

The production of Wh- questions in a group of Italian cochlear-implanted children

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Abstract. The acquisition of complex syntactic structures is problematic for children with hearing impairment, even for those who use cochlear implants. This study investigates for the first time the production of *wh*-questions in a group of 8 cochlear-implanted children, in order to compare their performance with that of 8 normal hearing children. Accuracy is lower in the group of cochlear-implanted children than in controls. However, individual performance variability was observed. Some cochlear-implanted children show good competence in Italian and use response strategies found in older children; other children produce ungrammatical sentences and sentences attested in young children's productions, which is evidence of the linguistic delay associated to hearing impairment, even when they are fitted with cochlear implants.

1 Introduction

Comprehension and production of complex syntactic structures are important abilities that allow to reach a good level of linguistic competence in the target language. These activities could be affected by preverbal sensorineural hearing loss, which blocks the transformation of the acoustic stimuli into neurological signals, causing a misprocessing of the auditory information by the brain (Aimar et al., 2009; Kral & O'Donoghue, 2010). Cochlear implants (CI, henceforth) are able to provide easy access to the sound and to the language, thus increasing the level of linguistic competence, even though previous research has shown that Italian-cochlear-implanted children have troubles with complex syntactic structures, namely relative clauses (Volpato & Adani, 2009; Volpato, 2010; Volpato, 2012; Volpato & Vernice, 2014) and sentences containing clitic pronouns (Guasti et al., 2012). Given the importance of early exposure to language in order to develop linguistic skills properly, this study investigates whether children who access language with delay due to hearing impairment are comparable to normal hearing peers in the use of interrogative sentences.

In this study, we test interrogative sentences introduced by *who* and *which* followed by a noun phrase (NP). Interrogative sentences are divided into subject and object *wh*- questions, depending on the grammatical function of the *wh*- element, either the subject (1a-2a) or the object (1b-2b) of the verb.

- (1) a. Chi ___ lava i cani
Who washes the dogs?
b. Chi lavano ___ i cani?
Who wash the dogs?
Who do the dogs wash?
- (2) a. Quale cuoco ___ saluta i calciatori?
Which chef greets the football players?

b. Quale cuoco salutano ___ i calciatori?
Which chef greet the football players?

In Italian, sentences like (1a-2a) are subject questions in which the singular verb agrees with the *wh*- operator and the NP in post-verbal position is plural. The sentence in (1b-2b) is an object question, in which the plural verb agrees with the plural subject in post-verbal position. In Italian, the *wh*- element *chi* ('who') which introduces an interrogative sentence is always singular. When the noun after the verb is plural, only verb agreement helps interpret a sentence either as a subject or as an

object question²⁶. *Wh-* questions are characterised by a dependency between the *wh-* operator in sentence initial position and a gap (___) in the position in which this operator is interpreted. This dependency is short in subject questions, which follow the canonical Italian SVO (subject-verb-object) word order, and is longer in object questions, which show a non-canonical (OVS) word order.

Given that the structure of object *wh-* questions is more complex compared to that of subject *wh-* questions, in literature, an asymmetry between subject and object questions in both comprehension and production has been observed (De Vincenzi, 1991, De Vincenzi et al. 1999; Guasti et al., 2012; Del Puppo et al., 2016). In typical language development in Italian, subject questions are fully comprehended by the age of 4, while object questions are problematic until the age of 10 years. As for production, children produce high percentages of subject questions at the age of 4-5 years (88% for *who* questions; 80% for *which* questions), but the percentage of object questions is lower (71% and 73%, respectively) (Guasti et al., 2012). Even at an older age (6-9 years) object questions show lower percentages of occurrence than subject questions (Del Puppo et al., 2016). Various strategies are adopted for object questions, all of which were correct and appropriate for the context.

In populations with hearing impairment, the acquisition of *wh-* questions is delayed in hearing impaired speakers of English and Hebrew since they have difficulties understanding and producing complex syntactic structures, containing long-distance dependencies (English: Quigley et al., 1974; Hebrew: Friedmann & Szterman, 2011; Palestinian-Arabic: Friedmann & Haddad-Hanna, 2014). In production tasks, ungrammatical sentences are often uttered when *wh-* questions are targeted. No data on the acquisition of *wh-* questions are available for Italian hearing-impaired children. Therefore, it is important to test these syntactic structures also in this population in Italian, since *wh-* questions are very common in both spoken and written language and their comprehension and production is crucial from a pragmatic point of view both in daily communication and in classroom activities.

2 Methodology

In this section we describe the participants of the experimental and the control groups, the task, and we provide an analysis of the response strategies.

2.1 The experimental group

The experimental group is composed of 8 hearing impaired children fitted with a CI (CI-group, henceforth), ranged in age from 7;5 and 10;10 (mean age: 8;7). Seven participants suffer from bilateral sensorineural hearing loss, and one from bilateral mixed hearing loss. The participants were born to hearing parents and are hearing impaired since birth. They were diagnosed and fitted with a hearing aid (HA, henceforth) in a period comprised between the birth and 3;6 years. The participants received the CI between 0;7 and 8;8 years, therefore their experience with the CI varies between 1;2 and 7;1 years. Three participants receive a monaural stimulation through a CI. Five participants are binaurally stimulated, since they are fitted with a CI and a contralateral HA or CI. The participants have been exposed only to oral language. Six participants follow a speech therapy, while two participants have recently stopped it. All participants have been trained orally. None of them know or use any sign language. The participants were selected and tested at the Ear-Nose-Throat Clinic (ENT Clinic, henceforth), Department of Neurosciences, University of Padua.

The following table summarises personal and clinical data of the CI-group:

²⁶ When the noun after the verb is singular (*Chi lava il cane?* ‘who washes the dog?’) ambiguity problems should arise as to what interpretation is to be given to the sentence.

Table 1: Personal and clinical data of the CI participants. The “*” marks that some data are missing.

ID	Age	Type Of Hearing Loss	Age HA	Age CI	Type Of Stimulation	Speech Therapy
R.B.	9;10	sensorineural	*	8;8	monaural	yes
V.Z.	7;10	sensorineural	0;2	1;6	monaural	no
F.Z.	10;10	mixed	3;0	5;7	binaural	no
N.V.	8;1	sensorineural	0;4	2;7	binaural	yes
S.V.	7;8	sensorineural	*	1;2	binaural	yes
A.T.	9;0	sensorineural	3;6	7;10	monaural	yes
E.N.	7;5	sensorineural	at birth	0;7	binaural	yes
M.M.	9;9	sensorineural	0;4	2;8	binaural	yes

The results of the CI-group were compared with those of 8 typically developing children of comparable chronological age (TD-group, henceforth). TD-children ranged in age from 7;0 to 10;10 years (mean age: 8;5). Despite the age ranges of the two groups are slightly different, no significant difference was found between the age (in months) of the CI and TD groups (Mann-Whitney $U=27.5$, $p=.636$).

2.2 The task for the elicitation of *wh*- questions

The participants were administered the elicited production task developed by Guasti et al. (2012). The test includes 24 items, investigating the use of subject and object *who* and *which* questions, with six items for each condition.

The four conditions are summarised in the following table.

Table 2: Experimental design: conditions

Question type	Wh-element	Test sentences
Subject	Who	<i>chi acchiappa gli gnomi?</i> who catches the gnomes?
	Which	<i>quale gatto lava le scimmie?</i> which cat washes the apes?
Object	Who	<i>chi sporcano gli elefanti?</i> who the elephants dirty?
	which	<i>quali bambine seguono la signora?</i> which girls follow the woman?

For this task, 18 transitive reversible verbs, such as *bite*, *dirty*, *wash*, were used. The use of transitive reversible verbs prevents the child to derive the meaning of the sentence by relying on semantic or pragmatic cues, since being semantically reversible, these verbs can be compatible with both nouns. *Who*-subject questions always feature a singular verb, and *who*-object questions employ a plural verb. The following picture shows an example of an item used for the elicitation of a subject *who*-question.

As fig.1 was shown, the experimenter described the picture “Someone is catching the ghosts. Ask your mum/dad who.”. The target sentence was “Who is catching the ghosts?”.

Three subject *which* questions have singular verbs (Which cook is greeting the football players?) and three contain a plural verb (Which witches wet the man?); three object *which* questions have singular verbs (Which cows does the horse chase?) and three have a plural verb (Which child do the smurfs dream of?).

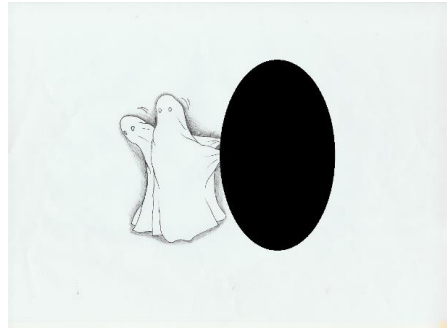


Fig. 1: Picture eliciting a subject *who*-question

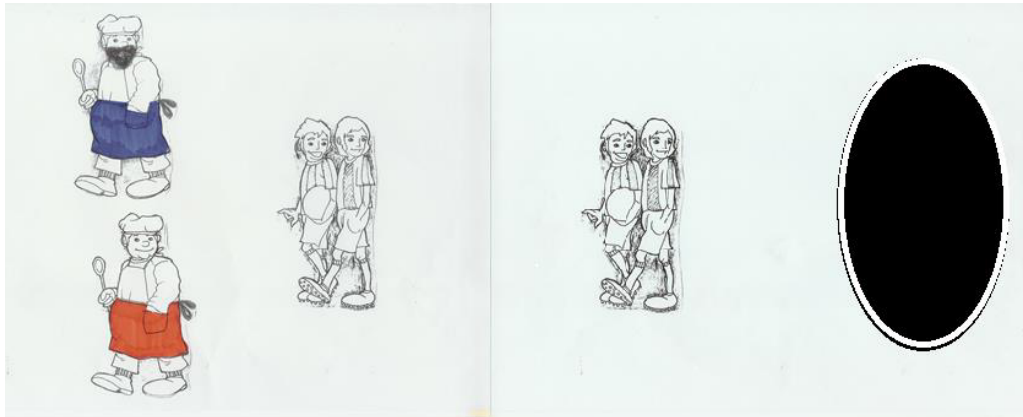


Fig. 2: Picture eliciting a subject *which*-question

For the item in fig. 2, the picture on the left was shown first, and the experimenter introduced the characters “There are a cook with a blue apron, a cook with a red one, and two football players.”. When the picture on the right appeared, the experimenter described it “One of the cooks is greeting the football players. Ask your mum/dad which cook.”. The expected answer was “Which cook is greeting the football players?”.

The participants were assessed in a quiet room of the ENT Clinic. While in Guasti et al. (2012; 2015) the participants heard the stimuli by a recorded voice and then they were asked to make a question to a puppet, for this study all participants received the stimuli directly from the experimenter. This was due to the fact that in this way, hearing impaired children can rely also on lip reading. The children were asked to make a question to their parents, who did not know the correct answer, and had to guess pretending to be a magician.

The task was presented on a laptop computer screen and the stimuli were displayed through a Power Point presentation. The questions produced by the participants were audio recorded and transcribed by one of the experimenters.

2.3 Response coding

We considered as correct responses all *who* and *which* questions with the following structures: *wh*-questions with a final NP (*chi colpiscono i bambini?* ‘who the children hit?’); *wh*- questions with the NP topicalization (*i bambini, chi colpiscono?* ‘the children, who hit?’); *wh*- questions in which the final argument was not expressed (*chi colpiscono?* ‘who hit?’); cleft *wh*- questions (*chi è che (i bambini) colpiscono (i bambini)?* ‘who is that (the children) hit (the children)?’); passive *wh*-questions (*chi è colpito dai bambini?* ‘who is hit by the children?’); *in situ wh*- questions (*la fatina tira quali bambini?* ‘the fairy pulls which children?’); and *wh*- questions with a resumptive clitic pronoun (*quale cane i gatti lo stanno leccando?* ‘which dog the cats are licking him?’).

We analysed as incorrect the responses with the following structures: questions introduced by a *wh*-element different from the target *who* or *which* (*i gatti, chi leccano?* ‘the cats, who lick?’ instead of *quale cane leccano i gatti?* ‘which dog lick the cats?’); questions with the inversion of the thematic roles (*che cuoco salutano i calciatori?* ‘which cook greet.PL the football players.SUBJ?’ meaning

‘which cook do the football players greet?’ instead of *quale cuoco saluta i calciatori?* ‘which cook greets the football players?’); incomplete or ungrammatical sentences (*quale cuoco?* ‘which cook?’)²⁷; sentences with a *wh-* element different from the target one (*che bambini sognano i puffi?* instead of *quale bambino sognano i puffi?* ‘which child do the smurfs dream of?’).

3 Results

The following table shows the number and the percentages of correct responses provided by each group:

Table 3: number and % of correct responses for the CI- and the TD-groups.

		CI-group		TD-group	
		No.	%	No.	%
WHO	subject	43/48	90%	43/48	90%
	object	37/48	77%	38/48	79%
WHICH	subject	32/48	67%	37/48	77%
	object	25/48	52%	32/48	67%
TOTAL		137/192	71%	150/192	78%

A lower level of accuracy is observed in the CI-group compared to the TD-group. However, both groups display the same pattern in the production of *wh-* questions. *Who* questions are more preserved than *which* questions, and subject *wh-* questions are easier to produce than object *wh-* questions.

The performances of the two groups differ in the strategies adopted to produce a question. The following table summarises the strategies adopted by each group:

Table 4: number and % of response strategies adopted by each group.

	CI-group				TD-group			
	WHO		WHICH		WHO		WHICH	
	subject	object	subject	object	subject	object	subject	object
NP-final	39	24	30	17	34	25	36	24
(Wh V N)	81%	50%	62%	35%	71%	52%	75%	50%
Topicalised	0	11	0	3	0	6	0	1
	0%	23%	0%	6%	0%	13%	0%	2%
Cleft	4	0	2	2	8	2	0	0
	8%	0%	4%	4%	17%	4%	0%	0%
Passives	0	0	0	2	0	2	0	6
	0%	0%	0%	4%	0%	4%	0%	13%
No Argument	0	2	0	0	0	2	1	1
	0%	4%	0%	0%	0%	4%	2%	2%
Other Wh-operators	0	1	5	13	4	4	6	12
	0%	2%	10%	27%	8%	8%	13%	25%
Ungrammatical/incomplete	3	8	8	9	1	5	4	3
	6%	17%	17%	19%	2%	10%	8%	6%
In situ	0	0	0	1	0	0	0	0
	0%	0%	0%	2%	0%	0%	0%	0%
Clitic pronoun	0	0	0	1	0	1	0	0
	0%	0%	0%	2%	0%	2%	0%	0%
Theta inversion	2	2	3	0	0	1	0	1
	4%	4%	6%	0%	0%	2%	0%	2%

²⁷ In this category, we included ungrammatical structures, questions with the only *wh-* element, incomplete sentences, and sentences which are the repetition of the last part of the sentence uttered by the experimenter.

4 Discussion & Conclusion

In this study, the production of subject and object questions introduced by *who* or *which* followed by a noun phrase (NP) was analysed in a group of 8 Italian-speaking CI-children, in order to determine whether these participants differ from 8 normal hearing children in the use of these complex structures.

For both groups, the typical asymmetry between the production of subject and object *wh*- questions, and between the production of *who* and *which* NP questions was observed. Subject *wh*- questions were easier than object *wh*- questions, and *who* questions were more preserved than *which* NP questions.

These asymmetries were found also in previous studies for other populations with typical and atypical language development (TD-children and adults: De Vincenzi, 1991, 1999; Friedmann et al., 2009; Guasti et al., 2012; Belletti & Guasti, 2015; children with developmental dyslexia: Guasti et al., 2015; patients with agrammatic aphasia: Garraffa & Grillo, 2008; hearing-impaired children: Quigley et al., 1974; Friedmann & Szterman, 2011; Friedmann & Haddad-Hanna, 2015). The subject/object asymmetry can be explained by the length of syntactic dependency between the sentence initial position of the *wh*- operator and the position in which it is interpreted. As proposed by the Minimal Chain Principle (De Vincenzi, 1991), the hypothesis is that subject questions are easier because the dependency is short, while object questions are problematic because the dependency between the two positions is longer. Long dependencies as those featuring object questions increase the computational load necessary to produce them. The preference for shorter dependencies is confirmed by the fact that one of the error made by the children when an object *wh*- question was elicited (*Chi lavano i cani?* ‘who wash.PL the dogs.SUBJ.’) was the production of a subject *wh*- question (*Chi lava i cani?* ‘who washes the dogs?’).

The asymmetry between *who* and *which* questions is due to the structural complexity of the *which*+NP phrase. Sometimes, children fail in this operation and leave the *which*+NP in its original position (*La fatina tira quali bambini?* ‘the fairy pulls which children?’) or simplify the *which*+NP into *who* (*chi lava le scimmie?* ‘who washes the monkeys?’ instead of *quale gatto lava le scimmie?* ‘which cat washes the monkeys?’). The avoidance of the *which*+NP question when pragmatically required is a strategy that makes it possible for the children to reduce the complexity of that kind of sentence.

Comparing the performances of the two groups, the data analysis showed lower percentages of correct sentences in the CI group as opposed to the TD one for all sentence conditions, except for subject *who* questions. This difference between hearing impaired and hearing individuals was previously showed by other studies carried out on other languages (for English: Quigley et al., 1974; for Hebrew: Friedmann & Szterman, 2011, for Palestinian Arabic: Friedmann & Haddad-Hanna, 2015).

In the present study, it is interesting to observe that the CI-children adopted a large number of strategies when both subject and object questions were targeted, and individual performance variability was observed. The most frequent (incorrect) strategy was the production of ungrammatical sentences, which were uttered by the youngest and by two of the older participants. In addition, most CI-children replaced the *wh*- element with one which was not appropriate for the context (for example, they used *chi* ‘who’ or *che* ‘what’ instead of *which*+NP). This strategy was observed for various children, regardless of their age. In some cases, children produced *wh*- questions with reversed thematic roles. However, some other CI-children who did not produced the target sentence used some strategies that were nonetheless pragmatically correct, such as topicalised sentences, cleft *wh*- questions. The CI-children who produced appropriate sentences displayed to have good competence in Italian and use response strategies found in TD children; other CI-children, who produce ungrammatical sentences, showed an atypical behaviour that is evidence of the linguistic delay associated to hearing impairment.

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