups of normal hearing children, was previously found by a considerable number of studies carried out on different populations across different languages (see 4.2 above).

Subject relatives (133) are easier than object relatives (134) because the relation between the relative head and the position from which it has moved and in which it is interpreted is short.

(133)	Mi piacciono	[i bambini	[che <i bambini>	lavano la tigre]]
	I like	[the children	[that <the children	wash the tiger]]

(134)	Mi piacciono	[i bambini	[che il papà pettina	<i bambini>]]
	I like	[the children	[that the father combs	<the children>]]

Moreover, in subject relatives the canonical unmarked SVO word order is maintained. Instead, object relatives are characterized by a longer movement and a long-distance relationships between the position in which the object is pronounced in the main clause and the merge position in which it is interpreted (134). Movement of the object produces a marked OSV (or OVS) word order. As pointed out in section 4.5, syntactic complexity and long-distance relations place a heavy load on performance systems (De Vincenzi 1991; Gibson 1998; Jakubowicz, Tuller 2008; Contemori, Garraffa 2010; Jakubowicz 2011; Tuller et al. 2011; Volpato, Vernice 2014).

The low percentage of accuracy of children with cochlear implants as opposed to normal hearing controls in both subject and object relatives may be explained by the type of dependency establishing between the position of first merge of head and the final landing position (Volpato, Vernice 2014). Although subject relatives maintain

a SVO word order, they involve A' movement. Right-branching relatives are characterized by the presence of two thematic relations, since the subject or the object of the relative clause are the object of the main clause. The fact that also subject relatives are problematic for children with cochlear implants is likely due to the presence of movement and the computation of an element with respect to two verbs. In example (133), for instance, the DP *i bambini* 'the children' is the object of the verb *piacere* 'to like', but it is also the subject of the verb *lavare* 'to wash'.

A further analysis carried out by Volpato and Vernice (2014) on the group of children with cochlear implants aimed at investigating whether a correlation exists between performance on subject and object relatives and clinical variables (i.e., length of cochlear implant use, age of hearing aid fitting, and age of cochlear implantation). Interestingly, the length of cochlear implant use was found to positively correlate with the production of subject relatives ($r = .23$ $p < .004$). Children using a cochlear implant for a longer time appear to have better linguistic outcomes in this structure than children using it for a shorter period of time. Previous studies highlighted the association between syntax development and duration of use of cochlear implants in children with hearing impairment (e.g. Schorr, Roth, Fox 2008).

In the elicitation of both subject and object relatives, different strategies were found. These strategies are detailed in the following sections separately for subject and object relatives.

4.11 Answering strategies for targeted subject relatives

In subject relatives, only the target structure shown in (131) is appropriate for the context. The other strategies, which were not appropriate, consisted in the production of simple SVO word order sentences without relativization (135), relative clause in which the complementizer *che* 'that' was replaced by a different wh-filler (such as *dove* 'where') (136), subject relatives with theta-role inversion, in which an object relative was produced instead of a subject relative (137), sentences in which the complementizer *che* was omitted (138), ungrammatical sentences (139), incomplete relatives (140):

(135) 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'

(136) 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 where (he) lifts the elephant'

(137) Target: I bambini che baciano la bambina
'The children that kiss the child.FEM'
Production: I bambini che bacia la bambina
the children that kisses the child.FEM
'The children that the child.FEM kisses'

(138) Target: Mi piace il bambino che guarda la tigre
'The child that looks at the tiger'
Production: Mi piace il bambino … guarda la tigre
'I like the child... looks at the tiger'

(139) Target: Il bambino che rincorre l'orso
'The child that run after the bear'
Production: Il bambino rincorrere l'orso
'The child to-run-after the bear'

(140) Target: Mi piace il bambino che pettina il cane
'I like the child that the combs the dog'
Production: Mi piace il cane
'I like the dog'

Sentences which were not included in one of the previous options were classified under the label 'Other strategies'.

The following table shows the percentages of responses provided for the different strategies when a subject relative was targeted:

Table 30 Mean (M) and Standard Deviation (SD) of answering strategies for target subject relatives in the four groups (taken from Volpato, Vernice 2014)

	CI		LA		AA		CA	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Target SRs	88%	23%	99%	5%	96%	8%	100%	0%
I bambini che accarezzano il gatto								
SVO sentence	5%	16%	1%	2%	2%	4%	0%	0%
Il bambino rincorre l'orso								
***Wh*-fillers**	2%	5%	0%	0%	0%	0%	0%	0%
Il bambino quello dove alza l'elefante								
Ungrammatical sentences/various errors	1%	3%	0%	0%	0%	0%	0%	0%
Il bambino rincorrere l'orso								
Omission of *che*	1%	2%	0%	0%	0%	0%	0%	0%
Mi piace il bambino guarda la tigre								
Theta-role inversion	1%	2%	0%	0%	0%	0%	0%	0%
I bambini che bacia la bambina								
Incomplete sentences	0%	0%	0%	0%	1%	2%	0%	0%
Mi piace il cane								

Other strategies	2%	4%	1%	2%	1%	3%	0%	0%

While for almost all trials, the groups of normal hearing children produced subject relatives correctly, children with cochlear implants used other strategies. The most frequent strategy consisted in the use of simple SVO sentences. This strategy was rare in the groups of younger hearing children, and completely absent in the group of older ones. The CI group used different *wh*-fillers instead of the complementizer *che* (*dove* 'where', *quando* 'when'), and produced ungrammatical sentences. These strategies were never used by any of the hearing groups.

The presence of a considerable number of simple SVO sentences and ungrammatical structures in productions by the participants with cochlear implants is a phenomenon observed cross-linguistically and found in studies assessing relative clause production in other populations with hearing impairment, for instance in Hebrew (Friedmann, Szterman 2006) and French (Delage 2008). Both the use of simple SVO and ungrammatical sentences can be considered a marker for atypical performance or linguistic delay in acquisition.

4.12 The use of resumption in target object relatives

In addition to the target structure with a gap in the object position, some children produced object relatives with resumptive elements, either clitic pronouns (141), or full DPs (142):

(141) Il bambino che l'orso ***lo*** accarezza
the child that the bear ***him*** caresses
'The child that the bear caresses him'

(142) Il bambino che l'orso accarezza ***il bambino***
'The child that the bear caresses ***the child***'

The following table shows the number and percentage of the three types of object relatives (target object relatives, object relatives with resumptive pronouns, and object relatives with resumptive DPs) out of the total number (156) of sentences (taken from Volpato, Vernice 2014).

Table 31 Mean (M) and Standard Deviation (SD) of resumptive relatives in the four groups (taken from Volpato, Vernice 2014)

	CI		LA		AA		CA	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Target ORs (with gap)	6%	8%	14%	29%	19%	30%	13%	27%
Il bambino che il papà lava								
ORs with resumptive clitic	10%	23%	15%	22%	8%	14%	1%	5%
Il bambino che il papa lo lava								
ORs with resumptive DP	7%	13%	4%	9%	3%	7%	0%	0%
Il bambino che il papà lava il bambino								
Total ORs	**23%**		**33%**		**30%**		**15%**	

The LA group is the group in which the percentage of occurrence of resumptive clitic pronouns is the highest as opposed to the other groups. A chi square analysis revealed a significant difference in the use of this strategy across groups [$\chi^2(3) = 9.35$ $p<.01$]. In this case, mostly the LA group contributed to the result. As for object relatives with resumptive DPs, they are more frequent in the CI than in the other groups. However, no significant difference across groups is attested. Interestingly, both strategies (resumptive DPs and resumptive clitic pronouns) are (almost) absent in the group of older normal hearing participants. As children grow older, only object relatives with gap are observed in their productions. Notice that resumptive clitic pronouns and DPs were not found when subject relatives were elicited.

The use of resumptive elements in object relatives by children with hearing impairment was previously pointed out by Friedmann and Szterman (2006) and Friedmann et al. (2008). Hebrew-speaking children with hearing impairment heavily rely on resumptive pronouns in object relatives (occurring in 42% of productions), while children with normal hearing children use this strategy more rarely (only 30% of productions). The authors justified the use of resumptive pronouns as a strategy to rescue the structure when movement is impaired, since the presence of these elements does not imply movement.

In Italian, resumptive pronouns in object relatives are found to the same extent in both the group of children with cochlear implants and the group of younger normal hearing children (LA and AA groups), but they are almost absent in the group of older children (CA group). For Italian, the hypothesis proposed for Hebrew cannot be adopted. The percentage of object relatives with resumptive pronouns is very similar in the CI group and in the LA and AA groups, and it is not possible to hypothesize that normal hearing children cannot access syntactic movement (Volpato, Cardinaletti 2015). Furthermore, empirical evidence shows that the relative clauses produced by Italian-

speaking children are derived by movement (Guasti, Shlonsky 1995; Guasti et al. 1997; Guasti, Cardinaletti 2003), and the same is true for relatives containing resumptive pronouns in Italian (Belletti 2005).

Moreover, resumptive pronouns in Hebrew and Italian have a different status: they are strong in Hebrew and clitic in Italian. This entails a different analysis for these elements in the two languages. Italian should be considered on a par with Palestinian Arabic, another language in which object relative clauses contain resumptive clitic pronouns and for which a movement analysis is proposed (Friedmann, Costa 2011). The proposal put forward for Hebrew cannot be adopted for the Italian participants with cochlear implants, since these children are able to perform syntactic movement. Rather, they prefer opting for strategies (resumptive pronouns) that are typical of the Italian colloquial register (Guasti, Cardinaletti 2003).

In addition to object relatives with resumptive clitic pronouns, structures with resumptive DPs were also found in children with cochlear implants as well as in the groups of younger typically developing children. In the group of age-matched controls, this construction is not found. Resumptive DPs were also observed in Hebrew children with hearing impairment, with a percentage of occurrence similar to that of the Italian participants with cochlear implants (7%). The hypothesis put forward for Hebrew by Friedmann et al. (2008) is that the copy of the head DP in the first merge position is spelled out because of an impaired PF component.

Again, this hypothesis cannot be adopted for Italian. As we have seen, Italian normal hearing children (groups LA and AA) also produce object relatives with resumptive DPs. For this populations, it cannot be hypothesized that the PF component be impaired. A different hypothesis should be formulated. Although object relatives with resumptive DPs (referred to as *double-headed* by Cinque 2011) are not grammatical in Italian, they are found in many adult languages (e.g., Papuan, Niger-Congo, Austronesian, and Chadic). Hence, Italian children who use resumptive DPs in object relatives are exploiting a possibility made available by UG. Volpato and Cardinaletti (2015) suggested that language acquisition is characterised by a learning-by-forgetting mechanism. Children have a wide variety of possible relative clauses made available by UG. Thanks to the input to which they are exposed, they abandon (forget) the possibilities which are not consistent with the target language. The fact that in children with cochlear implants, the percentage of occurrence of resumptive DPs is higher than in age-matched control and comparable to young hearing children may be a sign of linguistic delay due to the auditory deficit. Exposure to language starts later for them and, due to the partial and degraded input they manage to access, they probably need more time to set the parameters correctly and acquire the possibilities offered by the target language. The

authors conclude that the presence of resumptive DPs in object relatives does not imply problems with syntactic movement and/or impairments in the PF component.

4.13 Answering strategies in target object relatives

Several different strategies were found in the participants' productions when object relatives were targeted. Sometimes, when in object relatives both DPs displayed the same number features, children produced ambiguous sentences, namely sentences in which either a subject or an object reading was possible:

(143) 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.

Although Italian allows for postverbal subjects, we are not sure that the children were using an object relative. For this reason, sentences like those in (143) were kept separate in the analysis from both subject and unambiguous object relatives.

In some cases, when object relatives were targeted, the participants used the same strategies they also used for targeted subject relatives. They produced non-target sentences with theta-role inversion in which a subject relative was produced instead of an object relative (144), object relatives in which the complementizer *che* was replaced by a different *wh*-filler (such as *dove* 'where') (145), sentences in which the complementizer *che* was omitted (146), ungrammatical structures (147), and incomplete sentences, in which only a portion of the sentence was uttered (148):

(144) 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

(145) Target: Il bambino che il papà lava
'The child that the father washes'
Production: Mi piace il bambino quello dove il papà lava
'I like the child the one where the father washes'

(146) Target: Mi piace il bambino che il dottore guarda
'The child that the doctor looks at'
Production: Mi piace il bambino … il dottore guarda
'I like the child... the doctor looks at'

(147) Target: Il bambino che il cane segue
The child that the dog follows
Production: Mi piace il bambino così cammina e così il cane insegua
I like the child so walks and so the dog follow.SUBJ.MOOD

(148) Target: I bambini che la maestra premia
'The children that the teacher praises'
Production: Premia i bambini
'(She) praises the children'

In addition to these context-inappropriate productions, other strategies, which are only found when object relatives were elicited, consisted in the production of passive relatives (149) and causative constructions, built with *farsi* + verb 'to make oneself + verb', as in (150). Both types of sentences, in which a subject relative is produced instead of an object relative, are grammatical and appropriate for the context:

(149) Il bambino che è pettinato dal papà
'The child that is combed by the father'

(150) Il bambino che si fa pettinare dal papà
the child that himself makes comb by the father
'The child that has himself combed by the father'

Answering strategies that were not included within any previous coding category were classified as 'Other strategies'. One of these strategies is shown in the following example:

(151) 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 takes his dog for a walk'

The list of all strategies used by each group when object relatives were elicited are reported in Table 32. Under the label 'Object relatives', target object relatives with gap, object relatives with resumptive clitic pronouns, and object relatives with resumptive DPs are all grouped together ('Total ORs' in Table 31):

Table 32 Mean (M) and Standard Deviation (SD) of the different answering strategies for targeted object relatives (taken from Volpato, Vernice 2014)

	M	SD	M	SD	M	SD	M	SD
Object relatives	23%	30%	33%	34%	30%	30%	15%	27%
Ambiguous sentences Il bambino che bacia la mamma	17%	16%	11%	7%	15%	15%	13%	20%
Passive relatives Il bambino che è lavato dal papà	26%	41%	14%	28%	15%	26%	42%	39%
Causative constructions Il bambino che si fa lavare dal papà	3%	12%	21%	32%	21%	33%	27%	35%
***Wh*-fillers** Il bambino quello dove il papà lava	6%	14%	0%	0%	0%	0%	0%	0%
Simple SVO sentence Il papà pettina i bambini	6%	12%	2%	5%	1%	2%	0%	0%
Theta-roles inversion I bambini che baciano il cane	4%	6%	1%	2%	1%	2%	1%	5%
Head inversion Il papà che pettina i bambini	3%	6%	10%	16%	6%	14%	0%	0%
Omission of'*che* Mi piace il bambino…guarda il dottore	1%	3%	0%	0%	0%	0%	0%	0%
Incomplete sentences Premia i bambini	0%	0%	1%	5%	1%	5%	0%	0%
Ungramm. sent./other errors Il bambino così cammina e così il cane insegua	3%	5%	0%	0%	0%	0%	0%	0%
Other strategies	8%	9%	8%	12%	10%	12%	2%	5%

Volpato and Vernice (2014) investigated the asymmetries observed between the different groups (CI, LA, AA, and CA) when object relatives were elicited. For some strategies, namely object relatives and passive relatives, the CI group is at an intermediate position between the groups of younger hearing children (LA and AA) and the group of older participants (CA group). The CI group produced less object relatives than the LA and AA groups, but more than the age-matched controls. Conversely, the CI group produced more passive relatives than the LA and AA groups, but less than the CA group. The CA group is the group in which the use of passive relatives showed the highest percentage of occurrence. Indeed, the significant difference in the use of passive relatives [$\chi^2(3) = 9.27$, $p<.01$] is provided by the CA group.

A strategy which was very frequent in normal hearing children, but rare in the group of children with cochlear implants consisted in the use of causative constructions (*farsi* + verb 'to make oneself + verb'). Conversely, some other strategies were more frequent in the CI group than in the normal hearing groups (simple SVO sentences and theta-role inversion).

Some strategies which are only used by children with cochlear implants are the production of *wh*-fillers replacing the complementizer (such as *dove* 'where', *quando* 'when'), the production of sentences in which the complementizer is omitted, and the production of ungrammatical sentences. These strategies are never used by the three control groups. Remember that ungrammatical sentences were also found in the subject relatives produced by the CI group (see section 4.11).

In the two groups including young hearing children (LA and AA), object relatives were replaced by subject relatives by turning the embedded subject into the relative head. Although such a structure is not appropriate for the context, it nonetheless shows that thematic roles are correctly assigned, contrasting with what happens in sentences in which theta-roles are reversed.

A strategy occurring to the same extent in all populations and showing no performance difference across groups consists in the use of ambiguous sentences.

Volpato (2011), Volpato and Vernice (2014), and Volpato and Cardinaletti (2015) discussed some of these findings focusing on the use of some specific strategies, namely resumptive relatives, causative constructions, target object relatives, and passive relatives.

4.14 The use of causative constructions in children with cochlear implants

A strategy that was largely found in the groups of normal hearing children, especially in the younger ones, consisted in the production of causative constructions, an example of which is reported in (152):

(152) I bambini che si fanno lavare dal papà
the children that make themselves washed by the dad
'The children that have themselves washed by the dad'

As shown in section 4.2, causative constructions are frequent in typical language development around the age of 6-7 years. Hence, such a production is not unexpected in the hearing control groups. Surprisingly, children with cochlear implants rarely used this strategy (only 3% of the elicited object relatives). Volpato (2011) and Volpato and Vernice (2014) suggested that the low percentage of occurrence in the experimental group's productions is to be attributed to the presence of the functional verb *fare* 'to make' in the causative construction, which involves the assignment of an additional thematic role.

To understand the complexity of this structure, it is necessary to consider a simple causative construction as in (153):

(153) I bambini fanno lavare il pupazzo dal papà
the children make wash the puppet by the dad
'the children have the puppet washed by the dad'

In this sentence, three thematic roles are assigned. The verb *lavare* 'wash' assigns thematic roles to the DPs *il pupazzo* 'the puppet' and *il papà* 'the father'. The verb *fare* 'to make' assigns a thematic role to the DP *i bambini* 'the children'.

If the internal argument is realized by a reflexive pronoun instead of a DP, we obtain the following sentence:

(154) I bambini fanno lavare se stessi dal papà
the children make wash themselves by the dad
'the children make have themselves washed by the dad'

In (154), the verb *lavare* 'to wash' assigns two thematic roles, one to *se stessi* 'themselves' and the other to the DP *il papà* 'the dad', while the DP *i bambini* 'the children' receives its thematic role from the verb *fare* 'to make', as in (153). The sentence in (152) differs from (154) in that it contains the reflexive clitic *si* instead of *se stessi*. In addition, the DP *i bambini*, which is the subject of the verb *fare* 'to make', has been relativized.

The assignment of an extra thematic role by *fare*, the presence of the reflexive clitic pronoun *si*, and the computation of a relativized element probably constitute a non-trivial problem for children with cochlear implants, resulting in the rather frequent absence of this structure from their productions.

4.15 The inter-individual variability in the CI group

Much cross-linguistic research carried out on children with hearing impairment, and especially on cochlear implant users, have emphasized the wide inter-individual variability within the experimental groups (e.g., Moeller 2000; Tuller, Jakubowicz 2004; Friedmann, Szterman 2006). Volpato (2010b) and Volpato and Vernice (2014) also observed much inter-individual variability within the group of children with cochlear implants.

The following table (taken from Volpato, Vernice 2014) shows the distribution of the individual responses of the participants with cochlear implants in the production of targeted object relatives.

Table 33 Individual productions within the CI group in the elicitation of object relatives (OR=object relatives, PR=passive relatives, CS=causative sentences, AMB=ambiguous sentences)(taken from Volpato, Vernice 2014)

							SRs instead of ORs		Ungrammatical sentences		
Subj.	**OR**	**PR**	**CS**	**AMB**	**Simple SVO**	***Wh*-fillers**	**Theta roles inv.**	**Head inv.**	**'che' omission**	**Other errors**	**Other strategies**
1	5			4	1		1		1		
2		10		1	1						
3	2	1		7			2				
4			5	1	1		1			1	3
5	9			2							1
6		12									
7		11		1							
8	6			3			1				2
9	10			1						1	
10	1	7		1				2			1
11	1			3		6	1				1
12				2	2	1		2	1	2	2
13	2				5	2				1	2
Total	**36**	**41**	**5**	**26**	**10**	**9**	**6**	**4**	**2**	**5**	**12**
Mean	**23%**	**26%**	**3%**	**17%**	**6%**	**6%**	**4%**	**3%**	**1%**	**3%**	**8%**
SD	**30%**	**41%**	**12%**	**16%**	**12%**	**14%**	**6%**	**6%**	**3%**	**5%**	**9%**

Much variability is found within the CI group. Some children with cochlear implants produced passive relatives and some others produced object relatives. One participant produced a small number of causative constructions, which are nonetheless correct strategies for the task, but then, he/she produced sentences that were not appropriate.

Some children showed difficulties with the task and produced grammatical but context-inappropriate answers (SVO sentences, relative clauses with theta-role inversion, and head inversion), sentences in which different *wh*-fillers replaced the complementizer *che*, or ungrammatical sentences (incomplete sentences and sentences in which the complementizer *che* is omitted). Interestingly, children producing passive relatives never or rarely used other answering strategies.

As we have seen, in typically developing children, passive relatives are more frequent in older than in younger children, who prefer producing other types of structures, among which object relatives. In adolescence and adulthood, the use of passive structures is the prevailing strategy. The fact that in the CI group, some children opt for this strategy is a sign that those children have attained a good com-

petence of Italian, despite the delayed exposure to the linguistic input during the time window crucial for language acquisition.

In cases in which the strategy of passive relatives does not yet represent an available option, some children produced object relatives.

The fact that some children with cochlear implants produced ungrammatical sentences shows that their performance deviates from that of normal hearing controls, for whom these constructions were never observed. The presence of ungrammatical sentences or other incorrect constructions in the production of children with cochlear implants may prove that they were not able to make up for the lack of exposure to the linguistic input in the early stages of language acquisition.

5 The repetition tasks and the role of memory resources in grammar development

Summary 5.1 Introduction. – 5.2 The memory system and the measures assessing memory skills. – 5.3 Memory skills: the comparison between typically developing children and adolescents. – 5.3.1 The word repetition task. – 5.3.2 The nonword repetition task. – 5.3.3 The digit span tasks. – 5.3.4 The sentence repetition task. – 5.4 Memory resources: the comparison between participants with hearing impairment and participants with normal hearing. – 5.4.1 The word repetition task. – 5.4.2 The nonword repetition task. – 5.4.3 The forward and backward digit span tasks. – 5.4.4 The sentence repetition task. – 5.5 The relationship between grammar and memory resources in typically developing individuals. – 5.6 The relationship between language and memory resources in individuals with hearing impairment.

5.1 Introduction

In the previous chapters, the comprehension and the production of subject and object relative clauses was investigated and discussed in groups of individuals with normal hearing and hearing impairment. To explain the difficulties that these individuals have with these complex syntactic structures, and especially object relatives, grammatical-based approaches have been adopted. The low performance with object relatives by children with hearing impairment is to be attributed to the movement of the object to a non-canonical position. In particular, movement is especially impaired when the object shares a subset of features (namely the lexical restriction, Friedmann, Belletti, Rizzi, 2009) with the argument it crosses over. A further refinement of this proposal suggested that in normal hearing children,

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the feature set associated to the DPs modulates the comprehension of relative clauses and explains the high percentages of accuracy in the conditions with number mismatch and the low percentages in the match conditions (the two DP have the same number features). A feature number mismatch facilitates the correct interpretation of object relatives in hearing children and adolescents, but not in children with hearing impairment. Conditions with number mismatch were problematic because number agreement fails to be computed, and this causes incorrect theta role assignment.

In addition to syntactic deficits, the difficulties that children with cochlear implants have with grammar and complex syntactic structures have also been attributed to cognitive resources, and specifically to reduced memory abilities (the relevant studies are presented in section 5.6 below). That memory skills may influence language acquisition, also including complex syntax, is well-documented by several studies carried out cross-linguistically. This was found to be true for both typically developing children and children with language disorders and individuals with hearing impairment.

This chapter focuses on memory skills and on the relationship between comprehension of complex syntactic structures (namely relative clauses) and memory resources in children and adolescents with normal hearing, children with cochlear implants, and LIS signers, presenting data collected in Volpato (2010b). The first part of the chapter is devoted to briefly sketch the multicomponent memory system and to present some measures assessing memory skills (word and nonword repetition, sentence recall, digit span). Then, I present data from typically developing populations and populations with hearing impairment (children with cochlear implants and adolescent LIS signers). In the second part of the chapter, I investigate how memory resources may predict or may be associated to outcomes in different linguistic domains, with a focus on the correlation existing between comprehension and memory resources.[35]

5.2 The memory system and the measures assessing memory skills

According to Baddeley's multicomponent memory system (Baddeley, Hitch 1974; Baddeley 1986), working memory is a mental storage where verbal information is temporarily hold and manipulated (Gathercole et al. 2006). It includes the phonological loop, namely a

35 It would be interesting to investigate how the different measures assessing working memory interact with each other. These questions go far beyond the scope of this study and are left for future research.

system devoted to the storage of verbal (phonological) information, the visuospatial sketchpad, which is responsible for the storage of visual and spatial information, and the central executive, which coordinates the operations on the information stored in the phonological loop and the visuospatial sketchpad.

One measure to evaluate storage of verbal/phonological information is nonword repetition. The nonword repetition task assesses rapid phonological processing and measures phonological information stored in phonological short-term memory. The process necessary to repeat non-existing words is complex. A completely novel sound pattern is perceived without the possibility of relying on pragmatic or semantic knowledge and must be held and verbally rehearsed in immediate phonological memory. The last part of the process is to turn the perceived sound pattern into an articulatory output.

Differently from nonword repetition, the digit span task investigates memory resources for word units (digits) that are already stored in the mental lexicon (Baddeley 2003). Digit span tasks are used to measure immediate verbal memory. Forward digit spans consist in repeating digits in the same order as they are presented. Backward digit spans consist in repeating digits in reverse order. The two tasks share a component of verbal short-term memory. Forward digit span, tapping short-term memory, involves significant storage, but only minimal processing. Backward digit span, which taps working memory, also includes an additional component which allows performing operations on linguistic material, and places significant demands on both processing and storage.

Children's phonological capacity increases with age and is measured using a variety of tasks. In addition to nonword repetition and digit recall, recall of unrelated series of words and repetition of words within a sentence (Baddeley 1986; Gathercole et al. 2004; Alloway, Gathercole 2005) are also important tools to assess phonological short-term memory. Individuals with deficits in the phonological short-term memory show difficulties in the recall of both word lists and sentences (Alloway, Gathercole 2005). Sentence repetition assesses the ability to repeat spoken sentences, namely the ability of children to recode and keep phonological representations active in immediate memory for short periods of time. These processes can affect immediate memory because information must be kept active in memory for other complex linguistic activities (spoken word recognition, sentence comprehension, and language production). Short-term memory contributes to sentence recall as well. A study carried out by Alloway and Gathercole (2005) presents data from two groups of 4- and 5-year-old children matched on nonverbal abilities: one group with high phonological memory and the other with low phonological memory, in order to investigate the association between phonological memory measured with a nonword repetition task and short-term

memory measured with a sentence repetition task. The children with low phonological memory were also significantly poorer in sentence recall. Archibald and Joanisse (2009) suggested that sentence repetition may be the best example of a core speech-language skill that is strongly related to working memory.

Deficits in phonological short-term memory hinder the adequate storage of verbal material. Phonological short-term memory, as measured by nonword repetition, has been found to be lower in children with developmental language disorders than in typically developing children. In various language (e.g. English, French, and Italian), nonword repetition is a clinical marker of a language deficit (Gathercole, Baddeley 1990; Bishop, North, Donlan 1996; Bortolini et al. 2006; Botting, Conti-Ramsden 2001; Delage, Frauenfelder 2012; Dispaldro, Leonard, Deevy 2013). In addition to poor performance on nonword repetition, children with dyslexia have phonological short-term deficits documented through poor sentence recall (Catts et al. 2005; Mann, Shankweiler, Smith 1984).

As pointed out at the beginning of this section, the issue concerning the assessment of memory skills is much debated. It is not always well-defined what skills the different tasks tap. In the following sections, starting from this background, I present data on typically developing children compared with a group of adolescents using different tasks. This makes it possible to determine whether a difference exists between young children and adolescents, and depending on the task, which memory skills may be more problematic in the younger participants.

5.3 Memory skills: the comparison between typically developing children and adolescents

In Volpato (2010b), memory resources were assessed in typically developing children and adolescents using many repetition tasks (words, nonwords, digits, and sentence recall), in order to investigate whether children's verbal/phonological short-term memory and working memory skills are comparable to the memory skills of adolescent students. Data were collected from the group of 16 typically developing children (age range: 5;3-7;5, mean age 6;5) and a group of 16 typically developing adolescents (age range: 15;1-17;5, mean age 15;5). Further details on the participants are found in section 2.10.

5.3.1 The word repetition task

The word repetition task consisted in the repetition of trials assembled into sequences of increasing length, ranging from 2 to 6 words, and presented at the rate of one word 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 the most common nouns. Each series was arranged so that adjacent words did not form meaningful units and did not show phonological similarities. Every participant was presented with four sequences for each series and was asked to repeat them immediately after the experimenter had read them. One point was assigned for each word recalled in the correct position. The word span was assessed in the oral modality. Appendix A1 provides the list of words used in the word repetition task.

The Mann-Whitney statistical test was used to compare the number of correct words repeated by each group. Table 34 reports the results in the word repetition task (number and percentage of correct words repeated in the correct position) in two-, three-, four-, five- and six-word sequences for the group of children and for the group of adolescents.

Table 34: No. and SD of correctly repeated words in each word sequence by typically developing children and adolescents

Groups	Series of words									
	2		3		4		5		6	
	Mean No.	SD	Mean No.	SD	Mean No.	SD	Mean No.	SD	Mean No.	SD
Children	8	0	11.94	0.25	13.88	2.33	12.13	6.02	5.38	4.30
Adolescents	8	0	12	0	16	0	16.69	2.39	12.88	4.49

Adolescents performed at ceiling in the repetition of two-, three-, and four-word series. The number of correctly repeated words was quite high also for five-word series. More problematic was instead the repetition of six-word sequences. Typically developing children performed at ceiling in the repetition of two- and three-word-series. For four-word series, accuracy is quite high as well. More problematic is the repetition of five-word series and six-word series, for which the number of repeated words is 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 ($p<.001$). The phonological/verbal short-term memory is definitely lower in children when they are required to store long sequences.

5.3.2 The nonword repetition task

The group of children was also assessed using a nonword repetition task. The nonword repetition task is a subtest of the "Batteria della valutazione del linguaggio in bambini dai 4 ai 12 anni" (Battery for the assessment of language in children from 4 to 12 years, Fabbro 1999), adapted to Italian from the French version ("Batterie d'évaluation du langage oral de l'enfant aphasique") developed by De Agostini et al. (1998).

The nonword repetition task consisted in the repetition of 15 nonexisting words of different length (one-two-three-four syllables). The task included four monosyllabic nonwords, five disyllabic nonwords, five trisyllabic nonwords, and one four-syllable nonwords.

For this task, normative data are available for typically developing children ranging in age from 4 to 11 years. One point is awarded for each word correctly repeated. The score of 0 is assigned for every error type.

Data were not collected from typically developing adolescents, because norms are not available for the age range considered. Comparison with normative data is only possible for children. In average, the group of children repeated 13.56 nonwords correctly (SD 2.10). Comparing the performance to normative data, two children were two standard deviations below the mean. The others showed a level of performance corresponding to their age peers.

5.3.3 The digit span tasks

The forward and backward digit span tasks were included in the TEMA (Test di Memoria e Apprendimento, *Test of Memory and Learning*) (subtest 7 and subtest 13, respectively), developed by Reynolds and Bigler (1995). They consisted in the immediate serial recall of sequences of digits (1-10) of increasing length. Trials 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 digit, and the individual was required to 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 reverse order. Testing proceeded until the children incorrectly repeated fewer than 4 digits in two consecutive trials. One point was assigned for each digit recalled in the correct position. The higher the score, the better the performance. Normative data are available for the different ages 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. In the forward digit span task, the mean raw score was 37.06 (SD 13.78), and the mean standard score was 10.94 (2.89). In the backward digit span task, the mean raw score was 10.75 (SD 6.79), and the mean standard score was 10 (2.13). Most children showed age-appropriate performance. Only three children showed below mean performance in the forward digit recall, showing some difficulties with phonological short-term memory. Three children showed below mean performance in the backward digit span task, thus showing some difficulties with working memory.

5.3.4 The sentence repetition task

In this task, the participants were required to repeat twenty sentences of different length and syntactic complexity. The experimenter said each sentence aloud, and the children were required to recall the sentence immediately. The difficulty of sentences ranged from simple active structures with SVO order to sentences with more complex syntactic structures, namely relative clauses, passive sentences, coordinated sentences, and clitic left-dislocation sentences. The list of trials is shown in Appendix A2.

Children's responses were audio recorded. Performance on the sentence recall task was scored following Alloway and 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 consider the variability in syntactic complexity or sentence length. Hence, to attribute a score percentage to each participant, the accuracy of recall was determined considering as correct each word which was recalled in its original position within the sentence.

Following the scoring methods proposed by Alloway and Gathercole (2005), I counted the number of correct words (out of 146 total words) repeated in the correct position. Table 35 shows the accuracy scores obtained in this task by typically developing children and adolescents.

Table 35 Accuracy scores in the sentence repetition task by typically developing children and adolescents

Groups	Correct words	
	No.	SD
Children	132.69	11.33
Adolescents	145.69	1.25

The group of typically developing 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. Children achieved lower scores than adolescents. Nonetheless, the overall percentage of accuracy is quite high, above 90%. 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 observed between the two groups ($p<.001$). Adolescents performed significantly better than children. These data show that phonological short-term memory as measured by sentence recall is poorer in young children.

5.4 Memory resources: the comparison between participants with hearing impairment and participants with normal hearing

In the previous sections, data on typically developing children and adolescents were presented. Young children have sometimes lower scores than adolescents. However, in most cases, memory resources are age appropriate.

Phonological short-term memory and working memory skills have also been studied in individuals with hearing impairment and in cochlear implant users. Cross-linguistically, children with either conventional hearing aids or cochlear implants were found to perform lower than normal hearing children in nonword repetition (for English, Briscoe, Bishop, Norbury 2001; Dillon et al. 2004; Burkholder, Pisoni 2005; Dillon, Pisoni 2006; Casserly, Pisoni 2013; Nittrouer et al. 2014; for German, Penke, Wimmer 2018; for Greek, Talli, Tsalighopoulos, Okalidou 2018; for Egyptian, Shazly et al. 2016; for Turkish, Akçakaya et al. 2019; for Swedish, Willstedt-Svensson et al. 2004; Ibertsson et al. 2008) and digit span tasks (for English, Fagan et al. 2007; Conway, Pisoni, Kronenberger 2009; Pisoni et al. 2011; Pisoni,

Cleary 2003; for Italian, Arfé, Rossi, Sicoli 2015). Burkholder and Pisoni (2005) found that children with hearing impairment are three times slower than age-matched normal hearing children in the digit span recalling.

The fact that nonword repetition is affected in children with cochlear implants may be due to their impaired speech perception and the consequent degraded phonological representations.

Pisoni et al. (2011) investigated phonological short-term memory measured by nonword repetition and forward digit span, and working memory measured by backward digit span in children with cochlear implants. They tested them in two different moments and found that children with cochlear implants showed delays with respect to normal hearing children at the first administration but after 10 years almost half of the participants fell in the average range. Children with cochlear implants improved in rapid phonological coding and short-term memory skills. Instead, after 10 years, several children showed weaknesses and delays in verbal working memory. The authors suggested that digit span scores may be affected by the way in which speech is perceived. Indeed, speech perception may require considerable attentional resources, in order to accurately recognize digits, thus increasing the cognitive load of the task, hindering the representation and storage of phonological information in short-term memory, and reducing the resources available for working memory.

The opposite trend was found for Greek by Talli, Tsalighopoulos, Okalidou (2018). The authors compared 15 Greek-speaking children with cochlear implants ranging in age from 4;6 to 8;6 and age-matched controls and younger controls matched on length of exposure to the linguistic input through cochlear implants. The participants were assessed in phonological short-term memory measured with a nonword repetition task, and phonological/verbal short-term memory, measured with backward and forward digit span tasks (in addition to vocabulary). The children with cochlear implants performed lower than the age-matched controls in both nonword repetition and digit recall, but when compared to younger normal hearing children, low performance was only observed in phonological short-term memory. Following Houston et al. (2005), the authors have suggested that phonological representations in children with cochlear implants are not as robust as normal hearing children with the same hearing experience, and this would explain the low performance in nonword repetition. The poor performance and the low scores in these memory measures may depend on the quality of received input, which is partial and degraded, and does not favour appropriate phonological representation in short-term memory (Nittrouer, Caldwell-Tarr, Lowenstein 2013; Talli, Tsalighopoulos, Okalidou 2018).

Contrary to much evidence showing that individuals with cochlear implants have difficulties with nonword repetition, a study carried

out on very young Italian-speaking cochlear implant users (aged 4;2-6;10) showed the opposite tendency, i.e. children with cochlear implants were not significantly different from typically developing age peers in nonword repetition (Guasti et al. 2014). The lack of significant difference between experimental and control samples in Guasti et al. (2014) as opposed to other studies was attributed to some phonological and prosodic characteristics of Italian, which facilitates encoding, storing, and rehearsal of new words. As for the assessment of digit span, a study carried out by Colombo, Arfé, and Bronte (2012) similarly pointed out that no significant difference was observed between a group of children with cochlear implants (age 7-12) and a group of normal hearing children (age 6-12) matched on grade level.

Using a sentence repetition task presented visually, Moberly, Pisoni, and Harris (2018) have compared memory resources of a group of adults with cochlear implants and normal hearing peers in order to assess speech recognition: the participants heard a sentence and were asked to repeat as much of the sentence as they could. Scores were attributed counting the percentage of total words and the percentage of sentences correctly produced. Accuracy of adult users was not significantly different from that of controls.

As we have seen, the results of the above-mentioned studies do not converge. In addition, for Italian, few published data exist on memory resources of individuals with hearing impairment and cochlear implants users.

The work carried out in Volpato (2010b) aims at contributing to the debate using the different repetition tasks (words, nonwords, digits, and sentence recall) used to investigate verbal/phonological short-term memory and working memory skills in typically developing children and adolescents. Children with cochlear implants and adolescent LIS signers are compared with normal hearing participants. In the following sections, the data of the group of 13 children with cochlear implants (age range: 7;9-10;8, mean age 9;2) are compared to the data of the 13 normal hearing children (age range: 5;7-7;9, mean age 6;7) matched on language skills. In addition, the group of 6 adolescent LIS signers (age range: 15;5-17;6) was compared to a language-matched group of normal hearing young children (N=6, age range: 5;3-7;5), and an age-matched group of normal hearing adolescents (N=6, age range: 15;3-17;5).

5.4.1 The word repetition task

In this task, participants were required to repeat different sequences of two-syllable of unrelated words (Volpato 2010b) immediately after the experimenter had read them. The Mann-Whitney statistical test was used to compare the number of correct words repeat-

ed by each group. Table 36 reports the results in the word repetition task (number and percentage of correct words repeated in the correct position) in two-, three-, four-, five- and six-word sequences for the children with cochlear implants (CI) and their language-matched controls (LA):

Table 36 No. and SD of correctly repeated words in each word sequence by children with cochlear implant and language-matched children

	Series of words									
Group	**2**		**3**		**4**		**5**		**6**	
	Mean No.	**SD**	**Mean No.**	**SD**	**Mean No.**	**SD**	**Mean No.**	**SD**	**Mean No.**	**SD**
CI	7.85	0.38	11.69	0.63	11.69	4.57	7.31	4.89	4.23	3.63
LA	8	0	11.92	0.28	14.15	2.82	13.77	4.17	5.23	3.17

Normal hearing children (LA group) obtained higher scores than children with cochlear implants (CI) in the repetition of all sequences. Overall, a significant difference was found between the two groups (U=35.5 p=.012). However, by comparing the performance between the two groups in each word sequence, a significant difference was only found in the repetition of series of four (U=48 p=.048) and five words (U=27 p=.003).

Table 37 reports the mean and SD of correctly repeated words by LIS signers (LIS), language-matched children (LA), and age-matched adolescents (CA).

Table 37 No. and SD of correctly repeated words in each word sequence by LIS signers, language-matched children, and age-matched adolescents

	Series of words									
Group	**2**		**3**		**4**		**5**		**6**	
	Mean No.	**SD**	**Mean No.**	**SD**	**Mean No.**	**SD**	**Mean No.**	**SD**	**Mean No.**	**SD**
LIS	8	0	11.33	1.21	9.50	3.94	9.17	5.74	8.17	3.71
LA	8	0	11.83	0.41	14.33	1.63	11.83	5.56	4	3.22
CA	8	0	12	0	16	0	17	1.55	13.33	5.01

All groups did not show any difficulty in repeating two-word and three-word series. For LIS signers, four-, five-, and six-word series were much more problematic. The language-matched group (LA) showed much difficulty in the repetition of five-word sequences, and especially in the repetition of six-word series. The age-matched controls (CA) only showed difficulties in six-word sequences. Overall, the CA group performed significantly better than both LA and LIS groups (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).

5.4.2 The nonword repetition task

In the nonword repetition task, children were asked to repeat 15 nonwords of increasing length.

The following table shows the number of correct nonwords repeated by children with cochlear implants and language-matched controls.

Table 38 Mean No and SD of correctly repeated nonwords by the CI and the LA groups

Group	Mean No.	SD
CI	13.77	1.04
LA	14.54	1.67

Comparing each participants' scores with the norms reported in Fabbro (1999), it was possible to see that 1 hearing child performed two standard deviations below the normative mean, while the others performed at ceiling. In the group of children with cochlear implants, 7 participants performed at ceiling, while 6 of them performed one standard deviation below the normative mean.

In the control group, the number of correctly repeated nonwords is higher than in the experimental group. The highest number of errors in the CI group also resulted in a significantly lower performance of this group as opposed to that of the LA group (Mann-Whitney, U=43 p=.011).

Table 39 compares number of correct nonwords repeated by the group of LIS signers and that of language-matched controls (LA) (for this task no data are available for age-matched controls, since norms were available only for children aged from 4 to 11 years).

Table 39 Mean No and SD of correctly repeated nonwords by the LIS adolescents and their language-matched controls

Group	Mean No.	SD
LIS	14.83	0.41
LA	12.83	2.23

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

For hearing children, the mean number of correct nonwords is quite high. Only 1 child was behind the threshold level for his age.

5.4.3 The forward and backward digit span tasks

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). These tasks consisted in the immediate serial recall of sequences of digits of increasing length. Children had to repeat the digits in same exact order as presented by the experimenter in the forward digit span task, and in reversed order in the backward digit span task. One point was attributed for each digit correctly repeated in the exact position within the sequence. The following table reports the mean raw and standard scores (and SDs) obtained by the group of children with cochlear implants (CI) and their normal hearing language-matched controls (LA) in each of the two subtests.

Table 40 Mean raw score and mean standard score (and SD) for each group in each digit span task

Group	Forward digit span				Backward digit span			
	Raw Score		Standard Score		Raw Score		Standard Score	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CI	31	8	8	2	16	6	10	1
LA	34	11	10	3	15	7	11	2

On the basis of the TEMA guidelines, 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. For the forward digit span task, the number of children who performed below the mean was 6 for the CI group, 3 for the LA group; the number of children who showed mean performance was 7 for the CI and LA group. Only 3 children of the

LA group were above the mean for their age. For the backward digit span task, the number of children who performed below the mean was 1 for the CI group, 1 for the LA group. The number of children who showed mean performance was 12 for the CI group, 9 for the LA group. The number of children who performed above the mean was 3 in the LA group. No children in the CI group performed above the mean. Even though the mean score of each subtest is lower in the CI group than in LA group, the Mann-Whitney test reveals no significant difference between the experimental group and the control group in any of the two TEMA subtests ($p>.05$ for all comparisons).

The analysis was not possible when comparing LIS signers and their control groups because data on forward and backward digit span were not available for the experimental group.

5.4.4 The sentence repetition task

In this task, the participants were required to repeat 20 sentences of different length and syntactic difficulty. Following the scoring methods proposed by Alloway and Gathercole (2005), I counted the number of correct words (out of 146 total words) repeated in the correct position. Table 41 shows the accuracy scores obtained in this task by children with cochlear implants (CI) and language-matched hearing controls (LA).

Table 41 Accuracy scores in the sentence repetition task by CI and LA groups

Group	Correct words	
	No.	SD
CI	123.31	18.06
LA	134.85	9.70

Both groups experienced some difficulties in the repetition of long and/or complex sentences, namely coordinated structures and relative clauses. Sometimes, left-dislocation 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. Even though the percentage of accuracy is higher in the LA group than in the CI group, no significant difference was observed between the two groups ($p>.05$).

Table 42 shows the accuracy scores of LIS signers compared to the language-matched (LA) and the age-matched (CA) hearing children.

Table 42 Accuracy scores in the sentence repetition task by CI and LA groups

Group	Correct words	
	No.	SD
LIS	118.67	18.92
LA	129.33	10.78
CA	146	0

Hearing adolescents performed at ceiling. LIS signers and hearing children instead obtained lower scores. In the group of LIS signers, a high inter-individual variability was found. The LIS and the 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. The between-group analysis highlighted a significant difference between the CA group and both the LIS and the LA groups (p=.002, in both cases).

5.5 The relationship between grammar and memory resources in typically developing individuals

In previous sections, memory resources in typically developing individuals and in groups of individuals with hearing impairment and cochlear implant users have been presented. I now address the important issue concerning the relationship between the scores obtained in different memory tasks (word and nonword repetition, forward and backward digit recall, and sentence recall) and the comprehension of complex syntactic structures.

Over the years, for typically developing children, the scores obtained in memory skills were found to be an important predictor of language development, vocabulary learning in both native language and foreign languages (Montgomery 1995; Baddeley 2003; Gathercole 2006; Repovš, Baddeley 2006), and reading abilities (Baddeley 2003; Cain, Bryant, Oakhill 2004).

In one of the first studies exploring the interaction between language and memory, Montgomery (1995) asked school-age typically developing children (and children with language learning impairment) to complete a nonword repetition task and a sentence comprehension task. Results of a correlation analysis revealed a strong positive association between the two tasks, suggesting that phonological short-term memory capacity is important to children's sentence comprehension. Children rely on phonological short-term memory dur-

ing sentence comprehension because words and phrases are temporarily stored to understand the sentence (Robertsson, Joanisse 2010).

Phonological short-term memory (as measured with nonword repetition) has been shown to play a role in sentence processing. Phonological short-term memory was found to predict reading skills (Mann, Liberman, 1984). However, Just and Carpenter (1982) pointed out that the process of spoken sentence comprehension also resorts to working memory, because verbal information must also be processed. Increases in syntactic complexity place a burden on listeners' working memory system. It is necessary to parse the syntactic form and understand the sentence through the decoding of its compositional semantics. Deficits or difficulties in phonological short-term memory also have consequences on working memory, making the processing of syntactic information during spoken sentence comprehension difficult.

The role of memory skills in the comprehension of Italian complex grammatical constructions, namely relative clauses, has been investigated by Arosio, Adani and Guasti (2009). They found that backward digit span predicts comprehension of structures involving movement and long-distance dependences in Italian typically developing children. It positively correlated with relative clause comprehension. In 7-year-olds, backward digit span was associated to accuracy in object relative clauses with preverbal subjects. At the age of 9 and 11, the backward digit span correlated with object relatives with postverbal subjects.

Volpato (2010b) also investigated whether a relation exists between relative clause comprehension and the different measures tapping memory skills. As we have seen in section 3.4.1, the relative clause comprehension task was much more articulated than the test by Arosio, Adani and Guasti (2009). It included more sentence conditions obtained by the manipulation of number features in both the relative head and the embedded DP. The relationship between accuracy in this task and scores in the repetition tasks was investigated both overall and between each sentence condition and the memory measures. In addition, more memory measures are used than in Arosio, Adani and Guasti (2009), namely repetition of words, nonwords, sentences, and forward and backward digit spans.

In typically developing children (age range: 5;3-7;5), the comprehension of relative clauses, overall, positively correlated with backward digit recall ($p=.003$), replicating the results by Arosio, Adani and Guasti (2009). More specifically, positive correlations were observed between backward digit span and accuracy scores obtained in the comprehension of different relative clause conditions, as Table 43 shows.

Table 43 Correlations between relative clause comprehension and backward digit recall in typically developing children

Sentence condition	r_s	P
AMB_SG_SG	.570	.006
AMB_PL_PL	.679	.001
SR_SG_PL	.506	.016
OR_SG_SG	.512	.015
OR_PL_PL	.767	<.001
OR_SG_PL	.712	<.001
OR_PL_SG	.782	<.001
ORp_PL_SG	.555	.007
ORp_SG_PL	.627	.002

In (young) typically developing children, the backward digit span task is strongly associated with almost all sentence conditions, in particular with ambiguous structures and all object relative conditions.

The performance of complex operations in relative clause comprehension may place a heavy load on the computational system. In addition to working memory, verbal short-term memory, as measured through the word repetition task, and especially phonological short-term memory, as measured by nonword repetition, are also related to relative clause comprehension in typically developing children. The scores on the word repetition task positively correlated with the sentence type ORp_SG_PL (r_s=.484 p=.022). The scores on nonword repetition positively correlated with all object relatives (both with preverbal and postverbal subjects) and with one ambiguous condition, as shown in Table 44.

Table 44 Correlations between relative clause comprehension and nonword repetition in typically developing children

Sentence condition	r_s	P
AMB_PL_PL	.499	.018
OR_SG_SG	.699	<.001
OR_PL_PL	.701	<.001
OR_SG_PL	.597	.003
OR_PL_SG	.668	.001
ORp_SG_PL	.638	.001
ORp_PL_SG	.590	.004

Significant positive correlations were also found between sentence repetition scores and performance on the comprehension of different sentence conditions, especially those involving movement of the object to the relative head position. The results of the correlation analysis are reported in Table 45.

Table 45 Correlations between relative clause comprehension and sentence recall in typically developing children

Sentence condition	r_s	p
OR_SG_SG	.515	.014
OR_SG_PL	.486	.022
OR_PL_SG	.433	.044
ORp_SG_PL	.497	.019
ORp_PL_SG	.468	.028

From all these analyses, it is evident that memory places a heavy burden on the processing of complex syntactic structures. For typically developing children, low scores in both phonological short-term memory and working memory positively correlated with the comprehension of various sentences conditions, and especially object relatives with both preverbal and postverbal subjects.

The scores obtained in the sentence repetition task were found to positively correlate with comprehension of relative clauses also in typically developing adolescents (age range: 15;1-17;5). For this group, however, the relationship was only found with one ambiguous sentence condition, namely AMB_PL_PL (r_s=.537 p=.032). In some cases, also for typically developing children, memory measures correlated with the comprehension of ambiguous sentences. This relationship shows that ambiguous sentences are also particularly taxing, since several elements must be stored and processed as in the other sentence conditions. In addition, the analysis and the processing of ambiguity may impose a high demand on the computational system.

5.6 The relationship between language and memory resources in individuals with hearing impairment

A great deal of cross-linguistic research has also addressed the issue concerning the relationship between language development and memory skills in children with hearing impairment, also including children with cochlear implants (a.o., Pisoni, Geers 2000; Briscoe et al. 2001; Cleary, Dillon, Pisoni 2002; Dawson et al. 2002; Dillon et al. 2004; Szagun, 2004; Willstedt-Svensson et al. 2004; Volpato, Adani, 2009; Pisoni et al. 2011; Harris et al. 2013; Kronenberger et al. 2014; Nittrouer et al. 2014; Hansson et al. 2017; Penke, Wimmer, 2018; Talli, Tsalighopoulos, Okalidou 2018).

The linguistic behaviour of individuals with hearing impairment, and especially of children with cochlear implants, shows much inter-individual variability. As pointed out in chapter 1, some children with cochlear implant show performances comparable to normal hearing

children. Other children show difficulties and delays in different linguistic domains (sentence processing, vocabulary, and syntax). The difficulties that sometimes children with cochlear implants encounter with language might be attributed to an impaired memory system (Pisoni et al. 2011). In children with cochlear implants, a positive correlation has been found between phonological short-term memory skills and lexical and grammatical skills (Cleary, Pisoni, Kirk 2002; Willstedt-Svensson et al. 2004; Nittrouer et al. 2014; Hansson et al. 2017; Talli, Tsalighopoulos, Okalidou 2018). Cleary, Pisoni, and Kirk (2002) found that nonword repetition was strongly correlated with spoken word recognition, language comprehension, speech intelligibility, and speech rate. Dillon et al. (2004) investigated the relation between nonword repetition and vocabulary, speech and linguistic abilities in 24 children with cochlear implants and found that performance in the repetition task was significantly correlated with spoken word recognition, language comprehension, and speech production.

These difficulties with language and grammar may be due to difficulties in processing and temporary storage of linguistic information, which, in turn, are related to impaired phonological representations. Indeed, damaged phonological representations may hinder the ability to create lexical and grammatical representations from auditory input (Gahtercole et al. 2004; Casserly, Pisoni 2013; DeCaro et al. 2016; Talli, Tsalighopoulos, Okalidou 2018).

For Swedish, Hansson et al. (2017) tested nonword repetition, grammatical production, and sentence comprehension measured using a standardized test in 13 adolescents with cochlear implants (age: 11;9-19;1) and 16 children with cochlear implants (age: 5;3-8;0). Phonological short-term memory measured by nonword repetition has been found to be problematic in Swedish-speaking children with cochlear implants. The impaired phonological short-term memory skills also had consequences on the development of language and on grammatical accuracy. In both groups, nonword repetition correlated with accuracy in grammatical production, and in the group of younger children with cochlear implants, it also correlated with sentence comprehension. For Greek, Talli, Tsalighopoulos, Okalidou (2018) observed as well that for children with cochlear implants, a positive correlation was found between vocabulary scores and phonological short-term memory measured by nonword repetition. For younger normal hearing controls, vocabulary correlated with all cognitive measures. This is likely due to the fact that young typically developing children have not developed covert verbal rehearsal strategies yet because of their young age, but they will then acquire the capacity to use them. Conversely children with cochlear implants could have problems in exploiting such strategies even at an older age.

Less efficient rehearsal strategies may also account for low ver-

bal short-term memory skills (measured through digit span tasks) in deaf individuals, also including cochlear implant users (Pisoni, Cleary 2003). Pisoni and Geers (2000) analysed the role of working memory in children with cochlear implants and found a correlation between auditory digit span and some linguistic measures (speech intelligibility, speech perception, language comprehension, and reading proficiency), thus proving that working memory may also influence the performance outcomes. Cleary, Pisoni, and Kirk (2002) showed a strong relationship between forward digit span and spoken word recognition in children with cochlear implants. In Pisoni et al. (2011), children with longer digit spans also had better spoken word recognition abilities. The memory system is fundamental for the encoding, storing, maintenance and retrieval of phonological and lexical information and representations of words in order to successfully perform a wide variety of production and comprehension tasks. Digit recall scores showed a relationship with grammar and language outcomes. Indeed, the forward digit span was correlated with speech and language outcomes. This finding has shown that verbal sequential short-term memory is important for developing speech perception and speech language skills. Pisoni et al. (2011) also showed that immediate verbal short-term phonological memory (assessed with a forward digit span task) and immediate verbal working memory (assessed with digit backward), together with verbal rehearsal speed, are important underlying neurocognitive factors that are strongly related to auditory, speech and language experience and that influence several different speech and language outcomes in children with cochlear implants.

Differently from these studies, Talli, Tsalighopoulos, Okalidou (2018), who in addition to nonword repetition, also tested digit span recall, found that scores in the digit span tasks were not associated to outcomes in receptive vocabulary.

In addition to backward digit recall, the repetition of a sentence implies the use of working memory, which interacts with speech perception, and linguistic and sequencing skills. The ability to repeat sentences is strongly related to working memory and may be at risk in children with cochlear implants.

In the studies I have presented so far, the authors mainly used standardized measures to investigate both memory resources and language skills, and the relationship between them. Other studies that focus on the correlation between memory and language skills in individuals with hearing impairment instead adopted non-standardized measures to assess language, and in particular, complex syntax comprehension. In comprehending complex syntactic structures, verbal sequences are stored and manipulated to correctly relate the moved constituent to the position in which it is interpreted, and the role of working memory is fundamental to perform such a

task. Individuals with hearing impairment have less resources to access auditory input and consequently, to develop memory skills properly, which in turn may have consequences for the construction of grammar and the acquisition of complex syntactic structures. Tuller and Delage (2014), for French, suggested that the difficulty that children with hearing impairment encounter with complex sentences containing third person accusative clitic pronouns is due to memory resources rather than to a syntactic deficit. Another study in which a relationship was found between memory resources and syntax development is Volpato and Adani (2009). This study has investigated whether digit span scores correlate with relative clause comprehension in Italian-speaking children with cochlear implants (see section 3.6.1). A significant positive correlation was found between comprehension of object relatives with postverbal subjects and forward and backward digit span. These findings show that the computation of agreement between the embedded verb and the postverbal subject places heavy load on working memory and consequently hinders correct theta-role assignment.

However, as for the relationship between memory skills and processing of complex syntactic structures, the different studies do not always converge on results. Lack of correlation between comprehension of complex syntax and memory capacities was found by Penke and Wimmer (2018), in which difficulties in comprehension of *who*-questions by a group of very young German-speaking children (ages 3-4) with hearing aids cannot be attributed to phonological short-term memory as measured by repetition of nonwords. Memory deficits may affect syntactic movement operations in which the moved constituent has to be stored in memory until it can be related to the position in which it is interpreted. However, the *who*-questions tested by Penke and Wimmer (2018) were very short constructions and memory skills were probably sufficient to support their comprehension.

Given these controversial results, the research carried out in Volpato (2010b) was a further attempt to investigate whether difficulties with comprehension of complex syntax are due to limited memory skills, to some (morpho)-syntactic deficit, or both. In this case, the different conditions of the relative clause comprehension task were correlated with the different memory assessment tasks. Differently from Volpato and Adani (2009), and comparably to Penke and Wimmer (2017), no significant relationships were found in children with cochlear implants between scores on the relative clause conditions and nonword repetition, forward and backward digit span, sentence recall. The only significant positive correlation was found between mean percentage of accuracy in relative clause comprehension and word repetition (r_s=.615 p=.025). Overall, it seems therefore that the relative clause structure may overload the computational system.

In adolescents LIS signers as well, a significant positive correlation was found between short-term memory as measured by word repetition and scores in the relative clause ambiguous condition in which both DPs were plural (AMB_PL_PL, r_s=.907 p=.013). The need to process a long-distance dependency containing plural (marked) number features and the sentence ambiguity may place a heavy load on the computational system. It is important to point out that, especially in the case of adolescent LIS signers, only 6 participants are included in the experimental sample. A larger sample would be necessary to obtain more reliable results and to provide a more in-depth analysis of the relationship between complex syntax performance and memory skills.

This analysis shows that the source of the difficulty encountered by children with normal hearing and children with cochlear implants seems to be different. While for the former, especially the group of younger participants, working memory appears to play a significant role in the computation of relative clauses, for the latter, memory is responsible to a less extent of the computation of these complex syntactic structures. For the group of children with cochlear implants, the difficulty is largely due to a morpho-syntactic deficit associated to hearing impairment, which hinder the correct number computation.

Conclusions

The main aim of this work was to investigate the comprehension and production of restrictive right-branching relative clauses by populations with hearing impairment and populations with normal hearing.

The research carried out during my PhD was the first study investigating the syntactic competence of complex sentences in Italian-speaking children with cochlear implants, whose performance was compared with a group of younger hearing children matched on general morphosyntactic abilities (TCGB). In addition, a group of adolescent LIS signers was compared to a group of younger children matched on morphosyntactic abilities and a group of adolescents matched on chronological age. As for the hearing populations, a group of young children was compared to a group of adolescents and a group of adults.

Following much experimental cross-linguistic research on the acquisition of relative clauses in populations with typical and atypical language acquisition, new tools were developed in order to assess comprehension and production of these structures in Italian.

The comprehension task tested different relative clause types: ambiguous sentences, subject relatives, object relatives with preverbal subjects, and object relatives with postverbal subjects. Number features of relative heads and embedded DPs were also manipulated as to obtain 10 different conditions. This task tested many more conditions than previous research, thus succeeding in obtaining a more accurate analysis of the performance of both participants with normal hearing and participants with hearing impairment.

The production task tested subject and object relative clauses in which the relative head and the embedded DP were either in the singular or in the plural, and both referents were animate.

The ability of children with hearing impairment to comprehend relative clauses was found to be significantly lower than that of normal hearing children. Despite the significant difference in performance between the two populations, within-group analyses showed that children with hearing impairment pattern with hearing children as far as the gradient of difficulty of relative clauses is concerned. In both populations, an asymmetry between subject and object relatives was found, replicating previous results on the comprehension of these structures by other typical and atypical populations. Subject relatives were more accurate than object relatives, and object relatives with preverbal subjects were more accurate than object relatives with postverbal subjects. The higher accuracy on subject relatives is explained by the short relationship between the relative head and the site from which it has been extracted. In object relatives with preverbal subjects, the performance of the two groups is qualitatively and quantitatively different, especially as far as the type of incorrect responses is concerned. The source of difficulty was attributed to different reasons. Hearing participants showed higher percentages of correct responses in those conditions in which the DPs were dissimilar in terms of number features (OR_SG_PL and OR_PL_SG) than when the two DPs displayed the same features (OR_SG_SG and OR_PL_PL), and performed significantly better than the group of participants with hearing impairment in the sentence type OR_SG_PL. Sentences containing the Num(ber) projection strongly facilitated hearing children in assigning the correct interpretation. The difficulties found in hearing children with object relatives displaying the same number on both DPs were explained by intervention effects (Friedmann, Belletti, Rizzi 2009). Sentences containing disjoint specification of number features help assigning correct sentence interpretation. 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) leads children to the correct selection of target referents.

Whereas marked number features were crucial for normal hearing children, they often failed to be computed by children with hearing impairment. Both attraction phenomena in the sense of Kayne (1989) and failed computation of the plural verbal morpheme explain the performance and the difficulties experienced by participants with hearing impairment.

In the course of (typical) language development, namely at adolescence, the number of correct responses in object relative comprehension increases, although some errors still occur. The structures that are difficult for children are also problematic (to a less extent) for adolescents.

The difficulty that all groups experienced with ORp is explained by the fragile subject-verb agreement occurring with postverbal sub-

jects, which is only based on the AGREE relation, and is not strengthened by Spec-Head agreement (Guasti, Rizzi, 2002; Franck et al. 2006).

The production task was developed following the model proposed by Friedmann and Szterman (2006), 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.

The asymmetry between subject and object relatives found in the comprehension task was also found in the production task, replicating previous studies on the production of relative clauses by populations with typical and atypical language development.

However, despite the difficulties experienced in the comprehension task with object relatives, both children with normal hearing and children with hearing impairment did produce object relatives. Conversely, neither adolescents nor adults with normal hearing produced any object relative clause.

When object relatives were not produced, all participants adopted different strategies turning the target sentence into a subject relative. The most frequent strategy consisted in the production of passive relatives. Children produced a quite high percentage of passive relatives, but there is a difference between hearing children and children with hearing impairment. Hearing children produced a high percentage of object relatives, as opposed to passive relatives, while children with cochlear implants produced a high number of passive relatives, as opposed to object relatives. Children with cochlear implants adopted the passive strategy which was largely used by older Italian-speaking individuals, namely adolescents and adults (Utzeri 2006; 2007; Carpenedo 2009; Belletti, Contemori 2010). This phenomenon is linked to age. Since children with hearing impairment 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.

The reason for which passive relatives are acquired later than object relatives is related to the fact that they involve subject extraction and the presence of two chains: They are derived through *smuggling* (Collins 2005) and subsequent extraction to perform relativization (Belletti 2009). 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. The delayed production of passive relatives is also explained by adopting the minimalist theory of Agreement (Chomsky 1995). Following Guasti and Rizzi (2002), I 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 (Franck 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.

Comparing production and comprehension of relative clauses, the former seems to precede the latter. Indeed, children produce structures that they sometimes fail to 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, McKee, Emiliani 1990). We 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. Comprehension may be driven by particular strategies, as for instance interpreting the first DP, i.e. the relative head, as the subject. When encountering the DP in the embedded subject position, reanalysis of the sentence is necessary. This is not always possible for young children (De Vincenzi 1991).

In addition to investigating syntactic competence, the experiment also included different repetition tasks, measuring participants' memory skills. The inclusion of these tasks was necessary in order to verify whether the difficulties experienced in the comprehension task may be attributed to limited memory resources.

That the source of difficulty in the group of typically developing children is different from that in the group of children with cochlear implants is further emphasized by the results obtained from a correlation analysis between memory and comprehension. While for the group of younger participants with normal hearing, working memory appeared to be associated to the computation of all relative clause conditions, for the group of participants with hearing impairment, memory was responsible to a less extent of the computation of these complex syntactic structures. Some memory skills were lower in children with cochlear implants than in children with normal hearing, and, overall, relative clause comprehension correlated with some memory measures in children with cochlear implants. Even though low memory skills may also imply low language skills, the difficulty that children with cochlear implants encounter with (object) relative clauses is to be attributed to a morpho-syntactic deficit (computation of number) associated to hearing impairment.

In conclusion, I hope that the findings of such a detailed research on the syntactic competence and memory skills of children with cochlear implants may not only advance our knowledge but also be useful in defining new rehabilitation strategies.

References

Adams, Catherine (1990). "Syntactic comprehension in children with expressive language impairment". *British Journal of Disorders of Communication*, 25, 149-71.

Adani, Flavia (2008). *Feature effects in relative clause comprehension* [PhD dissertation]. University Milano-Bicocca.

Adani, Flavia (2011). "Re-thinking the Acquisition of Relative Clauses: Towards a Grammatically-based Account". *Journal of Child Language*, 38(1), 141-65. DOI http://dx.doi.org/10.1017/S0305000909990250.

Adani, Flavia et al. (2010). "Grammatical Feature Dissimilarities Make Relative Clauses Easier: a Comprehension Study with Italian Children". *Lingua*, 120(9), 2418-66. DOI https://doi.org/10.1016/j.lingua.2010.03.018.

Adani, Flavia; Sehm, Marie; Zukowski, Andrea (2012). "How do german children and adults deal with their relatives". *Advances in language acquisition: proceedings of generative approaches to language acquisition (GALA) Conference 2011, Thessaloniki*. Newcastle Upon Tyne: Cambridge Scholars Publishing, 14-22.

Adani, Flavia et al. (2014) "Number Dissimilarities Facilitate the Comprehension of Relative Clause in Children Affected by (Grammatical) Specific Language Impairment". *Journal of Child Language*,41(4), 811-41. DOI http://dx.doi.org/10.1017/S0305000913000184

Ajello, Roberto et al. (2001). "Morphosyntactic fragility in the spoken and written italian of the deaf". Fava Elisabetta (ed.), *Clinical Linguistics: Theory and applications in speech pathology and therapy*. Amsterdam: John Benjamins Publishing Company, 49-74.

Akçakaya et al. (2019). "Early cochlear implantation: verbal working memory, vocabulary, speech intelligibility and participant variables". *Cochlear implants international*, 20(2), 62-73. DOI https://doi.org/10.1080/14670100.2019.1565077

Alloway, Tracy P.; Gathercole, Susan. E. (2005). "Working memory and short-term sentence recall in young children". *European Journal of Cognitive Psychology*, 17(2), 207-20.

Antón-Méndez, Inés; Nicol, Janet L.; Garrett, Merrill F. (2002). "The relation between gender and number agreement processing". *Syntax*, 5, 1-25.

Apuzzo, Mah-rya L.; Yoshinaga-Itano, Christine (1995). "Early identification of infants with significant hearing loss and the Minnesota child development inventory". *Seminars in Hearing*, 16, 124-39.

Archibald, Lisa M. D.; Joanisse, Marc F. (2009). "On the sensitivity and specificity of nonword repetition and sentence recall to language and memory impairments in children". *Journal of speech, language, and hearing research*, 54(4), 899-914. DOI https://doi.org/10.1044/1092-4388(2009/08-0099)

Arfè, Barbara; Rossi, Cristina; Sicoli, Silvia (2015). "The contribution of verbal working memory to deaf children's oral and written production". *Journal of deaf studies and deaf education*, 20(3), 203-214.

Arnon, Inbal (2005). "Relative clause acquisition in Hebrew: Towards a processing-oriented account". Brugos, Alejna; Clark-Cotton, Manuella R.; Ha, Seungwan (eds), *Proceedings of the 29th Annual Boston University Conference on Language Development*. Somerville, MA: Cascadilla Press, 37-48.

Arosio, Fabrizio; Adani, Flavia; Guasti, Maria Teresa (2005). "Processing grammatical features by Italian children". Belletti, Adriana; Bennati, Elisa; Chesi, Cristiano; Ferrari Ida (eds), *Acquisition and development. Proceedings of gala 2005.* Siena: Cambridge Scholars Press, 15- 27.

Arosio, Fabrizio; Adani, Flavia; Guasti Maria Teresa (2009) "Grammatical features in the comprehension of Italian Relative Clauses by children". Brucart, José; Gavarrò, Anna; Solà, Jaume (eds), *Merging Features: Computation, Interpretation and Acquisition*. Oxford: Oxford University Press, 138-55.

Arosio, Fabrizio; Guasti, Maria Teresa; Stucchi, Natale A. (2011). "Disambiguating information and memory resources in children's processing of italian relative clauses". *Journal of psycholinguistic research*, 40(2), 137-54.

Baddeley, Alan D. (1986). *Working memory*. Oxford: Oxford University Press.

Baddeley, Alan D. (2001). "Is working memory still working?" *American Psychologist*, 56, 849-64.

Baddeley, Alan D. (2003). "Working memory and language: an overview". *Journal of communication disorders*, 36, 189-208.

Baddeley, Alan D.; Hitch, Graham (1974). "Working memory". Bower, Gordon H. (ed.), *The psychology of learning and motivation: Advances in research and theory*, vol. 8. New York: Academic Press, 47-89.

Belletti, Adriana (1990). *Generalized verb movement: aspects of verb syntax*. Torino: Rosenberg et Sellier.

Belletti, Adriana. (2005). "Extended Doubling and the VP periphery". *Probus,* 17(1), 1-36.

Belletti, Adriana (2009). "Notes on Passive Object Relatives". Svenonius, Peter (ed.), *Functional Structure from Top to Toe*. Oxford: Oxford University Press, 97-114.

Belletti, Adriana; Contemori, Carla (2010). "Intervention and attraction. On the production of subject and object relatives by Italian (young) children and adults." Castro, Ana, Costa, João, Lobo, Maria, Pratas, Fernanda (eds), *language acquisition and development. Proceedings of GALA 2009*. Cambridge: Cambridge Scholars Press, 39-52.

Belletti, Adriana et al. (2012). "Does gender make a difference? Comparing the effect of gender on children's comprehension of relative clauses in Hebrew and Italian". *Lingua*, 122(10), 1053-69.

Bencini, Giulia M. L.; Valian, Virginia V. (2008). "Abstract sentence representation in 3-year-olds: Evidence from language production and comprehension". *Journal of Memory and Language*, 59, 97-113.

Berent, Gerald P. (1996). "The acquisition of English syntax by deaf learners". Ritchie,William C.; Bhatia, Tej K. (eds), *Handbook of second language acquisition*. San Diego, California: Academic Press, 469-506.

Bernstein, Judy B. (2001). "The DP hypothesis: identifying clausal properties in the nominal domain". Baltin, Mark; Collins, Chris (eds), *The Handbook of Contemporary Syntactic Theory.* Oxford: Blackwell Publishers, 536-61.

Beronesi, Sandra; Massoni, Piera; Osella Maria Teresa (1991*). L'italiano segnato esatto nell'educazione bimodale del bambino sordo.* Torino: Omega.

Beronesi, Sandra; Volterra, Virginia. (1986). "Il bambino sordo che sbaglia parlando". *Italiano & Oltre*, 3, 103-5.

Bertone, Carmela; Volpato, Francesca (2009). "Oral language and sign language: possible approaches for deaf people's language development". *Cadernos de Saúde*, 2, 51-*62.*

Bianchi, Valentina. (1999). *Consequences of antisymmetry: headed relative clauses*. Berlin: Mouton de Gruyter.

Bigoni, Anna et al. (2003). "Sviluppo del linguaggio in bambini sordi trattati con il metodo orale, in Sordità: aspetti riabilitativi, educativi e linguistici". *Saggi – Child Development & Disabilities*, XXIX(1), 25-40.

Bishop, Dorothy M.V.; North, Trista; Donlan, Chris (1996). "Nonword repetition as a behavioural marker for inherited language impairment: Evidence from a twin study". *Journal of Child Psychology and Psychiatry*, 37, 391-403.

Blamey, Peter J. et al. (2001). "Relationships among speech perception, production, language, hearing loss, and age in children with impaired hearing". *Journal of Speech, Language, and Hearing Research*, 44, 264-85.

Boothroyd, Arthur; Geers, Ann E.; Moog, Jean S. (1991). "Practical implications of cochlear implants in children". *Ear and hearing*, 12, 81-9.

Bortolini, Umberta et al. (2006). "Clinical markers for specific language impairment in Italian: the contribution of clitics and non-word repetition". *International Journal of Language and Communication Disorders*, 41(6), 695-712.

Botting, Nicola; Conti-Ramsden, Gina (2001). "Non-word repetition and language development in children with specific language impairment (SLI)". *International Journal of Language and Communication Disorders*, 36, 421-32. DOI https://doi.org/10.1080/13682820110074971.

Branchini, Chiara (2014). *On relativization and clefting. An analysis of Italian Sign Language*. Berlin: Mouton De Gruyter.

Briscoe, Josie et al. (2001). "Phonological processing, language, and literacy: A comparison of children with mild-to-moderate sensorineural hearing loss and those with specific language impairment". *Journal of Child Psychology and Psychiatry*, 42, 329-40.

Bruni, Romano (2002). *CESPEE – Complesso per l'esame dello sviluppo psicolinguistico in età evolutiva.* Nuova edizione riveduta sulla base delle indicazioni dell'autore, a cura di Fanzago, Franca. Padova: Diade.

Burkholder, Rose A.; Pisoni, David B. (2005). "Working memory capacity, verbal rehearsal speed, and scanning in deaf children with cochlear implants". Spencer, Patricia Elizabeth; Marschark, Marc (eds), *advances in the spoken language development of deaf and hard-of-hearing children.* Oxford: Oxford University Press, 328-57.

Cain, Kate E.; Bryant, Peter E.; Oakhill, Jane (2004). "Children's reading comprehension ability: Concurrent prediction by working memory, verbal ability, and component skills". *Journal of Educational Psychology*, 96, 31-42.

Carminati, Nella (2005). "Processing reflexes of the feature hierarchy (Person>Number>Gender) and implications for the linguistic theory". *Lingua*, 115, 259-85.

Carpenedo, Chiara (2009). *Answering strategies in the production of relative clauses by a group of young students* [BA Thesis]. Venezia: Università Ca' Foscari.

Caselli, Maria Cristina et al. (1994). *Linguaggio e Sordità.* Firenze: La Nuova Italia.

Caselli, Maria Cristina et al. (2012). "Cochlear implant in the second year of life: Lexical and grammatical outcomes". *Journal of Speech, Language, and Hearing Research*, 55, 382-94.

Casserly, Elizabeth D.; Pisoni, David B. (2013). "Non-word repetition as a predictor of long-term speech and language skills in children with cochlear implants". *Otology & Neurotology*, 34, 460-70.

Catts, Hugh W. et al. (2005). "Are specific language impairment and dyslexia distinct disorders?". *Journal of Speech, Language, and Hearing Research*, 48, 1378-96.

Cecchetto, Carlo; Geraci, Carlo; Zucchi, Sandro (2006). "Strategies of Relativization in Italian Sign Language". *Natural Language and Linguistic Theory*, 25, 945-75.

Chesi, Cristiano (2006). *Il linguaggio verbale non standard dei bambini sordi*. Roma: Edizioni Universitarie Romane.

Chilosi, Anna Maria; Cipriani, Paola (2006). *TCGB. Test di comprensione grammaticale per bambini* (in collaboration with Giorgi, Alessandra; Fazzi, Barbara; Pfanner, Lucia), Pisa: Edizioni del Cerro.

Chilosi, Anna Maria et al. (2013). "A longitudinal study of lexical and grammar development in deaf Italian children provided with early cochlear implantation". *Ear & Hearing*, 34, e28-37. DOI https://doi.org/10.1097/AUD.0b013e31827ad687.

Chin, Steven B.; Pisoni, David B. (2000). "A phonological system at 2 years after cochlear implantation". *Clinical Linguistics and Phonetics*, 14, 53-73.

Chinellato, Paolo (2004). *Disturbi di sintassi nell'afasia non fluente: un'analisi linguistica dell'agrammatismo italiano e dialettale* [PhD dissertation]. Padova: Università degli Studi di Padova.

Chomsky, Noam (1975). *Reflections on Language*. New York: Pantheon Books.

Chomsky, Noam. (1977). "On wh-movement". Culicover, Peter; Wasow, Thomas; Akmajian, Adrian (eds), *Formal syntax*. New York: Academic Press, 77-132

Chomsky, Noam (1995). *The Minimalist Program*. Cambridge, MA: MIT Press.

Chomsky, Noam (2000). "Minimalist inquiries: The framework". Martin, Roger; Michaels, David; Uriagereka, Juan (eds), *Step by step: Essays in honor of Howard Lasnik*. Cambridge (MA): MIT Press, 89-155.

Chomsky, Noam (2001). "Derivation by Phase". Kenstowicz, Michael (ed.), *Ken Hale: A life in language.* Cambridge (MA): MIT Press, 1-52.

Cinque, Guglielmo (1978). "La sintassi dei pronomi relativi cui e quale nell'italiano moderno". *Rivista di Grammatica Generativa,* 3(1), 31-126.

Cinque, Guglielmo (1982). "On the theory of relative clauses and markedness". *The Linguistic Review*, 1, 247-94.

Cinque, Guglielmo (1988). "La frase relativa". Lorenzo Renzi (ed.), *Grande grammatica italiana di consultazione*, vol. 1. Bologna: il Mulino, 443-503.
Cinque, Guglielmo (1999). *Adverbs and functional heads*. New York: OUP.
Cinque, Guglielmo (ed.) (2002). *Functional Structure in DP and IP. The Cartography of Syntactic Structures*, vol 1. Oxford: Oxford University Press.
Cinque, Guglielmo (2011). "On Double-Headed Relative Clauses". *Linguística. Revista de Estudos Linguísticos da Universidade do Porto*, 6, 67-91.
Cinque, Guglielmo (2013). Typological Studies. Word Order and Relative Clauses. New York: Routledge.
Clark, Eve V. (1993). *The Lexicon in Acquisition.* Cambridge: Cambridge University Press.
Cleary, Miranda; Dillon, Caitlin; Pisoni, David B. (2002). "Imitation of nonwords by deaf children after cochlear implantation: Preliminary findings". *Annals of Otology, Rhinology and Laryngology*, 111, 91-6.
Cleary, Miranda; Pisoni, David B.; Kirk, Karen I. (2002). "Working memory spans as predictors of spoken word recognition and receptive vocabulary in children with cochlear implants". *Volta Review*, 102, 259-80.
Colletti, Vittorio et al. (2005). "Cochlear Implantation at under 12 months: Report on 10 Patients". *Laryngoscope*, 115(3), 445-9.
Collins, Chris (2005). "A Smuggling approach to the passive in English". *Syntax*, 8(2), 81-120.
Colombo, Lucia; Arfè, Barbara; Bronte, Tiziana (2012). "The influence of phonological mechanisms in written spelling of profoundly deaf children". *Reading and Writing*, 25(8), 2021-38. DOI https://doi.org/10.1007/s11145-011-9343-6.
Connor, Carol M. et al. (2000). "Speech, vocabulary, and the education of children using cochlear implants: oral or total communication?". *Journal of Speech, Language, and Hearing Research*, 43(5), 1185-204.
Connor, Carol M. et al. (2006). "The Age at Which Young Deaf Children Receive Cochlear Implants and Their Vocabulary and Speech-Production Growth: Is there an added value for early implantation?". *Ear and Hearing*, 27(6), 628-44.
Contemori, Carla; Garraffa, Maria (2010). "Comparison of modalities in SLI syntax: a study on the comprehension and production of non-canonical sentences". *Lingua*, 120, 1940-55.
Contemori, Carla; Marinis, Theodoros (2012). "Real-time processing of number mismatch in relative clauses by English-speaking children and adults". Stavrakaki, Stavroula; Konstantinopoulou, Xenia; Lalioti, Marina (eds), *Advances in language acquisition: Proceedings of Generative Approaches to Language Acquisition Conference GALA 2011*. Newcastle Upon Tyne: Cambridge Scholars Publishing, 44-52.
Contemori, Carla; Belletti, Adriana (2013). "Relatives and passive object relatives in Italian-speaking children and adults: Intervention in production and comprehension". *Applied Psycholinguistics*, 35(6), 1021-153. DOI http://dx.doi.org/10.1017/S0142716412000689.
Conway, Christopher M.; Pisoni, David B.; Kronenberger, William G. (2009). "The importance of sound for cognitive sequencing abilities: The auditory scaffolding hypothesis". *Current Directions in Psychological Science*, 18, 275-79.
Correa, Leticia M. (1995). "An alternative assessment of children's comprehension of relative clauses". *Journal of Psycholinguistic Research*, 24, 183-203.

Crain, Stephen; McKee, Cecile; Emiliani, Maria (1990). "Visiting relatives in Italy". Frazier, Lin; de Villiers, J. (eds), *Language processing and language acquisition.* Dordrecht: Kluwer, 335-56.

Curtiss, Susan (1977). *Genie: A Psycholinguistic Study of a Modern-Day "Wild Child"*. New York: Academic Press.

Curtiss, Susan (1989). "The independence and task-specificity of language". Bornstein A.; Bruner, J. (eds), *Crosscurrents in contemporary psychology. Interaction in Human Development.* Erlbaum (Hillsdale, N.J.), 105-37.

Davidson, Kathryn; Lillo-Martin, Diane; Chen Pichler, Deborah (2014). "Spoken English language development among native signing children with cochlear implants". *Journal of deaf studies and deaf education*, 19(2), 238-50. DOI https://doi.org/10.1093/deafed/ent045.

Dawson, Pam W. et al. (2002). "Short-term auditory memory in children using cochlear implants and its relevance to receptive language". *Journal of Speech, Language, and Hearing Research,* 45(4), 789-801.

De Agostini, Maria et al. (1998). "Batterie d'évaluation du langage oral de l'enfant aphasique: Standardisation française (4-12 ans). Oral language evaluation battery of aphasic children: A French standardisation". *Revue de Neuropsychologie*, 8, 319-67.

DeCaro, Renée et al. (2016). "The two sides of sensory-cognitive interactions: Effects of age, hearing acuity, and working memory span on sentence comprehension". *Frontiers in Psychology*, 7, 236.

De Filippis Cippone, Adriana. (2002). *L'impianto cocleare. Manuale operativo*. Milano: Masson.

De Villiers, Jill. G. et al. (1979). "Children's comprehension of relative clauses". *Journal of Psycholinguistic Research*, 17, 57-64.

De Villiers, Jill G.; de Villiers, Peter A.; Hoban, E. (1994). "The central problem of functional categories in English syntax of oral deaf children". Tager-Flusberg, H. (ed.), *Constraints on language acquisition: Studies of atypical children*. Hillsdale, NJ: Lawrence Erlbaum, 9-47.

De Villiers, Peter. A. (1988). "Assessing English syntax in hearing-impaired children: Elicited production in pragmatically motivated situations", in Kretchmer, Richard R.; Kretchmer, Laura W. (eds), "Communication assessment of hearing-impaired children: From conversation to classroom", num. monogr., *The Journal of the Academy of Rehabilitative Audiology*, 21, 41-71.

De Villiers, Peter A.; Pomerantz, Sarah B. (1992). "Hearing-impaired students learning new words from written context". *Applied Psycholinguistics*, 13, 409-31.

De Vincenzi, Marica (1991). *Syntactic parsing strategies in Italian: The Minimal Chain Principle*, vol. 12. Dordrecht/Boston/London: Kluwer Academic Publishers.

De Vincenzi, Marica (1996). *Test di comprensione delle frasi interrogative soggetto/oggetto in italiano*. Roma, CNR: Istituto di Psicologia.

De Vincenzi Marica; Di Domenico Elisa (1999). "A distinction among phi features: the role of gender and number in the retrieval of pronoun antecedents". *Rivista di Linguistica*, 11, 41-74.

Delage, Hélène (2008). *Évolution de l'hétérogénéité linguistique chez les enfants sourds moyens et légers: Étude de la complexité morphosyntaxique* [PhD dissertation].Tours: Université François – Rabelais.

Delage, Hélène; Frauenfelder, Ulrich H. (2012). "Développement de la mémoire de travail et traitement des phrases complexes: Quelle relation?".

3e Congrès Mondial de Linguistique Française. SHS Web of Conferences, 1, 1555-73.

Delage, Hélène; Tuller, Laurice (2007). "Language development and mild-to-moderate hearing loss: does language normalize with age?". *Journal of Speech, Language and Hearing Research*, 50(5), 1300-13.

Demuth, Katherine; Moloi, Francina; Machobane, Malillo (2010). "3-year-olds' comprehension, production, and generalization of Sesotho passives". *Cognition*, 115, 238-51.

Devescovi, Antonella et al. (1992). "Rilevazione delle prime fasi dello sviluppo morfosintattico attraverso una prova di ripetizione." *Rassegna di Psicologia*, 9(2), 29-53.

Di Domenico, Elisa (1997). *Per una teoria del genere grammaticale.* Padova: Unipress.

Dillon, Caitlin M.; Pisoni, David B. (2006). "Nonword repetition and reading skills in children who are deaf and have cochlear implants". *The Volta Review*, 106, 121-45.

Dillon, Caitlin M. et al. (2004). "Imitation of nonwords by hearing-impaired children with cochlear implants: Segmental analyses". *Clinical Linguistics and Phonetics*, 18, 39-55.

Dispaldro, Marco; Leonard, Laurence B.; Deevy, Patricia (2013). "Clinical Markers in Italian-Speaking Children with and without Specific Language Impairment: A Study of Non-Word and Real Word Repetition as Predictors of Grammatical Ability". *International Journal of Language and Communication Disorders*, 48, 554-64.

Dixon, Peter (2008). "Models of accuracy in repeated-measures designs". *Journal of Memory and Language*, 59, 447-56.

D'Ortenzio, Silvia (2019). *Analysis and treatment of movement-derived structures in Italian-speaking cochlear implanted children* [PhD dissertation]. Venezia: Università Ca' Foscari.

Eilers, Rebecca E.; Oller, Kimbrough D. (1994). "Infant vocalizations and the early diagnosis of severe hearing impairment". *Journal of Pediatrics*, 124, 199-203.

Emiliani, Maria et al. (1994). "Comprensione di alcuni aspetti lessicali e morfosintattici dell'italiano parlato nei bambini ipoacusici. Uno studio longitudinale". *Età evolutiva*, 48, 51-61.

Engen, Elizabeth; Engen, Trigg (1983). *Rodhe Island test of language structure*. Austin, TX: Pro-Ed.

Fabbretti, Daniela (2000). "L'italiano scritto dai sordi: un'indagine sulle abilità di scrittura dei sordi adulti segnanti nativi". *Rassegna di Psicologia*, 17, 1-21.

Fabbretti, Daniela; Tomasuolo, Elena (a cura di) (2006). *Scrittura e Sordità.* Roma: Carocci Editore.

Fabbretti, Daniela; Volterra, Virginia; Pontecorvo, Clotilde (1998). "Written language abilities in Deaf Italians". *Journal of Deaf Studies and Deaf Education*, 3, 231-44.

Fabbro, Franco (1999). "Neurolinguistica e neuropsicologia dei disturbi specifici del linguaggio nel bambino: Proposta di un esame del linguaggio". *Saggi*, 25, 11-23.

Fabbro, Franco (2003). "Introduzione". *Sordità: aspetti riabilitativi, educativi e linguistici. Saggi. Child e Development & Disabilities*. Bosisio Parini (LC): Ed. Ass.ne "La Nostra Famiglia", 7-10.

Fagan, Mary K. et al. (2007). "Neuropsychological correlates of vocabulary, reading, and working memory in deaf children with cochlear implants". *Journal of Deaf Studies and Deaf Education*, 12, 461-71.

Ferrari, Franca (2005). *A syntactic analysis of the nominal systems of Italian and Luganda: How nouns can be formed in the syntax* [PhD dissertation]. New York: New York University.

Ferreiro, Emilia et al. (1976). "How do children handle relative clauses? A study in comparative developmental psycholinguistics". *Archives de Psychologie*, 44, 229-66.

Franchi, Elisa (2004). *Piena competenza e assenza di competenza linguistica. Una distinzione messa in evidenza dalla Logogenia. Essere copula e ausiliare in italiano infantile e in un sordo profondo prelinguale non segnante* [PhD dissertation]. Firenze: Università di Firenze.

Franck, Julie et al. (2006). "Agreement and movement: A syntactic analysis of attraction". *Cognition*, 101, 173-216.

Friedmann, Naama, (2008). "Traceless relatives: Agrammatic comprehension of relative clauses with resumptive pronoun". *Journal of Neurolinguistics*, 21(2), 138-49.

Friedmann, Naama; Belletti, Adriana; Rizzi, Luigi (2009). "Relativized relatives. Types of intervention in the acquisition of A-bar dependencies". *Lingua*, 119, 67-88.

Friedmann, Naama; Costa, João (2011). "Last resort and no resort: Resumptive pronouns in Hebrew and Palestinian Arabic hearing impairment". Rouveret, Alain (ed.), *Resumptive pronouns at the interfaces (Language Faculty and Beyond Series*). Amsterdam: John Benjamins, 223-39.

Friedmann, Naama; Haddad-Hanna, Manar. (2014), "The comprehension of sentences derived by syntactic movement in Palestinian Arabic-speaking children with hearing impairment". *Applied psycholinguistics*, 35, 473-513.

Friedmann, Naama; Novogrodsky, Rama (2004). "The acquisition of relative clause comprehension in Hebrew: a study of SLI and normal development". *Journal of Child Language*, 31(3), 661-81.

Friedmann, Naama, Novogrodsky, Rama (2007). "Is the movement deficit in syntactic SLI related to traces or to thematic role transfer?" *Brain & Language*, 101(1), 50-63.

Friedmann, Naama; Rusou, Dana. (2015). "Critical period for first language: The crucial role of language input during the first year of life". *Current opinion in neurobiology*, 35. 27-34. DOI https://doi.org/10.1016/j.conb.2015.06.003.

Friedmann, Naama; Szterman, Ronit (2006). "Syntactic movement in orally-trained children with hearing impairment". *Journal of Deaf Studies and Deaf Education*, 11, 56-75.

Friedmann, Naama; Szterman, Ronit (2011). The Comprehension and Production of Wh-Questions in Deaf and Hard-of-Hearing Children. *Journal of Deaf Studies and Deaf Education*, 16, 212-35.

Friedmann, Naama et al. (2008). "Resumptive pronouns as a last resort when movement is impaired: Relative clauses in hearing impairment". Armon-Lotem, Sharon; Danon, Gabi; Rothstein Susan (eds), *Current Issues in Generative Hebrew Linguistics*. Amsterdam: John Benjamins, 267-90.

Fry, Dennis Butler (1966). "The development of the phonological system in the normal and the deaf child". Smith, Frank; Miller, George A. (eds), *The genesis of language.* Cambridge (MA): MIT Press, 187-206.

Fryauf-Bertschy, Holly et al. (1997), "Cochlear implant use by prelingually deafened children: The influences of age at implant and length of device use". *Journal of Speech, Language, and Hearing Research*, 40, 183-99.

Furth, Hans C. (1966). *Thinking without language: psychological implication of deafness*. New York: Free Press.

Garraffa, Maria; Grillo, Nino (2008). "Canonicity effects as grammatical phenomena". *Journal of Neurolinguistics*, 21(2), 177-97.

Gathercole, Susan E. (2006). "Non-word repetition and word learning: The nature of the relationship". *Applied Psycholinguistics*, 27, 513-43.

Gathercole, Susan; Baddeley, A. (1990). "Phonological memory deficits in language disordered children: Is there a causal connection?". *Journal of Memory and Language*, 29, 336-60.

Gathercole, Susan E. et al. (2004). "Working memory skills and educational attainment: Evidence from National Curriculum assessments at 7 and 14 years of age". *Applied Cognitive Psychology*, 40, 1-16.

Gathercole, Susan E. et al. (2006). "Working memory in children with literacy and mathematical difficulties". *Journal of Experimental Child Psychology*, 93, 265-81.

Geers, Ann E. (2002). "Factors Affecting the Development of Speech, Language, and Literacy in Children with Early Cochlear Implantation". *Language, Speech, and Hearing Services in Schools*, 33(3), 172-83.

Geers Ann E. (2006). "Factors influencing spoken language outcomes in children following early cochlear implantation". *Advances in Oto-Rhino-Laryngology*, 64, 50-65.

Geers, Ann; Brenner, Chris; Davidson, Lisa (2003). "Factors Associated with Development of Speech Perception Skills in Children Implanted by Age Five". *Ear and Hearing*, 24(1), 24S-35S.

Geers Ann E. et al. (2002). "Rehabilitation factors contributing to implant benefit in children". *Annals of Otology, Rhinology & Laryngology Suppl*., 189, 127-30.

Geers, Ann et al. (2009). "Spoken Language Scores of Children Using Cochlear Implants Compared to Hearing Age-Mates at School Entry". *Journal of Deaf Studies and Deaf Education*, 14, 371-85.

Gibson, Edward (1998). "Linguistic complexity: Locality of syntactic dependencies". *Cognition*, 68, 1-76.

Gilbertson, Margie; Kamhi, Alan G. (1995). "Novel word learning in children with hearing impairment". *Journal of Speech and Hearing Research*, 38, 630-642.

Goodluck, Helen; Stojanovic, Danijela (1996). "The structure and acquisition of relative clauses in Serbo-Croatian". *Language Acquisition*, 5, 285-315.

Goodluck, Helen; Tavakolian, Susan L. (1982). "Competence and processing in children's grammar of relative clauses". *Cognition*, 11(1), 1-27.

Govaerts, Paul J. (2004). "Audiometric tests and diagnostic workup". Willems, Patrick J. (ed.), *Genetic hearing loss*. New York: Marcel Dekker Inc., 33-48.

Govaerts, Paul J.; Schauwers, Karen; Gillis, Steven (2002). "Language acquisition in very young children with a cochlear implant: introduction". *Antwerp Papers in Linguistics*, 102, 1-10.

Grillo, Nino (2008). Generalized *minimality: Syntactic underspecification in Broca's aphasia* [PhD dissertation]. University of Utrecht, the Netherlands: LOT.

Grosjean, Francois (2010). "Bilingualism, biculturalism, and deafness". *International Journal of Bilingual Education and Bilingualism*, 13(2), 133-45.

Grosselle, Sabrina. (2008). *Valutazione della Competenza Linguistica Generale di Adolescenti Sordi Segnanti* [BA Thesis]. Venezia: University of Venice:
Guasti, Maria Teresa. (2002). *Language acquisition: The growth of grammar.* Cambridge (MA): MIT Press.
Guasti, Maria Teresa; Cardinaletti, Anna (2003). "Relative clause formation in Romance child's production". *Probus. Special Issue on Language Acquisition*, 15(1), 47-89.
Guasti, Maria Teresa; Rizzi, Luigi (2002). "Agr and Tense as distinctive syntactic projections: Evidence from acquisition." Cinque, Guglielmo (ed.), *The cartography of syntactic structures.* New York: Oxford University Press, 167-94.
Guasti, Maria Teresa; Shlonsky, Ur (1995). "The acquisition of French relative clauses reconsidered". *Language Acquisition*, 4, 257-76.
Guasti, Maria Teresa et al. (1997). "Les relatives que nous apprenons". *Rivista di grammatica generative*, 21, 107-28.
Guasti, Maria Teresa et al. (2014). "The effect of language structure on linguistic strengths and weaknesses in children with cochlear implants: evidence from Italian". *Applied Psycholinguistics*, 35(4), 739-64.
Hakansson, Gisela; Hansson, Kristina (2000). "Comprehension and production of relative clauses: A comparison between Swedish impaired and unimpaired children". *Journal of Child Language*, 27, 313-33.
Hamburger, Henry; Crain, Stephen (1982). "Relative acquisition". Kuczaj, Stan (ed.), *Syntax and semantics.* Vol. 1 of *Language development*. Hillsdale, N.J.: Lawrence Erlbaum, 245-274.
Hammer, Annemiek (2010). *The acquisition of verbal morphology in cochlear-implanted and specific language impaired children* [PhD dissertation]. Leiden: LOT Dissertation Series, 255.
Hammer, Annemiek et al. (2014). "The production of Dutch finite verb morphology: A comparison between hearing-impaired CI children and specific language impaired children". *Lingua*, 139, 68-79. DOI `https://doi.org/10.1016/j.lingua.2013.11.010`.
Hammes, Dianne M. et al. (2002). "Early identification and cochlear implantation: critical factors for spoken language development". *Annals of Otology, Rhinology & Laryngology Suppl.*,189, 74-8.
Hansson, Kristina et al. (2017). "Phonological processing, grammar and sentence comprehension in older and younger generations of Swedish children with cochlear implants". *Autism and Developmental Language Impairments*, 2, 1-14.
Harris, James W. (1991). "The exponence of gender in Spanish". *Linguistic Inquiry*, 22, 27-62.
Harris, Michael S. et al. (2013). "Verbal short-term memory development and spoken language outcomes in deaf children with cochlear implants". *Ear and Hearing*, 34, 179-92.
Hayes, Heather et al. (2009), "Receptive Vocabulary Development in Deaf Children with Cochlear Implants: Achievement in an Intensive Auditory-Oral Setting". *Ear and Hearing*, 30(1), 128-35.
Hodges, Annelle V. et al. (1999). "Speech perception results in children with cochlear implants: contributing factors". *Otolaryngology – Head & Neck Surgery*, 121(1), 31-4.
Ibertsson, Tina et al. (2008). "A methodological contribution to the assessment of nonword repetition – A comparison between children with specific lan-

guage impairment and hearing-impaired children with hearing aids or cochlear implants". *Logopedics Phoniatrics Vocology*, 33, 168-78.
Jaeger, T. Florian (2008). "Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models". *Journal of Memory and Language,* 59, 434-46.
Jaeggli, Osvaldo A. (1986). "Passive". *Linguistic Inquiry*, 17, 582-622.
Jakubowicz, Celia (2011). "Measuring derivational complexity: new evidence from typically developing and SLI learners of L1 French". *Lingua*, 121, 339-51.
Jakubowicz, Celia; Strik, Nelleke (2008). "Scope-marking strategies in the acquisition of long distance wh-questions in French and Dutch". *Language and Speech*, 51, 101-32.
Jakubowicz, Celia; Tuller, Laurice. (2008). "Specific Language Impairment in French". Ayoun, Dalila (ed.), *Studies in French Applied Linguistics.* Amsterdam: John Benjamins, 97-133.
Jiménez, María; Pino, María; Herruzo, Javier. (2009). "A comparative study of speech development between deaf children with cochlear implants who have been educated with spoken or spoken + sign language". *International Journal of Pediatric Otorhinolaryngology*, 73, 109-14. DOI https://doi.org/10.1016/j.ijporl.2008.10.007.
Johnson, Carol; Goswami, Usha (2010), "Phonological awareness, vocabulary, and reading in deaf children with cochlear implants". *Journal of Speech, Language and Hearing Research*, 53, 237-61.
Just, Marcel A.; Carpenter, Patricia A. (1992). "A capacity theory of comprehension: Individual differences in working memory". *Psychological Review*, 99, 122-49.
Kayne, Richard (1989). *Notes on English Agreement.* CIEFL Bulletin, Hyderabad.
Kayne, Richard (1994). *The antisymmetry of syntax*. Cambrdige (MA): MIT Press.
Kidd, Evan; Bavin, Edith L. (2002). "English-speaking children's comprehension of relative clauses: Evidence for general-cognitive and language-specific constraints on development". *Journal of Psycholinguistic Research,* 31, 599-617.
Kirk, Karen I.; Hill-Brown, Carolyn (1985). "Speech and language results in children with a cochlear implant". *Ear and Hearing,* 6 (suppl), 36-47.
Klima, Edward S.; Bellugi, Ursula (1979). *The Signs of Language*. Cambridge: Harvard University Press.
Koopman, Hilda; Sportiche, Dominique (1991). "The position of subjects". *Lingua*, 85, 211-58.
Kronenberger et al. (2014). "Executive functioning and speech-language skills following long-term use of cochlear implants". *Journal of Deaf Studies and Deaf Education*, 19, 456-70.
Labelle, Marie (1990). "Predication, Wh-movement and the development of relative clauses". *Language Acquisition*, 1, 95-119.
Lampitelli, Nicola (2010). "Nounness, gender, class and syntactic structures in Italian nouns". Bok-Bennema, Reineke; Kampers-Mahne, Brigitte, Hollebrandse, Bart (eds), *Romance Languages and Linguistic Theory 2008. Selected Papers from"Going Romance"Groningen 2008*. Amsterdam: John Benjamins, 195-214.
Lederberg, Amy R. (2006). "Language development of deaf children with hearing parents". Lieven Elena (ed.), *Encyclopedia of language and linguistics*. 2nd ed. Oxford: Elsevier Ltd., 361-7.

Lederberg, Amy R.; Spencer, Patricia E. (2001). "Vocabulary development of deaf and hard of hearing children". Clark, Diane M.; Marschark, Marc; Karchmer Michael A. (eds), *Context, Cognition, and Deafness*. Washinton DC: Gallaudet University Press, 88-112.

Lederberg, Amy R.; Spencer, Patricia E. (2005). "Critical periods in the acquisition of lexical skills: evidence from deaf individuals". Fletcher, Paul; Miller, Jon F. (eds), *Language disorders and developmental theory.* Philadelphia, PA: John Benjamins, 121-45.

Lenneberg, Eric H. (1967). *Biological Foundations of Language.* New York, NY: Wiley.

Lund, Emily (2016). "Vocabulary Knowledge of Children with Cochlear Implants: A Meta-Analysis". *Journal of Deaf Studies and Deaf Education*, 21, 107-12.

Manetti, Claudia (2013). "On the production of passives in Italian: evidence form an elicited production task and a syntactic priming study with preschool children". Baiz, Sarah; Goldman, Nora; Hawkes, Rachel (eds), *BUCLD 37 Proceedings Online Supplement*, 1-16.

Mann,Virginia A.; Liberman, Isabelle Y. (1984). "Phonological awareness and verbal short-term memory". *Journal of Learning Disabilities*, 17, 592-9.

Mann, Virginia A.; Shankweiler, Donald; Smith, Suzanne. T. (1984). "The association between comprehension of spoken sentences and early reading ability: The role of phonetic representation". *Journal of Child Language*, 11, 627-43.

Manrique, Manuel et al. (2004). "Advantages of cochlear implantation in prelingual deaf children before 2 years of age when compared with later implantation". *Laryngoscope*, 114, 1462-9.

Maragna, Simonetta (2000). *La sordità. Educazione, scuola, lavoro e integrazione sociale.* Milano: Hoepli.

Marconi, Lucia et al. (1993). *Lessico elementare.* Bologna: Zanichelli.

Marschark, Mark (2009). *Raising and Educating a Deaf Child: A Comprehensive Guide to the Choices, Controversies, and Decisions Faced by Parents and Educators.* Oxford: Oxford University Press.

Mayne, Alison; Yoshinaga-Itano, Christine; Sedey Allison L. (2000). "Receptive vocabulary development of infants and toddlers who are deaf or hard of hearing". *Volta Review*, 100, 29-52.

McKee, Cecile; McDaniel, Diana; Snedeker, Jesse (1998). "Relatives children say". *Journal of Psycholinguistic Research*, 27, 573-96.

Meisel, Jürgen M. (2013). "Sensitive phases in successive language acquisition: The critical period hypothesis revisited". Boeckx, Cedric; Grohmann, Kleanthes K. (eds), *The Cambridge Handbook of Biolinguistics*. Cambridge: Cambridge University Press, 69-85. DOI https://doi.org/10.1017/CBO9780511980435.007.

Messenger, Katherine et al. (2009). "Semantic factors in young children's comprehension and production of passives". Chandlee, Jane et al. (eds), *Proceedings of the 33rd Boston University Conference on Language Development*. Somerville (MA): Cascadilla Press, 355-66.

Miyamoto, Richard T. et al. (1999). "Communication skills in pediatric cochlear implant recipients". *Acta Otolaryngologica*, 119, 219-24.

Miyamoto, Richard T. et al. (2008). "Language skills of profoundly deaf children who received cochlear implants under 12 months of age: A preliminary study". *Acta Oto-Laryngologica*, 128, 373-7.

Moberly, Aaron C.; Pisoni, David B.; Harris, Michael S. (2018). "Visual working memory span in adults with cochlear implants: Some preliminary findings". *World Journal of Otorhinolaryngology - Head and Neck Surgery*, 3(4), 224-30.

Moeller, Mary P. (2000). "Early intervention and language development in children who are deaf and hard of hearing". *Pediatrics*, 106(3), E43. DOI https://doi.org/10.1542/peds106.3.e43

Moeller, Mary P.; Osberger, Mary J.; Eccarius, Malinda (1986). "Language and learning skills of hearing-impaired students. Receptive language skills". *ASHA monographs*, (23), 41-53.

Moeller, Mary P. et al. (2007). "Vocalizations of infants with hearing loss compared with infants with normal hearing: Part I—phonetic development". *Ear and Hearing*, 28, 605-27

Montgomery, James W. (1995). "Sentence comprehension in children with specific language impairment: The role of phonological working memory". *Journal of Speech and Hearing Research*, 38, 187-99.

Nadol, Joseph B. Jr.; Merchant, Saumil N. (2001). "Histopathology and molecular genetics of hearing loss in the human". *International Journal of Pediatric Otorhinolaryngology*, 61(1), 1-15.

Newport, Elissa L.; Supalla, Ted. (1999). "Sign languages". Wilson, Robert; Keil, Frank (eds), *The MIT encyclopaedia of the cognitive sciences.* Cambridge, MA: MIT Press, 758-60.

Nicholas, Johanna Grant; Geers, Ann E. (2006). "Effects of early auditory experience on the spoken language of deaf children at 3 years of age". *Journal of Ear and Hearing*, 27(3), 286-98.

Nicholas, Johanna Grant; Geers, Ann E. (2007). "Will they catch up? The role of age at cochlear implantation in the spoken language development of children with severe to profound hearing loss". *Journal of Speech, Language and Hearing Research*, 50(4), 1048-62.

Nicol, Janet L. (1988). *Coreference processing during sentence comprehension.* [PhD Dissertation]. Cambridge: MIT Press.

Nikolopoulos, Thomas P. et al. (2004), "Development of spoken language grammar following cochlear implantation in prelingually deaf children". *Archives of Otolaryngology—Head and Neck Surgery*, 130(5), 629-33.

Nittrouer, Susan; Caldwell-Tarr, Amanda; Lowenstein, Joanna H. (2013). "Working memory in children with cochlear implants: Problems are in storage, not processing". *International Journal of Pediatric Otorhinolaryngology,* 77, 1886-98. DOI https://doi.org/10.1016/j.ijporl.2013.09.001

Nittrouer, Susan et al. (2014). "Nonword repetition in children with cochlear implants: A potential clinical marker of poor language acquisition". *American Journal of Speech-Language Pathology*, 23, 679-95.

Norbury, Courtenay F.; Bishop, Dorothy V. M.; Briscoe, Josie (2001). "Production of English finite verb morphology: a comparison of SLI and mild-moderate hearing impairment". *Journal of Speech, Language, and Hearing Research*, 44, 165-79.

Norbury, Courtenay F.; Bishop, Dorothy. V.M.; Briscoe, Josie (2002). "Does impaired grammatical comprehension provide evidence for an innate grammar module?". *Applied Psycholinguistics*, 2, 247-68.

Novogrodsky, Rama; Friedmann, Naama (2006). "The production of relative clauses in syntactic SLI: A window to the nature of the impairment". *Advances in Speech-Language pathology*, 8, 364-75.

O'Brien, Karen; Elaine Grolla; Diane Lillo-Martin (2006). "Long Passives are Understood by Young Children". Bamman, David; Magnitskaia, Tatiana; Colleen Zaller (eds), *Proceedings of the 30th annual Boston University Conference on Language Development*. Somerville, MA: Cascadilla Press, 441-51.

Oller, D. Kimbrough; Eilers, Rebecca E. (1988). "The role of audition in infant babbling". *Child development*, 59, 441-9.

Osberger, Mary J.; Zimmerman-Phillips, Sue; Koch, Dawn B. (2002). "Cochlear Implant Candidacy and Performance Trends in Children". *Annals of Otology, Rhinology and Laryngology*, 111, 62-5. DOI https://doi.org/10.1177/00034894021110S513

Parsier, Simon C.; Chute, Patricia (1991). "Cochlear implants: Indications and technology". *Medical Clinics of North America,* 75*,* 1267-76.

Paul, Peter. V. (2009). *Language and deafness*. 4th ed.). Boston: Jones & Bartlett.

Penke, Martina; Wimmer, Eva (2018). "Deficits in comprehending *wh*-questions in children with hearing loss–the contribution of phonological short-term memory and syntactic complexity". *Clinical Linguistics and Phonetics*, 32(3), 267-84.

Pérez-Leroux, Ana T. (1995). "Resumptives in the acquisition of relative clauses". *Language acquisition*, 4, 105-38.

Picallo, Carme M. (1991). "Nominals and nominalizations in Catalan". *Probus*, 3, 279-316.

Picallo, M. Carme (2005). "Some notes on grammatical gender and l- pronouns". Von Heusinger, Klaus; Kaiser, Georg A., Stark Elisabeth (eds), *Arbeitspapier Nr. 119. Proceedings of the workshop 'Specificity and the Evolution /Emergence of nominal determination systems in romance*". Konstanz: Universität Konstanz, 107-21.

Picallo, M. Carme (2008). "Gender and number in Romance". *Lingue e Linguaggio*, 1, 47-66.

Pinker, Steven (1994). *The Language Instinct: How the Mind Creates Language*. New York: Harper Collins.

Pisoni, David B.; Cleary, Miranda (2003). "Measures of working memory span and verbal rehearsal speed in deaf children after cochlear implantation". *Ear and Hearing*, 24, 106S-20S. DOI https://doi.org/10.1097/01.AUD.0000051692.05140.8E

Pisoni, David B.; Geers, Ann E. (2000). "Working memory in deaf children with cochlear implants: Correlations between digit span and measures of spoken language processing". *Annals of Otology, Rhinology and Laryngology*, 109, 92-3.

Pisoni, David B. et al. (2011). "Measures of digit span and verbal rehearsal speed in deaf children following more than 10 years of cochlear implantation". *Ear and Hearing*, 32, 60s-74s.

Pivi, Margherita (2014). *On the acquisition of Italian restrictive relative clauses in typical and atypical development* [unpublished PhD dissertation]. Venezia: Università Ca' Foscari.

Pivi, Margherita; Del Puppo, Giorgia (2015). "L'acquisizione delle frasi relative restrittive in bambini italiani con sviluppo tipico e con dislessia evolutiva". Favilla, Maria Elena, Nuzzo, Elena (a cura di), *Grammatica Applicata: Apprendimento, Patologie, Insegnamento*. Milano: Studi AItLA 2, 59-73.

Quigley, Stephen P.; Paul, Peter V. (1984). *Language and Deafness.* San Diego, CA: College-Hill Press.

Quigley, Stephen P.; Smith, Nicholas L.; Wilbur, Ronnie B. (1974). "Comprehension of relativized sentences by deaf students". *Journal of Speech and Hearing Research*, 17, 699-713.

R Core Team (2008/2018). *R: A language and environment for statistical computing*. R foundation for Statistical Computing, Vienna, Austria. URL `https://www.R-project.org/`.

Rampelli, Silvia (1989). *Aspetti linguistici dei sottotitoli e fruibilità da parte delle persone sorde. Prospettive teoriche e ambiti applicativi.* [Graduation Thesis]. Roma: Sapienza Università di Roma.

Re, Agnese (2010). *Strategies for the production of relative clauses by 5,6,7-year-old children* [BA thesis]. Venezia: Università Ca' Foscari.

Repovš, Grega; Baddeley, Alan D. (2006). "The multi-component model of working memory: explorations in experimental cognitive psychology". *Neuroscience*, 139(1), 5-21.

Reynolds, Cecil R.; Bigler, Erin D. (1995), *TEMA. Test di memoria e apprendimento*, Centro Studi Erickson, Trento. Translated from Test of Memory and Learning (TOMAL), PRO-ED, Austin Texas, 1994.

Rinaldi, Pasquale; Caselli, Maria Cristina. (2009). "Lexical and Grammatical Abilities in Deaf Italian Preschoolers: The Role of Duration of Formal Language Experience". *Journal of Deaf Studies and Deaf Education*, 14(1), 63-75.

Rinaldi, Pasquale; Caselli, Maria Cristina. (2014). "Language development in a bimodal bilingual child with cochlear implant: A longitudinal study". *Bilingualism: Language and Cognition*, 17, 798-809.

Ritter, Elizabeth (1991). "Two Functional Categories in Noun Phrases: Evidence from Modern Hebrew". Rothstein, Susan D. (ed.), *Syntax and Semantics*, vol. 25. New York: Academic Press, 37-62.

Ritter, Elizabeth (1993). "Where's Gender?". *Linguistic Inquiry*, 24, 795-803.

Ritter, Elizabeth (1995). "On the syntactic category of pronouns and agreement". *Natural Language & Linguistic Theory*, 13, 405-43.

Rizzi, Luigi (1982). *Issues in Italian Syntax*. Dordrecht: Foris Publications.

Rizzi, Luigi (1986). "Null objects in Italian and the theory of pro". *Linguistic Inquiry,* 17(3), 501-57.

Rizzi, Luigi (1990). *Relativized minimality*. Cambridge, MA: MIT Press.

Rizzi, Luigi (1994). "Some notes on linguistic theory and language development: The case of root infinitives". *Language Acquisition*, 3, 371-93.

Rizzi, Luigi (1997). "The fine structure of the left periphery". Haegeman, Liliane (ed.), *Elements of grammar.* Dordrecht: Kluwer, 289-330.

Rizzi, Luigi (2001). "Reconstruction, weak island sensitivity and agreement". Cecchetto, Carlo et al. (ed.) *Semantic Interfaces: Reference, Anaphora and Aspect*. Chicago: CSLI, 145-76.

Rizzi, Luigi (2004a). "Locality and Left Periphery". Belletti, Adriana (ed.), *Structures and Beyond. The Cartography of Syntactic Structures.* vol. 3. Oxford, New York: Oxford University Press. 223-251.

Rizzi, Luigi (Ed.) (2004b). *The structure of CP and IP: The cartography of syntactic structures, Vol. 2*. New York: Oxford University Press.

Rizzi, Luigi (2006). "On the form of chains: Criterial positions and ECP effects". Cheng, Lisa L.; Corver, Norbert (eds), *Wh-movement moving on.* Cambridge, MA: MIT Press, 97-134.

Rizzi, Luigi; Shlonsky, Ur (2007). "Strategies of Subject Extraction". Sauerland, Uli; Gärtner, Hans M. (eds), *Interfaces + Recursion = Language?*. Berlin: Mouton De Gruyter, 115-60.

Robertson, Erin K.; Joanisse, Marc F. (2010). "Spoken sentence comprehension in children with dyslexia and language impairment: The roles of syntax and working memory". *Applied Psycholinguistics*, 31, 141-65.

Ruben, Robert J. (1997). "A Time Frame of Critical/Sensitive Periods of Language Development". *Acta Oto-Laryngologica*, 117, 202-5.

Ruigendijk, Esther; Friedmann, Naama (2017). "A Deficit in Movement-Derived Sentences in German-Speaking Hearing-Impaired Children". *Frontiers in Psychology*, 8, 689. DOI https://doi.org/10.3389/fpsyg.2017.00689

Rvachew, Susan et al. (1999) "The impact of early onset otitis media on babbling and early language development". *Journal of the Acoustical Society of America*, 105, 467-75.

Salvi, Giampaolo; Vanelli, Laura (2004). *Nuova grammatica italiana.* Bologna: il Mulino.

Schirmer, Barbara R. (2000). *Language and literacy development in children who are deaf*. Boston MA: Pearson Education, Inc.

Schauwers, Karen; Gillis, Steven; Govaerts, Paul J. (2005). "Language acquisition in children with a cochlear implant". Fletcher, Paul; Miller, Jon F. (eds), *Developmental theory and language disorders.* Amsterdam, Philadelphia: John Benjamins Publishing, 95-119.

Schauwers, Karen; Gillis, Steven; Govaerts, Paul J. (2008). "The Characteristics of Prelexical BabblingAfter Cochlear Implantation Between 5 and 20Months of Age". *Ear and Hearing*, 29, 627-37.

Schauwers, Karen et al. (2004). "Cochlear implantation between 5 and 20 months of age: the onset of babbling and the audiologic outcome". *Otology and Neurotology*, 25(3), 263-70.

Schorr, Efrat; Roth, Froma; Fox, Nathan (2008). "A Comparison of the Speech and Language Skills of Children With Cochlear Implants and Children With Normal Hearing". *Communication Disorders Quarterly*, 29, 195-210. DOI https://doi.org/10.1177/1525740108321217.

Shazly Mohamed et al. (2016). "Auditory short-term memory in children with cochlear implant". *The Egyptian Journal of Otolaryngology*, 32, 98-104.

Sheldon, Amy (1974). "The role of parallel function in the acquisition of relative clauses in English". *Journal of Verbal Learning and Verbal Behavior*, 13, 272-81.

Shlonsky, Ur (1992). "Resumptive pronouns as a last resort". *Linguistic Inquiry*, 23, 443-68.

Soi, Daniela; Brambilla, Daniele (2003). "Sordità infantile. Aspetti epidemiologici ed eziologici". *Child Development & Disabilities – Saggi*, 1, 11-23.

Spencer, Linda J.; Barker, Brittan A.; Tomblin, J. Bruce (2003). "Exploring the language and literacy outcomes of pediatric cochlear implant users". *Ear and Hearing*, 24, 236-47.

Spencer, Patricia E. (2004), "Individual Differences in Language Performance after Cochlear Implantation at One to Three Years of Age: Child, Family, and Linguistic Factors". *Journal of Deaf Studies and Deaf Education*, 9(4), 395-412.

Sportiche, Dominique (1988). "A Theory of floating quantifiers and its corollaries for constituent structure". *Linguistic Inquiry*, 19, 425-49.

Starke, Michael (2001). *Move dissolves into Merge: A theory of locality* [unpublished PhD dissertation]. University of Geneva, Geneva, Switzerland.

Stavrakaki, Stavroula (2001). "Comprehension of reversible relative clauses in specifically language impaired and normally developing Greek children". *Brain and Language*, 77, 419-31.

Stavrakaki, Stavroula; Tasioudi, Matina; Guasti, Maria Teresa (2015). "Morphological cues in the comprehension of relative clauses by Greek children with specific language impairment and typical development: A comparative study". *International Journal of Speech-Language Pathology*, 17, 617-26.

Stella, Giacomo; Pizzoli, Claudia; Tressoldi, Patrizio E. (2000). *Peabody: Test di vocabolario recettivo.* Torino: Omega Edizioni.

Svirsky, Mario A. et al. (2000). "Language development in profoundly deaf children with cochlear implants". *Psychological Science*, 11, 153-8.

Svirsky, Mario A.; Teoh, Su W.; Neuburger, Heidi S. (2004). "Development of language and speech perception in congenitally, profoundly deaf children as a function of age at cochlear implantation". *Audiology and Neurotology*, 9, 224-33.

Szagun, Gisela (2004). "Learning by ear: on the acquisition of case and gender marking by German-speaking children with normal hearing and with cochlear implants". *Journal of Child Language*, 31, 1-30.

Szterman, Ronit; Friedmann, Naama (2014). "Relative clause reading in hearing impairment: different profiles of syntactic impairment." *Frontiers in psychology*, 5, 1229. DOI https://doi.org/10.3389/fpsyg.2014.01229.

Szterman, Ronit; Friedmann, Naama (2015). "Insights into the syntactic deficit of children with hearing impairment from a sentence repetition task". Hamann, Cornelia; Ruigendijk, Esther (eds), *Language Acquisition and Development: Generative Approaches to Language Acquisition 2013.* Newcastle: Cambridge Scholars Publishing.

Taeschner, Traute; Devescovi, Antonella; Volterra, Virginia (1988). "Affixes and function words in the written language of deaf children". *Applied Psycholinguistics*, 9, 385-401.

Tagliaferro, Laura (2011). *The comprehension and production of passive sentences in three-to-four-year-old children* [MA thesis]. Venezia: Università Ca' Foscari.

Talli, Ioanna; Tsalighopoulos, Miltiadis; Okalidou, Areti (2018). "The relation between short-term memory and vocabulary skills in Greek children with cochlear implants: The role of hearing experience". *First Language*, 38, 359-81.

Tavakolian, Susan L. (1981). "The conjoined-clause analysis of relative clauses". Tavakolian, Susan L. (ed.), *Language acquisition and linguistic theory.* Cambridge, MA: MIT Press, 167-87.

Thornton, Anna M. (1999). "Diagrammaticità, uniformità di codifica e morfomicità nella flessione verbale italiana". Benincà, Paola; Mioni, Alberto M.; Vanelli, Laura (a cura di), *Fonologia e morfologia dell'italiano e dei dialetti d'Italia.* Roma: Bulzoni, 483-502.

Thornton, Anna M. (2001). "Some reflections on gender and inflectional class assignment in Italian". Schaner-Wolles, Chris et al. (eds), *Naturally! Linguistic studies in honour of Wolfgang Ulrich Dressler.* Torino: Rosenberg & Sellier, 479-87.

Tobey, Emily A. et al. (2000). "Factors associated with speech intelligibility in children with cochlear implants". *Annals of Otologty, Rhinology and Laryngology*, suppl. 185, 28-30.

Tobey, Emily A. et al. (2003). "Factors associated with development of speech production skills in children implanted by age five". *Ear and Hearing*, 24, 36S-45S.

Tomblin, J. Bruce et al. (1999). "A comparison of language achievement in children with cochlear implants and children using hearing aids". *Journal of Speech, Language and Hearing Research*, 42, 497-511.

Tomblin, J. Bruce et al. (2005). "The effect of age at cochlear implant initial stimulation on expressive language growth in infants and toddlers". *Journal of Speech, Language, & Hearing Research*, 48(4), 853-67.

Tuller, Laurice (2000). "Aspects de la morphosyntaxe du français des sourds" *Recherches linguistiques de Vincennes*, 29, 143-56.

Tuller, Laurice; Delage, Hélène (2014). "Mild-to-moderate hearing loss and language impairment: How are they linked?". *Lingua*, 139, 80-101.

Tuller, Laurice; Jakubowicz, Celia (2004). "Développement de la morphosyntaxe du français chez des enfants sourds moyens". *Le Langage et l'Homme: Logopédie, Psychologie, Audiologie*, 14, 191-207.

Tuller, Laurice et al. (2011). "Clitic pronoun production as a measure of atypical language development in French". *Lingua*, 121(3), 423-41.

Tur-Kaspa, Hana; Dromi, Esther (1998). "Spoken and written language assessment of orally trained children with hearing loss: syntactic structures and deviations". *Volta review*, 100, 186-202.

Tur-Kaspa, Hana; Dromi, Esther (2001). "Grammatical deviations in the spoken and written language of Hebrew-speaking children with hearing impairments". *Language, Speech, and Hearing Services in Schools*, 32, 79-89.

Tye-Murray, Nancy; Spencer, Linda; Woodworth, George G. (1995). "Acquisition of speech by children who have prolonged cochlear implant experience". *Journal of Speech and Hearing Research*, 38, 327-37.

Utzeri, Irene (2006). *Produzione e acquisizione delle frasi relative sul soggetto e sull'oggeto in italiano: un contributo sperimentale allo studio comparativo* [MA thesis]. Siena: Università di Siena.

Utzeri, Irene (2007). "The production and acquisition of subject and object relative clauses in Italian". *Nanzan Linguistics Special Issue*, 3, 283-314.

Varlokosta, Spyridoula; Armon-Lotem, Sharon (1998). "Resumptives and Wh-movement in the acquisition of relative clauses in modern Greek and Hebrew". *Proceedings of the 22nd Boston University Conference on Language Development (BUCLD 22).* Somerville, MA: Cascadilla Press, 737-46.

Verbist, A.J.J. (2010). *The acquisition of personal pronouns in cochlear-implanted children* [Ph.D. Dissertation. Leiden. LOT Dissertation Series.

Vergnaud, Jean-Roger (1985). *Dépendances et niveaux de représentation en syntaxe,* John Benjamins, Amsterdam.

Verin, L. (2010). *Le frasi passive in età prescolare: un test di comprensione e produzione e un'esperienza di lettura ad alta voce* [MA thesis]. Venezia: Universitò Ca' Foscari.

Volpato, Francesca (2008). "Clitic pronouns and past participle agreement in Italian in three hearing impaired bilinguals Italian/LIS". *Rivista di Linguistica*, 20(2), 308-45.

Volpato, Francesca (2010a). "The phi features of clitic pronouns: Evidence from hearing-impaired adults". *Rivista di Grammatica Generativa,* 35, 121-42.

Volpato, Francesca (2010b). *The acquisition of relative clauses and phi features in hearing and hearing-impaired populations* [unpublished PhD dissertation]. Venezia: Università Ca' Foscari.

Volpato, Francesca (2011). "Valutazione delle abilità linguistiche dei bambini con impianto cocleare: uno strumento per indagare la produzione delle frasi relative". Franchi, Elisa; Musola, Debora (a cura di), *Acquisizione dell'italiano e sordità*. Venezia: Libreria Editrice Cafoscarina, 71-85.

Volpato, Francesca (2012). "The comprehension of relative clauses by hearing and hearing-impaired, cochlear-implanted children: the role of marked number features". Ferré, Sandrine; Prévost, Philippe; Tuller, Laurice; Zebib, Rasha (eds), *Selected Proceedings of the Romance Turn IV Workshop on the Acquisition of Romance Languages*. Newcastle: Cambridge Scholars Publishing, 284-308.

Volpato, Francesca; Adani, Flavia (2009). "The subject/object relative clause asymmetry in hearing-impaired children: evidence from a comprehension task". Moscati, Vincenzo; Servidio, Emilio (eds), *Proceedings, XXXV. Incontro di Grammatica, Generativa, STiL - Studies in Linguistics*, vol. 3. Siena: Università di Siena, 269-81.

Volpato, Francesca; Cardinaletti, Anna (2015). "Resumptive relatives and passive relatives in Italian cochlear-implanted and normal hearing children: evidence from an elicited production task". Hamann, Cornelia, Ruigendijk, Esther (eds), *Language acquisition and development. Proceedings of GALA 2013*. Newcastle: Cambridge Scholars Publishing, 568-83.

Volpato, Francesca; Vernice, Mirta (2014). "The production of relative clauses by Italian hearing and hearing-impaired children". *Lingua,* 139, 39-67.

Volpato, Francesca; Laura Verin; Anna Cardinaletti (2014). "The Acquisition of Passives in Italian: Auxiliaries and Answering Strategies in an Experiment of Elicited Production". Costa, João; Fiéis, Alexandra; Freitas, Maria João; Lobo, Maria; Santos, Ana Lúcia (eds), *New Directions in the Acquisition of Romance Languages: Selected Proceedings of The Romance Turn V*. Newcastle upon Tyne: Cambridge Scholars Publishing, 371-94.

Volpato, Francesca; Verin, Laura; Cardinaletti, Anna (2016). "The comprehension and production of verbal passives by Italian preschool-age children". *Applied Psycholinguistics*, 37, 901-31.

Volpato, Francesca et al. (2013). "The comprehension of (eventive) verbal passives by Italian preschool age children". Stavrakaki, Stavroula; Lalioti, Marina; Konstantinopoulou, Polyxeni (eds), *Advances in language acquisition: Proceedings of Generative Approaches to Language Acquisition Conference GALA 2011 Thessaloniki*. Newcastle Upon Tyne: Cambridge Scholars Publishing, 243-50.

Volterra, Virginia; Bates, Elizabeth (1989). "Selective impairment of Italian grammatical morphology in the congenitally deaf: a case study". *Cognitive Neuropsychology*, 6, 273-308.

Volterra, Virginia; Capirci, Olga; Caselli, Maria Cristina (2001). "What atypical populations can reveal about language development: the contrast between deafness and Williams syndrome". *Language and Cognitive Processes,* 16, 219-39.

Wie, Ona Bø et al. (2007). "Children with a cochlear implant: Characteristics and determinants of speech recognition, speech-recognition growth rate, and speech production". *International Journal of Audiology*, 46(5), 232-43. DOI https://doi.org/10.1080/14992020601182891.

Willstedt-Svensson, Ursula et al. (2004). "Is age at implant the only factor that counts? The influence of working memory on lexical and grammatical de-

velopment in children with cochlear implants". *International Journal of Audiology*, 43, 506-15.
Wolgemuth, Keith S.; Kamhi, Alan G.; Lee, Rene F. (1998). "Metaphor performance in children with hearing impairment". *Language, Speech, and Hearing Services in Schools*, 29, 216-31.
Yoshinaga-Itano, Christine; Baca, Rosalinda L.; Sedey, Allison L. (2010). "Describing the trajectory of language development in the presence of severe-profound hearing loss: A closer look at children with cochlear implants". *Otology & Neurotology*, 31, 1268-74.
Yoshinaga-Itano, Christine et al. (1998). "Language of early- and later-identified children with hearing loss". *Pediatrics*, 102, 1168-71.
Young, Gretchen A.; Killen, Deanne H. (2002). "Receptive and expressive language skills of children with five years of experience using a cochlear implant". *Annals of Otolaryngology Laryngology*, 111, 802-10.
Zwart, Jan-Wouter C. (2000). "A head raising analysis for relative clauses in Dutch". Alexiadou, Artemis et al. (eds), *The syntax of relative clauses*. Amsterdam: John Benjamins, 349-85.

Appendixes

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 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	AMB_SG_SG	La pecora che lava il cavallo
AMB	AMB_SG_SG	Il cammello che pettina il cigno
AMB	AMB_SG_SG	La moto che segue la macchina
AMB	AMB_SG_SG	La giraffa che tocca il coniglio
AMB	AMB_SG_SG	Il cane che spaventa il coniglio
AMB	AMB_SG_SG	L'orso che saluta la tartaruga
AMB	AMB_PL_PL	I pesci che tirano i pinguini
AMB	AMB_PL_PL	I topi che spingono le galline
AMB	AMB_PL_PL	I gattini che guardano le capre
AMB	AMB_PL_PL	Le galline che portano i lupi
AMB	AMB_PL_PL	Gli asini che lavano gli orsi
AMB	AMB_PL_PL	Le macchine che tirano i camion
SR	SR_SG_PL	Il coniglio che colpisce i topi
SR	SR_SG_PL	Il pesce che segue le tartarughe
SR	SR_SG_PL	Il cavallo che insegue i leoni
SR	SR_SG_PL	La giraffa che pettina gli orsi
SR	SR_SG_PL	Il bambino che lava le bambine
SR	SR_SG_PL	La pecora che colpisce i gatti
SR	SR_PL_SG	I leoni che guardano l'elefante
SR	SR_PL_SG	Le scimmie che fermano il pinguino
SR	SR_PL_SG	I cani che toccano il ragazzo
SR	SR_PL_SG	Le tigri che mordono il cavallo
SR	SR_PL_SG	I pinguini che lavano il nonno
SR	SR_PL_SG	Le zebre che tirano la giraffa
OR	OR_SG_SG	La gallina che il pulcino becca
OR	OR_SG_SG	L'elefante che l'uccellino porta
OR	OR_SG_SG	La lepre che la giraffa saluta
OR	OR_SG_SG	Il bambino che la nonna pettina
OR	OR_SG_SG	Il leone che la tartaruga tira
OR	OR_SG_SG	L'elefante che la scimmia insegue
OR	OR_PL_PL	Le moto che le macchine spingono
OR	OR_PL_PL	Le oche che i pinguini fermano
OR	OR_PL_PL	Gli asini che i cani lavano.
OR	OR_PL_PL	Le mucche che i cammelli tirano
OR	OR_PL_PL	I serpenti che le tigri guardano
OR	OR_PL_PL	Le rane che le ragazze seguono
OR	OR_SG_PL	Il pinguino che i gatti guardano
OR	OR_SG_PL	Il nonno che i pinguini lavano
OR	OR_SG_PL	La giraffa che le zebre tirano

OR	OR_SG_PL	Il ragazzo che i cani toccano
OR	OR_SG_PL	Il pinguino che le scimmie fermano
OR	OR_SG_PL	Il cavallo che le tigri mordono
OR	OR_PL_SG	Le scimmie che l'elefante insegue
OR	OR_PL_SG	Le tartarughe che l'orso saluta
OR	OR_PL_SG	Le bambine che il bambino lava
OR	OR_PL_SG	I gatti che la pecora colpisce
OR	OR_PL_SG	I leoni che l'elefante guarda
OR	OR_PL_SG	Gli orsi che la giraffa pettina
ORp	ORp_SG_PL	La pecora che tirano le scimmie
ORp	ORp_SG_PL	Il cammello che lavano gli orsi
ORp	ORp_SG_PL	L'uccellino che guardano i cani
ORp	ORp_SG_PL	Il cigno che beccano i pulcini
ORp	ORp_SG_PL	La macchina che seguono i camion
ORp	ORp_SG_PL	La tigre che baciano le bambine
ORp	ORp_PL_SG	I conigli che tira la gallina
ORp	ORp_PL_SG	I nonni che tocca la tartaruga
ORp	ORp_PL_SG	Le ragazze che ferma il vigile
ORp	ORp_PL_SG	I bambini che insegue il cavallo
ORp	ORp_PL_SG	I gattini che guarda il pinguino
ORp	ORp_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 clause production

Subject relative clauses

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…

This volume deals with the syntactic competence of Italian-speaking individuals with hearing impairment (cochlear implant users and LIS signers) and individuals with normal hearing (children, adolescents, and adults), focusing on relative clauses, a central topic in current research. The volume also presents the participants' performance in different memory tasks discussing the relationship between sentence comprehension and memory resources in children with hearing impairment and with normal hearing.

Francesca Volpato is a researcher at Ca' Foscari University of Venice. She has investigated important aspects of the linguistic competence in Italian of monolingual and bilingual children, adolescents, and adults with typical and atypical language development, focusing on comprehension and production of complex sentences containing unstressed elements and marked word orders (clitic left dislocated sentences, interrogative sentences, relative clauses, and passive sentences). She has contributed to the linguistic and psycholinguistic research through the development of assessment tools aimed at investigating morpho-syntactic abilities in Italian in different populations, and discussing results following the most recent linguistic theories.

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