

# TRAINING THE COMPREHENSION AND PRODUCTION OF RESTRICTIVE RELATIVE CLAUSES \*

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## 1. INTRODUCTION

Preverbal sensorineural hearing loss can be caused by a malfunctioning of the hair cells in the inner ear, or by damage of the auditory nerve. In both cases, the transformation of the acoustic stimuli into neurological signals is blocked, and the auditory information cannot be processed by the brain (Aimar et al. 2009; Kral & O'Donoghue 2010). Since the detection and discrimination of sounds are impaired, the quantity and the quality of the linguistic input available to hearing impaired individuals are limited causing a delay in several language domains including phonology, vocabulary, and morphosyntax (Chesi 2006; Friedmann & Szterman 2006; Hammer 2010; Volpato 2010, 2012; Volpato & Vernice 2014). To a large extent, morphosyntactic deficits concern the use of complex sentences and especially sentences with a non-canonical order of constituents, such as object relative clauses as in (1) (Volpato & Adani 2009; Volpato 2010, 2012; Volpato & Vernice 2014); *wh*-questions with object extraction as in (2) (Friedmann & Szterman 2011; Friedmann & Haddad-Hanna 2014; Volpato & D'Ortenzio 2017).

(1) Mi piacciono i bambini che il papà pettina.  
to-me.CL like.3PL the children that the father comb.3SG  
'I like the children that the father combs.'

(2) Quali bambini tira la fatina?  
which.PL children pull.3SG the fairy?  
'Which children does the fairy pull?'

This study focuses on three different types of restrictive relative clause in Italian: subject relative clauses SRs (3a), object relative clauses with preverbal subject ORs (3b) and object relative clauses with postverbal subject ORps (3c), which distinguish themselves on the basis of which grammatical role the head of the relative clause has within the embedded clause and the position of the subject of the relative clause.

(3) a. [<sub>DP</sub> il [<sub>CP</sub> [<sub>NP</sub> bambino] che [<sub>IP</sub> <il bambino> pettina i cavalli]]].  
[<sub>DP</sub> the [<sub>CP</sub> [<sub>NP</sub> child] that [<sub>IP</sub> <the child> comb.3SG the horses]]]  
'The child that combs the horses.'

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- b. [DP *il* [CP [NP *bambino*] che [IP *i* cavalli pettinano <~~*il bambino*~~>]]].  
 [DP *the* [CP [NP *child*] that [IP *the* horses comb.3PL <~~*the child*~~>]]]]  
 'The child that the horses comb.'
- c. [DP *il* [CP [NP *bambino*] che [IP *pro* [<sub>1</sub> *pettinano*] [VP *i* cavalli [~~*pettinano*~~ <~~*il bambino*~~>]]]]].  
 [DP *the* [CP [NP *child*] that [IP *pro* [<sub>1</sub> comb.3PL] [VP *the* horses [~~*comb the child*~~]]]]]]  
 ]]]]]  
 'The child that the horses comb.'

Restrictive relative clauses (RC) are subordinate clauses which delimit the range of possible referents of the head of the relative. They feature long-distance dependencies between the relative heads filling dedicated positions within CP, and the corresponding gaps within IP. In (3), the DP *il bambino* (the child) is pronounced in a position different from the one in which it is interpreted with respect to the embedded verb. In (3a) *il bambino* is interpreted as the subject of *pettina* (combs), whereas in (3b) and (3c) *il bambino* is interpreted as the object of *pettinano* (comb).

### 1.1. The acquisition of RCs

RCs are at the core of several studies on different Italian populations: healthy adults (De Vincenzi 1991); adults with an acquired language disorder (agrammatic patients: Garraffa & Grillo 2008); typically developing children (Guasti & Cardinaletti 2003; Utzeri 2007; Arosio et al. 2009; Belletti & Contemori 2010; Volpato 2010; Adani 2011); SLI children (Contemori & Garraffa 2010); hearing impaired children and adolescents (Volpato 2010, 2012; Volpato & Vernice 2014). All these studies point out an asymmetry in both comprehension and production of RCs, namely SRs are easier than ORs. Moreover, some studies point out a further asymmetry between ORs and ORps, the former being easier than the latter (Volpato & Adani 2009; Volpato 2010, 2012)<sup>2</sup>.

Studies on typical language development pointed out that typically developing children (TD-children) between 3;0 and 3;11 produce 61% of correct SRs. This percentage raises to 90% at the age of 4;0 (Belletti & Contemori 2010), and is higher than 90% at adolescence and adulthood (Carpenedo 2011; Volpato 2010). The production of ORs is sharply lower than SRs; TD children between the age of 5;3 and 7;5 produce 18% of ORs, while adolescents and adults do not produce any ORs (Volpato 2010). When the production of an OR is required, TD children resort to several strategies in order to avoid the production of an OR. For example, they produce ORs with resumptive clitic pronouns as in (4), or they produce different types of passive object relatives, such as copular (as in (5)) or causative (as in (6)) (Guasti & Cardinaletti 2003; Utzeri 2007; Belletti & Contemori 2010; Volpato 2010; Manetti & Belletti 2013).

- (4) *Il bambino che il papà lo lava.*  
 the child that the father him.CL wash.3SG  
 'The child that the father washes him.'

- (5) *Il bambino che viene lavato dal papà.*  
 the child that come.3SG wash.PAST.PART by-the father  
 'The child that is washed by his father.'

<sup>2</sup>The complexity of ORs depends on the structure similarity between the A'-moved element and the intervening subject (Friedmann et al. 2009). Gordon et al. (2004), and Gordon & Lowder (2012) state that object relatives in which the embedded DP is a pronoun, a proper name, or a quantifier are easier than object relatives in which the embedded DP is a definite description.

- (6) Il bambino che si fa lavare dal papà.  
 the child that himself make.3SG wash.INF by-the father  
 ‘The child that has himself washed by his father.’

The same trend has been shown in the comprehension of RCs. TD children show an excellent comprehension of SRs already between the age of 3;4 and 3;11, when they reach the 91% of correctness (Adani 2011). On the contrary, TD children between 3;4 and 3;11 show a lower comprehension of ORs (53%) and of ORps (36%). This percentage raises at the age of 7;0 when TD children comprehend 89% of ORs and 70% of ORps. An adult-like level is reached by the age of 11, when the performance is above chance level for SRs, ORs, ORp (Arosio et al. 2009).

The same asymmetries showed by TD-children were found also in CI children. Volpato and Vernice (2014) analysed the production of RCs in a group of 13 Italian-speaking CI children aged 7;9-10;8 (mean age: 9;2). They found the typical asymmetry between SRs and ORs in this experimental group, confirming previous studies on the acquisition of RCs. Indeed, CI children produced 88% of SRs. When they avoided this structure, they produced simple SVO sentences (5%), they substituted the complementizer *che* ‘that’ with the *wh*-fillers *dove* ‘where’ and *quando* ‘when’ (2%) or they resorted to other strategies (2%). CI children produced 23% of ORs. ORs were mostly replaced with the production of: ambiguous sentences (17%); passive relatives (26%); sentences in which *wh*-fillers replaced the complementizer (6%); sentences in which the complementizer was omitted (1%); incomplete or ungrammatical sentences (3%); sentences with Theta-role inversion (4%); SRs with head inversion (3%); causative structures (3%); simple SVO order sentences (6%); or they resorted to other strategies (8%). These strategies emerge to a smaller extent in the production of normal hearing children of the same age. A further outcome of this study is that older children, from both the experimental and control groups, resorted to passive relatives when an OR was elicited. The production of passive relatives instead of ORs is largely attested in the production of normal hearing children from the age of 8 (Re 2010; Carpenedo 2011), adults and adolescents, and could be considered as an age-appropriate performance (Utzeri 2007; Belletti & Contemori 2010; Volpato 2010; Manetti & Belletti 2013; for the analysis of the preference for passive relatives over ORs, see Belletti 2009).

CI children show the same tendencies as their normal hearing TD peers also in the comprehension of RCs. Volpato & Adani (2009) analysed the comprehension of SRs, ORs and ORps in a group of 8 Italian-speaking CI children aged 6;9-9;3 (mean age: 7;9). As in the previous study, in this experiment CI children showed a lower performance than TD-children and the typical asymmetry between SRs, ORs, and ORps. CI children comprehended 89% of SRs, 55% of ORs, and 22% of ORps. More in detail, according to Volpato & Vernice (2012), CI children showed better comprehension of sentences bearing the same number features on the two DPs. In case of number mismatch conditions, CI selected the reversible errors (22%) when the head of the RC was singular, hence they selected the picture showing the specular action of the sentence uttered by the experimenter. When the head of the RC was plural CI children selected the agent error (21%), therefore they selected the AGENT of a sentence instead of the THEME.

## 1.2. Monaural vs. binaural stimulation

Recent studies on language development in CI children analyse whether the type of acoustic stimulation can enhance the acquisition of an oral language, namely whether a binaural stimulation is better than a monaural stimulation.

A monaural stimulation is given by the usage of only one CI, while a binaural stimulation is given by the use of a CI and a conventional hearing aid (HA) or a second CI. While in

monaural stimulation only one auditory nerve is stimulated, in binaural stimulation both auditory nerves receive impulses. As shown by previous studies, people with a binaural stimulation benefit from improved speech perception in both quiet and noisy listening conditions, improved sound localization ability, and reduced listening effort (Martini et al. 2013; Kalluri 2011; Sarant et al. 2014).

Some studies investigated the benefits of a binaural stimulation in language development. Nittrouer & Chapman (2009) analysed language development in a group of 42 hearing impaired children resorting to a mono or binaural stimulation and found that children with a binaural stimulation (bilateral CIs, or a CI and a HA) showed better language abilities than children with only a CI. However, Sarant et al.'s (2014) study on a group of 91 CI children does not show any significant correlation between the performance of monaural CI children and that of binaural CI children.

### 1.3. Treatment of RCs

Complex structures derived by *wh*-movement, such as ORs, can be rehabilitated through explicit teaching of *wh*-movement (for agrammatic patients: Thompson & Shapiro 1995; Thompson et al. 2003, 2005; for SLI children: Levy & Friedmann 2009). Focusing treatment on the explicit teaching of verb argument structure, the Theta Criterion and *wh*-movement, it is possible to improve the patient's performance not only on RCs, but also on other structures governed by the same syntactic movement, for instance *wh*-questions.

#### 1.3.1. Treatment in aphasia

Thompson and Shapiro and their research group carried out several experiments focused on the treatment of complex sentences with agrammatic patients.

Thompson, Shapiro & Roberts (1993) and Thompson et al. (2003) described a syntactically-based treatment for training different *wh*-question types, object clefts, object RCs and passive sentences, in order to analyse generalization effects. Their treatments are based on syntactic principles and follow a schema which comprises several stages during which the implicit knowledge of the agrammatic patient is turned into explicit knowledge. For instance, during the first stage, the experimenter teaches verb argument structure to the patient by producing verbs and their arguments. One important outcome of these studies was that not all impaired structures need to be treated but rather it is possible to treat only one type of sentence, and treatment effects generalize to other sentences that are derived by the same type of movement.

Moreover, Thompson & Shapiro (1994) examined the hypothesis that generalizations to untrained sentences were only detectable if trained sentences are more complex than untrained sentences but not vice versa. Thus, after training object clefts (*wh*-movement), it is possible to improve the production of *who* questions (*wh*-movement) but not the production of passives (NP-movement).

#### 1.3.2. Treatment in SLI

Following the approaches by Thompson and Shapiro and their research group, Levy & Friedmann (2009) proposed a syntactic treatment to a 12;2-year-old Hebrew-speaking child with syntactic SLI. Before treatment, the participant was tested on the comprehension, repetition, and production of different structures derived from *wh*-movement and verb movement. On the one hand, the results showed appropriate performance in SVO sentences and movement-derived sentences in which the canonical order of constituents is preserved

(SRs). On the other hand, the participant showed problematic performance on ORs and object *wh*-questions.

The treatment comprised 16 sessions, each lasting between 20 and 60 minutes, carried out over six months. The treatment comprised three parts: explanation, training, and testing, during which the intact sensitivity to verb argument structure was used. Each structure was trained first in writing and then orally. Only after it was clear that the child was able to deal with a certain structure a new structure was presented. The Theta Criterion was introduced first, then *wh*-movement was presented starting from SRs, in which the child performed above chance. To investigate generalization effects on structures derived by the same type of movement, *wh*-questions were not trained. Results after treatment showed an improvement in both trained and untrained structures compared with the baseline, pointing out generalization effects on *wh*-questions.

#### 1.4. Aims of the study

The aims of this study are: (i) On the one hand, to analyse the performance of Italian-speaking CI children and adolescents in the production of RCs, and to check the effects of type of stimulation (binaural vs. monaural) on CI participants; (ii) On the other hand, to describe a treatment based on the explicit teaching of syntactic properties administered to a CI child, who showed an impaired production of ORs.

## 2. THE PRODUCTION OF RCs

In this section, the methodology and the results of the study on the production of RCs by CI children and adolescents are discussed.

The aim of this first study is to establish how delayed exposure to an oral language conditions the production of syntactically complex structures, and whether the acquisition of syntactically complex structures depends on the type of acoustic stimulation, namely whether a binaural stimulation is better than a monaural stimulation.

### 2.1. Method

#### 2.1.1. *Participants*

The experimental group included 11 children and adolescents with bilateral sensorineural hearing loss fitted with a CI (CI group). All of them had profound hearing loss ( $\geq 90$  dB). All participants were hearing-impaired since birth and were born to hearing parents. They ranged in age from 5;7 to 12;7 (mean age: 8;7). They received their first HA between the age of 0;2 and 6;0. They received the CI between the age of 0;10 and 8;7, therefore the time of CI use varied from 0;3 to 8;7 years. They have been exposed exclusively to the oral language. No participants knew or used any sign language. They were trained orally. Participants did not show any other associated mental or linguistic disabilities. All participants were selected and tested during their clinical follow-up examination at the Ear-Nose-Throat Clinic (ENT Clinic, henceforth) at the Padua University Hospital. Since the ENT Clinic is a well-known centre in Italy, the participants came from several regions of Italy for their periodic follow-up. Table 1 presents some clinical information about the CI children.

ID	AGE	ETIOLOGY	HA	CI	STIMULATION	HA	CI	CI
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						AGE	AGE	USAGE
<b>S1</b>	10;5	congenital	right	left	binaural	5;0	8;8	1;9
<b>S2</b>	6;3	congenital	no	left+right	binaural	2;0	2;5	3;10
<b>S3</b>	5;7	congenital	left	right	binaural	0;8	0;10	4;9
<b>S4</b>	6;1	progressive	left	right	binaural	2;10	4;6	1;7
<b>S5</b>	12;7	congenital	no	right	monaural	2;10	4;2	8;5
<b>S6</b>	11;9	congenital	no	left	monaural	4;0	4;0	7;9
<b>S7</b>	7;5	congenital	no	left+right	binaural	0;2	1;6	5;11
<b>S8</b>	11;2	progressive	no	right	monaural	5;8	6;0	5;2
<b>S9</b>	8;5	congenital	no	left	monaural	1;3	2;7	5;10
<b>S10</b>	7;6	congenital	no	left+right	binaural	0;6	5;6	2;0
<b>S11</b>	7;6	congenital	right	left	binaural	0;6	7;3	0;3

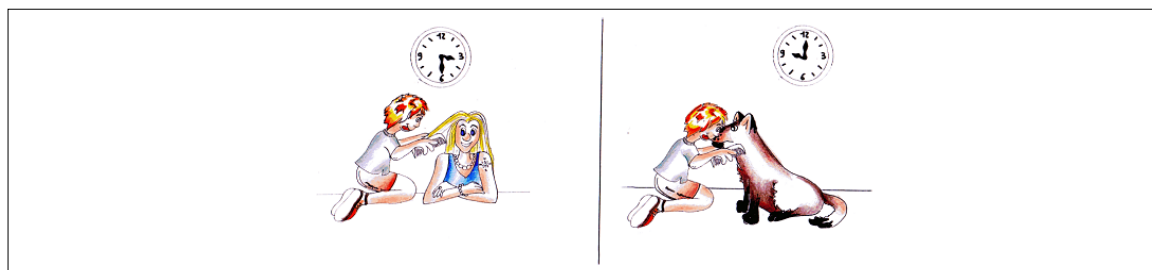
Table 1: personal and clinical information about the participants in the experimental group (ID:identification number; HA:hearing aid; CI:cochlear implant; HA AGE:age of the first hearing aid; CI AGE:age of cochlear implant)

Their performance was compared with a control group composed of 11 normal hearing TD children and adolescents (NH group) matched on chronological age (5;7-12;7; mean age: 8;7). Participants of the NH group came from the Veneto Region.

### 2.1.2. Materials

The production of RCs was investigated by using a preference task developed by Volpato (2010) following the approach by Friedmann & Szterman (2006). The task assesses the production of subject relatives (12 trials) and object relatives (12 trials). Experimental sentences are semantically reversible, namely they contained verbs whose thematic roles could be compatible with both DPs in the clause, preventing the child from deriving the meaning of the sentence by relying on semantic or pragmatic cues. All verbs are transitive used in the present tense, in order to avoid difficulties related to the presence of auxiliaries and past participle morphology, which are often problematic for hearing-impaired children and may increase the difficulty of the task (Chesi 2006). The trials present number features in match and mismatch conditions (Volpato 2010, 2012). The experimental trials alternate with filler sentences, i.e. non-reversible simple sentences containing either intransitive verbs or transitive verbs with inanimate objects. Filler sentences were included in the task to divert the attention of the tested participant from the real aim of the investigation. Moreover, filler sentences keep children's attention high, and renew their confidence and interest in the task.

The task consists in showing two pictures to the participant and asking him/her to express a preference between the two options, in order to force him/her to produce a relative clause. Some examples are showed below:



Experimenter: Ci sono due disegni. Nel primo il bambino pettina la mamma, nel secondo il bambino pettina il cane. Quale bambino ti piace di più? Inizia la frase con “Mi piace il bambino...”  
*‘There are two pictures. In the former the child combs the mother, in the latter the child combs the dog. Which child do you like? Start with I like the child...’*  
 Target response: Mi piace il bambino che pettina la mamma/il cane.  
*‘I like the child that combs the mother/the dog’*

Figure 1. Elicitation of a SR

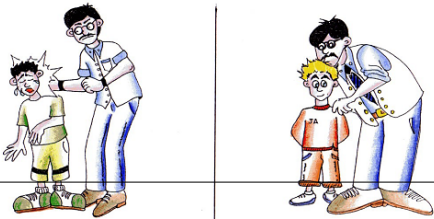
	
<p>Experimenter: Ci sono due immagini. Nella prima il papà colpisce il bambino, nella seconda il papà bacia il bambino. Quale bambino ti piace di più? Inizia con “Mi piace il bambino...”  <i>‘There are two pictures. In the former the father hits the child, in the latter the father kisses the child. Which child do you like? Start with “I like the child...”’</i>                      Target response: Mi piace il bambino che il papa bacia/colpisce.  <i>‘I like the child that the father kisses/hits’</i></p>	

Figure 2. Elicitation of an OR

### 2.1.3. Procedure

The task was presented orally. Trials were randomized and presented on separate A4-sized pages in the same order to all participants. Participants were tested in a quiet room in the ENT Clinic, and their responses were audio-recorded and then transcribed by the author.

Since the aim of the study was to assess language competence and not auditory skills, the task was administered to CI children without the experimenter’s mouth hidden by her hands, in order to give the participants the opportunity to rely on lip-reading when the stimuli were not perfectly heard.

The experimental part was preceded by a training session aiming at familiarizing children with nouns, verbs, items and experimental setting.

All the experiments were conducted with the informed and overt consent of each participant or their caregiver in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) and the standards established by the local Institutional Review Board.

### 2.1.4. Coding

During the analysis of the data collected, only SRs and ORs with the structures presented in (7) and (8), respectively, were considered as correct answers:

- (7) Il bambino che pettina la mamma.  
 the child that comb.3SG the mother  
 ‘The child that combs his mother.’

- (8) Il bambino che (il papà) pettina (il papà)<sup>3</sup>  
 the child that (the father-SUBJ) comb.3SG (the father-SUBJ)  
 'The child that (his father) combs (his father).'

Other response strategies, even though they were grammatically correct in Italian, were considered incorrect.

A non-licit strategy was the production of simple SVO word order sentences without relativization, as in (9):

- (9) Target: I bambini che i nonni baciano.  
 the children that the grandparents kiss.3PL  
 'The children that their grandparents kiss.'  
 Production: I nonni baciano i bambini  
 'The grandparents kiss their children.'

A further response strategy was the production of sentences with reversed thematic roles. In this case an OR was produced instead of a SR (10), and conversely, a SR was produced instead of an OR (11):

- (10) Target: I bambini che accarezzano il gatto.  
 the children that carress.3PL the cat  
 'The children that caress the cat.'  
 Production: I bambini che accarezza il gatto.  
 the children that carress.3SG the cat  
 'The children that caresses the cat.'

- (11) Target: I bambini che il barbiere pettina.  
 the children that the barber comb.3SG  
 'The children that the barber combs.'  
 Production: I bambini che pettinano il barbiere.  
 the children that comb.3PL the barber  
 'The children that comb the barber.'

Sentences in which the target embedded subject became the relative head of the matrix clause, so as to turn an OR into a SR, were coded as SRs with head-inversion (12):

- (12) Target: I bambini che i cani baciano  
 the children that the dogs kiss.3PL  
 'The children that the dogs kiss.'  
 Production: I cani che baciano i bambini.  
 the dogs that kiss.3PL the children  
 'The dogs that kiss the children.'

In some cases, ORs were produced by resorting to resumptive elements, either a pronoun, as in (13), or a full DP, as in (14):

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<sup>3</sup> In the mismatch condition in ORs, namely the first DP was singular and the second was plural (or the other way around), the embedded subject was considered as correct when it was placed either in pre-verbal or post-verbal position, since in Italian both positions are licit, and the sentence is unambiguously an object relative. When both DPs were either singular or plural, the OR was considered as correct only when the embedded subject was placed in pre-verbal position. When the embedded postverbal DP shares the same number features as the relative head the sentence is ambiguous and can be interpreted either as a SR or an ORp. These productions were disregarded.



(13) Il bambino che l' orso lo accarezza.  
 the child that the bear him.CL caress.3SG  
 'The child that the bear caresses.'

(14) Il bambino che l' orso accarezza il bambino.  
 the child that the bear caress.3SG the child  
 'The child that the bear caresses.'

Children avoided the production of ORs also by resorting to different types of passive relatives, namely copular (15) or causative built with *farsi* + verb 'to make oneself + verb' (16). They were considered both grammatical and appropriate for the context. In both cases, a SR is produced instead of the target OR:

(15) Il bambino che è pettinato dal papà.  
 the child that be.3SG comb.PAST.PART by-the father  
 'The child that is combed by his father.'

(16) Il bambino che si fa pettinare dal papà  
 the child that himself make.3SG comb.INF by-the father  
 'The child that has himself combed by his father.'

Sentences in which the verb or a noun were replaced with a non-target verb or noun were coded as "other". For example, in (17) the transitive verb *baciare* 'kiss' was replaced with the ditransitive verb *dare* 'give'<sup>4</sup>:

(17) Target: Il bambino che i nonni baciano  
 the child that the grandparents kiss.3PL  
 'The child that his grandparents kiss.'  
 Production: I nonni che danno un bacio al bambino.  
 the grandparents that give.3PL a kiss to-the boy  
 'The grandparents that give a kiss to the child.'

Finally, all ungrammatical sentences, such as sentences with omissions or wrong position of the elements, were coded as "ungrammatical".

## 2.2. Results

In this section, the results of the preference task will be presented. First a quantitative analysis of the data will be provided, then a qualitative analysis.

### 2.2.1. Quantitative analysis

The CI group produced 86% of target SRs, while the NH group produced 99% of target SRs. The production of target ORs was lower than that of SRs for both groups: the CI group produced only 3% of target ORs<sup>5</sup>, while the NH group produced 19% of target ORs.

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<sup>4</sup> In this case, even though the sentence was syntactically correct, it was countered as non-target because the participants produced a SR instead of an OR and used a ditransitive verb instead of a transitive verb. In no cases were grammatical ORs counted as incorrect due to the presence of a different noun/verb.

A repeated-measure logistic regression was carried out in order to analyse accuracy data, using the statistical software R (R Development Core Team 2008). The independent variables are group (CI group and NH group) and sentence type (SRs and ORs). Random effects were subjects and items. The dependent variable was the proportion of accurate responses.

It was found that the CI group performed worse than the NH group in the production of SRs (Wald  $Z= 2.828$ ,  $p=0.004$ ). No significant effect was found in the production of ORs between groups (Wald  $Z= 0.594$ ,  $p= 0.56$ ).

In this analysis, also the variable “type of stimulation” (monolateral CI vs. bilateral CI; monolateral CI vs. CI and HA; bilateral CI vs. CI and HA) was taken into consideration, but no significant results were observed: monolateral CI vs. bilateral CI (Wald  $Z= 0.452$ ,  $p= 0.6652$ ); monolateral CI vs. CI and HA (Wald  $Z= -0.664$ ,  $p= 0.507$ ); bilateral CI vs. CI and HA (Wald  $Z= -0.231$ ,  $p= 0.817$ ). Therefore, the variable “type of stimulation” is not a predictor of performance in the CI group.

### 2.2.2. Qualitative analysis

In this section a qualitative analysis of the data is provided.

Both the CI and the NH group performed above chance in the elicitation of SRs. However, CI children resorted to several strategies when a SR was not produced. The most used strategy was the production of simple SVO sentences without syntactic movement, sentences in which the complementizer was omitted (*mi piace il bambino saluta il bambino – I like the child greets the child*), other sentences (*mi piacciono i bambini quelli con i cani – I like the children that.PL with the dogs*), and someone produced ungrammatical sentences. NH children performed at ceiling and the only alternative strategy was the production of sentences with Theta-role inversion, namely ORs instead of SRs. Table 2 summarizes the results of the elicitation of SRs:

	CI	NH
<b>TARGET SR</b>	86%	99%
Il bambino che pettina il cane		
<b>SIMPLE SVO SENTENCES</b>	5%	0%
I bambini tirano i topi		
<b>COMPLEMENTIZER OMISSION</b>	4%	0%
Il bambino [...] rincorre il gatto		
<b>THETA-ROLE INVERSION</b>	0%	1%
Il bambino che la zebra saluta		
<b>UNGRAMMATICAL/INCOMPLETE SENTENCES</b>	2%	0%
Saluta il papà		
<b>OTHER</b>	4%	0%
I bambini che prendono la rete e prendono la farfalla		

Table 2: answering strategies in the elicitation of a SR

When an OR was elicited, CI children performed worse than their NH age peers. When CI children avoided the production of an OR they resorted to several strategies: SRs with head inversion; ungrammatical sentences; ORs with a resumptive element, a full DP or a

<sup>5</sup> An ORps was produced in only one case: *Mi piacciono i bambini che sgrida la maestra ‘to-me.CL like.3SG the children that scold.3SG the teacher’*. Since it was the only ORp produced, it was counted together with the other ORs.

clitic pronoun; SVO sentences. Older CI children behaved as their NH peers and produced passive relatives instead of ORs. Differently from CI children, NH children resorted to a strategy that was never found in the CI group, hence they produced sentences with a causative structure. Table 3 summarizes the results of the elicitation of ORs.

	CI	NH
<b>TARGET ORs</b>	3%	19%
Il bambino che il cane rincorre		
<b>OR WITH RESUMPTIVE CLITIC PRONOUNS</b>	2%	13%
Il bambino che il cane lo rincorre		
<b>OR WITH RESUMPTIVE FULL DPs</b>	10%	0%
Il bambino che il cane rincorre il bambino		
<b>PASSIVE RELATIVES</b>	21%	42%
I bambini che sono inseguiti dal cane		
<b>CAUSATIVE STRUCTURES</b>	0%	12%
Il bambino che si fa pettinare dal papà		
<b>SIMPLE SVO SENTENCES</b>	4%	0%
Il papà lava il bambino		
<b>THETA-ROLE INVERSION</b>	14%	1%
I bambini che pettinano il barbiere		
<b>HEAD INVERSION</b>	18%	1%
I cani che baciano i bambini		
<b>UNGRAMMATICAL SENTENCES</b>	11%	0%
Quello che segue il bambino il cane		
<b>OTHER</b>	17%	5%
Il bambino che riceve il bacio dalla mamma		

Table 3: answering strategies in the elicitation of an OR

### 2.3. Discussion

In this section, the results of the elicited production task are discussed. The discussion will focus on the asymmetry between SRs and ORs in the CI group in comparison with the NH group, and how syntactic phenomena and developmental factors may influence the production and the use of ORs, ORps, and passive relatives.

#### 2.3.1. Answering strategies by CI and NH children

As shown by the results, both the experimental and the control groups display the same asymmetry between SRs and ORs. Thus, the production of the former structure is more preserved than the latter, even though the CI group had a worse performance than the NH group. This result confirms previous studies showing that CI children follow the same performance pattern as NH children (Friedmann & Szterma, 2006, 2011; Volpato 2010; Volpato & Vernice 2014). However, when a RC was elicited, children from both the experimental and the control groups resorted to several strategies.

When a SR was elicited, the most used strategy adopted by CI children is the production of a simple SVO sentence in which no relativization occurs. Probably, the difficulty with relative clauses is to be attributed to the presence of a chain between the position internal to the subordinate sentence and the external position in the main clause, and

the consequent computation of an element with respect to two verbs. The SVO strategy is never found in NH children and can be considered a marker for linguistic delay in acquisition (Italian: Volpato & Vernice 2014; Hebrew: Friedmann & Szterman 2006; French: Delage 2008).

As seen in the sections above, ORs were more problematic than SRs, and both CI children and NH children often resorted to other strategies when an OR was elicited. The reason why these structures are difficult may be attributed to a violation of the Relativized Minimality (RM) principle (Rizzi 1990, 2004). RM states that in configurations as in (18) the relation between the relative head in the main clause (X) and its copy in the embedded object position (Y) may be blocked by the presence of an intervening element (Z), i.e. a potential bearer of the relevant relation: thus, Z intervenes between X and Y.

(18) X ... Z ... Y

Friedmann et al. (2009), grounding their hypothesis on Rizzi's RM, proposed that children cannot establish a correct relation between the moved constituent and the position from which it has been extracted because of the presence of an interfering lexically restricted NP in the embedded subject position, as shown in the example in (19).

(19) Mi           piacciono i bambini che il papà pettina      <i bambini>.  
 to-me.CL like.3PL   the children that the father comb.3SG   <the children>.  
   R +NP                           +NP                                   R +NP  
 'I like the children that the father combs'.

Conversely, when the head in the main clause and its copy in the embedded position display a lexically unrestricted *wh*-pronoun, as for example *chi* 'who' in (20) children's performance accuracy increases, since the head (*who*) and the intervener (*the boy*) do not share any feature specification.

(20) Mostrami       chi il bambino abbraccia <chi>  
 Show-to-me.CL who the boy hug.3SG <who>  
                           +R    +NP   +R  
 'Show me who the boy hugs'.

Applying their principle to language development, Friedmann et al. (2009) found that sentences containing object extraction are problematic for young children, since they cannot establish a correct relation between the moved element and the position from which it has been moved because the intervener and the moved head share a subset of features that children are not able to disjoin.

Older children often produce passive relative clauses instead of ORs. Passive relatives are largely attested in adults' and adolescents' elicited productions (Utzeri 2007; Volpato 2010). According to Belletti (2009), older children produce passive relatives because these are easier to compute as they do not involve intervention, thanks to the smuggling operation occurring in their derivation. Smuggling (Collins 2005) allows the movement of the VP chunk containing the verb and the direct object to a position above the subject, as (21) shows.

(21) [<sub>CP</sub> il bambino che [<sub>IP</sub> è          [<sub>VP</sub> pettinato    <il bambino>]   dal [<sub>VP</sub> papà        [<pettinato il  
 [<sub>CP</sub> the child   that [<sub>IP</sub> is.3SG [<sub>VP</sub> comb.PART <the child>]   by [<sub>VP</sub> the father [<combed  
 bambino>]]]]  
 the child>]]]]  
 'The child that is combed by the father'.

The use of passive relatives is considered as a marker of proper language acquisition. This means that in spite of the delayed exposure to the linguistic input during the sensitive period, it was possible for the CI children to attain language competence comparable to same-age peers.

A further strategy employed by CI and NH children is the production of an OR with a resumptive element, namely the partial repetition of a copy of the moved head (Belletti 2009). While NH children only produced ORs with resumptive clitic pronouns (*mi piace il bambino che l'orso lo accarezza* - I like the child that the bear him caresses), CI children produced ORs resumptive full DPs (*mi piace il bambino che l'orso accarezza il bambino* - I like the child that the bear caresses the child). The former strategy is also common in very informal adult speech (Guasti & Cardinaletti 2003; Utzeri 2007). The production of causative constructions, found in NH children, is not found in CI children. In causative constructions, the presence of the functional verb *fare* "to make", which assigns an additional thematic role, is problematic for hearing-impaired children (Volpato & Vernice 2014).

Among the answers produced by CI-children, there are some which do not represent context adequate strategies, and which were never found in the production of NH children, namely sentences containing head inversion and Theta-role inversion, and ungrammatical sentences. Ungrammatical sentences distinguish the CI group from the NH group, especially as far as ORs are concerned, replicating previous findings that hearing-impaired participants are more likely to produce ungrammatical sentences than hearing children (Chesi 2006; Delage 2008; Friedmann & Szterman 2006; Volpato & Vernice 2014). The use of these sentences in CI children can be considered as a consequence of the language impairment caused by hearing impairment.

Very common in the production of the CI group are SRs containing head inversion instead of ORs. Although this answer does not represent an adequate strategy, it is evident that children are able to correctly assign the thematic roles of AGENT and THEME to the arguments of the relative clause, but avoid the production of an OR (Volpato & Vernice 2014).

### 2.3.3. Binaural vs. monaural stimulation

A binaural stimulation (two CIs, or one CI and one conventional hearing aid) is largely recommended in case of severe to profound sensorineural hearing losses, since it can provide a better localization of sounds and better listening in noisy places (Martini et al. 2013; Kalluri 2011; Sarant et al. 2011).

It is not clear yet whether binaural stimulation can help the acquisition of complex structures, and conflicting results have been found in studies on the acquisition of morphosyntax in monaural and binaural stimulation (Nittrouer & Chapman 2009; Sarant et al. 2014).

In this study, no significant difference was found in the correlation between type of hearing device and production of RCs. Therefore, the performance in RCs production is not predicted by the use of a monaural or a binaural stimulation.

## 3. THE TREATMENT OF RELATIVE CLAUSES

One of the participants of the study group produced a considerable number of ungrammatical sentences. More in detail, he produced 58% of ungrammatical sentences when an OR was elicited. For this reason, he was selected for treatment focused on the explicit teaching of syntactic movement.

The treatment described here was deeply influenced by Levy and Friedmann's (2009) treatment of a Hebrew-speaking child with SLI.

The aim was to analyse whether specific linguistic training would improve the participant's performance in the production and comprehension of RCs, and whether the effects of the treatment would be maintained over time. For this pilot study, no generalization effect was investigated. Thus, both subject and object relatives were treated.

### 3.1. Method

In the following section, the participant, the materials used, and the treatment itself are described.

#### 3.1.1. Participant

The participant (S9 in Table 1 above) was selected and tested during his clinical follow-up examination at the ENT Clinic at Padua University Hospital. LB is an 8;5-year-old boy with profound bilateral sensorineural hearing loss, fitted with a CI on his left ear. He was born to hearing parents and has been hearing impaired since birth. LB was first diagnosed with hearing impairment at the age of 2 and promptly received HA. Since the child did not receive enough advantage from the conventional HA, he received a CI at the age of 2;7. At the time of the study LB has had experience of CI use for 5;10 years. LB received speech-language therapy once a week. He was supported by two assistant teachers for four hours a day at school, and by a communication assistant for twelve hours a week.

Before LB's competence on RCs was assessed, audio-perceptual abilities were tested through an identification task by a speech therapist during a clinical examination at the ENT Clinic. The task examined the auditory discrimination of vowels, consonants, disyllabic words, trisyllabic words, non-words, and sentences. This test is regularly administered with the speech therapist's mouth hidden by his/her hand, in order to evaluate the prosthetic gain in a condition of normal volume of speech. LB showed good auditory discrimination for all the items assessed by the identification task. Results are presented in Table 4:

	<b>LB</b>
<b>VOWEL IDENTIFICATION</b>	100%
<b>CONSONANT IDENTIFICATION</b>	94%
<b>DISYLLABIC WORD IDENTIFICATION</b>	100%
<b>TRISYLLABIC WORD IDENTIFICATION</b>	100%
<b>NON-WORD IDENTIFICATION</b>	100%
<b>SENTENCE IDENTIFICATION</b>	100%

Table 4: LB's results at the audio-perceptual examination

LB was also assessed on the comprehension of RCs. The test used will be described in the next section.

#### 3.1.2. Character selection task

The comprehension of RCs was assessed through a test elaborated by Volpato (2010). The character selection task follows the approach by Arnon (2005), who modified Friedmann & Novogrodsky (2004).

The task consists in touching the correct referent matching the sentence read by the experimenter. For each stimulus, two different scenarios were presented to the participant: in the first scenario, some characters perform an action (e.g. the rabbit hits the mice), and in the

second scenario, the action is the same, but the thematic roles are reversed (e.g. the mice hit the rabbit). With this paradigm, felicity conditions are satisfied by the presence of at least two instances for each DP (Hamburger & Crain 1982). This made it possible to increase the experimenter’s ability to detect non-random behaviour.

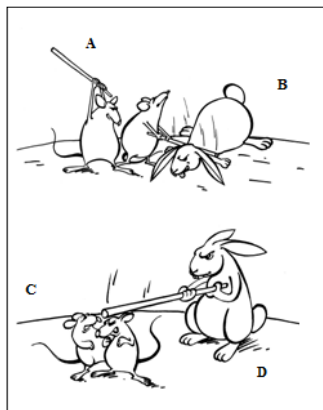


Figure 3: example of an experimental sheet

The structures assessed by the character selection task are: SRs, ORs, and ORps. The task is composed of 48 experimental trials, 12 ambiguous sentences, i.e. sentences that could be interpreted as either a SR or an ORp, and 20 filler sentences. Some examples are provided in Table 5:

<b>AMBIGUOUS SENTENCES</b>	SR_SG_SG	<i>La mucca che spinge l'elefante</i> the cow that pulls the elephant
	SR_PL_PL	<i>Le mucche che spingono gli elefanti</i> the cows that pull the elephants
<b>SRs</b>	SR_SG_PL	<i>la mucca che spinge gli elefanti</i> the cow that pulls the elephants
	SR_PL_SG	<i>le mucche che spingono l'elefante</i> the cows that pull the elephants
<b>ORs</b>	OR_SG_SG	<i>la mucca che l'elefante spinge</i> the cow that the elephant pulls
	OR_SG_PL	<i>la mucca che gli elefanti spingono</i> the cow that the elephants pull
	OR_PL_PL	<i>le mucche che gli elefanti spingono</i> the cows that the elephants pull
	OR_PL_SG	<i>le mucche che l'elefante spinge</i> the cows that the elephant pulls
<b>ORps</b>	ORp_SG_PL	<i>la mucca che spingono gli elefanti</i> the cow that pull the elephants
	ORp_PL_SG	<i>le mucche che spinge l'elefante</i> the cows that pulls the elephants

Table 5: the different conditions tested by the character selection task

Experimental sentences were semantically reversible: they contained verbs whose thematic roles could be compatible with both DPs in the clause, preventing the child from deriving the meaning of the sentence by relying on semantic or pragmatic cues. As in the production task, verbs were transitive and used in the present tense, so as to avoid difficulties

related to the presence of auxiliaries and past participle morphology, which are often problematic for hearing-impaired children and may increase the difficulty of the task (Chesi 2006).

The task was presented orally. Trials were randomized and presented on separate A4-sized pages. Since the aim of the study was to assess language competence and not auditory skills, the task was administered without the experimenter's mouth hidden by her hand, in order to give the opportunity to the participant to rely on lip-reading when the stimuli were not perfectly heard. This task was administered after the test on the production of RCs in order not to influence LB's responses in comprehension.

### 3.1.3 *Treatment of RCs*

The intervention given to LB was carried out over three months and consisted of six sessions, each lasting 75 minutes. It was much shorter than treatment reported in previous studies. During each session, comprehension and production exercises were given in both written and oral modalities. Each session included an explicit explanation and a training part. The sessions were distributed into three distinct stages, and only after it was clear that LB already knew a certain structure was another structure presented.

The first stage focused on verb argument structure and Theta criterion, so as to turn LB's implicit lexical knowledge into explicit knowledge, which could be used as a support during the explanation of *wh*-movement (as in Levy & Friedmann 2009). During this first stage, intransitive verbs, reversible and non-reversible transitive verbs, and ditransitive verbs were used. The first task given to LB was to write simple SVO sentences using several verbs. One sentence with a non-reversible transitive verb was chosen out of the sentences he generated, and verb argument structure was explained, namely the verb needs a specific number of arguments to allow the construction of a well-formed sentence. When an intransitive or a ditransitive verb was encountered, thematic roles different from AGENT and THEME were called adjuncts so as not to confuse the child. When LB was able to explain the verb argument structure, the Theta criterion was introduced by explaining the relation between the verb and its arguments using the terms AGENT and THEME. Afterwards, LB was asked to identify the AGENT and THEME in each sentence by underlining them with different colours. Finally, the metaphor described by Levy & Friedmann (2009) was used to summarize verb argument structure and the Theta criterion. The verb is like an officer who can control a variable number of soldiers depending on his rank (verb argument structure). Soldiers do not have the same roles, and the verb-officer decides which role his soldiers must play (the Theta criterion).

The second stage of the treatment comprised three sessions and was entirely dedicated to *wh*-movement. As in Levy & Friedmann (2009), sentences in which the participant performed above chance even before the treatment, hence SRs, were trained first. During this session, only non-reversible and reversible transitive verbs were used as target. Each structure (SRs, ORs, and ORps) was first introduced without semantic reversibility, in order to enable reliance on non-syntactic cues. A semantically reversible version of each structure was introduced only after *wh*-movement was clear to LB. During this stage, a card game was used to teach *wh*-movement. To explain syntactic movement, each sentence was presented on cards, in order to show to LB that sentences may be created by the movement of a constituent from one position to another position in the sentence. It was explained to him that the constituent that moves leaves a trace in its original position, for the transfer of the thematic role to the new position. A chain establishes a relation between the original position and the final one.



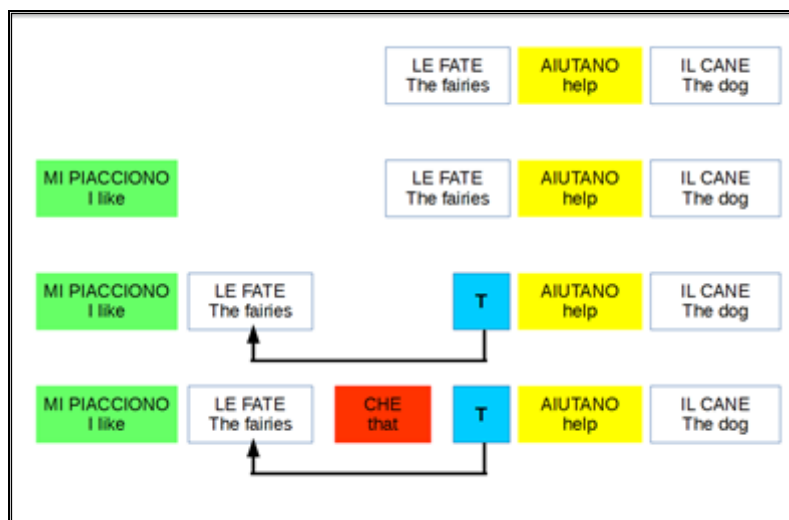


Figure 4: Example of SR with the card game

A metaphor was used to reinforce the concepts of traces and chains<sup>6</sup>. In this case, the trace is compared to a postman, who brings a letter from the verb to the moved constituent; the thematic role assigned by the verb is written on the letter. After the theoretical part, LB was given some comprehension and production exercises, which were always administered with the card game.

The last session represented the third and last stage of the intervention. During this session, the topics taught during the previous sessions were reviewed. Both the oral and written modalities were used during the review, and both comprehension and production exercises were administered to learn syntactic movement. At the end of this session, LB drew all the necessary movements that occur in each type of RC starting from the easiest structure, i.e. SRs.

### 3.2. Results

Before treatment, LB showed the typical asymmetry between SRs, ORs and ORps in both production and comprehension tasks.

In the production test, he showed preserved production of SRs and problematic production of ORs, i.e. he avoided the target structure altogether and produced ungrammatical sentences, he produced 17% of wrong sentences when a SR was elicited, and 58% of ungrammatical sentences when an OR was elicited. LB however showed a high performance in the comprehension test, even higher than the control group.

The results collected soon after the end of the treatment showed that LB performed at ceiling in each task and in each structure and did not show any asymmetry in the production and comprehension of RCs. LB was also tested five months after the end of the treatment, and his performance showed no regression.

The following table gives an overview of the results of LB before and after treatment, compared to NH children. As Table 6 shows, results were maintained five months after treatment.

	LB			NH
	PRE	POST 1	POST 2 5 months after	

<sup>6</sup> This metaphor was elaborated by LB himself during one of the training sessions on *wh*-movement.

<b>Production</b>	<b>SR</b>	10/12	83%	12/12	100%	12/12	100%	165/168	98%
	<b>OR</b>	0/12	0%	12/12	100%	11/12	92%	10/168	6%
<b>Comprehension</b>	<b>SR</b>	12/12	100%	12/12	100%	12/12	100%	142/168	85%
	<b>OR</b>	22/24	92%	24/24	100%	24/24	100%	248/336	74%
	<b>ORp</b>	9/12	75%	12/12	100%	11/12	92%	115/168	68%

Table 6: Participants' results in the production and comprehension tests before the treatment (PRE), after the treatment (POST 1) and some months after the completion of the treatment (POST 2).

It is worth mentioning that in the Post2 assessment, he resorted to different strategies to produce ORs, for instance he produced ORs with resumptive clitics, like *Mi piace il bambino che l'orso lo morde* 'I like the child that the bear bites him'. This piece of data will be discussed in the following section.

### 3.3. Discussion

The aim of this pilot study was to test the treatment of syntactic movement with a CI child who had difficulties in the production of RCs, especially ORs.

The intervention followed the protocols administered to people with agrammatic aphasia by Thompson and Shapiro (1994, 1995), and the therapeutic intervention administered to a 12-year-old Hebrew-speaking child with syntactic SLI by Levy & Friedmann (2009). Intervention was based on the explicit teaching of verb argument structure, the Theta criterion, and *wh*-movement.

The main outcome of this study is that this type of intervention proves suitable for CI children who display the same difficulties in the production and comprehension of complex structures as agrammatic patients and SLI children.

Before treatment, LB produced a high number of ungrammatical sentences when an OR was elicited. All ungrammatical sentences had the same structure: *mi piace il bambino che fa il diritto alla mamma di baciare* 'I like the child that makes the right to the mother to kiss'. Regardless of syntax, the sentence is agrammatical because the expression *fare il diritto a qualcuno di fare qualcosa* (lit. 'to make someone the right to do something') does not exist in Italian, but *dare il diritto a qualcuno di fare qualcosa* (lit. 'give someone the right to do something') does.

Soon after treatment, LB showed better performance in both comprehension and production of relative clauses and performed at ceiling (100%) in all the tasks. Moreover, during the character selection task (Volpato 2010), he was able to identify ambiguous sentences which could be interpreted as SRs or ORps (*tocca i pinguini che spingono le giraffe* - touch the penguins that push the giraffes). LB's performance was assessed again five months after the completion of the treatment in order to verify if the effects of language treatment would be maintained over time. LB's production of SRs remained at ceiling, while the production of ORs changed. When an OR was elicited, he resorted to a different strategy than the target one by producing ORs with resumptive clitics (*mi piace il bambino che il papà lo pettina* - I like the child that the father combs him). This grammatical structure is found in the production of younger normal hearing children (Guasti & Cardinaletti 2003; Utzeri 2007; Volpato 2010), and in adult spoken Italian (Cinque 1988; Guasti & Cardinaletti 2003). The main result is that LB did not produce ungrammatical sentences anymore.

## 4. CONCLUSION

In this paper, two studies were presented: in the former, an analysis of the production of RCs by CI children and adolescents was carried out; in the latter, the treatment based on the explicit teaching of relative clauses administered to a CI child was described.

The results of the first study confirm previous outcomes (Volpato & Vernice 2014): older CI and NH children often produce passive relative clauses instead of ORs. This strategy can be considered as an age-appropriate indicator of CI children's language competence (Utzeri 2007; Volpato 2010). A further strategy employed by CI and NH children is the production of ORs with resumptive elements, namely the partial repetition of a copy of the moved head (Belletti 2009). CI children produced a high number of ORs with resumptive full DPs (*mi piace il bambino che l'orso accarezza il bambino* - I like the child that the bear caresses the child), while NH children only produced ORs with resumptive clitic pronouns (*mi piace il bambino che l'orso lo accarezza* - I like the child that the bear him.CL caresses). NH children produced a high number of causative constructions, which were never found in the production of CI children. Among the answers produced by CI children which do not represent context adequate strategies, and which were never found in the production of NH children, sentences containing head inversion, sentences with Theta-role inversion, and ungrammatical sentences should be mentioned. Differently from Volpato & Vernice (2014), this study also aimed at analysing the influence of a binaural stimulation in the acquisition of complex structure. However, the statistical analysis did not show any significant result. Further studies are needed on this topic.

The second study presented the results of an experimental treatment based on the explicit teaching of syntactic movement to a CI child who displayed no production of ORs. Results showed improvement in all tasks. Moreover, the effects of the treatment were maintained over time. Therefore, it is possible to claim that treatment based on the explicit teaching of syntactic rule is also suitable for CI children.

This study further shows that short-term treatment appears to have the same results as long-term treatment. The treatment described in this paper comprised seven sessions and lasted approximately three months, while the treatments given to agrammatic patients (Thompson et al. 1997) and to a syntactic SLI child (Levy & Friedmann 2009) lasted more than six months and comprised between 16 and 42 sessions. This result can be interpreted as an advantage from the clinical point of view: a short-term therapy is more adaptable to speech therapy sessions.

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