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RESEARCH

Intervention effects in the relative clauses of agrammatics: The role of gender and case

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Individuals with agrammatic aphasia are known to have difficulties interpreting Object Relative Clauses (ORCs), but not Subject Relative Clauses (SRCs). This asymmetry is recently understood by resorting to locality principles, captured by a featural version of Relativized Minimality (RM). The same principles are held responsible for intervention effects of phi-features with the same value in child language, when these are syntactically active. There are no studies on the intervention effects of phi-features in agrammatism.

This work investigates comprehension of headed Relative Clauses (RCs) by Greek-speaking non-fluent Broca's aphasics (agrammatics), focusing on gender and structural case, which the language marks on both the determiner and the noun. Two RC tasks were administered, differing on whether the case of the first (relativized) DP was nominative or accusative, depending on the preceding instruction. The findings established the expected SRC vs. ORC asymmetry, shedding light to earlier misleading results due to side effects of case morphology. Moreover, a strong similarity effect of gender was found in ORCs, although it is not a syntactically active feature in the relevant sense in Greek. We claim that the similarity effects of gender in the ORCs of Greek-speaking agrammatics are not intervention effects anchored to some specific principle of syntactic locality. Support for this claim is also provided by their presence even in the SRCs of the same individuals.

As for structural case, neither intervention nor general similarity effects of it were detected. There were, however, additional difficulties for SRCs whose relativized subject had accusative, not patterned by ORCs with nominative relativized objects. We suggest that one has to ensure that relativized subjects end up with nominative case in the RCs tasks of languages with rich case morphology, and conjecture that phi-features are not involved in the computation of locality in agrammatism.

Keywords: Relative clauses; agrammatism; gender; case; Relativized Minimality

1 Introduction

Individuals with agrammatic aphasia are known to have difficulties interpreting object Relative Clauses (RCs). Relative clauses (RCs) are standardly considered to involve movement of a noun from some position within the sentence in which it originates to the very beginning of it, known as left periphery. Syntactic movement is also standardly considered to leave a mark at the position from which it started, shown by the brackets in (1) and (2).

(1) This is the boy who <boy> pushed the girl. Subject RC
(2) This is the boy who the girl pushed <boy>. Object RC

This paper focuses on the comprehension of (headed) RCs by agrammatics, that is, on sentences such as in (1) and (2), in which the subject or the object has moved to the left periphery, hence, subject RCs (SRCs) and object RCs (ORCs) respectively. During recent

years a new and different approach to the problems RCs pose in agrammatism has been developed, which explains, among other things, the well-known asymmetric performance between SRCs and ORCs (Grillo 2003; 2009; Garraffa & Grillo 2008). The low performance of agrammatics on ORCs, (2), is accounted for by resorting to a fundamental principle of contemporary syntactic theory that regulates the dependency between a moved linguistic expression and its extraction site, the principle of Relativized Minimality (RM), (Cinque 1990 et seq.; Rizzi 1990 et seq.). When a syntactic constituent is displaced, a relation is created between the position at which it ends up and the position from which it started, which is the position at which it is interpreted. For RM, syntactic relations have to be satisfied in the most local structural domain (Minimal Configuration), defined as below:

(3) Minimal Configuration: … X … Z … Y …
Y is in a Minimal Configuration with X iff there is no Z such that
i. Z is of the same structural type as X, and
ii. Z intervenes between X and Y[1]

Grillo proposes that ORCs, (2), are impaired in agrammatism because the noun phrase, henceforth, Determiner Phrase (DP) 'the girl', i.e., Z in (3), intervenes between the DP 'the boy', X, and the position from which it originated, <boy>, Y in (3). Since the two DPs are of the same structural type, a notion to which we will return, the noun that has moved cannot form a syntactic relation with the trace it left behind in the most local structural domain. This is not the case for SRCs, (1), since the noun that moves to the beginning of the sentence is the subject, and no other DP/noun intervenes in its relation with the position from which it started.[2]

The obvious question that arises is why (2) does not create problems for healthy individuals. The answer that follows from Grillo's account is that, although the DP 'the girl' is found between the DP 'the boy' and its trace in the language of healthy individuals, the two DPs are not of 'the same structural type'. The presence of a *wh*-feature renders the relativized noun a member of a different class of items (a Q element, belonging to the Operators class), hence, the relativized object 'the boy' is different from the intervening subject DP 'the girl', which belongs to the Argumental class of nominal elements. This is not the case for agrammatics, however, as Grillo (2003; 2009) claims: the moved noun 'boy' is not associated with Q features in agrammatism and this is precisely what constitutes the core of the impairment, namely, a compromise of the full array of morphosyntactic features of linguistic expressions. A result of this compromise is that the two DPs in sentences such as (1) and (2) are of the same structural type, with the consequence that the second counts as an intervener in the relationship of the first with its trace in (2). This

[1] The difficulties ORCs pose for agrammatics have been approached in various other manners previously, one such focusing on their non-canonical word order and assignment of thematic roles, a view that goes back to Caramazza & Zurif (1976), and see also Bastiaanse & van Zonneveld (1998; 2005).

A much more syntactic approach to these difficulties has held that the traces of the moved elements are not present in the grammar of agrammatics (Trace Deletion Hypothesis; Grodzinsky 1990; 2000; 2006). As a result, there is trouble in interpreting ORCs, or other sentences in which the first DP is not an agent/logical subject.

[2] Grillo adopts a raising analysis to RCs, pointing out, however, that the same results can follow from a matching analysis. For an in depth review of the various accounts of RCs, see Bhatt (2002) and Bianchi (2002). It is not crucial either whether the term "trace", or "copy", Chomsky (1993), terms that are associated with a somehow different approach to movement, is used to refer to the position from which the moved elements have started.

Finally, while the notion of "same structural type" was defined in terms of the positions that the relevant elements occupied along the A vs. A' distinction in earlier versions of RM (Rizzi 1990), the notion refers to elements with the same morphosyntactic feature composition in the current version (Starke 2001; Rizzi 2004 et seq.). Rizzi (2013) points out that the shift to featural RM has been shown to meet empirical adequacy in a manner the position-based RM did not.

line of reasoning explains the problems of agrammatics with ORCs (and also with object *wh*-questions).

The idea that Relativized Minimality can explain similar behavior demonstrated by other populations has been explored extensively since then, although mostly in the context of early grammars. Directly inspired by Grillo's work, Friednmann et al. (2009) investigated children's RCs (and *wh*-questions). The authors manipulate the relativized DP or the intervening subject of ORCs in terms of their feature make up, in a way that there is either a partial match or a complete mismatch between the two. Moreover, they establish a more systematic categorization in terms of the features of the two DPs that participate in the sentences. For instance, a relativized element is considered to carry an [+R] feature, in the spirit of the [+Q] feature of questions. If the relativized (or questioned) element is lexically restricted, it further carries an [+NP] feature. The notion "lexically restricted" is better understood when comparing headed ORCs as in (4), which contain a lexically restricted DP, and free ORCs as in (5), which do not (both being structures investigated by Friednmann et al. 2009).[3] Obviously, the two DPs are more similar in (4) than in (5).

(4) Show me the monkey that the boy is hugging.
[+R, +NP] [+NP]

(5) Show me who the boy is hugging.
[+R] [+NP]

The results of these studies supported the view that the difficulties children experience with headed ORCs follow as intervention effects of the subject DP, hence, can be accounted for via RM. Other studies that manipulated the relation between the features of the displaced element and the DP that intervenes in the relation of the former with its extraction site arrive at interesting classifications in terms of whether all features of the two DPs must be identical or a subset of them is sufficient to induce intervention effects, and how child and adult grammars differ in this respect (Bentea et al. 2016; Villata et al. 2016).

Most relevant for the current study is the study of Belletti et al. (2012), which compares children's comprehension of RCs in Hebrew and Italian. Besides confirming the expected subject-object asymmetry in both languages, with ORCs creating many more problems than SRCs, this study revealed a selective effect of the feature gender. The authors showed that, when moved and intervening DPs have the same value for the feature gender in Hebrew ORCs (and object *wh*-questions), children perform lower than when the two DPs have a different value for it. Crucially, gender did not have an impact on the Italian-speaking children, who performed similarly (bad) on both types of ORCs. This difference between Hebrew and Italian offered Belletti et al. (2012) novel evidence to elaborate further into what may count as an intervening feature and whether "sameness" of a feature alone is sufficient to induce difficulties. Belletti et al. repeat the claim in Friednmann et al. (2009), this time supported by their comparative findings, that gender has the effect it does in Hebrew because it belongs to the set of morphosyntactic features that function as attractors for movement (of the subject to the specifier of IP in this case, Shlonsky 1997). A direct manifestation of the different status of the feature gender in the two languages is that verbs inflect for gender in Hebrew, but not in Italian. As is already known, DPs with the same number feature pose additional difficulties for Italian-speaking children's ORCs, Adani et al. (2010). This finding is also consistent with the claim in Belletti et al. (2012), since the Italian verb inflects for number, and number *is* a feature that triggers movement

[3] The notions correspond to the D-linked vs. non-D-linked distinction respectively (discussed in Pesetsky 1987 and Cinque 1990 first).

(of the relevant DP to subject position) in a similar manner gender (and number) does in Hebrew, hence, it is a syntactically active morphosyntactic feature.

The Belletti et al. study is important for many reasons: first, because it is one of the few studies that focus on a phi-feature of the DPs involved in RCs, rather than a discourse-type feature associated with elements that have moved to the left periphery, e.g., a [+Q] or a [+R] feature. Then, and most importantly, because by comparing two languages on the same structure and the same feature and obtaining different results, Belletti et al. demonstrate directly that not any type of similarity of morphosyntactic features can induce intervention effects. Therefore, the study clearly argues for a grammar specific source of intervention, rather than for some general cognitive similarities of DPs that are independent of their morphosyntactic properties.[4]

The progress that has been made during these years in immature and adult typical grammar has not been matched by research on aphasia, it seems to us. Although Grillo (2009) proposed explicitly the set of features that may create problems if present in both the moved and the intervening DPs, most of them have not been investigated to date. Exceptions are the study of Salmons (2015) for Catalan, which, nevertheless, focuses on a set of different structures that also involve the left periphery (i.e., topicalization and focus). Most recently, Adelt at al. (2017) study German RCs off-line and on-line in aphasia, but do not distinguish between case, number and gender features in order to reach conclusions with respect to the intervention effects due to each of them independently.

There were also other, less theoretical, reasons that made us undertake this study. One of two recent studies on the RCs of Greek-speaking agrammatics did not find a clear difference between SRCs and ORCs, Nerantzini et al. (2014). Nerantzini et al. found that, although the performance of the agrammatics they tested was better on SRCs than on ORCs, the difference between the two types of RCs was not statistically significant. One would want to find out, therefore, whether this result is something that indeed holds in the language, or it was merely an accident, most probably due to some flaw of the experiment, which the authors themselves actually suspect, and we bring up later in the Discussion section.

Finally, in addition to the above, one would also want to know more about the effect of the various morphosyntactic features of the DPs involved in the structures that implicate movement, and their potential intervention effects in agrammatism, since, as already mentioned, not many such studies exist. Moreover, the ones that have been conducted, not just in Greek but also crosslinguistically, have so far focused on scope-discourse related features, which are associated with the left periphery (Nerantzini et al. 2014; Varlokosta et al. 2014; Salmons 2015). Given the previous discussion and the progress that has been made in child language, we thought that the morphosyntactic feature that should be investigated in agrammatism is gender. The main reason is because it is a phi-feature of DPs that has led to important claims regarding the computation of intervention effects on the basis of child language (Friednmann et al. 2009; Adani et al. 2010; Belletti et al. 2012; Bentea et al. 2016). It is natural to ask, therefore, whether impaired adult language follows the same pattern, with Greek expected to behave like Italian, since there is no obvious reason to believe that gender is an active morphosyntactic feature in the language. If the contrary is found one should ask why this is so and what this entails for a theory of intervention effects or for the two grammars (immature and agrammatism), which have often been compared or considered to behave similarly in several respects (Avrutin 2000). We will claim that, contrary to discourse/left periphery related features and contrary to

[4] For other studies that also argue for a grammatically based source of performance errors, sensitive not only to the markedness of the intervener, but also to its structural position, see Garraffa & Di Domenico (2016).

what has been found and claimed for children's grammar, phi-features are not relevant for computing locality and inducing intervention effects in agrammatism. When such effects appear to be present they are similarity effects that are not anchored to some specific principle of grammar.

2 The language and the study

2.1 Greek RCs

RCs of different kinds (restrictive, non-restrictive or pseudo-relatives) and embedded clauses after emotive factive predicates are introduced by the complementizer *pu* in Greek. Sentence (6a) below is a SRC and (6b) is an ORC.

(6) a. O naftis pu akoluthi ton nearo … (SRC)
the.NOM sailor.NOM that follows the.ACC young man.ACC
'The sailor that follows the young man …'

b. O naftis pu akoluthi o nearos … (ORC)
the.NOM sailor.NOM that follows the.NOM young man.NOM
'The sailor that the young man follows …'

DPs are marked with case (nominative or accusative in subject and object positions respectively) and gender morphology (masculine, feminine, or neuter), overtly expressed both on the determiner and the noun.[5] Unlike nominals, verbs are not inflected for gender, hence, Greek is unlike Hebrew in this respect, and like Italian, indicating that gender is not a syntactically active feature in the relevant sense in Greek.

A-bar movement e.g., *wh*-, focus movement or relativization of an object across a subject triggers subject inversion, hence, the subject surfaces post-verbally in (7)–(8). The consensus in previous literature about the position of inverted subjects in *wh*-questions is that they are in a VP-internal position (cf. Anagnostopoulou 1994; Kotzoglou 2006).[6] We assume that inverted subjects are no different in RCs, therefore they occupy a VP-internal position, which counts as an intervening one for the movement dependency established in ORCs, (9).

(7) O naftis pu akoluthi o nearos…/
the.NOM sailor.NOM that follows the.NOM young man.NOM/
?*O naftis pu o nearos akoluthi…
the.NOM sailor.NOM that the.NOM young man.NOM follows
'The sailor that the young man follows …'

(8) Pjon akoluthi o naftis/ *Pjon o naftis akoluthi?
who.ACC follows the.NOM sailor.NOM/ who.ACC the.NOM sailor.NOM follows
'Who does the sailor follow?'

(9) O naftis [$_{CP}$ pu [$_{T}$ akoluthi [$_{VP}$ o
the.NOM sailor.NOM that follows the.NOM
nearos [$_{v}$ <akolouthi> < naftis> …
young man.NOM
'The sailor that the young man follows …'

[5] There is some degree of syncretism with respect to gender morphology of feminine nouns. Syncretism is much more pervasive in neuter nouns, this is why they are avoided in this and other related experiments.

As for the sentences in (6), they are in isolation, this is why the relative head in (6b) does not retain the (accusative) case it is assigned underlyingly, and cannot be case marked accusative by a matrix predicate either, since there isn't any. Rather, it is probably exceptionally assigned a default nominative, along with the relative head in (6a), where one cannot detect this process because it is a SRC.

[6] And see also Roussou & Tsimpli (2006) for the view that post-verbal subjects are in a low clitic position.

Table 1: Participants' Profile.

	P1	P2	P3	P4	P5	P6
Gender	Male	Male	Male	Male	Male	Male
Age	48	56	51	65	71	53
Education (years)	12	12	10	12	9	6
Type of lesion	Left CVA	Left CVA	Left CVA	Left CVA	Left CVA	Left CVA
Lesion site	Left inferior frontotem-poral	Left inferior frontotem-poral	Left inferior frontotem-poral	Left inferior frontotem-poral	Left inferior frontotemporal	Left
Hemiparesis	Yes	yes	Yes	Yes	Yes	yes
Mini mental state examination	28/30	27/30	27/30	27/30	27/30	27/30
BDAE – Auditory comprehension words	90	100	80	80	90	100
BDAE – Auditory compre-hension commands	90	90	90	90	90	90
BDAE – Auditory com-prehension complex material	100	90	90	100	100	90
Total	90	90	90	90	90	90
BDAE – Oral expression – word repetition	70	70	50	40	50	60
BDAE – Oral expression – sentence repetition (1)	60	70	50	50	60	50
BDAE – Oral expression – sentence repetition (2)	70	80	70	40	70	70
BDAE – Reading words	60	70	60	0	60	70
BDAE – Reading sen-tences	60	60	60	0	60	60
Spontaneous Speech Data						
Words per minute	13.5	34.2	27.7	14	13.5	42.7
Grammatical sentences	4	5	6	6	5	7
MLU	1.6	2.05	1.8	1.9	1.6	2.3
Noun: Verb ratio	1.5–(1)	1.1	1.5–(1.l)	1.25–(0.6)	1.4–(0.6)	1.7 (1.4)

2.2 The participants

18 right handed individuals participated in the study to be reported, all native speakers of Greek. 6 of them were non-fluent Broca's aphasics, (Ps), and 12 constituted their control group, (Cs). There were two control participants for each aphasic, matched for age, gender and education. The participants with Broca's aphasia were assessed via the Greek version of the Boston Aphasia Battery (Papathanasiou et al. 2008). Aspects of this assessment appear in Table 1, along with additional characteristics that make up the aphasic participants' profile.

All aphasic participants were diagnosed as non-fluent Broca's aphasics (agrammatics) by an experienced speech-language pathologist on the basis of their spontaneous speech, which consisted of short and simple sentences, with verbs almost exclusively in the present tense, and some omission of determiners. Their spontaneous speech samples, based on the Cookie Theft story, appear in the Appendix.

2.3 The materials

A number of language tasks were administered to the participants, in addition to the RC tasks that are the focus of the present study and will be presented in detail in the following section. These were: a) a Past Tense/Reference elicitation task, b) an object clitics elicitation task, c) two comprehension tasks of passive sentences (short and long passives).[7] For the purposes of a different project (see Nerantzini et al. 2015), the aphasic participants were also assessed on their mastery of case morphology. The tasks were administered in three or four sessions within a week.

3 First study of Relative Clauses

Two tasks were administered for assessing the comprehension of RCs. They differed slightly from each other in ways we will explain, along with the reasons that lead us to administer two instead of one tasks.

The first study (Study I) investigated the comprehension of SRCs and ORCs via a picture matching task, as part of a larger protocol with 94 sentences in total. There were 48 RCs in the protocol, 24 of which were SRCs, and 24 ORCs. In half of the sentences of each type the two DPs had the same value for the feature gender (match condition), hence, in 6 sentences the two DPs were feminine and in the other 6 masculine. In the other half the two DPs had a different value for gender (mismatch condition); in 6 of these the first DP was masculine and the second feminine, and in the other 6 the reverse. The DPs referred to professions, e.g., "sailor", "cook", etc., and family and other related terms, such as "grandmother", "grandfather". Hence, grammatical gender had a rather direct correspondence to physical gender. Representative items of the four conditions of the task appear in (10). As demonstrated in (10), each sentence was preceded by the instruction *edho ine* 'here is', an important aspect of the study, as it will become obvious soon. Figure 1 contains the three-slide sets that assess the four conditions in (10).

(10) a. *Subject relative same gender* (SRC-match)
Edho ine o kirios pu fotoghrafizi ton maghira.
here is the.NOM man.NOM that photographs the.ACC cook.ACC
'Here is the man that photographs the cook.'

b. *Subject relative different gender* (SRC-mismatch)
Edho ine o papus pu chirokroti ti nifi.
here is the.NOM grandpa.NOM that applauds the.ACC bride.ACC
'Here is grandfather that applauds the bride.'

c. *Object relative same gender* (ORC-match)
Edho ine i vasilisa pu akoluthi i kiria.
here is the.NOM queen.NOM that follows the.NOM lady.NOM
'Here is the queen that the lady follows.'

d. *Object relative different gender* (ORC-mismatch)
Edho ine i jaja pu fotoghrafizi o ghabros.
here is the.NOM grandma.NOM that photographs the.NOM groom.NOM
'Here is the grandmother that the groom photographs.'

[7] The detailed results of these tasks, as well as related discussion, can be found in Nanousi & Terzi (2017) and Terzi (2017). For the curious reader, we report here that the aphasics had above 90% target performance on the comprehension of passives sentences, but did poorly on the past tense (especially of pseudo-verbs) and on the object clitics elicitation tasks. In all these tasks control participants performed at ceiling, or almost at ceiling.

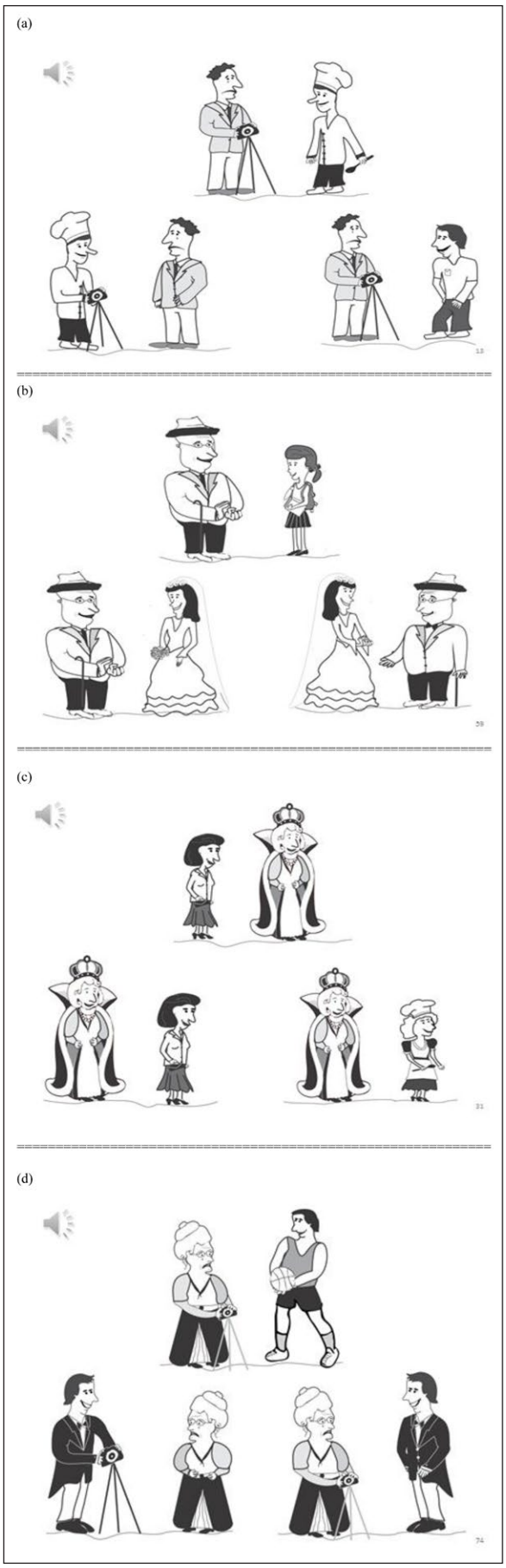

Figure 1: Picture matching task assessing comprehension of RCs.

Table 2: Error rate on RCs – Study I.

Aphasics	*SRC Total*	*SRC Match*	*SRC Mismatch*	*ORC Total*	*ORC Match*	*ORC Mismatch*	*Actives Total*	*Controls*	*SRC Total*	*ORC Total*
	n = 24	**n = 12**	**n = 12**	**n = 24**	**n = 12**	**n = 12**	**n = 24**		**n = 48**	**n = 48**
P1	2	2	0	10	9	1	0	C1a+C1b	0	1
P2	1	1	0	7	5	2	0	C2b+C2b	1	1
P3	0	0	0	9	5	4	0	C3a+C3b	0	0
P4	5	4	1	11	7	4	0	C4a+C4b	1	4
P5	5	4	1	14	7	7	0	C5a+C5b	0	2
P6	3	3	0	9	6	3	2	C6a+C6b	0	0
Total	16	14	2	60	39	21	2	*Total*	2	8
	16/144 (11.1%)	14/72 (19.4%)	2/72 (2.8%)	60/144 (41.7%)	39/72 (54.2%)	21/72 (29.2%)	2/144 (1.4%)		2/288 (0.7%)	6/288 (2.0%)

The picture selection task was administered on a computer screen by using a powerpoint presentation. Three pictures were presented in each slide, one that corresponded to the sentence we wanted to assess (target picture), and two more. For SRCs, besides the target picture, there was a picture depicting the corresponding ORC and a third one (distractor) in which the subject of the target sentence performed the action of the same verb to another individual. For ORCs, besides the target picture, there was a picture of the counterpart SRC and a third one in which the object of the target sentence performed the action of the same verb to another individual. Sentences were pseudorandomized, and the position of the target picture was pseudorandomized both within each condition and within the entire protocol, so that: a) sentences with the same verb were not next to each other, b) no more than two sentences of the same condition were next to each other, and c) no more than two sentences with the target picture in the same position were not next to each other. The sentences were recorded by two female native speakers of Greek, so that all participants heard them in exactly the same manner. Participants were instructed to choose the right picture after they hear the corresponding sentence. In the beginning they were presented with two slides that contained all the characters of the task, and, subsequently, they were given four training sentences to match to the corresponding pictures. It took two sessions for the aphasic participants to complete the task.

3.1 Results

The results of Study I appear in Table 2. This Table also contains the results of the aphasic group on the active transitive sentences of the task, and those of the control participants on SRCs and ORCs together.

As one may observe, there is a significant difference between the overall performance of the aphasic participants on ORCs and SRCs. Whereas more than 41% of the participants appear to regularly struggle with ORCs, the respective error rate for SRCs is slightly higher than 11%. The difference is statistically significant (paired t-test, $t(5) = -11.931$, $p < 0.001$) and is further supported by the fact that the error rate on active sentences is much lower. In fact, only 2 errors were observed in sentences with two DP arguments such as 'Here the grandmother photographs the groom', which amounts to an error rate of 1.4%, indicating that the aphasic participants had no problem with the task per se.

A more analytical drill-down of the ORCs across the gender distinction revealed another statistically significant difference, at the 5% level (paired t-test, $t(5) = 2.666$, $p < 0.05$). The error rate on ORCs with DPs that have the same value for the feature gender (ORCs

– match) is 54.2%, while of the ORCs with DPs of different gender (ORCs – mismatch) is only 29.2%. It should be pointed out that although participants were presented with three pictures to choose from, chance level was not at 33% since they almost never picked the distractor picture. Finally, the error rate of the healthy controls was 0.7% for SRCs and 2% for ORCs and because it was so low we did not analyze their results any further.

Some first conclusions to draw therefore are that: a) ORCs do indeed create a much bigger problem than SRCs for the Greek-speaking agrammatics, and b) same value for the feature gender constitutes an additional source of difficulty for the comprehension of ORCs. Such an effect of the feature gender has been reported, but in studies of immature grammar/child language, cf. Belletti et al. (2012). The current findings suggest at first glance that the gender feature plays a similar role in the language of the Greek-speaking individuals with Broca's aphasia.

A closer look at the details of the experiment, however, reveal two factors that have to be given a second thought before settling with the findings just reported. These are factors that may have rendered ORCs more difficult than what they actually are, hence, may have rendered the difference between ORCs and SRCs more pronounced, but for reasons other than the intervention effects that we are investigating. As a consequence, the effect of gender may have been more pronounced as well. Recall that the experimenter introduced the sentences with the phrase 'here is …', (10). If one introduces a sentence in this manner, the DP that follows the introduction *must* bear nominative case. This is fine for SRCs, because the first DP of the sentence is the subject with the agent thematic role, and it typically bears nominative case in a language such as Greek. It may not be fine for ORCs, however, since the first DP, which corresponds to the relativized object, also bears nominative case, despite the fact that it starts out with accusative and it is the DP with the patient thematic role. This case discrepancy between the relativized element in its surface vs. underlying positions, which is an outcome of the manner in which the experiment is administered, may pose an additional difficulty for ORCs. Because case morphology is often considered to assist in figuring out grammatical functions/thematic roles, see, for instance, Stavrakaki et al. (2015) for typically developing Greek-speaking children, it may be that it creates additional difficulties for the ORCs of this task and it blurs the results.

This is not the only difficulty that may arise for ORCs. Notice that the second DP of ORCs bears nominative, which looks all right, because it is the subject of the sentence and the DP with the agent thematic role. However, taken together with the first DP, it results in that both DPs bear the same (nominative) case in a task that assesses ORCs. This by itself may constitute an additional reason why ORCs are more demanding than subject SRCs in the overall: case morphology, which is distinct and overt in Greek, may be involved in the computation of similarity between the moved object and the intervening subject and induce additional difficulties in ORCs. It should be clarified that case has not been considered as one of the morphosyntactic features involved in the computation of similarity in the relevant sense (Rizzi 2004; Grillo 2009). Nevertheless, one would probably not want to exclude such a possibility, especially because it had not been tested experimentally before the current study was undertaken (and see also footnote 10).

To sum up, although the agrammatics of the current study performed clearly different on SRCs and ORCs, with much lower scores on the latter, it is conceivable that the ORCs turned out more difficult for reasons other than those that have standardly been taken to explain the difficulties they pose in agrammatism within a RM approach. They are reasons that have to do with the particular morphosyntactic features of the DPs in the language(s) under investigation, and how these interact with the manner in which the sentences are administered. They may arise in a paradigm such as the one at hand when a) the two DPs of ORCs end up with the same case feature, and b) there is no mapping between case and

thematic roles of the type expected in the active sentences of a Nominative language such as Greek, that is, accusative for the object with the patient thematic role and nominative case for the subject with the agent thematic role. We thought that these are potential confounds that should not be overlooked and one should not settle with the results of an experiment that contains them.

4 Second Study

In order to address the potential confounds of Study I, we administered to the same participants a follow up experiment (Study II). This time ORCs were not rendered additionally difficult for the independent reasons mentioned in the previous section, i.e., there were no relativized objects with nominative case, nor DPs with the same value for case.

The RC task employed in Study II differed from that of Study I in a simple, yet crucial, aspect: the RCs to be matched with the corresponding pictures were introduced by the instruction *dhikse mu* 'show me'. The consequence of this modification was that the DP that follows the instruction, namely, the relativized DP, has to bear accusative case (compare the head nouns of (10) and (11)). As a result, ORCs do not face the potential confounds mentioned in the previous section because: a) the first DP of the sentence has accusative case, it is the object of the sentence and has the patient thematic role, (11c)–(11d), and b) the two DPs of the sentence bear a different value for the feature case, that is, accusative and nominative. It turns out, however, that this is not an entirely trouble free task either, only that, contrary to the previous one, a potential confound arises for SRCs this time. Notice that the first DP of SRCs has accusative case, although it is the subject DP with an agent thematic role, (11a)–(11b), and this may render SRCs more difficult. Nevertheless, this is the only potential difficulty, and it is not of the relevant type for intervention effects. That the two DPs of SRCs have the same (accusative) value for the feature case is not expected to induce additional difficulty, since no intervention configuration is involved.

(11) a. *Subject relative same gender* (SRC-match)
Dhikse mu ton kirio pu fotoghrafizi ton maghira.
show me the.ACC man.ACC that photographs the.ACC cook.ACC
'Show me the man that photographs the cook.'

b. *Subject relative different gender* (SRC-mismatch)
Dhikse mu ton papu pu chirokroti ti nifi.
show me the.ACC grandpa.ACC that applauds the.ACC bride.ACC
'Show me the grandfather that applauds the bride.'

c. *Object relative same gender* (ORC-match)
Dhikse mu ti vasilisa pu akoluthi i kiria.
show me the.ACC queen.ACC that follows the.NOM lady.NOM
'Show me the queen that the lady follows.'

d. *Object relative different gender* (ORC-mismatch)
Dhikse mu ti jaja pu fotoghrafizi o ghabros.
show me the.ACC grandma.ACC that photographs the.NOM groom.NOM
'Show me the grandmother that the groom photographs.'

The same number of sentences was administered as in the previous study. There were 24 SRCs and 24 ORCs. In half of them, the two DPs have the same gender feature (match condition), while in the other half they have a different value for it (mismatch condition). Similar considerations as in Study I hold for the distribution of masculine and feminine DPs.

Table 3: Error rate on RCs – Study II.

Aphasics	*SRC Total*	*SRC Match*	*SRC Mismatch*	*OMC Total*	*ORC Match*	*ORC Mismatch*	*Actives Total*	*Controls*	*SRC Total*	*ORC Total*
	n = 24	**n = 12**	**n = 12**	**n = 24**	**n = 12**	**n = 12**	**n = 24**		**n = 48**	**n = 48**
P1	4	3	1	12	9	3	0	C1a+Clb	0	1
P2	2	2	0	8	6	2	0	C2b+C2b	1	0
P3	2	2	0	11	7	4	1	C3a+C3b	1	1
P4	4	3	1	11	6	5	1	C4a+C4b	0	3
P5	7	4	3	15	9	6	0	C5a+C5b	1	2
P6	3	2	1	10	6	4	2	C6a+C6b	0	1
Total	22	16	6	67	43	24	4	Total	3	8
	22/144 (15.3%)	16/72 (22.2%)	6/72 (8.3%)	67/144 (46.5%)	43/72 (59.7%)	24/72 (33.3%)	4/144 (2.8%)		3/288 (1.0%)	2/288 (0.7%)

4.1 Results

The results of Study II appear in Table 3. A quick look at it leaves us with the impression that performance has not changed in important ways from that in Study I.

The results in Table 3 are in accordance with the findings of Study I in many ways. Again, the observed difference between SRCs (15.3% error rate) and ORCs (46.5% error rate) is statistically significant at the 0.001 level (paired t-test, $t(5) = -17.516$, $p < 0.001$). Healthy controls had similarly low error rates, that is, 1% on SRCs and 0.7% on ORCs.

Importantly, even in this task there is a serious and statistically significant gap in performance on ORCs whose DPs have the same value for gender and those that do not, that is, an error rate of 59.7% vs. 33.3% respectively ($t(5) = 4.503$, $p < 0.01$).

Let us now turn to the effects of case that the two experiments reveal. The hypothesized additional difficulty on the SRCs of Study II, assumed to be induced by the fact that the relativized subject with the agent thematic role bears accusative case, indeed amounts to lower performance. The error rate on SRCs this time is higher when compared to the error rate of Study I, i.e., 15.27% vs. 11.11%, although the difference does not reach significance ($t(5) = -1.936$, $p = 0.11$). We consider this finding to indicate that when morphological case does not assist in figuring out the thematic role of a DP, in particular, when an agent subject has an accusative case feature, this may have a negative effect on the comprehension of a SRC in agrammatism, the extend of which has to be further confirmed.

Turning to ORCs, we are faced with an unexpected finding. Recall that Study II was designed so that ORCs in particular be void of difficulties that are independent of the aims of the investigation. Yet, a higher error rate emerged, namely, 46.5% (vs. 41.7% in Study I). The difference is not enormous, yet, it reaches significance ($t(5) = -3796$, $p < 0.05$). It is difficult to tell what the source of the lower performance on ORCs of Study II is, especially because the task was created with the expectation of similar, if not better, performance. What we can probably tell, however, is that lack of mapping between case and thematic role in this particular direction, that is, nominative for object DPs, does not pose difficulties in agrammatism. Most importantly, we can also claim with certainty that same value for the feature case of the two DPs participating in ORCs does not induce minimality effects, as there was no improved performance whatsoever on the ORCs of Study II, in which the two DPs had a different value for case. In other words, by contrast to gender, case morphology does not seem to play a role in the computation of similarity

between a moved DP and an intervening one for Greek-speaking agrammatics. We will return to these novel findings in the Discussion section.[8]

5 Discussion

Let us remind that one of the main aims of this study was to assess comprehension of SRCs and ORCs by Greek-speaking non-fluent Broca's aphasics, given the somehow inconclusive results of Nerantzini et al. (2014). In order to finalize our findings, we believe we should compare the results on those sentences that are not associated with any of the factors that may pose additional complications, along the lines laid out in the previous sections, regardless of whether the findings are to the expected direction or not. To this effect, we compare the performance of the aphasic participants on the SRCs of Study I with those on the ORCs of Study II. In these conditions, and for both types of sentences, we obtain: a) mapping between value of case feature and thematic role, in the sense that subjects have nominative case and agent thematic role, and objects have accusative case and patient thematic role, and b) the two DPs of the sentences have a different case feature, a factor that is actually relevant for ORCs only. We do not see anything wrong with this comparison methodologically or from a clinical point of view, since the two tasks were administered within three months from each other, a time span that is very short for independent clinical changes in the profiles of the aphasic participants.[9] Hence, we conclude with an error rate of 11.1% on SRCs and 46.5% on ORCs, a highly significant difference again ($t(5) = -10.041$, $p < 0.001$). Moreover, ORCs with DPs of the same gender value have a 59.7% error rate, while those of different gender have an error rate of 33.33%, a significant difference, as reported in Table 3 earlier. These are the findings that we consider to characterize the profile of the non-fluent aphasics of the current study on RCs, and the discussion that follows will be based on them, unless otherwise specified.

The performance of the Greek-speaking agrammatics on the comprehension of RCs that we have reported answers, but also poses, a number of questions. Let us start with the factual ones: as mentioned in the Introduction, in a recent study of the language abilities of Greek-speaking Broca's aphasics, Nerantzini et al. (2014) found that the six agrammatics they assessed performed slightly better on the comprehension of SRCs compared to ORCs, (73% vs. 67%), but the difference was not significant. The authors attribute the lack of a more pronounced difference between SRCs and ORCs to a flaw of the protocol

[8] Notice that the SRCs of Study II, (11a) repeated below as (i), are string identical to pseudo-relatives, (ii):

(i) Dhikse mu ton kirio pu fotoghrafizi ton maghira.
show me the man that photographs the cook
'Show me the man that photographs the cook.'

(ii) Idha ton kirio pu fotoghrafizi ton maghira.
saw–3s the man that photographs the cook
'I saw the man that photographs the cook.'

One could, therefore, doubt that the SRCs of Study II are structurally identical to those of Study I, hence, that it is valid to compare performance on the SRCs of the two Studies. We believe that if the structure of SRCs was indeed considered identical to that of pseudo-relatives by the aphasic participants in Study II, their error rate would probably be lower. This is so because, if anything, pseudo-relatives are standardly taken to not involve movement (of the subject to sentence initial position), Cinque 1992; Moulton & Grillo 2015). This is clearly not the case, as we saw. By contrast, on the assumption that movement per se may result in additional difficulties, the findings of Study II arguably offer support to the idea that the Greek pseudo-relatives, just like headed/restrictive relatives, *do* involve movement of the (subject) noun, a claim that has actually been made by Angelopoulos (2015). To be fair, however, no such views on the effects of movement alone exist in the psycholinguistic literature, to our knowledge.

[9] To address the concern of a reviewer, let us add here that the time between the onset of aphasia and the experiments was between 5 and 10 years for participants 1–5. Therefore, the spontaneous recovery that sometimes emerges during the first year after onset was very unlikely to have occurred in the three-month period between the two Studies. For participant 6, aphasia onset occurred 10 months before the experiment, but his results did not indicate recovery within the three-month period.

they administered. The sentences of their task were administered in the same manner as in our Study II, hence, the results raised the concern whether additional difficulty was posed for SRCs because the relativized subject appeared with accusative case, minimizing their difference from ORCs. Since we ran two studies with SRCs, in one of which the relativized subject had a nominative case feature, while in the other accusative, we can address this concern.

Comparison of the two studies we conducted showed that the accusative case feature of the relativized subject indeed affected performance on SRCs negatively. It is not entirely clear how crucial this negative effect is, however, since, a) the difference between the SRCs of the two studies, although to the predicted direction, was not found statistically significant, and b) there is still a significant difference between SRCs and ORCs in our Study II. Yet, we believe Nerantzini et al. (2014) have a point evoking lack of correspondence between value of case feature and thematic roles, in the manner described. Such an effect may not always be present, however, as it was the case with our Study II. Besides, there may be other factors that interfere, such as the absolute error rate. Notice that the error rate on the ORCs of the Nerantzini et al. study was much lower when compared to ours, namely, 33% vs. 46.52% respectively, rendering the difference between SRCs and ORCs less pronounced. Therefore, by conducting the two minimally different studies on RCs, we establish the expected SRC vs. ORC asymmetry for Greek-speaking Broca's aphasics, addressing at the same time the concerns that the findings of Nerantzini et al. raised. We demonstrated that when the asymmetry between SRCs and ORCs is not particularly pronounced it may be because participants have relatively good performance in the overall, or there may be something in the experimental procedure that minimizes the difference between the two types of sentences, by either rendering SRCs more difficult, or ORCs easier (the former factor operating in the Neranzini et al. study). Consequently, we believe that, all other things being equal, ORCs are more difficult that SRCs in Greek, as it is predicted on any possible grounds. It is not a surprise, therefore, that the immediately following study of Varlokosta et al. (2014), which assessed six different Greek-speaking agrammatics, found a significant asymmetry in the comprehension of SRCs vs. ORCs. Note that the error rate on ORCs in the Varlokosta et al. study was very similar to ours, that is, 45%, vs. 46.5% in our case, that is, much higher than the error rate in Nerantzini et al.

Let us now move on to the remaining issues that the current study has aimed to address, namely, which morphosyntactic features of the DPs that intervene in the movement of a relativized DP may be held responsible for posing additional strains on the ORCs of agrammatics, and why some features, but not others, matter.

5.1 The role of case

Recall that one of the reasons that called into question the results of Study I was the fact that the two DPs of ORCs ended up having the same value (nominative) for the feature case. We became concerned, therefore, that ORCs were rendered even more difficult precisely for this reason, despite the fact that case features have not been considered to enter into the computation of locality by the RM based accounts we have discussed.[10] Nevertheless, case features had not been investigated for minimality effects in early or atypical language, at least not until the research reported here was undertaken.

Comparing the performance on the ORCs of Study I and Study II offered the opportunity to investigate whether the morphosyntactic feature case is involved in computing locality and inducing intervention effects. If case were such a feature, one would expect Study II

[10] Although there have been accounts that consider structural case to trigger movement of the associated DP (Bittner & Hale 1996) hence, could be considered a syntactically active feature.

to give a lower error rate for ORCs than Study I, because the two DPs do not have the same value for case. This is not what we obtained however: by contrast, the error rate was 46.5% in Study II, while it was 41.7% in Study I. Although we are not in position to explain the higher error rate in Study II, the finding leads us to conclude with certainty that structural case is by no means one of the features of DPs that may induce intervention effects in agrammatism. Therefore, it is correctly left out by the featural RM approach to understanding developing language systems or systems affected by pathologies.

Interestingly, a study that appeared during the submission process of this paper reached similar conclusions with respect to the intervention effects of the structural case of DPs. Friednmann et al. (2016) examined a number of populations, including agrammatics, on object *wh*-questions and object topicalization, by manipulating the object marker *et* in Hebrew, and concluded that overt case marking cannot rescue a structure that builds a movement chain over an intervener. The study we are reporting here offers further support via Greek, which is a language with overt case marking as well, but different from that of Hebrew, in the sense that the different values of case are manifested on both the determiner and the noun, and DPs always have an overtly expressed value for case.

It is important to note that this aspect of the behavior of the aphasic participants cannot possibly be attributed to problems they may have with structural case, a well-known weakness in agrammatism, as amply demonstrated by Ruigendijk & Bastiaanse (2002) and Ruigendijk & Friednmann (2008), among others. In other words, one cannot possibly claim that the aphasics of our study did not differentiate between ORCs with DPs that bear the same case feature and those that do not because they cannot tell the morphological instantiation of the different values of the feature case. We know this because we ran a set of experiments on case, as part of a different project, see Nerantzini et al. (2015), in which the aphasics of the current study participated as well and were found to have close to ceiling performance on a judgement and a production task of nominative and accusative case.

Before closing this section, let us draw attention to the other case related issue raised in this work. In section 3.1.1 we first expressed the concern whether lack of mapping between a particular thematic role and a particular value of the feature case may have posed additional difficulties on the ORCs of Study I, raising at the same time the question of whether overt morphological case assists in recovering grammatical functions in agrammatism, an issue that is independent of the potential minimality effects of case.[11] We found that subjects/agents with an accusative case feature render SRCs harder, the extent to which is not clear, as results did not reach statistical significance and should probably be replicated, but they are to the expected direction.[12] On the other hand, objects/patients with nominative case did not render ORCs more difficult; if anything, we found the opposite

[11] We believe that these two effects of case cannot be distinguished in the Hebrew study of Friednmann et al. (2016), because of the manner in which morphological case is manifested in the language, and they have not been distinguished in other studies either.

[12] This effect is conjectured to also be present in the study of Varlokosta et al. (2014) explaining why their agrammatic participants performed similarly in subject and object free RCs. Recall that the same effect was considered to be present in the headed RCs of Nerantzini et al. (2014), yet, the same task was administered in Varlokosta et al. (2014). In this paper, we show that this conjecture is on the right track, and, in addition, we offer ways of testing RCs in a reliable manner in a language in which rich case morphology creates such side effects. We suggest that the way to overcome them is to administer the two tasks we did and report the results of SRCs from Study I and of ORCs from Study II. Alternatively, and in the interest of time, one may only administer Study I, since ORCs do not become more difficult when relativized objects end up with nominative.

A reviewer adds that case, as a manner of assisting recovery of grammatical functions, does not seem to play a role in the RCs of Greek-speaking children with SLI, by contrast to their typical language peers (Stavrakaki et al. 2015). This study had not reported independent assessment of case, however, that is, whether children with SLI had trouble with the values of case independently, in particular, whether they mastered the difference between nominative and accusative.

effect. This discrepancy regarding the role of morphological case in assisting identification of thematic roles may be related to the fact that DPs with nominative case and patient thematic role are abundant in the language, as subjects of unaccusatives or passives, for instance. On the other hand, no agents with accusative case are to be encountered in any syntactic environment, hence, the difficulties on the SRCs of Study II.

5.2 The role of gender

We left for last what is a focal aspect of this study, that is, the impact of gender features on the comprehension of ORCs. Investigating gender features in this context is important for a number of reasons. First, it is a feature that has not been studied in terms of its impact on the computation of A'-dependencies in agrammatism, neither in Greek, nor crosslinguistically. Moreover, it is not a feature that is associated with the left periphery, hence, potential difficulties cannot be attributed to the well-known impaired left periphery in agrammatism (Friednmann & Grodzinsky 1997).

Most importantly, however, it is a feature that has led to important claims regarding an accurate classification of the morphosyntactic features that may induce intervention effects, albeit on the basis of child language. It has been repeated several times already, that, after comparing Italian- and Hebrew-speaking children's ORCs, Belletti et al. (2012) concluded that gender has this ability in Hebrew, but not in Italian, because only in Hebrew is it a syntactically active feature. As has been amply demonstrated here, however, same gender features *do* induce additional strains on the ORCs of Greek-speaking agrammatics. This is surprising, as gender cannot be considered an active feature in Greek in any obvious manner. For one thing, Greek verbs are not inflected for gender.

We are led to consider a number of factors as potentially responsible for this unexpected finding. One may think that the results of the Italian children reported in Belletti et al. (2012) constitute an accident. Besides being the less interesting approach to the puzzle, this is not right on factual grounds. Similar results were obtained even earlier, by Adani et al. (2010), for Italian-speaking children. Moreover, the interpretation Adani et al. offer is not much different: the authors argue that external and syntactically active features, such as number, induce intervention effects, while internal and (possibly) lexicalized features, like gender, do not. Notice, furthermore, that the type of DPs the two studies employ in their experiments are rather different. While Belletti et al. employ DPs similar to ours, that is, DPs in which grammatical gender largely corresponds to natural gender, the Adani et al. study mostly employs DPs that refer to animals, for which no such direct correspondence holds. Yet, both studies obtain similar results on gender (and number) of the Italian-speaking children, a convergence that cannot be accidental.

Another possibility is that Belletti et al. (2012) were not right about gender acting as it does in Hebrew as a consequence of being syntactically active. Alternatively, it may be that not only syntactically active features in the sense of Belletti et al. are able to induce intervention effects, but also other properties of gender may be relevant for minimality. Greek has, for instance, a tripartite distinction of gender (masculine, feminine, neuter), by contrast to Hebrew and Italian, and gender is marked on both the determiner and the noun, by contrast to Hebrew.

A yet conceivable possibility is that one should not necessarily expect intervention effects of the type we have discussed to operate in adult impaired grammar, just because this happens to be the case in other domains of child and agrammatic language. It may be that features that are not syntactically active crosslinguistically facilitate or pose additional strains in agrammatism, in a way that does not hold for immature grammar, raising of course the question whether these are effects that can be captured via a RM/

grammar based approach. Unfortunately, there are no studies of Italian agrammatics on the intervention effects of gender. Likewise, there have been no studies of Greek-speaking children on the role of gender in computing locality. If there were, and it was found that children behaved like agrammatics, one would either entertain the idea that the morphosyntactic feature gender is different in Greek, in ways that have to be investigated along the lines of the previous paragraph, or that the RM approach to intervention effects that associates only syntactically active features with locality and intervention is not on the right track. These are clearly way too many open issues to allow for a valuable conclusion regarding the effects of gender we have reported in the grammar of the Greek-speaking agrammatics. A manner to narrow them down is by investigating the behavior of Greek-speaking children on gender in ORCs, hence eliminate the last open issue.

5.3 Greek immature RCs: The answer to the puzzle

In Angelopoulos & Terzi (2017) 15 Greek-speaking children age 4;1–5;2 (mean age: 4;9) were administered the very same RC tasks that were administered to the agrammatic participants. We report here the results of SRCs from Study I and of ORCs from Study II, for the reasons we have explained in footnote 12. Children did significantly better on SRCs than on ORCs (20.5% vs. 4.7% error rate respectively, $t(14) = -8.218$, $p < 0.001$), but there was no difference within ORCs depending on whether the two DPs had the same or different value for the feature gender (21.1% vs. 20% respectively, $t(14) = 1.418$, $p = 0.158$). Because children's error rate on ORCs was not particularly high, and certainly much lower than the error rate of the agrammatics we studied, we wanted to exclude the possibility that children's grammar was approaching adult typical grammar, a state of affairs which is expected to minimize the intervention effects under investigation. In order to factor out this possibility we divided the children in two age groups, below and above age 4;6. The younger children (mean age: 4;4) had much higher error rates on both ORCs and SRCs (40.0% vs. 6.8% respectively, $t(4) = -7.14$, $p < 0.001$). The error rate of the younger children on ORCs was in fact very close to that of the agrammatics we have reported (46.5%). Still, even the younger children of the group did not differ in terms of whether the two DPs of ORCs had the same or different value for the feature gender (41.7% vs. 38.3% error rate respectively, $t(4) = 1.426$, $p = 0.159$).

The study of Greek-speaking children's RCs revealed, therefore, that gender does not induce minimality effects in the immature Greek grammar. This is an expected finding under the claim that difficulties with ORCs which are the result of intervention effects in immature grammars are induced by syntactically active features (Belletti et al. 2012), along with the fact that gender is not a syntactically active feature in Greek in the relevant sense, i.e., a feature associated with syntactic movement of the DP. At the same time the finding confirms that, since gender behaves as expected under the above premises, no further investigation is necessary in quest of specific properties it may have in Greek in order to understand its unexpected effects in agrammatism. If there was something particular about the morphosyntactic feature gender in Greek, potentially responsible for the difficulties induced in the match conditions of ORCs in agrammatism, this would presumably carry over to immature grammar. However, our study of Greek-speaking children demonstrated that it doesn't.

We should, therefore, focus on other aspects of the language of agrammatics in order to understand the effects of gender on ORCs. We argue that these effects are not explicitly anchored to some specific principle of syntactic locality in the case of the agrammatics of the current study, and perhaps of agrammatics crosslinguistically, despite the fact that

they look like RM effects. Alternatively put, we believe that, although the performance of the agrammatics we tested on RCs seem to follow from an extension of RM to language pathology (see Rizzi 2013 for a related view), this is actually not the case, at least not for a phi-feature such as gender. Our view seems to be on the right track on both conceptual and empirical grounds. Conceptually, because there is no possible ground on which gender can be considered an active moprphosyntactic feature in Greek, along the lines of Belletti et al. (2012 et seq.), a view that was actually confirmed by the ORCs of Greek-speaking children. Empirically, because, if the similarity effects of gender on the ORCs of agrammatics were effects of syntactic locality and intervention of the type RM is about, one would not expect to find them in other domains as well.

It turns out that we find them, however. Very similar effects of gender hold for the SRCs of the agrammatics we tested, despite the fact that no intervention configuration whatsoever is present, namely, nothing intervenes between the relativized subject, *o kirios* 'the man' and the extraction site at which it is interpreted, as demonstrated by the SRC in (10a), repeated slightly modified for reasons of exposition below:

(10) a. Edho ine o kirios pu <o kirios> fotoghrafizi
here is the.NOM man.NOM that photographs
ton maghira.
the.ACC COOK.ACC
'Here is the man that photographs the cook.'

The SRCs results of Study I in Table 2 demonstrate that the overall error rate on SRCs is 11.1%, a much lower error rate than on ORCs. What we also see in Table 2, however, is that for those SRCs whose two DPs have the same value for the feature gender (SRC-match condition) the error rate is 19.4%, while it drops drastically to 2.8% for the subject RCs whose DPs have a different value for gender (SRC-mismatch condition). This difference is statistically significant ($t(5) = 3.873$, $p < 0.05$), and by no means does it fall under RM intervention effects.[13]

To recap, the sharp effect that the morphosyntactic feature gender was found to have on the ORCs of Greek-speaking agrammatics raised serious questions as to whether associating it with a specific principle of syntactic locality, namely, RM, is on the right track for understanding language pathology. This is so because of the very precise views RM holds about the properties of the morphosyntactic features that may induce intervention effects, which do not characterize the feature gender in Greek. Closer investigation of the effects of gender in: a) immature Greek grammar and b) the SRCs of the same group of Greek-speaking agrammatics, led us to conclude that the behavior of agrammatics on ORCs, although much reminiscent of RM effects, actually falls outside their scope. We are led to believe that this is the case for agrammatism when it comes to morphosyntactic features that are not related to the left periphery of the sentence, a domain of grammar that is known to be particularly vulnerable in agrammatism and has been accounted for via RM since Grillo (2008). Gender is precisely such a feature.[14] At the same time, the idea of relating difficulties with ORCs to a syntactic locality principle such as RM, which

[13] Even in the SRCs of Study II, which we decided to leave out of the central discussion for reasons we explained in the beginning of the Discussion section, there is an error rate of 22.2% for SRCs whose DPs have the same gender feature and 8.3% for those with a different gender feature, a highly significant difference ($t(5) = 7.906$, $p < 0.001$).

[14] It should be noted that we did not assess the abilities of the agrammatic participants of our study on gender independently. We tend to believe, however, that these are not compromised. This is so because other studies that have been conducted, either in Greek (Mastropavlou, 2008; Nerantzini et al. 2009) or in other languages (Bastiaanse et al. 2003), have concluded that gender is a relatively intact morphosyntactic feature in agrammatism.

seemed seriously undermined by the findings of Greek-speaking agrammatics, because of the status of gender in the language, turned out not to be challenged. In other words, the claims of RM as to which features may be implicated in computing locality, namely, active morphosyntactic features, continues to be valid, but for early grammar. As for adult impaired grammar, with agrammatism being a core case of it, although this may be so for morphosyntactic features involving the left periphery, it does not seem to hold for phi-features.

6 Conclusion

This work investigated the comprehension of headed RCs by Greek-speaking agrammatics with the aim to establish the SRC vs. ORC asymmetry reported in the literature, and understand the source of the limitations when it comes to the latter type of sentences, with focus on the effects of a particular morphosyntactic feature, the phi-feature gender. The first aim was instigated by some puzzling results on the subject vs. object asymmetries of the RCs of Greek-speaking agrammatics, and the second by the distinct crosslinguistic properties of the phi-feature gender, which has led to recent novel claims on which features compute locality and induce difficulties in early grammar as a consequence of intervention effects. In the course of investigating the above issues, and in order to establish reliable results, we were forced to clarify the effects of the feature case, both as a morphosyntactic feature that may facilitate or impede identification of thematic-roles, and in terms of potential intervention effects it may induce.

We established that ORCs are indeed more difficult than SRCs, a finding that is expected on various grounds and approaches. Importantly, we shed light into why Greek-speaking agrammatics have not always demonstrated a clear asymmetry on these two core types of RCs: it is either the effect of mismatch between value of case feature and thematic role of the DPs involved, in particular, agents/subject DPs with accusative render SRCs more difficult, and/or the overall absolute performance on the RCs. The former factor never arises in languages without the rich case morphology of Greek, but should be taken into serious consideration when investigating such a language.

As for Case, we found that, although marked on both the determiner and the noun in Greek, it is not a feature that plays a role in the computation of locality between a moved DP and a DP that intervenes between it and its extraction site. On the other hand, and although this requires further confirmation, it seems to be a feature that may assist in recovering grammatical functions, since, subject DPs with an agent thematic role and accusative case were more difficult to interpret, than when with the expected nominative. The different role of case along both dimensions has not been identified or investigated before.

Gender was found to behave in an unexpected manner for a syntax-based RM approach to the difficulties on ORCs. When the two DPs of ORCs had a different value for the feature gender, the sentences were comprehended much better than when they had the same value, suggesting at first glance that gender *is* a feature that plays a role in the computation of locality in the grammar of Greek-speaking agrammatics. This was not predicted by a RM approach, since only syntactically active features are considered to play a role in computing locality and induce intervention effects, but gender cannot be considered as such in Greek. A follow up experiment with Greek-speaking children demonstrated that gender is rightly considered not syntactically active in the language, as verbs do not inflect for gender and it was not found to induce intervention effects in child grammar. Because the same morphosyntactic feature is found to behave differently in agrammatism we had to conclude either that the features computing locality in agrammatism are different from those that have the same effect in immature grammar, or that the similarity effect of the

feature gender is not the consequence of a narrowly computed syntactic principle such as RM. We concluded with the latter explanation, namely, that we encountered a similarity effect that is not explicitly anchored to a principle of grammar, as it also holds in syntactic environments such as SRCs, which are not intervention environments. It remains to be seen why gender behaves unlike case with respect to similarity effects.

Abbreviations

ACC = accusative, NOM = nominative, DP = determiner phrase, RC = relative clause, ORC = object relative clause, SRC = subject relative clause, RM = Relativized Minimality

Additional file

The additional file for this article can be found as follows:

- **Appendix:** Spontaneous speech samples of the agrammatic participants. DOI: https://doi.org/10.5334/gjgl.274.s1

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Competing Interests

The authors have no competing interests to declare.

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