

Dissociation of case and number information in agreement processing

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A type of agreement errors, known as *agreement attraction*, occurs when speakers produce a verb that agrees with the plural noun in an intervening phrase rather than the subject head, as in **The key to the **cabinets** are rusty* [1, 2]. Its comprehension analogue occurs when the ungrammatical verb *are* in the above sentence appears somewhat grammatical and is therefore read faster relative to when preceded by the singular *cabinet* [10, 14]. Cue-based retrieval attributes attraction to retrieval interference: Cues issued at the verb aim to retrieve the earlier subject for integration purposes, but retrieve a number-matching attractor instead [4, 11]. It follows then that differential case on nouns distinguishing subjects from non-subjects should potentially reduce misretrievals, with the implication that attraction strength should also be reduced as compared to equivalent sentences with similarly case-marked nouns. A contender to cue-based retrieval is Marking and Morphing (M&M), which is primarily a production model [3], but which has recently been extended to comprehension [6]. M&M sees attraction as arising from spreading of the attractor's plural feature, which sometimes makes the entire subject phrase seem more plural and, therefore, as matching the ungrammatical verb. Importantly, M&M reserves no role for case in alleviating attraction, because the only factor that can influence feature spreading is the syntactic distance between the nouns in the subject phrase.

Previous research does not yield clear conclusions about the role of case marking because of (i) mixed results (ii) lack of robust evidence for the purported role of case in alleviating attraction (iii) lexical differences across conditions, making it difficult to attribute the observed effects to case proper [5, 7, 8, 12, 13]. We re-addressed the question in Modern Eastern Armenian (MEA), controlling for some of these previously uncontrolled factors. We ran three experiments, using relative clauses (RCs) with non-intervening attractors (see Table 1), where we found attraction effects but where case information hardly modulated attraction strength. Specifically, in a forced-choice task ($n=176$) sentence preambles like *The painter(s) that the sculptor* were more likely to be completed with an ungrammatical verb *ignored*._{PL} when the sentence began with a plural rather than singular attractor, *painters*. Notably, the error rate was only negligibly higher when the two nouns carried the same versus differential case, 0.6 %, 95 % credible interval (CrI):[-0.2, 1.4]. Furthermore, in two self-paced reading tasks (SPR1: $n=48$, SPR2: $n=117$) plural attractors elicited the expected facilitation in the spillover region following the ungrammatical verb, with no effect in grammatical conditions [9]. Additionally, SPR2 manipulated case marking on noun phrases and found that differential case impacted verb processing but not attraction: Differential case led to faster reading times at the ungrammatical verb regardless of attractor number, -34 ms, 95 % CrI: [-74, 4]. Similar facilitation due to case also emerged in grammatical conditions, -16 ms, 95 % CrI: [-39, 8].

We confirmed the existence of attraction in MEA, but we found no support for an attractor number by case interaction. A lack of a such interaction is compatible with M&M. However, the model needs to address how a structurally distant attractor outside the subject phrase could nonetheless elicit attraction. To capture this finding, M&M may need to assume that features could migrate from any number source to any other part of the sentence and to assign a reasonably small weight to the distance parameter. By contrast, our findings are unexpected under cue-based retrieval unless we make additional assumptions. One such assumption is that there may be separate retrievals at the verb—one for assigning thematic roles and another for licensing agreement features on the verb. Case cue might be given priority in the retrieval for thematic interpretation, but it might have a limited use in the retrieval for an agreement licenser. This could explain how case and number information could dissociate in comprehension, producing only main effects, as in SPR2. An alternative way of capturing this dissociation is to assume that case is used predictively to determine a forthcoming verb's feature structure, but that case plays no role in retrieving the agreement licenser after number prediction fails to instantiate on the verb. We formalize this view in Fig. 1.

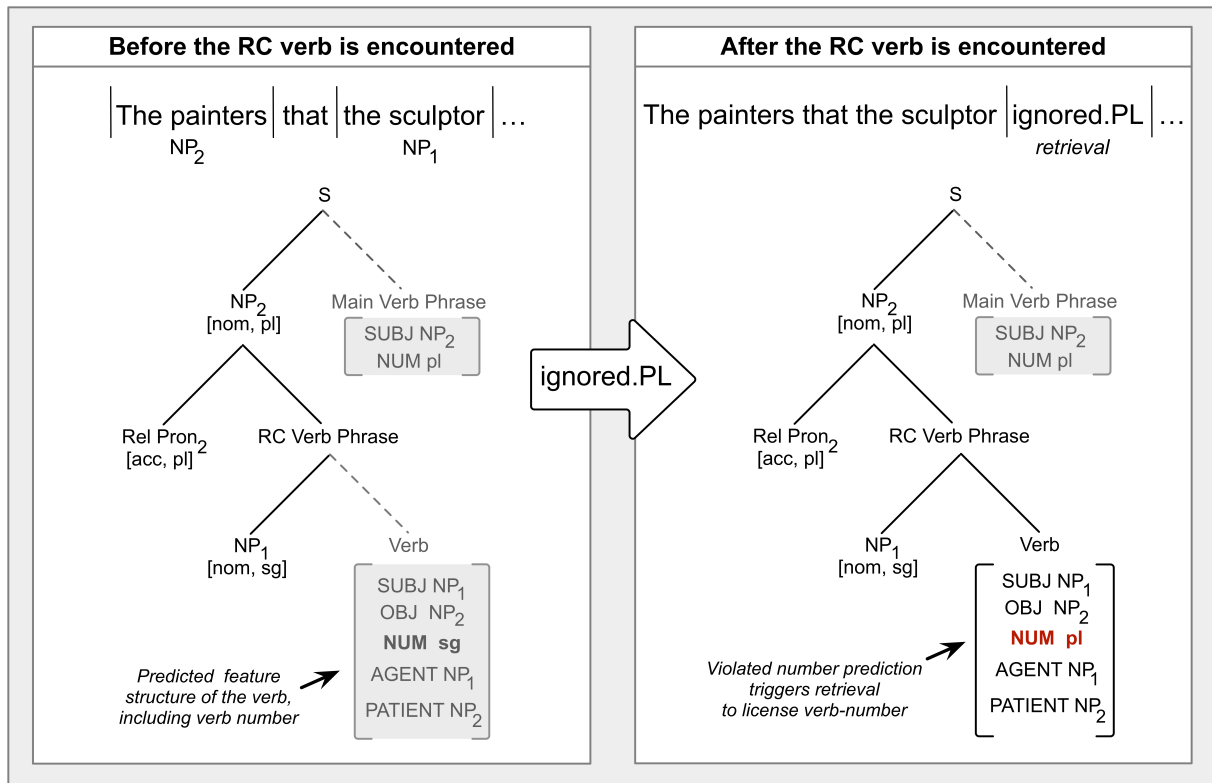


Figure 1: Here we illustrate a particular view of how a cue-based retrieval account could be modified to capture our pattern of results. This view draws on the assumption that case cues are deployed in a prediction stage, whereas number cue is called upon in a reanalysis stage, with no chance for an interaction. The left panel shows the parse tree built prior to seeing the RC verb. Here we assume a left-corner parser which has used case cues to work out who is likely to do something to whom in advance of verb information and to anticipate a relative and main clause verb with a certain feature structure (predicted chunks are in gray). These structures specify the syntactic and semantic profile of the arguments that each of the forthcoming verbs may take: subject as the most agent-like argument, object as the most patient-like argument. Included in the structure are also some agreement constraints for the possible verb form (e.g., number = SG). Importantly, any prediction that will contradict the bottom-up input will be edited to reflect the input. The right panel shows the aforementioned scenario: With the appearance of the ungrammatical RC verb, a mismatch is detected between predicted and actual number. This triggers an update in the parse tree (change is shown in red) and an error-driven retrieval to find a number licenser. Crucially, because case properties of the nouns were not in conflict with the bottom-up input, these features will not need a revision and will play no role in the retrieval.

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Table 1: In MEA, human nouns are unambiguously nominative when they are the grammatical subject and non-nominative when they play a role other than the subject. We used this distinction to investigate whether differentially case-marked nouns would elicit less attraction relative to similarly case-marked nouns while also holding lexical words, their thematic roles and sentence proposition the same across conditions. Our stimuli consisted of a relative clause that modified either the subject of an impersonal passive clause (i.e., nominative attractor) or the object of an impersonal active clause (i.e., non-nominative attractor). Experimental manipulations involved attractor number (sg/pl attractor), whether case differed between the RC subject and attractor (same/different case) and whether the RC verb agreed or disagreed with the RC subject (i.e., grammatical/ungrammatical). The forced-choice task used 48 items that appeared in conditions 1-2 and 5-6. This task used only half sentences where each trial terminated with a participants' choice of a verb form, resulting either in a grammatical (ignored.SG) or an ungrammatical (ignored.PL) continuation of the preamble. By contrast, the two SPRs used full sentences. SPR1 presented 36 items in conditions 1-4 where case was held constant. SPR2 presented 48 items in all eight conditions.

Same case	1. Grammatical, singular attractor			
	Nkarič-Ø-ë painter-[SG.NOM]-DEF	or-in that-SG.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec' ... ignore-AOR.3[SG]
	2. Grammatical, plural attractor			
	Nkarič-ner-ë painter-[PL.NOM]-DEF	or-onc' that-PL.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec' ... ignore-AOR.3[SG]
Different case	3. Ungrammatical, singular attractor			
	Nkarič-Ø-ë painter-[SG.NOM]-DEF	or-in that-SG.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec'-in ... ignore-AOR.3[PL]
	4. Ungrammatical, plural attractor			
	Nkarič-ner-ë painter-[PL.NOM]-DEF	or-onc' that-PL.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec'-in ... ignore-AOR.3[PL]
Different case	... c'owc'ahandes-i exhibition-DAT	ënt'ac'k'owm POST	vağowc' long	mekowsac'-v-el ... ostracize-PASS-PTCP.PRF
	... ē/en-Ø be-PRS.3SG/3PL	arvestaget-ner-i artist-PL-GEN	šrjanak-ic'. circle-ABL	

"The painter(s) that the sculptor ignored.SG/*PL during the exhibition has/have long been ostracized from the art community."

Different case	5. Grammatical, singular attractor			
	Nkarč-Ø-i-n Painter-[SG-ACC]-DEF	or-in that-SG.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec' ... ignore-AOR.3[SG]
	6. Grammatical, plural attractor			
	Nkarič-ner-i-n painter-[PL-ACC]-DEF	or-onc' that-PL.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec' ... ignore-AOR.3[SG]
Different case	7. Ungrammatical, singular attractor			
	Nkarč-Ø-i-n painter-[SG-ACC]-DEF	or-in that-SG.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec'-in ... ignore-AOR.3[PL]
	8. Ungrammatical, plural attractor			
	Nkarič-ner-i-n painter-[PL-ACC]-DEF	or-onc' that-PL.ACC	k'andakagorç-Ø-ë sculptor-[SG.NOM]-DEF	arhamarh-ec'-in ... ignore-AOR.3[PL]
Different case	... c'owc'ahandes-i exhibition-DAT	ënt'ac'k'owm POST	vağowc' long	mekowsac'-r-el ... ostracize-PTCP.PRF
	... en-Ø be-PRS.3PL	arvestaget-ner-i artist-PL-GEN	šrjanak-ic'. circle-ABL	

"They have long ostracized from the art community the painter(s) that the sculptor ignored.SG/*PL during the exhibition."