Case cues and word order in relative clause processing: Reading time evidence from Georgian

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Abstract: The present study explores relative clause processing in Georgian, a split-ergative language with both prenominal and postnominal relative clauses. This combination of morphosyntactic properties makes the language an ideal testing ground for theories of the Subject-Gap Advantage (SGA), the observation that subject-gap relatives are generally easier to process than object-gap relatives. We present data from four self-paced reading experiments, manipulating the position and internal case alignment of relative clauses. Results provide evidence that processing is influenced both by the structural position of the gap and ambient morphological cues. The most robust effect is a cost associated with DPs in the ergative case. This must be due at least partially to the informativity of ergative morphology, since even ergative DPs which do not unambiguously belong to a filler–gap dependency are read slowly. However, reading time patterns at relative pronouns and certain RC-final verbs do not follow from informativity alone, and are most consistent with the hypothesis that subject gaps are privileged above all others. The fact that both morphological and structural cues guide relative-clause processing in Georgian echoes results from certain other ergative languages (Avar, Niuean), and supports the view that a range of factors are at play during the processing of filler–gap dependencies.

Keywords: ergativity, Georgian, relative clauses, sentence processing, subject gap advantage

1. Introduction

A wealth of evidence indicates that a relative clause whose gap is in subject position (1a) (a Subject Relative Clause; SRC) is easier to process than one with a gap in object position (1b) (an Object Relative Clauses; ORC).

(1) a. the writer [$_{RC}$ who ___ inspired the painter] *SRC*
b. the writer [$_{RC}$ who the painter inspired ___] *ORC*

This Subject-Gap Advantage (SGA) manifests across both a wide range of measurements — including acceptability judgements, disambiguation preferences, reading times, eye movements, and ERPs — and a wide range of languages — from Dutch (Frazier 1987) to Turkish (Kahraman et al. 2010) to Zapotec (Author1 et al. 2019). For detailed reviews of the literature on the SGA, see Gibson (1998) and Kwon et al. (2010).

However, the underlying source of the SGA remains unclear. A number of factors have been proposed to explain the processing asymmetry, but here we focus on just three: syntactic structure, the informativity of morphological cues, and linear/temporal distance. Within the relative clause processing literature, languages with nominative–accusative case alignment and postnominal relative clauses are overrepresented — but these are the very morphosyntactic properties which happen to be least informative for teasing apart the effects of structure, morphological informativity, and distance. And even studies on languages with underrepresented features (in particular ergative–absolutive alignment or prenominal relatives) have their limitations, since, internal to most languages, it is not possible to independently manipulate all these factors.

The present study presents reading-time data from Georgian, whose properties are practically tailor-made to study relative clause processing. It is a language with a split-ergative case system, flexible word order, a wealth of relativization strategies, and speakers that read fluently and are generally computer literate. Together, these factors make it possible to compare reading times of pre- and post-nominal relative clauses, or ones with either nominative–accusative or ergative–absolutive case alignment. The four self-paced reading experiments detailed here do just that. Together, they lend support to theories which derive the SGA from structural and cue-based principles.

A Structural Theory of the SGA posits that certain syntactic positions are inherently more accessible for filler–gap dependencies than others. Keenan & Comrie's (1977) Accessibility Hierarchy is one implementation of this idea (2).

(2) *The Accessibility Hierarchy* (Keenan & Comrie 1977:66)
Subject > Direct Object > Indirect Object > Oblique > Possessor > Object of Comparison

This scale of grammatical relations is theorized to have cognitive ramifications: the farther to the left a position is, the easier it will be to process a dependency with a gap there.[1] Evidence for the Accessibility Hierarchy comes from robust typological implications: if a given relativization strategy in a language permits relativization from one point on the hierarchy, it will generally also permit relativization from all positions above it on the hierarchy. If all languages' grammatical relations are organized according to this hierarchy, then the Structural Theory predicts the SGA to be universal.

[1] Most filler–gap processing research has focused only on constructions with gaps in subject or direct object position; little work has investigated gaps lower on the Accessibility Hierarchy (though see Lin 2018 for a recent exception).

A second factor hypothesized to contribute to the SGA is the informativity of morphology (especially case morphology) in and around the relative clause. This Case Informativity Theory posits that the cognitive effort necessary to integrate an argument into a syntactic structure is proportional to the amount of syntactic structure it entails (Polinsky et al. 2012; cf. Hale 2006). Thus, arguments in unmarked cases (nominative or absolutive) will be easier to process than ones in dependent cases (accusative or ergative). To illustrate, consider the following Russian relative clauses. The SRC (3a) is introduced by a relative pronoun in the nominative case. This morphology is compatible with a wide range of continuations: the gap must be in subject position, but otherwise the relative clause might be transitive or intransitive, past or non-past, active or passive. In contrast, the ORC (3b) begins with an accusative-case relative pronoun. Compared to nominative, accusative is more informative, as it entails the presence of upcoming transitive structure. The Case Informativity Theory therefore predicts the accusative relative pronoun of the ORC to be more difficult to process than the nominative one in the SRC — in other words, it predicts an SGA for a nominative–accusative language like Russian.

(3) a. *sobak-a,* [$_{RC}$ ***kotor-aja*** __ *košk-u* *dogonjaet*]
dog-F.NOM **which-F.NOM** cat-F.ACC chase:PRES.3SG
'the dog [$_{RC}$ which __ is chasing the cat]'
b. *sobak-a,* [$_{RC}$ ***kotor-uju*** *košk-a* __ *dogonjaet*]
dog-F.NOM **which-F.ACC** cat-F.NOM chase:PRES.3SG
'the dog [$_{RC}$ which the cat is chasing __]' (Russian; glosses adapted from Polinsky 2011)

In contrast, consider the processing profile of relative clauses with ergative–absolutive alignment, like the following from Hindi (4). Here, the morphology of the SRC's relative pronoun (ergative) is more informative than that of the ORC's (absolutive), since absolutive case appears in more syntactic environments than ergative case does in Hindi (cf. Dillon et al. 2012). By the metric of case informativity, then, we should observe an *object*-gap advantage (OGA) across this pair of sentences, manifesting at or just after the relative pronouns.

(4) a. *maĩ-ne* *ek* *ciṛiyā* *khīñcā* [$_{RC}$ *jis-ne* __ *ek* *cūhā* *khā* *liyā.*]
1SG-ERG one bird.NOM draw.PFV REL-ERG one rat.NOM eat take.PFV
'I drew a bird [$_{RC}$ which __ ate a rat]'
b. *maĩ-ne* *ek* *ciṛiyā* *khīñcā* [$_{RC}$ *jo* *ek* *cūhe-ne* __ *khā* *liyā.*]
1SG-ERG one bird.NOM draw.PFV REL.NOM one rat-ERG eat take.PFV
'I drew a bird [$_{RC}$ which a rat ate __]' (Hindi; Pranav Anand, p.c.)

Crucially, the Informativity Theory predicts that the difficulty associated with accusative or ergative should not be limited to environments involving filler–gap dependencies. Even in root clauses, dependent case morphology will license predictions about upcoming structure that are relatively taxing to integrate.

Finally, the SGA may be due to the length of a relative-clause dependency. This length, between the filler and the gap, might be measured in some number of linguistic units (Gibson 1998) or in temporal distance (Lewis & Vasishth 2005). Such a theory assumes that fewer processing resources are available to other parsing operations while a filler is held in active memory, waiting to be linked to a gap. Returning to English, it is clear how the Distance Theory predicts an SGA. In an SRC (5a), the head noun filler can be associated with its gap as soon as the parser crosses the complementizer, observing that the subject position is empty. In an ORC (5b), the subject and verb additionally intervene, making for a dependency which is longer, and therefore more difficult.

(5) a. the writer [$_{RC}$ that __ inspired the painter]
b. the writer [$_{RC}$ that the painter inspired __]

Considering a language with prenominal relative clauses, like Korean (6), the situation is different. Assuming gaps to be posited in canonical argument positions (Korean is an SOV language), then an SRC dependency will be longer than an ORC dependency. All things being equal, then, the Distance Theory predicts an OGA for a language with prenominal relatives. It is worth noting, however, that the picture is likely more complicated for Korean, since it has null pronouns, argument scrambling, and its relative clauses are not unambiguously marked until their right edge (by the verbal suffix *–n* 'ADNOMINAL'); together these factors mean that it is not a trivial task for the parser to determine where a relative clause dependency even starts. See Yun et al. (2015) for an account that takes such uncertainties into consideration for Korean and other typologically similar languages.

(6) a. [$_{\text{RC}}$ __ *uywon-ul* *kongkyekha-n*] *enlonin-i*
senator-ACC attack-ADN journalist-NOM
'the journalist [$_{\text{RC}}$ that __ attacked the senator]'
b. [$_{\text{RC}}$ *uywon-i* __ *kongkyekha-n*] *enlonin-i*
senator-NOM attack-ADN journalist-NOM
'the journalist [$_{\text{RC}}$ that the senator attacked __]' (Korean; Kwon et al. 2010:549)

Table 1 summarizes the predictions made by the three theories discussed above for languages of various typological profiles. Two parameters are manipulated: case alignment pattern, and relative clause position. It is clear that a language represented by the first column (namely, a nominative–accusative language with postnominal relatives, like English), is the least informative kind when testing these theories. But the other parameter settings also involve some degree of analytical uncertainty. If a language represents just one of these columns, then, it may not be able to unambiguously adjudicate among the three theories.

<table>
<tr><th></th><th colspan="2">Nominative–accusative Alignment</th><th colspan="2">Ergative–absolutive Alignment</th></tr>
<tr><th></th><th>N [RC …]
(postnominal RC)</th><th>[RC …] N
(prenominal RC)</th><th>N [RC …]
(postnominal RC)</th><th>[RC …] N
(prenominal RC)</th></tr>
<tr><td>Structure</td><td rowspan="3">SGA</td><td rowspan="2">SGA</td><td>SGA</td><td>SGA</td></tr>
<tr><td>Informativity</td><td>OGA</td><td rowspan="2">OGA</td></tr>
<tr><td>Distance</td><td>OGA</td><td>SGA</td></tr>
</table>

Table 1: *Predictions for various types of languages made by three theories of the SGA*

Enter Georgian. While it has only been the focus of a handful of previous psycholinguistic studies (Skopeteas et al. 2012, Author1 & Author2 2017, Lau et al. 2018, Lau et al. submitted), it is a language especially well-suited to compare these theories of the SGA. With split-ergative case alignment with both pre- and post-nominal relative clauses, Georgian instantiates all four columns in Table 1. Taking advantage of this fact, we manipulated the position of a relative clause and its internal case alignment in four self-paced reading experiments in order to pinpoint loci of real-time processing difficulty. Across these experiments, the most consistent effect is a slowdown associated with relative-clause coarguments in the ergative case (an effect also found in ERPs and reading times by Lau et al. submitted). This is compatible with both the Structural and Informativity Theories. Ergative coarguments eliminate the possibility of an SRC parse — thereby forcing a parser that privileges subject gaps into a reparse — but ergative morphology is also highly informative in Georgian — so it triggers taxing predictions about the upcoming structure. Neither theory alone can account for the full array of other effects, though. For example, ergative coarguments that precede cues for a filler–gap dependency (i.e., ergatives that could be confused for root-clause arguments) also evince processing difficulty: a result only predicted by the Informativity Theory. On the other hand, ergative relative pronouns are read no slower than uninformative nominative ones: a result only predicted by the Structural Theory. So, it seems that both factors are at play in Georgian — as seems to be the case in Avar (Polinsky et al. 2012) and Niuean (Longenbaugh & Polinsky 2016). As for the Distance Theory, we find scant evidence that supports it. Regions at the right edge of prenominal relative clauses and just after exhibit a numerical trend in favor of ORCs, but this does not reach significance.

The paper is structured as follows. We first delve into some previous research on cross-linguistic RC processing (Section 2) and describe morphosyntactic properties of Georgian relevant to the experiments (Section 3). From there we dive into the experiments themselves, first discussing the pair manipulating RC position (Sections 4 & 5), then the pair manipulating RC-internal case alignment (Sections 6 & 7). Finally, we discuss the results of these experiments in a broader context and their implication for the cross-linguistic picture of relative clause processing (Section 8).

2. Previous research

This section reviews cross-linguistic findings in relative clause processing, reviewing studies on languages with prenominal relative clauses, and ones on ergative languages. The processing of prenominal relatives has been most thoroughly investigated in Chinese (Hsiao & Gibson 2003, Lin & Bever 2006, Vasishth et al. 2013, and others), Japanese (Ueno & Garnsey 2008), and Korean (Kwon et al. 2010, 2013). These languages have generally exhibited an SGA, though traces of an OGA are occasionally reported. Experimental evidence from Chamorro (Wagers et al. 2018), where pre- and post-nominal relatives can be compared directly, shows that the SGA is weaker in prenominal RCs than postnominal RCs, but this asymmetry may be due to a confluence of morphosyntactic properties, rather than just distance.

Relative clause processing has been studied in a growing number of ergative languages, including Basque (Carreiras et al. 2010), Avar (Polinsky et al. 2012, Polinsky 2016), Ch'ol and Q'anjob'al (Clemens et al. 2015), and Niuean (Longenbaugh & Polinsky 2016, Tollan et al. 2019). A mixed picture has emerged: some studies find an SGA, others an absolutive-gap advantage (i.e., an OGA in transitive clauses), and yet others find evidence for both.

2.1 Prenominal relative clauses and the subject gap advantage

Among the existing studies on languages with prenominal relative clauses, most have focused on Chinese, Japanese, and Korean. In all three languages, the left edge of a relative clause is not directly signaled by a complementizer or relative pronouns (7). Since all of these languages have null pronouns and can scramble arguments, this means some relative clauses (in particular, ones that modify clause-initial noun phrases) will be temporarily ambiguous and may be initially parsed as a root clause.

(7) a. [RC __ *Gōngjī* *yìyuán-de*] *jìzhě* *chéngrèn-le* *cuòwù.*
attack senator-ADN reporter admit-PFV error
'The reported [RC that __ attacked the senator] admitted the error.' **[SRC]**
(Chinese; Kwon et al. 2013:539)

b. [RC *Giin-ga* __ *hinanshita*] *kisha-ga* *ayamari-o* *mitometa.*
senator-NOM attacked reporter-NOM error-ACC admitted
'The reporter [RC that the senator attacked __] admitted the error.' **[ORC, ACC gap]**
(Japanese; Kwon et al. 2013:539)

c. [RC __ *Uywon-ul* *kongkyekha-n*] *kica-ka* *silswu-lul* *siinhayssta.*
senator-ACC attack-ADN reporter-NOM error-ACC admitted
'The reported [RC that __ attacked the senator] admitted the error.' **[SRC, NOM gap]**
(Korean; Kwon et al. 2013:539)

Processing studies on Japanese and Korean have routinely found an SGA, despite the linear order of relative clause and head noun (Miyamoto & Nakamura 2003, Ishizuka et al. 2006, Ueno & Garnsey 2008; Kwon et al. 2007, Kwon 2008, Kwon et al. 2010, Kwon et al. 2013). For example, in two eye-tracking experiments on Korean, Kwon et al. (2010) found that ORCs were read significantly more slowly than SRCs. This finding was observed across several measures: reading times of the whole sentence, regression-path duration at head nouns, and rereading times at regions across the sentence. The authors interpret their results as strong evidence in favor of a Structural Theory of the SGA; the OGA predicted by Distance Theories was not borne out.

Ueno & Garnsey (2008)'s self-paced reading and ERP experiments on Japanese yielded similar results. Reading times at the head noun were significantly higher in the ORC condition than the SRC condition. As for ERPs, object gaps elicited a greater bilateral anterior negativity than subject gaps during the relative clause and a greater centro-posterior positivity after the relative clause. Both effects the authors interpret as reflecting an SGA. However, Ishizuka et al. (2006) suggest that findings such as these in Japanese are not due to the structural position of the gap, but rather the greater temporary ambiguity of the language's ORCs compared to its SRCs. They attempt to eliminate this confound by providing contexts which lessen the ambiguity, and after this adjustment they indeed find an OGA. But, as Kwon et al. (2010) discuss, there are several issues with Ishizuka et al.'s context sentences that cast doubt on the findings. Furthermore, Ishizuka et al. did not replicate the OGA result in subsequent experiments (Kwon et al. 2010:563, fn. 12), and one of Kwon et al. (2010)'s experiments, which utilized similar disambiguating contexts for Korean, also did not find an OGA. Overall, then, data from both Korean and Japanese support a Structural Theory for the processing of prenominal relative clauses.

Processing work on Chinese relative clauses has yielded mixed results (see discussion in Kwon et al. 2010, Vasishth et al. 2013, Wagers et al. 2018), some studies finding an SGA (Lin 2006, 2008; Lin & Bever 2006, 2011; Vasishth et al. 2013, Exp. 1–2), others an OGA (Hsiao & Gibson 2003, Hsu & Chen 2007, Lin & Garnsey 2011, Gibson & Wu 2011; Vasishth et al. 2013, Exp. 3). For instance, both Hsiao & Gibson (2003) and Lin & Bever (2006) compare reading times of SRCs and ORCs, using stimuli very similar to the example in (7a). Hsiao & Gibson (2003) find a significant difference in RTs only at the second word of the relative, with SRCs being slower (they also test doubly-embedded relatives, which showed comparable RT patterns). They interpret this as an OGA, in line with the predictions of the Distance Theory. But Lin & Bever (2006) did not replicate these results; instead, they found a consistent SGA starting at the right edge of the relative clause, a result more in line with the Structural Theory. In light of the muddy empirical landscape, Vasishth et al. (2013) conduct a meta-analysis of fifteen RC processing studies on Chinese, including three novel experiments. They conclude that the evidence favors an SGA for the language, and that apparent OGA findings are likely due to the local structural ambiguities inherent to SRCs that modify matrix subjects.

The languages discussed so far have rigid relative clause placement: there is no optionality as to the linear order of RC and head noun. There are languages, though, which admit both prenominal and postnominal relatives. Chamorro, a verb-initial Austronesian language of the Mariana Islands, is an example. Besides flexible RC position, Chamorro also boasts *wh*-agreement, a special type of morphology that registers the syntactic role of an extracted element (Chung 1994, 1998). *Wh*-agreement is optional on relative clause verbs, but when it appears it reliably indicates the position of the gap. A few Chamorro examples are given in (8).

(8) a. *i* [$_{RC}$ *k⟨um⟩uentutusi* *yu'* *nigap*] *na* *palåo'an*
DET ⟨WH.SUBJ⟩speak.PROG 1SG yesterday LK woman
'the woman [$_{RC}$ who __ was speaking to me yesterday]' **[prenominal SRC, +*wh*-agr.]**

b. *i* *lalåhi* [$_{RC}$ *ni* *ma* *kakassi* *i* *ma'estra*]
DET men C AGR tease.PROG DET teacher
'the men [$_{RC}$ that __ were teasing the teacher]' **[postnominal SRC, −*wh*-agr.]**
(Chamorro; glosses adapted from Wagers et al. 2018:210)

Wagers et al. (2018) conducted a picture-matching experiment that took advantage of these morphosyntactic properties. They compared prenominal, postnominal, and headless relative clauses, which were either ambiguous (one condition: transitive without *wh*-agreement), or unambiguous (two conditions: passive, or transitive with *wh*-agreement). Stimuli were presented auditorily and participants used tablet computers to select a picture most appropriate for the item. Ambiguous RCs were assigned subject-gap parses more frequently than object-gap parses, but this preference was much stronger for postnominal RCs than prenominal RCs. In the unambiguous conditions, the error rate mirrored trends in disambiguation. Among RCs disambiguated by object *wh*-agreement, the most errors occurred in postnominal relatives, which were most frequently associated with an SRC parse in the ambiguous conditions; prenominal relatives, which were more likely to be parsed with object gaps when ambiguous, had the most errors among RCs disambiguated by subject *wh*-agreement. However, in terms of latency subject-gap interpretations corresponded to the earliest responses, even in conditions where object-gap responses were more common.

According to Wagers et al., results from this experiment indicate that a constellation of parsing principles is at work in Chamorro, working together to maximize incremental well-formedness. Within a relative clause, the parser will have several dependencies to satisfy: the movement relationship between the filler and its gap, the *φ*-agreement relationship between the subject and the verb, and potentially also a *wh*-agreement relationship linking a verb and a gap. In a postnominal RC, these dependencies unfold in such a way to strongly favor a subject-gap parse: very early in the relative, at the verb region, the parser can satisfy two dependencies (filler–gap and subject–verb agreement) by projecting a gap in subject position and associating it with the head noun they just encountered. In a prenominal relative, though, this is not possible. The complementizer–verb sequence signals the very same dependencies, but having not yet encountered the head noun, the parser cannot satisfy the outstanding filler–gap and agreement dependencies. Instead, parsing continues, dependencies unresolved, until the RC coargument is encountered. If this coargument has *φ*-features matching verb agreement, choosing to link it to subject position will be the most economical parsing decision, since that satisfies the agreement dependency. Later on in the string, the relative clause ends and the parser encounters the head noun. Only then can the filler–gap dependency be satisfied: and since the coargument has already taken the subject position, the next best option (assuming the Accessibility Hierarchy) is to put a gap in object position.

So, while Wagers et al. do find an OGA in prenominal relative clauses (or at least an attenuated SGA), they do not interpret this as evidence in favor of the Distance Theory. Instead, a confluence of factors — some language-specific (like idiosyncratic morphological cues) and others apparently language-general (like the preference for subject gaps) — guide relative clause processing. The challenge of integrating multiple dependencies at staggered time points is one we return to in the discussion section for Experiment 1 (Section 4.3).

2.2 The Subject-Gap Advantage in ergative languages

Ergative languages have increasingly been the subject of psycholinguistic investigation (Longenbaugh & Polinsky 2017). Because they associate informative morphology with transitive subjects rather than direct objects, ergative languages can tease apart the Structural and Case Informativity Theories of the SGA. However, the empirical picture that has emerged for the processing of transitive relative clauses in ergative languages is mixed: some studies report an SGA (Clemens et al. 2015), others an OGA (Carreiras et al. 2010, Heller & Tollan 2018), and still others find evidence for both effects (Polinsky et al. 2012, Longenbaugh & Polinsky 2016).

The earliest studies on the interaction of relative clause processing and ergativity are on Basque, where Carreiras et al. (2010) claim to find evidence for an absolutive-gap advantage (i.e., an OGA in transitive RCs). In two SPR studies and one ERP experiment, they compare prenominal relatives like those in (9). Their stimuli are designed to take advantage of a particular quirk of Basque morphology: a noun's absolutive plural form (suffixed with *–ak*) is homophonous with its definite ergative singular form (*–a-k*). Notice that their SRC and ORC conditions are string-identical until the very last word of the sentence. There, the agreement on an auxiliary (*have* or *be*) disambiguates the number and case features of the matrix subject — and since the matrix subject is the RC head noun, this auxiliary also disambiguates the features and position of the relative clause gap, several words back.

(9) a.

[$_{\text{RC}}$ __	*Irakasle-ak*	*aipatu*	*ditu-en*	]	*ikasle-a-k*	*lagun-ak*	*ditu.*
	teacher-ABS.PL	mentioned	have:3SG>3PL-REL		student-DEF-ERG	friend-ABS.PL	have:3SG>3PL

'The student [$_{\text{RC}}$ that __ mentioned the teachers] has friends.' **[SRC, ERG gap]**

b.

[$_{\text{RC}}$ *Irakasle-a-k*	__	*aipatu*	*ditu-en*	]	*ikasle-ak*	*lagun-ak*	*dira.*
teacher-DEF-ERG		mentioned	have:3SG>3PL-REL		student-ABS.PL	friend-ABS.PL	be:3PL

'The students [$_{\text{RC}}$ that the teacher mentioned __] are friends.' **[ORC, ABS gap]**

(Basque; glosses adapted from Carreiras et al. 2010:82)

The authors found significantly higher reading times in the SRC condition than in the ORC condition at the disambiguating sentence-final auxiliary. The EEG study corroborated these findings: at the same region, the SRC condition had a significantly larger P600, an ERP linked to syntactic processing difficulty. The authors interpret these results as an OGA, and suggest that something like a 'Case Accessibility Hierarchy' (cf. Moravcsik 1974) guides Basque parsers: gaps associated with absolutive case (whether subjects or objects) are more accessible than ones associated with ergative case.

However, as Clemens et al. (2015) discuss, there are at least two reasons to be wary of this conclusion. First, it could be that the processing difficulty observed at the SRC auxiliary isn't due to the gap site of relative clause, but rather the argument structure of the matrix clause. In the reported materials, the ORC conditions always contain an intransitive, copular matrix auxiliary (*be*), while the SRCs have a transitive auxiliary (*have*). It is plausible that the transitive argument structure of *have* is more difficult to process than the intransitive copular structure of *be*, and that this difference explains the asymmetry in the SRC condition. Second, the apparent ORC preference could stem from a morphological disambiguation preference, assuming Basque speakers, confronted a noun ambiguous between ERG.SG and ABS.PL, are more inclined to parse it as ERG.SG. This seems like a reasonable hypothesis — corpus data indicate ERG.SG nouns are indeed more common than ABS.PL ones in Basque (Austin 2007; via Clemens et al. 2015:428, fn. 8). Given such an inclination, participants will be more likely to choose an ORC parse during the first four words of the stimulus. Increased processing difficulty at the disambiguating sentence-final auxiliary could simply indicate a garden path effect, since that auxiliary forces the parser to revise the original ORC parse. For these reasons, Carreiras et al.'s findings do not unequivocally support their claim that Basque parsers are guided by a Case Hierarchy.

Another set of processing studies has been conducted on Avar (Polinsky et al. 2012 and Polinsky 2016), a Northeast Caucasian language with prenominal RCs. Data from these experiments support both the Structural and Informativity Theories: within RCs, informative morphology on ergative coarguments leads to processing difficulty; at the head nouns, structural and cue-based factors cancel each other out, leading to an apparent null result across transitive conditions.

(10) [RC __ *ʕoloqana-y* *yas* *repetici-yal-de* *y-ač:-un* *y-ač'-ara-y*]
unmarried-II girl.ABS(II) rehearsal-OBL-LOC II-bring-GER II-come-PTCP-II
artistika *bercina-y* *y-igo.*
actress.ABS(II) beautiful-II II-AUX
'The actress [RC that __ brought the young girl to the rehearsal] is pretty.' **[SRC, ERG gap]**
(Avar; Polinsky et al. 2010:271)

Using a self-paced reading task, Polinsky et al. (2012) compared relative clauses with gaps in ergative subject position, absolutive direct object position, or (intransitive) absolutive subject position. They find two important effects. First, the absolutive coargument of an S_{ERG}RC was read significantly faster than either the ergative coargument of an O_{ABS}RC or the oblique coargument of an S_{ABS}RC. This conforms to the predictions of the Informativity Theory — absolutive is the least informative case value, and therefore should be easiest to integrate into the structure. Note that the slowdown here occurs even before the parser has reason to anticipate a relative clause dependency; two words in, the sentence is still compatible with a declarative root-clause interpretation.

The second important finding occurs at the first spillover region after the head noun. Here the intransitive S_{ABS}RC condition is read significantly faster than either of the conditions involving a transitive RC, which are not read at significantly different speeds. Polinsky (2016:176–178) describes a picture-matching experiment on Avar that replicates this finding: response latencies are shorter for S_{ABS}RC than either S_{ERG}RC or O_{ABS}RC conditions. To explain this difference, Polinsky et al. appeal to an interaction of structure and case informativity. On the one hand, if subject gaps are intrinsically better than object gaps, no matter their case value, we should expect the S_{ERG}RC to be read faster than the O_{ABS}RC. On the other hand, if morphological cues facilitate predictive parsing, we expect the reverse. That is because in an O_{ABS}RC, the ergative coargument back at the second word of the relative prompted the parser to anticipate a syntactic position for an absolutive object. Since this absolutive position has already been projected, it is relatively easy to link it to the head noun. As for the S_{ERG}RC, its absolutive coargument does not necessarily license a structural position for an ergative element. Therefore, the parser is burdened with projecting a transitive subject position, and also satisfying the relative clause dependency by linking the head noun to that position. In other words, the Accessibility Hierarchy favors the S_{ERG}RC (whose gap is a subject) but predictive parsing principles favor the O_{ABS}RC (whose structural position was licensed several words back). If weighted roughly equally, these factors will cancel each other out across the two transitive conditions. As for the S_{ABS}RC condition, both principles are on the side of a gap in absolutive subject position. Thus Polinsky et al. explain this second effect by appealing to both the Structural and Case Theories.

A very similar set of results has been observed for Niuean (Austronesian), which is the subject of a picture-matching task conducted by Longenbaugh & Polinsky (2016). Participants were presented with illustrations depicting characters interacting in various ways. Auditory stimuli prompted participants to select one of the characters; these stimuli consisted of questions containing relative clauses of various types, as in (11). Answers containing intransitive relative clauses were answered significantly faster than ones containing transitive relative clauses. S_{ERG}RC and O_{ABS}RC response latencies, though, were not significantly different. This directly mirrors the results for Avar, where intransitive conditions were consistently easier to process than transitive ones.

(11) a. *Ko fe* *e* *kulī* [RC *ne* *epoepo* __ *e* *puti?*]
Where ABS dog NFT lick ABS cat
'Where is the dog [RC that __ is licking the cat?]' **[SRC, ERG gap]**
b. *Ko fe* *e* *puti* [RC *ne* *epoepo* *he* *kulī* *__?*]
Where ABS cat NFT lick ERG dog
'Where is the cat [RC that the dog is licking __?]' **[ORC, ABS gap]**
(Niuean; Longenbaugh & Polinsky 2016:111–112)

Tollan et al. (2019) observe a slightly different pattern for Niuean. Using the visual-world paradigm, they tracked eye movements during subject- or object-extracted *wh*-questions like those in (12). Note that these are ambiguous for extraction site up until the case-marked coargument. Each experimental trial began with an auditorily presented context sentence that established which figures in the visual world acted on which others. Participants then heard a *wh*-question asking about one of those figures. A second experimental factor besides gap site was the verb's case frame / argument structure: the question contained either a transitive verb with an ergative subject and an absolutive object (an S_{ERG}>O_{ABS} case frame), a transitive verb with quirky an S_{ABS}>O_{OBL} case frame, or an intransitive verb with an ABS subject and an OBL adjunct.

(12) a. *Ko e pusi fē ne tutuli tūmau* __ *e lapiti?*
PRED cat which PAST chase always ABS rabbit
'Which cat __ always chases the rabbit?'
b. *Ko e pusi fē ne tutuli tūmau he kulī* __*?*
PRED cat which PAST chase always ERG dog
'Which cat does the dog always chase __?' (Niuean, Tollan et al. 2019:4)

During the verb+adverb sequence (when the extracted argument's structural position is still ambiguous), Tollan et al. observe the following eye-movement patterns. In conditions with S_{ERG}>O_{ABS} transitive verbs, there were significantly fewer looks to visual-world figures compatible with a subject-question parse than there were in conditions with either S_{ABS}>O_{OBL} transitive or S_{ABS}>O_{OBL} intransitive verbs. The authors interpret this as an absolutive-gap advantage, since Niuean speakers are inclined to anticipate that a gap will be in a position associated with absolutive case during all three conditions. This corresponds to a subject gap for questions with S_{ABS}>O_{OBL} case frames (hence the high proportion of subject-compatible gazes in these conditions), but an object gap for questions with S_{ERG}>O_{ABS} case frames (hence the lower proportion of such gazes in this condition). Tollan et al. (2019) do not attempt to reconcile their eye-tracking results in Niuean with Longenbaugh & Polinsky's (2016) picture-matching data, but the empirical discrepancy between the methodologies is an intriguing one.

Complicating the picture on RC processing in ergative languages further is Clemens et al.'s (2015) study on Ch'ol and Q'anjob'al, two verb-initial Mayan languages. Unlike the previously discussed experiments, these authors find a clear subject-gap advantage for Ch'ol and Q'anjob'al, with no evidence for an absolutive-gap advantage.

Clemens et al. conduct two picture-matching experiments, one on each Mayan language. Auditory stimuli contained relative clauses which were either ambiguous for gap-site, RCs which were biased towards a particular gap-site interpretation by an animacy discrepancy between the head noun and RC coargument, or (for Q'anjob'al) RCs where were structurally unambiguous. Ch'ol relative clauses involving two 3SG arguments are always structurally ambiguous (13), but Q'anjob'al's relatives are typically unambiguous; this language requires special 'agent focus' morphology and syntax when a transitive subject undergoes Ā-movement, as (14) shows.

(13) *Ta' jul-i jiñi x'ixik* [$_{RC}$ *ta'-bä i-tsäk'-ä jiñi wiñik.*]
PFV arrive-INTR DET woman PFV-REL 3.ERG-cure-TR DET man
'The woman [$_{RC}$ that __ cured the man] arrived.' **[SRC, ERG gap]**
or 'The woman [$_{RC}$ that the man cured __] arrived.' **[ORC, ABS gap]**
(Ch'ol, Clemens et al. 2015:437)

(14) a. *Max jay ix ix* [$_{RC}$ *max h-el-a' Ø* __.]
PFV arrive DET woman PFV 2.ERG-see-TR *pro*:2SG
'The woman [$_{RC}$ that you saw __] arrived.' **[ORC, ABS gap]**

b. *Max* *jay* *ix* *ix* [RC *max-ach* *il-**on**-i* __ *Ø*.]
PFV arrive DET woman PFV-2.ABS see-**AF**-INTR *pro*:2SG
'The woman [RC that __ saw you] arrived.' **[SRC, transitive subject gap: agent focus necessary]**
(Q'anjob'al, Clemens et al. 2015:438)

For both Ch'ol and Q'anjob'al, accuracy and response latencies indicate an SGA: ambiguous RCs elicited SRC-congruent responses a majority of the time, responses to SRC-biased transitive RCs were more accurate than responses to ORC-biased ones, and response times were shortest after relative clauses compatible with a subject-gap parse. As for the structurally unambiguous conditions in Q'anjob'al, these items elicited SRC-compatible and ORC-compatible responses in roughly equal proportion. This is a surprising result, given that the presence of an agent focus morpheme in a transitive relative clause should only be compatible with an SRC interpretation, and its absence with an ORC interpretation. The authors suggest that this result may stem from a preference to extract patients as passive subjects rather than active objects, and therefore a transitive ORC is relatively unusual. Alternatively, it may indicate that the extraction asymmetry in (14) is not as strict as has been previously reported for the language.

Setting aside the issue regarding the Q'anjob'al agent focus construction, these experiments demonstrate a clear SGA, results most compatible with the Structural Theory of relative-clause processing. So why didn't the Mayan languages exhibit the kind of ergative penalty observed in Avar, Basque, and (possibly) Niuean? Clemens et al. propose that head-marking morphology (like the ergative-aligned verbal agreement in Mayan) is less useful for incremental processing than dependent-marking morphology (like the ergative-aligned case system of Avar, Basque, and Niuean). Indeed, if the head noun and RC coargument have identical *φ*-features in Ch'ol, RC-internal verbal agreement plays no disambiguating role; both DPs in the clause could potentially control either the ergative or absolutive agreement affixes. Dependent marking, on the other hand, is instrumental for assigning arguments their structural positions, given the tight correlation of argument structure and presence of particular case categories. In the absence of case cues, as in Mayan, it seems the parser must default to more general parsing strategy, such as using the Accessibility Hierarchy.

3. Background on Georgian

This section details two areas of Georgian grammar relevant to the present study (see Aronson 1990 for a detailed description of the language). The first is the split-ergative case system, which strongly dissociates case morphology and syntactic role. As described in Section 3.1, a given argument may appear in different cases depending on the tense–aspect–mood (TAM), and each of the three core case categories varies in which syntactic roles, and how many, they map to. The processing profile of this complex case system is the focus of Skopeteas et al. (2012), whose results we summarize in Section 3.2. In Section 3.3 we turn to Georgian's relativization strategies. This study employs three such strategies — *rom*-relatives, *rom*-correlatives, and *wh*-relatives — which allow us to manipulate both the linear order of the relative clause and the head noun it modifies, and also the informativity and distribution of morphological cues within the relative clause itself. Finally, Section 3.4 lays out the predictions made by the Structural, Case Informativity, and Distance hypotheses for Georgian relative clauses of various types.

3.1 Case alignment

Georgian has a complex TAM-conditioned split-ergative case system (Harris 1985, Nash 2017a). This means that the case of an argument varies depending on its syntactic role and the TAM of the clause. TAMs fall into three groups; in each group, we find a different case alignment pattern. The first group includes the present, future, imperfective past, and a few others. In these TAMs, transitive, unergative, and unaccusative subjects all appear in the nominative case, while objects are in the dative case (15). This constitutes a Nominative–Accusative alignment pattern, since all subjects are marked in a distinct way from all objects, appearing in the nominative and dative cases, respectively.

(15) Future: Nominative–Accusative alignment

a. *bavšv-i ekim-s çign-s miscems.*
child-NOM doctor-DAT book-DAT give:FUT.3SG>3
'The child will give the book to the doctor.'

b. *bavšv-i itamašebs.*
child-NOM play:FUT.3SG
'The child will play.'

c. *dok-i gaṭq̇deba.*
pitcher-NOM break:FUT.3SG
'The pitcher will break.'

The second group of TAMs includes the aorist (perfective past) and optative (a kind of subjunctive). Here transitive and unergative subjects appear in the ergative case, while direct objects and unaccusative subjects appear in the nominative; indirect objects are dative (16). This kind of pattern, where intransitive subjects pattern either with transitive subjects or with direct objects, is known as Active alignment (Harris 1990; also known as Split-S alignment). Nevertheless, for convenience we will refer to it as the Ergative–Absolutive alignment — technically a misnomer, since not all intransitive subjects pattern with direct objects like they would in a strictly defined ergative–absolutive alignment system.

(16) Aorist: Active alignment #1 ('Ergative–Absolutive')

a. *bavšv-ma ekim-s çign-i misca.*
child-ERG doctor-DAT book-NOM give:AOR.3SG>3
'The child gave the book to the doctor.'

b. *bavšv-ma itamaša.*
child-ERG play:AOR.3SG
'The child played.'

c. *dok-i gaṭq̇da.*
pitcher-NOM break:AOR.3SG
'The pitcher broke.'

Finally, we see another Active alignment pattern in the last group of TAMs. These include the perfect (whose primary use is as a past evidential) and the pluperfect (often used as a past subjunctive). Here transitive and unergative subjects are dative, while direct objects and unaccusative subjects are nominative. As for indirect objects, they appear in a PP headed by the enclitic postposition *–tvis* 'for'. For clarity, we'll refer to this pattern as the Dative–Absolutive alignment.

(17) Perfect: Active alignment #2 ('Dative–Absolutive')

a. *bavšv-s ekim-is-tvis çign-i miucia.*
child-DAT doctor-GEN-for book-NOM give:PERF.3SG>3
'The child has [apparently] given the book to the doctor.'

b. *bavšv-s utamašia.*
child-DAT play:PERF.3SG
'The child has [apparently] played.'

c. *dok-i gamṭq̇dara.*
pitcher-NOM break:PERF.3SG
'The pitcher has [apparently] broken.'

The three case alignment patterns in Georgian are summarized in the following table. ‘A’ stands for transitive subjects, ‘S_A’ for unergative subjects, ‘S_O’ for unaccusative subjects, ‘O’ for direct objects, and ‘IO’ for indirect objects. Note that the three core cases are distributed unevenly: ergative appears only on external arguments in just two TAMs, while nominative and dative can occur in any TAM, and on any nearly any kind of argument. Consequently, the case categories vary in how informative they are in cueing the parser to surrounding syntactic structure and morphosyntactic features.

	A	**S_A**	**S_O**	**O**	**IO**	**Alignment**
FUT…	NOM			DAT		NOM–ACC
AOR…	ERG		NOM		DAT	Active #1 (‘ERG–ABS’)
PERF…	DAT		NOM		PP_{for}	Active #2 (‘DAT–ABS’)

Table 2: *Summary of Georgian’s split ergativity*

3.2 Case processing in Georgian

With the aim of investigating how Georgian’s split-ergative case system is processed, Skopeteas et al. (2012) conduct two grammaticality judgement experiments manipulating word order and case alignment. Stimuli consisted of written three-word sentences (SOV or OSV word order) which were presented on a computer screen. The first two words, the DP arguments, were presented by themselves for 5,000 ms. Then, the verb appeared, and participants were asked to judge the sentence as grammatical or ungrammatical. (All experimental items were grammatical, but fillers were either grammatical or ungrammatical.)

Both experiments compared verbs with $S_{NOM}>O_{DAT}$ case frames to ones with $S_{DAT}>O_{NOM}$ frames. For the first experiment these were transitive verbs in either NOM–ACC- or DAT–ABS-aligned TAMs. A main effect of case alignment affecting response latencies obtained in this experiment, with DAT–ABS sentences leading to significantly slower responses than NOM–ACC ones. The second experiment compared $S_{DAT}>O_{NOM}$ psych verbs to $S_{NOM}>O_{DAT}$ unaccusatives with applicative objects. Here, the authors found main effects of case alignment (responses to psych verbs being slower), word order (OSV being slower), and a significant interaction between the two factors; all three effects were driven by the dramatically slower response latencies to $O_{NOM}S_{DAT}V$ sentences with psych verbs.

Skopeteas et al. conclude the following. First, absent any disambiguating information, Georgian speakers are biased to parse nominative DPs as subjects and dative DPs as objects — even though the language has nominative objects and dative subjects. This explains why $S_{DAT}>O_{NOM}$ case frames take longer to process than $S_{NOM}>O_{DAT}$ ones. This bias persists even when a dative DP is linearly first, suggesting that word order is a lower-ranked cue to grammatical role than case is. Second, upon encountering a verb that does require a dative subject, revising the links between case and role is easier for stimuli containing psych verbs than for stimuli containing DAT–ABS transitive verbs. Moreover, the authors observe that unscrambled $S_{DAT}O_{NOM}V$ clauses are relatively easy to process given a psych verb (at least compared to scrambled $O_{NOM}S_{DAT}V$ clauses), but both word orders are difficult to process given a DAT–ABS transitive verb. The obvious difference between psych verbs and DAT–ABS transitive verbs is that the former license their dative subjects lexically (i.e., in all TAMs), whereas the latter do so inflectionally, by virtue of the mechanism enforces the language’s split ergativity. However, it remains an open question just why lexical dative subjects have a privileged processing status.

3.3 Relativization strategies

Georgian has an impressive array of relativization strategies (Author1 2013, Nash 2017b, Bhatt & Nash 2018). Three types of relative clauses are relevant for the present experiment. First is the *wh*-relative. As in English, a *wh*-relative involves the Ā-movement of a *wh*-phrase relative pronoun. This *wh*-phrase appears at the left edge of the relative clause, hosts the enclitic –*c*, and bears the case morphology associated with the corresponding gap site. Any verbal argument and a wide range of adjuncts can be relativized using the *wh*-relative strategy.

(18) *vnaxe* (*is*) *mxaṭvar-i* [RC *romel-ma-c* *gušin* __ *mçeral-s*
see:AOR.1SG (DEM) painter-NOM which-ERG-REL yesterday writer-DAT
momġeral-i *gaacno.*]
singer-NOM introduce:AOR.3SG>3
'I saw that/the painter [RC who __ introduced the singer to the writer.]'

Second is the *rom*-relative, which resembles a *that*-relative in English. *Rom*-relatives are postnominal, involve Ā-movement of a null operator, and contain the declarative complementizer *rom*. While *rom* appears at the left edge of complement clauses, the complementizer has a different distribution in relatives and certain other subordinate clauses. As (19) shows, *rom* may appear in any non-initial position, as long as it is before the verb and does not split up a constituent. As for the gap, it may appear in any argument position and at least some adjunct positions. Consultants often prefer a demonstrative to appear with the head noun of a *rom*-relative, but this element is not absolutely obligatory.

(19) *vnaxe* (*is*) *mxaṭvar-i,* [RC {**rom*} *gušin* {*rom*} *mçeral-s* {*rom*} *momġeral-i*
see:AOR.1SG (DEM) painter-NOM {*C} yesterday {C} writer-DAT {C} singer-NOM
{*rom*} *gaacno* {**rom*}.]
{C} introduce:AOR.3SG>3 {*C}
'I saw that/the painter [RC that __ introduced the singer to the dancer.]'

A third relativization strategy is the *rom*-correlative. Broadly speaking, a correlative is a species of adjunct clause which introduces a referent (or multiple referents) that is picked up in the matrix clause by anaphoric proform (Bittner 2001:39; see also Srivastav 1991, Dayal 1996, Lipták 2009). If the proform is a demonstrative, appearing within a matrix-clause DP, then the correlative has a very similar function to a relative clause. One kind of correlative in Georgian is illustrated in (20).[2] Like a *rom*-relative, it contains the non-initial complementizer *rom*, and a gap in argument position formed by Ā-movement of a null operator. But unlike a *rom*-relative, it is separated from the head noun, appearing at the left periphery of the matrix clause, and a demonstrative is obligatory on the head noun. The correlative can be translated roughly into English as a left-dislocated headless relative.

(20) [RC {**rom*} *gušin* {*rom*} *mçeral-s* {*rom*} *momġeral-i* {*rom*} *gaacno* {**rom*},]
{*C} y.d. {C} writer-DAT {C} singer-NOM {C} introduce:AOR.3SG>3 {*C}
vnaxe *(*is*) *mxaṭvar-i.*
see:AOR.1SG *(DEM) painter-NOM
≈ '[RC The one that __ introduced the singer to the writer yesterday,] I saw that painter.'

This particular correlative construction will be useful in the present study, as it is maximally parallel to a *rom*-relative: at least in terms of strings of words, the two differ only in the position of the subordinate clause. Thus, throughout this paper we will refer to both correlatives and relative clauses proper as

[2] Argument-modifying correlatives with other shapes also exist, like head-internal correlatives. See Bhatt & Nash (2018) for more details.

‘relatives’, ‘SRCs’, or ‘ORCs’ for the sake of terminological simplicity. It is important to keep in mind, though, that correlatives are not simply prenominal relatives; indeed, the syntax and semantics of correlativization and relativization are importantly distinct (Dayal 1996, Bhatt 2003, Bhatt & Nash 2018). It may be, then, that their processing profiles are also distinct. But insofar as both types of constructions involve $\bar{\text{A}}$-movement, and require the parser to link a filler to a gap — whatever linear order the filler and gap appear in — we will assume that they are sufficiently similar to warrant direct comparison in Experiments 1 and 2.

One final caveat: Georgian noun-modifying correlatives are superficially similar to a range of adjunct clauses, including one strategy for forming *when-* and *because*-clauses (21a), and also counterfactual conditionals (21b). These clauses are also left-peripheral and contain a non-initial *rom*. And while they do not contain gaps in argument position, they may contain null pronouns. Consequently, these adjunct clauses may be locally or even globally ambiguous with a noun-modifying correlative (22).

(21) a. [CP *laṭaria* *rom* *moigo,*] *mcxobel-ma* *šeçq̇viṭa* *mušaoba.*
lottery.NOM C win:AOR.3SG baker-ERG quit:AOR.3SG work.NOM
‘[When s/he won the lottery,] the baker quit his/her job.’
or ‘[Because s/he won the lottery,] the baker quit his/her job.’

b. [CP *laṭaria* *rom* *moego,*] *mcxobel-i* *šeçq̇veṭda* *mušaoba-s.*
lottery.NOM C win:PLU.3SG baker-NOM quit:COND.3SG work-DAT
‘[Had s/he won the lottery,] the baker would have quit his/her job.’

(22) [CP __ *laṭaria* *rom* *moigo,*] *im* *mcxobel-ma* *šeçq̇viṭa* *mušaoba.*
{*pro*, gap} lottery.NOM C win:AOR.3SG DEM baker-ERG quit:AOR.3SG work.NOM
‘[When s/he won the lottery,] that baker quit his/her job.’ **[adjunct clause]**
or ‘[The one that won the lottery,] that baker quit his/her job.’ **[noun-modifying correlative]**

It is an open question whether the similarity between these adjunct clauses and noun-modifying correlatives is skin deep, or if it indicates a deeper syntactic parallel. One possibility is that the adjunct clause are essentially correlatives with gaps in adjunct position. The connection between correlatives and conditionals is a well-studied one (e.g., Izvorski 1997, Bhatt & Pancheva 2006), making this an attractive analytical possibility, but future research will be necessary to confirm it.

3.4 Predictions

To contextualize the design and results of Experiments 1–4, it will be useful to spend some time unpacking the predictions made by the Structural, Informativity, and Distance Theories for SRCs and ORCs in Georgian. Consider first a *wh*-relative. One possible *wh*-relative is schematized in (23): first comes a head noun, then a *wh*-phrase relative pronoun, the coargument, and the verb. Each of these DPs will bear a case suffix (K_1–K_3), and the verb will bear TAM morphology.

(23) HdN-K_1, [RC whP-K_2 CoArg-K_3 V-TAM]

Only the Informativity Theory predicts processing differences at the head noun. The more informative its case value (K_1), the harder it will be to process, since informative cues will license the parser to anticipate a more specific structure for the matrix clause. Ergative head nouns, then, should be read more slowly than either nominative or dative ones. The same prediction applies at the relative pronoun and coargument, since their case morphology gives cues to the structure of the relative clause. There should be no processing differential at the relative clause verb. The relative clause will be unambiguously transitive by the time the parser encounters the verb, as two DPs (the relative pronoun and the coargument) will have already been incorporated into the structure.

The Structural Theory, on the other hand, predicts that the parser defaults to a subject-gap parse, and will only abandon that parse in the face of unambiguous evidence that the gap cannot be in subject position. As subjects can be nominative, ergative, or dative in Georgian, this means (all things being equal) that the value of K_2 should not affect processing; a relative pronoun in any case could in principle be linked to a subject gap. Of course, Skopeteas et al.'s (2012) findings complicate this picture slightly. If the Georgian parser is biased to treat any dative DP as an object, including a relative pronoun, then a dative relative pronoun would be associated with an object gap. If this is the case, the Structural Theory predicts dative relative pronouns to be read more slowly than nominative or ergative ones.

Moving on to the coargument, the only possible value of K_3 which would necessitate a revision of an initial SRC parse is ergative. This is because a nominative *wh*P could indicate an SRC in the NOM–ACC alignment; ergative case, which can only appear on subjects, foils this hypothesis.

If dative relative pronouns are treated by the parser as compatible with a subject gap, then neither *wh*P_{NOM}–$CoArg_{DAT}$ nor *wh*P_{DAT}–$CoArg_{NOM}$ sequences will give the parser any strong reason to suspect the gap to be in a specific position; after all, there are both S_{DAT}>O_{NOM} and S_{NOM}>O_{DAT} clauses. So, it will not be until the verb that the string is disambiguated. Assuming an initial subject-gap parse, reading times will increase at a perfect verb that follows a *wh*P_{NOM}–$CoArg_{DAT}$ string, and at a future verb that follows a *wh*P_{DAT}–$CoArg_{NOM}$ string. Those verbs disambiguate to the ORC parse, dashing the parser's hopes. Of course, if *wh*P_{DAT} initially incurs an object-gap penalty, it will actually be *wh*P_{DAT}–$CoArg_{NOM}$–V_{PERF} sequences that require a reparse; *wh*P_{DAT}–$CoArg_{NOM}$–V_{FUT} strings would conform to the initial (pessimistic) ORC prediction.

The tree diagram in Figure 1 schematizes these predictions (setting aside the possibility that dative is linked with objecthood). The Structural Theory predicts processing difficulty at every ORC cue.

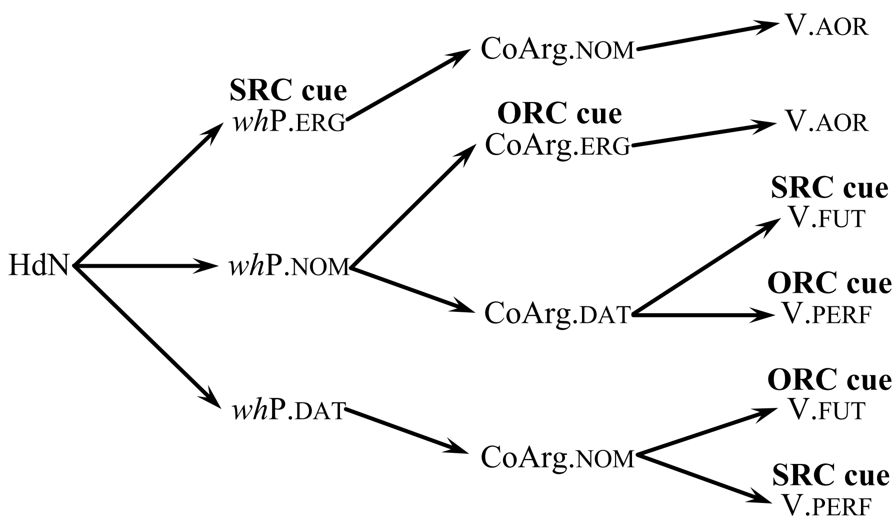

Figure 1: *Incremental gap-site disambiguation points for a hypothetical* wh-*relative (23).*

What about linearity? Assuming the distance between fillers and gaps is computed relative to the default SOV word order, the Distance Theory makes identical predictions to the Structural Theory for postnominal *wh*-relatives. Subject gaps will be preferred because they make for shorter dependencies than object gaps.

We now turn to a *rom*-relative, like the one schematized in (24). Our three theories make very similar predictions for this kind of relative as they did for the *wh*-relative. The only difference is that the gap's case and grammatical role must be triangulated from the coargument's case and the verb's TAM morphology. But this does not affect the predicted incremental processing differentials: points at which SRCs are eliminated (ergative coarguments and the verbs in FUT and PERF ORCs) will still be hurdles for parsers using structural- or distance-based heuristics; head nouns and coarguments in the ergative will still be difficult if informativity leads to processing trouble.

(24) HdN-K_1, [$_{RC}$ CoArg-K_2 *rom* V-TAM]

Finally, let us consider the predictions for *rom*-correlatives. There are two types that should be considered, schematized in (25). These crucially differ in whether the correlative coargument is unambiguously in a subordinate structure or not. If it follows *rom* (25a), the coargument must belong to an embedded clause. If it precedes *rom* (25b), it is possible to initially parse that DP as a part of a root clause.

(25) a. [$_{RC}$ XP *rom* CoArg-K_1 V-TAM,] … DEM HdN-K_2
b. [$_{RC}$ CoArg-K_1 *rom* XP V-TAM,] … DEM HdN-K_2

In the case of the temporarily ambiguous coargument (25b), only the Informativity Theory predicts a difference in processing caused by the value of K_1. The other theories only expect RT differences in structures that unambiguously involve filler–gap dependencies.

But at what point does a correlative unambiguously involve a filler–gap dependency, exactly? As shown above, Georgian correlatives can be string-identical to certain adjunct clauses — which do not involve gaps, at least not in argument position. One possibility is that the parser waits for unambiguous bottom-up evidence to posit a filler–gap dependency. This seems to be the case in English, as Staub et al. (2018) show. In a series of eye-tracking experiments, they compare the processing profile of DPs like those in (26).

(26) a. the information [$_{RC}$ that the health department provided __]
b. the information [$_{Comp}$ that the health department provided a cure]

Here the embedded clauses are temporarily ambiguous between a relative clause (i.e., a structure that involves a filler–gap dependency) and a complement clause (one that does not). Staub et al. observed consistent processing difficulty at regions where a string that had been temporarily compatible with a complement-clause parse was disambiguated as a relative clause. This effect obtained no matter how biased a particular lexical item was to occur with a complement or relative clause (as calculated by corpus frequencies). They interpret their results as support for the hypothesis that the parser avoids the maintenance of long-distance filler–gap dependencies whenever possible.

With that in mind, it may be the case the Georgian speaker assumes that a sentence-initial *rom*-clause is an adjunct clause — i.e., that it is not a correlative, which would involve an argument gap that needs to be matched to a filler. A garden-path effect will obtain at the point in the string when it becomes clear that the *rom*-clause was a correlative all along. Since Georgian allows null pronouns in all argument positions, the mere fact that an argument is missing from the *rom*-clause is not a sufficient signal. Instead, the demonstrative-modified head noun in the matrix clause is likely the cue that disambiguates the string towards a correlative parse. (Though even this cue might not be foolproof, as (22) shows.) If this hypothesis about how *rom*-clauses are interpreted is correct, the head noun will trigger a garden-path effect. And, since the head noun requires the empty category within the *rom*-clause to be reinterpreted as the gap of a filler–gap dependency, any costs associated with the structural position of that gap, or the distance between it and the filler, will compound the difficulty of this garden path.

In other words, if the Structural Theory is on the right track, we expect the head nouns of object-gap correlatives to be read more slowly than those of subject-gap correlatives. The Distance Theory predicts the opposite, assuming that an object gap in a prenominal correlative structure counts as being closer to the head noun than a subject gap does.

4. Experiment 1

The goal of Experiment 1 was to compare the predictions of the Structural and Distance theories by contrasting postnominal *rom*-relatives and prenominal *rom*-correlatives. Changing the order of the head noun and relative clause affects the length of ORC and SRC dependencies. If dependency length is a driving factor in Georgian, then postnominal relatives should exhibit an SGA, while correlatives should exhibit an OGA. If structure is most important, though, an SGA will emerge in both orders.

4.1 Method

Participants

57 native Georgian speakers living in Tbilisi, Georgia (45 females, average age = 23) were recruited via social media. They were paid for their participation. One participant was excluded from subsequent analysis because they answered less than 70% of comprehension questions for the fillers incorrectly, and because their median RT was much slower than the rest (more than 2 standard deviations beyond the mean of participant medians).

Materials

24 item sets were constructed in a 2×2 design, crossing Relative Clause Position (postnominal relative vs. prenominal correlative) and Gap Site (subject gap vs. object gap). These sentences conformed to the template in (27).

(27) a. Postnominal relative template (Experiment 1)

Dem+HdN,	[$_{RC}$ CoArg+C^0	XP$_1$	XP$_2$	V,]		Spill$_1$	Spill$_2$	Spill$_3$	Spill$_4$.
W_1	W_2	W_3	W_4	W_5		W_7	W_8	W_9	W_{10}

b. Prenominal correlative template (Experiment 1)

	[$_{RC}$ CoArg+C^0	XP$_1$	XP$_2$	V,]	Dem+HdN	Spill$_1$	Spill$_2$	Spill$_3$	Spill$_4$.
	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}

The relative clause itself (W_2–W_5) consisted of a coargument and the complementizer *rom* (presented in a single SPR window, W_2), a two-word adjunct phrase, and a clause-final verb. The relative clause verb was always in the aorist, a TAM which triggers the ERG–ABS case alignment. Consequently, the coargument of the SRCs appeared in the NOM case, and the coarguments of the ORCs appeared in the ergative case. Matrix clause material included the head noun (appearing either at W_1 or W_6) and a four-word continuation (W_7–W_{10}) to capture potential spillover effects. The head noun was always the subject of the matrix clause, but its case was counterbalanced between nominative, ergative, and dative. Syntax and argument structure of the matrix clause varied across item sets. The animacy of the head noun and relative clause coargument were equal, and were counterbalanced across itemsets: half had human arguments and half animal. Examples (28) give the RC-modified DP from a representative item set.

(28) a. Postnominal, Subject Gap (N [$_{RC}$ …] order)

is	***gogo,***	[$_{RC}$ ***bič̣-i***	*rom*	*bnel*	*ṭq̇e-ši*	*naxa,*	] ...
DEM	girl.NOM	boy-NOM	C	dark	forest-in	see.AOR	

'that girl [$_{RC}$ that __ saw the boy in the dark forest] …'

b. Postnominal, Object Gap (N [RC …] order)
is ***gogo,*** [RC ***bič̣-ma*** *rom* *bnel* *ṭq̇e-ši* *naxa,*] …
DEM girl.NOM boy-ERG C dark forest-in see.AOR
'that girl [RC that the boy saw __ in the dark forest] …'

c. Prenominal, Subject Gap ([RC …] N order)
[RC ***bič̣-i*** *rom* *bnel* *ṭq̇e-ši* *naxa,*] ***is*** ***gogo*** …
boy-NOM C dark forest-in see.AOR DEM girl.NOM
≈ '[RC the one that __ saw the boy in the dark forest,] that girl …'

d. Prenominal, Object Gap ([RC …] N order)
[RC ***bič̣-ma*** *rom* *bnel* *ṭq̇e-ši* *naxa,*] ***is*** ***gogo*** …
boy-ERG C dark forest-in see.AOR DEM girl.NOM
≈ '[RC the one that the boy saw __ in the dark forest,] that girl …'

These experimental items were presented among 76 filler sentences, which comprised 36 experimental items for Experiment 3 (see Section 6.1), and 40 more sentences which did not contain relative clauses. Each of the 100 sentences was followed by a yes–no comprehension question. All of the stimuli, in this experiment and the others, were constructed by the first author in consultation with three native speakers.

Procedure

Subjects participated online via Ibex Farm (Drummond 2007). Upon accessing the experiment, participants read a brief introduction describing the general purpose of the task, filled in demographic information, and consented to participation. To familiarize them with the self-paced reading task and experimental procedure, participants were presented with three practice items consisting of a sentence and a comprehension question. After this, the experiment proper began. The experimental items were distributed in a Latin Square, and randomized along with the fillers. Feedback was provided after each comprehension question. After finishing all 100 sentence–question pairs, an optional debriefing question appeared.

Analysis

Reading times and comprehension question response latency were analyzed using linear mixed-effects regression; question accuracy was analyzed using logistic mixed-effects regression. The Gap conditions were coded by two coefficients using centered sum contrasts: SRC (−½) and ORC (+½). Likewise for the Relative Clause Position conditions: postnominal relative (−½), prenominal correlative (+½). Unless otherwise stated, maximal random effects structure was included (Barr et al. 2013). Models were estimated using the *lme4* package in R (Bates et al. 2014). *T*-tests were calculated using Satterthwaite's method via the *lmerTest* package in R (Kuznetsova et al. 2017).

4.2 Results

Figure 2 reports mean reading times for each SPR window, partitioned by relative clause position. The most striking effect is that ergative coarguments are read significantly more slowly than nominative coarguments for both prenominal correlatives and postnominal relatives. Results from linear mixed-effects model are given in Table 3 (random by-participant intercepts were removed because of convergence issues, but slopes were retained). Another significant effect emerges at the verb region; these results are shown in Table 3 (for convergence issues, the by-participant slope was removed). Here we see a main effect of relative clause type, with correlatives being faster. Finally, correlative head nouns in the subject-gap condition appear to be read slower than those in the object-gap condition, but this effect was not significant ($\beta = 55 \pm 44$, $t(29) = -1.2$, $p = 0.23$).

Turning to performance on comprehension questions, we found no effects of Gap or RC position on either accuracy or response time. The average accuracy was 88% and the average latency was 3587 ms. For experimental conditions, mean accuracy spanned a narrow range from 86% to 89%, and it was comparable for the fillers (88%).

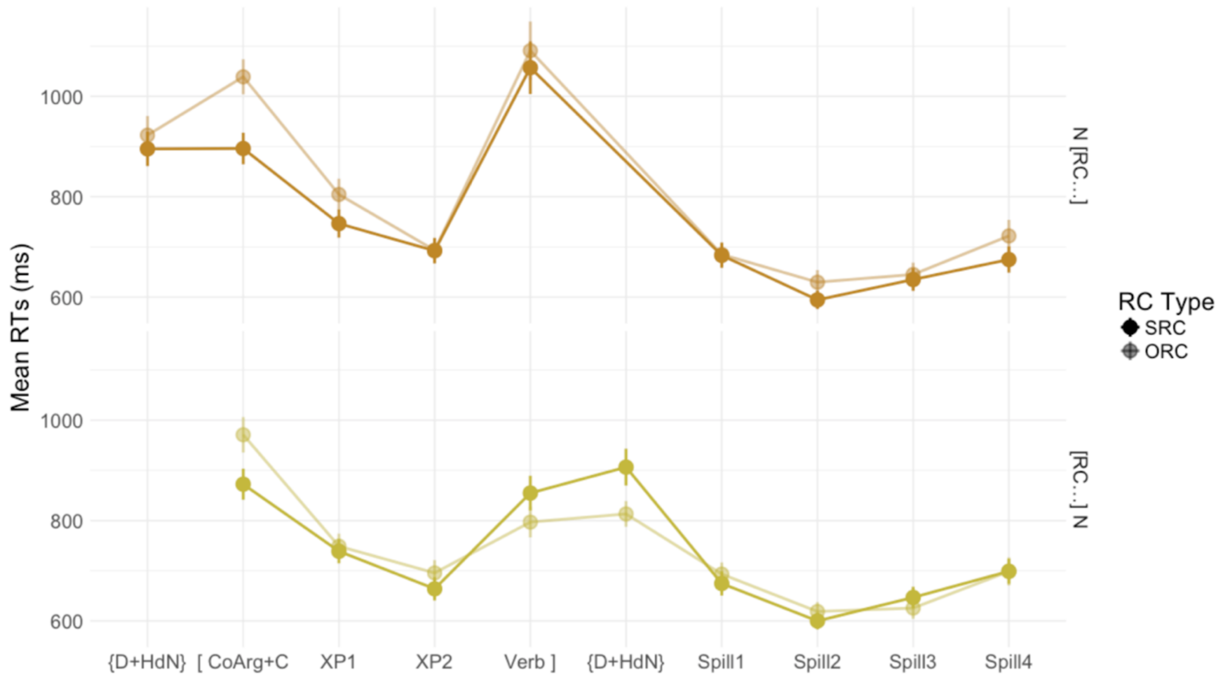

Figure 2: *Mean reading times for Experiment 1.*

	β	**SE**	***t***	**df**	***p***
(Intercept)	962	51	19	67	< 0.001
Gap	114	31	3.7	104	< 0.001
Clause Type	−40	31	−1.3	22	< 1
Gap:Clause	−27	59	−0.45	30	< 1

Table 3: *Experiment 1 linear mixed-effects model for reading times at the relative clause coargument (random by-participant intercepts were removed, but slopes were retained).*

	β	SE	*t*	df	*p*
(Intercept)	970	64	15	56	< 0.001
Gap	−2.3	50	−0.047	26	< 1
Clause Type	−250	65	−3.8	45	< 0.001
Gap:Clause	−86	91	−0.94	27	< 1

Table 4: *Experiment 1 linear mixed-effects model for reading times at the relative verb (by-participant slopes were removed).*

4.4 Discussion

We observed a large RT slowdown when participants read the ergative coargument in both postnominal and prenominal RCs. This ergative coargument cost is consistent with the predictions of both the Case Informativity and Structural Theories. Ergative case is highly informative, since it entails a specific argument structure and set of TAMs, and it also serves as an effective gap-site disambiguator, since an overt subject within a relative eliminates the possibility of an SRC parse.

It is notable that the ergative cost manifests even in the prenominal correlatives. From the perspective of the Case Informativity Theory, this is entirely expected; ergative case is more informative than nominative in all syntactic environments. From the perspective of the Structural hypothesis, though, the effect is surprising, since the sequence DP+*rom* at the beginning of a sentence is not an unambiguous structural cue to a correlative. As discussed in Sections 3.3 and 3.4, this string is also consistent with an adjunct clause, an environment where the preference for subject gaps over object gaps is presumably irrelevant. So, if gap position in the key factor determining processing cost here, it must be that parsers treat a DP+*rom* sequence as a correlative (a structure with an argument gap) right off the bat. However, this seems to challenge Staub et al. (2018)'s findings that parsers avoid positing filler–gap dependencies whenever possible. Therefore, the simplest explanation for the fact that an ergative coargument cost obtains in both postnominal relatives and prenominal correlatives is that the relative informativity of ergative case is taxing for the parser.

Of course, since the coargument and complementizer were presented in a single SPR window, Experiment 1's correlatives were more like those schematized in Section 3.4 as (25a) than (25b). Decisive evidence in favor of the Informativity Theory would be if the ergative cost lingers in a correlative whose coargument could be initially parsed as a root-clause argument. The design of Experiment 2 aims to test for just this possibility.

The second significant result of this experiment was that verbs in prenominal correlatives were read faster than verbs in postnominal relatives. To understand why this might be, let's first consider why relative-final verbs might be read slower than other regions in the first place. We suggest this could be a kind of integration cost, of the kind Wagers et al. (2018) discuss for Chamorro. Upon encountering a RC-final verb, the parser is confronted with a number of tasks: linking previously-ambiguous case morphology to the appropriate syntactic roles, integrating the arguments and adjuncts into the verb's argument structure & lexical semantics, conclusively resolving the filler–gap dependency, and shifting gears back to processing the matrix clause. The processing cost of these demands compound and cause the parser to slow down.

So why is there no similar slowdown in the correlative verbs? We hypothesize that the processing burden found at a single region of a postnominal RC is spread across two regions in a prenominal one. The verb of a correlative triggers the parser to disambiguate case morphology, integrate argument structure, and turn to a different clause, but the filler–gap dependency can only be partially resolved: the gap site may be disambiguated, but the lexical content associated with it will not be encountered until the next word, the head noun. And in fact, the head noun region of the correlatives of this experiment were read, at least impressionistically, slower than comparable regions in other conditions. This is compatible with the fact that cluster of processing tasks, which are resolved by a single word in postnominal RCs, are stretched across two words in prenominal RCs. Consequently the processing burden is distributed across two words here.

5. Experiment 2

This being among the first studies on Georgian filler–gap processing, we sought to replicate the findings of the previous experiment in Experiment 2. The main change to the design was that the complementizer *rom* was presented in its own SPR window, rather than in the same window as the relative clause coargument. This made the coargument of the prenominal relative clause temporarily compatible with a root-clause parse, thereby addressing the fact that Experiment 1 cannot adjudicate fully between the Structural and Case Informativity Theories. And with this change, Experiment 2 replicates the main findings of Experiment 1. Postnominal RC conditions show another dramatic ergative coargument effect. In prenominal RCs, ergative coarguments also condition a slowdown, but a smaller one. This suggests that ergative qua ergative is indeed relatively difficult to parse, as predicted by the Case Informativity Theory.

5.1 Method

Participants

63 native Georgian speakers were recruited for Experiment 2 (44 women, average age = 23). One participant lived in Kutaisi, Georgia; the rest were from Tbilisi. They were paid for their participation. Seven participants were ultimately excluded from analysis, either due to comprehension scores lower than 70% (n = 6), or because their median RT was much slower than the rest (n = 1; more than 2 standard deviations beyond the mean of participant medians).

Materials

24 item sets were constructed in a 2×2 design, crossing Relative Clause Position (postnominal relative vs. prenominal correlative) and Gap Site (subject gap vs. object gap).

(29) a. Postnominal relative template (Experiment 1)

Dem+HdN,	[$_{RC}$	Adj	CoArg	C^0	XP	V,	]		Spill$_1$	Spill$_2$	Spill$_3$.
w_1		w_2	w_3	w_4	w_5	w_6			w_8	w_9	w_{10}

b. Prenominal correlative template (Experiment 1)

	[$_{RC}$	Adj	CoArg	C^0	XP	V,	]	Dem+HdN,	Spill$_1$	Spill$_2$	Spill$_3$.
		w_2	w_3	w_4	w_5	w_6		w_7	w_8	w_9	w_{10}

The materials differed from Experiment 1's in the following ways. The relative clause consisted of five words, each with its own SPR window. The first two words were an adjective and a noun (w_2 and w_3), together making up the coargument DP. The noun was either in the nominative case (for the SRC conditions) or the ergative case (for the ORC conditions); the adjective was selected from a morphological class that does not show case concord with the head noun (cf. the adjectives in Experiments 1 and 3, which did participate in case concord). At w_4 was the complementizer *rom*. This was given its own window in order to delay the cue to embeddedness in the prenominal conditions, as in the schematized correlative above (25b). Since the initial string [Adj N] is temporarily compatible with a root-clause parse, delaying the presentation of *rom* until after the coargument DP allows us to test the role of case informativity outside of disambiguated embedded environments. Rounding out the relative is a one-word adjunct (an adverb, locative/temporal PP, or noun in the instrumental case) and the clause-final verb (always in the aorist TAM).

The head noun was presented together with the demonstrative (W_1 or W_7). It was always the matrix clause subject, but its case was counterbalanced (nominative, ergative, or dative). The head noun and coargument were matched in animacy, and itemsets were counterbalanced for the animacy of these nouns: they were either human, animal, or inanimate. Representative relative clauses and head nouns follow.

(30) a. Postnominal Subject Gap (N [RC …] order)

is	***gogo,***	[RC	*axalgazrda*	***bič̣-i***	*rom*	*ṭqe-ši*	*naxa,*	] ...		
DEM	girl.NOM		young	boy-NOM	C	forest-in	see.AOR			

‘that girl [RC that __ saw the young boy in the forest] …’

b. Postnominal Object Gap (N [RC …] order)

is	***gogo,***	[RC	*axalgazrda*	***bič̣-ma***	*rom*	*ṭqe-ši*	*naxa,*	] ...		
DEM	girl.NOM		young	boy-ERG	C	forest-in	see.AOR			

‘that girl [RC that the young boy saw __ in the forest] …’

c. Prenominal Subject Gap ([RC …] N order)

		[RC	*axalgazrda*	***bič̣-i***	*rom*	*ṭqe-ši*	*naxa,*	]	***is***	***gogo*** …
			young	boy-NOM	C	forest-in	see.AOR		DEM	girl.NOM

≈ ‘[RC the one that __ saw the young boy in the forest,] that girl …’

d. Prenominal Object Gap ([RC …] N order)

		[RC	*axalgazrda*	***bič̣-ma***	*rom*	*ṭqe-ši*	*naxa,*	]	***is***	***gogo*** …
			young	boy-ERG	C	forest-in	see.AOR		DEM	girl.NOM

≈ ‘[RC the one that the young boy saw __ in the forest,] that girl …’

These items were presented among 76 filler sentences, including 36 experimental items for Experiment 4 (Section 7.1) and 40 more sentences which did not contain relative clauses. Each of these 100 sentences was followed by a yes–no comprehension question.

Procedure and Analysis

The procedure and analysis were identical to Experiment 1 (Section 4.1).

5.2 Results

Mean reading times are shown in Figure 3. Table 4 gives results from linear mixed-effect modeling on RTs at the coargument noun region. We observe a significant main effect of gap site at this region, with the ORC condition again being slower. This is the only significant effect. We did not replicate the main effect of relative clause type at the verb region in this experiment ($\beta = 41 \pm 48$, $t(28) = -0.86$, $p = 0.40$).

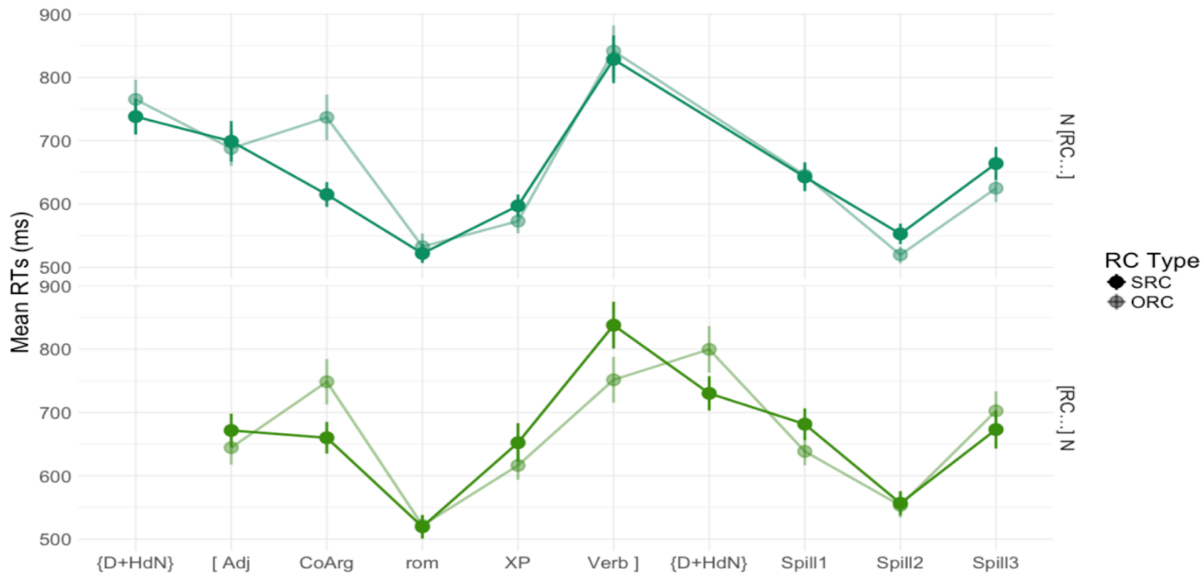

Figure 3: *Mean reading times by region for Experiment 2, separated relative clause position.*

	β	**SE**	***t***	**df**	***p***
(Intercept)	690	35	20	58	< 0.001
Gap	100	39	2.6	31	< 0.05
Clause Type	30	37	0.82	24	< 1
Gap:Clause	−19	62	−0.31	38	< 1

Table 5: *Experiment 2 linear mixed-effects modeling for reading times at the relative clause coargument.*

Comprehension accuracy ranged from 79% to 82% across experimental conditions; it was 80% on average. These were slightly lower than the average accuracy for filler question (85%). Response latencies were on average 3,049 ms. There was no significant effect on either comprehension measure caused by the experimental manipulations.

5.3 Discussion

As in Experiment 1, relative-clause coarguments in the ergative case were read more slowly than coarguments in the nominative case. The most straightforward interpretation of this effect stems from informativity: ergatives are taxing not (just) because they eliminate SRC parses, but because they supply the parser with more information about the ambient clause than nominatives do. This is bolstered by the fact that the correlative coargument was presented before a cue to embeddedness (the complementizer *rom*).

6. Experiment 3

Experiments 3 investigates the processing profile of *wh*-relatives. Unlike a *rom*-relative, a *wh*-relative provides immediate information about the gap site: the *wh*-phrase relative pronoun that appears at its left edge bears the case associated with the syntactic position of the gap. Of course, Georgian's split-ergative case system means that this is often an ambiguous cue; the gap site might not be fully disambiguated until the coargument or verb is encountered.

6.1 Method

Participants & Materials

The same 57 participants from Experiment 1 participated in this experiment, as Experiment 1 and Experiment 3 were conducted in the same session.

36 itemsets were constructed in a 2×3 design, crossing Gap Site (SRC vs. ORC) and relative-clause internal TAM / Case Alignment (Future/NOM–ACC vs. Aorist/ERG–ABS vs. Perfect/DAT–ABS). The items conformed to the following template.

(31) Stimulus template (Experiment 3)

Adv	HdN,	[RC *wh*P	XP_1	XP_2	Adj	CoArg	V,	]	$Spill_1$	$Spill_2$	$Spill_3$	$Spill_4$.
W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8		W_9	W_{10}	W_{11}	W_{12}

The relative clause consisted of a *wh*-phrase (W_3), which bears the case associated with the gap site; a two-word adjunct phrase (W_4 and W_5); a two-word coargument DP, consisting of an adjective which shows case concord (W_6) and a noun (W_7); and finally the verb (W_8). Matrix clause material included a sentence-initial adverb (W_1), the head noun (W_2), and a four-word continuation (W_9–W_{12}). The head noun always served as the subject of the matrix clause, but across itemsets its case was counterbalanced, rotating between nominative, ergative, and dative. The head noun and coargument were of equal animacy, either both being human or both animal nouns.

The head noun DP of a sample itemset is given below. Note that the gap position is manipulated simply by swapping the case morphology of the *wh*-phrase and the coargument.

(32)

a. Future (NOM–ACC alignment), Subject Gap

gogo,	[RC *romel-**i**-c*	*bnel-Ø*	*ṭq̣e-ši*	*maġal-**Ø***	*bič̣-**s***	*naxavs*	] …
girl.NOM	which-**NOM**-REL	dark-DAT	forest-in	tall-**DAT**	boy-**DAT**	see.FUT	

'the girl [RC who __ will see the tall boy in the dark forest] …'

b. Future (NOM–ACC alignment), Object Gap

gogo,	[RC *romel-**sa**-c*	*bnel-Ø*	*ṭq̣e-ši*	*maġal-**i***	*bič̣-**i***	*naxavs*	] …
girl.NOM	which-**DAT**-REL	dark-DAT	forest-in	tall-**NOM**	boy-**NOM**	see.FUT	

'the girl [RC who the tall boy will see __ in the dark forest] …'

c. Aorist (ERG–ABS alignment), Subject Gap

gogo,	[RC *romel-**ma**-c*	*bnel-Ø*	*ṭq̣e-ši*	*maġal-**i***	*bič̣-**i***	*naxa*	] …
girl.NOM	which-ERG-REL	dark-DAT	forest-in	tall-**NOM**	boy-**NOM**	see.AOR	

'the girl [RC who __ saw the tall boy in the dark forest] …'

d. Aorist (ERG–ABS alignment), Object Gap

gogo,	[RC *romel-**i**-c*	*bnel-Ø*	*ṭq̣e-ši*	*maġal-**ma***	*bič̣-**ma***	*naxa*	] …
girl.NOM	which-**NOM**-REL	dark-DAT	forest-in	tall-ERG	boy-**ERG**	see.AOR	

'the girl [RC who the tall boy saw __ in the dark forest] …'

e. Perfect (DAT–ABS alignment), Subject Gap

gogo,	[RC *romel-**sa**-c*	*bnel-Ø*	*ṭq̣e-ši*	*maġal-**i***	*bič̣-**i***	*unaxavs*	] …
girl.NOM	which-**DAT**-REL	dark-DAT	forest-in	tall-**NOM**	boy-**NOM**	see.PERF	

'the girl [RC who __ has (apparently) seen the tall boy in the dark forest] …'

f. Perfect (DAT–ABS alignment), Object Gap

gogo,	[RC *romel-**i**-c*	*bnel-Ø*	*ṭq̣e-ši*	*maġal-**Ø***	*bič̣-**s***	*unaxavs*	] …
girl.NOM	which-**NOM**-REL	dark-DAT	forest-in	tall-**DAT**	boy-**DAT**	see.PERF	

'the girl [RC who the tall boy has (apparently) seen __ in the dark forest] …'

These experimental items were embedded among 64 filler sentences, comprising 24 experimental items for Experiment 1 (see Section 4) and 40 more sentences which did not contain relative clauses. Each of the 100 sentences was followed by a yes–no comprehension question.

Procedure & Analysis

The procedure was identical to Experiments 1 and 2 (see Section 4.1).

Reading times and comprehension question response latency were analyzed using linear mixed-effects regression; question accuracy was analyzed using logistic mixed-effects regression. The Gap conditions were coded using centered sum contrasts: SRC (−½) and ORC (+½). TAM conditions were coded by Helmert contrasts: the first coefficient (TAM1) compared the Aorist condition (+⅔) with the mean of the Future (−⅓) and Perfect Conditions (−⅓); the second coefficient (TAM2) compared the Future condition (+½) with the Perfect (−½). Unless otherwise stated, maximal random effects structure was included (Barr et al. 2013). Models were estimated using the *lme4* package in R (Bates et al. 2014). *T*-tests were calculated using Satterthwaite's method via the *lmerTest* package in R (Kuznetsova et al. 2017).

6.2 Results

The following plot report mean RTs region by region (Figure 4). Significant effects are found at the first region of the coargument (the adjective which bears case concord, W_6) and at the RC-final verb (W_8). Results from linear mixed-effects models are given in Tables 5 and 6, respectively (the latter model removes the by-participant slope and by-group intercept for convergence issues). The significant interaction of Gap and TAM2 indicates that the coargument was read more slowly in the SRC condition, but only in the aorist condition (i.e., when the coargument was ergative). The significant main effects of TAM1 and TAM2 show that perfect verbs were read the most slowly, future verbs were of intermediate speed, and aorist verbs were read the most quickly. This scale corresponds to both the length and morphological complexity of these three TAM categories. Crucially, in the aorist conditions there was no effect at the relative pronoun ($\beta = 26 \pm 29$, $t(41) = -0.90$, $p = 0.38$) or the subsequent spillover region ($\beta = 22 \pm 35$, $t(24) = 0.62$, $p = 0.54$).

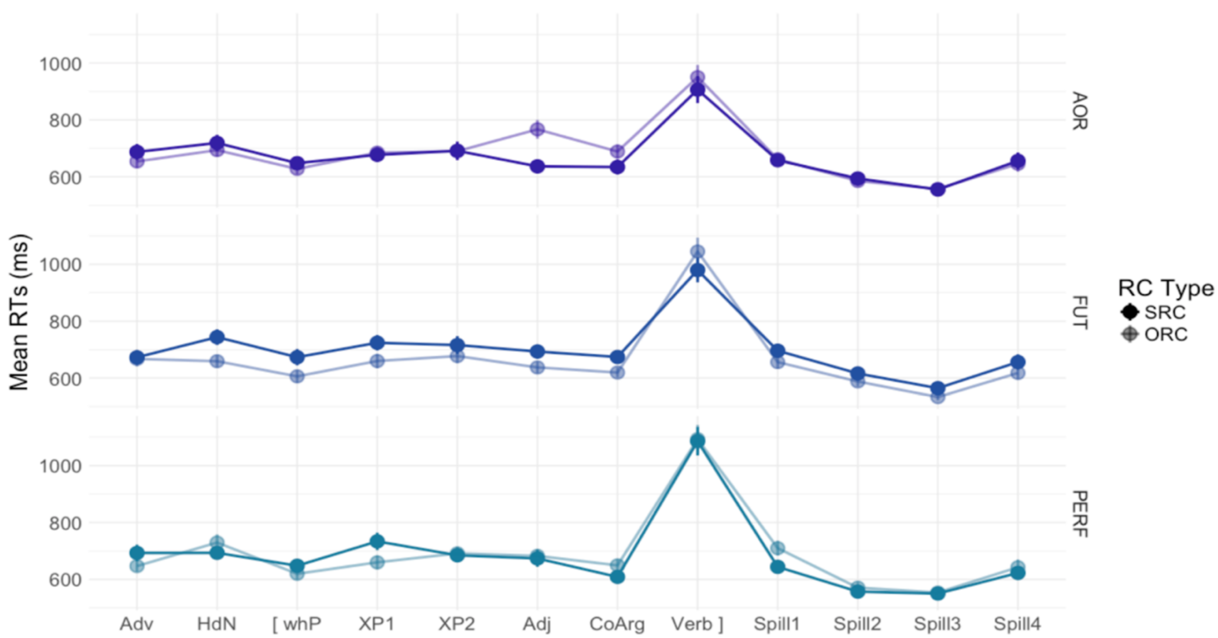

Figure 4: *Mean readings times by region for Experiment 3, separated by relative clause* TAM.

	β	SE	*t*	df	*p*
(Intercept)	690	31	22	71	< 0.001
Gap Type	23	29	0.77	45	< 1
TAM1: (FUT − PERF)	−11	25	−0.45	37	< 1
TAM2: (AOR − ½(FUT+PERF))	40	24	1.7	39	< 1
Gap:TAM1	−64	50	−1.3	38	< 1
Gap:TAM2	160	45	3.6	69	< 0.001

Table 6: *Experiment 3 linear mixed-effects modeling for reading times at the adjective region of the relative clause coargument.*

	β	SE	*t*	df	*p*
(Intercept)	1050	72	15	57	< 0.001
Gap Type	53	42	1.3	44	< 1
TAM1: (FUT − PERF)	−100	39	−2.6	60	< 0.05
TAM2: (AOR − ½(FUT+PERF))	−130	33	−3.8	150	< 0.001
Gap:TAM1	69	73	0.94	120	< 1
Gap:TAM2	−15	66	−0.23	120	< 1

Table 7: *Experiment 3 linear mixed-effects modeling for reading times at the verb region of the relative clause coargument (model removes the by-participant intercept and by-item interaction slope).*

In the future conditions, note that a baseline difference between the SRC and ORC conditions starts at the head noun and lingers through the relative clause. This must be a spurious effect, because at the head noun window there is no evidence that a filler–gap dependency of any kind will follow. This baseline error is likely related to a technical issue in this experiment which distributed the lists unequally among participants.

Turning to performance on comprehension questions, we found no effects of Gap or RC position on either accuracy or response time. The average accuracy was 83% and the average latency was 2878 ms. For experimental conditions, mean accuracy spanned a narrow range from 80% to 87%, slightly lower than accuracy for the fillers (88%).

6.3 Discussion

The effects observed in Experiment 3 are most compatible with the Structural Theory of RC processing. Recall that this theory predicts that cues which eliminate the possibility of an SRC parse will cause RTs to slow: these include the ergative coargument of aorist ORCs, and the verbs of future and perfect ORCs

(Figure 1). And indeed, a cost associated with ergative coarguments is found in this experiment. The ergative coargument cost is of course also compatible with the Case Informativity Theory, but the lack of an effect at the *wh*-phrase region is unexpected from an informativity perspective. Whatever syntactic position an ergative-marked DP appears in, it will drastically narrow down the clause's possible argument structures and TAMs. Ergative *wh*-phrases, then, should be just as slow as ergative coarguments. Equal reading times for nominative and ergative *wh*-phrases is predicted by the Structural Theory, though, as both are at least temporarily compatible with subject-gap parses.

7. Experiment 4

Experiment 4 aims to replicate the main findings of Experiment 3, while making a few minor changes to the design. The most notable design change is how the itemsets were counterbalanced for animacy: as in all previous experiment, head nouns and coarguments were matched in animacy, but itemsets drew from pairs of nouns that were either human, animal, or inanimate. As we will see, post-hoc analysis reveals that animacy affects processing in revealing ways.

7.1 Method

Participants & Materials

The same 63 participants from Experiment 2 participated in this experiment, as Experiments 2 and 4 were run in the same session.

36 itemsets were constructed in a 2×3 design, crossing Gap Site (SRC vs. ORC) and relative-clause internal TAM / Case Alignment (Future/NOM–ACC vs. Aorist/ERG–ABS vs. Perfect/DAT–ABS). The items followed the following template.

(33) Stimulus template (Experiment 4)

HdN,	[RC	*wh*P	Adj	CoArg	XP_1	XP_2	V,	]	$Spill_1$	$Spill_2$ $Spill_3$.
w_1		w_2	w_3	w_4	w_5	w_6	w_7		w_8	w_9 w_{10}

The materials differ from those in Experiment 3 in a few ways. First, the order of the coargument DP and the adjunct XP were swapped; this was to ensure space between the coargument and the verb to disentangle effects that might emerge at both locations.

Second, the adjectives used in this experiment all belonged to a morphological class which does not show case concord. Syncretisms across the adjectival concord system mean that not all agreeing adjectives will indicate the case of their containing DP unambiguously. This experiment gets around this complication by ensuring that all case the morphology present in the coargument DP is unambiguous and appears on the noun.

Third, the animacy of head nouns and coarguments was counterbalanced across itemsets with three categories (human, animal, and inanimate) rather than just two. It has been observed that the animacy of a relative clause head noun can modulate the strength of the SRC advantage, with inanimate head nouns potentially neutralizing the advantage altogether (Mak et al. 2002; Traxler et al. 2005; Gennari & MacDonald 2008; Wagers & Pendleton 2016; a.o.). Thus, including head nouns from across the animacy spectrum means the data represent a wider array of parsing strategies.

The RC-modified DP from a representative itemset follows.

(34) a. Future (NOM–ACC alignment), Subject Gap
gogo, [$_{RC}$ *romel-**i**-c* *axalgazrda* *bič̣-**s*** *bnel-Ø* *ṭqe-ši* *naxavs*] ...
girl.NOM which-**NOM**-REL young boy-**DAT** dark-DAT forest-in see.FUT
'the girl [$_{RC}$ who __ will see the tall boy in the dark forest]'

b. Future (NOM–ACC alignment), Object Gap
gogo, [$_{RC}$ *romel-**sa**-c* *axalgazrda* *bič̣-**i*** *bnel-Ø* *ṭqe-ši* *naxavs*] ...
girl.NOM which-**DAT**-REL young boy-**NOM** dark-DAT forest-in see.FUT
'the girl [$_{RC}$ who the tall boy will see __ in the dark forest]'

c. Aorist (ERG–ABS alignment), Subject Gap
gogo, [$_{RC}$ *romel-**ma**-c* *axalgazrda* *bič̣-**i*** *bnel-Ø* *ṭqe-ši* *naxa*] ...
girl.NOM which-ERG-REL young boy-**NOM** dark-DAT forest-in see.AOR
'the girl [$_{RC}$ who __ saw the tall boy in the dark forest] …'

d. Aorist (ERG–ABS alignment), Object Gap
gogo, [$_{RC}$ *romel-**i**-c* *axalgazrda* *bič̣-**ma*** *bnel-Ø* *ṭqe-ši* *naxa*] ...
girl.NOM which-**NOM**-REL young boy-**ERG** dark-DAT forest-in see.AOR
'the girl [$_{RC}$ who the tall boy saw __ in the dark forest] …'

e. Perfect (DAT–ABS alignment), Subject Gap
gogo, [$_{RC}$ *romel-**sa**-c* *axalgazrda* *bič̣-**i*** *bnel-Ø* *ṭqe-ši* *unaxavs*] ...
girl.NOM which-**DAT**-REL young boy-**NOM** dark-DAT forest-in see.PERF
'the girl [$_{RC}$ who __ has (apparently) seen the tall boy in the dark forest] …'

f. Perfect (DAT–ABS alignment), Object Gap
gogo, [$_{RC}$ *romel-**i**-c* *axalgazrda* *bič̣-**s*** *bnel-Ø* *ṭqe-š* *unaxavs*] ...
girl.NOM which-**NOM**-REL young boy-**DAT** dark-DAT forest-in see.PERF
'the girl [$_{RC}$ who the tall boy has (apparently) seen __ in the dark forest] …'

These experimental items were embedded among 64 filler sentences, comprising 24 experimental items for Experiment 2 (see Section 5) and 40 more sentences which did not contain relative clauses. Each of the 100 sentences was followed by a yes–no comprehension question.

Procedure & Analysis

The procedure was identical to all other experiments (see Section 4.1). The Analysis was identical to Experiment 3 (Section 6.1), which had a similar design.

7.2 Results

Reading times are shown below (Figure 5). A linear mixed-effects model reveals no significant effects at the coargument region (largest $\beta = 111 \pm 71$, $t(51) = -1.6$, $p = 0.12$), at the relative pronoun (largest $\beta = 35 \pm 18$, $t(29) = 1.9$, $p = 0.06$), or at the adjective spillover region (largest $\beta = 36 \pm 22$, $t(510) = 1.6$, $p = 0.11$). At the verb region, though, there were main effects of TAM1 and TAM2 (Table 7), just as in Experiment 3. Again, RTs correlate with verbs' length/morphological complexity.

As in the previous experiments, there were no significant effects of experimental conditions on comprehension measures. Responses to experimental conditions were between answered correctly between 80% and 87% of the time, with a mean accuracy of 83% — close to the average accuracy in the filler questions (85%). The average response latency was 2,878 ms.

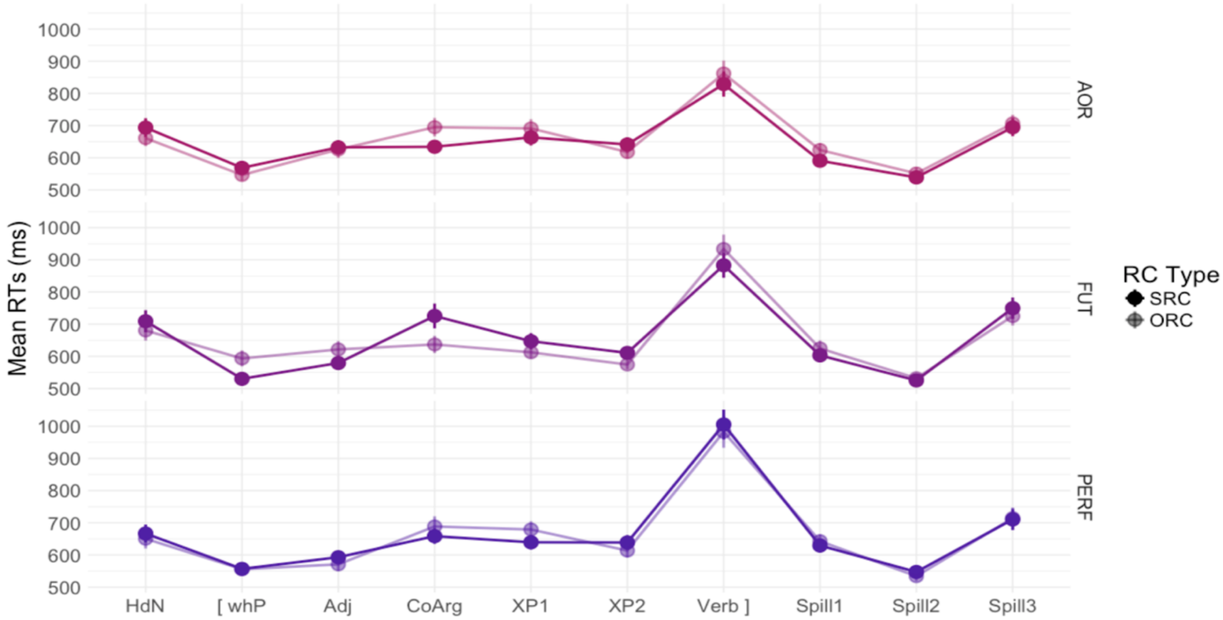

Figure 5: *Mean reading times by region for Experiment 4, separated by relative clause* TAM.

	β	**SE**	***t***	**df**	***p***
(Intercept)	910	54	17	65	< 0.001
Gap Type	28	37	0.76	31	< 1
TAM1: (FUT − PERF)	−92	42	−2.2	45	< 0.05
TAM2: (AOR − ½(FUT+PERF))	−120	41	−2.9	44	< 0.01
Gap:TAM1	84	82	1.0	57	< 1
Gap:TAM2	7.1	68	0.11	67	< 1

Table 8: *Experiment 4 linear mixed-effects model for reading times at the relative clause verb.*

7.3 Discussion

Given the robust ergative coargument effects in Experiments 1–3, the null result at this region for this experiment is notable. However, we believe this lack of result is a consequence of the animacy counterbalancing described in Section 7.1. It has been observed that expectations regarding the structure of a relative clause can be modulated by adjusting the animacy of the head noun: nouns high on the animacy scale lead to strong subject-gap expectations; ones low on the animacy scale lead to weak subject-gap expectations, or even object-gap expectations (Gennari & MacDonald 2008, Wagers & Pendleton 2016). Recall that a third of the itemsets in Experiment 4 had inanimate head nouns. If such a head noun leads to the parser to expect an object gap, then in these trials an ergative RC coargument — an unambiguous subject — will come as no surprise. This ORC expectation, we believe, dampens the ergative coargument cost that arises in trials with human and animal head nouns, which are more likely to condition SRC expectations, and therefore lead to a garden-path effect at ergative coarguments.

Suggestive evidence in favor of this interpretation comes from exploratory analyses of the animacy counterbalancing. Figure 6 shows how RTs are modulated by gap site, TAM, and animacy. Especially revealing are the patterns at the RC-final verbs in the aorist and future conditions. As reported in Table 8, ORC verbs are markedly slower than SRC verbs given human arguments, but this trend evens out for animals, and reverses for inanimates. This pattern is in line with our thoughts above: human head nouns lead to a strong subject-gap expectation, and inanimate head nouns lead to a moderate object-gap expectation.

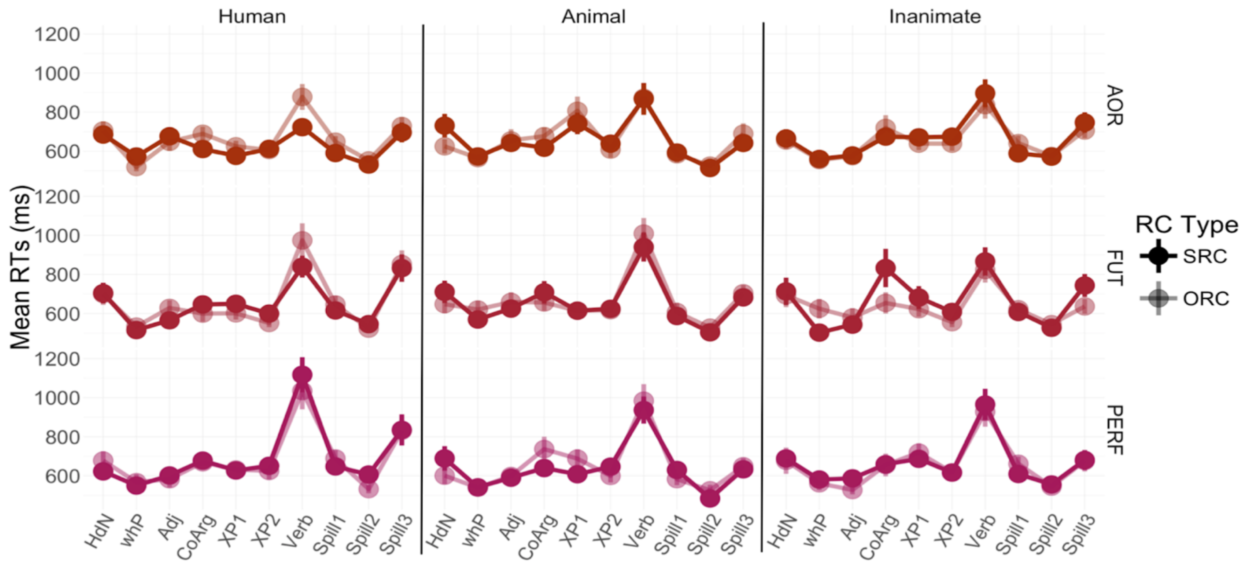

Figure 6: *Mean RTs (ms) for Experiment 4, partitioned by* TAM *and argument animacy.*

	Verb.AOR			**Verb.FUT**		
	SRC	**ORC**	$\Delta_{O\text{-}S}$	**SRC**	**ORC**	$\Delta_{O\text{-}S}$
Human	723 (42)	868 (66)	155 (78)	840 (56)	974 (87)	134 (103)
Animal	868 (82)	873 (74)	5 (110)	940 (74)	1009 (80	69 (109)
Inanimate	896 (72)	836 (69)	−60 (100)	836 (56)	823 (64)	−44 (85)

Table 9: *Results at the verb region for the aorist and future conditions of Experiment 4, separated by argument animacy. Reported are mean RTs in ms (with standard errors), and mean differences ($RT_{ORC} - RT_{SRC}$).*

Also, recall that the head noun was further counterbalanced across itemsets for case. Table 9 gives mean RTs for the head noun region partitioned by animacy and case. These data complicate the picture for the Informativity Theory. Ergative head nouns are indeed read faster than nominative or dative ones overall, but breaking down the averages by animacy reveals that the ergative penalty only applies to non-human nouns. For humans, it is dative case that causes a slowdown.

	NOM	ERG	DAT	
Human	648 (32)	670 (31)	**750 (37)**	683 (19)
Animal	642 (31)	**725 (42)**	633 (35)	667 (21)
Inanimate	630 (35)	**754 (48)**	663 (34)	681 (23)
	640 (19)	714 (23)	677 (20)	677 (12)

Table 10: *Mean RTs in ms (with SEs) at the head noun region of Experiment 4, separated by case and animacy.*

This pattern cannot be accounted for by the strongest version of the Informativity Theory. The animacy of an argument does not entail anything about its grammatical role, or about upcoming syntactic structure (at least not in Georgian, where there are no grammaticized animacy hierarchy effects). In other words, just based on the syntactic distribution of case categories, which is in principle orthogonal to animacy, all ergatives should be equally informative and costly. The picture that is emerging, however, suggests the parser is aware of canonical relationships between grammatical role and animacy, and also between grammatical role and case. Non-humans are canonical objects and non-canonical subjects. Therefore, seeing them in a case which entails subjecthood (ergative) is more surprising than seeing them in a case with is compatible with objecthood (nominative or dative). As for humans, what is unexpected is that there is any RT difference at all — human nouns are canonical subjects, and nominative, ergative, and dative are all possible subject cases. But the fact that dative human nouns are read slowest recalls Skopeteas et al. (2012)'s findings: they discovered that dative case in Georgian, for one reason or another, is linked to objecthood. Humans being non-canonical objects, and dative case apparently being a canonical object case, the combination of dative and human will be relatively surprising.

8. General discussion and conclusion

In this study, four self-paced reading experiments on Georgian manipulated the position of a relative clause and its internal case alignment. We observe RT patterns which are most amenable to a combination of the Structural and Informativity Theories of the SGA. The Structural Theory posits that subject gaps are universally preferred over object gaps during filler–gap processing (Keenan & Comrie 1977). Thus, it predicts that cues which entail an object gap — or at least eliminate the possibility of a subject gap — should incur a penalty. One such cue in Georgian is ergative morphology on a relative-clause internal DP. And across three experiments (Experiments 1–3), we observe a robust cost due to ergative coarguments (an effect replicated in Lau et al.'s (submitted) ERP and reading-time studies), bearing out this prediction. Also harmonious with the Structural Theory is the fact the case of a relative pronoun does not affect how quickly it is read (Experiments 3–4). Since nominative, ergative, and dative relative pronouns are all at least temporarily compatible with a subject-gap parse, they all satisfy the parser's desire for a subject gap equally well.

However, one observed effect cannot be explained by the Structural Theory alone. In Experiment 2, correlative coarguments were presented before the complementizer *rom*, which signals an embedded structure. The ergative cost also emerged here, even though there is no reason to posit a filler–gap dependency of any kind before encountering *rom*. The Case Informativity Theory, on the other hand, accounts for this effect straightforwardly. It proposes that an element's processing cost is proportional to how specific a prediction the parser is licensed to make by that element's morphology, especially case morphology. Ergative in Georgian is found in a very restricted set of environments, so encountering this morphology, whether inside or outside an unambiguous filler–gap context, will be taxing, explaining the ergative coargument effect in Experiment 2. However, we observe one type of ergative DP which did not cause a slowdown: the relative pronouns of the *wh*-relatives in Experiments 3 and 4. So informativity alone cannot explain the full range of effects, either.

How do our results compare to those from other ergative languages? Unlike Basque (Carreiras et al. 2010) or Niuean (Tollan et al. 2019), Georgian does not seem to simply privilege gaps associated with the unmarked case (nominative). If it did, then nominative relative pronouns would have been read faster than either ergative or dative ones. Indeed, Georgian's postnominal relative clauses seem to pattern with Ch'ol and Q'anjob'al's (Clemens et al. 2015), insofar as subject gaps enjoy a processing advantage. As for the prenominal relatives in Georgian, here the results most closely resemble those from Polinsky et al. (2012)'s study on Avar. In that language ergative coarguments also conditioned a slowdown, and RTs at the right edge of transitive prenominal relative clauses exhibited no significant relationship to gap position. One direction for future research would be to test how intransitive subject gaps are processed in Georgian. If things behave like Avar, they should be easier to process than either transitive-subject or direct-object gaps. But a potential source of variation is Georgian's Active alignment, which means some intransitive subject gaps will be associated with nominative case, and others with ergative (Table 2).

Another avenue for follow-up work is animacy. Exploratory analyses in Experiment 4 led to some interesting preliminary observations surrounding the interactions of animacy and case, and how they influence the parser's expectations. A very simple design would be to manipulate the case (nominative, ergative, or dative) and animacy (human or non-human) of a root-clause argument and track differences in reading times. Especially intriguing is the fact that dative seems to be linked to object position, even though dative subjects are plentiful in Georgian (a finding that echoes Skopeteas et al. 2012's results). So diving deeper into the processing profile of dative case in particular may shed light on how grammatical knowledge and real-world knowledge influence predictive parsing.

Georgian is a language with typologically rare properties, but one with literate, computer-savvy speakers. This makes the language especially well-suited to psycholinguistic research. The present study — along with Skopeteas et al. (2012), Author1 & Author2 (2017), Lau et al. (2018, submitted) — has given proof to this concept. Our experiments have capitalized on a unique constellation of grammatical properties in Georgian, which make the language an ideal testing ground for various theories of relative clause processing. Results suggest that multiple factors guide relative clause processing: syntactic structure, morphological cues, and also potentially arguments' animacy.

References

Aronson, Howard I. 1990. *Georgian: A Reading Grammar*. Columbus, Ohio: Slavica.

Austin, Jennifer. 2007. Grammatical interference and the acquisition of ergative case in bilingual children learning Basque and Spanish. *Bilingualism: Language and Cognition*, 10, 315–331.

Barr, Dale J., Roger Levy, Christoph Scheepers, & Harry J. Tily. 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), 255–278.

Bhatt, Rajesh. 2003. Locality in correlatives. *Natural Language and Linguistic Theory*, 21(3), 485–541.

Bhatt, Rajesh, and Léa Nash. 2018. Deconstructing correlatives: Individuals and properties – the case of Georgian *rom*-relatives. Paper presented at The Fifth meeting of The Semantics of African, Asian and Austronesian Languages (Triple A 5). Konstanz, Germany. June 27–29.

Bhatt, R., & R. Pancheva. 2006. Conditionals. In *The Blackwell Companion to Syntax*, eds. M. Everaert & H. van Riemsdijk, 638–687. Oxford: Blackwell.

Bittner, Maria. 2001. Topical referents for individuals and possibilities. In *Proceedings of SALT XI*, eds. R. Hastings et al., 36–55.

Carreiras, Manuel, Jon Andoni Duñabeitia, Marta Vergara, Irene de la Cruz-Pavía, and Itziar Laka. 2010. Subject relative clauses are not universally easier to process: Evidence from Basque. *Cognition*, 115, 79–92.

Chung, Sandra. 1994. *Wh*-agreement and 'referentiality' in Chamorro. *Linguistic Inquiry*, 25, 1–44.
Chung, Sandra. 1998. *The design of agreement: Evidence from Chamorro.* Chicago: University of Chicago Press.
Clemens, Lauren Eby, Jessica Coon, Pedro Mateo Pedro, Adam Milton Morgan, Maria Polinsky, Gabrielle Tandet, and Matthew Wagers. 2015. Ergativity and the complexity of extraction: a view from Mayan. *Natural Language and Linguistic Theory*, 33, 417–467.
Dayal, Veneeta. 1996. *Locality in Wh-Quantification: Questions and Relative Clauses in Hindi*. Dordrecht: Kluwer.
Dillon, Brian, Andrew Nevins, Alison C. Austin, and Collin Phillips. 2012. Syntactic and semantic predictors of tense in Hindi: An ERP investigation. *Language and Cognitive Processes*, 27(3), 313–344.
Drummond, Alex. 2007. Ibex (Internet-based experiments). Software. https://code.google.com/p/webspr/.
Frazier, Lyn. 1987. Syntactic processing: Evidence from Dutch. *Natural Language and Linguistic Theory*, 5, 519–559.
Gennari, Silvia P., and Maryellen C. MacDonald. 2008. Semantic indeterminacy in object relative clauses. *Journal of Memory and Language*, 58, 161–87.
Gibson, Edward. 1998. Linguistic complexity: Locality of syntactic dependencies. *Cognition*, 68, 1–76.
Gibson, Edward, and Iris Wu. 2013. Processing Chinese relative clauses in context. *Language and Cognitive Processes*, 28, 125–155.
Harris, Alice C. 1981. *Georgian syntax: A study in relational grammar.* Cambridge Studies in Linguistics London, 33.
Harris, Alice C. 1990. Georgian: A language with active case marking: A reply to B.G. Hewitt. *Lingua*, 80(1), 35–53.
Hsiao, Franny, & Edward Gibson. 2003. Processing relative clauses in Chinese. *Cognition*, 90(1), 3–27.
Hsu, Chun-Chieh, and Chen, Jenn-Yeu. 2007. A new look at the subject–object asymmetry: the effects of linear distance and structural distance on the processing of head-final relative clauses in Chinese. In *Interdisciplinary Approaches to Relative Clauses* (REL07). Cambridge: Cambridge University.
Ishizuka, Tomoko, Kentaro Nakatani, and Edward Gibson. 2006. Processing Japanese relative clause in context. Paper presented at the 19th annual CUNY Conference on Human Sentence Processing (CUNY 19), New York, NY.
Izvorski, Roumyana. 1996. The syntax and semantics of correlative proforms. In *The Proceedings of the 26th Meeting of the North East Linguistics Society (NELS 26)*, ed. C. Schütze. 133–147.
Kahraman, Barış, Atsushi Sato, Hajime Ono, and Hiromu Sakai. 2010. Relative clauses processing before the head noun: Evidence for strong forward prediction in Turkish. *Proceedings of the 6th Workshop on Altaic Formal Linguistics (WAFL6), MIT Working Papers in Linguistics*. Cambridge: MIT.
Keenan, Edward L., and Bernard Comrie. 1977. Noun phrase accessibility and universal grammar. *Linguistic Inquiry*, 8, 63–99.
Kwon, Nayoung. 2008. Processing of syntactic and anaphoric gap–filler dependencies in Korean: Evidence from self-paced reading time, ERP, and eye-tracking experiments. Doctoral dissertation, University of California San Diego.
Kwon, Nayoung, Yoonhyoung Lee, Peter C. Gordon, Robert Kluender, and Maria Polinsky. 2010. Cognitive and linguistic factors affecting subject/object asymmetry: An eye-tracking study of pre-nominal relative clauses in Korean. *Language*, 86, 546–582.
Kwon, Nayoung, Robert Kluender, Marta Kutas, and Maria Polinsky. 2013. Subject/object processing asymmetries in Korean relative clauses: Evidence from ERP data. *Language*, 89, 537–585.
Kuznetsova, Alexandra, Per B. Brockhoff, & Rune H. B. Christensen. 2017. lmerTest Package:Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, 82(13), 1–26.
Lau, E., N. Clarke, M. Socolof, R. Asatiani, and M. Polinsky. 2018. Early (predictive) detection of conflicting constraints? ERP evidence from Georgian. Poster presented at the 31st Annual CUNY Conference on Human Sentence Processing (CUNY 31). University of California Davis, Davis, CA. March 15–17.

Lau, E., N. Clarke, M. Socolof, R. Asatiani, and M. Polinsky. (Submitted). A subject relative clause preference in a split-ergative language: ERP evidence from Georgian. Manuscript, University of Maryland.

Lewis, Richard L., and Shravan Vasishth. 2005. An activation-based model of sentence processing as skilled memory retrieval. *Cognitive Science*, 29, 375–419.

Lin, Chien-Jer Charles. 2006. Grammar and parsing: A typological investigation of relative clause processing. Doctoral dissertation, University of Arizona.

Lin, Chien-Jer Charles. 2008. The processing foundation of head-final relative clauses. *Language and Linguistics*, 9, 813–38.

Lin, Chien-Jer Charles. 2018. Subject prominence and processing dependencies in prenominal relative clauses: The comprehension of possessive relative clauses and adjunct relative clauses in Mandarin Chinese. *Language*, 94(4), 758–797.

Lin, Chien-Jer Charles, and Thomas G. Bever. 2006. In *West Coast Conference on Formal Linguistics (WCCFL)*, eds. Donald Baumer, David Montero, and Michael Scanlon, Vol. 25, 254–260. Somerville: Cascadilla Proceedings Project.

Lin, Chien-Jer Charles, and Thomas G. Bever. 2011. Garden Path and the Comprehension of Head-final Relative Clauses. *Studies in Theoretical Psycholinguistics*, 277–297.

Lipták, Anikó, ed., 2009. *Correlatives Cross-Linguistically*. Amsterdam: Benjamins.

Longenbaugh, Nick, and Maria Polinsky. 2016. The processing of long-distance dependencies in Niuean. In The *Proceedings of the 22nd Meeting of the Austronesian Formal Linguistics Association (AFLA 22)*, ed. Henrison Hseih, 106–120.

Mak, Willem M., Wietske Vonk, and Herbert Schriefers. 2002. The influence of animacy on relative clause processing. *Journal of Memory and Language*, 47, 50–68.

Miyamoto, Edson T., and Michiko Nakamura. 2003. Subject/object asymmetries in the processing of relative clauses in Japanese. In *The Proceedings of the West Coast Conference on Formal Linguistics (WCCFL)*, 22, 342–55.

Moravcsik, Edith A. 1974. Object–verb agreement. *Working Papers on Language Universals*, 15, 25–140.

Nash, Léa. 2017a. The structural source of split ergativity and ergative case in Georgian. In *The Oxford Handbook of Ergativity*, eds. Jessica Coon, Diane Massam, and Lisa deMena Travis.

Nash, Léa. 2017b. Simple correlatives in Georgian. Paper presented at Correlative Workshop, Queen Mary University London. March 13.

O'Grady, William. 1997. Syntactic development. Chicago, IL: Chicago University Press.

O'Grady, William, Miseon Lee, & Miho Choo. 2003. A subject–object asymmetry in the acquisition of relative clauses in Korean as a second language. *Studies in Second Language Acquisition*, 25, 433–448.

Polinsky, Maria. 2011. Reanalysis in adult heritage language: New evidence in support of attrition. *Studies in Second Language Acquisition*, 33(2), 305–328.

Polinsky, Maria. 2016. *Deconstructing Ergativity: Two types of ergative languages and their features*. Oxford University Press.

Polinsky, Maria, Carlos Gómez Gallo, Peter Graff, and Ekaterina Kravtchenko. 2012. Subject preference and ergativity. *Lingua*, 122, 267–277.

Skopeteas, Stavros, Gisbert Fanselow, and Rusudan Asatiani. 2012. Case inversion in Georgian: Syntactic properties and sentence processing. In *Case, Word Order and Prominence*, 145–171. Springer Netherlands.

Srivastav, Veneeta. 1991. The syntax and semantics of correlatives. *Natural Language and Linguistic Theory*, 9(4), 637–686.

Staub, Adrian, Francesca Foppolo, Caterina Donati, and Carlo Cecchetto. Relative clause avoidance: Evidence for a structural parsing principle. *Journal of Memory and Language*, 98, 26–44.

Tollan, Rebecca, Diane Massam, and Daphna Heller. 2019. Effects of case and transitivity on processing dependencies: Evidence from Niueam. *Cognitive Science*, 43(6), 1–14.

Traxler, Matthew J., Rihana S. Williams, Shelley A. Blozis, and Robin K. Moris. 2005. Working memory, animacy, and verb class in the processing of relative clauses. *Journal of Memory and Language*, 53, 204–24.

Ueno, Mieko, and Susan M. Garnsey. 2008. An ERP study of the processing of subject and object relative clauses in Japanese. *Language and Cognitive Processes*, 23, 646–688.

Vasishth, Shravan, Zhong Chen, Qiang Li, and Gueilan Guo. 2013. Processing Chinese relative clauses: evidence for the subject-relative advantage. *PLoS One*, 8(10), e77006.

Wagers, Matthew, Sandra Chung, and Manuel F. Borja. 2015. The real-time comprehension of *wh*-dependencies in a *wh*-agreement language. *Language*, 91, 109–144.

Wagers, Matthew, Sandra Chung, and Manuel F. Borja. 2018. Grammatical licensing and relative clause parsing in a flexible word-order language. *Cognition*, 178, 207–211.

Wagers, Matthew, and Emily Pendleton. 2016. Structuring expectation: Licensing animacy in relative clause comprehension. In Kyeong-Min Kim et al. (eds.), *Proceedings of the 33rd West Coast Conference on Formal Linguistics*.