Expectations for Novelty: Does Information Structure affect Syntactic Processing?

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What are we testing?

The observed complexity of different types of relative clause structures is often attributed to their syntactic structure (Gibson et al., 2013). However, it has been shown that syntactic explanations alone fail to make the right predictions (Gibson et al., 2005; Gordon et al., 2001). In the current study we investigate the influence of information structure on comprehenders' relative clause processing.

What has previous research found?

Gibson et al. (2005):

- Foregrounded information is more easily processed later in a sentence.
- Assumption:
  - non-restrictive relative clauses assign their content foregrounded status,
  - restrictive relative clauses assign their content backgrounded status
- Restrictive relative clauses were parsed slower sentence final than non-restrictive relative clauses.
  → object-modifying
- Sentence initial relative clauses were parsed faster overall
  → subject-modifying
- Results replicated by Santi et al. (2019).

however…

- No evidence that restrictive and non-restrictive relative clauses by their nature, assign different statuses to their content.

Hypotheses and research questions

We test four hypotheses, two of which make predictions based on syntactic explanations (i-ii, Gibson et al. 2013), and two which incorporate information structural constraints (iii, Gibson et al., 2005; iv, Diessel, 2001):

(i) Perspective shifts are harder to process
(ii) Longer-distance dependencies require more storage, causing processing difficulty
(iii) Information Flow Hypothesis: new information is processed more easily later in a sentence
(iv) Clause type mapping: new information is processed more easily in a matrix clause

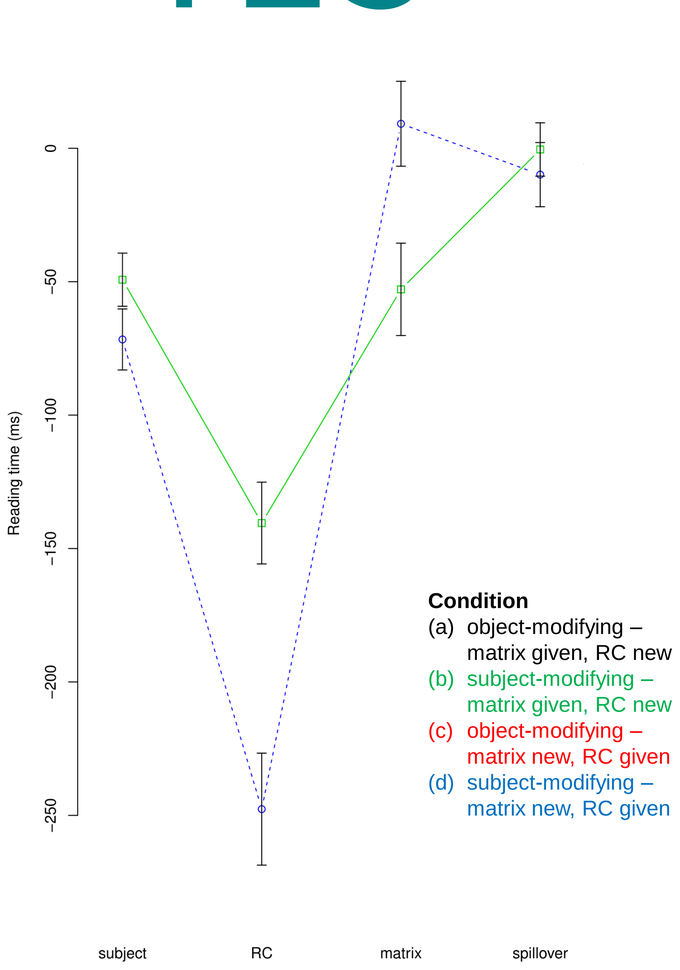
This leads to the following research questions:

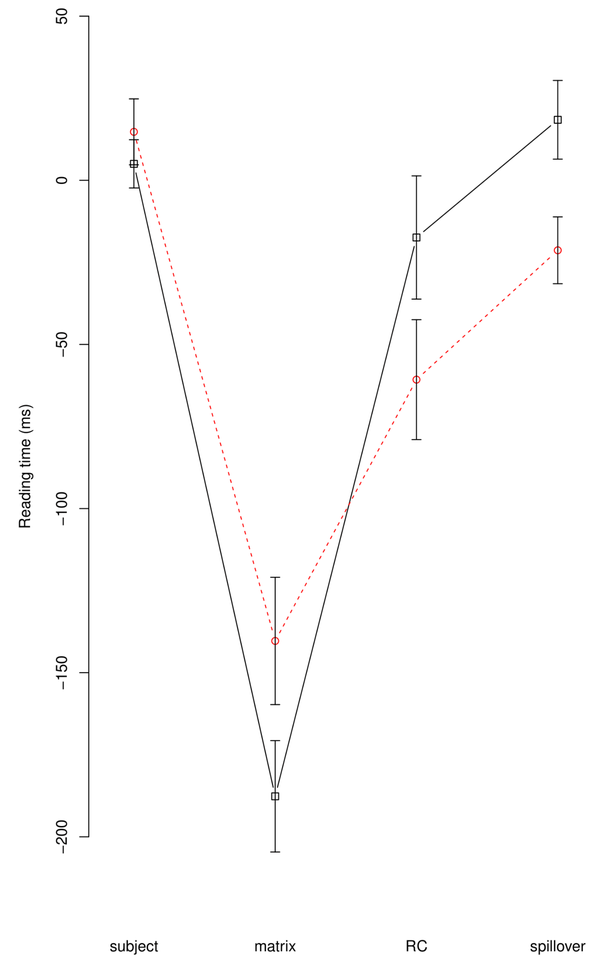
(i) Is new information better understood early or late in a sentence?
(ii) Is new information better understood in a matrix clause or a relative clause?
(iii) Are syntactic theories of relative clause processing better at predicting relative clause complexity than those that incorporate information structural constraints?

How are we testing this?

- Self-paced reading task in Ibex farm
- 32 items in four conditions (+short narratives)
  - each of which is predicted to be more/less difficult to process based on the abovementioned hypotheses
- 63 monolingual speakers of American English
- Crowdsourced via Amazon mechanical Turk.
- Analysis of residual reading times
  → Mixed effects model (lme4 package, Bates et al., 2014)

YES* – but (only) on clause level#





* Participants processed the matrix clause in subject-modifying relative clause constructions more quickly if it contained ***new*** information. They processed the relative clause in these constructions more quickly if it contained ***given*** information. Participants show the opposite tendency for object-modifying relative clause constructions: matrix clauses containing ***given*** information are processed more quickly, and relative clauses containing ***new*** information are processed more quickly.

How did we design our experiment?

Self-paced reading task: moving-window, sequence-by-sequence (chunks)

- max 120 characters per line (including spaces)
- max 15 characters difference between lines preceding the line containing the target region, and the line containing the target region
- chunks: 1-10 words (10 words being largest target region chunk – RC)
- at natural and unnatural breaks

Item design:

- short narratives relating to the first person and their family/friends (cohesion)
- no implicitly causal verbs (Ferstl et al., 2011)
- givenness:
  → subjects and objects always given by context for all conditions, and equally given across conditions
  → actions/events (verbs) marked for givenness, achieved by making these habitual in the preceding context
  → always only one clause containing a given event/action.

What is our design?

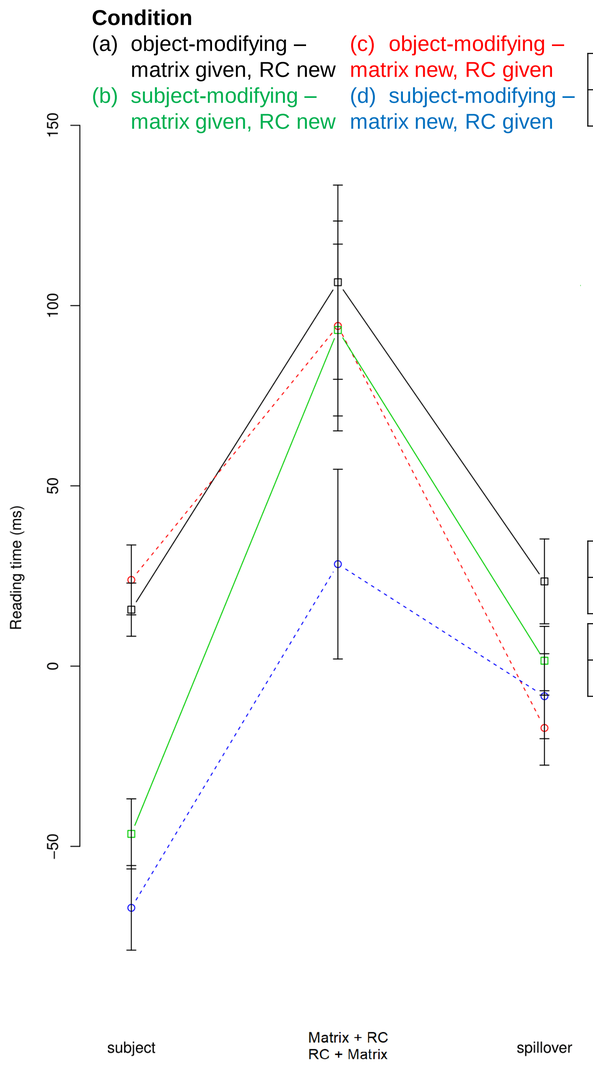
- Non-restrictive relative clause structures
- 2 x 2 design
- object-modifying & subject-modifying
- New information in the matrix clause & given information in the relative clause, or vice versa
  → information status manipulated by a short narrative preceding the relative clause structure

(a) object-modifying – matrix *given*, RC *new*
(b) subject-modifying – matrix *given*, RC *new*
(c) object-modifying – matrix *new*, RC *given*
(d) subject-modifying – matrix *new*, RC *given*

	(a)	(b)	(c)	(d)
perspective shifts	✗	✓	✗	✓
long-distance dependency	✓	✗	✓	✗
information structure (1) order: first given, then new	✓	✗	✗	✓
information structure (2) clause type mapping: RC given, matrix new	✗	✗	✓	✓

Intro	My aunt loves to be part of the rumor mill, and just like my mom, takes any opportunity to engage in the latest stories. Because of this, I always pay close attention to what I'm saying around her. At my birthday party,	My mom, like my aunt, is a big fan of drinking rum. She thinks she is really good at hiding it by adding some coke to it. Everybody knows what is actually in her glass of course. A few weeks ago, at my birthday party,
(a)	*my aunt was gossiping with my mom, **who was drinking rum & coke**.*	
(b)	*my aunt, **who was drinking rum & coke**, was gossiping with my mom.*	
(c)		*my aunt **was gossiping with my mom**, who was drinking rum & coke.*
(d)		*my aunt, who was drinking rum & coke, **was gossiping with my mom**.*
Wrap-up	As I walked by, I heard they were talking about me. My mom got startled and spilled her drink all over my aunt.	As I walked by, I heard they were talking about me. My mom got startled and spilled her drink all over my aunt.

#Full sentence analysis



- Reading times for the matrix and the relative clauses added up
- Considered as a single target region

matrix + RC – condition	(a)	(b)	(c)	(d)
raw reading time (mean)	2029	2077	2039	1973

- Mixed effects model
- Residual reading time depended on:
  - position of the relative clause (object-modifying / subject-modifying)
  - status of information in the relative clause (given / new)
- No significant effect for either

however…

- Reading times of matrix or relative clause in isolation compared between all conditions:
  → significant effect s for relative clause position & information status in both cases

RC – condition	(a)	(b)	(c)	(d)
raw reading time (mean)	1177	1049	1050	929

matrix – condition	(a)	(b)	(c)	(d)
raw reading time (mean)	851	1028	988	1044

- Replication of Gibson et al. (2005)'s results
- Potential issue in relative clause processing research?
  → significant differences found in processing of matrix and relative clauses, depending on their position and the status of the information they convey cancelled out once these clauses are considered together.
  → total processing demand of relative clause structures – while distributed differently across sentences – is not found to be different between conditions

References

Bates et al. (2014). Fitting linear mixed–effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48.
Diessel (2001). The Ordering Distribution of Main and Adverbial Clauses: A Typological Study. *Language, 77*(2), 433-455.
Ferstl et al. (2011). Implicit causality bias in English: a corpus of 300 words. *Behavioral Research Methods, 43*, 124–135.
Gibson et al. (2013). The processing complexity of English relative clauses. In M. Sanz, I. Laka, & M. K. Tanenhaus (Eds.), *Language Down the Garden Path* (pp. 149–173).
Gibson et al. (2005). Reading relative clauses in English. *Cognitive Linguistics, 16*(2), 313–353.
Gordon et al. (2001). Memory interference during language processing. *JEP:LMC*, *27*(6), 1411–1423.
Santi, A., Grillo, N., Molimpakis, E., & Wagner, M. (2019). Processing relative clauses across comprehension and production: similarities and differences. *Language, Cognition and Neuroscience*, *34*(2), 170–189.

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