Processing syntactic ergativity in Tongan relative clauses

Hajime Ono[1], Koichi Otaki[2], Manami Sato[3], 'Ana Heti Veikune[4], Peseti Vea[4], Yuko Otsuka[5], & Masatoshi Koizumi[6]

[1]hajime@tsuda.ac.jp, Tsuda Univ.; [2]Chukyo Univ.; [3]Okinawa International Univ.; [4]Univ. of South Pacific, Tonga; [5]Sophia Univ.; [6]Tohoku Univ.

https://sites.google.com/site/hajimeonoling/

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Highlights

- A self-paced reading study was conducted with Tongan relative clauses (RCs).
- The region with the resumptive pronoun (RP) in Erg-Subject RCs took longer to read, possibly due to a costly structure-building.
- In Abs-Object RCs, in contrast, there was a slowdown at the Erg-NP region, which may reflect the filler-gap integration cost.
- The lack of major slowdown in Abs-Subject RCs suggests that the lack of RP led the parser to expect Abs-Subject RCs.

1. Introduction

(1) Various hypotheses in sentence processing (wrt., preference, predictions, time-course, etc.) have been proposed, but based on the "**un-balanced**" **sample** of languages (Anand, Chung, & Wagers, 2011).

(2) We would like to investigate to what extent those hypotheses are truly "universal". Some of the well-known preferences (SO word order, etc.) seem to be language particular (Koizumi, et al., 2014, Yano, et al., 2019, Yasunaga, et al., 2015).

(3) In many languages*, the processing cost for **Subject Relative Clauses (SRC)** is lower than that for **Object Relative Clauses (ORC).** * English, German, French, Dutch, Korean, Japanese, Turkish, etc. (Kwon, et al., 2013 for review)

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

(5) SRC advantage has often been observed in languages with SVO and SOV word orders, and languages with a Nom-Acc case system.

(6) Basque (SOV, Erg-Abs case system)
ORC preference, compared to Erg-SRC (Carreiras, et al. 2010)
→ to be discussed in detail below

(7) What is a potential source for the SRC/ORC advantage?

(8) Tongan = VSO, Ergative-Absolutive case system

2. Background: Tongan

(9) Ergative / Absolutive case system

a. S	:	the subject of intransitive verb	Absolutive
b. O	:	the object of transitive verb	Absolutive
c. A	:	the subject of transitive verb	Ergative

(10) SRC (ERG-NP extracted, **RP** required)

‘a	e	tōketā	[na’a	**ne**	taa’i	___	‘a	e	neesi].
ABS	DEF	doctor	PST	RP	hit		ABS	DEF	nurse

“the doctor who hit the nurse”

(11) ORC (ABS-NP extracted, RP cannot appear)

‘a	e	tōketā	[na’e	taa’i	‘e	he	neesi	___].
ABS	DEF	doctor	PST	hit	ERG	DEF	nurse	

“the doctor who the nurse hit”

(12) SRC (ABS-NP extracted, intransitive (middle) verb)

‘a	e	tōketā	[na’e	tali	___	ki	he	neesi].
ABS	DEF	doctor	PST	wait.for		OBL	DEF	nurse

“the doctor who waited for the nurse”

(13) “**ne**” as a subject pronoun (no gap)

Na’e	taukave’i	‘a	e	tōketā	[na’a	**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.”

3. Processing of Relative Clauses, etc.

3.1. Previous studies on Ergative languages

(14) a. Carreiras, et al. (2010): Basque (Self-paced reading, ERP)
b. Polinsky, et al. (2012): Avar (Self-paced reading)

(15) Basque: Abs-ORC preference, vs. the Ergative-extracted SRC.

- **Case (Morphological) Markedness account**
  Processing dependencies with Abs is less costly, because Abs is morphologically unmarked.

(16) Avar: Increased RT at Erg-NP in the RC.

- **Case (Hierarchical) Markedness account**
  Ergative is a dependent case, and processing Erg-NP triggers a lot of structure-buildings.

3.2. Previous studies on V-initial languages

(17) a. Wagers, et al. (2018): Chamorro
b. Tanaka, et al. (2019): Tagalog

(18) Chamorro: (Auditory sentence comprehension)
Post-nominal RCs, S-gap choice = 94%

- **The Accessibility Hierarchy account (+ dependency length)**
  Subject is more prominent than Object.

(19) Tagalog (children, comprehension)
Agent SRC (+ agent voice morphology) preference over patient ORC (+patient voice morphology)

- **Frequency account**
  An animate head noun tends to appear with Agent SRC.

3.3. Previous studies on Ergative + V-initial languages

(20) a. Tollan, et al. (2019): Niuean

Visual world eye-tracking (wh-question)

b. Yano, et al. (2019): Truku Seediq (ERP);
Yasunaga, et al. (2015): Kaqchikel (ERP)

(21) A dependency with Abs-Object is preferred (vs. Erg-Subj).

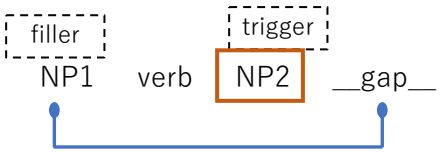
- **Case Frequency account**
  Abs has a wider distribution, then less costly to process.

(22) Yano, et al. (2019), Yasunaga, et al. (2015), ERP (word order)

(23) In a derived word order (SVO), the post-verbal NP elicited a P600 effect.

- **Filler-gap integration account**
  Integrating a filler to a gap incurs a processing cost.

(24)



3.4. Our study

(25) Lessons we learned:

- Encountering an Ergative marker (NP/morphology?) is "informative". The parser can posit a detailed structure.
- Verb morphology (RP in Tongan) can be a strong cue for the structure yet to be seen (cf. Sauppe, et al., 2016).
- Dependency with the Erg-NP position is costly.

(26) But at the same time,

- Subject / Agent advantage is quite robust.

(27) **Research Questions**

- What is the role of RP in Tongan RC processing?
  > Does it facilitate the processing, or slow down?
  > Does it interact with the Subj-advantage (if any)?
- In what position in a sentence does the processing cost show up?
  > around the RP, and/or at the NP in RC?

4. Experiment

4.1. Method

Participants

(28) 55 native speakers of Tongan (students in USP, Tonga)

Materials

(29) a. 21 sets (3 conditions); **see the examples below**.
b. 46 filler sentences; 5 practice trials.

Task

(30) **Self-paced reading**: Sentences were presented phrase by phrase; reading time (RT) for each phrase was measured. Comprehension questions followed every sentence.

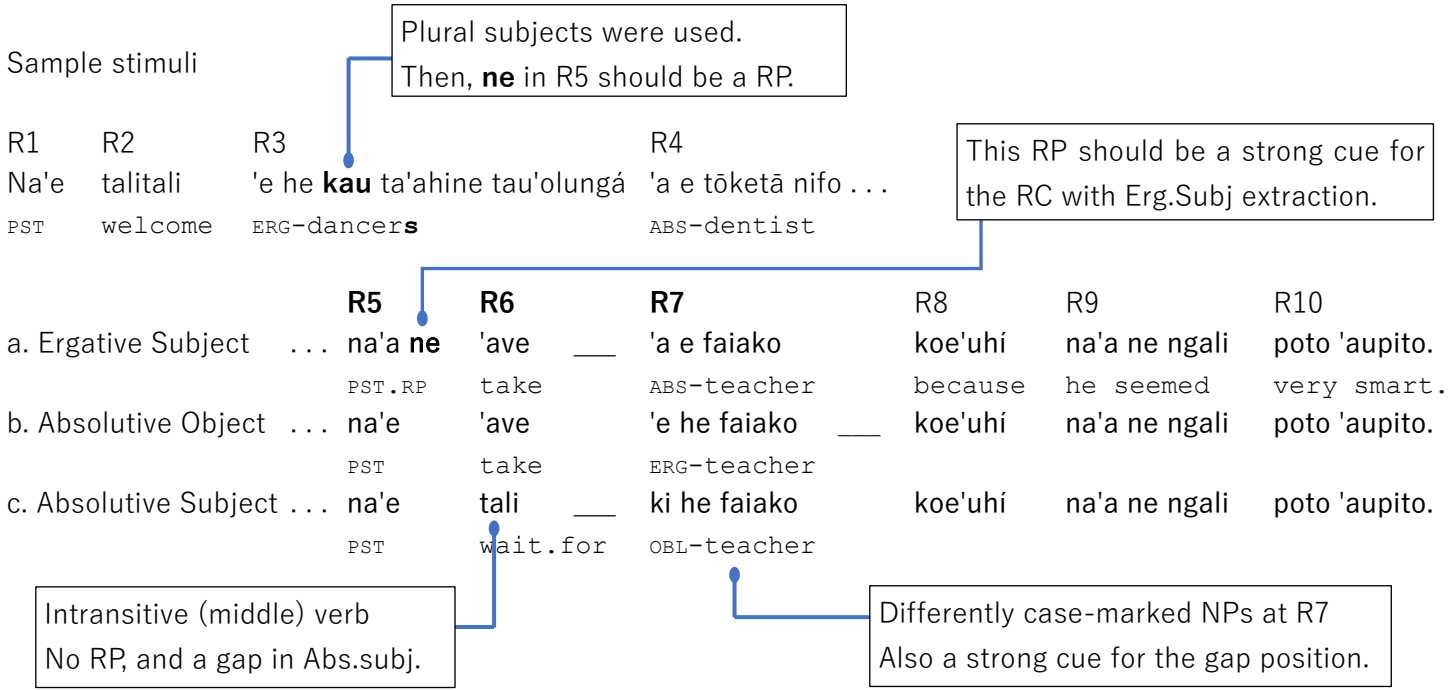
4.2 Design

Three Extraction Types (template)

(31) The dancers welcomed the dentist . . .

a. Erg.Subj {who ___ took the teacher} because . . .
b. Abs.Obj {who the teacher took __ } because . . .
c. Abs.Subj {who ___ wait for (to) the teacher} because . . .

(32) Sample stimuli



	R1	R2	R3	R4
	Na'e	talitali	'e he **kau** ta'ahine tau'olungá	'a e tōketā nifo . . .
	PST	welcome	ERG-dancer**s**	ABS-dentist

	R5	R6	R7	R8	R9	R10
a. Ergative Subject . . .	na'a **ne**	'ave	___ 'a e faiako	koe'uhí	na'a ne ngali	poto 'aupito.
	PST.RP	take	ABS-teacher	because	he seemed	very smart.
b. Absolutive Object . . .	na'e	'ave	'e he faiako ___	koe'uhí	na'a ne ngali	poto 'aupito.
	PST	take	ERG-teacher			
c. Absolutive Subject . . .	na'e	tali	___ ki he faiako	koe'uhí	na'a ne ngali	poto 'aupito.
	PST	wait.for	OBL-teacher			

Predictions

(33) If RP is not expected, and if it triggers a complicated structural decisions, there should be a slowdown in Erg.Subj condition.

(34) Filler-gap integration effects should be observed either at the verb or the NP region.

4.3 Analysis

(35) Residual reading time (**ResRT**) was calculated (based on all fillers and target items).

a. In Region 5 (tense (+ RP)), Ergative Subject condition was always longer, due to the resumptive pronoun.
b. In Region 6 (RC verb), transitive verbs were slightly longer

than intransitive (middle) verbs (# of syllables, 4.33 vs. 3.09, t = 2.86, p<.007) (See Appendix C for details).

(36) ResRT = Raw RT – Predicted RT
based on the # of syllables (cf. Ferreira & Clifton, 1986, a.o.)
A linear regression equation was built for each participant.

(37) Contrast coding: dummy coding was used, Erg.Subj condition being the baseline (0). Two fixed factors were tested, one against Abs.Obj condition, and the other against Abs.Subj condition.

(38) Comprehension question (CQ) accuracy data were submitted to logistic mixed effects regression models, and ResRT data were submitted to linear mixed effects (LME) models.

4.4. Results

Accuracy

(39) Data from 3 participants were eliminated, whose CQ accuracy rates were 2 standard deviations (or more) lower than the mean.

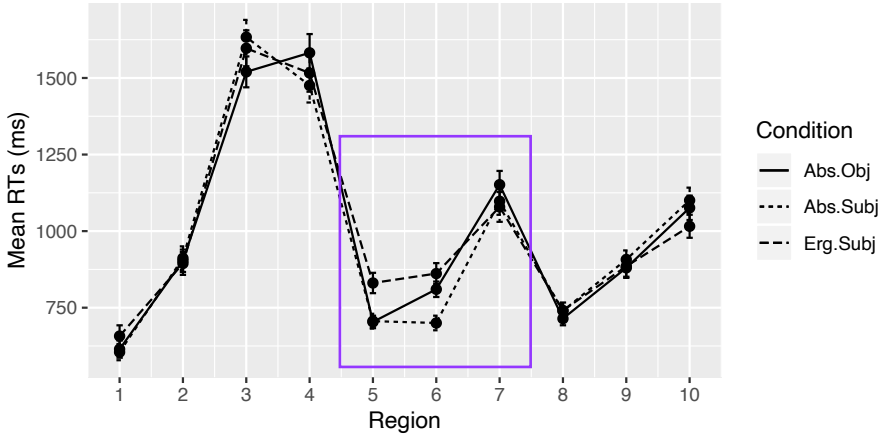
(40) There was no significant difference among three conditions.

Ergative Subj	73.6% (SE 2.33)
Absolutive Obj	75.3% (SE 1.99)
Absolutive Subj	72.4% (SE 2.21)

RT trimming memo:
Data in which CQ was correctly answered was included. RawRT larger than 5,000ms (ResRT larger than 3,500ms) were first eliminated. Then, 2.5 SD trimming (by region, by condition).

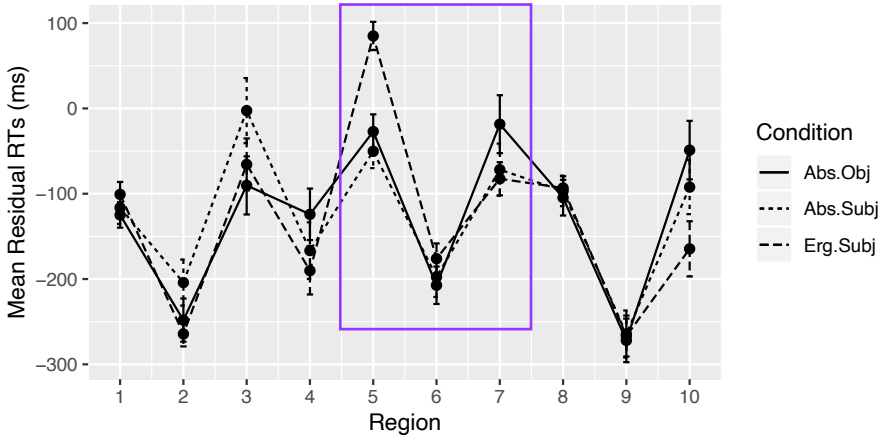
Reading Time

(41) Mean **Raw** RT (error bars = SE)



	R5	R6	R7
Erg.Subj	TNS+RP	tr.verb	abs.NP
Abs.Obj	TNS	tr.verb	erg.NP
Abs.Subj	TNS	middle	obl.NP

(42) Mean **Residual** RT (error bars = SE)



(43) Residual RT data in Region 5, 6, and 7 (critical regions) (error bars = SE)

Region 5 (Tense (+ ne))

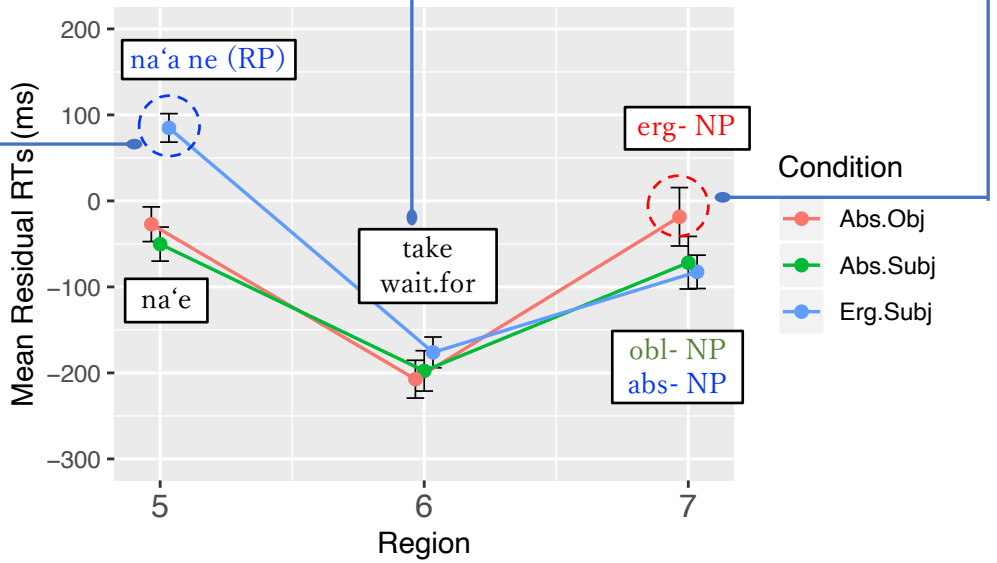
- Erg.Subj RC condition was slower than the others (p<.001).
- The effect is not due to the length.

Region 6 (verb)

- There was an effect in RawRT, but it disappeared in ResRT.

Region 7 (RC-NP)

- Abs.Obj RC condition was slower than Erg.Subj RC condition (p<.04).



(44) **Summary of the results**

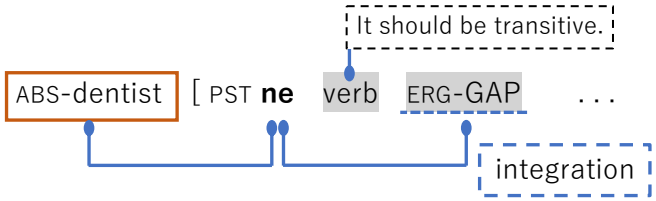
- Processing cost increased upon encountering the tense marker and a RP (ne) (R5).
- An Ergative-NP inside the RC was read slower than other types of NPs (R7).
- Absolutive Subject extraction condition was read very smoothly, in general.

5. Discussion

Processing cost associated with RP in Region 5

(45) The presence of RP triggers a complex structure-building of RC.
- dependency between the head noun and the RP.
- gap creation and early integration between the filler and the gap in Ergative subject position.
- a transitive verb (and its argument structure) is predicted.

(46) A structure-building, triggered by the RP, in Erg.Subj condition



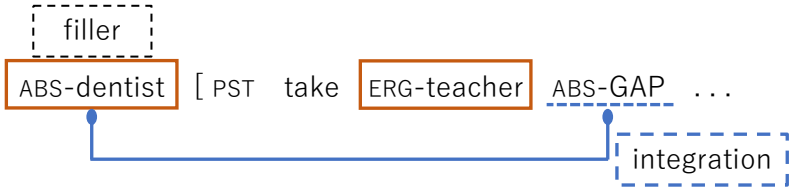
(47) In Abs.Subj and Abs.Obj conditions, in contrast, the tense marker can only indicate that the dependency is not with ergative; ambiguities remained (i.e., verb type, gap position).

Slowdown (Abs.Obj condition, Erg-NP) in Region 7

(48) Expectation cannot account for the slowdown. The verb information was given in Region 6.
- In Abs.Obj condition, an Erg-NP was expected to appear.
- In Erg.Subj condition, an Abs-NP was expected to appear.

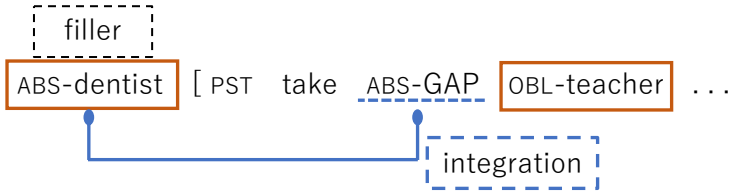
(49) **#1 Erg-NP = The filler-gap integration cost**
When the parser sees an Erg-NP, it integrates the filler and the immediately-following gap (Kaan, et al. 2000, Phillips, et al. 2005, Yano, et al. 2019, Yasunaga, et al. 2015).

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



(51) In contrast, in Erg.Subj extraction condition, the filler-gap integration has already been finished in Region 5.

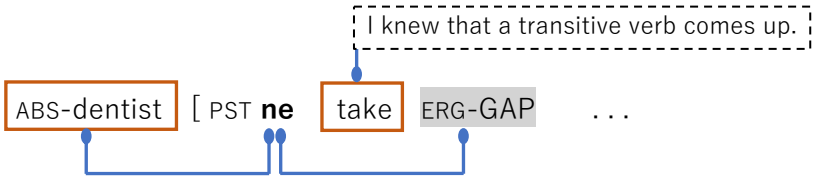
(52) In Abs.Subj condition, a similar filler-gap integration should occur at OBL-NP, but no obvious processing slowdown.



(53) The contrast between Erg.Subj and Abs.Subj conditions suggests that there is a subject-advantage and/or a preference for the linearly shorter dependency.

(54) An alternative explanation
#2 Slowdown in Region 7 = A spill-over effect from Region 6
In Erg.Subj and Abs.Obj conditions, a transitive verb appeared in Region 6, but what it tells the parser to do is quite different.

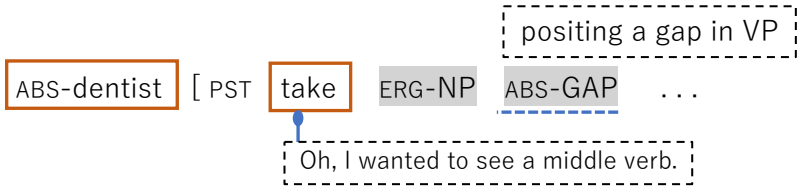
(55) **Erg.Subj condition** (**not much to do**)
- Given the RP in Region 5, a transitive verb was fully expected to show up in Region 6.
- The parser was happy to see it.



(56) **Abs.Obj condition** (**a lot of things to do**)
- The transitive verb triggers a detailed RC structure building.
- Projecting the Erg-Subject position.
- Gap creation in an object position.
- Possibly a prediction error for a middle verb from Region 5.

> This is reflected on the slowdown in Region 7.

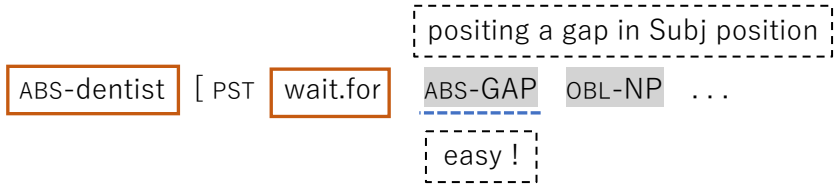
(57) A structure-building, triggered by the transitive verb.



(58) **What about Abs.Subj condition?**
- The middle verb triggers a detailed RC structure building.
- Gap creation in the Abs subject position.

> Why no major processing cost, then?

(59) A structure-building, triggered by the middle verb.



(60) The contrast between Abs.Obj and Abs.Subj conditions suggests there is a subject-advantage and/or a preference for the linearly shorter dependency (and/or a prediction for the middle verb).

(61) This could be due to the use of animate NP as the head noun (cf. Tanaka, et al. 2019, Tagalog).

Summary: 2 suggestions.

(62) **A. The RP triggers a detailed (and costly) structure building** (but, it reduces the processing cost at the verb and NP in RC). Erg.Subj RC is more costly than that with Abs.Subj RC.

- The Absolutive-advantage in Tongan RC is due to the processing cost of RP in Ergative extraction.

(63) **B. There is a subject advantage or a preference of the linearly shorter dependency**. Positing a gap in an Abs.Subj position was easier than positing an Abs gap in VP (in Abs.Obj condition).

- This could be due to the middle verb prediction.
- However, this “subject” advantage in Tongan RC is not strong enough to overturn the processing cost associated with RP (the Ergative extraction).

(64) Tongan children's SRC preference (Otaki, et al. 2020, BU)
Performance on Erg.Subj (wh-extraction) was no worse than that on Abs.Subj.
> more dependent on something like the "Agent-first" strategy, and ignoring the RP?

6. Conclusion

(65) We ran a self-paced reading experiment in Tongan, a V-initial language with syntactic ergativity.

(66) Abs.Subj condition was read very smoothly; Erg.Subj and Abs.Obj conditions showed some slowdown, but in different positions.

(67) The RP in Tongan was costly to read, leading to the major processing cost for the Erg.Subj extraction. The slowdown in Abs.Obj condition reflects the filler-gap integration cost.

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Appendix A. Ono, et al. AFLA26

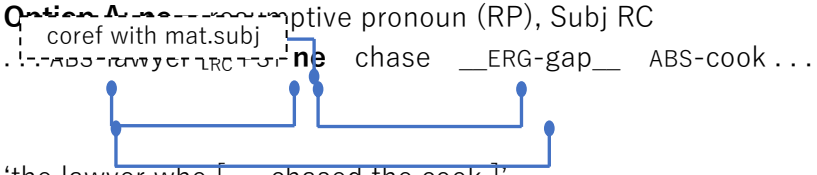
What we did

(68) We examined Erg-Subj extraction condition and Abs-Obj extraction condition.

(69) There was a slowdown in Erg-Subj condition, compared to its control condition. No comparable slowdown in Abs-Obj condition.

(70) The clitic **ne** ambiguity

Option A: **ne** = resumptive pronoun (RP), Subj RC



'the lawyer who [__ chased the cook]'

Option B: **ne** = subject pronoun, Obj RC

. . . ABS-lawyer [$_{RC}$ PST **ne** chase __ABS-gap__ . . .

'the lawyer who [she chased __]'

(71) Native speakers of Tongan preferred Option B, suggesting that they did not like the Erg-Sub extraction.
> **Abs-ORC preference ?!**

Discussion

(72) **Dependencies with the Erg-Subj** is costly.

(73) **An alternative account?**
#1 | There was a matrix subject, which is a singular. There may be a strong preference to take **ne** as a subject pronoun, over as a resumptive pronoun.

(74) **#2** | Could it be that the current observation is about Object-advantage, not absolutive-advantage?

Appendix B. Model summary, Comprehension accuracy

Three conditions were dummy-coded, with the Erg-Subj extraction condition taken as the baseline. In the following, "f1" stands for the factor estimating the effect of the Abs-Obj condition, and "f2" stands for the factor estimating the effect of the Abs-Subj condition, both compared against the Erg-Subj extraction condition.

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 C. 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	.

Appendix D. Verb length (Region 6)

Mean length of the transitive verbs was longer than that of the middle (intransitive) verbs in Region 6.

	mean # of syllables (SE)
Transitive	4.33 (0.25)
Middle	3.10 (0.35)

Welch's Two Sample t-test ($t(36) = 2.864$, $p < .01$)