LUND UNIVERSITY

An Eye Tracking Study of Swedish Filler-Gap Dependencies : Processing Relative Clause Extractions

Tutunjian, Damon; Heinat, Fredrik; Klingvall, Eva; Wiklund, Anna-Lena

2015

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
Tutunjian, D., Heinat, F., Klingvall, E., & Wiklund, A.-L. (2015). *An Eye Tracking Study of Swedish Filler-Gap Dependencies : Processing Relative Clause Extractions*. Poster session presented at Architectures and Mechanisms for Language Processing, University of Malta, Malta.

Total number of authors:
4

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

An eye-tracking study of Swedish filler-gap dependencies:
Processing relative clause extractions

Damon Tutunjian*, Fredrik Heinat**, Eva Klingvall*, and Anna-Lena Wiklund*
Lund University* and Linnaeus University**
damon.tutunjian@englund.lu.se, fredrik.heinat@lnu.se, eva.klingvall@englund.lu.se, anna-lena.wiklund@nordlund.lu.se

Introduction

Complex noun phrases involving relative clauses (1) are standardly treated as instances of "strong islands": structural configurations into which a filler-gap dependency (FGD) cannot be formed between the filler (*those kinds of flowers*) and the gap ([-]) (Ross, 1967; den Dikken & Szabolcsi, 2002). This constraint is widely assumed to be universal.

Unexpectedly, Swedish and the other Mainland Scandinavian languages allow relative clause extractions (RCEs) (2) (Engdahl & Ejerhed, 1982; Erteschik-Shir, 1973), thus presenting a challenge to the universality of island constraints.

(1) * Those kinds of flowers, I saw a man that sold [-].

(2) Såna blommor såg jag en man som sålde [-]. (Swedish)
Those kinds of flowers saw I a man that sold [-]

Existing accounts for the Swedish data

- Discourse-organizational factors (Ertechik-Shir & Lappin, 1979)
- Island obviation by way of covert resumption (Cinque, 1990)
- Structural reanalysis during parsing (Kush et al., 2013)

Unfortunately, none of these accounts stands up under closer scrutiny (see Christensen & Nyvad, 2014; Engdahl, 1997; Heinat & Wiklund, 2015; Lindahl, 2015; Müller, 2015). Thus, what drives the apparent felicity of Swedish RCEs remains undetermined.

Approaching the question via processing

- No on-line processing data exists for Swedish.
- Not clear whether processing patterns track intuitive well-formedness.

First step:
- look for basic differences in processing between Swedish RCEs and other FGDs at the embedded verb (tvättade) and the following PP region (på bensinmacken) (see examples 3-6) where integration is presumed to occur, while controlling for the possible influence of non-structural factors (e.g., working memory), which might affect the processing of FGDs.

Second step:
- Two studies suggest that in acceptability judgments and in online processing, only non-islands should show any modulating effects from plausibility and working memory on any primary manipulation.
  - Sprouse et al. (2012) found no evidence that acceptability-based island-effects show any modulation from individual differences in general processing resource capacity, as measured via two Working Memory Span (WM) tasks and grammaticality judgement data (cf. Hofmeister & Sag, 2010).
  - Traxler and Pickering (1996) demonstrated via eyetracking that manipulations to the plausibility of a filler$_A$ as a continuation of a verb only affected integration for non-island structures, with no differences being found for island structures.

If correct, the presence of an interaction between structural and non-structural factors on Swedish RCEs could then serve as a positive heuristic for non-island status. This would help to confirm that processing of such structures is in-line with their intuitive acceptability.

Research goals and predictions

Use eyetracking to test whether:
•Swedish RCEs elicit processing costs similar to licit or illicit long-distance FGDs at the embedded verb (tvättade) and the following PP region (på bensinmacken).

•Any basic structural differences are modulated by non-structural factors (frequency, pragmatic fit, and working memory).

Possible outcomes:
•Swedish RCEs will pattern more like non-islands, in line with their intuitive acceptability. Such a finding would leave us with at least two possible interpretations:
- Swedish RCEs do not involve island structures, and thus a structural account is still needed.
- True variation exists in island constraints

•Swedish RCEs, although intuitively acceptable will pattern more like island structures. Such a finding would disfavor ”deep variation” in the island constraints themselves (see Phillips 2013).

Eyetracking while reading experiment

Method

Eyetracking While Reading (Eyelink 1000 tower mount)

Reverse Digit Span (DS) (adapted into Swedish from MacWhinney et al., 2001). Participants hear a series of digits (3-infinite set size) and then enter them on a computer keyboard in reverse.

Automated O-span task (OS) (adapted into Swedish from Unsworth, et al., 2005). Mouse-driven recall task. Participants complete three interleaved sets: math operation and letter recall, each set size (3-7 count). Total of 75 letters and 75 math problems.

Participants
48 native Swedish speakers

Materials
Eighty long-distance FGD sentence items (constructed using the Korp corpus), each appearing in four structural variants (Structure) (3-6) and sixty distractor items rotated over four lists.

Region 1 (verb) Region 2 (PP)

(3) That-clause extraction (TCE) (non-island)
Såna där gamla skottkärror såg jag att en man alltid tvättade [-] på bensinmacken när...
such old wheelbarrows saw I that a man always washed [-] at gas-station-the when...

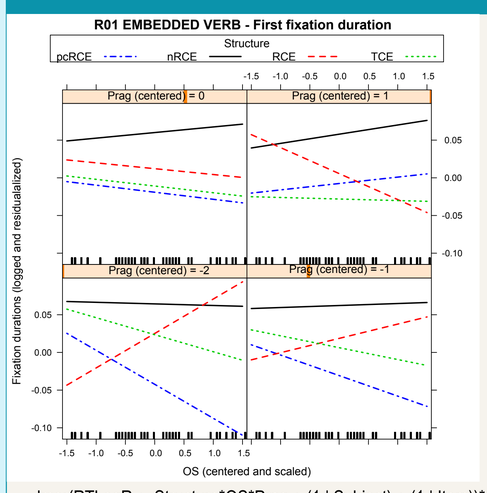
(4) Restrictive relative clause extraction (RCE) (?-island)
Såna där gamla skottkärror såg jag en man som alltid tvättade [-] på bensinmacken när...
such old wheelbarrows saw I a man that always washed [-] at gas-station-the when...

(5) Non-restrictive relative clause extraction (nRCE) (island)
Såna där gamla skottkärror såg jag en man som förresten tvättade [-] på bensinmacken när...
such old wheelbarrows saw I a man that by-the-way washed [-] at gas-station-the when...

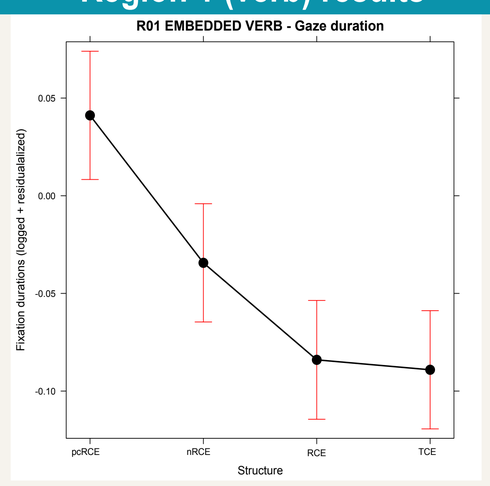
(6) Pseudo-coordinated relative clause extraction (pcRCE) (?-island with intransitive light verb as a control)
Såna där gamla skottkärror såg jag en man som alltid stod och tvättade [-] på bensinmacken när...
such old wheelbarrows saw I a man that always stood and washed [-] at gas-station-the when...

Analysis
Linear mixed models (Bates et al., 2014) to analyze log residualized fixations durations in two regions (verb and PP) for four eyetracking measures: First Fixation Duration, Gaze Duration, Regression Path Duration (note: this measure did not produce interpretable results), and Total Duration, as well as four non-structural predictors: Transitional probability of embedded verb and filler (Freq); Pragmatic coherence/contextual fit rating for non-extracted versions of each sentence (7-point scale; 24 participants) (Prag); O-span (OS); and Reverse digit span (DS)

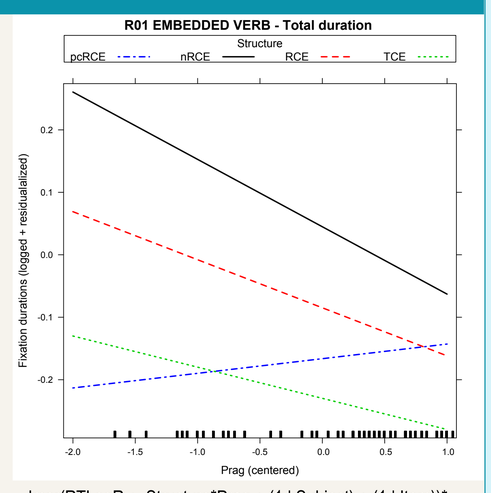
Region 1 (verb) results



lmer(RTLogR ~ Structure*OS*Prag + (1 | Subject) + (1 | Item))*
- pcRCE + RCE + TCE < nRCE (p<.001)
- RCE's slope < pcRCE as OS and Prag increase (p<.05)

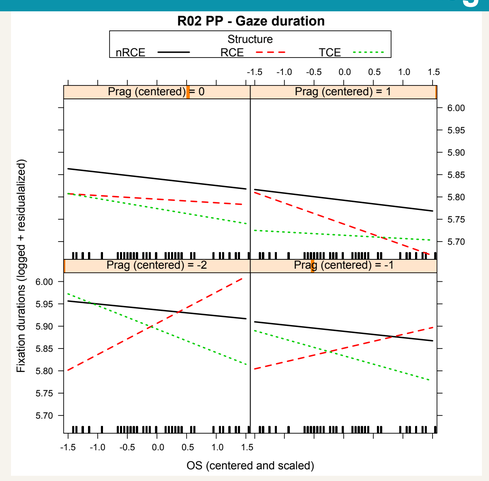


lmer(RTLogR ~ Structure + OS*Prag + (1 | Subject) + (1 | Item))*
- nRCE + RCE + TCE < pcRCE (p<.001)
- RCE +TCE < nRCE (p<.05) + (p<.01)

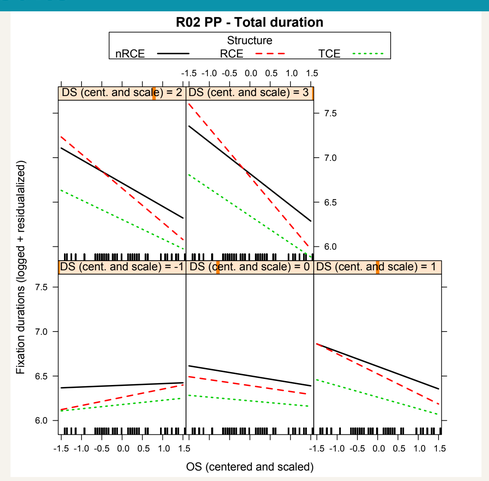


lmer(RTLogR ~ Structure*Prag + (1 | Subject) + (1 | Item))*
- TCE < RCE < nRCE (p<.001)
- RCE's + TCE's + nRCE's slope < pcRCE as Prag increases (p<.05)

Region 2 (PP) results



lmer(RTLog ~ Structure*OS*Prag + (1 | Subject) + (1 | Item))TCE < nRCE (p < .05)*
- RCE's slope < TCE as OS and Prag increase (p < .05)



lmer(RTLog ~ Structure*OS*Prag + Structure*OS*DS + (1 + Structure | Subject) + (1 + Structure | Item))*
- RCE + TCE < nRCE (p < .001)
- RCE's slope < TCE as DS and OS increase (p < .05)

*Note: model specifications represent the final converging model minus predictors that did not improve model fit.

Conclusions

Early measures:
- RCE and TCE show similar facilitation relative to nRCE in early measures (First Fixation and Gaze Duration) at the verb (Region 1). This similarity was also present in one early measure (Gaze Duration) at the PP (Region 2). In Region 1, RCE also showed additional facilitation against the pcRCE control as OS and Prag increased.
- Interpretation: RCEs are processed more similarly to TCEs and are modulated by non-structural factors. They thus exhibit non-island like behavior during the first stages of filler-gap integration.

Late measures:
- For both late measures of processing in Region 1, and for Total Durations in Region 2, RCEs were processed with more ease than nRCEs, patterning more similarly to TCEs as both OS and Prag increased. In Region 1 Total Durations, nRCE also showed some facilitation against the pcRCE control as Prag increased, but this could just be reflective of a late repair mechanism.
- Interpretation: Swedish RCEs are processed more similarly to non-island TCEs during late stages of integration.

Summary:
- RCEs appear to be easier to process than nRCEs. Facilitation is dependent in part on non-structural factors (working memory span and pragmatic fit).
- Our study thus provides novel evidence that Swedish RCEs are not processed like syntactic islands, in line with offline intuitions.

References

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). *lme4: Linear mixed effects models using Eigen and S4*. R package version 1.1-7.
Christensen, K. R., & Nyvad, A. M. (2014). On the nature of escapable relative islands. *Nordic Journal of Linguistics*, *37*(01), 29-45.
Cinque, G. (1990). *Types of Ā-dependencies*. MIT press.
den Dikken, M. & Szabolcsi, A. (2002). Islands. In L. Cheng & R. Sybesma (Eds), *The Second Glot International State-of-the-Article Book* (pp.213–240). Mouton de Gruyter, Berlin.
Engdahl, E. (1997). Relative clause extractions in context. *Working Papers in Scandinavian Syntax* , 60:51–79.
Engdahl, E. & Ejerhed, E., editors (1982). *Readings on unbounded dependencies in Scandinavian languages*, volume 43 of *Acta Universitatis Umensis*. Universitetet i Umeå, distibuted by Almqvist & Wiksell International, Stockholm.
Erteschik-Shir, N. & Lappin, S. (1979). Dominance and the functional explanation of island phenomena. Theoretical linguistics 6:41–86.
Erteschik-Shir, N. (1973). *On the nature of island constraints*. PhD thesis, MIT, Cambridge, Mass.
Heinat, F. & Wiklund, A.L. (2015). Scandinavian Relative Clause Extractions: Apparent restrictions. *Working Papers in Scandinavian Syntax*, 94:36-50
Hofmeister, P. & Sag, I. A. (2010). Cognitive constraints and island effects. *Language*, 86(2):366–415.
Kush, D., Omaki, A., & Hornstein, N. (2013). Microvariation in islands? In J. Sprouse & N. Hornstein (Eds.), *Experimental Syntax and Island Effects* (pp. 239–264). Cambridge University Press, Cambridge.
MacWhinney, B., James, J. S., Schunn, C., Li, P., & Schneider, W. (2001). Step—a system for teaching experimental psychology using e-prime. *Behavior Research Methods, Instruments, & Computers*, 33(2):287–296.
Lindahl, F. (2015, March). Swedish relative clauses as weak island. In LSA Annual Meeting Extended Abstracts.
Müller, C. (2015). Against the Small Clause Hypothesis: Evidence from Swedish relative clause extractions. Nordic Journal of Linguistics , 38(1):67–93.
Phillips, C. (2013a). On the nature of island constraints II: Language learning and innateness. In J. Sprouse & N. Hornstein (Eds.), *Experimental Syntax and Island effects* (pp. 132–59). Cambridge University Press, Cambridge.
Ross, J. R. (1967). *Constraints on variables in syntax*. PhD thesis, MIT, Cambridge, Mass. [published as 'Infinite syntax'. 1986].
Sprouse, J., Wagers, M., & Phillips, C. (2012a). A test of the relation between working-memory capacity and syntactic island effects. *Language*, 88(1):82–123.
Traxler, M. J. & Pickering, M. J. (1996). Plausibility and the processing of unbounded dependencies: An eye-tracking study. *Journal of Memory and Language*, 35(3): 454–475.
Unsworth, N., Heitz, R. P., Schrock, J. C., &Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods*, 37(3):498–505.

Acknowledgements

This research was conducted at the Lund University Humanities Lab and was funded by a grant from the Crafoord Foundation and the Bank of Sweden Tercentenary Foundation. We thank Joost van de Weijer for his assistance with our statistical analysis