Language comprehension, argument interpretation and event-related potentials

Grammatical function reanalysis

- Language comprehension proceeds incrementally and comprehenders commit to initial interpretations even when the information at hand is ambiguous (e.g., Crocker 1994; Hawkins 2007).
- Processes of reanalysis occur when an initial interpretation of a locally ambiguous structure is disambiguated towards a (dispreferred) interpretation.
- There is a general subject-first preference in language comprehension: initial ambiguous argument NPs are preferably interpreted as subjects (e.g., Lee 2004; Demiral et al. 2018).
- Grammatical function reanalysis involves a revision of an initial subject-first interpretation towards an object-first interpretation (Haupt et al. 2000).

At which level of representation does the revision process occur?

Structural accounts

Grammatical function reanalysis involves a revision of the syntactic structure of the sentence and is functionally equivalent to traditional syntactic reanalyses (e.g., de Vincenzo 1999; Fräder & Fossén 1989).

The extended Argument Dependency Model

Grammatical function reanalysis involves a remapping of thematic roles to argument NPs - no structural revision is required (Bornkessel & Schlessewsky 2006; Bornkessel-Schlessewsky & Schlessewsky 2008, 2009a, 2009b).

Study questions

- Does grammatical function reanalysis occur during reading of Swedish, object-topicalized sentences?
- If so, which neurophysiological ERP response correlates with the reanalysis?
- Is this effect dependent on the sentence structure?
- How does the reanalysis process vary across participants?

Condition | Example sentence |
--- | --- |
SPro-V-OPro | psuS SS luger | på munnen |
OPro-SPro | psuS SS luger | på munnen |
SPro-V-OLex | psuS SS luger | på munnen |
OPro-SLex | psuS SS luger | på munnen |
SPro-V-SLex | psuS SS luger | på munnen |
OPro-V-SLex | psuS SS luger | på munnen |

Sentence materials

- 2*40 stimulus set with present or past tense sentences counterbalanced across two stimulus lists
- 6 blocks of 40 sentences, with even distribution of condition, stimulus set and grammatical category (tense and number) across blocks. Pseudo-randomized within-block order. Block order counterbalanced across participants (latin-square design)
- Visual, word-by-word sentence presentation: 400 ms per word with a 100 ms ISI, followed by a sentence comprehension task

Predictions

- Disambiguation towards object-initial interpretation at Argument 2 in OLex-V-SPro should engender ERP response associated with grammatical function reanalysis in earlier studies: structural accounts predict P600 component - eADM account predicts N400 component - Reanalysis effect in OLex-V-SPro should be in comparison to: - OPro-V-SPro: no difference between the pronoun forms of Argument 2 - SLex-V-OPro: no difference between the word class of Argument 1

Lexical arguments should elicit an N400 effect in comparison to corresponding pronoun arguments (e.g., Münte et al. 2001, Neville et al. 1992 and Roit et al. 2007).

Participants

- 32 native Swedish speakers (11 male, mean age of 25), mostly linguistics students
- Data from 8 participants excluded from final analysis due to excessive EEG artifacts

EEG recordings and analysis

- Recording was performed using a high-impedance 128 electrode HydroCel Sensor Net (Electrical Geodesics, Inc.)
- Initial analysis: Single subject ERPs were calculated relative to the onset of Argument 1 and 2 (1000 ms time window) on the basis of artifact-free single trial epochs
- Statistical analyses: conducted on mean amplitudes in selected time windows of the ERPs across and within 8 regions of interest (ROIs): Left Anterior Inferior, Left Anterior Superior, Midline Anterior, Right Anterior Superior, Right Anterior Inferior, Left Posterior Inferior, Left Posterior Superior, Right Posterior Superior and Right Posterior Inferior.
- Bonferroni-corrected follow-up analyses by comparing individual conditions and/or groups of conditions within ROIs

The present study

Results and discussion

Grammatical function reanalysis ERP correlate

*"Reanalysis N400" effect* engendered by Argument 2 in OLex-V-SPro
- Negativity in the 375-550 ms time window with a local, right-parietal scalp distribution
- Significant difference between OLex-V-SPro, SLex-V-OPro and OPro-V-SPro across Right Posterior ROI: F(2, 50) = 3.69, p < .05
- Occurs in comparison to both OPro-V-SPro (see panel A) and SLex-V-OPro (see panel B)
- Significant contrast difference between OLex-V-SPro and OPro-V-SPro, t(25) = 2.04, p < .05, on the one hand, and SLex-V-SPro and OLex-V-OPro, t(25) = 1.85, p < .05, on the other
- No differences between non-critical conditions with pronominal second arguments observed
- No significant difference between SPro-V-OPro, OPro-V-SPro and SLex-V-OPro, F(2, 50) = 0.25, p > .05
- The fact that grammatical function reanalysis engender a "reanalysis N400" effect rather than a P600 indicates that the reanalysis process involves a remapping of thematic roles to argument NPs rather than a phrase structure revision.
- The "reanalysis N400" can be generalized to written language comprehension of a language in which the grammatical functions of arguments primarily are determined on the basis of word order.

Lexical vs. pronominal argument ERP correlates

*"Lexical N400" effect* elicited by nouns in comparison to corresponding pronouns
- Negativity in the 300-475 ms time window with a right-parietal scalp distribution for Argument 1 and a centro-parietal distribution for Argument 2
- Argument 1: significant effects in the Left and Right Superior ROI:s, all ps < .05
- Argument 2: significant effects in the Left and Right Inferior ROI:s, all ps < .05
- This effect is in line with earlier studies (Münte et al. 2001, Neville et al. 1992 and Roit et al. 2007) and reflects the greater "semantic content" and increased semantic integration costs of open class words in comparison to closed class words.

Frontal dipolar effect

elicited by nouns in comparison to corresponding pronouns
- Long-latency positivity in Left Anterior ROI:s mirrored by a negativity in the Right Anterior ROI:s with a broader scalp distribution for Argument 1 than for Argument 2
- Argument 1: significant effects in Left Anterior and Right Anterior ROI:s, all ps < .05
- Argument 2: significant effects in the Left and Right Inferior ROI:s only, all ps < .05
- This effect was unexpected but could stem from increased electro-ocular activity during the reading of nouns in comparison to pronouns due to a general word class length difference

Correlations between word length and 200-600 ms mean amplitudes of electrodes F9 (left lateral), R8(8) = .22, p < .05 and F10 (right lateral), R8(8) = .35, p < .005

Scalp Map

The ERP response to grammatical function reanalysis in German

Critical stimuli: locally ambiguous verb-final complement clauses:
- Er wuβte daß die Professorinnen die Studentin gesehen haben/hat
- He knew that the Nominative/Accessorial professors, the Nominative/Accessorial students seen have/had

The extended Argument Dependency Model

Grammatical function reanalysis involves a remapping of thematic roles to argument NPs - no structural revision is required (Bornkessel & Schlessewsky 2006; Bornkessel-Schlessewsky & Schlessewsky 2008, 2009a, 2009b).

The neurophysiological correlate to grammatical function reanalysis in Swedish

Thomas Hörberg

the neuropsychological correlate to grammatical function reanalysis in Swedish

EEG recordings and analysis

- Recording was performed using a high-impedance 128 electrode HydroCel Sensor Net (Electrical Geodesics, Inc.)
- Initial analysis: Single subject ERPs were calculated relative to the onset of Argument 1 and 2 (1000 ms time window) on the basis of artifact-free single trial epochs
- Statistical analyses: conducted on mean amplitudes in selected time windows of the ERPs across and within 8 regions of interest (ROIs): Left Anterior Inferior, Left Anterior Superior, Midline Anterior, Right Anterior Superior, Right Anterior Inferior, Left Posterior Inferior, Left Posterior Superior, Right Posterior Superior and Right Posterior Inferior.
- Bonferroni-corrected follow-up analyses by comparing individual conditions and/or groups of conditions within ROIs

Scalp Map


