Production of third-person direct object clitics in deaf children with cochlear implants speaking Italian

Abstract

Previous research has shown that the production of third-person singular accusative object clitics (3DO clitics) might be taxing in Italian-speaking pre-school children with cochlear implants (CIs). We investigated this topic by assessing 3DO clitic production in 14 children with an average age of 8 years, who had received a CI between age 1 and 4. The first goal of the study was to analyze whether school-aged children with CIs exhibit atypical behavior in 3DO clitic production. The second goal was to analyze whether children with CIs are prone to agreement errors in case of gender mismatch between the subject and the 3DO clitic, as has been shown for normal-hearing, typically developing children. To achieve this, we used two tasks in which subject and object clitic grammatical genders were manipulated so that they would or would not match. As for the first goal, the majority of children with CIs had good performance on the clitic tasks. However, some participants' performance was poor. The pattern of deviant responses differed among the poor performers. We believe that children with CIs showing impairments in 3DO clitic production need careful individual analysis in order to plan effective speech therapy. As for the second goal, children with CIs were more prone to agreement errors in the mismatch condition compared to the match condition; this dimension needs to be considered when assessing and eventually rehabilitating clitic production.

Keywords: direct object clitics; cochlear implant; Italian; language development

Introduction

Just like all Romance languages, Italian has pronominal clitics, a set of phonologically weak pronouns. Italian clitic pronouns must occur adjacent to a verb, and when the verb is finite, they must precede it. Italian clitics are marked for case (accusative/dative/genitive/oblique-locative). Accusative and dative clitics are also marked for number (singular/plural), gender (feminine/masculine), and person (first/second/third) (see Belletti & Guasti, 2015).

The present work investigates the production of third-person singular accusative object clitics (hereinafter, 3DO clitics) in Italian-speaking deaf children with cochlear implants (CIs). Pronominal clitics have received a great deal of attention in the context of language acquisition research because their production is somewhat difficult[1]. Even when normal-hearing, typically developing children who speak Italian begin to produce 3DO clitics at age two (see (1a) for an example of the correct use of a 3DO clitic), in the early stages they optionally omit them, producing an ungrammatical sentence (1b). Later, children might avoid the use of 3DO clitics by replacing them with a full lexical element in the canonical object position (1c). The sentence in (1c) is not ungrammatical, but it is infelicitous as an answer to question (1).

(1) Cosa fa la mamma alla bambina? *What does the mother do to the child?*

(a) *La* pettina. *CL^{3sF} combs.*

(b) *Ø pettina. *Combs.*

(c) Pettina la bambina. *Combs the child.*

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1 Difficulties in the acquisition of 3DO clitics have been reported in various Romance languages (see Varlokosta et al., 2016).

The acquisition of Italian 3DO clitics is generally considered complete by age four and ungrammatical/infelicitous production is only sporadic at age five (e.g., Schaeffer, 2000; Leonini, 2006; Caprin and Guasti, 2009; Dispaldro, Caselli, and Stella, 2009; Moscati and Tedeschi, 2009).

The failure to produce 3DO clitics is a good clinical marker for developmental language disorders (DLD) in Italian (Bottari, Cipriani, Chilosi, and Pfanner, 2001; Bortolini et al., 2006; Leonard and Dispaldro, 2013; Arosio, Branchini, Barbieri, and Guasti, 2014; Guasti et al., 2016) and other Romance languages (see Jakubowicz, Nash, Rigaut, and Gerard, 1998; Hamann, Rizzi, and Frauenfelder, 2003 for French; Bedore and Leonard, 2005 for Spanish). Findings on Italian indicate that DLD children tend to omit 3DO clitics at age five, whereas they prefer to substitute them with a full lexical constituent at age seven (Arosio et al., 2014; Guasti et al., 2016). This highlights how the failure to produce 3DO clitics as a clinical marker for DLD applies to both pre-school and school-age children.

Starting from the fact that 3DO clitic production is challenging in young TD children and DLD children, Guasti et al. (2014) assessed 3DO clitic production in a group of 33 Italian-speaking, deaf pre-school children with CIs (mean age=63.9 months, SD=8.7; mean age of implant=21.7, SD=10.4). Compared to a group of normal-hearing, typically developing children matched in age and gender, the children with CIs produced fewer 3DO clitics. Moreover, the responses by children with CIs included more omissions than those by children with normal hearing. Interestingly, among children with CI there was a clear effect of age at implantation: participants implanted earlier produced more 3DO clitics than participants implanted later.

Given these facts, the following question arises: is 3DO clitic production as challenging for children with CIs as it is for DLD children? Are children with CIs

persistently impaired in 3DO clitic production, or is the acquisition of this complex morphosyntactic structure only delayed as a result of delayed language exposure? If the latter is the case, will children with CIs eventually catch up? This led us to expect good performance in the production of 3DO clitics in school-age children with CIs. The latter scenario is plausible, as Guasti et al. (2014) noticed that the children with CIs who participated in their study produced approximately the same number of clitics as the typically developing children with normal hearing reported by Schaeffer (2000). In Schaeffer, the children were three years old, which roughly corresponded to the mean hearing age (calculated by subtracting the age of implant from the chronological age) of the children with CIs studied by Guasti et al. (2014).

Therefore, the first goal of the present work was to evaluate the production of 3DO clitics in school-aged children with CIs in order to shed more light on what happens with more exposure to language.

Connected to this main goal, it was our aim to evaluate what biographical factors (age at diagnosis, age of implant), if any, are correlated with 3DO clitic production, and whether 3DO clitic production correlates with standardized tests assessing morphosyntactic comprehension and receptive vocabulary.

The present research was motivated by a further goal. In a recent study, Arosio and Giustolisi (2019) showed how experimental manipulation of the gender features of the subject may have an impact on 3DO clitic production in normal-hearing, typically developing children. In a set of two studies, the authors elicited the production of 3DO clitics in contexts with gender feature match/mismatch between the subject and the 3DO clitic. In study 1, 3DO clitic production was tested in sentences with an overt lexical subject (a noun phrase, NP), as in (2a-d):

(2)

(a) Match F-F: Bianca la rincorre. (*Bianca*^{F} *CL*^{3sF} *chases*).

(b) Mismatch M-F: Paolo la rincorre. (*Paolo*^{M} *CL*^{3sF} *chases*).

(c) Match M-M: Paolo lo rincorre. (*Paolo*^{M} *CL*^{3sM} *chases*).

(d) Mismatch F-M: Bianca lo rincorre. (*Bianca*^{F} *CL*^{3sM} *chases*).

In study 2, 3DO clitic production was assessed in sentences with a null subject (*pro*), as in (3a-d):

(3)

(a) Match F-F: La^{F} rincorre. (*pro*$^{antecedent\text{-}F}$ *CL*^{3sF} *chases*).

(b) Mismatch M-F: La^{F} rincorre (*pro*$^{antecedent\text{-}M}$ *CL*^{3sF} *chases*).

(c) Match M-M: Lo^{M} rincorre (*pro*$^{antecedent\text{-}M}$ *CL*^{3sM} *chases*).

(d) Mismatch F-M: Lo^{M} rincorre (*pro*$^{antecedent\text{-}F}$ *CL*^{3sM} *chases*).

In both studies, four- and five-year-old normal-hearing, typically developing children optionally produced 3DO clitics with the wrong gender morphology in the gender mismatch condition. Stemming from Zesiger et al.'s (2010) work, the authors argued that these errors were caused by subject interference. Specifically, they depended on structural configurations found in the syntactic derivation of sentences with 3DO clitics in which agreement between the clitic and a postverbal argument position should be established across subjects (Arosio and Giustolisi, 2019).

For the sake of simplicity, we will illustrate 3DO clitic derivation by adopting a single theoretical approach – namely, that of Sportiche (1992/1996, 1999). According to Sportiche, 3DO clitics are the head of a clitic phrase (ClP) projection and are in a local agreement relation with a null pronoun *pro* moved from the VP internal argument position, as in (4).

(4) $[_{TP} \ldots [_{ClP} [_{DP_1}$ *pro*$] [_{Cl}$ clitic$] [_{VP} [_{DP}$ external argument$] [_{V}$ verb$] [t_{DP_1}]]]]$

According to (4), a determiner phrase (DP_1) containing the *pro* moves from the verbal object position (t_{DP_1}) to the specifier of ClP in order to establish a local agreement relation with the clitic. Under this configuration, the external argument of the verb (that will move to the sentence subject position later) is also a DP endowed with a subset of features of DP_1, and so is closer than DP_1 to the clitic head, and can access the specifier of ClP, according to Arosio and Giustolisi (2019). The same authors claim it interferes in the movement of DP_1, giving rise to a computational complexity that children tend to avoid or that is prone to agreement errors. When avoiding the complexity, children drop the clitic projection and produce an ungrammatical sentence where the verb object is not overtly realized as in (1b), or they produce an infelicitous sentence where the verb object is not topicalized and is overtly realized by a full constituent as in (1c). When there are agreement errors, the more local external verb argument erroneously moves instead of the *pro* in order to establish an agreement relation with the clitic phrase. In this case, when there is a gender feature mismatch between the external verb argument and the clitic antecedent, the clitic erroneously spells out the gender feature of the external verb argument. Arosio and Giustolisi found that both a lexical subject and a null subject caused gender feature interference, therefore they argued that the gender features that the null subject inherits from its antecedent and the lexical features of lexical DPs interfere in the same way in DO clitic derivation.

In the present study, we assessed 3DO clitic production in deaf children with CIs by manipulating the gender features of the intervening subject, which could match or not match the gender features of the 3DO clitic. If the acquisition of clitics by children with CIs is only delayed in comparison to their hearing peers, school-aged deaf children

with CIs should be prone to gender agreement errors in a situation of gender mismatch between the subject and object. Like Arosio and Giustolisi (2019), we used two different tasks, one eliciting the clitic in sentences with an overt lexical subject (Task 1 NP) and one in sentences with a silent *pro* subject (Task 2 *pro*). As explained below, Task 1 corresponded to the task used in Arosio and Giustolisi's study 1, whereas Task 2 was slightly different.

The results of our study provide a description of morphosyntactic abilities in children with CIs and a theoretical interest in the nature of their linguistic problems. Moreover these results might have practical implications through providing useful recommendations for speech therapists and other clinicians working with Italian children with CIs.

Methods

Participants

Twenty children with severe/profound hearing loss with CIs were recruited for our study. Six cases were excluded for the following reasons: i) Italian was not the language spoken at home by the parents (three children); ii) refusal to continue the study (two children); and iii) technical problems with the laptop used to administer the tasks (one child). The final sample consisted of 14 Italian children (6 female, 8 male; mean age=102 months, SD=22). The children were born deaf in hearing families, and diagnoses of severe/profound hearing loss occurred between 4 and 42 months of age (M=18, SD=11). CIs were implanted between 12 and 53 months (M=24, SD=13). Six of the children had bilateral CIs (five simultaneous and one sequential) and eight had

unilateral CIs (two children with bimodal hearing)[2].

All the children were acquiring Italian as their first and only language.

All of them had age-appropriate nonverbal intelligence scores as measured by Raven's Coloured Progressive Matrices (Italian Standardization; Belacchi et al., 2008).

Table 1 shows the demographic characteristics of the children.

--- Insert Table 1 about here ---

All of the children underwent a linguistic assessment battery that evaluated the following:

(1) Receptive vocabulary, using the Italian version of the Peabody Picture Vocabulary Tests (PPVT; Stella, Pizzoli, and Tressoldi, 2000). The test includes 175 tables containing 4 pictures each. The child's task was to indicate which of the four pictures corresponded to a target word uttered by the experimenter. Raw scores represent correct responses and standard scores are computed according to norms for different age groups.

(2) Comprehension of morphosyntax, using the "Grammatical Comprehension" task of the BVL 4-12 battery (Marini, Marotta, Bulgheroni, and Fabbro, 2015). This test includes 40 tables containing 4 pictures each. The child's task was to indicate which of

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[2] When assessing the linguistic outcomes of children with CI, the type of stimulation used (unilateral vs. bilateral) is another important point. For what concerns the present study, our sample size was small and we did not consider it appropriate to divide it into subgroups. However, as a note, a U test for audibility and speech perception in quiet test showed homogeneous results between children with unilateral and bilateral implants.

the four pictures corresponded to a target sentence uttered by the experimenter. Raw scores represent correct responses and z-scores were calculated according to norms for different age groups.

Informed consent was obtained from the parents of all the participating children.

The study was conducted according to the standards of the Helsinki Declaration and was approved by the local ethics committee.

Materials

The production of 3DO clitics was assessed with two different tasks, Task 1 (with a NP subject) and Task 2 (with a pro subject). Task 1 is the same as the task used in Study 1 of Arosio and Giustolisi (2019). Task 2 is similar to the task used in Study 2 of Arosio and Giustolisi, but employs a slightly different procedure. Specifically, to balance Task 1 and Task 2 in the number of pictures shown, and to prompt the answers using the same question in Task 1 ("and then?"), we used a three-picture task. On the contrary, Arosio and Giustolisi (2019) used a two-picture task to elicit clitics in sentences with a null subject.

Each task included 20 items. Each item was comprised of three pictures, and each picture was accompanied by a sentence uttered by the experimenter. In each item, the participants were supposed to produce a sentence that contained a clitic pronoun. In each test, the grammatical gender of the subject and the clitic were manipulated in a 2x2 experimental design, as illustrated in Table 2. Items were evenly distributed across conditions (5 M-M, 5F-M, 5M-F, and 5 F-F).

--- Insert Table 2 about here ---

A detailed description of the two tasks follows.

Task 1 (NP): Clitic production with lexical subject interference

The experiment began with the introduction of two characters: Paolo (a boy) and Bianca (a girl). The experimenter verified twice that participants had learnt the name of the characters by showing different pictures of Paolo and Bianca and asking the participants to say the characters' names. Then, a familiarization phase followed, including three items of the same type as the experimental items. During the familiarization, feedback was given, and when participants provided wrong or inappropriate responses, they were prompted to try to rephrase their answers. The 20 experimental items followed the familiarization phase. Each item was composed of three drawings representing the two characters. Each drawing was accompanied by a sentence uttered by the experimenter. In the first drawing, the two characters were doing nothing, and the experimenter uttered a sentence saying that they would perform two transitive actions. Then, the second picture depicted either Paolo or Bianca performing one of the two transitive actions just mentioned. The third picture depicted the other character performing the other transitive action, and participants were prompted to continue the story by asking them "*and then*?" Table 3 provides an example of a match condition (F-F).

--- Insert Table 3 about here ---

Task 2 (pro): Clitic production with null subject interference

Each item included two drawings representing two characters, the subject and the object of the actions, and a drawing representing the subject alone. Each drawing was accompanied by a sentence uttered by the experimenter. Children were shown the drawing with the subject only first, and while viewing it, they heard a sentence saying what the subject would like to do. Then, while viewing the second picture, in which the second character was introduced, participants heard a second sentence saying that the

subject (first character) was looking at the object (second character). Then, the third picture, in which the subject was performing a transitive action on the object, was shown. While viewing the third picture, the children were prompted to continue the story by asking them "*and then*?" Table 4 provides an example of a mismatch condition (F-M).

--- Insert Table 4 about here ---

The experimental set included 20 items, preceded by 3 familiarization items. During the familiarization, feedback was provided and when participants gave wrong or inappropriate responses, they were prompted to try to rephrase their answers.

Procedure

The two tasks were administered through a PowerPoint presentation in the same experimental session in a counterbalanced order. The 20 items of each test were presented in a fixed random order.

Participants' responses were audio-recorded and subsequently transcribed.

Coding

Responses were classified into five different categories: correct, wrong clitic, DP, omission, and other. If the target clitic was produced, the response was considered "correct." If a clitic was produced but with the wrong morphology, the response was classified as a "wrong clitic." If a full nominal phrase (precisely, the determiner + the noun) corresponding to the clitic was used instead of the pronoun, the response was classified as "DP." If the object was omitted (neither a clitic nor a full nominal phrase), the response was classified as an "omission." Irrelevant responses were classified as "other."

Results

In this section, we report the results of the linguistic assessment and the clitic tasks. We will first provide a qualitative analysis of the data, followed by a quantitative analysis.

Table 5 shows the results of the overall linguistic assessment.

--- Insert Table 5 about here ---

The PPVT raw scores ranged between 51 and 156, with PPVT standard scores between 55 and 105. The BVL raw scores ranged between 24 and 38, with BVL z scores between -3.05 and 0.69.

As for the clitic tasks, the aggregate results are reported in Table 6. Overall, participants responded appropriately, producing sentences with an NP subject in Task 1 and sentences with a pro subject in Task 2.

--- Insert Table 6 about here ---

In both tasks, the participants produced, on average, between 75.7% and 80.7% of correct clitics. The mean percentages of clitics with the wrong morphology varied across tasks and conditions between 5.7% and 12.1%. The mean percentages of DPs produced instead of the clitic varied between 6.4% and 10.7 %, whereas the mean percentages of omissions were between 2.1% and 9.3%. Irrelevant responses were scarce; therefore, they were not further considered in the analysis. As Table 6 shows, across tasks and conditions, variability was high in all categories. Figure 1 provides a representation of the individual responses.

--- Insert Figure 1 about here ---

As Figure 1 shows, 2 children (CI_02 and CI_10) obtained a full score, with 100% of clitics produced in the 2 tasks. Six participants (CI_01, CI_05, CI_06, CI_11,

CI_12, and CI_37) had a score of 90% or higher considering the 2 tasks. Three children (CI_04, CI_09, and CI_14) scored between 82 and 88%. There were three children with very poor performance: CI_03 who produced almost no clitics, either omitting them or substituting them with the full DP. CI_07 had very high rates of DP production in Task 2 (*pro*), whereas CI_08 produced a large number of clitics with the wrong morphology.

The quantitative analysis proceeded as follows: First, we compared accuracy in the two clitic tasks across conditions to verify if there were significant differences between tasks and conditions. We performed the same analysis on the error category to verify if participants produced more wrong clitics in one of the two tasks and/or in one of the two conditions. In both cases, we performed a mixed model logistic regression analysis. The analysis of the DP category considered only Task 1 (NP) because, as depicted in Figure 1, 12 out of 14 participants did not produce DPs in Task 2 (pro). On the contrary, the analysis of the omission category considered Task 2 (pro) because in Task 1, the majority of participants (9 out of 12) did not produce omissions. Then, we performed a correlation analysis to determine if there were significant relationships between the performance on the tasks (clitic and standardized linguistic), and the demographic characteristics of the children with CIs.

To begin with, we analyzed the results of the clitic tasks. As for the "correct" category, accuracy was the dependent variable. Task (NP vs. *pro*), condition (match vs. mismatch), and their interaction were entered as fixed factors. Subjects and items were entered as random intercepts. The full model was progressively simplified following a backward elimination procedure. The results of the analysis are reported in Table 7.

--- Insert Table 7 about here ---

Neither task nor condition was a significant predictor of accuracy on the clitic tasks.

As for the "wrong clitic" category, the presence/absence of a wrong clitic was the dependent variable. Task (NP vs. *pro*), condition (match vs. mismatch), and their interaction were entered as fixed factors. The subjects were entered as random intercepts. The full model was progressively simplified following a backward elimination procedure. The results are illustrated in Table 8.

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The regression analysis showed that there were no significant differences across tasks. On the contrary, participants produced more incorrect clitics in the mismatch condition than in the match condition (10.3% vs. 5.7%), and this difference was significant (β=0.748, SE=0.339, z=2.210, p=0.03).

Considering the "DP" category in Task 1 only, the dependent variable was the presence/absence of a direct object DP instead of the target clitic. The condition (match vs. mismatch) was entered in the model as a fixed factor, with subject and item as random factors. The difference between the presence of DPs in the match and mismatch conditions was not significant (β=0.368, SE=0.568, z=-0.647, p=0.52).

As for the "omissions" category in Task 2, the dependent variable was the presence/absence of omissions instead of the target clitic. The condition (match vs. mismatch) was entered in the model as a fixed factor, with subject and item as random factors. The difference between omission rates in the match and mismatch conditions was not significant (β=0.902, SE=0.785, z=1.150, p=0.25).

We then focused on the correlation analysis. We performed the analysis using accuracy (number of correct responses) in each clitic task. The other variables that we considered were the PPVT raw score, the BVL raw score, age at diagnosis, and age of

implant. We calculated Spearman's partial correlation controlling for chronological age. The results are provided in Table 9.

--- Insert Table 9 about here ---

In both tasks, the correlation between accuracy and the BVL raw scores was positive and significant. In addition, the correlation between accuracy and the PPVT raw scores was positive, but it reached significance only for task *pro*.

In contrast, the correlation among accuracy, age at diagnosis and age of implant was negative for both tasks, meaning that accuracy on the clitic tasks decreased as the age at diagnosis/age of implant increased. However, this correlation was significant for task *pro* only.

Discussion

This study investigated the production of 3DO clitics in a group of 14 children aged between 65 and 128 months who had received a CI between 12 and 53 months. The first main goal of the study was to investigate the extent to which the production of 3DO clitics is taxing in children with CIs, analyzing whether school-aged children with CIs exhibit atypical behavior or not. Moreover, it was our purpose to analyze what factors (biographical characteristics and linguistic measures) are correlated with 3DO clitic productions. The second goal was to analyze whether children with CIs are prone to gender interference errors, as has been shown for normal-hearing, typically developing children. We did so by employing two different tasks, in part to provide useful recommendations to clinicians.

As for the first goal, the analysis revealed that the majority of children with CIs who participated had good or very good performance on the clitic tasks. This indicates that children with CIs can develop the morphosyntactic competence needed to correctly produce 3DO clitics. In general, performance on the clitic tasks correlated positively

with the scores obtained in the linguistic assessment. The correlation with grammatical assessment (BVL) was significant for both tasks. This result was expected, considering that the clitic tasks investigated a morphosyntactic structure that is among those assessed by the BVL. The correlation with lexical assessment (PPVT) was positive and significant for the *pro* task, whereas it was positive but not significant for the NP task. Considering that our sample size was small, we do not see those results as diverging. Moreover, the lexical materials of both tasks were similar. What we would like to highlight is the overall positive link with performance in the clitic tasks and in the standardized tests assessing linguistic comprehension, especially grammatical comprehension. This suggests that it might be appropriate in children with low linguistic scores to also evaluate clitic comprehension.

Although the performance of the majority of participants was good, some children's performance was very poor (in line with studies on children with CIs consistently reporting high variability among subjects, see e.g. Volpato and Vernice, 2014). Comparing Table 5 and the first panel of Figure 1, one can notice that the three children producing fewer correct clitics (CI_03, CI_07, and CI_08) were those with the lowest BVL z-scores (-3.03, -2.1, and -3.05, respectively). This might suggest that their very poor performance on the clitic tasks was a manifestation of more general morphosyntactic impairments. For these three cases, however, the nature of these morphosyntactic impairments did not seem to be unique. In fact, the pattern of deviant responses was very different among the three children. Participant CI_03 showed high rates of omission and substitution with a full DP. CI_07 exhibited different patterns of errors in the two tasks, substituting almost all clitics with a full DP in Task 2 (*pro*) and showing various patterns of interference errors, omission, and production of full DPs in Task 1 (NP). CI_08, on the other hand, was very sensitive to interference phenomena.

This has practical implications: children with CIs showing impairments in 3DO clitic production need careful case-by-case analysis in order to plan an effective speech therapy.

Very interestingly, the children's performance on the clitic tasks correlated negatively with their age at diagnosis and age at implantation. Specifically, the correlation was significant for task *pro*, but not significant for task NP. This negative correlation replicates the findings of Guasti et al. (2014), who also found a clear correlation between the performance on the clitic task and age of implant (using a task that required the production of 3DO clitics in sentences with a null subject, like the present task *pro*). Overall, these results highlight the importance of prompt implantation[3], as extensively suggested by research on the linguistic outcomes of children with CIs (e.g. Tomblin et al., 2005; Nicholas and Geers, 2007; Geers and Nicholas, 2013), and indicate that although children start to produce clitics at around age two, the seeds that bring this to accurate production must be sown earlier.

We will now focus on our second main goal, that is, analyzing whether children with CIs are prone to interference errors when there is a gender mismatch between the subject of the sentence and the 3DO clitic antecedent, as shown for normal-hearing typically developing children aged four and five (Arosio and Giustolisi, 2019). A mixed model logistic regression analysis on the percentages of 3DO clitics produced with the wrong morphology indicated that deaf children with CIs were more prone to agreement errors in the mismatch condition (different gender features between the subject and

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[3] How prompt is "prompt"? According to the Year 2019 Position Statement of the Joint Committee on Infant Hearing, CIs are suitable for children around 12 months of age, and better outcomes are achieved from those implanted by age 2, as suggested, for example, by Ching et al. (2009) and Dettman, Pinder, Briggs, Dowell, and Leigh (2007).

object) compared to the match condition (same gender features between the subject and object) in both tasks. This is in line with what was reported by Arosio and Giustolisi and provides further evidence that the syntactic derivation of Italian sentences with 3DO clitics might cause agreement errors depending on the interference of the external verb argument before it moves to the sentence subject position.

In addition to the theoretical implications, we believe that this will be of great interest to practitioners involved in speech therapy. In fact, the agreement match/mismatch between the subject and the 3DO clitic is an aspect that needs to be considered when assessing 3DO clitic production.

As for rehabilitation practice, future research is needed in order to investigate what kind of materials are most effective in triggering learning in CI children showing problems with 3DO clitic production. One possibility is that the use of materials with 3DO clitics in the match condition, along with an easier context, could be more supportive in the first step. On the contrary, children could benefit from exposure to more complex structures, as shown by Friedmann (2005) in Broca's aphasics. Further research is needed to identify the most suitable practice.

Finally yet importantly, the results of the present study add to the growing literature on the language abilities of Italian-speaking deaf children with CIs (Volpato 2011; Caselli et al., 2012; Rinaldi, Baruffaldi, Burdo, and Caselli, 2013; Guasti et al., 2014; Volpato and Vernice, 2014; Murri, Cuda, Guerzoni, and Fabrizi, 2015; D'Ortenzio and Volpato, 2019; Giustolisi et al., 2019; Volpato, 2020). As discussed by Guasti et al. (2014), language typology is a key factor in language development; therefore, it is important to provide detailed descriptions of the linguistic behaviors of children with CIs speaking languages other than English, for which the amount of literature is very sparse compared to that on English-speaking children with CIs (for a

review, see Nittrouer and Caldwell-Tarr, 2016). Moreover, the growing body of literature on the language abilities of Italian-speaking deaf children with CIs should benefit from new works by different research groups employing different methodologies and assessing children implanted at different hospitals and following different rehabilitation programs. This will allow us to paint a rich picture of the language abilities of Italian-speaking deaf children with CIs. In turn, this may be useful for theoretical cross-linguistic research and practical clinical applications.

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Declarations of interest

The authors report no conflicts of interest.

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Tables

ID	Gender	Age*	Age of diagnosis*	Age of implant*	Type of implant	Type of stimulation
01	M	94	9	19	NUCLEUS	Bilateral sequential
02	F	119	18	21	AB	Unilateral
03	M	106	38	48	AB	Bimodal
04	M	65	15	19	AB	Bilateral simultaneous
05	F	69	22	25	MED EL	Bilateral simultaneous
06	F	128	24	35	AB	Unilateral
07	M	123	15	19	AB	Unilateral
08	M	91	42	53	MED EL	Bimodal
09	M	128	22	25	AB	Bilateral simultaneous
10	F	121	4	12	AB	Unilateral
11	M	104	8	12	AB	Unilateral
12	M	104	4	12	AB	Bilateral simultaneous
13	F	74	15	19	MED EL	Bilateral simultaneous
14	F	107	18	23	NUCLEUS	Unilateral
*Ages in months.						

Table 1. Demographic characteristics of the children with CI.

		Object (Clitic)	
		Masculine	Feminine
Subject	Masculine	M-M: match	M-F: mismatch
	Feminine	F-M: mismatch	F-F: match

Table 2. Schematic representation of the gender features manipulation.

Picture 1	PAOLO AND BIANCA DOING NOTHING.
Sentence 1	In questa storia Paolo e Bianca vogliono toccare e poi salutare qualcuno. *In this story, Paolo and Bianca want to touch and greet someone.*
Picture 2	PAOLO TOUCHING A WOMAN.
Sentence 2	Paolo tocca una signora. *Paolo touches a woman.*
Picture 3	BIANCA GREETING THE WOMAN.
Sentence 3 (prompt)	E poi? *And then?*
Expected answer	Bianca la saluta. *Bianca^{F} CL^{F} greets*

Table 3. Task 1 (NP): match (F-F) condition example.

Picture 1	A WOMAN DOING NOTHING.
Sentence 1	In questa storia una signora vuole salutare qualcuno. *In this story, a woman wants to greet someone.*
Picture 2	THE WOMAN AND A BOY.
Sentence 2	Prima guarda un bambino. *First (pro^{F}) looks at a boy.*
Picture 3	THE WOMAN GREETING THE BOY.
Sentence 3 (prompt)	E poi? *And then?*
Expected answer	Lo saluta. *(pro^{F}) CL^{M} greets.*

Table 4. Task 2 (pro): mismatch (F-M) condition example.

ID	PPVT raw score	PPVT standard score	BVL raw score	BVL z score
01	88	87	38	0.69
02	122	96	38	0.1
03	60	55	27	-3.03
04	51	70	29	0.18
05	77	89	30	0
06	121	88	35	-1.16
07	98	77	32	-2.1
08	116	91	24	-3.05
09	156	96	38	-0.08
10	129	101	38	0.1
11	110	98	37	0.09
12	118	104	37	0.09
13	79	90	33	0.24
14	89	83	34	-0.84

Table 5. By subject results of the overall linguistic assessment.

		CORRECT	WRONG CLITIC	DP	OMISSION	OTHER
NP	match	75.7 (43.0)	5.7 (23.3)	8.6 (28.1)	9.3 (29.1)	0.7 (8.4)
	mismatch	76.4 (42.6)	12.1 (32.8)	6.4 (24.6)	3.6 (18.6)	1.4 (11.9)
pro	match	80.7 (39.6)	5.7 (23.3)	10.7 (31.0)	2.1 (14.5)	0.7 (0.8)
	mismatch	75.7 (43.0)	8.6 (28.1)	9.3 (29.1)	5.0 (21.9)	1.4 (11.9)

Table 6. By subject results of the overall linguistic assessment. Scores (mean and standard deviations) are expressed in percentages.

Model	Fixed effects	Estimate	Standard Error	z	p
Task * Condition	Task	0.533	0.471	1.131	0.26
	Condition	0.064	0.457	0.141	0.89
	Task * Condition	-0.582	0.657	-0.886	0.37
Task + Condition	Task	0.235	0.332	0.708	0.48
	Condition	-0.218	0.332	-0.656	0.51
Task	Task	0.233	0.334	0.698	0.48

Table 7. Mixed model logistic regression analysis of accuracy in the two clitic tasks.

Model	Fixed effects	Estimate	Standard Error	z	p
Task * Condition	Task	1.3^{e-07}	0.531	0.00	1.00
	Condition	0.964	0.468	2.060	0.04 *
	Task * Condition	-0.461	0.677	0.682	0.50
Task + Condition	Task	-0.285	0.329	-0.868	0.39
	Condition	0.750	0.339	2.212	0.03 *
Condition	Condition	0.748	0.339	2.210	0.03 *

Table 8. Mixed model logistic regression analysis of presence of clitics with the wrong morphology in the two clitic tasks.

	Task NP		Task *pro*	
	Spearman's rho	p	Spearman's rho	p
PPVT raw scores	0.406	0.17	0.599	0.03
BVL raw scores	0.688	< 0.01	0.706	< 0.01
Age of diagnosis	-0.367	0.22	-0.577	0.04
Age of implant	-0.357	0.23	-0.576	0.04

Table 9. Spearman partial correlation analysis: rho and p-values.

Figures
Figure 1

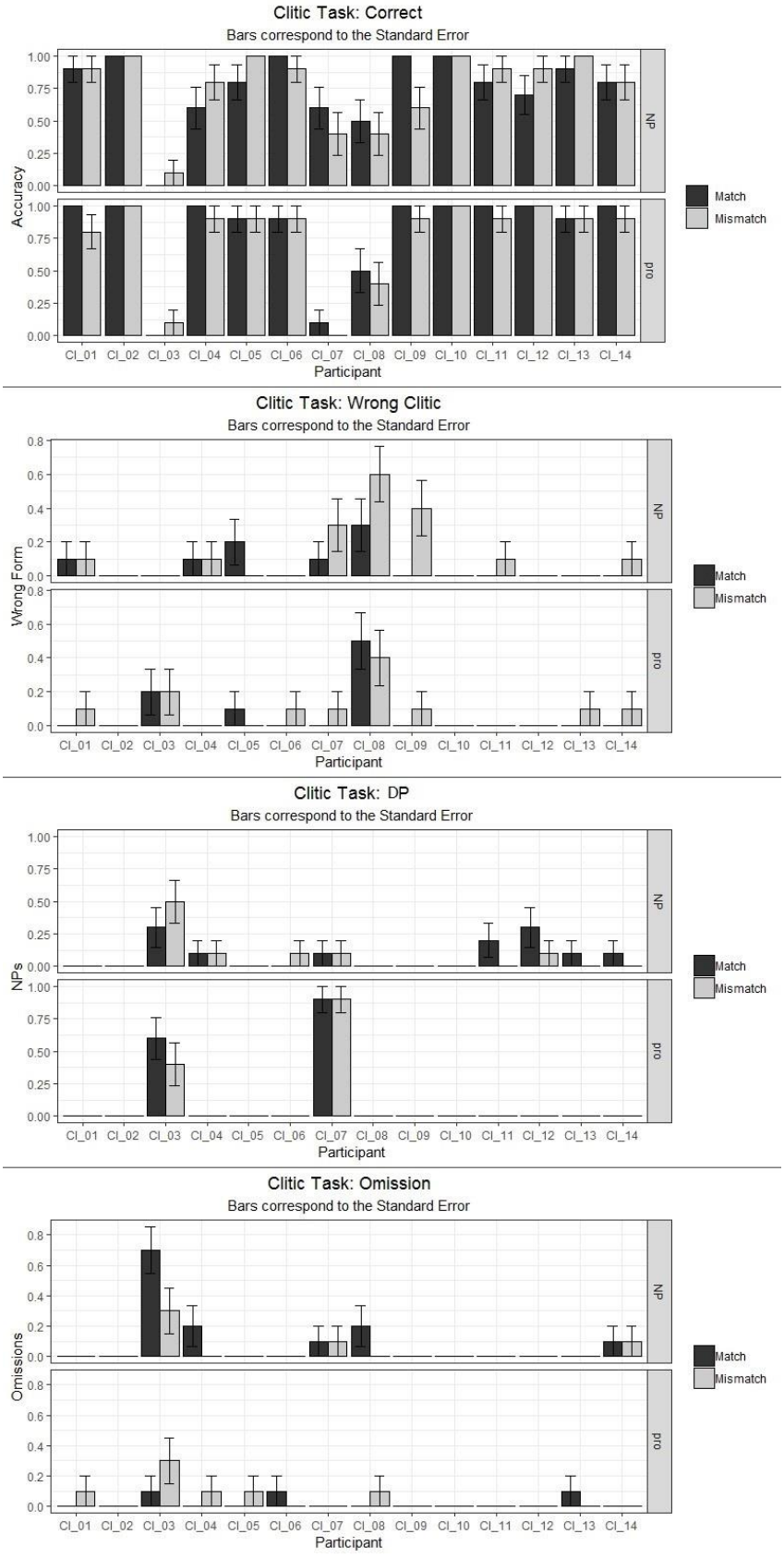

Figure captions

Figure 1. Mean individual scores in the two clitic tasks Participants are reported on the x-axis, whereas percentages of occurrence of each dependent variable are reported on the y-axis. In each panel, the upper graph refers to the NP task, whereas the lower graph refers to the *pro* task. The results of the match condition are depicted in dark grey and those of the mismatch condition in light grey. The bars correspond to the standard error.