Processing grammatical features by Italian children

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1. Introduction

In this study we concentrate on the way preschool and school aged Italian speaking children process subject and object relative clauses that are disambiguated through different grammatical devices. Studies on adult processing have established that subject relatives are easier to comprehend than object relatives in a variety of languages regardless of whether they are temporally ambiguous or not (e.g., Frauenfelder, Segui & Mehler, 1980, for French; King & Kutas, 1995, for English, Schriefers, Friederici & Kuehn, 1995 for Dutch). Studies on the acquisition of relative clauses have concentrated on the availability of the mechanisms underlying the formation of relatives. Some studies have shown that children have a hard time comprehending relative clauses (e.g., Tavakolian, 1982) and on this basis have concluded that children do not build relative clauses as adults do; other studies have shown that children's difficulties with relative clauses can be alleviated if the presuppositions for their use are satisfied (e.g., Hamburger & Crain, 1982; Crain, Mckee, Emiliani, 1990). Less investigated is the question of how children exploit different grammatical devices towards understanding relative clauses. In this respect, Italian relative clauses (henceforth, RCs) are particularly interesting since in Italian we find two kinds of object RCs in which different grammatical devices cue the "object meaning". In this paper, we examine how children use these cues during development and how different processing models deal with our data.

2. Italian RCs

Italian relative RCs, as in (1), can be ambiguous between an object and a subject reading. Sentence (1) can be interpreted as a subject RC or as an object RC with the embedded subject in the postverbal position.

(1) Il ragazzo che guarda il pagliaccio
The boy that watch^{3Sing} the clown

Subject reading: The boy who is watching the clown
Object reading: The boy who the clown is watching

In addition, Italian speakers can convey an object reading by the use of an unambiguous RC with the embedded subject in the preverbal position as shown by the example below:

(2) Il ragazzo che il pagliaccio guarda
The boy that the clown watch^{3Sing}

It is the preverbal position of the embedded-NP that makes (2) an object RC. When possible, in cases in which the head of the RC (henceforth head-NP) and the embedded-NP do not share the same number features, Italian speakers can convey an object reading by the use of an unambiguous RC with the embedded subject in the postverbal position that agrees with the embedded verb, as shown in the sentence in (3):

(3) Il ragazzo che guardano i pagliacci
The boy that watch^{3Pl} the clowns
"The boy who the clowns are watching"

As we can see from (2) and (3), object relative clauses can be unambiguously conveyed by making use of (1) a structural strategy, i.e., the position of the embedded subject, (2) a morphological strategy, i.e., number agreement between the embedded verb and the post verbal NP subject (with the head-NP displaying different agreement features). In our study we want to test the strength and the reliability of the morphological cue and the structural cue in children' processing of relative clauses.

3. Our Study

In our study we tested 92 Italian monolingual children divided into four age groups as represented in the table below

31 children,	Mean Age 5;3
35 children,	Mean Age 7;3
13 children,	Mean Age 9;1
13 adolescents,	Mean Age11;3
24 undergraduate students	

The children were recruited form kindergarten and schools in Milano, Modena and Como (Italy), adults were students at the Università degli Studi di Milano-Bicocca.

Before starting the experiments children were familiarized with a puppet. They were told that the puppet was learning Italian and that it needed their help to improve its Italian. The experiments were introduced by the puppet in a game setting and were run in a quiet room in the children' schools. Children were tested in two sessions on different days. Adults were tested with the same procedure used for children, except for the puppet mediation that was omitted in this case.

During our study we administrated: (1) a Grammaticality Judgement Test to investigate whether the participants were sensitive to agreement violations between the inflected verb and its subject, (2) a Picture Selection Task, testing children's comprehension of relative clauses, (3) two Memory Tests, in order to search for possible effects of memory resources limitations in RC processing.

3.1. The grammaticality Judgement Test

In the GJT (McDaniel & Cairns, 1996) participants were asked to listen to a series of sentences pre-recorded on a computer and delivered through loudspeakers. The test was not administrated to 11-year-olds. Children were told that the sentences had been recorded by the puppet and that they had to say whether what the puppet said was correct or not. When the puppet was wrong, children were asked to correct him. We presented 18 sentences, 9 of them with singular subjects and 9 with plural subjects. Eight of the 18 sentences were grammatical and 10 were ungrammatical because of number agreement violations. Sentences were presented in a pseudo-random order. An example of tested sentences is given below:

Subject-verb agreement mismatch

(4) * I cuochi cuoce la pasta
the cooks make^{3Sing} the pasta
Lit: The cooks is making pasta

Subject-verb agreement match

(5) I bambini mangiano la mela
The children eat^{Pl} the apple
Lit: The children are eating the apple

3.2. Picture Selection Task

In this experiment we wanted to test children's processing of relative clauses. The structures we tested were the following:

- 18 unambiguous **subject** relatives (SUBJ) as below

(6) Fammi vedere il cane che rincorre i cavalli
Let-me see the dog that chease^{3Sing} the horses
Lit: Show me the dog that is chasing the horses

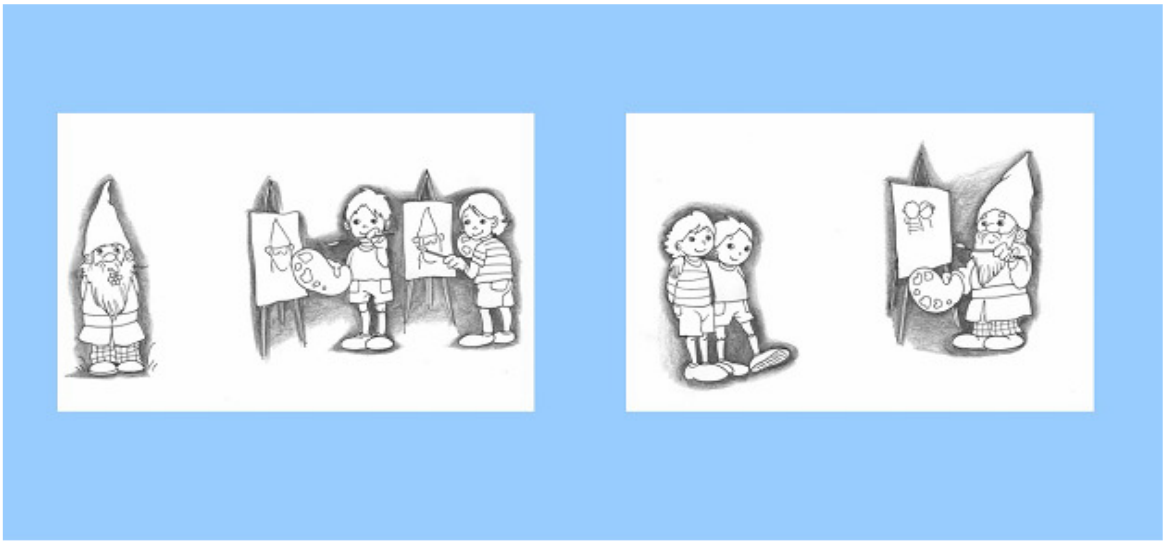
- 18 unambiguous **number marked object** relatives (Onum) as below

(7) Fammi vedere il cane che rincorrono i cavalli
Let-me see the dog that chease^{3Pl} the horses
Lit: Show me the dog that the horses are chasing

- 18 unambiguous **position marked object** relatives (Opos) as below

(8) Fammi vedere il cane che il cavallo rincorre
Let-me see the dog that the horse chease^{3Sing}
Lit: Show me the dog that the horse is chasing

The tested sentences were obtained by taking 18 lexical verbs controlled for length and familiarity. From each of these verbs we build three types of RCs: Subject RC (SUBJ), Object RCs disambiguated through number agreement on the embedded verb (Onum) and object RCs disambiguated through the position of the embedded subject (Opos). Then, we created three lists including 18 RCs, 6 per types, plus 18 fillers. We randomized the order of the items in each list and interspersed each item with a filler sentence. Each sentence in the three lists was then associated with two pictures, one representing a subject reading of the RC and the other one the object reading (see picture1). Subjects were randomly assigned to each list and were tested individually. The experiment was run on a portable computer connected to external loudspeakers in a quiet room in the subjects' schools. During the experimental trials, children heard a sentence through the loudspeakers and immediately afterwards two pictures were presented on the computer screen. They were asked to point out which picture matched the sentence. Before starting the experiment a familiarization session was run until the children had understood the task.



Picture 1: Sample of the stimuli. The above pictures appeared after the participant heard one of the three following sentences (English glossed) *Show me the dwarf that is painting the children* or *Show me the dwarf that the children are painting* or *Show me the dwarf that are painting the children*

3.3. Memory Tests

In order to search for possible effects of memory resource limitations in RC processing we administrated the following memory tests: Ciccarelli's (Ciccarelli, 1998) *Backward Repetition Span Test*, and a *Dual Span Test* (Cornoldi et al. 2003). Ciccarelli's backward repetition span test requires to maintain in memory an ordered sequence of words and to repeat it back in the reverse order. The *Dual Span Test* is aimed at evaluating not only storage resources but also the capability of inhibiting non-relevant information in that children had to repeat back a list of words and clap when they heard the name of an animal.

4. Results

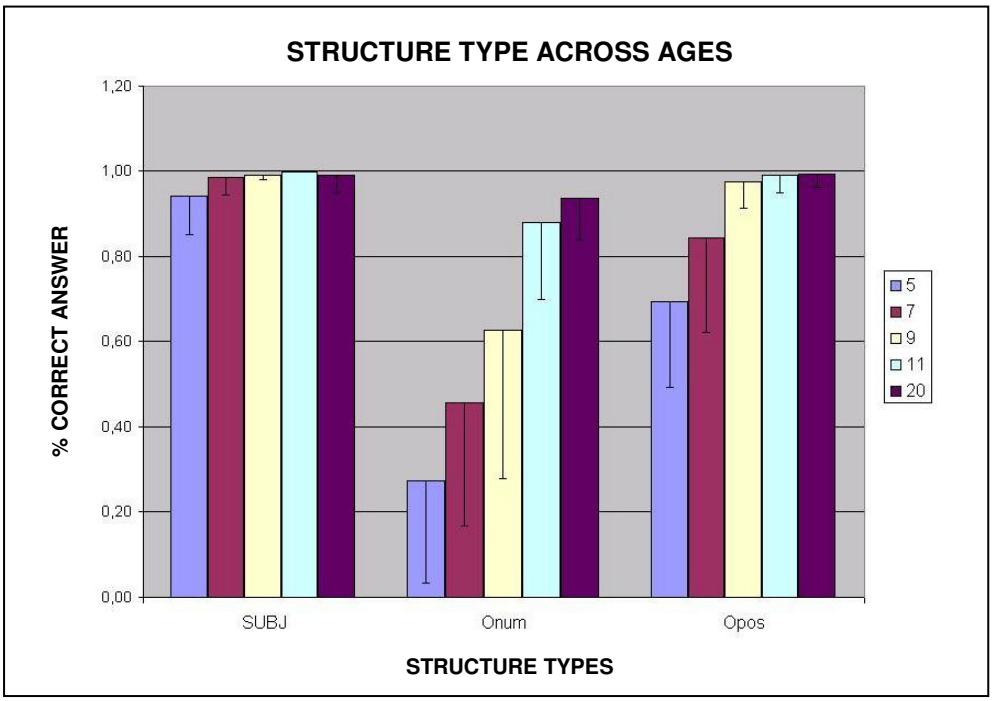
4.1. The Grammaticality Judgement Test

The grammaticality judgement task was administrated in order to investigate how sensitive were the children to number agreement violations; sensitivity to number agreement is relevant for correctly processing object RCs with a postverbal subject, as it is number agreement on the embedded verb in (7) that informs children that they are not processing a subject RC.

The mean overall accuracy rate for GJT in the children groups was .92 (range=.38-1; SD: .13). In more detail, the 5-year-olds' accuracy rate was .81 (range= .38-1; SD .16), the 7-year-olds's was .98 (range= .81-1; SD .04) and the 9-year-olds's was 1. Given the main purpose of GJT, we excluded 17 of 31 5-year-old children (those with less than .85 of correct answers in the grammaticality judgement task). With this adjustment, the new mean overall accuracy rate was .97 (range= .83-1; SD .04), while for the 5-year-old group rate was .94 (range= .86-1; SD .05).

4.2 Picture Selection Task

We run a repeated-measures ANOVA with age as the independent variable and percentages of correct answers as the dependent variable. The results are represented in the histogram below where Onum indicates object RCs with a postverbal subject in which disambiguation is given by number agreement, Opos indicates object RCs with a preverbal subject in which disambiguation is given by the position of the embedded subject and SUBJ indicates subject RCs.



We found an effect of age F(4, 111)=40,861, p<.001, of RC type F(2, 222)=111,82, p<.001 and an interaction between age and clause type F(8, 222)=15,824, p <.001. Post hoc Scheffé tests show that for object RCs with postverbal subjects (Onum) there is a difference between 5-year-olds on the one hand and 9-, 11-year-olds and adults on the other (p>.05). There is also a significant difference between 7-year-olds vs. 11-year-olds and adults (p<.001). For object RCs with a preverbal subject there is a difference between 5-year olds and adults (p<.05).

One can argue that the poor performance on number marked object RCs (Onum) might depend on the insensitivity to number agreement of a small group of children. In order to examine this possibility, we excluded 17 children who did not reach .85 of correct answers on the GJT. A new ANOVA was conducted, but no difference emerged with respect to the previous ANOVA (we still found an effect of age, of clause type and an interaction between the two); in particular post hoc Scheffé test shows that there is still a difference between the 5-year olds and 9-, 11-year olds, adults.

5. Discussion

The fact that in our study subject RCs are easier then object RCs is consistent with the findings of a number of studies on a variety of languages (Frauenfelder, Segui & Mehler, 1980; King & Kutas, 1995; Schriefers, Friederici & Kuehn, 1995) and it conforms to the predictions of a variety of processing theories like the *Dependency Locality Theory* (Gibson 1998, 2000), *Competition Model* (Bates & MacWhinney, 1987) and *Minimal Chain Principle* (De Vincenzi, 1999). However, the increased difficulty with object RCs including a postverbal subject does not conform to the predictions of the *Dependency Locality Theory* and of the *Competition Model*. In fact, according to both the *Competition Model* and the *Dependency Locality Theory* object RCs with a preverbal subject should be more difficult than object RCs with a postverbal subject. Let us see why.

According to the *Competition Model,* subjects base their interpretation on the most valid and reliable cue in their language. According to the model, Italian is a language in which subject-verb agreement is high in cue validity and is stronger than position. Thus, the model predicts that disambiguation carried out by number

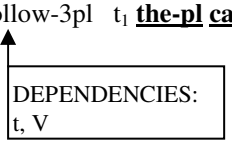
agreement should be easier than disambiguation carried out by position, that is, that object RCs with a postverbal subject should be easier than object RCs with a preverbal subject, but this was not the case.

According to the *Dependency Locality Theory* the least number of elements needed to complete a grammatical sentence at a given stage of processing determines the memory cost of the analysis. Consider the object RC in (9) (we omit irrelevant details). At the word after the subordinator *che* (that), the parser finds an article. To complete the sentence it has to postulate an NP subject, the embedded verb, the trace of the object and the matrix verb, as shown in the box.

(9) La volpe$_1$ [che il gatto$_2$ insegue t$_1$] zoppica
The-sg fox$_1$ [that the cat$_2$ follow-3sg t$_1$]] limp-3sg

Consider now the object RC with a postverbal subject in (10). At the word following the *che* (that), the parser finds a verb. To complete the sentence the least number of elements necessary are the trace of the object and the matrix verb, as Italian is a null subject language, and at the verb the null subject is likely to have been already present (there is no need to postulate a postverbal subject, as a preverbal one is already present and moreover, postverbal subjects are not the rule, but just a possibility).

(10) La volpe$_1$ [Op$_1$ che pro$_2$ inseguono t$_1$ i gatti$_2$] zoppica
The-sg fox$_1$ [Op$_1$ that pro$_2$ follow-3pl t$_1$ the-pl cats$_2$] limp-3sg



Thus, according to the *Dependency Locality Theory* the number of elements needed to complete a RC with a postverbal subject is lower than the number of elements needed to complete an object RCs with a preverbal subject and consequently the former is expected to be easier than the second, contrary to what we found.

Different predictions emerge from the *Minimal Chain Principle*. According to this proposal the parser prefers shorter and monoargumental chains. Compare sentence (2) and (3) repeated below:

(2) Il ragazzo che il pagliaccio guarda — Object reading only: The boy who the clown is watching
The boy that the clown watch^{3Sing}

(3) Il ragazzo che guardano i pagliacci — Object reading only: The boy who the clowns are watching
The boy that watch^{3Pl} the clowns

Consider sentence (2). When the parser sees the complementizer "che" ("that") it postulates a relative clause, it inserts a silent operator to the left of the complementizer and it builds the shortest chain by inserting a trace immediately to the left of the complementizer, that is, in subject position. After that, the parser sees the NP "il pagliaccio" that disconfirms this analysis. It deletes the trace and after it has seen the verb it inserts a trace in object position and builds a new chain, as shown below:

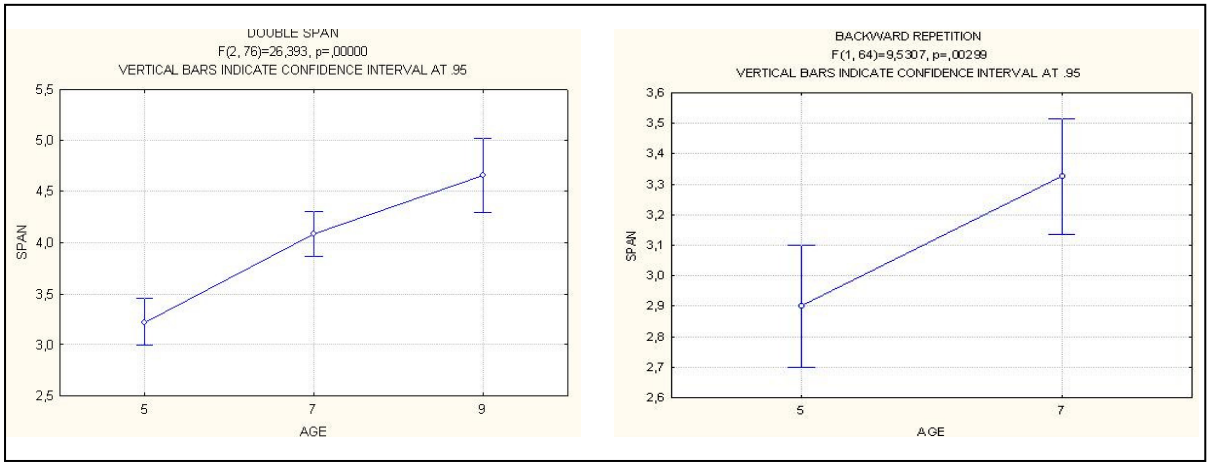
(2a) Il ragazzo$_1$ Op$_1$ che ~~t$_1$~~ il pagliaccio$_2$ guarda t$_1$
The^{Sing} boy$_1$ Op$_1$ that ~~t$_1$~~ the clown$_2$ watch^{3Sing} t$_1$

Now consider sentence (3). After having built the minimal chain as before, the parser sees the verb that calls for a revision of this analysis. It deletes the inserted subject trace and inserts a null pronominal referential entity in the embedded subject position. Notice that according to the MCP monoargumental chains are preferred and the null pronominal element forms a monoargumental chain. Then, the parser inserts the trace in object position after the embedded verb. At this point, it sees the NP "i pagliacci" that must be assumed to be a postverbal subject. Then, it needs to be coindexed with the pronominal element in the embedded subject position, according to standard analysis (Rizzi, 1982).

(3a) Il ragazzo$_1$ Op$_1$ che ~~t$_1$~~ pro$_2$ guardano^{3Pl} t$_1$ i pagliacci$_2$
The^{Sing} boy$_1$ Op$_1$ that ~~t$_1$~~ pro$_2$ watch^{3Pl} t$_1$ the^{Pl} clowns$_2$

If you compare (2a) with (3a), the Minimal Chain Principle will predict (2) to be easier than (3) since in (3a) we find two chains while in (2a) we find one chain. More in general the Minimal Chain Principle will predict object RCs with a preverbal subject to be easier than object RCs with a postverbal subject, as we found.

Thus, our data show that children from age 5 conform to the MCP in parsing sentences. Object relatives are harder than subject relatives, as it was found also in studies on adults. Moreover, the processing of object RCs with a postverbal subject is particularly problematic and a clear developmental trend is observed. Five- and 7-year-olds behave differently than 9-, 11-year-olds and adults. One explanation may be that the processing of object RCs with a postverbal subject is more demanding in terms of memory and computational resources as it involves the construction of two chains. In order to investigate whether the development of working memory could affect the processing of RCs with a postverbal subject, we administrated some memory tests. Though we found a group result (see graph below), as memory abilities develop, we did not find any individual correlation between memory test results and the picture selection task data.



Correlation between scores on the working memory tests and RC comprehension has been found in recent studies (Felser et al. 2003). Contrary to ours, these studies used online measures of sentence comprehension. The use of different methods may be the source of the discrepancy and in ongoing research we are obtaining online measures of RC processing.

In sum, we found that children conform to the MCP from age 5. This results is in line with what De Vincenzi et al. (1999) found in the processing of wh-questions by Italian speaking children. In addition, we found that children find object RCs disambiguated by position easier to process than object RCs disambiguated by number agreement. While this result cannot be handled by the competition model or the dependency locality, it can be explained by the MCP, as the latter type of object RCs is more complex than the former one.

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