

2 The experiment: linguistic structures and materials

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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.

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 bacía <il cane>
 b. [_{DP} Il [_{CP} [_{NP} cane] che [_{IP} la tigre bacía [_{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_o i nonni <il bambino>]
the child [that kiss.3.PL_i the grandfathers, <the child>]
‘the child that the grandfathers kiss’
- (15) I bambini [che bacia_i il nonno <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 antecedents, 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.:

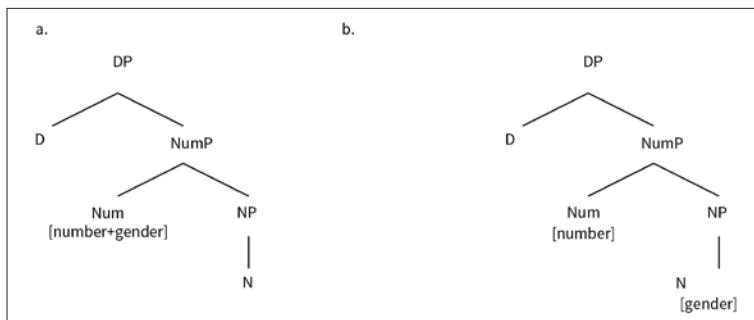
- (27) a. Tu e tuo fratello, la luce _____ (accendere), perché la stanza era al buio.
b. Tu e tuo fratello, la luce l(a)avete accesa, perché la stanza era al buio.
You and your brother, the light.FEM.SG, it.fem.sg have turned-on.fem.sg, because the room was at dark.
‘You and your brother turned on the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

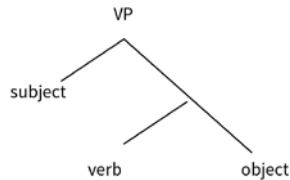
Another aspect that is relevant for the description of relative clauses concerns the way in which phi features realize agreement in clause structure. The discussion is built within the Principle and Parameter framework and the Minimalist Program (Chomsky 1995; 2000).

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 (Piccolo 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:

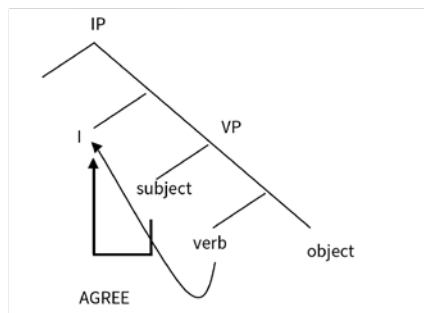
(32)



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.

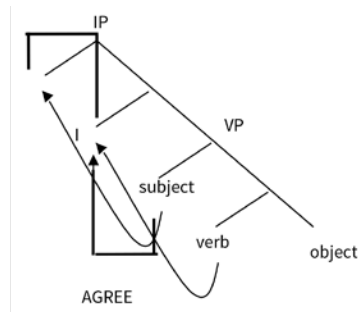
Successive merging operations introduce the functional structure of the sentence, namely the IP projection, which provides the syntactic configuration in which the subject-verb relationship is established. In addition to Merge, another important operation contributing to sentence derivation is AGREE. 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):

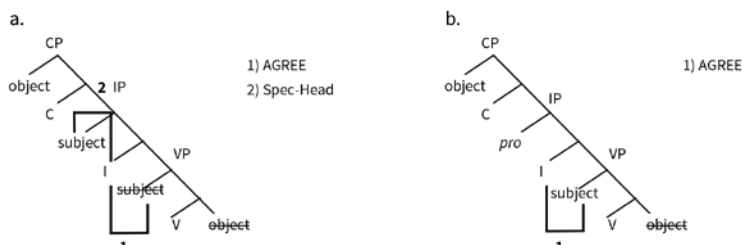
- (35) C'est les filles / Ce sont les filles
it is the girls / it are the girls
- (36) a. Many books are/*is on the table
b. There are/'s many books on the table
- (37) a. Le ragazze vengono/*viene.
the girls come / comes
b. Vengono / Viene le ragazze
come / comes the girls

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; Corrae 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. Filler 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 impairment 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.