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Spanish is *not* different: On the universality of minimal structure and locality principles

RESEARCH

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Abstract

A sensible assumption in psycholinguistics is that universal principles of optimal computation guide structural decisions made during sentence processing. This idea was questioned by the apparent cross-linguistic variation in Relative Clause attachment: a wealth of experimental results from the nineties showed that speakers of Spanish, among other languages, more readily converged towards the least optimal structural resolution (i.e. non-local attachment) challenging the universality of parsing principles of locality. A more recent development in this literature demonstrated that previous results were confounded by the availability of an additional parse, the so-called Pseudo-Relative, in the ill-behaved languages (Grillo 2012; Grillo & Costa 2014). Grillo and colleagues further suggested that the parser more readily disambiguates in favour of the Pseudo-Relative reading, when possible, because of its structural and interpretive simplicity in comparison to Relative Clauses and that non-local attachment is a direct consequence of this independent preference. We present novel results in support of this account from two offline forced-choice attachment questionnaires in Spanish. The results show that Pseudo-Relative availability significantly affects attachment preferences and that cross-linguistic variation in Relative Clause attachment is likely to be epiphenomenal and largely attributable to underlying grammatical differences.

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1 Introduction

A natural assumption in psycholinguistics is that the human language processor is designed to take quick decisions incrementally, choosing the simplest, most optimal and/or most readily available structure/interpretation to minimise cognitive resources cost. Economy principles of this sort have been very successful in accounting for observed parsing preferences in structure building and dependency formation processes. Strategies for minimizing computational load have been proposed for both type of processes together with a great wealth of empirical support showing better comprehension and faster processing times for structures involving simpler structures/interpretations over more complex ones (e.g. preference for the instrumental over the restrictive interpretation of PPs in sentences like: *John saw the man* ***with the binocular***) and more local dependencies over long distance ones (e.g. preference for local attachment of temporal modifiers in *John said that Mary left* ***yesterday***).

In this paper we discuss the complex interaction of these two types of economy principles, i.e. locality and minimal structure, in the domain of Relative Clause (RC) attachment ambiguities (1), which have previously been claimed to be processed differently across languages (Cuetos & Mitchell 1988; Grillo & Costa 2014). This vast literature painted a troubling asymmetry between speakers of *well-behaved* languages (e.g. English, Basque, Chinese), who displayed a preference for attaching the RC to the most local DP (1a), and speakers of "ill-behaved" languages like Spanish, Greek and Dutch, who displayed a surprising preference for attaching the RC non-locally (1b).

(1) a. John saw [$_{DP}$ the servant$_i$ [$_{PP}$ of the [actress$_j$[$_{CP}$ that was$_j$ on the balcony]].
b. Juan vio [$_{DP}$[$_{NP}$ al criado$_i$ [de la actriz]$_j$[$_{CP}$ que estaba$_i$ en el balcón]].
Juan saw the servant of the actress that was on the balcony
'Juan saw the servant of the actress that was on the balcóny.'

Grillo (2012) pointed out that research on the processing of RC attachment ambiguities necessarily needs to take into account the selective availability of Pseudo-Relative Small Clauses across languages and structural environments. Section 1.2 offers a rich characterisation of Pseudo-Relatives (PRs), but in advance, PRs are structures that only superficially appear as genuine RCs but at a closer look quickly reveal very different structural and interpretive properties:

- Under the RC parse the matrix sentence in (1) is a direct perceptual report of an entity (*the son of the doctor*) and the CP denotes an identifying property of either *the son* or *the doctor*.
- Under the PR interpretation, however, the string identical sentence in (2), involves a direct perception report of an event of running by the son, in a way highly reminiscent of English Acc-ing Small Clauses:

(2) Juan [$_{VP}$vio [$_{PR}$[$_{DP}$al hijo [del médico]] [$_{CP}$que corría]]].
Juan saw the son of.the doctor that ran.IMPF
Juan saw the son of the doctor running.

The relevance of PRs for the resolution of RC-attachment ambiguities is due to the fact that the attachment ambiguity disappears under the PR-parse because only the highest DP is an accessible subject of the embedded predicate.

When a PR parse is available, parsing sentences like (2) requires first of all choosing between projecting a PR and a RC (i.e. a choice that belongs to the domain of minimal structure principles) and only at a second stage, and only if a RC-parse is chosen, will the parser have to resolve an attachment ambiguity (i.e. a problem falling within the domain of locality principles). Grillo (2012) and Grillo & Costa (2014) argued for a parsing preference for PRs over RCs due to their relative structural and interpretive simplicity. One consequence of this preference is that an apparent disregard for locality principles will be observed for RC-attachment in languages and grammatical environments which license PRs.

In this paper we provide new evidence from two offline RC-attachment questionnaires in Spanish in support of this hypothesis. Our results strengthen the claim that apparent cross-linguistic variation in RC-attachment is epiphenomenal and tied in large measure to the selective PR-availability in different languages and grammatical environments.

The study also includes a preliminary exploration of the potential role of aspect in modulating the parser's choice between PR and RC parse based on the incompatibility between PRs and habitual interpretations.

In the remainder of the Introduction, we briefly sketch the literature on the processing of RC-attachment ambiguities (1.1), with particular reference to Spanish. We next introduce some fundamental structural and interpretive properties of PRs, focusing on the restrictions on PR-availability manipulated in our experiments (particularly restriction on licensing environments and aspectual properties of PRs) and on cross-linguistic variation in PR-availability and its potential role on determining cross-linguistic variation in parsing. In Section 1.3.1 we briefly introduce the main arguments for the so-called *PR-first hypothesis*, i.e. the proposal that PRs are preferred to RCs for their relative structural and interpretive simplicity. Finally, sections 3 and 4 present the results of two forced-choice attachment questionnaires which manipulate both PR-availability and Aspect. The results support the idea that RC-attachment in Spanish does not constitute an exception to locality principles. Two important conclusions will be drawn: RC-attachment appears to be strongly governed by locality principles, and PR-availability is largely responsible for apparent cross-linguistic variation in RC-attachment.

1.1 RC attachment

Principles of locality are a fine example of the parser preference for minimal effort: when grammar allows more than one option, the parser prefers to build structural relations with the closest possible element capable to carry that relation. This preference has been demonstrated across a variety of syntactic relations (e.g. movement and attachment) and is naturally rooted on primitive cognitive mechanisms like recency (Gibson 1991).

One apparent exception to this generalization came from the observation (Cuetos & Mitchell 1988) that whereas English speakers showed preference for attaching the RCs locally in the presence of complex DPs, i.e. of two possible hosts [DP + V + DP1 of DP2 + RC] (3a) speakers of Spanish appeared to prefer non-local attachment for the same sentences (3b).

(3) a. Someone shot [$_{DP}$ the servant$_i$ [$_{PP}$ of the [actress$_j$[$_{CP}$ that was$_j$ on the balcony]].
b. Alguien disparó contra [$_{DP}$ [$_{NP}$ el criado$_i$ [de la actriz]$_j$[$_{CP}$ que estaba$_i$ en el balcón]].
'Someone shot the servant of the actress that was on the balcony.'

Attachment to the first DP or high attachment (HA) in this case is more computationally costly as it requires to shift the attachee (i.e. the RC) up to DP1, neglecting the more local and economical option of attaching to NP2.[1] In the decades following the original Spanish findings, similar results showing a preference for non-local attachment of RC were replicated across a variety of languages (including French, Dutch, Serbo-Croatian and Greek a.o.), while speakers of other languages (e.g. Basque, Romanian and Chinese) were shown to be *well-behaved* like English. This research also appeared to show a number of *swing languages*, whose results appeared to vary with specific properties of the experimental items and/or the experimental design, and to some extent also across participants (see Grillo & Costa 2014: for discussion). To understand why such great amount of psycholinguistics research was dedicated to this issue it is important to consider that these findings are puzzling for at least three reasons. First and foremost variation in parsing preferences in what appeared to be the same grammatical structures is highly unexpected given the natural assumption that parsing preferences are grounded in simple, independently motivated and universal principles of economy of computation. The second related, but independent issue is that the apparent variation in parsing preferences is problematic for any theory of language acquisition: the challenge here is to explain how children can acquire a language while simultaneously also having to acquire language specific parsing strategies (Fodor 1998a; b). Under the assumption that parsing strategies are necessary to successfully identify the properties of a language (and acquire its grammar), we hit a paradox if knowledge of the language is needed to acquire parsing strategies that are specific to that language. Under these premises, it seems difficult to explain how language acquisition can happen at all.

1 Attachment to the most local DP by principles like *Late Closure*, which prompts the parser to *attach incoming material into the phrase or clause currently being processed*. The rationale for this principle is to avoid the maintenance of unattached items in working memory and fasten parsing attaching new material locally. Hence, Late Closure is, by definition, a principle of locality. Late Closure is used purely as an example, the issue here is broader and applies to any variant of this type of principle. See Grillo (2012); Grillo & Costa (2014) for discussion.

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A third issue relates to the specificity of the effect: the exceptional behaviour of the ill-behaved languages with respect to locality appeared to be limited to the realm of RC attachment ambiguity.

In all other structural domains the so-called *HA languages* appeared to align with English in showing a clear preference for local attachment of different types of phrases. Igoa et al. (1998), for example, showed that Spanish speakers show a clear preference for local attachment for a variety of phrases, including Prepositional Phrases.

In fact, further research showed that speakers of "high-attachment languages" demonstrated a preference for local resolution of RC attachment ambiguities in a number of well-defined environments. De Vincenzi & Job (1993), for example, showed that Italian speakers attach RCs locally in the environment of thematic prepositions (similar results were obtained for English and Spanish by Gilboy et al. 1995). More generally, a number of factors have been shown to affect RC attachment in similar ways across languages, these include: lexical semantics, prosody, pragmatics, discourse properties, such as focus and topicalization (see e.g. Fodor 2002; Frazier et al. 1996; Gilboy et al. 1995; Hemforth et al. 2015; Rohde et al. 2011, a.o.). Importantly, despite the repeated observation that different languages are affected in similar ways by each of these factors, none of them eliminated the original cross-linguistic difference. Rather the bulk of this evidence makes the Late Closure crisis rather exceptional in its specificity, as the problem narrows down to a specific structure under specific conditions.

The last development in the debate on crosslinguistic asymmetries in Relative Clause attachment came with the discovery of a confound in the previous literature. A subset of languages and constructions tested allowed for an additional Small Clause parse of the apparent RC: the so-called Pseudo-Relative (PR) (Grillo 2012):

(4) Juan vio [$_{PR}$ [$_{DP}$ al criado [de la actriz]] [$_{CP}$ que estaba corriendo]].
Juan saw the servant of the actress that was running
'John saw the servant of the actress running.'

The importance of the asymmetric availability of a PR interpretation lies in the fact that under this parse the attachment ambiguity disappears and only "High Attachment" is allowed. As illustrated in (4), this is because in PRs only the highest DP (*the servant*) is an accessible subject for the embedded predicate.

In the following subsection we will first describe some basic structural and interpretive properties of PRs together with some arguments to distinguish them from both restrictive and non-restrictive RCs. This brief introduction will also serve us to present the ingredients we manipulated in the following experiments, which directly tested the effects of PR availability on RC-attachment preference in Spanish. We will also see that PRs are not a unitary phenomenon across languages. As argued by Cinque (1995) PRs are multiply ambiguous,[2] importantly not all languages allow all parses. This accounts not only for variation in PR-licensing contexts across languages, but will also allow us to make different predictions for RC ambiguity resolution across PR-licensing languages.

1.2 Pseudo-Relatives

Grillo (2012) first pointed out an important confound in the RC-attachment literature: the asymmetric availability of Pseudo-Relatives (PRs). In a subset of the languages and contexts tested, including Spanish and other so-called HA languages (but not English and other LA languages), apparent RCs modifying the complement of perceptual verbs are actually ambiguous between a RC and a PR interpretation (5). PRs are finite constructions that are only superficially identical to RCs but display clear differences at the structural, interpretive (Burzio 1986; Casalicchio 2013; Cinque 1992; 1995; Graffi 1980; Grillo & Costa 2014; Grillo & Moulton

2 In line with the observations made by Cinque (1995), PRs allow for multiple parses which are subject to cross-linguistic variation. The three possible analyses discussed by Cinque are:

(a) A single CP constituent analysis: *visto* [$_{CP}$ DP *que* …].

(b) A two constituent analysis where the matrix verb takes only the DP as complement and the CP function as an adjunct: *visto* [DP] [$_{CP}$ *que* …].

(c) A single DP constituent where the 'que' clause is a modifier of the DP: *visto* [$_{DP}$ DP *que* …].

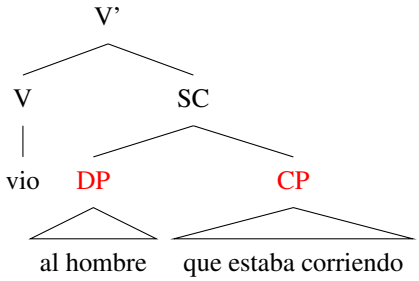
2016; Guasti 1988; Kayne 1975; Radford 1975; Rafel 1999; Rizzi 1992; Moulton & Grillo 2015) and prosodic levels (Grillo & Turco 2016).

(5) a. María vio [$_{PR}$[$_{DP}$ al hombre] [$_{CP}$ estaba que corriendo.]]
M. saw the man that was running
'Maria saw the man running.'

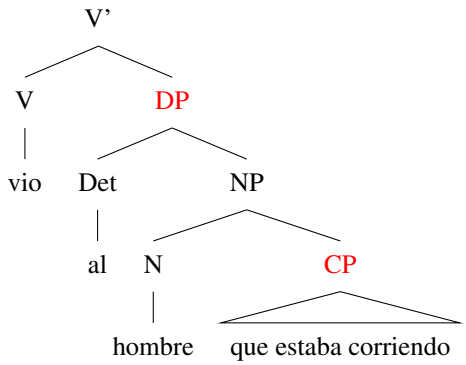
b. María vio [$_{DP}$ al [$_{NP}$ hombre [$_{RC}$ que estaba corriendo.]]]
M. saw the man that was running
'Maria saw the man that was running.'

At a structural level, PRs are similar to Acc-ing constructions in English (Cinque 1992), with the subject DP and CP standing in a sisterhood relation (6), contrary to RCs, where the same CP is embedded within the DP they modify (7). Like English eventive Small Clauses, PRs are projected as complements of perceptual verbs, while RCs are adjuncts.

(6) Pseudo-Relative



(7) Relative Clause



This structural difference is mapped into a different interpretation as PRs complements of perceptual verbs involve (direct) perceptual reports of events/situations (8), whereas RCs denote properties of entities (see Grillo & Moulton (2016); Moulton & Grillo (2015) for a more thorough discussion of the semantics of PRs). One of several consequences of this distinction is that the embedded event needs to be directly perceived in PRs but not in RCs.

(8) Pseudo-Relative
∃e∃e'[see(e) & Experiencer(e) (Maria) & Stimulus(e')(e) & Run(e') & Agent(e') (the man)]
There exists an event of *seeing* and the experiencer of that event is *Maria* and the stimulus is *an event of running* and *the man* is the agent.

(9) Relative Clause
∃e [see(e) & Experiencer(e) Maria) & Stimulus (the unique man that was running)(e)]
There exists an event of *seeing* and the experiencer of that event is *Maria* and the stimulus is the *the unique man that ran.*

A clear indication that PRs refer to inanimate situations comes from sentences like (10), where the masculine pronoun *lo* cannot refer to the embedded subject *the girl*, but only to the whole situation *the girl running*.

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(10) Lo que vi fue a la chica que corría.
What that I.saw was DOM the girl that ran.IMPF
'What I saw was the girl running.'

More generally, evidence for a distinct analysis of PRs and RCs comes from multiple sources. Contrary to RCs, for example, PRs are perfectly acceptable with proper names even in the absence of an intonational break typical of appositive RCs:

(11) He visto a Juan que corría.
I.have seen DOM J. that ran.IMPF
'I saw Juan running.'

An even clearer diagnostics comes from the availability of PRs with pronouns (12), which are not licensed with either restrictive or nonrestrictive RCs.

(12) a. María ha visto al candidato que pintaba. PR/RC
M. has seen DOM.the candidate that painted
'M. saw the candidate that was painting.'

b. María le ha visto que pintaba. PR-only
M. him has seen that painted
'Maria saw him painting.'

As discussed in Cinque (1995), who on this point largely follows Declerck (1981)'s analysis of ACC-ing constructions in English, sentences like (12b) also suggest that PRs allow at least for two alternative analyses: a single constituent analysis where the matrix verb takes the whole PR as complement as in example (6), and alternatively a two constituent analysis, where the matrix verb takes only the DP (*the candidate*) as complement and the CP function as an adjunct: *visto* $[_{DP}\ ]\ [_{CP}$ *que* …]. We go back to these different analyses below, when discussing crosslinguistic variation in PR-availability.

The structural and interpretive differences between PRs and RCs also explain a number of restrictions observed with PRs that do not apply to RCs, including constraints on licensing environment, Tense, Aspect and properties of the embedded predicate. Some of these restrictions apply across all PR-licensing languages, other are language specific, with some languages, e.g. Italian, allowing for more PR-licensing environments than e.g. Spanish. In the next subsection, we will review a selection of PR/RC asymmetries and briefly discuss variation across PR-languages that will serve as introduction to the following experiments.

1.2.1 Restrictions on PRs

Restrictions on Main Predicate When we compare PRs and RCs, one immediately striking observation is how highly constrained PR-distribution is when compared to the freedom with which RCs can appear anywhere a DP in need of a modifier is found. While RCs are, so to speak, immune to the properties of the predicate selecting the DP they modify, i.e. any DP can be modified with a RC independently from the context in which it appears, PRs are only available under a restricted set of predicates. This set is subject to cross-linguistic variation (to which we return below) and contains most typically verbs of perception (13), but also quasi-perceptual verbs (such as e.g. *film, record*), as these can freely introduce situations. Contrary to RCs, however, PRs are only allowed in environments that license situations/events and are not allowed under predicates that only take entities as complements, or with epistemic, stative and relational verbs. RCs are obviously perfectly acceptable in each of these environments. We will build on the first two of these restrictions (*matrix verb type* and *outer aspect*) in the following experiments, which will allow us to modulate PR availability within minimally different sentences.

(13) María ha visto a Claudia que corría.
Maria has seen DOM Claudia that ran.IMPF
'Maria saw Claudia running.'

(14) *Mario ha conocido/ ha querido/ está casado con Claudia que corría.
'*Mario met/loved/ is married to Claudia that ran.'

Restriction on Outer Aspect Also for the sake of simultaneity, the aspectual form of the embedded verb should be Progressive/Imperfective. Perfective aspect, which is associated with terminated events, would not be compatible with the ongoing interpretation (15).[3]

(15) *María vio a Alejandro que había corrido.
M. saw DOM Alejando that had ran
'Maria saw Alejandro that had run.'

Importantly, in languages which allow both a progressive and habitual interpretation of Imperfectives (like Italian or Spanish) only the progressive interpretation survives in PRs. Ban on habitual interpretation is easily diagnosed e.g. using bare plural objects whose meaning cannot fit in the boundaries of a single event:

(16) a. María vio al chico que corría.
M. saw DOM.the boy that ran
'Maria saw the boy running/that was running.'

b. María vio a Alejandro que corría.
M. saw DOM Alejandro that ran
'Maria saw Alejandro running/*that was running.'

c. *María vio a Alejandro que corría maratones.
M. saw DOM Alejandro that ran marathons
'Maria saw Alejandro running marathons.'

Naturally, bare plurals are allowed in PRs as long as their presence still allows for an episodic reading of the event, e.g. *Juan vio al chico que comía patatas/John saw the boy eating potatoes*.

1.2.2 Cross-linguistic Variation in PR availability

It is important to point out that PR-availability is not a unitary phenomenon across languages, in fact a great deal of variation in PR-licensing environment is often also found within a given language. This is in part due to the fact that, as convincingly argued by Cinque (1995), PRs (at least in some languages) allow multiple structural analyses.

A striking difference between Spanish and Italian is the wider distribution of PRs in structural contexts beyond perceptual reports in Italian, which cover absolute-with constructions (17a), locative and existential constructions (17b,c), complement of verbs like 'to remember' (17d), *sopportare* (17e), and nominals (17f), among others. Spanish does not allow PRs in any of these contexts (for each example, the first line corresponds to Italian and the second line to Spanish).

(17) a. Con Gianni che parla, non faremo niente.
*Con Juan que habla, no haremos nada.
'With John speaking, we will never do anything.'

b. In cucina c'è una pentola (d'acqua) che bolle.
*En la cocina hay una olla (de agua) que hierve.
'In the kitchen there is a pot of water boiling.'

c. Il giovedí c'è Gianni che suona.
*El jueves hay Juan que toca.
'On Thursdays there is John playing.'

d. Ricordo Gianni che partiva.
*Recuerdo a Juan que partía.
'I remember Juan leaving.'

e. Non sopporto Gianni che fuma in casa mia.
*No aguanto a Juan que fuma en mi casa.
'I can't stand John smoking in my house.'

3 See Casalicchio (2013) for discussion of exceptional cases in which terminated events are allowed in PRs, these typically denote a situation with some directly perceivable consequent state of an event, importantly the auxiliary still appears in its Imperfective form, as in e.g.: *Ho visto Maria che aveva appena rotto il vetro*/I saw M. that had just broken the glass.

f. La fotografia di Gianni che balla il tango è stata la più venduta.
*La fotografía de Juan que baila el tango ha sido la más vendida.
'The picture of John dancing tango was the one that sold the most.'
(Examples from Rafel 1999: 56–57)

Contrary to Italian, where PRs are licensed both in subject (18a) and object position, Spanish only allows PRs in object (18c) position, but not as syntactic subjects (18b) (example adapted from Grillo & Moulton 2016).

(18) a. Maria che balla è uno spettacolo.
Maria that dances is a show
'Mary dancing is quite a sight.'

b. *María que baila es todo un espectáculo.
M. that dances is all a show
'Maria dancing is something to see.'

c. Vi a María que bailaba, y fue todo un espectáculo.
saw.I DOM Maria that danced.IMPF, and was all an spectacle
'I saw Maria dancing, and it was something to see.'

A thorough discussion of these asymmetries is beyond the scope of the present paper. Evidence for the existence of multiple parses for PRs provides a rationale to explain away at least some of the observed variation: the distribution of PRs across languages should be tied to the availability of a given PR parse in that language. Thus, if a language only allows PRs in the environment of perceptual verbs (or more broadly in the context of predicates that can select situations), it would be reasonable to conclude that only single constituent/situation denoting PRs are allowed in that language. Some varieties of Dutch, for example, appear to allow PRs in the environment of perceptual verbs but not in the environment of verbs like *meet* or *catch*, i.e. predicates that only take entities as objects and not situations. This restriction could be captured assuming that this variety of Dutch only licenses single constituent, situation denoting PRs.[4]

A final, important dimension of variation, is the availability of alternative structures to introduce events/situations in PR-licensing environments. In Spanish, but not in standard Italian, there exists an unambiguous option for introducing event descriptions in PR-environments: the *gerundive Small Clause* (19a), which in English corresponds Acc-ing gerund (e.g. smoking).

(19) a. He visto a María bailando flamenco.
I.have seen DOM Maria dancing flamenco
I saw Maria dancing flamenco

b. *Ho visto a Maria ballando flamenco.
I.have seen DOM Maria dancing flamenco
'I saw Maria dancing flamenco.'

The presence of an unambiguous form in Spanish is bound to have important repercussions in the processing and interpretation of embedded clauses. Following Frazier & Clifton (1996); Gilboy et al. (1995), we argue that the use of an ambiguous structure, when alternative unambiguous ones are available to express a given content, will have important consequences on parsing preferences, in line with the Gricean Maxim of clarity (*be clear, avoid ambiguity*). In our particular case, the availability of unambiguous gerundive SC structure might arguably make PRs less appealing and reduce the strength of the parser's preference for PR interpretations (as predicted by PR-first Hypothesis, which we introduce in the next section).

1.3 PR-first Hypothesis

Based on the observation of the asymmetric distribution of PRs across languages, and the syntactic and semantic properties of both structures, Grillo (2012) put forward the *PR-first Hypothesis* to explain the cross-linguistic RC attachment variability, further developed in Grillo & Costa (2014).

4 See Grillo & Moulton (2016) for a discussion of potential sources of asymmetries in PR-availability in PR-languages.

PR-first Hypothesis: *When PRs are available, everything else being equal, they will be preferred to RCs.*

The rationale for PR-first is that PRs are less complex than RCs at the syntactic, semantic and discourse levels.

First of all, as shown in (6) and (7) PRs (at least in the case of single constituent analysis) are arguments, while RCs are adjuncts. Preference for arguments over adjuncts is well documented in the psycholinguistics literature, together with a general tendency of the parser to avoid restrictive interpretations whenever possible, at least out of a licensing context (see e.g. Staub et al. 2018, a.o.).

Furthermore, as the discussion above has shown, while RCs are fully specified clauses, PRs are Small Clauses, with greatly impoverished structures despite their appearances (see also Moulton & Grillo 2015; Grillo & Moulton 2016 on PRs being semantically transparent despite being finite clauses). One illustration of this comes from the observation that Tense is anaphoric in PRs, but referential in RCs. As seen above, PRs are also impoverished in terms of both inner and outer aspect. This impoverishment is readily translated into processing advantages, as the levels of uncertainty associated with each of these categories is greatly reduced in PRs when compared with RCs. This means that once a PR is projected, the set of choices available to the parser (for Tense and Aspect) is greatly reduced.

A third argument comes from discourse: the discourse licensing conditions of RCs, in fact, are more complex than those of PRs. RCs introduce properties of individuals which contribute to the identification of a unique individual from a set of alternatives. This set of alternatives must be either present in the current discourse or it must be presupposed. This rich contextual representation is not needed in the case of PRs, which simply introduce directly perceived situations. since PRs carry fewer unsupported presuppositions than RCs, they will be preferably adopted by the parser also from a discourse perspective (Altmann & Steedman 1988; Crain & Steedman 1985).

Finally, PRs should also be preferred from a pragmatic perspective because of the principle of *Relativized Relevance* (Frazier 1990). Frazier proposed that in the presence of ambiguities, the parser privileges interpretations that contribute to the main assertion of the clause. PRs, being arguments of the main predicate, are more relevant than RCs, which are being modifiers provide information which might be tangential to the main assertion of an utterance.

1.3.1 PR-first and attachment preferences

The *PR-first Hypothesis* has important consequences for RC attachment with complex DP. This is because under the PR-parse there is no ambiguity of attachment, as only the highest DP is an accessible subject for the embedded predicate, i.e. only the higher DP c-commands the subject gap in the CP (20). A straightforward prediction of the *PR-first Hypothesis* is that a preference for HA should be observed in languages and contexts which license PRs and, more importantly for the debate on universality of parsing principles, that a preference for LA should emerge when unambiguous RCs are tested (provided that other factors such as e.g. prosody are controlled for).

(20) María vio [$_{PR}$[$_{DP}$ al hijo$_{i}$ [$_{PP}$ del maestro$_{j}$]] [que corría$_{i,*j}$]].
Maria saw the son of.the teacher that ran.IMPF
'Maria saw the son of the teacher running.'

Support for *PR-first* comes both from review of previous results from the literature on RC-attachment and from a number of recent studies which directly manipulated PR-availability. The list of languages traditionally classified as *High Attachment* (HA) is composed mostly of languages that license PRs (including e.g. Spanish, Dutch, Italian, Serbo-Croatian, Greek), while languages that do not license PRs have been classified as *Low Attachment* (LA) based on previous results (e.g. English, Basque, Chinese).[5]

5 Notice once more that PR-availability is not the only factor involved in RC-attachment disambiguation. Therefore a perfect mapping between PR-availability and attachment preference is not predicted. Russian, German and Bulgarian, for example, have been traditionally classified as HA languages, while none of the three allows PRs. RCs in the three languages, however, are introduced by relative pronouns (and not complementizers) and are preceded by a comma in writing. See Hemforth et al. 2000; Grillo & Costa 2014 for discussion of how both variables have important effects on RC attachment for independent reasons.

Previous studies on RC-attachment can be hard to evaluate in light of the confound raised by selective PR-availability; to fully evaluate the impact of this factor, it is therefore essential to go beyond discussion of previous results and provide a direct test of PR-availability in different languages and environments. A number of recent studies directly manipulating PR-availability have consistently reported HA in globally ambiguous PR/RC environments (e.g. under perceptual verbs) and LA in unambiguous RC environments (e.g. under stative/relational predicates) in a number of PR-languages: Italian (Grillo & Costa 2014), Portuguese (Fernandes 2012; Grillo et al. 2012a; b; Tomaz et al. 2014), Greek (Grillo & Spathas 2014) and French (Pozniak et al. 2019). Importantly, whenever a PR parse is made unavailable, speakers of each of these language (previously classified as HA) consistently show a strong preference to attach RCs locally. The availability of PRs in these languages is key to explain their previous classification as HA languages.

Conversely, and importantly, the same contextual manipulation (of e.g. perceptual vs. non-perceptual predicates) does not lead to HA in languages, such as English, where PRs are not allowed (Grillo et al. 2015). This excludes the possibility that PR-availability effects are reducible to independent effects of plausibility or predicate semantics. Grillo et al. (2015) also observed that the PR-first can be generalised to the ambiguity between Small Clauses (SCs) and reduced RCs (e.g. *John saw the boy running the marathon*). The availability of SCs in English triggers HA of reduced RCs in a language that otherwise prefers LA.

This evidence renders the classic HA vs LA languages division somewhat obsolete, and strongly suggests that the availability of a PRs/SCs parse is a decisive factor determining RC attachment, and it certainly constitutes a potential confound not to be ignored when investigating RC-attachment.

In the present paper, we test the role of PR-availability in Spanish, a language which played a crucial role in the RC-attachment debate. We furthermore try to illustrate some potential ways to leverage the unique characteristics of the PR/RC ambiguity to try and shed some light on the processing of RCs and the general tendency of the parser to avoid them. Here we raise the question of whether the aspectual make up of the embedded clause can modulate this preference and push the parser away from the preferred PR parse and towards the avoided RC parse. We leverage the incompatibility of habituals with PRs and manipulate the availability of habitual interpretations to see if it counteracts the attested PR-preference.

2 Current study

The main goal of this work is to test the contribution of PR-availability in the processing of RC-attachment ambiguities in Spanish. Spanish grammar differs in two important ways from the grammar of other languages previously studied in this domain. First of all, the distributional properties of PRs are considerably more restricted in Spanish than in Italian, and furthermore, Spanish, but not Italian, licenses an unambiguous alternative structure which conveys similar meaning to the PR: the gerundive SC. These factors, as well as the central role Spanish played in the RC-attachment literature, make Spanish an important language to test the predictions of *PR-first*.

Since previous research systematically used past indefinite in the embedded clause, and past indefinite in Spanish is ambiguous between a punctual and habitual reading, we decided to include a contrast with Past Progressive. Whereas both allow an imperfective interpretation, only the Past Progressive is unambiguous in denoting a punctual interpretation (the only interpretation licensed under PRs). With this contrast we attempt to establish whether the availability of an habitual interpretation could ease the parsing of the dispreferred RC reading.

In languages like Spanish, the so-called *Simple Past* form is ambiguous between a punctual/episodic (and imperfective) interpretation and a habitual interpretation (21a). When the Past Progressive is used, as in (21b), only the punctual interpretation is available.

(21) a. La chica que corría
The girl that ran.IMPF
'The girl that was running/used to run'

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b. La chica que estaba corriendo
The girl that was running
'The girl that was running'

As discussed in section 1.1, while RCs do not impose any restrictions on the aspectual properties of the predicates they embed, only Imperfective/Progressive aspect is licensed in PRs. Perfectives, and crucially, habituals are banned from these constructions.

The aspectual interpretation of the past is therefore tightly linked to the PR/RC disambiguation, with the habitual reading only being available under the RC parse (but not vice-versa, i.e. the RC reading is still compatible with the progressive interpretation).

We can see two reasons why this aspectual manipulation might modulate the parser's preference for PRs or RCs. The first is tied to the semantics of RCs, which we claim is more easily compatible with habituals; the second is that, at least out of context, habitual readings might be more accessible to the parser than episodic readings.

RC semantics and habituals RCs denote properties of entities. Building an RC interpretation, therefore, requires first and foremost, to convert a proposition into a property. We hypothesize that habitual aspect might more readily lead to the property interpretation required by RCs, since (at least at an intuitive level) habits are easily converted into properties, while association with punctual events does not (at least out of the blue) provide such a strong grounding for property building. To illustrate, compare the sentence in (22a) and (22b) (where # marks pragmatic oddity):

(22) a. The boy used to run → the boy was a runner
b. The boy was running → #the boy was a runner

The availability of an habitual reading might therefore ease processing of RCs.

Processing of Habitual/Episodic ambiguity Punctual events, just like definite descriptions, make reference to particulars and need to be referentially supported by the context in a way that generic statements and habituals do not. To our knowledge, while an important literature exists on generics and habitual aspect in linguistics (see e.g. Carlson 2012; 2019), the processing of habitual vs. token events constitutes a significant gap in the psycholinguistics literature. Importantly, given that PRs are not compatible with habits, it will also allow us to pit against each other a potential preference for habitual readings and the PR-preference discussed so far.

The role of PR-availability and its interaction with the aspectual manipulation are explored in two offline questionnaires on RC attachment in Spanish. The predictions following PR-first are clear: more HA should be observed in contexts where PRs are available (following standards in this literature, percentages of DP1 attachment above 50% are interpreted as HA preference). With respect to the aspectual manipulation, if, as suggested above, the availability of the habitual reading supports the RC parse we expect relatively lower proportion of HA when the habitual reading is available in PR-compatible contexts. Conversely, we do not expect aspect to influence attachment in contexts which exclusively select for RCs.

3 Experiment 1: Attachment questionnaire

We present the results of a forced-choice attachment questionnaire designed to test the effect of PR-availability on the resolution of RC-attachment ambiguities in Spanish. The experiment also manipulates aspect of the embedded predicate, to determine whether availability of habituals modulates the effect of PR-availability. Event-taking (perceptual and quasi-perceptual verbs) and entity-taking (non-perceptual verbs) verbs are employed to build PR-compatible and RC-only environments in combination with Past Imperfective versus Past Progressive.

3.1 Participants

Forty Spanish native speakers (mean age = 37, SD = 5.9) members of the staff of the Spanish school Instituto Giner de los Rios (Oeiras, Lisbon) participated in an offline questionnaire using Linger (Rohde 2003). None of the participants was a linguist. All of them gave their informed consent before taking part in the study and were naive as to the goals of the experiment.

3.2 Materials & Design

Twenty-four experimental sentences were generated in 4 different versions in a 2 Verb Type (PR-compatible vs. RC-only verbs) × 2 Aspect (Past Imperfective vs Past Progressive) design.[6] Sentences were organized in a latin square design and distributed into four lists. Fillers (n = 71) contained active and passive sentences, but never RCs or PRs, or other type of syntactic ambiguities. Both target and fillers were translated and adapted from the materials in Grillo & Costa (2014) with the correspondent adjustments to Spanish and the aspectual manipulation (original items all contained embedded verb inflected with Past Imperfective aspect). Every sentence was followed by a comprehension question and the presentation of materials was counterbalanced.

Stimuli

(a) **PR-compatible – Past Imperfective**
Juan vio al hijo del médico que pintaba.
'John saw the son of the doctor painting/that painted'

(b) **PR-compatible – Past Progressive**
Juan vio al hijo del médico que estaba pintando.
'John saw the son of the doctor painting/that was painting.'

(c) **RC-only – Past Imperfective**
Juan trabaja con el hijo del médico que pintaba.
'John works with the son of the doctor that painted.'

(d) **RC-only – Past Progressive**
Juan trabaja con el hijo del médico que estaba pintando.
'John works with the son of the doctor that was painting.'

3.3 Procedure

Experimental sentences were presented one by one in the centre of the screen. Participants were instructed to read the sentences at their normal pace, and press the space bar as soon as they were done reading. Immediately after, a question was displayed on a separate screen, together with two option answers and participants were instructed to choose the correct one or, if uncertain, the one that seemed the best option to them. For target sentences, the two options referred to the two possible antecedents (i.e. DP1 or DP2). The order of presentation of the two DPs was counterbalanced across participants and items. The order of presentations of the items in each of the four versions was randomized. Participants were instructed to press the "F" key on their keyboard to choose the option presented on the left side of the screen and the "J" key to choose the option presented on the right side.

(23) Question:
¿Quién estaba pintando?
Who was painting?

A. El hijo
The son

B. El médico
The doctor

Before the experiment started, participants were presented with six practice items to help them familiarize with the procedure. The experiment lasted around 30 minutes.

3.4 Data analysis

Data were analysed with R Core Team (2018) version 4.0.4. fitting Generalized Linear Mixed-Effects Models with binomial distribution using the package lme4 (Bates et al. 2015). Maximal model was attempted first in all analyses (Barr et al. 2013). As fixed effects, we entered *Verb* (PR-compatible vs RC-only) and *Aspect* (Imperfective vs Progressive) and their interaction into the model, with by-subject and by-item random intercepts, random slopes for all repeated

6 The PR-compatible verbs employed in this experiment included perceptual and quasi-perceptual verbs: *ver* (see), *oir* (listen), *mirar* (look), *escuchar* (hear), *observar* (observe), *pillar* (catch), *fotografiar* (photograph), *imaginar* (imagine), *soñar* (dream), *dibujar* (draw) and *grabar* (record/film).

measures for participants and items, and random correlation parameters. If the model failed to converge, we first removed correlation parameters between random intercepts and random slopes. If it still failed to converge we then iteratively removed the random effects that accounted for the least variance in the (nonconvergent) maximal model until convergence was achieved. The final model that converged was the following: Attachment ~ Verb*Attachment + (1 + Verb|Subject) + (1 + Verb|item). The binary dependent variable of attachment preference was coded as 1 (HA) and 0 (LA). Each of the fixed factors was centered-coded as –1/2 and 1/2 (Schad et al. 2020).

Data and analysis code for all the experiments reported in this paper are available at the Open Science Framework webpage *https://osf.io/ynamz/*.

The results, summarized in ***Table 1*** for descriptive statistics and ***Table 2*** for inferential statistics, show a main effect of *Verb Type* with more HA for PR-compatible verbs ($p < 0.001$) and a main effect of *Aspect* with increased HA when aspect was Progressive $p = 0.014$). No interaction was found ($p > 0.05$).

PR-compatible verb		RC-only verb	
Imperfective	**Progressive**	**Imperfective**	**Progressive**
44	51	29	35

Table 1 Percentages of HA preference.

Fixed effects	Estimate	SE	z-value	p-value
Effect of Verb type	0.926	0.244	3.794	<0.001***
Effect of Aspect	0.399	0.162	2.457	0.014*
Verb type*Aspect	0.132	0.326	0.405	0.685

Table 2 Summary of LME analyses.

* p < 0.05; ** p < 0.01; *** p < 0.001.

3.5 Intermediate discussion

The difference in attachment preferences between PR-compatibles and RC-only verbs is in line with the predictions of the PR-*first* Hypothesis. Importantly, LA preference is observed whenever PRs are not available (see ***Figure 1***), supporting the hypothesis that previous results from Spanish were confounded by PR-availability and that cross-linguistic variation in RC attachment is epiphenomenal. The results in PR-compatible environments match those found in other PR-languages, although the percentages observed in this study are considerably lower, especially when compared with Italian (78.6% HA in PR-compatibles versus 24.2% RC-only). The grammatical differences between Spanish and Italian (introduced in section 2) might partly explain these results. The Italian versatility in the distribution of PRs in a number of environments is not observed in Spanish where PR-availability is more restricted, perhaps also due to the fact that this language licenses an unambiguous cognate structure, the gerundive Small Clause (SC) (*Juan vio a María bailando/John saw Mary dancing*).

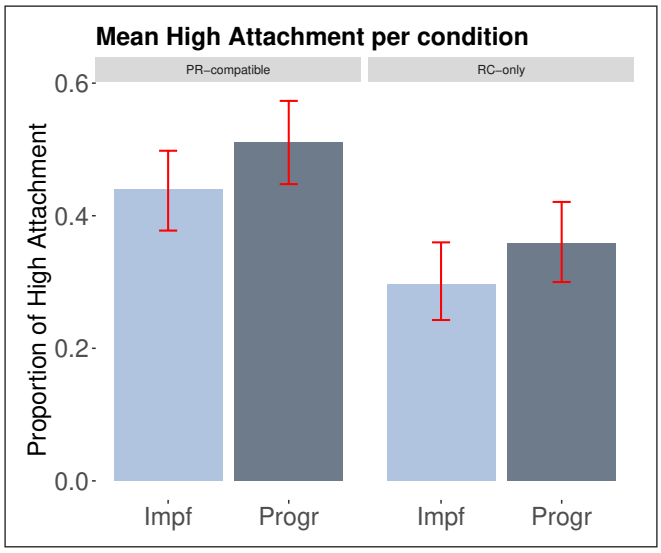

Figure 1 Mean proportion of HA across Verb type and Aspect.

Following Frazier & Clifton (1996) and Gilboy et al. (1995), we argue that the preference for a PR interpretation will be reduced by availability of an unambiguous alternative to PRs (the gerundive SC) because of the application of the Gricean maxim of clarity (*be clear/avoid ambiguity*). In this perspective: *when interpreting sentences, with nonprimary phrases, at least, readers/listeners act as if they assume that writers/speakers tend to avoid using an ambiguous expression when an unambiguous one is available, obeying the maxim of clarity* (Gilboy et al. 1995: p.156). The availability of the gerundive SC could potentially lead the reader/listener to infer that this option might have been chosen by the writer/speaker if the relevant meaning was intended, which may contribute to lower the effect of PR availability, at least in offline tests.

Focusing now on the main effect of aspect, we saw that Progressives led to numerically higher proportion of HA than Imperfectives. However, the lack of interaction between aspect and verb type prevents us from drawing any conclusions as to the hypothesis that the habitual interpretation of the Past Imperfective favours the RC reading. More importantly, the fact that the length of the RC in the Past Progressive condition was on average 7 characters/3 syllables longer than the Past Imperfective might explain the observed effect of aspect. Length of the RC has been reported to determine attachment in many languages, including Spanish (Teira & Igoa 2007; Fernández 2003; Hemforth et al. 2015; Fromont et al. 2017). Longer RCs increase the likelihood of occurrence of a prosodic break after NP2, which leads to more HA as explained by Fodor's *Balanced Sister Hypothesis* (Fodor 1998a; 2002): *When the prosodic contour projected onto the stimulus contains a prosodic break, a bias will be imposed to attach a phrase as a sister to a phrase of similar size (or similar prosodic weight*). That is, longer embedded clauses will prefer to modify the head of the complex NP (NP1), and shorter RCs will preferably modify the lower NP (NP2). In this experiment it is not possible to disentangle the effect of aspect from the effect of length/prosody, as the condition with Progressives is systematically the longer condition.

In the next experiment we aim to cancel the length confound using length-balanced materials, this will provide a replication of the results of Experiment 1 and a chance to further test the effect of the aspectual manipulation.

4 Experiment 2: Attachment questionnaire with length control

In this experiment we further test the effects of PR-availability on the resolution of RC-attachment ambiguities in Spanish while avoiding the problems posed by differences in length in the previous experiment. We matched length across conditions, while ensuring that this did not interfere with the availability of both the episodic and the habitual reading.

While the basic design is the same as the previous experiment, modulo length manipulation, the present experiment also controlled for potential training effects triggered by exposure to a great number of unambiguous RCs within the experiment (half of the stimuli contain unambiguous RCs, while the other half are ambiguous between a PR and RC reading). Of direct relevance for the present study, Fernandes et al. (2018), in two experiments on Italian, showed that lack of balance in the proportion of unambiguous RCs and PRs can lead to structural priming effects, generating a stronger preference for the RC reading over the course of the experiment. Following Fernandes et al. (2018), Pozniak et al. (2019) obtained similar results for French.

4.1 Participants

Eighty European Spanish native speakers (mean age = 30.09, SD = 7.3) were recruited on Prolific Academic with normal or corrected-to-normal vision and no history of language disorders. Each participant gave informed consent before taking part in the study and was paid a small fee for participation.

4.2 Materials & design

Target materials were translated and adapted from Tomaz et al. (2014) from Portuguese to Spanish. Materials had to also be adapted to the Imperfective/Progressive manipulation of the present experiment. Additionally, a word following the embedded verb was inserted in the condition with Past Imperfective trying to preserve the neutrality toward a punctual or an habitual reading. For instance, a word like 'marathons' was avoided as it would trigger habitual

reading, given that a man running marathons cannot be perceived in a single perception event. The experimental design was the same as in Experiment 1.

Stimuli

(a) **PR-compatible verb[7]/Imperfective**
Juan vio al hijo del médico que pintaba caballos.
'John saw the son of the doctor painting horses/that painted horses.'

(b) **PR-compatible verb/Progressive**
Juan vio al hijo del médico que estaba pintando.
'John saw the son of the doctor painting/that was painting.'

(c) **RC-only verb/Imperfective**
Juan trabaja con el hijo del médico que pintaba caballos.
'John works with the son of the doctor that painted horses.'

(d) **RC-only verb/Progressive**
Juan trabaja con el hijo del médico que estaba pintando.
'John works with the son of the doctor that was painting.'

4.3 Procedure

The procedure was similar to Experiment 1, but this time the experiment was built and hosted in Gorilla Experiment Builder *https://gorilla.sc* (Anwyl-Irvine et al. 2018). Furthermore, the presentation of items was pseudorandomized using blocks to make sure that each item number was presented equally in the first half as in the second half of the experiment. With this, we avoided that one item condition (say condition b, with PR-compatible verbs and Progressive aspect) had more chances to appear first in the experiment and potentially prime subsequent items. This manipulation helped balance the presentation of each item condition across the experiment, which will allow us to track potential effects of order of presentation (or cumulative exposure) reported in previous experiments.[8]

Data from one participant was excluded from analysis because mean comprehension accuracy to fillers was less than 80%.

4.4 Data analysis

Data were analysed with R Core Team (2018) version 4.0.4. fitting Generalized Linear Mixed-Effects Models with binomial distribution using the package lme4 (Bates et al. 2015). As fixed effects, we entered *Verb* (PR-compatible vs RC-only), *Aspect* (Imperfective vs Progressive) and *Position* (first vs second half of the experiment), and their interaction into the model, and participants and items as random effects with random slopes. Maximal model was attempted first (Barr et al. 2013). If the model failed to converge we first removed correlation parameters between random intercepts and random slopes, then iteratively removed the random effects that accounted for the least variance in the nonconvergent maximal model until convergence was achieved. The final model (Attachment ~ Verb*Aspect*Position + (1 + Position + Aspect || subject) + (1 + Verb + Aspect || item) was the maximally converging model supported by the data. Each of the fixed factors was re-coded as centered-contrasts (–1/2 and 1/2) (Schad et al. 2020). The results are summarized in ***Table 3*** for descriptive statistics and ***Table 4*** for inferential statistics. The binary dependent variable of attachment preference was coded as 1 (HA) and 0 (LA).

Table 3 Mean percentages of High Attachment.

	PR-compatible Imp	RC-only Imp	PR-compatible Progr	RC-only Progr
First	64.9	43.6	56.7	42.4
Second	51.4	35.1	53.6	31.3
Average	58.2	39.4	55.2	37

7 The type of PR-compatible verbs employed in this experiment were: *ver* (see), *oir* (listen), *mirar* (look), *escuchar* (hear), *observar* (observe), *pillar* (catch) and *imaginar* (imagine).

8 Some recent work has attested the effects of cumulative exposure in RC attachment ambiguities (Chun 2018), and also in research on the PR/RC ambiguity resolution (Fernandes et al. 2018; Pozniak et al. 2019). Whereas some of this work employs the concept of adaptation, or sometimes syntactic priming, we use the theory-neutral term of cumulative exposure effects instead of adaption or syntactic priming to refer to a change in the participant's structural preferences influenced by previous exposure.

Fixed effects	Estimate	SE	z-value	p-value
Effect of Verb type	−1.182	0.223	−5.292	<0.001***
Effect of Aspect	−0.152	0.224	−0.678	0.498
Effect of Position	−0.627	0.147	−4.263	<0.001***
Verb type*Aspect	−0.095	0.444	−0.215	0.829
Verb type*Position	−0.291	0.232	−1.251	0.211
Aspect*Position	0.262	0.230	1.141	0.254
Verb type*Aspect*Position	−0.715	0.457	−1.562	0.118

Table 4 Summary of LME analyses.

* p < 0.05; ** p < 0.01; *** p < 0.001.

To sum up, there is a general effect of Verb Type across both Progressives and Imperfectives. There is not a main effect of Aspect, nor an interaction between Verb Type and Aspect (see ***Figure 2***). The effect of Position indicates a general increase in LA preference over the course of the experiment, in line with previous results from Fernandes et al. (2018) and Pozniak et al. (2019) (see ***Figure 3***). These results replicate the effect of PR-availability found in Experiment 1 and indicate that the effect of aspect found in Experiment 1 may be better explained as an effect of length linked to implicit prosody.

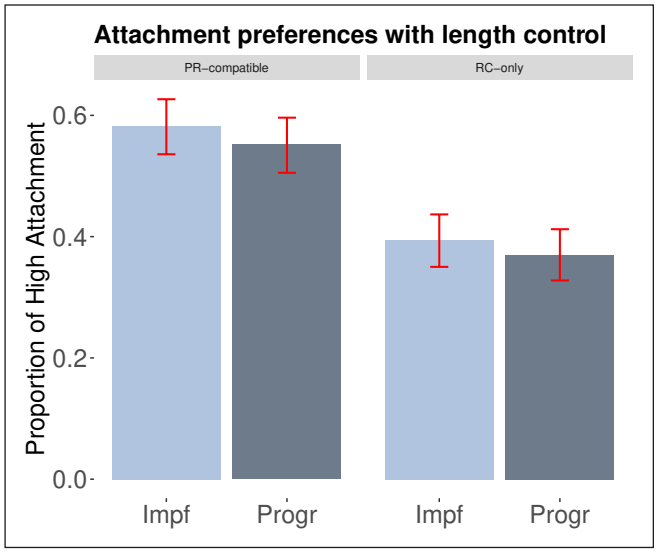

Figure 2 Mean proportion of HA across Verb type and Aspect.

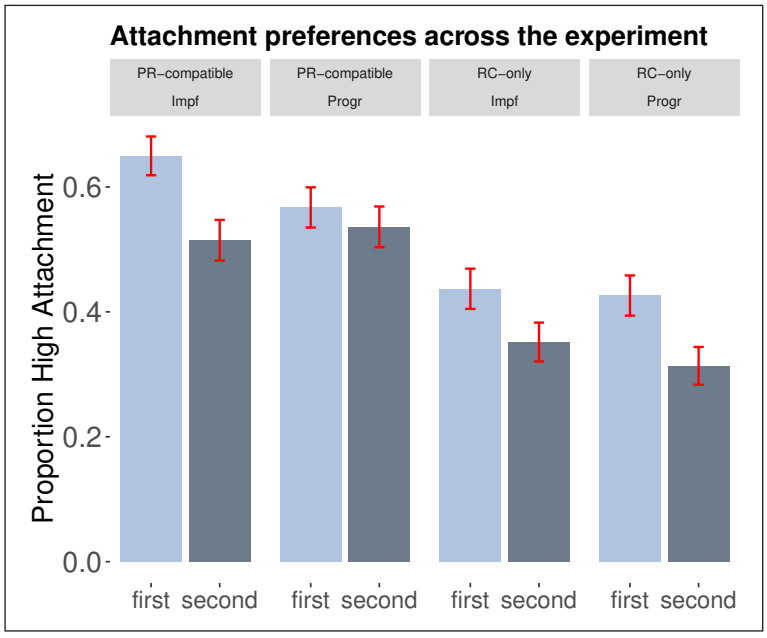

Figure 3 Mean proportion of HA across Verb type and Aspect.

4.5 Collapsing data from Experiment 1 and 2

Collapsed data from both experiments were analysed with R Core Team (2018) version 4.0.4. fitting Generalized Linear Mixed-Effects Models with binomial distribution using the package lme4 (Bates et al. 2015). Maximal model was attempted first (Barr et al. 2013). If it did not converge, we removed correlation parameters, then iteratively removed the random effects that accounted for the least variance in the data until convergence was achieved. As fixed effects, we entered *Verb type* (PR-compatible vs RC-only) *Aspect* (Imperfective vs Progressive) and *Experiment* (Experiment 1 and Experiment 2), and their interaction into the model, and participants and items as random effects with Experiment as random slope (Attachment ~ Verb*Aspect*Experiment + (1 + Experiment|subject) + (1 + Experiment|item). See ***Table 5*** for a summary of the results and ***Figure 4*** for a visual representation.

Fixed effects	Estimate	SE	z-value	p-value
Effect of Verb type	−0.987	0.099	−9.933	<0.001***
Effect of Aspect	0.108	0.096	1.124	0.260
Effect of Experiment	0.439	0.387	1.134	0.257
Verb type * Aspect	−0.076	0.194	−0.395	0.692
Verb type * Experiment	−0.207	0.198	−1.043	0.296
Aspect * Experiment	−0.534	0.193	−2.758	0.005**
Verb * Aspect * Experiment	0.062	0.389	0.159	0.873

Table 5 Summary of LME analyses.

* p < 0.05; ** p < 0.01; *** p < 0.001.

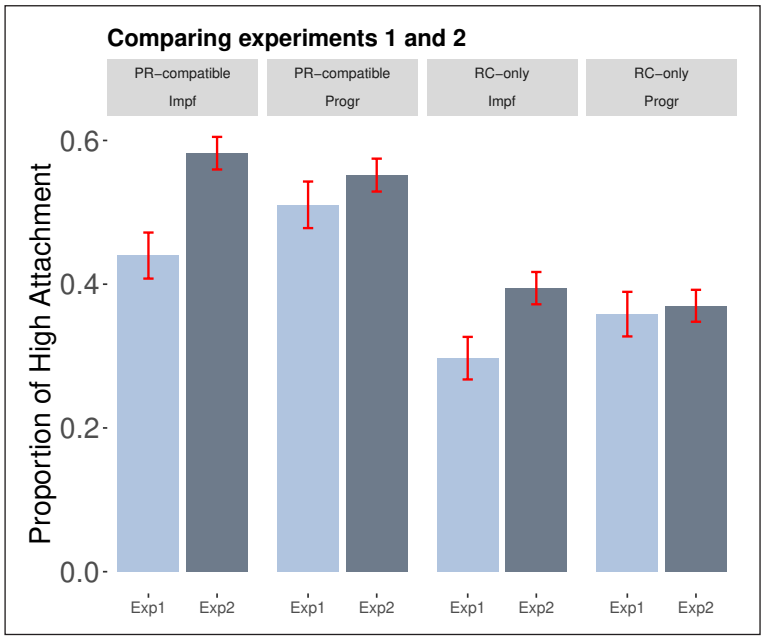

Figure 4 Attachment preferences across Experiment 1 and Experiment 2.

Planned comparisons with Experiment as a fixed factor, and participants and items as random effects in the subset with Imperfectives and Progressives confirmed that the interaction between Aspect and Experiment is due to differences between both experiments in the condition with Imperfectives (estimate = 0.646, *SE* = 0.255, *z-value* = 2.535, *p* = 0.011*) which supports the idea that previously observed effects of Aspect were due to length (see ***Figure 4***). There is no significant effect in the subset with Progressives (p > 0.05).

4.6 Discussion

First and foremost, Experiment 2 replicated the main results of the first attachment questionnaire: when PR-availability is controlled for, Spanish speakers display a preference for local attachment of RCs. This supports the claim that alleged cross-linguistic differences in RC-attachment are in fact epiphenomenal and largely dependent on grammatical variation. Higher

proportion of HA when PRs are available (57%) in comparison to RC-only environments (38%) (see ***Figure 2***, supports the predictions of *PR-first Hypothesis*: PRs are preferred by the parser and this is observable in higher preference for interpreting the non-local DP (i.e. the only accessible subject of a PR) as the subject of the embedded CP. These results are in line with previous findings from other PR-licensing languages, like Italian (Grillo & Costa 2014), French (Pozniak et al. 2019), Greek (Grillo & Spathas 2014) and Portuguese (Fernandes 2012; Grillo et al. 2012a; Tomaz et al. 2014; Costa et al. 2016).

The strength of the effect of PR-availability on RC-attachment is also comparable with previous results from French, Greek and Portuguese, while a stronger effect was observed for Italian in Grillo & Costa (2014) (with percentages of HA over 70% on average under PR-compatible verbs). There are many factors that could explain the Italian results, such as an effect of sampling, plausibility of the materials, or absence of the aspectual manipulation. These and other factors have not been consistently controlled across experiments in this literature which makes the comparison between studies difficult to make. Similar considerations apply to differences in the relative weight of high or low attachment between this and previous studies in the literature on Spanish. Importantly, our main argument does not rely on absolute proportion of high vs. low attachment, but on the significant difference between contexts that allow or disallow PRs and on the prediction that once PR-availability is controlled an overall preference for local attachment should be observed.

Additionally, and in particular in relation to the comparison between Spanish and Italian (but a similar argument also applies when comparing Italian with other languages, including French, Portuguese and Greek), there are reasons to suggest that differences in the observed pattern of attachment might well be rooted in more fundamental grammatical differences across the heterogeneous set of PR-languages. This is due to two important reasons: the first reason is that, contrary to these other languages, Italian does not license unambiguous alternatives to PRs, as e.g. Acc-ing constructions in Spanish (*Juan vio a María bailando/John saw Mary dancing*) or Prepositional Infinitive Constructions in Portuguese (*O João viu a Maria a dançar*). We follow Frazier et al (1996) and Gilboy et al. (1995) in suggesting that the availability of unambiguous alternatives to PRs will reduce the strength of the parser's preference for PR interpretation over the RC interpretation because of the application of the Gricean maxim of clarity (be clear, avoid ambiguity). The reader/listener might infer that the writer/speaker would have used the unambiguous gerundive SC to convey the eventive reading, which leads to the assumption that the choice of a finite embedded clause might be intended for the RC interpretation.

The second is that Italian (to our knowledge) is by far the most liberal language when it comes to PR-licensing. As discussed above in subsection 1.1, Italian licenses PRs in a variety of environments in which they are not available in other languages, including Spanish, suggesting that a number of structural possibilities to derive PR-like readings in Italian are not available in other languages.

The results of the second experiment show a main effect of Position, with a general increase of LA preference as the experiment progresses (***Figure 3***). We take this effect to suggest that cumulative exposure to RCs triggers a stronger preference for LA (as the preference in RC-only environments is to attach locally), with a cascade of the effect to both PR and RC environments. This is in line with previous results from Fernandes et al. (2018) and Pozniak et al. (2019), who show adaptation to the RC parse over the course of the experiment.

Moving on to the aspectual manipulation, the results seem to indicate that there is not a *prima facie* effect of aspect, and that the effects observed in the first experiment are better explained by relative length of the embedded clauses. One potential limitation of this particular study is that, due to the properties of the stimuli, the parser's choice for a PR interpretation precedes the aspectual ambiguity (the choice for PR arguably happening already at the Complementizer, i.e. at the region preceding the ambiguous Imperfective). There is a possibility that the lack of effect of the aspectual manipulation might be due to the fact that the parser might have set on the PR parse by the time the aspectual ambiguity is encountered, and since PRs are incompatible with habituals.

Notice also that to control for length and avoid confounds due to *implicit prosody*, the aspectual manipulation required the addition of a word in the Imperfective condition. Despite our efforts to maintain neutrality of readings, i.e. to select bare plural objects compatible with

both habitual and episodic readings, we can't exclude that this manipulation might have facilitated access to the habitual reading in Past Imperfective condition, as we cannot exclude that this manipulation might have triggered the effect for independent reasons. It could be argued, for example, that lengthening of the clause with a neutral word (*caballos*, 'horses') might have increased the informational load from the semantic and/or pragmatic point of view. Effects of load of information on RC-attachment were investigated by Hemforth et al. (2013), who reported that length effects observed in previous studies might covary with the effect of increasing load of information and pragmatic principles. The hypothesis they put forward combined Almor (1999)'s Informational Load Hypothesis (*the function of informational load should be to help identify the antecedent, add new information about it, or both*) and the Principle of Relativized Relevance (Frazier 1990) (*preferentially construe a phrase as being relevant to the main assertion of the sentence*). The implementation of these principles to the resolution of syntactic ambiguities lead Hemforth et al. (2013) to predict that informativeness influences attachment in a way that the more informative the content of an RC is, the higher the chance to attach it to a more central or relevant element of the utterance (which in this case is NP1). We do not discard a potential effect of Informational load in our experiment, as there is an initial increase in HA in the condition with PR-compatible verbs and Imperfectives that could be explained by the contribution of the additional word in this condition. The effect seems to be reduced in the second half of the experiment, where it is positioned even below PR-compatible verbs with Progressives in terms of proportion of HA, as shown in ***Figure 3***.

5 Conclusion

We presented novel evidence from Spanish supporting the universality of principles of locality and minimal structure. When the availability of PR parse is controlled for, Spanish speakers show a clear preference for local attachment of RCs. We also demonstrated a robust effect of PR-availability on attachment: in line with the predictions of the PR-*first* Hypothesis, a preference for HA is observed whenever a PR reading is available.

Contrary to our predictions, the aspectual manipulation did not appear to damp the parser's preference for PR-interpretation. The hypothesized effect of aspect on the processing of RCs, however, might not be easily captured in this experimental design due to strength of the PR preference and the fact that the parser might have set on a PR parse by the time that aspectual information is intergrated. In the future, we plan to further explore the potential role of aspect in facilitating the processing of RCs in other contexts and with more sensitive experimental techniques.

Abbreviations

HA = High Attachment, LA = Low Attachment, ACC = Accusative, CP = Complementizer Phrase, DP = Determiner Phrase, DOM = Differential Object Marking, IMPF = Imperfective, NP = Noun Phrase, PP = Prepositional Phrase, PR = Pseudo-Relative, SC = Small Clause, RC = Relative Clause, VP = Verb Phrase

Additional files

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

- **Supplementary Material 1.** Attachment questionnaire 1. *https://osf.io/ynamz/*
  Supplementary Material 2. Attachment questionnaire 2 (with length control). *https://osf.io/ynamz/*

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Competing interests

The authors have no competing interests to declare.

Author contributions

Miriam Aguilar and Nino Grillo conceived and planned the experiments. Miriam Aguilar carried out the experiments and analyzed the results. Both authors wrote the manuscript.

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