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Seit ihrer Gründung im Jahr 1969 durch Peter Hartmann und Arnim von Stechow sind die *Linguistischen Berichte* in Bezug auf Gegenstände und Methoden der Linguistik auf maximale thematische Offenheit hin ausgerichtet und halten im Hinblick auf die zugrunde gelegten wissenschaftlichen Standards zugleich an einem hohen theoretischen und empirischen Anspruch fest. Die methodenpluralistische Ausrichtung dient dem Ziel, die Entwicklung des Faches objektiv und kritisch zu dokumentieren.

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Syntax

Relative clauses are not adjuncts: an experimental investigation of a corollary of the raising analyses

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Abstract

Relative clauses and more generally clauses modifying nouns have been at the center of a long debate in the last forty years, opposing largely diverging syntactic analyses, comparing relevant data and discussing perspectives. The aim of this paper is to contribute to this debate by adding novel experimental data on how these structures are processed in an online reading task. Two eye-tracking experiments were designed to investigate the temporal structural ambiguity that can arise between object relative clauses (object RCs; *'the claim that linguists made* is a mistake)' and so-called complement clauses of a noun (CCs; *'the claim that linguists made* a mistake ...') in Italian and English. Although the pattern is complex, the results of both experiments suggest that a reanalysis effect is associated with CCs, showing an initial preference for the object RC structural interpretation. The implications of our results are discussed in relation to competing syntactic analyses for CCs ad RCs.

1 Introduction

The study of how temporary structural ambiguities are resolved in online tasks might contribute crucial evidence to test competing theories of syntactic analysis. In this paper we empirically investigate whether the processing of two temporary ambiguous structures, namely object relative clauses (RCs) and complement clauses of a noun (CCs), give rise to a garden path effect. By doing so, we test the predictions of alternative theories about the syntactic structure of RCs: the traditional analyses (including the null operator analysis and the matching analysis) and the raising analysis. Our experimental evidence will fuel the discussion about the correct approach to the syntactic analysis of these structures.

The paper is organized as follows. We begin with a review of previous syntactic analyses of RCs (Section 2) and proceed to present a recent analysis, which will be the starting point of our eye-tracking experiments (Section 3).

Then, we present the research questions that inspired our experiments (Section 4). Next, we report our experimental findings (Section 5 for Italian and Section 6 for English) and finally, we discuss the implications of our results (Section 7).

2 Different approaches to RCs in the generative tradition

At least three main accounts of RCs have been proposed in the generative tradition (see Bianchi 2002 for a somehow dated historical survey). For the sake of clarity, we will briefly present them, grouping the three different families of analyses under purely descriptive terms:

(i) (null) operator analyses
(ii) matching analyses
(iii) raising analyses.

According to the first type of approach, that we refer to as the (null) operator analyses, the relative clause 'head' is not transformationally related to the gap inside the relative clause. Instead, a relative pronoun (which is overt in (1b) but remains phonologically null in (1a)) moves to Spec,CP and leaves a trace in the gap position. The operator is identified with the relative clause 'head' through some kind of agreement procedure (see Chomsky 1981 and Browning 1986 for two variants of this approach). For concreteness, in the examples below a movement chain is indicated by inserting a trace, while ellipsis-type deletion is signaled by crossing out the category that goes unpronounced. We will use the term 'movement' and 'internal merge' interchangeably.

(1) a. $[_{DP}$ the book $[_{CP}$ Op that I will read $t_{Op}]]$
b. $[_{DP}$ the book $[_{CP}$ which I will read t_{which}]]

The second type of approach, the matching analyses (Chomsky 1965, Hulsey & Sauerland 2009, Kayne 1975, Sauerland 2003), is illustrated in (2).

(2) a. $[_{DP}$ the book $[_{CP}$ ~~book~~ that I will read $t_{book}]$
b. $[_{DP}$ the book $[_{CP}$ which ~~book~~ [I will read $t_{which\ book}]$

Under the matching analyses, the gap inside the relative clause is transformationally related to the category that has moved to the left periphery of the relative clause. However, this category is phonologically deleted under (near) identity with the external head. According to the matching analysis, then, the internal head and the external head are *not* part of a movement chain, but are related by whatever mechanism links an elided constituent and its antecedent in ellipsis cases.

The last type of approach, the raising analyses (see, e.g., Bhatt 2002, Bianchi 1999, Donati & Cecchetto 2011, Kayne 1994, Vergnaud 1974), shares with the matching analyses the assumption that the 'head' is inserted directly in the relativization site and a link is established with a position external to the relative clause. The difference between the two is that, under the raising approach, the internal head and the external head are part of a movement chain. When a relative pronoun is present, as in (3b), the raising of the 'head' happens in two steps. First a wh-movement step of the complex phrase, which is assumed to be a DP headed by the wh-element (*which* in 3b), then the movement of the head alone stranding the wh-determiner.

(3) a. $[_{DP}$ the $[_{CP}$ book [that I will read $t_{book}]$]
b. $[_{DP}$ the $[_{CP}$ book [which t_{book} [I will read $t_{which\ book}]$

An extensive evaluation of the three different approaches is beyond the scope of the present paper. We simply point out a conceptual and an empirical advantage of the raising analysis illustrated in (3) over the null operator approach illustrated in (1). First, it explains the relation between the gap and the 'head' with no need to introduce a special mechanism, since the existence of transformations is well-attested in constructions distinct from relative clauses. Second, an ample literature has pointed out empirical advantages of the raising analysis (see Bianchi 1999 for an extended discussion). These advantages can be summarized as follows: the head of the relative clause behaves as if it occupied the position of the gap inside the relative clause with respect to various diagnostics. For example, as observed in Vergnaud (1974) and much following work, the acceptability of (4) suggests that at some level the external head, *(the) headway*, occupies the argument position inside the relative clause, under the assumption that idiomatic expressions like *to make headway* must form a unit at some level of representation.

(4) The headway that John made is commendable.

The fact in (4), together with other reconstruction facts, admittedly less strong, have led various researchers to embrace the raising analysis[1].

There is however still a great amount of incertitude on the correct analysis to be given to RCs over all (see Borsley 1997 for a lucid critique of the raising analysis and Bianchi 1999 for a possible counter to these objections). In this paper, we would like to focus on another, often neglected, feature that distinguishes the raising analysis from its competitors, and try to test the correctness of this feature experimentally. What we have in mind concerns the position of the relative clause with respect to the main clause. The traditional view, whether implemented as the null operator analysis or as the matching one, defines RCs as typical adjoined clauses, modifying optionally the NP head, as in (5)[2].

[1] The validity of idioms as diagnostics for movement has been questioned, however. See in particular Ruwet (1991) and Nunberg, Sag & Wasow (1994), and recently Bruening (2015) for a discussion.

[2] Following Kayne (1994) and especially Bianchi (1999), we take for granted that the determiner introducing the head noun is inserted *after* the relative clause has been created by the occurrence of the relevant transformation; in other words, the determiner that introduces the head noun is never located inside the relative clause. This is strongly suggested by the fact that the external de-

(5) $[_{DP}$ the $[_{NP}$ $[_{NP}$ book $[_{CP}$ ø that I will read]]]

This vision is incompatible with the raising analysis, where the relative clause is the very source of the head noun, and thus cannot be optional or late inserted, by definition. While this severe departure from the traditional vision is true of any version of the raising analysis, it is particularly clear under one version of it, recently proposed in works by Cecchetto and Donati (C&D), namely Donati & Cecchetto (2011) and Cecchetto & Donati (2015). Following the terminology introduced by C&D, we will refer to this particular version of the raising analysis as the *relabeling analysis*. To fully appreciate the divergence between the relabeling and the null-operator and matching analyses, we will present the former in more details in the next section.

3 The relabeling analysis

The relabeling analysis is a version of the raising analysis in which it is explicitly assumed that the raising noun projects and gives its nominal label to the clause in its derived position, thus transformationally deriving the nominal distribution of the relative clause. The starting point of C&D is the observation that a word, intended as the output of the morphology module, plays a crucial role in labeling. Uncontroversially, a word 'projects' (provides the label) in head-complement configurations structures (for example, when the verb 'bought' is merged with the noun phrase 'a house' and the resulting category 'bought a house' is a *verb* phrase). They claim that the same happens when a RC is formed, modulo the fact that labeling takes place after movement of the noun. Their approach can be illustrated with the example of the *wh*-relatives in (6).

(6) $[_{DP}$ The $[_{NP}$ book $[_{CP}$ [which t_{book}] I will read read $t_{which\ book}$]]]]

The first step of the relevant part of the derivation is movement of 'which book' to a dedicated position in the left periphery of the CP. This is motivated by whatever motivates *wh*-movement. The second crucial step of the RC derivation is movement of the noun 'book'. This does not have any obvious morphological motivation but C&D claim that it is necessary in order to turn the clause into a noun phrase, which is then selected by the external determiner 'the'[3]. Technically, the word 'book', as all words do, has the power to (re)label the structure. This means that under the labeling analysis, not only the relative head is

terminer must take wider scope than a quantifier inside the relative clause: see Bianchi (1999) and (2000) for a discussion of this and other interesting aspects of the syntax of this determiner.

[3] The motivation of this movement step is discussed thoroughly by C&D, especially in Chapter 4 of Cecchetto & Donati (2015), to which we refer. In a nutshell, they assume a very restrictive theory of unprobed movement and conclude that the relabeling movement of the head noun is indeed unmotivated (« unprobed »). They discuss the consequences of this claim for the locality restrictions associated to relativization in acquisition and in typology.

transformationally related to a position inside the relative clause, but the relative head also labels the RC.

An important twist of the relabeling analysis becomes evident when one considers RC like (7) in which the head appears to be a phrase, namely the 'destruction of Rome'.

(7) The destruction of Rome which nobody witnessed

As phrases do not have a labeling power, C&D argue that what happens in (7) and similar cases is that 'of Rome', the alleged complement of the noun 'destruction', is late merged to the noun only after the latter has moved and has already turned the clause into a noun phrase[4]. This requires a deep revision of some assumptions about the parallelism between noun complementation and verb complementation on which we shall come back shortly.

C&D extend their analysis to *that*-relatives as (8).

(8) The book that John read

According to C&D's analysis, 'that' is a determiner which raises together with the head noun in the left periphery of the RC before the noun does its relabeling movement. Therefore, under the assumption that 'that' is a determiner, not a complementizer (cf. Kayne 1976 and Manzini & Savoia 2011 for independent evidence), the analysis of *that*-relatives is minimally different from the analysis of *wh*-relatives.

(8') The $[_{NP}$ book $[_{CP}$ that t_{book} John read $t_{that\ book}]]$

A point which is important for our purposes is the following: the fact that the head noun provides the label when it is moved makes the configuration resulting from relativization very similar to the configuration underlying complementation. In fact, both are cases of sisterhood between a 'head' (the word that provides the label) and a phrase. The difference is that the head is internally merged (moved) in case of relativization but externally merged (base generated) in case of complementation.

Therefore, *prima facie*, relativization shares similar labeling properties with a so-called complement clauses of a noun (CC), as in (9).

(9) The claim that linguists made a mistake

However, while the string *'that linguists made a mistake'* in (9) is traditionally analyzed as a complement clause of the noun, C&D strongly deny this. In fact, based on a variety of reasons that we cannot summarize here they claim that

[4] This analysis has clear consequences concerning expected reconstruction effects in relative clauses: if any modifier of the noun is late inserted after the noun has moved and has relabeled the structure in relative clauses, it should not be possible to interpret it within the relative clause. This feature of the relabeling analysis is claimed to be an advantage by Cecchetto & Donati (2015: chapter 4). Since this is not directly relevant for what is investigated here, namely the adjunct vs. complement status of the relative clause, we will simply refer to this work.

nouns never take complements (see also Adger 2013 for independent motivation). C&D do not simply mean that in the case of nouns the distinction between arguments and adjuncts is blurred (as revealed by the fact that transitive nouns do not require a complement). Crucially they also assume that so-called complements of the noun do not occupy the same structural position of complements of the verb. More specifically, C&D argue that any modifier of the noun, whether traditionally analyzed as an adjunct (the picture *on the shelf*) or as a complement (the picture *of John*), can be late merged to the noun after the noun has been merged with a determiner. The late merge possibility is of course a hallmark of adjunct structure. Since adjuncts are by definition not selected, they can be inserted in any point of the derivation, unlike complements and other categories that are needed for selectional requirements or theta role assignment.

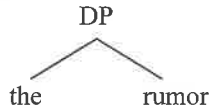
The observation that nouns do not take real complements, if true, of course extends to CCs, which, according to C&D, despite their name, should *not* be analyzed as complements of the noun (cf. Arsenjević 2009, Krapova & Cinque 2012, Jenks 2014 & Stowell 1981 for the same conclusion). Evidence that CC are not complements includes the fact that cross-linguistically, English being an example, the RC and the noun have a tighter relation than the CC and the noun, as shown by word order facts as the following:

(10) a. I don't believe the rumor that I heard this morning that he'll move
b. ??I don't believe the rumor that he'll move that I heard this morning
(from Jenks 2014)

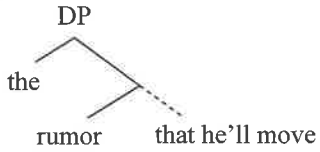
Before concluding this rough summary of the (re)labeling approach to RC, for concreteness we represent graphically the analysis for CC and RC proposed in C&D. A possible derivation for the CC is given in (11), where the dotted line indicates that the CC is late merged (cf. step (ii)), namely merged after D and N have been merged at step (i).

(11) The rumor that he'll move

(i)



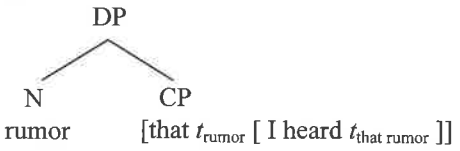
(ii)



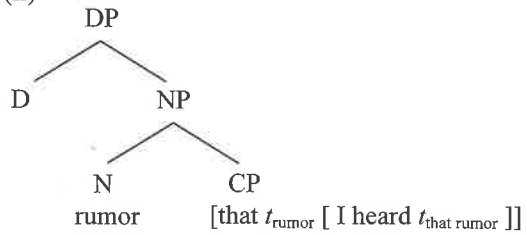
The derivation for a RC is given in (12). The derivation internal to the CP was already illustrated above, in (6) and (8). The crucial point here is that the N and the CP where the N originates must be merged at step (i), before the D determiner enters the derivation (step (ii)), since the movement of the head noun is necessary to turn a clause into the NP which is selected by D.

(12) the rumor that I heard this morning

(i)

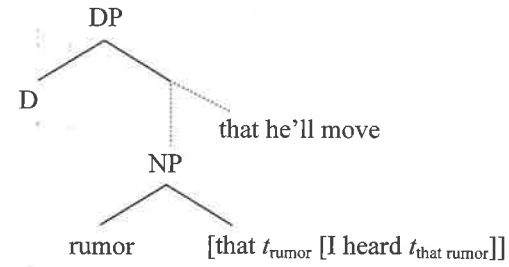


(ii)



As for the a structure in (13), in which a noun is modified both by a RC and by a CC, a natural extension of C&D's approach would be to say that the CC is late merged after the RC has been merged (again late merge is illustrated by the dotted line). Notice that late merge is countercyclical, since CC tampers the structure previously formed when D has merged with the NP resulting from relabeling of the head noun. However, since selection has already been satisfied when late merge takes place (D has selected NP, in the case at hand), this tampering is harmless and the node resulting from late merge can remain label-less (see Hornstein 2009 for a similar view about adjunction structures).[5]

(13) the rumor that I heard that he'll move



[5] The marginal status of (10b) indicates that the locus of late merge is not totally free, since (10b) should be fully acceptable if the CC could be late merged between the head noun and the RC. The question of the constraints on late merge is certainly important, but we must leave it to future work.

Summarizing, according to the raising analysis, and even more so in the (re)labeling version of it, RCs are not adjuncts, while they *are* adjuncts according to the other approaches to RCs discussed at the beginning, namely the null operator analysis and the matching analysis. Furthermore, C&D claim that, since modifiers of the noun (including CCs) can be late merged, CCs are to be treated as adjuncts. In the next section we will compare traditional approaches to RCs and the (re)labeling analysis by asking what predictions they make regarding online processing.

4 Different predictions of the different analyses of RCs: processing temporary ambiguous structures

Temporally ambiguous structures such as (14) can be completed either with a RC or with a CC.

(14) The claim that linguists made … (a mistake/was a mistake)

Temporally ambiguous structures may give rise to so-called garden path effects, as illustrated in the classical example (15).

(15) The horse raced past the barn fell.

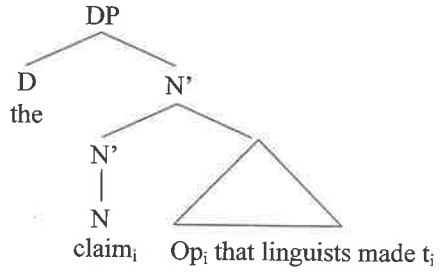
We know that when a reader reaches the word 'fell' in (15), she becomes puzzled, as clearly shown by various behavioral measures (e.g., longer reading times). This happens because the verb 'raced' is initially interpreted as the main verb. However, this interpretation is incompatible with the continuation of the sentence, which indicates that 'raced' should be interpreted as a past participle in a reduced relative clause (corresponding to 'the horse which was raced past the barn fell'). We might expect a similar phenomenon in the temporally ambiguous structure in (14), and in this paper we will test (i) if a garden path does arise and (ii) if a structure is systematically preferred by the parser. We then discuss how our experimental findings fit within the debate on RCs summarized in the preceding section.

Many different proposals have been put forth to capture the parsing preferences of the kind illustrated in (15). Some of them favor a view in which a range of possible constraints (e.g., lexical frequency, frequency of a syntactic frame, but also contextual accessibility, thematic fit, etc.) can determine the initial analysis of a temporally ambiguous structure (e.g., Trueswell 1996). Some others attribute a central role to syntax-driven strategies in directing the parser toward its initial choice in temporally ambiguous structures (Frazier 1979, Ferreira & Clifton 1986, Ferreira & Henderson 1990). For example, the 'Minimal Attachment Principle' (Frazier 1979) drives the parser to adopt the analysis involving the simplest structure compatible with the rules of a given language. According to De Vincenzi's (1991) Minimal Chain Principle, the parser avoids postulating a gap unless this is the only option allowed by the grammar rules.

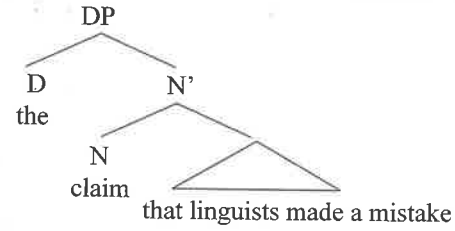
A discussion of the various models of parsing goes well beyond the scope of the present paper and of course we do not deny that non-structural factors like frequency biases might impact parsing strategies[6]. However, we take for granted that structural factors play a major role and our research question in this paper is accordingly restricted: what theory of RC is best suited to explain the preference of the parser (if any) with a temporally ambiguous structure like (14)?

We start from the classical approaches to RCs (the null operator analysis and the matching analysis), which have in common the fact that RCs are taken to be adjunct. Assuming these classical analyses, the prediction is that the CC parse should be preferred over the RC parse. This conclusion is forced both by the Minimal Attachment Principle, which predicts a general preference for the analysis that requires the simplest structure. As the RC parse in (16) involves one more node than the CC parse in (17), the latter wins. As for the Minimal Chain Principle, if anything[7], it also predicts that the CC analysis should be initially preferred, since a RC involves the gap of the null operator.

(16) RC structure, under the classical approaches



(17) CC structure, under the classical approach



Given that until the 1990s the raising analysis has been minority and syntactic-based models were mostly developed in the 1970s and 1980s, we do not know of any approach to structural ambiguities in the psycholinguistic literature based on the raising analysis, not to mention the relabeling version of it. It is clear

[6] Indeed, we plan to study the interaction of structural and non-structural factors in future work.

[7] This is under the assumption that chains headed by a null operator count for the Minimal Chain Principle. If they do not count, this principle is irrelevant for the initial choice of the parser, while the Minimal Attachment Principle still predicts that the CC parse should be preferred.

however that given the issue just discussed, namely the fact that RCs are not adjuncts under the raising analysis, the discussion must be rephrased: the Minimal Attachment Principle would not privilege one structure over the other, since at the end of day (after late merge has taken place) both RCs and CCs would include the same number of nodes. However, under the Minimal Chain Principle, a CC should be initially preferred because it contains no gap while the RC contains the trace of the head noun.

So, it might appear that both the null operator analysis to RCs and the raising analysis predict a preference for the CC parse, although for different reasons: the null operator analysis predicts a preference for the CC parse because it involves fewer nodes and because its involves no gap; the raising analysis predicts a preference for the CC parse because it involves no gap.

This notwithstanding, the predictions of the relabeling analysis may be different. Recall this analysis reverses the traditional perspective since it considers RCs complement-like categories and CCs adjunct-like categories. Crucially, there is evidence that the parser prefers complementation over adjunction when a temporary ambiguity arises. In fact, a core intuition underlying the syntax driven models is that the parse reflecting basic structure building (primary) operations, like head-complement configurations, is *initially* chosen in case of temporary ambiguity. For example, the noun phrase 'a mile' is analyzed as the direct object of the verb 'jogs' (cf. 18a), although the alternative analysis in (18b) is available, because verb phrase (VP) building takes absolute precedence.

(18) Since Jay always jogs a mile ...
  a. Since Jay always jogs a mile this seems like a short distance to him.
  b. Since Jay always jogs a mile seems like a short distance to him.

If at the abstract level of syntactic analysis RCs are the output of the same structure building operation that is observed in head-complement configurations, as assumed in the relabeling analysis, the RC parse should be preferred over the CC parse for the same reason that the parser favors the continuation in (18a) over the continuation in (18b): fundamental structure building operations take precedence. However, the relabeling analysis belongs to the family of raising analyses, so it assumes that RCs involve the gap of the head noun while CC do not. Therefore CC should be preferred, due to the Minimal Chain Principle. All in all, while other approaches predict a preference for the CC parse, the relabeling analysis does *not* predict this preference.

We summarize in Table 1 the predictions of traditional approaches and of the relabeling analysis as far as temporary ambiguities between CCs and RCs are concerned. A comment is needed about the predictions of relabeling analysis. If the Minimal Chain Principle and the principle that favors fundamental structure building operations have equal force, the relabeling analysis does not favor the RC or the CC parser. However, if the latter principle is stronger, the RC analysis is expected to be preferred over the CC one.

Analysis	Null operator analysis and matching analysis	Relabeling analysis
Details	Structurally RCs are adjuncts and CCs are complements	Structurally RCs are complements and CCs are adjuncts
Prediction	The CC is preferred due to the Minimal Attachment Principle (and the Minimal Chain Principle).	Conflicting predictions: The RC should be preferred because structure building operations take preference. The CC parse should be preferred due to the Minimal Chain Principle.

Table 1

In the next section we test the predictions of the two analyses by reporting the results of two eye-tracking experiments. Eye-tracking is particularly apt at detecting garden path effects (if they arise), because readers typically respond to difficulty either by slowing down or by going back to re-read earlier sentence regions (so-called regressions): monitoring eye-movement conveys these behavioral measures.

5 Experiment 1 – Italian

5.1 Participants

Thirty-five native speakers of Italian (9 M; Mean Age = 26 years) participated to this experiment in exchange for course credits. All participants had normal or corrected-to-normal vision. Six participants were excluded due to track losses (e.g., poor calibration or lack of accurate eye-tracking) or due to low comprehension scores (less than 75% correct responses) to the comprehension questions. The final analysis was run on 29 participants.

5.2 Materials and Design

We created 24 experimental sentences, using a total of seven nouns (see Appendix for materials and translation). Each noun occurred in three of the 24 sentences, except for 'ordine', which occurred in six sentences. Importantly, each sentence appeared in one of two conditions (see 19): in the object RC condition (i.e., 19a), or in the CC condition (i.e., 19b).

(19) a. Il progetto che il sindacato sosteneva fra gli operai irritò la Confindustria.
'The plan that the Trade Unions supported among workers annoyed the tycoons'.

b. Il progetto che il sindacato sostenesse gli operai irritò la Confindustria.
'The plan that the Trade Unions would support the workers annoyed the tycoons'.

Thus, each experimental set consisted of 2 sentences, which were virtually identical with respect to their lexical content but differed in their structure, which could be an object RC (19a) or a CC (19b). Crucially, sentences in the same set differed only in the verb region, which involved the indicative form of the verb and a PP in the RC (19a) and the subjunctive form of the verb and a DP in the CC (19b). Only one experimental set involved the same verb in both conditions (RC vs. CC) (i.e., object RC: 'L'insinuazione che il presidente avrebbe smentito con il suo vice stava già circolando', Lit.: *The insinuation that the president would deny with his assistant was already circulating* as opposed to CC: 'L'insinuazione che il presidente avrebbe smentito il suo vice stava già circolando'; Lit.: *The insinuation that the president would contradict his assistant was already circulating*). In this latter set, the difference between the two sentences is given by the presence of a PP following the verb in the object RC as opposed to the presence of a DP in the CC. Therefore, the independent variable was Sentence structure and included object RC and CC as experimental conditions in which each sentence could appear. The full list of experimental sets is provided in Appendix A.

Materials (experimental items and fillers) were counterbalanced across two presentation lists, such that each list contained an equal number of different versions of the items, and such that each item appeared an equal number of times in all the versions of the experimental set. As there were only two versions for each sentence (e.g., object RC vs. CC), we created two Latin Square lists to which participants were randomly assigned. In addition, 48 filler sentences were presented randomized within the list. Filler sentences included a structure involving a question (e.g., 'Puoi dirmi quale ballerina saluta il marinaio?', *Can you tell me which dancer is saying hello to the sailor?*). Six of the experimental sentences were followed by a comprehension question requiring a yes-no answer.

Experimental sets were not controlled for length of the verb region in letters. However, as we conducted mixed effects models, in every model we tested whether region's length, that is the number of characters in each region, exerted an effect on the dependent variables.

We normed the seven nouns with respect to whether they had a preference towards a subject RC, object RC, or CC interpretation. To do so, we searched Google and looked at the first 100 occurrences of the frame 'Det N that' for each of the 7 nouns (for example we searched the sequence 'the plan that'). Importantly, we distinguished between type and token, since in many cases the same phrase appeared more than one time among the first 100 results of the (Italian) Google search. Then, we counted the occurrences for subject RC, object RC and CCs respectively. On average, out of the total occurrences, 54% involved a subject RC, 20% an object RC and 26% a CC. As our variable was a count variable, we performed a Poisson regression (Cameron and Trivedi 1998). The analysis revealed that there were significantly more occurrences involving a subject RC than an object RC (Wald $Z = 3.71$, $p < .001$) and a CC (Wald $Z = 3.54$, $p < .001$). Interestingly, the proportions of CCs and object RCs did not differ (Wald $Z = -.19$, $p = .84$). The estimated bias towards a subject RC, an object RC or a CC for each noun was then log-transformed and included in the eye-tracking data analysis in order to evaluate whether it contributed significant information to the models.

As a second test of interpretation bias (subject RC, object RC, CC), we conducted a norming experiment, in which we tested to what extent the 7 nouns elicited the production of a subject RC, an object RC or a CC. In a continuation task, we asked 65 Italian native speakers (15 M; Mean age = 21 years) who did not take part to the current experiment, to continue sentences such as the Italian equivalent of 'The plan that ...'. Participants had to read a list of sentence onsets (involving the 7 nouns in the frame 'Det N that') and write up a continuation. Again, as our variable was a count variable, we performed a Poisson regression. The analysis revealed that there were significantly more continuations involving an object RC (as in *Il dubbio che ho è se venire o no a lezione*, 'the doubt I have is whether to come to class or not') as compared to continuations involving a subject RC (as in *Il dubbio che mi assale quando passo col rosso è passeggero* 'The doubt that strikes me when I run a red light is temporary') (60% vs. 17%; Wald $Z = -9.28$, $p < .001$) and a CC (as in *Il dubbio che non ho chiuso il gas mi tormenta* 'The doubt that I haven't turned off the gas obsesses me') (60% vs. 23%; Wald $Z = -7.16$, $p < .01$). The difference between proportions of continuations involving a subject RC and a CC was also significant (Wald $Z = -2.75$, $p < .005$). Interestingly, out of the total CCs produced we observed that 80% of them involved the subjunctive form of the verb. Also for the continuation task, the proportion of continuations involving a subject RC, an object RC or a CC for each noun was log-transformed and included in the analysis of the eye-tracking data to evaluate whether this bias contributed significantly to the fit of the models.

5.3 Procedure

Participants' eye movements were recorded using an Eye Tracker EyeLink 1000. Eye movements were taken from the right eye and view was binocular. The sentences were presented on a computer screen located about 50 cm from the participants' eye. Experimental sentences were presented one at a time and each sentence fitted on a single line. All words were presented in lower case (except for the first letter) and in Courier New typeface, font size 14. A trial started with a fixation cross in the center of the screen. Participants received written and oral instructions. They sat in front of a computer screen, holding a joystick. On the joystick were three buttons: one marked with a green sign to

continue from one sentence to the following one; a button on the left marked with 'S' (*sì*; 'yes') and a button on the right marked with 'N' (i.e., 'no') to reply to the comprehension questions. After the eye tracker was calibrated, participants were asked to read silently the sentences that appeared on the screen and then press the marked button on the joystick to continue to the next one. When comprehension questions occurred, participants were asked to reply to them by pressing the appropriate button on the joystick. Immediately afterwards a new sentence appeared on the screen. Participants were free to interrupt the experimental procedure any time between items.

5.4 Analyses

Regions of interest

We identified five regions of interest (see (20)). Sentence onset 1 was defined as the beginning of each sentence containing a determiner, a noun, and a relative pronoun, the region 2 included the subject NP, region 3 involved the critical region including the verb, then region 4 followed the critical region and finally the sentence ending 5. Two examples are provided below in (20a) and (20b):

(20) a. \1Il progetto che1\2il sindacato2\3**sosteneva fra3**\4gli operai4\5irritò la Confindustria5\
'The plan that the Trade Unions supported among workers annoyed the tycoons'.

b. \1Il progetto che1\2il sindacato2\3**sostenesse3**\4gli operai4\5irritò la Confindustria5\
'The plan that the Trade Unions would support the workers annoyed the tycoons'.

We considered as critical region the verb region (i.e., region 3), since this is the only region in which the two sentences in each experimental set (object RC or CC) differ and this is the region where disambiguation occurs. The region immediately following the critical region, i.e. region 4, was considered a spillover region. In addition, we also analyzed region 2, which immediately precedes the critical region 3, as it could reveal the effect of parafoveal preview (Blanchard et al., 1989).

Dependent measures

In the current study we collected a number of different eye-movement measures, including gaze durations, regression path and regressions. Gaze durations and regression path measures included First and Second pass reading time, Selective regression path and Total reading time. First pass reading time refers to the time spent in a region before moving on and leaving a region. Second pass reading time refers to the sum of the duration of the second run within a region; Selective regression path involves the duration of fixations and re-fixations within a region before the eyes enter a subsequent region; Total reading time refers to the sum of the duration across all fixations within a region. Note that some of these measures are known to reflect the early stages of the reading comprehension process, and might be possibly affected by lexical-retrieval processes (i.e., First pass; Rayner 1998), whereas other measures are assumed to reflect later processing as well as the integration of lexical material (i.e., Second pass reading time; Total reading time; Selective regression path) (Pickering et al. 2004). Regarding regression measures, we considered: Regression in, i.e., whether a region received regressions from a subsequent region; Regression in count, i.e., the number of times a region was entered from a subsequent one; Regression out, namely, whether regression(s) was made from a region to an earlier one, prior to leaving that region in a forward direction; Regression out count, i.e., proportions of regressions during the first pass within a region; Regression out full, i.e., whether regression(s) was made from a region to an earlier one. Note that Regression out only considers first-pass regressions whereas Regression out full considers all regressions, regardless of whether later regions were visited or not. Additionally, we included Regression out full count, i.e., the number of times a region was exited to an earlier region, and Skip, namely, whether a region was skipped in the first pass reading.

Importantly, according to the literature (e.g., Frazier & Rayner 1982; but see also Staub 2010), regressions indicate that the parser is engaged in reanalysis, exploiting whatever information is available in previous regions to guide its reanalysis. The likelihood of regression could thus signal that structures eliciting more regressions are less successfully parsed. Therefore, regression and regression path measures could possibly be the most revealing ones to disentangle whether re-analysis occurs more often in the RC vs. in the CC construction (Rayner 1998; Clifton et al. 2007; Vasishth et al. 2013).

All dependent variables were fitted to a series of mixed effects models and the analyses were conducted separately for regions 2, 3 and 4. Before the analysis, log-transformations were performed on the continuous variables to meet the normality requirements of linear modeling. Therefore, each regression models included Sentence structure (2 levels: RC or CC) as well as (log-transformed) length, and (log-transformed) frequency bias variables as independent measures. We first tested which fixed effects (e.g., Sentence structure, length, frequency variables) had to be included in the analysis, contributing to the model's fit. To assess the contribution of a predictor or an interaction between predictors to a model, we compared a full model (involving a maximal random structure too) against one containing one predictor less. If the inclusion of a predictor did not add to the fit of the model, we discarded it (e.g., Jaeger, 2008). Also for the random structure, in each model we tested whether the inclusion of a by-subjects and a by-items random slope for each of the fixed effects was appropriate in order to arrive at the most parsimonious model (Bates et al., submitted). In all the models we included a by-subjects and a by-items random intercept.

For sake of simplicity, in the paper we will report only p values referring to those models where the relevant fixed factor (i.e., Sentence structure) was sig-

nificant. The summary of the fixed effects in the mixed logit models (including also significant effects of length and frequency variables) for the data of Experiment 1 and 2, as well as the descriptives of both Experiments are available online (see: https://sites.google.com/site/mirtavernice/experimental-materials/Tables_14-1-16.doc; Table 2 and Table 3 summarize the data of Experiment 1; Table 4 and Table 5 those of Experiment 2).

5.5 Results

We discuss the experimental results separately for Region 2 ('il sindacato'), 3 ('sosteneva fra' vs. 'sostenesse') and 4 ('gli operai').

(21) a. \1Il progetto che1\2il sindacato2**3sosteneva fra3**\4gli operai4\5irritò la Confindustria5\
'The plan that the Trade Unions supported among workers annoyed the tycoons'.

b. \1Il progetto che1\2il sindacato2**3sostenesse3**\4gli operai4\5irritò la Confindustria5\
'The plan that the Trade Unions would support the workers annoyed the tycoons'.

REGION 2: This region is the one immediately preceding the critical region. Therefore differences between the two conditions cannot be due to the effect of the disambiguating verb. Not surprisingly, in Region 2 the analysis revealed only an effect of Length on Second pass and two frequency-related effects in Regression In and Second Pass. Another significant effect was that of Sentence structure on the Skip variable ($p < .05$): participants were more likely to skip Region 2 for object RCs ($M = .99$, $SD = .10$) than CCs ($M = .96$, $SD = .19$). Such finding is somewhat intriguing; whereas one possible explanation could be that this is purely accidental, one cannot totally exclude the possibility of parafoveal preview. That is, it could be due to a more costly pre-processing of region 3 for RC than CC clause (Kliegl & Engbert 2005).

REGION 3: This region is the one where disambiguation takes places. In Selective regression path, a reading measure, we found that RCs ($M = 674.28$, $SD = 397.12$) caused longer reading times than CCs ($M = 578.36$, $SD = 310.11$; $p < .003$), as graphically reported in Figure 1. Note that this apparent preference for CCs could be compensatory with the effect of Sentence structure that was found in region 2 for the Skip variable. A likely explanation for such effect could be that, as during the first pass participants skipped more often region 2 with object RCs, then they had to spend more time reading the subsequent region, namely region 3, when the sentence involved an object RC. Therefore, the difference found in this variable across conditions could be regarded as compensatory with respect to the higher skipping rate in RCs than in CCs of region 2.

As for regressions, we found a higher proportion of Regression out and Regression out full in CCs than in RCs (mean proportions of Regression out: CC = .79 [SD = .41]) vs. RC = .71 [SD = .45]; proportions of Regression out full: CC = .86 [SD = .35] vs. RC = .79 [SD = .42]). In both cases, the effect of Sentence structure was significant (all ps < .03). In Figures 2 and 3 the proportions of Regression out and Regression out full in regions 2, 3 and 4 are graphically represented.

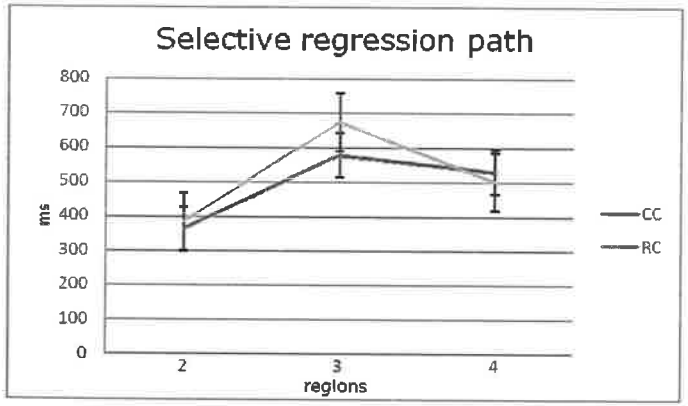


Fig. 1. Mean reading times for Selective regression path variable (duration of fixations and refixations within a region before the eyes enter a subsequent region) as a function of Sentence structure (CC vs. RC) for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

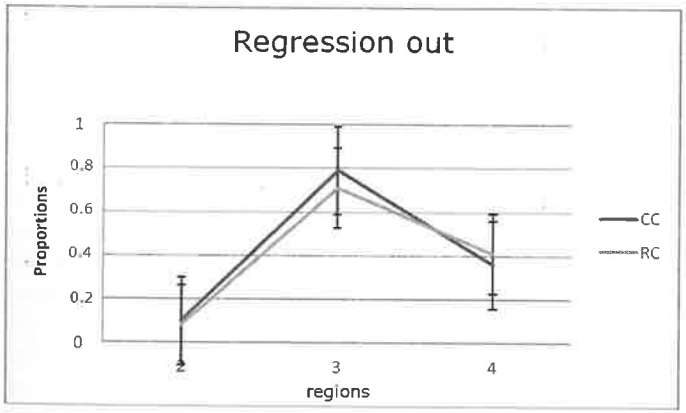


Fig. 2. Mean proportions of Regression out (whether regression(s) was made from a region to an earlier one, prior to leaving that region in a forward direction) as a function of Sentence structure (CC vs. RC) for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

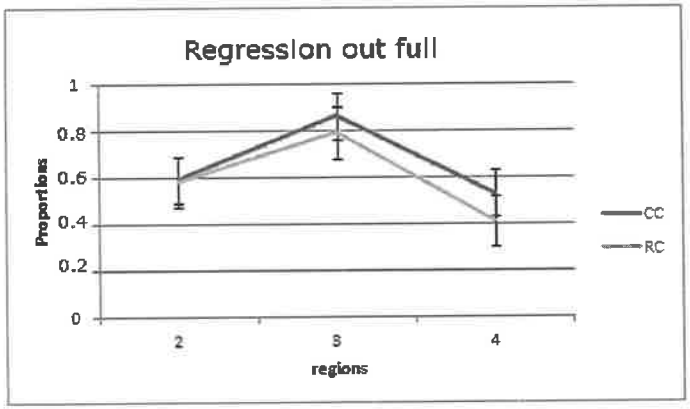


Fig. 3. Mean proportions of Regression out full (i.e., whether a regression was made from a region to an earlier one.) by Sentence structure (CC vs. RC) for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

To sum up, the analysis in region 3 revealed an effect of Sentence structure in Selective regression path, indicating a preference for CCs over object RCs. However in two late measures such as Regression out and Regression out full a different pattern emerged: participants were more likely to make regressions to previous regions in CCs as compared to object RCs. In all the other models (except for Regression out and Regression out full) there was only an effect of length. As for the frequency variables, none of them contributed significantly to the models.

REGION 4: In all the models there was no significant effect of Sentence structure. Additionally, we did not find any effect of frequency: the only significant predictor appeared to be length.

5.6 Discussion

In Experiment 1 we observed a consistent pattern of results: Regression out and Regression out full variables indicated that CCs caused more regressions than object RCs in region 3, and that this tendency was consistent both during the first-pass of the sentence (i.e., Regression out), as well as when considering the total passes of the sentence (i.e., Regression out full). The significant effect of Selective regression path variable in region 3, indicating that object RCs caused longer reading times, was more controversial. Indeed, as we observed, participants were significantly more likely to skip region 2 when the sentence involved an object RC. Therefore, Selective regression path times in region 3 could conceivably have been slowed down because of this (accidental) tendency to skip region 2 in object RCs.

Note however that another possible concern about our results could be that the regression pattern was biased to a certain extent by the fact that CCs occurred mostly with a less frequent and more complex verb form (namely, subjunctive), whereas object RCs involved almost exclusively the indicative verb form. In order to overcome such possible concern, we ran the next experiment in English, a language that involves no subjunctive vs. indicative alternation in RCs and CCs. By doing so, we can unravel the underlying processing of CC vs. object RC structures, regardless of the verb form involved.

6 Experiment 2 – English

6.1 Participants

Twenty-four Australian English native speakers (13 M; Mean Age = 27 years) participated in this experiment. All participants had normal or corrected-to-normal vision. As in the previous experiments all the participants were accurate in the comprehension questions (more than 75% of correct responses).

6.2 Materials

We created 18 sets of sentences, using a total of 6 nouns (*conclusion*, *evidence*, *information*, *remark*, *rule*, *suspicion*), which were followed by an object RC (i.e., 22a), or by a CC (i.e., 22b). All the nouns occurred in 3 sets of sentences. As in the previous experiment, each experimental set was constituted of 2 sentences, which were almost identical with respect to their lexical content but differed in their structure, which could be an object RC (22a) or a CC (22b). Again, sentences were divided into five regions. As in Experiment 1, sentences in the same set differed only in region 3, namely the region where the disambiguation occurred. Note however that, whereas in Italian Object RCs and CCs are mainly disambiguated at the verb region, in English the disambiguation occurs at the post-verbal region. Thus, in English the difference between the two sentences is only due to the presence of a PP in the object RC (cf. 22a) and of a DP in the CC (cf. 22b). The full list of experimental sets is reported in Appendix B.

(22) a. \1The conclusion that1\2they had reached2**3at the end3**\4of their work4\5elicited warm applause5\

b. \1The conclusion that1\2they had reached2**3the end3**\4of their work4\5elicited warm applause5\

We normed the six nouns with respect to whether they had a preference towards a subject RC, object RC, or CC interpretation. To do so, we searched Google (on the American version of Google) and looked at the first 100 occurrences of the frame 'Det N that' for each of the 6 nouns (i.e., we searched for 'the conclusion that'). For each noun, we counted the occurrences for subject RC, object RC and CCs respectively. On average, out of the total occurrences, 57% involved a CC,

29% a subject RC, and only 14 % an object RC. The Poisson regression analysis revealed that there were significantly more occurrences involving a CC than a subject RC (Wald Z = -7.46, p < .001) and an object RC (Wald Z = -11.52, p < .001). Interestingly, there were also significantly more subject RCs as compared to object RCs (Wald Z = 5.21, p <.001). The estimated biases towards a subject RC, an object RC or a CC for each noun were then log-transformed and included in the eye-tracking data analysis in order to evaluate whether they contributed significant fit to the models.

6.3 Design, Procedure and Analyses

Design, Procedure and Analyses were the same as in Experiment 1. The independent variable Sentence structure (object RC vs. CC) was manipulated within participants and items. We added 36 filler sentences involving a declarative matrix sentence (e.g., 'Carol says that the boy is watching films'). As in the previous experiment, we further included 6 comprehension questions involving a yes-no response.

6.4 Results

Also for Experiment 2 we report the results for Region 2 ('they had reached'), 3 ('at the end' vs. 'the end') and 4 ('of their work').

(23) a. \1The conclusion that1\2they had reached2**3at the end3**\4of their work4\5elicited warm applause5\

b. \1The conclusion that1\2they had reached2**3the end3**\4of their work4\5elicited warm applause5\

REGION 2: In all the models there was only an effect of length. Only the First Pass variable revealed a consistent effect of Sentence structure (p < .025), indicating that RCs (M = 292.39, SD = 217.74) caused longer reading times as compared to CCs (M = 267.28, SD = 195.21). However note that First pass variable refers to the reading times during the first-pass of the sentence, i.e., before the eyes entered region 3, where RC and CC structures are disambiguated. Therefore such effect cannot be due to our experimental manipulation.

No other effects (except for length and a frequency related effect on Selective regression path) were found in this region.

REGION 3: In Region 3, Selective regression path reading times showed that participants were on average slower with RCs (M = 611.72, SD = 383.61) in comparison with CCs (M = 418.95, SD = 264.84; p < .04). Also Regression out full count revealed significantly more regressions in RCs (M = 1.02, SD = 1.00) as compared to CCs (M = .81; SD = .89; p< .012). Selective regression path

reading times and Regression out full count data for regions 2, 3 and 4 are graphically represented in Figures 4 and 5 respectively.

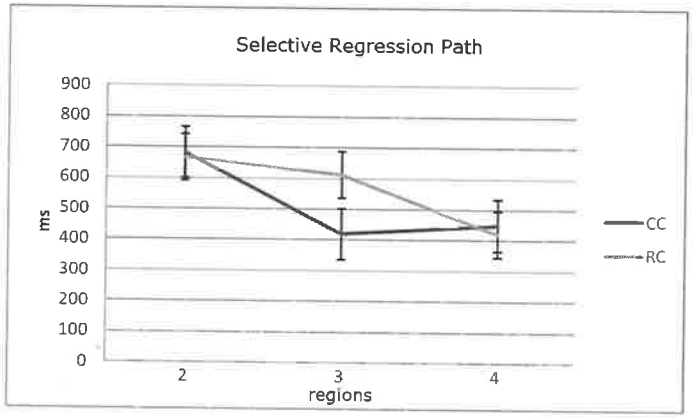


Fig. 4. Average reading times by Sentence structure (CC vs. RC) of Selective regression path variable for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

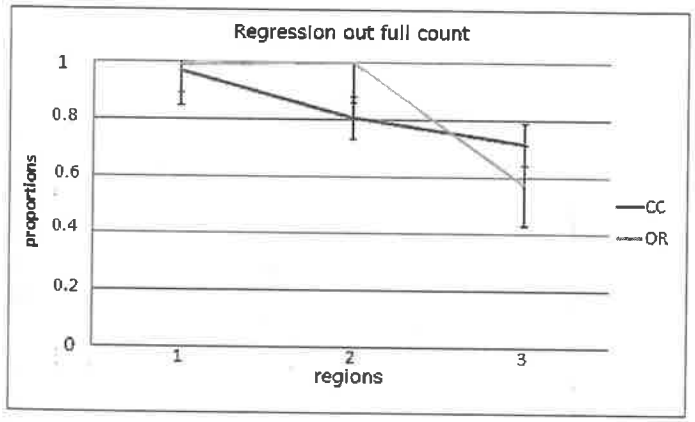


Fig. 5. Mean number of Regression out full count by Sentence structure (CC vs. RC) for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

This pattern is in contrast to what was observed in Experiment 1 on Italian. However, before concluding that a real cross-linguistic difference is observed, we checked the experimental stimuli in search for a potential bias. Interestingly, in some (five) of the object RC sentences, the post-verbal PP in region 3 was directly preceded by another preposition in region 2 (as 'The conclusion that they came to in Paris will have consequences for our actions'). We hypothesized that the processing of two adjacent prepositions could slow down reading times (as emerged in Selective regression path) and cause more regressions (i.e., Regression out full count).

In order to verify this hypothesis, we conducted a series of mixed effects models including the information about the presence (or absence) of two adja-

cent prepositions in the sentence as a dummy variable predictor. Remarkably, results confirmed that the presence of two adjacent prepositions between regions 2 and 3 significantly slowed down reading times in Selective regression path data (b = 35.49, SE = 13.37, t = 2.65, p < .013) and caused more regressions (b = .37, SE = .16, t = 2.29, p < .022). Crucially, when we added such variable to the models, it absorbed the effect of Sentence structure, that was no longer significant both in Selective regression path variable (b = 8.19, SE = 7.78, t = 1.053, p = .306) and Regression out full count (b =.09, SE =.09, t = 1.00, p = .316).

Overall, these findings led us to conclude that the slower reading times and the larger numbers of regressions with object RCs found in this region were due to a spurious effect. That is, they could be regarded as the reflex of an extra processing cost induced by the presence of two adjacent prepositions, instead of a re-analysis effect caused by the exposure to the RC structure. In all the other models we found only effects of length. None of the frequency variables appeared to predict the data in this region.

REGION 4. Importantly, Regression out data showed that CCs caused more regressions than RCs (p < .034). That is, participants were more likely to make regressions to previous regions with CC structures as compared to object RCs (proportions of Regression out: CC = .35 [SD = .48] vs. RC = .25 [SD = .43]; see Figure 6). Importantly, such pattern of regressions was consistent also in Regression out full and Regression out full count data, though in these variables the effect of Sentence structure did not reach significance (proportions of Regression out full: CC = .51 [SD = .50] vs. RC = .42 [SD = .42], see Fig. 7; proportions of Regression out full count: CC = .71 [SD = .83] vs. RC = .57 [SD = .76]; all ps = .06; see Fig. 5). In all the other models there was only an effect of length and, again, none of the frequency variables contributed to the models.

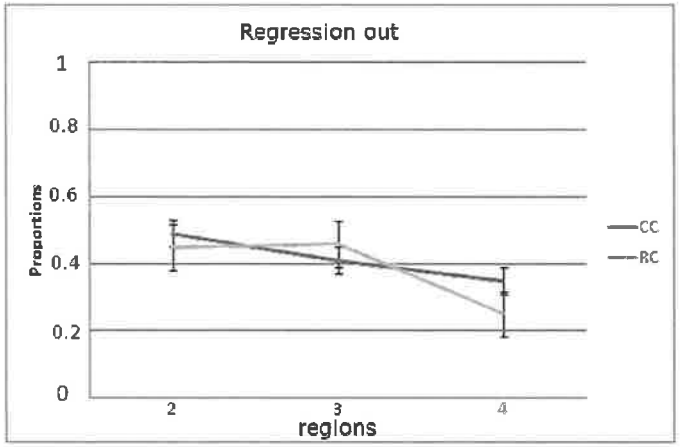


Fig. 6. Mean proportions of Regression out as a function of Sentence structure (CC vs. RC) for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

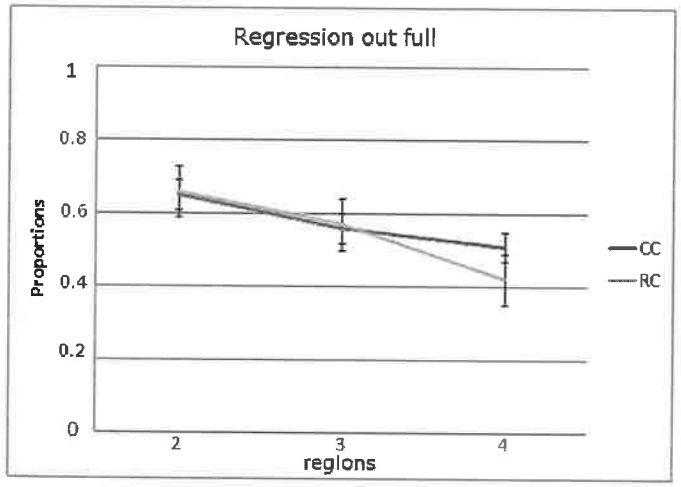


Fig. 7. Mean proportions of Regression out full by Sentence structure (CC vs. RC) for regions 2, 3 and 4. Error bars refer to the Standard Error of the mean.

6.5 Discussion

To summarize, the most important finding of Experiment 2 is the reliable effect found at region 4 in Regression out variable and, marginally, in Regression out full and Regression out full count, suggesting that CCs caused more regressions than object RCs. Note that this finding is consistent with that found in Experiment 1 with Italian data. The fact that the effect emerged in region 4 in English and in region 3 in Italian could be due to language-specific differences, that we will discuss further in the General Discussion.

As for the reading times, we found no reliable effects to support the claim that object RCs caused a slow-down in reading, and thus forced re-analysis. Indeed, as for the effect of Sentence structure found in the First pass variable at region 2, one needs to consider that this variable refers to the first-pass of the sentence, that is, before the eyes entered the region that allows to disambiguate between the two structures; though we cannot firmly exclude the possibility that parafoveal preview occurred. Furthermore, we demonstrated that the effect of Sentence structure obtained in region 3 in Selective regression path data, as well as in Regression out full count variable, was spurious, i.e., it was driven by the presence of two adjacent prepositions occurring only in object RCs. Results were clear-cut: computing sentences involving two adjacent prepositions was more costly (i.e., triggered more regressions and slowed down reading times) than when only one preposition was involved.

As for the frequency variables, there was some evidence for minor effects, but overall such variables contributed minor or null information to the fit of the models. We will discuss these findings and those from Experiments 1 and 2 further in the General Discussion.

7 General Discussion and conclusions

Our goal in this paper was to verify whether an experimental investigation based on eye-tracking methodology could provide evidence to decide between the two alternative (families of) analyses for RCs that have been proposed in the syntactic literature, namely what we called the classical analysis and the raising analysis. A preliminary question was whether a temporary ambiguity between a RC and a CC structure, like in the string of words 'the claim that John made ...', gives rise to a garden path effect. Answering this question required an experimental investigation, since the effect is not as sharp as in well-known cases of garden path.

In Experiment 1, we compared sentences containing a CC with minimally different sentences containing an object RC in Italian, while in Experiment 2 we did the same with English data.

As for this preliminary question, there is evidence suggesting that a garden path effect does arise, since the temporary ambiguity seems to be resolved in favor of the RC parse both in Experiment 1 and 2. The hallmark of the preference for RCs in Experiment 1 (Italian) is that CC caused significantly more regressions out of the critical region 3. Since region 3 is where the sentence is disambiguated, we interpret this result as an indication that some type of reanalysis is needed when the reader realizes that (s)he is reading a CC rather than an object RC. Interestingly, this effect is already detected by the Regression out variable, namely in CCs there are significantly more Regressions out from region 3 to a previous one, *prior to entering region 4*. Admittedly, our interpretation is weakened by the observation that a reading time measure (i.e., Selective regression path) at region 3 prima facie indicates longer reading times for RCs. However, we argued that this finding is due to a confounding, namely the fact that RCs happened accidentally to be more skipped than CCs in region 2 during the *first run* within that region. As region 2 precedes the disambiguation point, and the eyes did not enter yet region 3, this result cannot be due to any difference between CCs and RCs.

A further objection to our interpretation of the results of the Experiment 1 is that Italian CCs in most cases are fully felicitous only with a subjunctive verb (incidentally, this was confirmed by the completion task that we run). Accordingly, most CCs in Experiment 1 contained a subjunctive verb. Therefore, one might argue that the difficulty manifested by the bigger number of regressions with CCs might be a 'subjunctive effect', as arguably subjunctive is morphologically and semantically more complex than indicative.

In order to deal with this objection, we ran Experiment 2, in which CCs and object RCs are contrasted in English, a language in which CCs do not require the subjunctive mood. Crucially, the preference for RCs seems to be replicated in Experiment 2 and the hallmark for this preference was still a larger number of regressions, including Regression out. Interestingly, in English this effect was detected in Region 4 as a spill-over effect of the manipulation in Region 3, unlike in Italian where it was detected as early as in critical Region 3. The fact that the garden path effect does not emerge in the same exact region in Italian and English is not unexpected, though. Due to cross-linguistic differences and to the need to maintain the disambiguating point in Region 3, the division in areas is not precisely the same in the two languages. In particular, the embedded verb is in Region 3 in Italian experimental stimuli but is in Region 2 in English experimental stimuli. Therefore, the detection of the garden path effect in Region 3 in Italian might be due to the fact that the subjunctive form of the verb (which is found in this region) adds to the magnitude of complexity of the CCs.

A complication with the claim that also Experiment 2 shows an initial preference for CCs is that we detected longer reading times with RCs in Region 3. However, we argued that this effect disappears when one controls for a confounding factor (the fact that in some stimuli two prepositions appear one after the other as in 'The conclusion that they came *to in* Paris will have consequences for our actions').

Based on this complex pattern, we tentatively answer our first research question by saying that a garden path effect arises in the CCs both in Experiment 1 and in Experiment 2. Although the results of both experiments were partly affected by confounding factors, in both English and Italian a reanalysis process was signaled by the tendency to regress more with CCs in contrast with RCs. Note that in the literature (e.g., Frazier & Rayner, 1982; but see also Staub, 2010), regressions indicate that the parser is engaged in reanalysis, exploiting whatever information is available in previous regions to guide its reanalysis. The fact that regressions were more likely in CCs suggests that CCs are less successfully parsed than RCs. Therefore the RCs parse seems to be preferred in comparison with CCs.

Our second general question was whether such experimental investigation had something to say about the debate concerning the correct analysis for RCs in the syntactic literature. We compared what we called the classical approaches (namely the (null) operator and the matching analysis) and the raising analyses, with a special focus on the relabeling analysis proposed by C&D. The latter is particularly relevant for this paper since it reverses standard wisdom about RCs and CCs by assuming that RCs are akin to complementation (because the raised head provides the label much like a head provides the label in head-complement configurations) while CCs are akin to adjunction (because CCs can be late merged after D and the N taking the CP 'complement' have already been merged).

As we discussed in Section 4, the classical approaches to RCs predict a preference for the CC parse over the RC parse: if the CC is a genuine complement of the noun and the RC is adjoined to the noun, the DP containing the CC should have one node less. Therefore the CC parse should be preferred under the Minimal Attachment principle.

Also the raising analyses may predict a preference for the CC parse, but for another reason: a RC involves the complex chain of the head noun and the Minimal Chain Principle dictates that the parse that postulates the presence of a gap should be dispreferred.

The relabeling analysis is an exception, though. In fact it has the potential to explain why the RC parse seems to be initially chosen. Admittedly, a chain is postulated by the relabeling analysis as well, so in this respect the Minimal Chain Principle continues to favor the CC parse. However, the core of the relabeling analysis is the hypothesis that RCs are created by the same mechanism that is responsible for the creation of the Head-Complement configuration, while CCs are adjunct-like categories (despite their name), since they are late merged. We take for granted, as assumed in the garden path model, that basic structure building operations are preferred to adjunction structures. Therefore, in this respect, the relabeling analysis predicts that RCs should be preferred to CCs. All in all, the relabeling analysis does explain the initial preference of the parser for RCs if it is further assumed that, in case of conflict between the Minimal Chain Principle and whatever principle guarantees that basic structure building operations take priority, the latter wins.

We conclude this paper going back to the classical case of garden path effect in (15), namely 'The horse raced past the barn fell'. How come the reduced relative reading of this sentence is strongly disfavored, if, as our results seem to suggest, the RC parse is preferred when a RC/CC temporary ambiguity arises? We reason as follows: in (15) the preferred parse in which 'the horse' becomes the subject of predication involves a basic structure building operation, although it is different from the configuration of complementation that according to our analysis underlies relativization. For this reason, the principle that favors fundamental structure building operation does not discriminate between the two readings of the temporary ambiguous structure 'the horse raced past the barn …'. However, the Minimal Attachment principle does, since the reduced relative reading clearly involves more nodes than the simple transitive reading. Therefore the reduced relative reading is disfavored.

As for the CC/RC ambiguity, as we said in Section 4, the Minimal Attachment principle is irrelevant, because under the raising analyses (including the relabeling analysis) the RC parse does not have more nodes than the CC parse. So, the preference of the parser is determined by an interplay of the Minimal Chain Principle, which should favor CCs, and the principle that favors structure building operations over adjunction, which should favor RCs. Our result suggests that the latter principle takes priority.

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Appendix A

We report the sentences used in Experiment 1 (Italian) (RC vs. CC). For each Italian sentence is given, between brackets, the English translation.

1. L'ordine che l'ufficiale diede con/desse la notizia è arrivato tardi. [The order that the officer gave with/ should give the news arrived late]
2. L'ordine che la scuola impartì con/impartisse le istruzioni anti-incendio era ragionevole. [The order that the school gave with/gave the fire instructions was sensible]
3. L'ordine che il soldato portò con/portasse rispetto all'ufficiale non fu ben accolto. [The order that the soldier carried with/carried respect to the officer wasn't welcome]
4. La paura che Piero comunicava con/comunicasse la sua ansia ai figli era giustificata. [The fear that Piero communicated with/communicated his anxiety to his children was justified]
5. La paura che Gianni nascondeva ai/nascondesse i suoi figli lo rese sospetto. [The fear that Gianni hid to/hid his children made him suspicious]
6. La paura che i ragazzi esprimevano con/esprimessero il loro disagio fu troppo sottovalutata. [The fear that the boys expressed with/expressed their discomfort was underestimated]
7. Il comando che i poliziotti nascondevano alle/nascondessero le autorità civili era inquietante. [The order that the police officers hid to/hid the civic authorities was disturbing]
8. Il comando che le spie comunicarono alla/comunicassero con la sede di Mosca non arrivò in tempo. [The order that the spies transmitted with/transmitted with the Moscow Headquarters didn't arrive in time]
9. Il comando che il quartier generale trasmise con/trasmettesse il suo dispaccio era di estrema importanza. [The order that the Headquarter transmitted with/transmitted its message was crucial]
10. Il dubbio che Antonio comunicava con/comunicasse le sue azioni ci inquietò molto. [The doubt that Antonio expressed with/expressed his actions worried us]
11. Il dubbio che il ragazzo manifestava con/manifestasse il suo comportamento era condiviso da molti di noi. [The doubt that the boy showed with/showed his behavior was shared by many]
12. Il dubbio che l'oratore motivava nei/motivasse i presenti era infondato. [The doubt that the speaker motivated in/motivated the public was unfounded]

13. Il desiderio che Luca comunicò ai/comunicasse con propri genitori era comprensibile. [The desire that Luca communicated to/communicated with his parents was understandable]
14. Il desiderio che Maria manifestava con/manifestasse la sua gioia non era facile da realizzare. [The wish that Maria expressed with/expressed her joy was not easy to fulfill]
15. Il desiderio che Leo reprimeva nel/reprimesse il proprio comportamento era fonte di imbarazzo. [The desire that Leo repressed in/repressed his own behavior was a source of embarrassment]
16. L'ordine che i giornalisti ricevettero dai/ricevessero i politici fu decisivo. [The order that the reporters received from/received the politicians was crucial]
17. L'ordine che l'addetto stampa negò nella/negasse la prima dichiarazione non venne da noi. [The order that the press agent denied with/denied the first declaration was not from us]
18. L'ordine che il parroco confessò al/confessasse il vescovo era imbarazzante. [The order that the minister confessed to/confessed the bishop was embarrassing]
19. Il progetto che Gianni giustificava con/giustificasse le sue parole era farina del suo sacco. [The plan that Gianni justified with/justified his own words was the fruit of his labor]
20. Il progetto che il sindacato sosteneva fra/sostenesse gli operai irritò la Confindustria. [The plan that the Trade Unions supported among/should support workers annoyed the tycoons]
21. Il progetto che il candidato rivelò ai/rivelasse i suoi sostenitori era piuttosto audace. [The plan that the candidate revealed to/revealed his sustainers was rather bold]
22. L'insinuazione che il presidente nascose ai/nascondesse dei finanziatori gli fece dei danni. [The insinuation that the president hid to/hid his funders damaged him]
23. L'insinuazione che la polizia diffondeva con le/diffondesse delle calunnie sui suoi critici causò lo scandalo. [The insinuation that the police spread with/spread slanders on its critics caused a scandal]
24. L'insinuazione che il presidente avrebbe smentito con/avrebbe smentito il suo vice stava già circolando. [The insinuation that the president would deny/deny with his assistant was already circulating]

Appendix B

We report the sentences used in Experiment 2 (English) (CC vs. RC).

1. The conclusion that they came to Paris/to in Paris will have consequences for our actions.
2. The conclusion that they had reached the end/at the end of their work elicited warm applause.
3. The conclusion that Mary jumped to third grade/in third grade turned out not to be correct.
4. The evidence that they were aware of the time/at the time turned out to be of little use.
5. The evidence that John had sent some information/together with some information turned out to be relevant.
6. The evidence that he had exhibited little respect/with little respect for his neighbor did not help him.
7. The information that they had communicated with WikiLeaks/to WikiLeaks never got published.
8. The information that she had discovered the site/on the site turned out to be important.
9. The information that they had kept the secret/secret helped them.
10. The remark that John would cut his lengthy speech/from his lengthy speech was not interesting to the audience.
11. The remark that the president would add his personal conclusions/to his personal conclusions surprised everyone.
12. The remark that the president would make the new law/about the new law came as no surprise.
13. The rule that one class has to follow lunch/at lunch will shortly be abolished.
14. The rule that students must obey the teacher/along with the teacher is rather clear.
15. The rule that players have to learn the game/in the game cannot be abolished.
16. The suspicion that John's behavior had aroused his neighbors/in his neighbors contributed to his decline.
17. The suspicion that his words had provoked the audience/in the audience didn't help him.
18. The suspicion that he had caused the accident/by accident put an end to his campaign.