

Now You Hear It, Now You Don't: Number Mismatch in the Comprehension of Relative Clauses in French

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1. Introduction

A cross-linguistic observation about the acquisition of relative clauses is that different types emerge at different points in time. Those involving a subject dependency (as in (1a)) are acquired early, whereas those involving an object dependency are acquired later (1b) (see Adani, van der Lely, Forgiarini, & Guasti 2010; Adani 2011; Arnon 2005, 2009; Arosio, Guasti, & Stucchi 2011; Bentea, Durrleman, & Rizzi 2016; Contemori & Belletti, 2014; Corrêa 1995; Costa, Lobo, & Silva 2011; Friedmann & Novogrodsky 2004; Friedmann, Belletti, & Rizzi 2009; Hu, Gavarro, Vernice, & Guasti, 2016; a.o.)

1. a. Show me *the boy* that [___ is washing the cat].
b. Show me *the cat* that [the boy is washing ___].

However, not all object relative clauses (ORC) pose problems (Friedmann et al. 2009; Costa, Grillo, & Lobo 2012). Specifically, children comprehend well structures in which the object dependency is headed by the wh-operator 'who' (2):

2. Show me *who* [the boy is washing ___].

Friedmann et al. (2009) relate the problems children show with 'headed' object dependencies given in (1), as compared to 'free' object dependencies shown in (2), to Relativized Minimality (RM), a syntactic principle capturing the effects of intervention locality (Rizzi 1990, 2004, 2013; Starke 2001). RM states that two elements, X and Y, cannot be connected by movement if Z intervenes between them, and Z is of the same structural type as X. For example, in order to correctly interpret a sentence like (3), the wh-element *when* (corresponding to X) must be related to its trace (Y); but this relation cannot hold because another wh-element *who* (Z) intervenes in the path between *when* and its trace. The

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derives from the different status of this feature in the two languages. While gender in Hebrew is morphologically expressed on the verb and belongs to the set of Phi-features attracting a DP to subject position, the gender feature does not act as an attractor for movement in Italian and as such does not enter in the computation of intervention. Thus, the gist of Belletti et al.'s proposal is that a feature is syntactically 'active' in a given language if it functions as an attractor for movement in that language by belonging to the feature set of the clausal inflectional head (i.e. by being morphologically realized on the verb). From this perspective, the facilitating effect of number in Italian becomes clear, since number, unlike gender, acts as an attractor for movement in this language.

Based on the selective effect of gender in Hebrew and Italian, Belletti et al. (2012) propose to capture the RM effects present in child grammar by adding another relation, *intersection*, to the featural approach to Relativized Minimality as developed in Starke (2001) and Rizzi (2004), along the lines of (5):

5.	Target	Intervener	Trace	Adults	Children
	X	Z	Y		
Identity	A	A	<A>	*	*
Inclusion	A,B	B	<A,B>	ok	*
Intersection	A,C	C,D	<A,C>	ok	ok
Disjunction	A	B	<A>	ok	ok

(adapted from Belletti et al., 2012)

As summarized in (5), the point of difference between the child and the adult system lies in the fact that adults, but not children, are able to process the weaker featural differentiation between the relative head and the intervening subject provided by the inclusion relation. Children perform better with non-inclusion configurations. They are thus able to comprehend dependencies in which the featural specification of the relative head and the intervener are either in a disjunction or in an intersection relation, meaning that the intervener differs from the target in at least one 'relevant' feature. Relevant features are those active in triggering syntactic movement and this is evident if the features are expressed in the inflection of the finite tensed verb.

However the features examined so far, systematically overtly realized on the verbal inflectional head, confound 'relevance' and 'overtness'. Indeed gender in Hebrew and number in Italian are reliably audible, being not only morphologically, but also phonologically, expressed. This leaves open the question of what happens when features can be audible or inaudible, put differently overt or covert. French offers a good testing ground to answer this question, as number agreement between the subject and the verb is morphologically manifested in the inflectional head, like in Italian, but agreement is phonologically irregular, since it can be silent or audible depending on the verb. Despite the difference in spelling between the singular verb in (6a) and the plural verb in (6b), the two forms are homophonous. This is not the case in (7), where there is a difference in pronunciation between the singular and

plural forms of the verb. What determines these phonological properties of verbal number agreement in French is the conjugation class of a given verb, and a verb ending in *-er* such as *laver* (to wash) does not provide a phonological cue, in contrast to a verb ending in *-re* such as *mordre* (to bite).

6. a. Le garçon lave le chat.
 [lav]
 ‘The boy is washing the cat.’
 b. Les garçons lavent le chat.
 [lav]
 ‘The boys are washing the cat.’
7. a. Le chien mord le chat.
 [mɔʁ]
 ‘The dog is biting the cat.’
 b. Les chiens mordent le chat.
 [mɔʁd]
 ‘The dogs are biting the cat.’

Crucially, even if an ORC contains an embedded plural subject, the agreement morphology on the verb will only disambiguate the sentence towards an object reading when number marking is phonologically audible.

A pure feature-based approach along the lines of Friedmann et al. (2009) and Belletti et al. (2012) would predict that the number feature in French would have the same impact on comprehension in instances where it is audible or inaudible, because the different items of the paradigm have the same role with respect to the attracting property, namely that when a feature is an attractor in tensed verbs in a certain paradigm in a certain language, it is an attractor for the whole paradigm, even if it is not overtly manifested in some slots of the paradigm. An overt-inflection-based approach would predict that it is purely the overt phonological manifestation of number mismatch on the tensed verb that would influence the computation of intervention and as such the number feature in French would be less relevant for RM in those instances when it is not overtly realized. Hence, if the focus is on the auditory cue, certain lexical items in French are expected to yield different levels of performance as compared to others. Moreover, given that number agreement on the verb in French is not phonologically realized in a systematic way and thus is a less reliable cue for comprehension, this could lead to cross-linguistic differences as compared to a language where number agreement is more frequent and more reliable (i.e. Italian).

Indeed it has been proposed that cues would have different validity in different languages, depending on their frequency and reliability as a source of information (Bates and MacWhinney 1987; Bates, Devescovi, & D’Amico 1999). Those cues that are highest in reliability and availability would be the

ones that most strongly control comprehension and which are acquired first. As an illustration, subject-verb agreement is low in cue validity in English compared to Italian, so the age at which children would use this cue would differ between these languages. Similarly, French-speaking children could pick up on number later than Italian-speaking children, and thus draw on this cue less when parsing object dependencies.

In this study we capitalize on the properties of number agreement in French to explore whether (i) the phonological realization on the verb helps children in the computation of intervention and (ii) whether the computation of featural mismatches with features that are not systematically realized in the paradigm shows a developmental effect. In other words, do children take longer to capitalize on a feature which is part of a weaker paradigm because it would be a less reliable cue? It is important to bear in mind that the featural intervention account does not have a clear prediction about the developmental effect of different featural mismatches.

2. Participants

The participants were seventy French-speaking children (aged 4;7 to 8;9), with no diagnosed language or speech disorders, from the Geneva area, Switzerland. Table 1 summarizes the total number of participants, age range, mean age and standard deviation for each age group tested.

Table 1. Participant data per age group

Age group	No. of participants	Age range	Mean Age (S.D.)
5 y.o	27	4;7 – 5;7	5;3 (0.31)
6 y.o.	21	6;0 – 7;1	6;6 (0.41)
8 y.o.	22	7;3 – 8;9	8;2 (0.50)

3. Design and procedure

The materials included twenty-eight restrictive, right-branching relative clauses, fourteen subject (see examples in (8)) and fourteen object (illustrated in (9)). Half of the items contained a number mismatch between the head of relative and the embedded noun phrase. Additionally, among the items that contained a number mismatch, there were four with audible number agreement on the verb and three with silent (non-audible) number agreement. Since the study focused on the impact of an audible or non-audible number agreement on the comprehension of relative clauses, we only manipulated the plural or singular specification of the subject DP, while the object DP was always a DP in the singular.

8. a. *Subject relative clause – Number match*
 Montre-moi le garçon qui lave le chat.
 show-me the boy QUI washes the cat
 ‘Show me the boy that is washing the cat.’
- b. *Subject relative clause – Number mismatch (non-audible agreement)*
 Montre-moi les garçons qui lavent le chat.
 show-me the boys QUI wash the cat
 ‘Show me the boys that are washing the cat.’
- c. *Subject relative clause – Number mismatch (audible agreement)*
 Montre-moi les chiens qui mordent le chat.
 show-me the dogs QUI bite the cat
 ‘Show me the dogs that are biting the cat.’
9. a. *Object relative clause – Number match*
 Montre-moi le chat que le garçon lave.
 Show-me the cat QUE the boy washes
 ‘Show me the cat that the boy is washing.’
- b. *Object relative clause – Number mismatch*
 Montre-moi le chat que les garçons lavent.
 show-me the cat QUE the boys wash
 ‘Show me the cat that the boys are washing.’
- c. *Object relative clause – Number mismatch (audible agreement)*
 Montre-moi le chat que les chiens mordent.
 show-me the cat QUE the dogs bite
 ‘Show me the cat that the dogs are biting.’

The verbs used in the non-audible number agreement condition were *arroser* (to splash), *couvrir* (to cover), *laver* (to wash), *photographier* (to photograph), *coiffer* (to do somebody’s hair), *pousser* (to push), *taper* (to hit), *tirer* (to pull), whereas *mordre* (to bite), *suivre* (to follow), *peindre* (to paint), *applaudir* (to cheer), *nourrir* (to feed) appeared in the audible agreement condition. All nouns were matched for gender in order to neutralize the potential use of a gender mismatch as a cue for comprehension.

The visual material consisted of sets of pictures depicting actions performed by the same characters with reversed agent-patient roles (figure 1). The presence of two entities of each kind (e.g. two boys and two cats) made the use of relative clauses pragmatically felicitous (see Hamburger and Crain 1982).

A.



B.



Figure 1. Example of images for the number match (A) and number mismatch (B) conditions¹

We used a character-selection task adapted to French and based on Friedmann et al.'s (2009) design for Hebrew. A warm-up phase preceded the actual experiment aimed at familiarizing children with the characters and with precise pointing. At the beginning of each session, the experimenter explained to the child that he/she would see two images at a time and would have to point to the correct character in one of these images. Moreover, the experimenter drew the child's attention to the fact that he/she should choose and point out only one of the four possible options given in the images. If the child's response was ambiguous (e.g. pointing to the whole image), the experimenter would pretend that she did not pay attention and would ask the child to identify again the precise character. However, this very seldom happened, as children were very eager to point to only one character. A short lead-in introduced each target sentence: "Look! Here we see two boys and two cats!" The child was then prompted to point to the correct character as identified by an SRC or ORC like in examples (8) and (9) above. Each target sentence was used only once and was associated with a picture depicting four characters (figure 1). Children were tested individually in a separate room at their school. One experimental session lasted approximately twenty-five to thirty minutes. The experimenter also made sure that children could take a break if they wanted to or if they showed signs of fatigue. Each child received a small reward at the end of the task.

4. Predictions

Several predictions hold for the study. If the number feature in French, which is overtly manifested on the verb, counts as a trigger for movement much like in Italian, then it should also modulate comprehension of ORCs in French. As already shown in previous studies, a subject-object asymmetry should still hold, however those ORCs containing a number mismatch should yield better comprehension scores than those in which the subject and the object DP are both singular and thus match in the number feature. If the featural mismatch is crucial particularly for intervention, then its effect will be predominant in ORCs because they involve an intervention configuration, in contrast to SRCs. In addition, as mentioned in the introduction, a pure feature based account would

¹ We thank Candice Coyer for providing the images.

predict number mismatch to have the same impact on comprehension, regardless of whether verb agreement is audible or inaudible (so overt or covert). Thus, under this approach, we expect a similar comprehension pattern for both cases containing a number mismatch.

On the other hand, if the phonological realization of a feature on the inflectional head is relevant for the computation of intervention effects, then we should observe improved performance specifically in the number mismatch condition when the number agreement on the verb is audible, and not in cases where verb agreement is inaudible.

Also, if there is an increased cost associated with the processing of featural mismatches, which create an intersection relation between the features of the intervener and of the moved object, then we should see that performance with such structures should become less difficult for older age groups.

5. Results

Our data (Figure 2) show that: (i) children comprehended SRCs very well, whereas they had more difficulties assigning a correct interpretation to ORCs; (ii) the asymmetry in children's comprehension of SRC and ORC was present irrespective of whether the subject and object DPs matched or mismatched in their number specification; (iii) in the 5yo group, the presence of a number mismatch in ORCs (i.e. plural subject and singular object) did not yield better comprehension scores as compared to the cases with a number match; (iv) the mismatch in number specification improved performance with ORCs in the 6yo and 8yo children.

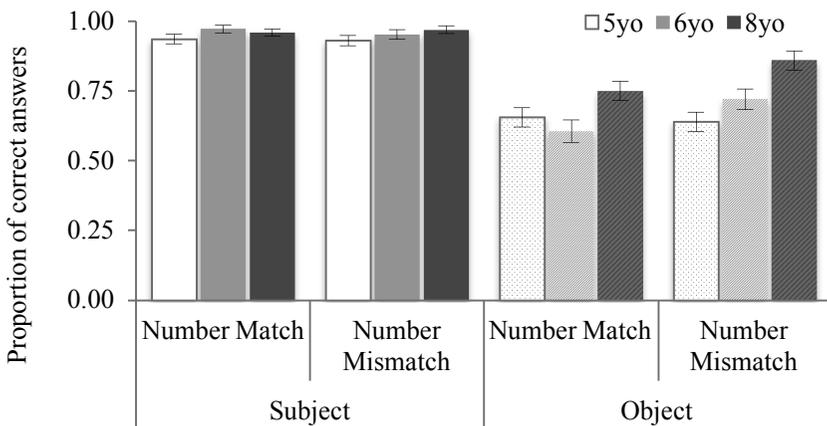


Figure 2. Proportion of correct responses for SRC and ORC by type of structure (subject vs. object), number match vs. mismatch condition, and age group.

A closer look at the results obtained for the conditions with audible and non-audible agreement (Figure 3) confirms that children comprehend SRCs better than ORCs, but also that there was no difference in performance between relative clauses with audible and with inaudible agreement in any of the three age groups tested.

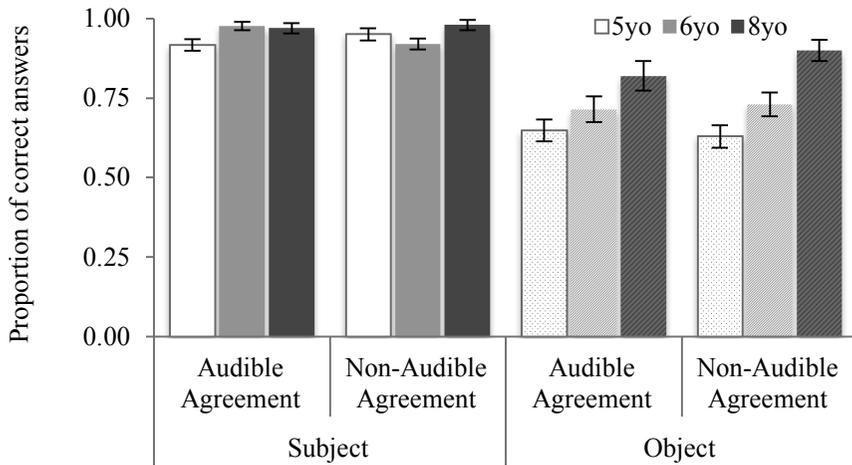


Figure 3. Proportion of correct responses for SRC and ORC with a number mismatch according to audible/inaudible agreement condition and age group

R (R Core Team, 2014) and the *lme4* package for Linear Mixed Effects (Bates, Maechler, Bolker, & Walker, 2014) were used to perform mixed-effect logit models in order to analyze the results (Baayen, Davidson, & Bates, 2008; Jaeger, 2008). Response accuracy was the categorical dependent variable. Sentence type (SRC vs ORC), Number (match vs mismatch) and Agreement (audible vs non-audible) were modelled as fixed factors and Age as a covariate. The fixed factors were coded with a sliding contrast specification. This means that the coefficient for the fixed factor indicates the difference between the mean of the dependent variable at each level of the factor (+Animate vs -Animate). The maximal random effect structure justified by the data included by-subject and by-item intercepts.

As predicted, there was a main effect of Sentence type (coef = 2.76, $SE = 0.39$, $z = 7.02$, $p < .001$), meaning that response accuracy was higher in the case of SRCs as compared to ORCs. While Number significantly affected the comprehension of relative clauses (coef = 0.56, $SE = 0.25$, $z = 2.17$, $p < .05$), there was no effect of Agreement ($\chi^2(1) = 0.02$, $p = 0.87$). This shows that children performed better in the number mismatch condition than in the number match condition, however the presence or absence of an audible agreement had

no significant impact on relative clause comprehension. Older children were also more accurate than younger ones for the comprehension of ORCs, as revealed by the significant effect of age (coef = 0.26, $SE = 0.13$, $z = 1.96$, $p < .001$). No interactions appeared as significant ($\chi^2(3) = 3.71$, $p = 0.29$).

6. Discussion

The study reported in this paper examined whether a mismatch in the number feature between the head noun and the embedded DP, as well as the presence or absence of audible number agreement on the verb, would facilitate the processing of relative clauses in French children aged 5yo to 8yo. Number agreement in French is morphologically present on the verb, but only realized phonologically depending on the lexical verb. Given that the number and gender features examined so far in previous studies (Adani et al. 2010; Belletti et al. 2012) have always been systematically overtly realized on the verbal inflectional head both morphologically and phonologically, number agreement in French provides a useful test case to show if (i) the impact of features on intervention depends on their phonological realization on the verb and (ii) if sensitivity to featural mismatches shows a developmental effect related to the feature's validity (i.e. whether a particular feature represents a frequent and reliable source of information guiding the acquisition process).

Our results show that number mismatch in French modulates comprehension of ORCs, so those dependencies that instantiate an intervention configuration. Children were less accurate with ORCs in which the subject and object DPs matched in number features, for example when they were both singular, as in (10), because these structures give rise to an inclusion relation which is difficult for children to compute.

10. +R+NP+Sg +NP+Sg
 Montre-moi le chat que le garçon lave.
 ‘Show me the cat that the boy is washing.’

Response accuracy improved when the target and the intervener were specified for different number features, so when the object was singular and the subject was plural as in (11). This shows that children were able to capitalize on the mismatch in number to arrive at an intersection relation between the features of the head noun and the intervener.

11. +R+NP+Sg +NP+Pl
 Montre-moi le chat que les garçons lavent.
 ‘Show me the cat that the boys are washing.’

Also, the items with (12) or without (illustrated in (11) above) audible number agreement on the verb yielded similar levels of accuracy.

12. +R+NP+Sg +NP+Pl
 Montre-moi le chat que les chiens mordent.
 ‘Show me the cat that the dogs are biting.’

This is not expected under an ‘overt-inflection-based’ view which would expect that comprehension should improve when number agreement is audible on the verb, but not in instances when it is non-audible. Our results are in line with a ‘pure-feature-based’ view that only takes into consideration morphosyntactic features acting as triggers for movement. Under this view, the number feature on the tensed verb in French has the same status both when number agreement is audible and when it is not.

In addition, our results revealed a difference in performance between the 5-year-old group, who seems to have difficulties computing fine-grained featural mismatches, and the older age groups tested (the 6-year-olds and the 8-year-olds), who are sensitive to the intersection relation created by number mismatch. This is in line with findings reported in Durrleman, Marinis, & Franck (2016) for the comprehension of wh-questions with a number mismatch in French and it is also compatible with studies showing that sensitivity to morphological number cues only emerges after the age of 5 (Johnson, de Villiers, & Seymour 2005; Miller & Schmitt 2009; Pérez-Leroux 2005). The facilitating role of number agreement found for the 6-year-olds and the 8-year-olds suggests that older children can interpret number as a distinctive feature and draw upon its presence to distinguish the set of features characterizing the intervening subject from the set of features present on the moved object. If the number feature is relevant in determining an intersection configuration, the fact that younger children have difficulties computing such structures indicates that the intersection relation only becomes relevant at a later time. This may suggest that younger children are only sensitive to disjunction vs everything else, while older children can take into account the finer distinction between intersection and inclusion.

The fact that the 5-year-old children in our study did not capitalize on the mismatch in number calls for an explanation when compared to cross-linguistic results reported for the same age group in Italian. Adani et al. (2010) showed that Italian children (mean age 5;9) comprehend ORCs with a mismatch in number significantly better (64% accuracy) than ORCs in which the subject and object DP matched in number features (41% accuracy). This contrasts with the results obtained in the present study, since the 5-year-old children (mean age 5;3) performed on a par on ORCs with a number match (64%) and a number mismatch (66%)².

² That the accuracy rate for ORCs with a number mismatch in Italian was as low as 41%, compared to 66% in French, could be due to the type of structures tested in Adani et al. (2010). These were center-embedded relative clauses, which have a higher level of complexity than the right-branching relatives used in the current study.

The difference in performance between French and Italian children is likely due to the strength associated with the number feature in the two languages. While Italian is a rich inflectional language in which number agreement has a systematic morphological and phonological manifestation on the lexical verb, French displays variability in the phonological realization of number agreement³. This variability in the nature of verbal inflectional morphology could have repercussions on the role that a feature plays for locality. If strength of inflection has been seen to play a role in triggering movement, this aspect will also impact the feature's visibility for the computation of intervention. The cross-linguistic difference in the role of a feature for locality is thus related to its strength, as determined by its systematic realization in a given paradigm. Moreover, if strength of a feature counts for the visibility of syntactic operations such as movement, this might also impact the processing cost of a particular feature and play a role in its ability to facilitate parsing for systems which are computationally immature. From this perspective, the strength of a feature can be tied to the notion of cue validity (Bates & MacWhinney 1987; Bates et al. 1999). To recall, cue validity is determined by its reliability (i.e. the proportion of times it predicts the relevant role assignment) and frequency in a given language. The most valid cues also tend to be the first ones used by children (Kail 1989). That number agreement is not phonologically realized in a systematic way on the verbal inflection in French weakens the strength associated with this particular feature and makes it less likely for younger children to use it as a source of reliable information for comprehension.

7. Conclusion

The overall goal of this work was to refine our understanding of the featural properties impacting the acquisition of relative clauses. Certain structural contexts have been claimed to selectively facilitate the parsing of ORCs, as compared to SRC clauses. This would be due to the presence of features 'relevant' for the computation of intervention, by their being part of the feature set triggering movement in a given language. To date the features identified as relevant have not only triggered movement, but also provided a phonological cue of who did what to whom via overt subject-verb agreement. As such, it is difficult to disentangle the influence of these two properties. With this investigation, we aimed to assess if and how overt realization on the clausal inflectional head is crucial for the improved effects associated thus far with the acquisition of featural mismatch configurations. We experimentally evaluated the comprehension of SRCs and ORCs with and without a number mismatch by

³ Indeed, Belletti (1990, 2008) postulates that the difference between two languages like Italian and French is due to the different nature of the verbal inflectional morphology in the two cases. It is uniformly represented in Italian, where it always triggers verb movement, but it varies in French and this has the consequence that the amalgamation of the lexical verb with the inflectional endings can be realized or not through verb-movement.

children acquiring French, a language where number is always part of the feature set triggering movement while nevertheless remaining covert with a subset of verbs. We have shown that a mismatch in this feature impacts performance selectively on ORCs, regardless of whether it is audible or inaudible, as of age 6. These results are in line with a pure feature-based view of RM, predicting that even inaudible features are relevant for locality. However this approach does not provide an explanation for the later age at which the featural mismatch affects acquisition in French as compared to that previously reported for Italian. This difference may stem from the cross-linguistic contrast between the weaker number paradigm in French as compared to Italian, the latter providing a more systematic and thus more reliable cue for children to capitalize on. These observations converge to suggest that features modulate comprehension of relative clauses involving intervention (i) once they are visible to morphosyntactic operations, (ii) regardless of their phonological realization, and (iii) over time, depending on their relative strength in a given language.

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