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Comprehension vs. production of oblique relatives by Italian-speaking typically developing individuals, from primary school to adulthood

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Abstract

This paper discusses both the comprehension and the production of oblique, pied-piping relative clauses from primary school age to adulthood. Relative clauses that are not produced before 10 years (Guasti & Cardinaletti 2003) are however comprehended in high percentages and above chance since primary school age. Production appears to be related to the educational level and experience with the formal register, as shown here by the comparison of different groups of students and adults. Unlike what happens

with object relatives (Adani et al. 2010, 2014; Volpato 2010, 2019), number mismatch does not facilitate the comprehension of oblique relatives, nor their production.

Keywords: oblique relatives, comprehension, production, Italian, pied-piping, formal register.

1. Introduction

Relative clauses are at the core of a long-lasting cross-linguistic debate, as they constitute a reference point for the analysis of syntactic complexity and processing strategies. They have been examined from both theoretical and acquisitional perspectives. Most research in a variety of languages and across different populations has focused on subject relatives (SR) and object relatives (OR), which in Italian are introduced by the complementizer *che* 'that', as shown in (1) and (2), respectively. Adopting Kayne's (1994) head movement analysis, they are derived by A-bar movement of the head of the relative from the first-merge position (marked by < >) to SpecCP.

(1) La [$_{CP}$ donna che [$_{IP}$ <donna> bacia i bambini]].
The [$_{CP}$woman that [$_{IP}$ <woman> is kissing the children]].

(2) I [$_{CP}$ bambini che [$_{IP}$ la donna bacia <bambini>]].
The [$_{CP}$ children that [$_{IP}$ the woman is kissing < children>]].

This paper compares *that*-relatives with oblique relatives, which in Italian are introduced by the relative pronouns *cui* or (*article*+)*quale*, preceded by a preposition or embedded in a DP (Cinque 1982). *Cui* 'whom/which' is a non-agreeing relative pronoun, while (*article*+)*quale* 'the whom/which' agrees with the head of the relative. The article agrees in gender and number with the noun, while *quale* only agrees in number. The label 'oblique relatives' encompasses different constructions, among them dative (DAT, (3)), locative (LOC, (4)), and genitive (GEN, (5)) relatives. In Kayne's analysis, oblique relative clauses are derived in more than one step through *pied-piping*, i.e., the movement of the relative pronoun to the left periphery involves movement of the whole PP (in DAT and LOC relatives) and the whole DP (in GEN relatives) containing it. In addition to A-bar movement to SpecCP, pied-piping relatives show SpecCP-internal movement. Following Kayne (1994) for English and French and Bianchi (1999) for Italian, the complement of the wh-determiner moves to SpecPP in DAT and LOC relatives. Along the same lines, the complement of the *wh*-determiner moves to specDP in GEN relatives (cf. Kayne 1994 for English genitive relatives). Prior to movement to SpecCP, in GEN relatives, the possessive wh-complement moves to the DP-internal subject position (SpecPossP) (cf. Cardinaletti 1998).[1]

[1] Genitive relatives are not built on complements of verbs but of nouns (e.g., the prepositional complement *del cane* 'of the dog' of the noun *padrone* 'owner' in the subject DP in (5); cf. *il padrone del cane cucina* 'the owner of the dog is cooking'). We nonetheless included GENs in this study because they involve relative pronouns, pied-piping and a

(3) il [$_{CP}$ [$_{PP}$ cane [$_{P'}$ a [$_{DP}$ cui <cane>]]] [$_{IP}$ i bambini danno il cibo <a cui cane>]]
'The dog to whom the children are giving the food.'

(4) la [$_{CP}$ [$_{PP}$ sedia [$_{P'}$ su [$_{DP}$ cui <sedia>]]] [$_{IP}$ il cane sale <su cui sedia>]]
'The chair onto which the dog climbs.'

(5) il [$_{CP}$ [$_{DP}$ cane [$_{D'}$ il [$_{PossP}$ [cui <cane>] padrone <cui cane>]]] [$_{IP}$ <il padrone cui cane> cucina]]
the dog the whose owner cooks
'The dog whose owner is cooking'

Building upon this theoretical framework, this study aims to investigate both the comprehension and the production of oblique relative clauses in Italian, in comparison to SRs and ORs. The available data only regard production (Guasti & Cardinaletti 2003; Volpato 2022; Piccoli et al. 2023). To explore the developmental trajectory and adult processing of these constructions, data were collected from several age groups, from school-age children to adult participants. Comparing students attending different school levels and two groups of adults with different educational levels, this study also aims to verify the impact of educational level and exposure to the formal register on both comprehension and production of these complex structures. This impact was hypothesized by Guasti & Cardinaletti (2003) on the basis of only production data from primary school children. Finally, starting from much existing literature on the linguistic cues that are available to speakers to develop the competence of *that*-relative clauses, specifically number features (Adani et al. 2010, 2014; Volpato 2010, 2019), this study seeks to investigate whether number morphology also plays a significant role to avoid a Relativized Minimality (RM) violation (Friedmann et al. 2009) and assign the correct grammatical functions in oblique relative clauses. As suggested by Costa et al. (2014, 2015), for relatives built on prepositional complements in Portuguese and Hebrew, the configuration might give rise to RM effects similar to those in ORs.

The paper is organised as follows. Section 2 presents acquisitional data concerning the production and comprehension of *that*-relatives and oblique relatives, and the research questions of our study. Section 3 describes the experimental study and presents the methodology adopted (participants, materials and methods to assess both comprehension and production). Section 4 presents the results, and Section 5 discusses them. Section 6 contains concluding remarks, along with directions for future research.

2. The acquisition of relative clauses

2.1 The acquisition of *that*-relatives

From an acquisitional standpoint, a general asymmetry has been highlighted in the mastery of *that*-relatives when comparing SRs and ORs. In Italian, SRs are correctly

complex derivation similar to DAT and LOC relatives built on prepositional complements of verbs.

comprehended from the earliest stages of language acquisition. Already at the age of 3 years, the rate of accuracy is above 90% (Adani 2011). As for ORs, three-year-old children demonstrate a comprehension of approximately 50%. While this percentage increases with age, comprehension rates typically remain below 90% by the age of 7 (Adani 2011; Volpato 2010, 2019), and residual errors are found even among high school students (Volpato 2010, 2019).

Findings from elicited production tasks suggest that SRs emerge a little bit later in child language development. However, once children start producing them, the rate is remarkably high, exceeding 90% from the age of 4 years. At this developmental stage, the rate of ORs is considerably lower than that of SRs (52%) (Belletti & Contemori 2010). As children grow older, within a few years, they produce SRs with 100% accuracy. Conversely, the production of ORs gradually decreases in favor of other answering strategies. As alternative strategies, children begin to use causative constructions (6) at about the age of 4 and passive relatives (7) at the age of 5 in contexts in which ORs (2) are elicited (Contemori & Belletti 2014). In adolescence and adulthood, ORs are almost completely absent.

(6) I bambini che si fanno baciare dalla nonna
'The children that make themselves kiss by the grandmother'

(7) I bambini che sono baciati dalla nonna
'The children that are kissed by the grandmother'

The asymmetry between SRs and ORs has been explained in terms of Relativized Minimality effects (Friedmann et al. 2009) occurring when movement to the CP domain is hindered due to a partial overlap in relevant morphosyntactic features of the object with an intervening element in the IP projection, i.e., the subject DP. In the process of comprehension of object *that*-relative clauses by typically developing children, a facilitation effect has been observed when the two DPs are dissimilar in terms of number features. Number mismatch is a cue that helps disambiguate the grammatical functions of the two DPs within the relative clause in both children and adolescent students (Adani et al. 2010; Volpato 2010, 2019). Conversely, this dissimilarity does not act as a facilitating cue in the production of targeted object relatives (Contemori & Belletti 2014). This has been attributed to the fact that speakers prefer using strategies that avoid syntactic intervention, such as passive relatives.

2.2 The acquisition of oblique relatives

The existing literature on the acquisition of oblique relative clauses has mainly focused on assessing production skills. Cf. e.g. Labelle (1990) for French, Varlokosta (1997) for Greek, McDaniel et al. (1998) for English. A general avoidance of pied-piping relatives has been observed.

For Portuguese and Hebrew, Costa et al. (2014, 2015) assessed both production and comprehension in children aged below 6 years. They found that 'children experience similar difficulties in producing and comprehending PP object relatives and DP object relatives' (Costa et al. 2015: 36) and suggested an approach in terms of RM effects occurring in both types of relative clauses. In both cases, the subject DP intervenes in the movement of the phrase containing the relative pronoun to CP. They

conclude that 'categorial similarity is irrelevant for intervention' (Costa et al. 2015: 41).

For Italian, using an elicited production task, Guasti & Cardinaletti (2003) assessed oblique (dative, locative, and genitive) relatives in children aged 5;2-10 years and observed that these constructions are not produced before the age of 10 years. The authors hypothesized that oblique relatives, belonging to the formal register and predominantly employed in written language, require explicit instruction within educational settings to be mastered.

A similar methodology (elicited production) has been adopted by a number of subsequent studies that have broadened the scope of inquiry by collecting data from older typically developing age groups, ranging from middle school age (11 years) to adulthood (22 years) (an overview of these investigations, based on the task developed by Piccoli 2018, is offered by Volpato 2022). The rate of target oblique relatives produced by the various groups increased with age: 32% for middle school students (11-14 years), just over 40% for high school students (15-20 years), and 60% for adults ranging in age from 20 to 22 years. While accuracy in the production of target sentences showed improvement with increasing age, performance never reached 100%.

The body of research conducted so far on production has identified various avoidance strategies, including non-target grammatical structures, constructions typical of colloquial or non-standard registers, and ungrammatical constructions. For instance, among non-target grammatical relatives, participants produced sentences in which the oblique (dative) relative (8a) was replaced by a subject relative containing a verb different from the target one (8b) or a passive verb (8c) and sentences in which genitive relatives (9a) were replaced by a grammatical construction containing two subject relatives one embedded into the other (9b). Relative clauses typical of informal, colloquial registers included dative relatives (8d), genitive relatives (9c) and locative relatives (10b) introduced by the complementizer *che* 'that'. In dative relatives, a resumptive pronoun may also be added (8d). *That*-relatives and resumptive relatives are very frequent in corpora of spoken colloquial Italian (cf. Guasti & Cardinaletti 2003 for an overview).

(8) a. Tocca il maiale a cui il coniglio dà l'uovo di Pasqua.
'Touch the pig to which the rabbit gives the Easter egg.'
b. Tocca il maiale che ha ricevuto l'uovo di Pasqua dal coniglio.
'Touch the pig who has received the Easter egg from the rabbit.'
c. Tocca il maiale a cui viene dato l'uovo di Pasqua.
'Touch the pig to whom the Easter egg was given.'
d. Tocca il maiale che il coniglio gli dà l'uovo di Pasqua.
'Touch the pig that the rabbit gives him the Easter egg.'

(9) a. Tocca il papà il cui figlio gioca a calcio.
'Touch the dad whose son plays football.'
b. Tocca il papà che ha il figlio che gioca a calcio
'Touch the dad who has the son who plays football.'
c. Tocca il papà che il figlio gioca a calcio.
'Touch the dad that the child plays football.'

(10) a. Tocca lo scatolone in cui entra il lupetto.
'Touch the big box which the wolf cub enters.'
b. Tocca lo scatolone che c'è dentro il lupetto.
'Touch the big box that there is inside the wolf cub.'

Locative relatives displayed the highest rate of production (51%) vs. dative (33%) and genitive relatives (35%). The lower level of accuracy observed in the production of dative relatives compared to locative relatives might be due to the higher number of arguments that require theta role assignment in the former structure, as opposed to the latter (three vs. two, respectively) and the fact that locatives offer fewer alternative constructions; for instance, they cannot be substituted by passive relatives.

In addition to production, the use of dative and genitive relatives in Italian was further explored using a repetition task (cf. Volpato 2022 for an overview of the studies that used this task).[2] The analysis carried out across different age groups, ranging from primary school children (6;5 years) to adult participants (36 years), has revealed a higher degree of accuracy compared to elicited production. However, although overall accuracy rates increased with age, similarly to what is observed in production, the level of performance consistently remained below 90%.

While in production, dative and genitive relatives showed comparable frequencies, in repetition, genitive relatives were more accurate than dative relatives (80% and 40%, respectively). These results might be due to the explicit presentation of the target structure, which somehow constrains participants' responses. Conversely, in production tasks, alternative, less demanding strategies are available to the participants (e.g., (9b,c)).

Volpato (2022) concludes by claiming that the degree of difficulty in the repetition and production of pied-piping relatives has to be measured in terms of syntactic complexity, namely, the number of movements involved in the derivation due to the presence of relative pronouns, combined with the number of arguments that are assigned thematic roles. The availability of more alternative structures for dative and genitive relatives than for locative relatives also appears to be relevant.

2.3 Research questions

The findings observed in previous studies have been influential in shaping the present research, which aims to fill some gaps in the literature on oblique relatives. On the one hand, both comprehension and production are assessed; comprehension provides a picture of the underlying grammatical knowledge of structures that are not yet produced. On the other hand, both the comprehension task and the elicited production task of oblique relatives manipulate number features.

As mentioned in the previous sections, all studies carried out so far on Italian have only assessed production or repetition of oblique relatives. Since data on comprehension are not available for Italian, our first research question is: Does comprehension of oblique relatives precede production, as in the case of *that*-relatives? If so, what is the comprehension rate of oblique relatives at the age at which

[2] The repetition task also included prepositional genitive relatives. These structures are not presented here because they do not appear in the test developed for this study.

these structures are not yet consistently produced, and does comprehension increase with age, similarly to production? We expect that children comprehend oblique relatives at an earlier age than that at which they produce them, and that, given the complexity of these structures, comprehension accuracy increases with age.

Previous studies observed that the production of oblique relatives increases with age but did not discuss the role that educational level has in the production or comprehension of these structures. Hence, our second research question is: Do educational level and familiarity with the formal register influence the production and/or comprehension of oblique relatives? We expect to find such an influence mainly in production, given that participants may resort to the syntactically simpler alternatives that are available to them, as shown in (8)-(10).

Previous studies on the comprehension of object *that*-relatives showed that dissimilar number features in the two DPs contribute to improved performance, particularly in children. This configuration helps avoid feature identity and the occurrence of a RM effect. As observed in Section 2.2, Costa et al. (2014, 2015) extended the RM approach to PPs displaying the same number features as the subject DPs. The third question is: Does the use of entities specified with different number features facilitate the comprehension of oblique relatives as it does in the case of object *that*-relatives? If Costa and colleagues are correct that categorial feature identity is not relevant for RM, a facilitation effect of number mismatch should also be visible in oblique relatives. If, however, oblique relatives do not display the structural configuration in which RM effects arise because they involve PPs, no such facilitation effects should be found. It might however also be the case that number manipulation helps one establish who did what to whom independently of RM configurations.

The studies carried out so far on the production of oblique relatives only investigated sentences in which all DPs display singular features. The fourth question is: Does the presence of DPs in the mismatch condition facilitate the production of oblique relatives? Even if oblique relatives were to be analyzed parallel to ORs, as in Costa et al. (2014), (2015), we expect no facilitation effects, given that manipulation of number features does not act as a facilitating cue in the production of targeted object relatives (Contemori & Belletti 2014).

3. The study

3.1. Participants

Five groups of typically developing individuals participated in this study: a group of primary school children (G1), a group of middle school students (G2), a group of high school students (G3), a group of adult university students (G4), and a group of adult workers with a high school diploma (G5). For each group, the number of participants (No.), the age range, and the mean age are reported in Table 1. The participants were recruited from different parts of Italy.

Table 1. Number (No.), age range, and mean age of the participants in each group

Group	*No.*	*Age range*	*Mean age*
G1	25	8-10	9;4
G2	16	13-13;11	13;3
G3	21	14-19	16
G4	25	19-32	21
G5	17	21-32	28

3.2. Materials

We tested the participants' competence in both *that*-relatives and oblique relatives using two tasks, one investigating comprehension and the other assessing elicited production.

3.2.1. The comprehension task

A referent selection task was used to assess comprehension of both *that*-relatives and oblique relatives. Participants were asked to select the correct referent out of four possible choices.

The test consists of 48 experimental sentences and 24 filler sentences. The experimental set includes 6 subject relatives (SR (11)), 6 object relatives (OR (12)), 12 dative relatives (DAT (13)), 12 locative relatives (LOC (14)), and 12 genitive relatives (GEN (15)). SRs and ORs were only presented in the number mismatch condition. DATs, LOCs, and GENs were presented in both the match and the mismatch condition (6 sentences each condition). The heads of DATs, LOCs, and GENs were singular, while the subject DPs were either singular or plural, thus making number marking also visible on the finite verb. In DATs, the objects were always singular. In all stimuli, the relative pronoun was non-agreeing *cui*.

(11) Indica i bambini che rincorrono il cane.
'Show me the children that are chasing the dog.'

(12) Indica il nonno che i topi salutano.
'Show me the granddad that the mice are greeting.'

(13) a. Indica il gatto a cui il topo dona un fiore.
'Show me the cat to whom the mouse is giving a flower.'
b. Indica la foca a cui le bambine fanno la foto
show me the seal to whom the girls are taking the picture
'Show me the seal that the girls are taking a picture of.'

(14) a. Indica il pulcino su cui il bambino sale.
'Show me the chick on which the child is climbing.'
b. Indica il pallone da cui i canguri escono.
'Show me the ball from which the kangaroos are coming out'

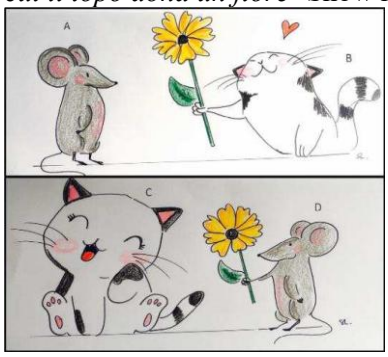
(15) a. Indica l'elefante il cui cucciolo canta.
'Show me the elephant whose cub is singing.'

b. Indica il figlio i cui genitori leggono.
‘Show me the son whose parents are reading.’

The characters in most stimuli were either animals or humans. Six of the locative items included inanimate entities, as in (14b). Reversible actions were depicted in these cases, too. Nouns and verbs were selected based on children’s high-frequency lexicon (Marconi et al. 1994).

The task was administered using a PowerPoint presentation. For each stimulus, participants were shown a slide displaying two pictures that depict an action. In one picture, the roles matched the sentence, while in the other, the roles were reversed. A registered voice read a sentence, and the participant had to point to the correct character or object. Figure 1 provides an example of an experimental trial. The picture matches the sentence in (13).

Figure 1. Example of an experimental trial matching with the dative relative *Indica il gatto a cui il topo dona un fiore* ‘Show me the cat to whom the mouse is giving a flower’



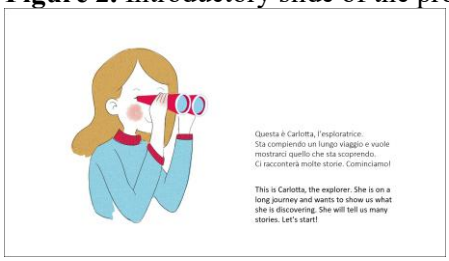
Source: Piccoli (2024)

3.2.2. The production task

To assess production, an elicitation task was used in which the experimenter introduced the characters, described a picture, and asked a question that forced the participant to answer by producing a relative clause. As in the comprehension task, the production task includes 48 experimental trials and 24 filler sentences. The conditions are the same as in the comprehension task. The experimental set includes 6 subject relatives, 6 object relatives, 12 dative relatives), 12 locative relatives, and 12 genitive relatives. SRs and ORs were only presented in the number mismatch condition. DATs, LOCs, and GENs were presented in both the match and the mismatch condition (6 trials each condition).

The test starts with a slide that introduces Carlotta the Explorer (Figure 2), who is travelling and is discovering many things through her binoculars. All stimuli were presented using a set of three slides (Figure 3). In the first slide, a recorded voice introduces the characters and the objects involved in the scene (16a); the second slide shows the characters that Carlotta observes with her binoculars and at the same time, the recorded voice asks the participant what Carlotta is looking at (16b); the third slide was inserted to prevent the participant from responding by pointing to the binoculars shown in the second slide.

Figure 2. Introductory slide of the production task

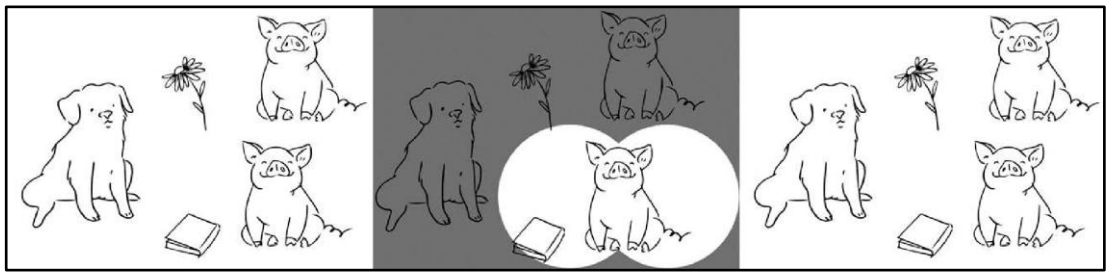


Source: Piccoli (2024)

(16) a. In questa storia ci sono due maiali e un cane. (Slide 1)
'In this story, there are two pigs and a dog.'
b. Il cane regala un fiore ad un maiale e un libro all'altro maiale.
Quale maiale vede Carlotta col binocolo? (Slide 2)
'The dog gives a flower to one pig and a book to the other pig.
Which pig is Carlotta observing with her binoculars?'
c. Quello a cui il cane regala un/il libro. (Target answer)
'The one to whom the dog gives a/the book.'

Figure 3. Example of an experimental trial eliciting a dative relative clause

Slide 1 Slide 2 Slide 3



Source: Piccoli (2024)

3.2.3. Response coding in the production task

Answers which contained the target relative clauses were coded as correct. For the scope of this paper, other answering strategies were not taken into account.

3.2.4. Procedure

Children, middle and high school students were tested individually in a quiet room at their school. Adults were also tested individually. Participants' responses were audio-recorded and transcribed. Transcriptions were checked by two different persons, one of the authors and a MA student at the University of Venice.

4. Results

Generalised linear mixed-effect (GLME) models were used to carry out between-group and within-group analyses in both the comprehension and the production tasks. Statistical analyses were carried out using the statistical software R (R Development Core Team, 2024, R Version 4.4.1). The analysis of the findings will be presented separately for each of the two tasks administered.

4.1 Results of the comprehension task

Table 2 shows the proportion of correct responses provided by each group in the comprehension task.

Table 2. Proportion of correct responses and standard deviation for each group in each sentence type

	SR		**OR**		**DAT**		**LOC**		**GEN**		
Group (mean age)	***Prop.***	***SD***	***Prop.***	***SD***	***Prop.***	***SD***	***Prop.***	***SD***	***Prop.***	***SD***	***Mean***
G1 (9;4)	0.95	0.12	0.70	0.30	0.60	0.36	0.68	0.35	0.59	0.37	0.67
G2 (13;3)	0.98	0.06	0.91	0.14	0.82	0.16	0.91	0.12	0.85	0.17	0.88
G3 (16)	0.99	0.04	0.97	0.11	0.96	0.05	0.97	0.04	0.96	0.05	0.97
G4 (21)	0.99	0.05	0.95	0.09	0.89	0.11	0.95	0.07	0.96	0.05	0.94
G5 (28)	1.00	0.00	0.93	0.12	0.92	0.08	0.93	0.10	0.96	0.04	0.94
Mean	0.98		0.88		0.83		0.88		0.85		

Comparing the different groups, the least accurate performance was observed in G1. While middle school participants showed improved accuracy, it did not reach 90%. Adult-like performance was observed in G3. G3, G4, and G5 indeed had comparable levels of accuracy. SRs consistently presented the highest levels of accuracy and approached ceiling effects across all groups. The typical asymmetry was observed between SRs and ORs. Among oblique relatives, dative relatives were the sentences with the lowest accuracy percentage, followed by genitives.[3]

In the statistical analysis, Sentence Type and Group were considered as independent fixed factors, Response Accuracy (Correct vs. Incorrect) was the dependent variable, and Subject and Items were added as random factors intercepts.

Likelihood ratio tests for nested models proved that the optimal fixed effects structure includes Sentence Type, Group, and their interaction (Table 3).

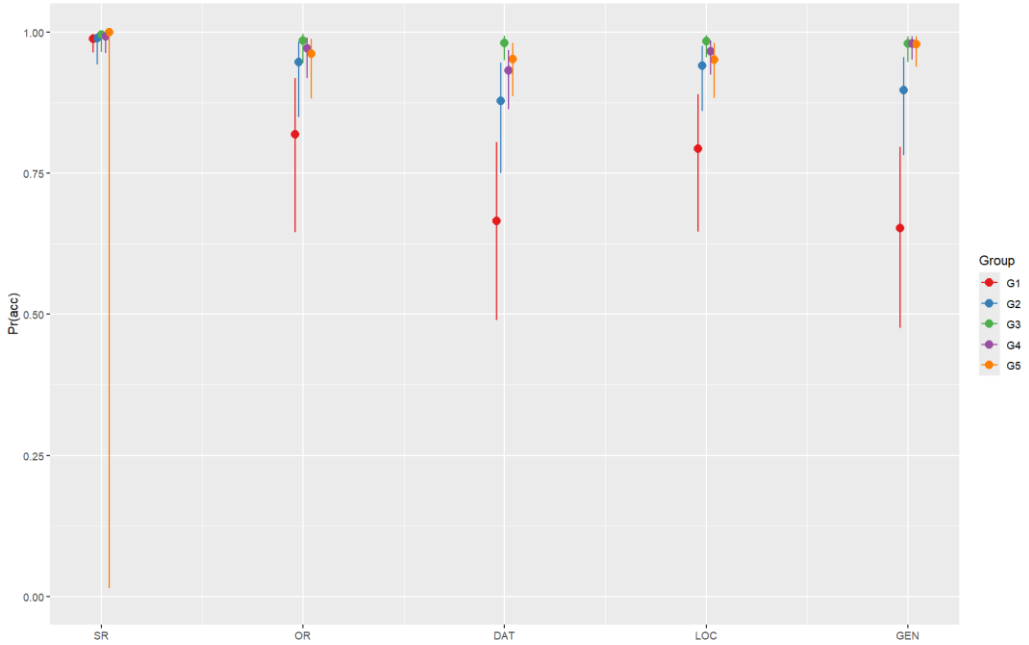
[3] An anonymous reviewer suggested that the fact that LOCs are comprehended better than DATs and GENs might be due to the presence of inanimate entities in the stimuli, resulting in non-reversible situations. Animacy does not appear to be a relevant factor. First, as we said in section 3.2.1, reversible actions were also depicted in these cases. Second, accuracy was exactly the same in items containing animate and inanimate entities (in both cases, the mean was 88%). Third, the difference among the three types of relatives did not turn out to be statistically significant in any group; see the text below.

Table 3. Comparisons of GLMM models in the comprehension task. Legenda: NPAR: number of model parameters; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; CHISQ: the difference in deviance obtained by adding the predictor(s) in the first column; p-values are derived from likelihood ratio test comparisons.

	NPAR	*AIC*	*BIC*	*CHISQ*	*P*
Group + Sentence Type	11	2610.3	2681.9	—	—
Group * Sentence Type	**27**	**2614.1**	**2790.0**	**28.219**	**0.03**

The effect of the interaction between Group and Sentence Type is shown in Figure 4.

Figure 4. Probability of comprehension accuracy for each group across the different sentence types



Tukey-corrected pairwise comparisons showed that G1 differs significantly from the other groups across all sentence types. For ORs, we found a significant difference between G1 and G3 ($p = .038$), for DATs between G1 and G3 ($p < .001$), G4 ($p = .007$), and G5 ($p = .004$), for LOCs between G1 and G3 ($p < .001$) and G4 ($p = .012$), and for GENs between G1 and G3 ($p < .001$), G4 ($p < .001$), and G5 ($p < .001$).

We also found a significant difference within G1 between SRs and all the other sentence types (all ps < .001). All the other post-hoc comparisons were not significant.

4.1.1. Number match vs. Number mismatch in the comprehension task

For this analysis, we exclusively focused on sentence types that were presented in both the match and the mismatch conditions (DATs, LOCs, and GENs).

Table 4 displays the proportions of correct responses differentiating between the match and mismatch conditions for the three sentence types in each group.

Table 4. Proportion of correct responses for match (M) and mismatch (MM) conditions for each group in each sentence type

	DAT		***LOC***		***GEN***		***TOTAL MEAN***	
Group (mean age)	***M***	***MM***	***M***	***MM***	***M***	***MM***	***M***	***MM***
G1 (9;4)	0.52	0.67	0.69	0.67	0.62	0.56	**0.61**	**0.64**
G2 (13;3)	0.79	0.84	0.90	0.92	0.85	0.83	**0.85**	**0.86**
G3 (16)	0.94	0.98	0.97	0.98	0.97	0.95	**0.96**	**0.97**
G4 (21)	0.85	0.93	0.97	0.92	0.97	0.96	**0.93**	**0.94**
G5 (28)	0.85	0.98	0.98	0.87	0.97	0.95	**0.93**	**0.93**
Mean	**0.78**	**0.87**	**0.89**	**0.86**	**0.87**	**0.84**	**0.85**	**0.86**

In DAT relatives, all groups showed higher percentages of accuracy in the mismatch condition. Conversely, in LOC and GEN relatives, percentages are slightly higher in the match condition for almost all groups (the only exceptions are G2 and G3, which displayed higher percentages in the mismatch condition in LOC relatives).

In this analysis, Sentence Type and Match/Mismatch Condition were considered as independent fixed factors, Response Accuracy (Correct vs. Incorrect) was the dependent variable, and Subject and Items were added as random factors intercepts. The analysis showed that for DAT, LOC, and GEN relatives, the match condition is not significantly different from the mismatch condition (for DAT relatives, the difference between the match and mismatch conditions is marginally significant ($p = .07$)).

4.1.2. Individual performance

In addition to group analyses, an individual performance analysis using the binomial distribution was carried out, in which we counted the number and percentage of participants who were above chance in each group and each sentence type (Table 5). The probability of selecting the correct referent in each stimulus was 25%. In SRs and ORs, each containing 6 sentences, participants were considered above chance when they answered at least 4 correct stimuli for each sentence type ($p = .03$). In DATs, LOCs, and GENs, each containing 12 sentences, participants were considered above chance when they answered at least 7 correct stimuli for each sentence type ($p = .01$).

Table 5. Number (No.) and proportion (Prop.) of above-chance participants in each group and each sentence type.

	SR		OR		DAT		LOC		GEN	
Group = No. part.	***No.***	***Prop.***	***No.***	***Prop.***	***No.***	***Prop.***	***No.***	***Prop.***	***No.***	***Prop.***
G1 = 25	24	0.96	17	0.68	16	0.64	17	0.68	17	0.68
G2 = 16	16	1.00	16	1.00	15	0.94	16	1.00	15	0.94
G3 = 21	21	1.00	20	0.95	21	1.00	21	1.00	21	1.00
G4 = 25	25	1.00	25	1.00	24	0.96	25	1.00	25	1.00
G5 = 17	17	1.00	17	1.00	17	1.00	17	1.00	17	1.00

In G1, almost all participants performed above chance in SRs, while a lower, but still high number of children performed above chance in ORs, DATs, LOCs, and GENs. Starting from middle school, almost all participants performed above chance in all sentence types.

4.2 Results of the production task

Table 6 shows the proportion of target sentences produced by each group in the elicited production task.

Table 6. Proportion (Prop) of target sentences and standard deviation (SD) for each group in the production of each sentence type

	SR		OR		DAT		LOC		GEN		
Group (mean age)	***Prop.***	***SD***	***Prop.***	***SD***	***Prop.***	***SD***	***Prop.***	***SD***	***Prop.***	***SD***	***Mean***
G1 (9;4)	0.95	0.12	0.15	0.18	0.11	0.23	0.12	0.23	0.01	0.04	0.20
G2 (13;3)	1.00	0	0.03	0.07	0.49	0.28	0.17	0.13	0.14	0.26	0.33
G3 (16)	0.99	0.04	0.08	0.15	0.56	0.31	0.41	0.26	0.40	0.36	0.48
G4 (21)	0.99	0.03	0.20	0.28	0.62	0.30	0.71	0.33	0.55	0.40	0.62
G5 (28)	1.00	0	0.09	0.21	0.23	0.23	0.25	0.29	0.12	0.22	0.28
Mean	0.98		0.12		0.40		0.35		0.26		

The findings indicate a correct production of SRs across all groups. As expected, the production rate of ORs is lower compared to SRs. Regarding oblique relatives, their occurrence rate is very low in primary school children. This rate shows a gradual increase in middle school, reaching higher percentages in high school (G3) and university (G4) students. In G5, the percentage decreases significantly, reaching levels similar to those of G1 (in DATs) or G2 (in LOCs and GENs).

In the statistical analysis, Sentence Type and Group were considered as independent fixed factors, Response Accuracy (Correct vs. Incorrect) was the dependent variable, and Subject and Items were added as random factors intercepts.

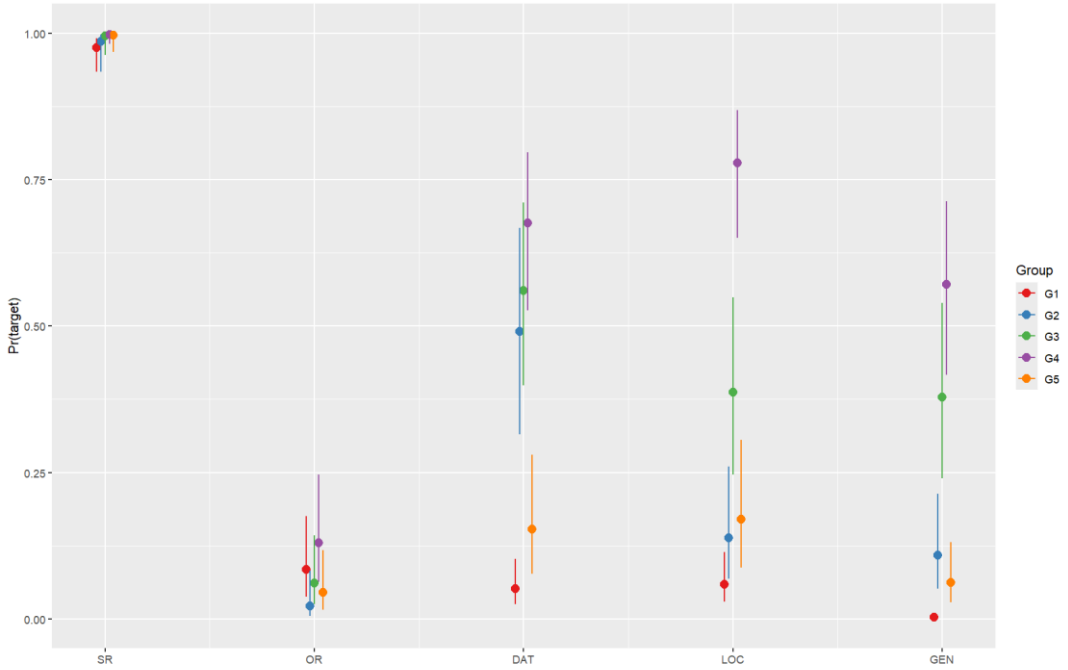
Likelihood ratio tests for nested models proved that the optimal fixed effects structure includes Sentence Type, Group, and their interaction (Table 7).

Table 7. Comparisons of GLMM models in the production task. Legenda: NPAR: number of model parameters; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; CHISQ: the difference in deviance obtained by adding the predictor(s) in the first column; p-values are derived from likelihood ratio test comparisons.

	NPAR	AIC	BIC	CHISQ	P
Group + Sentence Type	11	4039.7	4111.3	—	—
Group * Sentence Type	**27**	**3891.6**	**4067.6**	**180.02**	**<.001**

The effect of the interaction between Group and Sentence Type is shown in Figure 5.

Figure 5. Probability of target sentences produced by each group across the different sentence types



Tukey-corrected pairwise comparisons showed that for each sentence type, no significant differences were observed among the five groups in SRs and ORs. For DATs, G1 performed significantly lower than G2, G3, and G4. G5 performed significantly lower than G3 and G4. For LOCs, G1 performed significantly lower than G3 and G4; G2 and G3 performed lower than G4; G4 performed significantly better than G5. For GENs, G1 performed lower than G2, G3, G4, and G5. G2 performed lower than G4; G3 and G4 performed better than G5. All ps < .05. Post-hoc pairwise comparisons also showed that in G1, SRs are produced at significantly higher rates than ORs, DATs, LOCs, and GENs. GENs are produced at significantly lower rates than ORs, DATs, and LOCs. In G2, SRs are produced at significantly higher rates than ORs, DATs, LOCs, and GENs. ORs are produced at significantly lower rates than DATs. DATs are produced at significantly higher rates than LOCs and GENs. In G3

and G4, SRs are produced at significantly higher rates than ORs, DATs, LOCs, and GENs. ORs are produced at significantly lower rates than DATs, LOCs, and GENs. In G5, SRs are produced at significantly higher rates than ORs, DATs, LOCs, and GENs. All ps < .05. All the other pair comparisons were not significant.

4.2.1. Number match vs. Number mismatch in the production task

As in comprehension, the production analysis was limited to sentence types that included both the match and the mismatch conditions (DATs, LOCs, and GENs).

Table 8 displays the proportions of correct responses, differentiating between the match and mismatch conditions for each sentence type in each group.

Table 8. Proportion of correct responses for match (M) and mismatch (MM) conditions for each group in each sentence type

	DAT		**LOC**		**GEN**		**TOTAL MEAN**	
Group (mean age)	***M***	***MM***	***M***	***MM***	***M***	***MM***	***M***	***MM***
G1 (9;4)	011	0.11	0.11	0.12	0.01	0.01	**0.08**	**0.08**
G2 (13;3)	0.50	0.48	0.17	0.18	0.16	0.13	**0.27**	**0.26**
G3 (16)	0.55	0.56	0.37	0.44	0.34	0.46	**0.42**	**0.49**
G4 (21)	0.63	0.61	0.70	0.72	0.51	0.59	**0.61**	**0.64**
G5 (28)	0.22	0.25	0.25	0.24	0.09	0.15	**0.19**	**0.21**
Mean	**0.40**	**0.40**	**0.34**	**0.36**	**0.23**	**0.28**	**0.31**	**0.34**

With few exceptions, mismatch number conditions consistently show slightly higher percentages than match conditions. However, when performing a statistical analysis with Match/Mismatch Condition as an independent fixed factor, Response Accuracy (Correct vs. Incorrect) as the dependent variable, and Subject and Items as random factors intercepts, we observed no significant differences between the match and the mismatch conditions (p = .443).

5. Discussion

This study investigated oblique relative clauses in Italian compared with SRs and ORs introduced by *that*, through comprehension and production tasks administered to different groups of typically developing individuals. Early studies on the acquisition of relative clauses showed that oblique relatives are not produced before age 10 (Guasti & Cardinaletti 2003). Subsequent research showed that elicited production and repetition of these constructions increase at older ages, but more slowly than relative clauses introduced by the complementizer *che* 'that', which suggests a later and more protracted developmental pathway for the former. No previous study focused on the assessment of comprehension skills.

The first research question aimed to investigate the comprehension rate of oblique relatives at ages where their production is not yet consistent. Specifically, we

investigated whether comprehension abilities are in place before production and whether they increase with age, mirroring the developmental trajectory observed in production. In G1, the comprehension rate of oblique relative clauses (mean 63%) significantly exceeded their production rate (mean 8%). The group of primary school children demonstrated quite high comprehension rates, namely 60% of DATs, 68% of LOCs, and 59% of GENs. The majority of the children responded above chance. We conclude that children have knowledge of oblique relatives well before they produce them. Comprehension proficiency increases with age, reaching near-adult levels by middle school, and stabilizing at adult levels by high school. This result suggests that there is no direct link between exposure to the formal register and comprehension. Being allowed by UG, oblique relatives are comprehended at sufficiently high rates since primary school age. Their syntactic complexity, which also imposes heavy computational loads, explains why accuracy rates are not yet at ceiling at primary school age.

While the rate of accuracy in comprehension increases relatively rapidly across the different age groups, the percentage of target oblique relatives produced is notably lower for all groups, indicating a slower increase with age and familiarity with these structures. The rate of target oblique relative clauses is well below 80% for all groups, confirming previous findings (cf. Volpato 2022). In production, participants avoided pied-piping relatives and used the syntactically simpler alternative strategies at their disposal (even if not all of them belong to the standard variety). In the groups of primary and middle school students, DATs were significantly more frequent than GENs. The difficulty with GENs may be explained in syntactic terms as due to the higher number of movements involved in their derivation compared to DATs. They were substituted by simpler colloquial alternative strategies avoiding pied-piping (e.g., (9b,c)).[4] From high school onwards, there are no longer differences in the production of the three types of oblique relatives.

In our study, two groups of adult participants were included (university students, G4, and adult workers with a high school diploma, G5) and compared to students attending different school levels. High rates of comprehension accuracy were observed in both adult groups, a non-surprising result given that comprehension is in place by middle school age. Conversely, production outcomes revealed a significant difference between the two groups, with G4 demonstrating a higher percentage of target sentences than G5 in all three types of oblique relatives. For all but genitive relatives, G5 showed performance levels comparable to those of primary school children (G1). Although the adults in G5 have a high school diploma, they notably differed from high school students (G3). These unexpected results suggest that the productive use of oblique relative clauses is not primarily determined by age or educational level, but appears to be influenced by individuals' experience and practice with formal registers. The participants in G5, who may be less exposed to the formal register than both G3 and G4, produced fewer target sentences, preferring the use of other grammatical and appropriate constructions. High school students and university students are instead constantly exposed to formal registers during classes and lectures, and through the academic texts and materials they use. This extensive exposure may not be experienced by adults after leaving high school. Since we did not collect

[4] For reasons of space, this paper does not present all the answering strategies adopted by our participants. Cf. Section 3.2.3.

information about participants' reading habits and frequency of exposure to literacy, this interpretation of the results needs to be substantiated by further studies.

Our third research question concerned the role of number features in the comprehension of oblique relatives. Existing research on the acquisition of object *that*-relatives demonstrated that number features are crucial for the correct interpretation of these constructions. When the two DPs display different number specifications, the children's rate of accuracy increases (Adani 2011; Volpato 2010, 2019), and a similar improvement is also observed in adolescent students (Volpato 2010, 2019). This aspect remained unexplored in previous studies investigating the comprehension of oblique relatives, as stimuli for these structures only contained DPs with match (singular) number features (cf. Costa et al. 2014, 2015). In our study, oblique relatives were designed to include both match and mismatch conditions to investigate whether a mismatch in number specification on the DPs modulates sentence comprehension. Our findings demonstrate that Number does not appear to be a relevant feature for the interpretation of oblique relative constructions, unlike the results previously observed for object *that*-relatives. We suggest that the facilitation effect of number mismatch cannot be at play in oblique relatives because they do not instantiate a RM configuration (*pace* Costa et al. 2014, 2015). Note that while LOCs and GENs did not show any Number effects, a more marked difference between match (78%) and mismatch (87%) conditions was observed for DATs, which yielded a marginally significant effect. Interestingly, the number mismatch has a facilitation effect on the comprehension of those sentences with the highest number of arguments. Thus, number manipulation on the subject DP (and the finite verb) appears to have helped participants establish who did what to whom independently of RM configurations.

The fourth research question extends the preceding inquiry by exploring the effect of mismatch number features on production. This phenomenon was not investigated in previous studies on oblique relatives, which only assessed production skills using stimuli featuring match (singular) conditions. No differences between match and mismatch conditions were observed in production for any type of oblique relatives, similarly to what happens with *that*-relatives (Contemori & Belletti 2014). In production, participants avoid intervention (in ORs) and syntactic complexity (in oblique relatives) by resorting to different answering strategies.

6. Conclusions and future directions

This cross-sectional study investigated both comprehension and production of oblique relatives compared to *that*-relatives in different age groups ranging from primary school age to adulthood. It allowed us to get new insights into the trajectory of oblique relatives acquisition and to better understand the role of education and practice with formal registers.

The analysis revealed that although pied-piping relatives are rarely produced by primary school children, they are nonetheless comprehended at high percentages. Adult-like comprehension is observed at middle school age and does not appear to directly depend on experience with formal registers and written language. As a UG-based possibility, oblique relatives are understood as soon as the computational resources required for their processing become available.

Production skills instead increase with exposure to formal registers and written language (cf. Guasti & Cardinaletti's 2003 conjecture) and are influenced by the individuals' experience with formal registers. Adults with a high school diploma produce oblique relatives at rates comparable to those of primary school children and middle school students, and significantly differ from high school (in DATs and GENs) and university students (in DATs, LOCs, and GENs). This unexpected result should be corroborated by more information about adult participants' reading habits and frequency of exposure to literacy, an issue we aim to address in future research.

Finally, number mismatch does not have an effect on the comprehension of oblique relatives, differently from what was found for ORs, suggesting that categorial similarity does matter in the computation of intervention for RM, and no such configuration is found in oblique relatives.

A difference emerged among the different sentence types, especially in the productions by G1 and G2: DATs are produced in significantly higher numbers than GENs. This phenomenon is attributed to the higher number of movements involved in the derivation of GENs as opposed to DATs and to the possibility of using simpler grammatical alternative strategies when GENs are elicited. To better grasp the differences among the different types of oblique relatives, it is necessary to investigate other differences among them in both comprehension and production (also within each group), to analyse the errors made by the different groups in comprehension, and to analyse the answering strategies used by the different groups in production. This is left for future work.

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