Inanimacy as a predictive cue to derived subjects: Evidence from the development of the “semantic” P600

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1. Introduction & Background

Main Questions
- What information does the parser use to predict upcoming structure?
- Do children use this information the same way adults do?

Current Study
- Investigate a structural prediction mechanism with subject animacy as the relevant cue in adults and children.

Background
- Incrementality and temporary ambiguity: Sentential subjects are initially ambiguous between agent and theme interpretations.
- Animacy affects production and comprehension of derived subjects (Ferreira, 1994, 2000).
- Inanimate subjects must be derived because they are incompatible with agent interpretation.
- Theme interpretation is compatible with animate or inanimate subjects (Dowty, 1991).

Development of Animacy Cues
- The use of animacy appears to be later developing (Drenhaus & Frey, 2008; MacWhinney, Bates, & Kliegl, 1984).

- Children may have to rely on a default agent-first strategy which assigns agent interpretations to subjects (Townsend & Bever, 2001).

2. Methods

Materials
- 2 (animacy) x 2 (voice) design; 24 items (86 stimuli total).
- Content words matched for frequency across age groups.

Apparatus and Recording
- Continuous EEG: 64-channel QuikCap; Cz reference; sampled at 500 Hz; 100 Hz corner frequency, low-pass filtered online; Neuroscan SCAN software, SynAmps2 amplifiers.

ERP Analysis
- Data were low-pass filtered offline at 30 Hz and epoched into 1000 msec windows (-100–900 ms), time-locked to the onset of the verbs in each condition. Ocular artifact removed (Dien, 2005) and bad channels corrected using spherical spline interpolation (Lou & Fere, 2000).
- Each condition and each group averaged separately, rereferenced to linked mastoids, and baseline-corrected -100–0 ms.

Data Visualization
- Spatial maps plot the standard factor loading of the spatial PCA.
- Virtual ERP waves plot the grand average factor scores over time by condition.

3. Initial Study

Initial Question
- Do children show neurophysiological evidence for thematic reanalysis similar to adults?

Overall Acceptability
- Adults: 81% Children: 74%

Replication with Adults
- Thematic violations elicit a P600 on the verb.
  - v1 vs. 3 (T882, t16=3.912, p<.001).
  - v3 vs. 4 (T872, t16=4.588, p<.001).

Different Result for Children
- Thematic violations elicit an N400 on the verb.
  - v1 vs. 3 (T414, t16=2.198, p=.043).
  - v3 vs. 4 (not significant, all p>.05).

Discussion
- Adults use cues to thematic relations between subject and verb.
- Children are unable to use these cues. Why?
  - Lack of cue access.
  - Lack of cue implementation.

4. Results for Adults

Results
- 3 vs. 4: P600 (T872, t16=4.588, p<.001).
- 1 vs. 2: N400 (T934, t16=4.669, p<.001).

Discussion
- Inanimate subjects lead to a derived subject prediction (Step 2).
- No reanalysis, no P600 (Step 3).

5. Results for Children

Results
- 1 vs. 2: N400 (T416, t16=2.043, p=.05).
- 3 vs. 4 (not significant, all p>.05).

Discussion
- Animacy is not used to make structural predications (No Step 2).
- N400 may reflect increased processing to integrate event meaning of the passive.

6. General Discussion & Conclusion

The Mechanism underlying “Semantic” P600

- Kim & Osterhout (2005) propose that semantic P600s reflect conflict in subject-verb thematic relationships.
- We argue for a more precise implementation:
  - Semantic cues may predict particular upcoming structures.
  - Animacy predicts a derived subject structure because inanimate subjects are not compatible with agent interpretations.
  - “Semantic” P600s actually reflect reanalysis of a structural prediction triggered by animacy.

Development of the Mechanism
- The relationship between semantic cues and structure develops over time.
- Why so late? Perhaps exposure to more complex sentences requires more efficient processing mechanisms.
- Understanding this developmental profile will require better differentiation of access, prediction, integration, and reanalysis mechanisms during language comprehension.
- This will also contribute to better understanding of language development disorders.

Selected References


- 6 blocks of 16 sentences, pseudo-random order presentation.
- Sentences were presented word-by-word using rapid series visual presentation. 700 msec per word (650 msec + 50 msec blank screen).
- All sentences were followed by a probe question: “Is this a good/strict/special case?”
- 3 vs. 4 (not significant, all p>.05).

- Lack of cue access, prediction, integration, and reanalysis mechanisms during language development.
- This reanalysis process is reflected in the N400.

- Subject averaged ERP variance was analyzed using a two-step, spatial-temporal principal component analysis.
- Spatial maps plot the standard factor loading of the spatial PCA.
- Virtual ERP waves plot the grand average factor scores over time by condition.

- Data Visualization
- Subject averaged ERP variance was analyzed using a two-step, spatial-temporal principal component analysis.
- Step 1. Parse subject and recognize animacy.
- Step 2. If animate, predict verb and derived subject; otherwise, predict verb.
- Step 3. Parse verb, check morphology against predicted structure.
- We hypothesize that children have difficulty with Step 2.

- Inanimacy predicts a derived subject structure because inanimate subjects are not compatible with agent interpretations.
- This process is reflected in the N400.