PROCESSING SYNTACTIC ERGATIVITY IN TONGAN RELATIVE CLAUSES*

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In the psycholinguistic literature, it has been found that the processing cost for the subject relative clauses (SRC) is lower than that for the object relative clauses (ORC) in many languages (Kwon, et al., 2010, 2013, for a review). At the same time, grammatical properties in a given language such as word order and its case system are known to greatly influence how the parser handles sentences with grammatical dependencies. Our study examined the relative clause processing in Tongan to address this point. Tongan is an ergative-absolutive language, and exhibits syntactic ergativity; when an ergative subject undergoes A'-movement, the verb needs a clitic resumptive pronoun which agrees with the extracted subject. A self-paced reading experiment showed that the region with the resumptive pronoun was processed slowly, suggesting that it triggers a complicated and costly structure building. Also, an ergative NP in the relative clause, where an absolutive object was extracted, took more time to read than an absolutive NP or an oblique NP in other conditions. These results suggest that, in Tongan, a dependency with a shorter filler-gap distance has some advantage. But, at the same time, the ergative NP-extracted relative clauses put an extra processing cost for the native speakers of Tongan, which may be due to the dependent nature of the ergative case.

1. Introduction

In the sentence processing field, various hypotheses have been proposed in order to account for native speakers' structural preferences, and many others. But, still, we have a serious "un-balanced sample" problem (Anand, Chung, & Wagers, 2011). The set of languages that have been used in those studies is quite limited; the languages investigated so far are mostly from Indo-European or East Asian languages exhibiting a nominative-accusative case alignment, and consequently, it is typologically quite un-balanced. One of our goals is to add into the literature,

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Tongan, a VSO language with an ergative-absolutive case alignment. We would like to investigate to what extent some of those hypotheses proposed in the literature are truly "universal" through the lens of Tongan. We expect to see some variations, and if so, we are interested in why (see Ono, et al. 2020 for the initial attempt to answer some of the relevant questions).

One observation we would like to pay attention to is a well-known processing asymmetry between Subject Relative Clauses (SRC) and Object Relative Clauses (ORC). In many languages, the processing cost for SRC is found to be lower than that for ORC (see Kwon, et al. 2010, 2013 for a review). A typical paradigm is shown in (1). The processing advantage of SRC has been found in various measures such as reading time, eye-tracking, and so forth. We should note that the SRC advantage has often been observed in SVO or SOV languages, and typically with a nominative-accusative case alignment.

(1) a. SRC: the doctor [who ___ criticized the nurse]
b. ORC: the doctor [who the nurse criticized ___]

However, the SRC advantage does not seem to be universal. Basque, a language with an ergative-absolutive case alignment, has been claimed to have an ORC preference (Carreiras, et al. 2010). In addition, Polinsky, et al. (2012) showed that Avar, another language with an ergative-absolutive case alignment, has an absolutive advantage. Those studies, which will be reviewed below, indicate that the case system plays a major role in processing dependencies.

It should be noted that Basque and Avar are morphological ergative languages, while Tongan is a syntactic ergative language (Otsuka, 2000). In the next section, we will review grammatical properties of Tongan that are relevant for the current study. In particular, we are interested in how native speakers of Tongan utilize resumptive pronouns in processing sentences. In Tongan, a resumptive pronoun appears when an ergative argument is extracted to form a relative clause. Because this makes a sharp contrast to Basque and Avar, Tongan seems to provide us with an interesting testing ground for examining what factors are playing a major role in processing relative clauses in those languages.

2. Background: Tongan

There are a few grammatical properties in Tongan that are relevant in this paper. As shown in (2) and (3), Tongan is a verb-initial language, and the verb is preceded by a tense-marker. As for the post-verbal nominals, Tongan uses an ergative-absolutive case system. In (2), the sole argument with an intransitive verb is marked with the absolutive case-marker *'a*, which also shows up in the theme argument of a transitive verb in (3). The subject of a transitive verb is marked with an ergative case-marker *'e*.[1]

[1] Strictly speaking, the article *e* (allomorph *he*) indicates specificity and not definiteness. The latter is expressed in Tongan phonologically as "definitive accent", stress on the final vowel of the final word of the relevant noun phrase, orthographically indicated as an acute accent, as in *fefiné* vs. *fefine*. In this paper, however, we gloss *e/he* as definite and dispense with orthographic representation of definitive accent in Tonga examples for the sake of simple exposition.

(2) Na‘e ‘alu [‘a e fefine] ki Tonga.
PST go ABS DEF woman to T
‘The woman went to Tonga.’

(3) ‘Oku ‘ofa‘i [‘e Sione] [‘a e fefine].
PRS love ERG J ABS DEF woman
‘John loves the woman.’

In Tongan, relative clauses are post-nominal. There was no relative pronoun that indicates the left edge of the relative clause, as illustrated in (4).

(4) Post-nominal RC (ORC, ABS-NP extracted)
‘a e tōketā [na‘e taa‘i ‘e he neesi ___]
ABS DEF doctor PST hit ERG DEF nurse
‘the doctor who the nurse hit __ ’

One property which we pay attention to in this paper is syntactic ergativity (Otsuka 2000). The ergative argument can undergo A’-movement, and relativization is possible; but then a resumptive pronoun must appear in a pre-verbal position. In (5), a resumptive pronoun *ne* shows up which corresponds to a 3rd person singular NP, ‘the doctor’. When an absolutive argument undergoes A’-movement, the resumptive pronoun cannot appear, as shown in (6).[2]

(5) SRC (ERG-NP extracted, RP required)
‘a e tōketā [na‘á ne taa‘i ___ ‘a e neesi]
ABS DEF doctor PST RP hit ABS DEF nurse
‘the doctor who hit the nurse’

(6) SRC (ABS-NP extracted, intransitive verb)
‘a e tōketā [na‘e kata ___ mo e neesi]
ABS DEF doctor PST laugh with DEF nurse
‘the doctor who laughed with the nurse’

In Tongan, *ne* is also a 3rd person singular subject pronoun, as shown in (7), which may be optionally dropped.

(7) *ne* as a subject pronoun
Na‘e taukave‘i ‘a e tōketā [na‘á ne taa‘i ‘a e neesi].
PST claim ABS DEF doctor PST 3S hit ABS DEF nurse
‘The doctor claimed that he hit the nurse.’

This potentially creates a temporal ambiguity, but adding a plural subject allows us to avoid this ambiguity in our test sentences in the experiment.

[2] The past tense marker *na‘e* has an allomorph *na‘á*, which is used when it is followed by a clitic pronoun.

3. Processing of Relative Clauses

We will briefly review some issues about the processing of relative clauses and some related observations. Previous studies on ergative-absolutive languages suggest that there is an absolutive advantage in those languages. Carreiras, et al. (2010) examined Basque in their self-paced reading experiment and an ERP experiment, and observed that SRC, where an ergative subject is associated with the head noun, is processed slower (or elicits a larger P600 effect). They proposed that the morphological complexity on the ergative marker is playing an important role. In Basque, the absolutive case-marker is phonologically null while the ergative case-marker is *-k*, and they argue that the dependency with a position associated with a morphologically complex case-marker is costly to process. Though their morphological markedness account is quite attractive, it is unclear how it influences the processing cost of the dependency in relative clauses because the position at issue is a gap, which has no phonological content.

Polinsky, et al. (2012) investigated relative clause processing in Avar. Avar is a morphological ergative language, and has pre-nominal relative clauses like Japanese. In their self-paced reading experiment, the participants took more time to process the ergative NP than the absolutive NP in the relative clause, and they suggested that it is due to the ergative being a dependent case. The term "dependent" means that its presence is conditioned by the existence of the other. According to Polinsky, et al. (2012), absolutive is "independent" because the absolutive NP can be the sole argument of the predicate, but there has to be an absolutive NP for the presence of an ergative NP. They argue that the ergative NP is more costly because the presence of the ergative NP triggers more structural predictions than that of the absolutive NP. For example, the presence of the ergative marker tells the parser that the verb must be transitive and there is an absolutive NP somewhere in the structure.

Let us look at some previous studies on verb-initial languages; in particular, some languages in the Austronesian language family. Wagers, et al. (2018) on Chamorro, and Tanaka, et al. (2019) on Tagalog, both observed the SRC preference on post-nominal relative clauses. Such an observation suggests that factors related to the Accessibility Hierarchy play a role. The Accessibility Hierarchy (Keenan and Comrie 1977, 1979, Comrie and Keenan 1979) says that subject is more prominent than object. While this was originally proposed to account for the typological observations, the spirit of which can be utilized to account for the processing asymmetry between SRC and ORC. Tanaka, et al. (2019) have a slightly different explanation as well. Based on the corpus study, they found the correlation between the animate head noun and the use of SRC, where the head carries an agent theta-role. They then argue that such a distributional bias can account for the SRC preference.

Slightly different is it from the genuine frequency account. Tollan, et al. (2019) suggest that a wider distribution of absolutive than ergative can account for the absolutive advantage. They investigated the comprehension of *wh*-questions in Niuean, which shares lots of characteristics with Tongan. In their visual world eye-tracking study, they observed that the dependency with an absolutive object is preferred to that with an ergative subject.

There is yet another observation about the filler-gap dependency formation, which is quite relevant to the current experiment to be introduced shortly. It seems fair to assume that one of the processing steps in comprehending relative clauses is to integrate the filler (which is a head noun) to the gap, an empty slot, inside the relative clause. Yano et al. (2019) and Yasunaga, et al. (2015) observed that the processing cost increases when the parser finally determines the gap position and integrates the filler. For example, consider (8). Suppose that NP1 is a dislocated

phrase (we call this "filler") from the post-verbal gap position. In order to comprehend the sentence, the parser needs to integrate the filler to the gap. Examining Truku Seediq (spoken in Taiwan) and Kaqchikel (in Guatemala), Yano et al. and Yasunaga et al. observed a P600 effect (which is an indicator for the processing cost; see also Kaan, et al. 2000, Phillips, et al. 2005) at NP2, suggesting that upon hearing NP2, the native speakers of those languages integrated the filler to the gap. This suggests that the identification of the gap and integration need a major cognitive cost.

(8) filler trigger
NP1 [verb NP2 gap

Following these previous studies on relative clause processing, we expect that an ergative marker, i.e., a resumptive pronoun in Tongan, is potentially quite informative. The parser can start positing a detailed structure building upon encountering a resumptive pronoun. Such a structure building may come with a cost, possibly due to the costly dependency formation with the ergative subject position. At the same time, we have observed that the subject advantage is quite robust, as seen in Chamorro and Tagalog, so we would like to know whether the processing cost related to ergativity does interact with the subject advantage, if there is any such effect. Finally, we would like to examine where in the sentence the processing cost shows up. Information about the location where the effect appears in a sentence should tell us a lot about the processing mechanism of Tongan relative clauses (see also Ono, et al. 2000).

4. Experiment

We conducted a self-paced reading experiment in which participants read sentences presented phrase by phrase (Just, Carpenter, and Woolley 1982). The time they spent in each region was measured and recorded, in addition to the accuracy for the comprehension question that follows every sentence.[3]

4.1. Method

Fifty-five native speakers of Tongan participated in the experiment. They are all students recruited at University of South Pacific, Tonga Campus, and they were naïve to the purpose of the experiment. Written informed consent was obtained, as well as some linguistic background questionnaire about their daily use of Tongan and other languages given prior to the experiment. They were provided some food package for their participation in the experiment.

Twenty-one sets of target stimuli were prepared with 3 conditions. In addition to the target sentences, 46 filler sentences were also prepared which were similar to target sentences in terms of the length and complexity. All sentences used in the experiment were checked for their naturalness by two native speakers of Tongan.

[3] Approval for the study was obtained from the Prime Minister's Office of the Kingdom of Tonga, the Ethics Committee of the Graduate School of Arts and Letters, Tohoku University, Japan and the Research Ethics Committee of the University of the South Pacific.

4.2. Design

A sample set of target stimuli is shown in (9). We prepared 3 conditions. In Ergative Subject (Erg.Subj) condition and Absolutive Object (Abs.Obj) condition, the same transitive verb was used in the relative clause. In Absolutive Subject (Abs.Subj) condition, in contrast, a middle verb was used so that the subject is marked with an absolutive case-marker. R1, R2, etc. refer to the region numbers, which indicate how a sentence was divided into phrases. R1 to R4 show the content in the main clause, which was common among all conditions. R5, R6, and R7 represent the relative clause part of the sentence, which are the critical regions in this experiment. In R5, the past tense-marker appears, which indicates the beginning of the relative clause. Only in Erg.Subj condition, the resumptive pronoun *ne* also appears with the tense-marker in this region. R6 is the relative clause verb region. In R7, an NP inside the relative clause shows up. Here, the native speakers of Tongan can, more or less, determine the structure of the relative clause, and hence the position of the gap.

One of the important characteristics of the target sentence is that the subject in the main clause (R3) is always plural. This property is important because it eliminates the possibility that the pronoun *ne* in R5 is taken as a pronoun referring back to the matrix subject. This should be a strong cue for the native speakers of Tongan that *ne* is a resumptive pronoun for the dependency associated with the ergative position.

(9) Sample stimuli

R1	R2	R3	R4
Na‘e	talitali	‘e he kau ta‘ahine tau‘olungá	‘a e tōketā nifo . . .
PST	welcome	ERG-dancers	ABS-dentist

“The dancers welcomed the dentist . . .”

	R5	R6		R7	
a. Ergative Subject . . .	na‘á ne	‘ave	___	‘a e faiako	
	PST.RP	take		ABS-teacher	
b. Absolutive Object . . .	na‘e	‘ave		‘e he faiako	___
	PST	take		ERG-teacher	
c. Absolutive Subject. . .	na‘e	tali	___	ki he faiako	
	PST	wait.for		OBL-teacher	

Erg.Subj “. . . who took the teacher . . .”
Abs.Obj “. . . who the teacher took . . .”
Abs.Subj “. . . who waited for the teacher . . .”

	R8	R9	R10
. . .	koe‘uhí	na‘á ne ngali	poto ‘aupito.
	because	he seemed	very smart.

There are a few predictions. If the resumptive pronoun is not initially expected, and if the resumptive pronoun triggers multiple structural decisions, there should be a slowdown in R5 in Erg.Subj condition. Also, we expect to see a filler-gap integration effect at the NP regions (R7) in the relative clause. If the dependency formation is sensitive to linear / structural distance, then the effect would appear in Abs.Obj condition.

4.3. Analysis

To analyze the reading time (RT) data, we calculated Residual Reading Time (along with Raw Reading Time), based on all stimuli including filler sentences. There are at least two motivations. First, in R5, due to the resumptive pronoun, Erg.Subj condition was always longer than the other two conditions. Second, in R6, transitive verbs in Erg.Subj condition and Abs.Obj condition were longer than the intransitive (middle) verbs in Abs.Subj condition, on average (the number of syllables, 4.33 vs. 3.09, $t(36) = 2.86$, $p < .007$). Residual RT was calculated by subtracting the predicted RT from the Raw RT. The predicted RT was estimated by a linear regression equation for each participant and the number of syllables in the region.

Data from three participants were eliminated, whose accuracy rates for the comprehension questions were 2 standard deviations (or more) lower than the grand mean accuracy rate. Reading time data was put into analyses whose comprehension question was answered accurately. Raw RT longer than 5,000 ms. and Residual RT longer than 3,500 ms. were eliminated first, then they were further trimmed with the 2.5 SD cut-off line calculated by each region by condition.

Based on the remaining reading time data, we performed the linear mixed effect regression analyses with the lme4 package in R version 3.4.0 (R Development Core Team 2014, Baayen 2008, Baayen et al. 2008, Bates et al. 2014). Three conditions were dummy-coded, with Erg.Subj condition taken as the baseline. Two fixed factors were tested, one against Abs.Obj condition, and the other against Abs.Subj condition. In the model, in addition to those fixed factors, random intercepts and random slopes were estimated for participants and items. We estimated a model first, and removed data whose residual was greater than 2.5 standard deviations (Baayen and Milin 2010), then we re-built the final model. See Appendices A and B for the model summaries.

4.4. Results

For the mean comprehension accuracy rates, there was no significant difference among three conditions (Erg.Subj 73.6% [SE = 2.33], Abs.Obj 75.3% [1.99], Abs.Subj 72.4% [2.21]). Figure 1 shows the mean Raw RT for each region by condition, and Figure 2 the mean Residual RT (R5, 6, and 7 are the critical regions).

In R5 (tense (+ resumptive pronoun)), Erg.Subj condition was slower than the other 2 conditions. This effect was observed in both Raw RT and Residual RT, so this is not the length effect due to the presence of the resumptive pronoun in Erg.Subj condition ($p < .001$). In R6 (relative clause verb), there was an effect in Raw RT, but the effect disappeared in Residual RT. This indicated that the effect in Raw RT was probably due to the longer length of the transitive verbs. In R7 (NPs in the relative clause), Abs.Obj condition was read longer than Erg.Subj condition in Residual RT ($p < .04$). In sum, in R5, the resumptive pronoun increased the reading time, and in R7, the ergative NP took longer to read, compared to other types of NPs. Also, Abs.Subj condition was read very smoothly, in general.

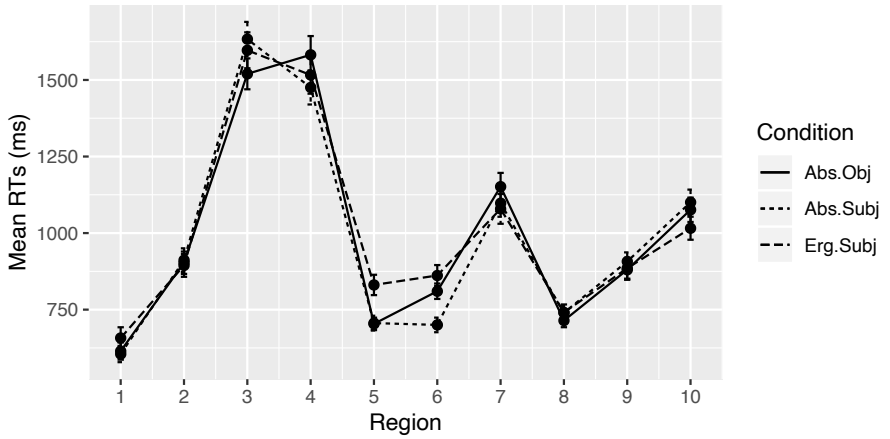


Figure 1. Region-by-region mean raw reading times (error bars represent SE).
Relative clauses are presented in R5-7.

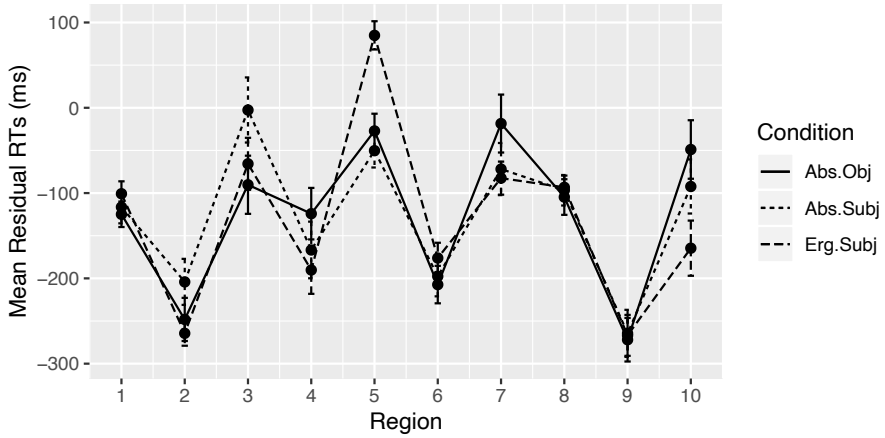


Figure 2. Region-by-region mean residual reading times (error bars represent SE).
Relative clauses are presented in R5-7.

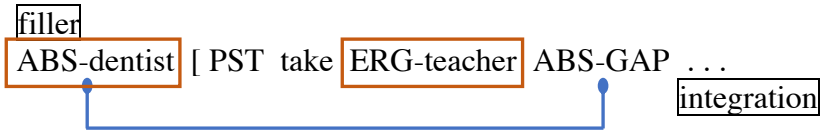
5. Discussion

In this experiment, we examined reading time data on relative clause processing in Tongan. The data allows us to examine the dependency formation in a verb-initial language with syntactic ergativity. One major finding is that the native speakers of Tongan took time to read the resumptive pronouns. In Section 3, we suggest that the presence of a resumptive pronoun triggers a complex structure building for relative clauses. This means that the presence of the resumptive pronoun tells the parser many things; the gap is in the Erg.Subj position, and the verb has to be transitive, and so on. In contrast, in Abs.Subj and Abs.Obj conditions, the lack of resumptive pronoun may provide some information, but not much. There remain structural ambiguities, which seem not to increase the processing cost very much.

We observed a reading time slowdown in R7. A mere expectation cannot account for the pattern. Given the lack of resumptive pronoun in R5 and the transitive verb in R6, an Erg-NP would be expected in Abs.Obj condition. As for the slowdown in R7, we can suggest two possibilities that are slightly different from each other. At this point, we do not have any clear

piece of evidence to reject either account, so both accounts are presented below. Under the first approach, we suggest the processing cost of the Erg-NP is driven by the filler-gap integration cost. As illustrated in (10), upon seeing the Erg-NP, the parser can identify the gap and integrate the filler to the gap, which immediately follows. In other words, the filler-gap integration is triggered by the appearance of Erg-NP, resulting in the slowdown in R7.

(10) Filler-gap integration, triggered by ERG-NP



In contrast, a slowdown was not observed in R7 in Erg.Subj condition. But this is expected because in Erg.Subj condition, the filler-gap integration has already been finished in R5, where the resumptive pronoun is presented. The presence of a resumptive pronoun and a transitive verb should be enough for the parser to determine that there is a gap in the ergative subject position. Abs.Subj condition in R7 did not show a slowdown, either. It seems, however, that the integration process similar to Abs.Obj condition should occur at this region. We suggest that the integration cost in Abs.Obj condition was larger than that in Abs.Subj condition. This could be accounted for by a subject-advantage or the dependency in Abs.Subj condition is linearly shorter. One may wonder if, in Abs.Subj condition, the filler-gap integration can occur in an earlier position, namely at the middle verb. We suggest that the integration does not occur at the verb because, at the verb, there still exists a possibility that the filler can be associated with the oblique position in the relative clause. In such a case, the filler will be linked to an in-situ resumptive pronoun *ia* if the filler is a 3rd person singular NP.

Now, let us consider the second approach for the slowdown in R7. In this second approach, we could suggest the slowdown to be a spillover effect from R6. Note that in Erg.Subj and Abs.Obj conditions, the same transitive verb appeared in R6, but what the parser has to do is quite different in each condition. Recall that in Erg.Subj condition, there was a resumptive pronoun in R5. Because this resumptive pronoun has already provided information about the verb, the presence of a transitive verb in R6 should be fully expected, then there should not be a major processing cost. In contrast, in Abs.Obj condition, the transitive verb in R6 should trigger a lot of structural predictions, including steps such as projecting the Erg-Subject NP, and gap creation in an object position. It could be that the parser expects to see an intransitive middle verb given the tense marker in R5, if Tongan is equipped with the subject-advantage and the absolutive-advantage, as it is hinted in Avar. In that case, the appearance of a transitive verb would cause a prediction error. Then in Abs.Subj condition, the intransitive middle verb in R6 should trigger some structural predictions. But again, we did not see a major processing cost in this condition. This suggests that the processing cost for positing a gap in Abs.Subj is lower than that in Abs.Obj. This could be accounted for by a subject-advantage or the dependency in Abs.Subj condition is linearly shorter.

In sum, we saw that the resumptive pronoun in Tongan incurred a processing slowdown, and we suggested that it reflects a detailed structure-building prediction triggered by the resumptive pronoun. Although it seems to reduce the processing cost for the rest of the sentence, the resumptive pronoun itself is a major factor responsible for the costly processes. We also

observed the processing advantage of Abs.Subj condition over Abs.Obj condition. Because both positions are associated with absolutive case, the contrast is not about Case. We suggest that subject-advantage or linear-length of the dependency plays a role. Note, however, that this subject-advantage is not strong enough to overturn the processing cost associated with the resumptive pronoun which is a major characteristic of syntactic ergativity in Tongan. Therefore, it seems that ergativity influences the processing of relative clauses in Tongan more strongly than the subject advantage.

Finally, we would like to mention another observation from a related piece of work from our research group: Otaki, et al. (2020). We tested Tongan children's comprehension of *wh*-questions, a construction fairly close to relative clauses. We observed that their performance on Erg.Subj condition (i.e., a fronted *wh*-phrase is associated with the ergative-subject position) was no worse than that on Abs.Subj condition (a fronted *wh*-phrase is associated with the absolutive-subject position). This suggests that in Tongan children, factors like the subject advantage or agent first strategy are stronger than the ergativity in processing *wh*-questions.

6. Conclusion

We ran a self-paced reading experiment in Tongan, a verb-initial language with syntactic ergativity. Sentences with relative clauses in which an absolutive subject is linked to the head of the relative clause were read very smoothly; other conditions with a transitive verb (and the gaps are in the ergative subject or the absolutive object position) showed some slowdown, but in different positions. The resumptive pronoun in Tongan was costly to read, leading to the major processing cost for the sentences with a relative clause that has an ergative subject gap. The slowdown in the relative clause with a gap in the absolutive object position is another major finding in our experiment; we suggest that it reflects either the filler-gap integration cost or a spillover effect from the verb region.

Appendix A. Model summary, Comprehension accuracy

Final Model: glmer (Accuracy ~ f1 + f2 + (1 + f1 + f2 || subject) + (1 + f1 + f2 || item, family = binomial)

	Estimate	SE	z	p	
(Intercept)	1.824	0.414	4.405	<0.001	***
f1 (Abs-Obj)	–0.241	0.414	–0.584	0.559	
f2 (Abs-Subj)	0.028	0.578	0.049	0.961	

Appendix B. Model summary, Residual reading time

Region 5

Final Model: lmer (ResRT ~ f1 + f2 + (1 + f1 || subject) + (1 + f1 || item)

	Estimate	SE	t	p	
(Intercept)	80.84	15.45	5.234	< 0.001	***
f1 (Abs-Obj)	–107.29	22.68	–4.730	< 0.001	***
f2 (Abs-Subj)	–120.38	17.72	–6.795	< 0.001	***

Region 6

Final Model: lmer (ResRT ~ f1 + f2 + (1 + f1 + f2 || subject) + (1 + f1 + f2 || item) + subj.accuracy + item.accuracy

	Estimate	SE	t	p	
(Intercept)	−159.20	148.25	−1.074	0.286	
f1 (Abs-Obj)	−27.42	20.60	−1.331	0.188	
f2 (Abs-Subj)	5.57	33.47	0.166	0.869	
subj.accuracy	1.62	1.44	1.123	0.267	
item.accuracy	−2.043	1.33	−1.532	0.140	

Region 7

Final Model: lmer (ResRT ~ f1 + f2 + (1 + f1 + f2 || subject) + (1 + f1 || item) + subj.accuracy

	Estimate	SE	t	p	
(Intercept)	−326.58	139.05	−2.349	0.021	*
f1 (Abs-Obj)	75.31	33.64	2.239	0.032	*
f2 (Abs-Subj)	42.08	28.77	1.463	0.146	
item.accuracy	3.25	1.81	1.801	0.076	.

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