ERP studies of visual and auditory processing of negated sentences

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2019

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

Link to publication

Citation for published version (APA):

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Previous research shows that negation is ignored in initial processing and the event-related potential (ERP) component N400 is insensitive to negation in the presence of semantic priming effects [2-3, 5]. But other evidence has shown that negation can be readily integrated and incongruities in negated sentences can elicit an N400 [6]. Most of this research has focused on negated forms such as not, no or any while little is known about prefixed negated words (e.g. unauthorised, unintentional) despite their high frequency of occurrence in language use [7].

### Aim and research questions

- Two ERP experiments in visual and auditory modalities to investigate affirmitives (authorized), negation (unauthorized) and sentential negation (not authorized) in sentential contexts such as example (1):  
  
  1) The White House announced that the new Obama biography was  
  
  authorized/unauthorized/not authorized and the details in the book were correct/wrong in  
  
  fact.

- EPs time-locked to the critical word (underlined), the concrevity of which was  
  
  determined by the adjective (bold) in the first part of the sentence. We asked the  
  
  following questions:

  **Visual study:**
  - Is there a delay in the integration of negated meanings?
  - Is prefual negation processed similar to the negated form or the affirmative form?

  **Auditory study:**
  - Is auditory presentation of sentences more natural and easier than visual processing?

### Results

**Summary of findings**

**Visual:**
- **Affirmative:** N400-P600: successful detection of incongruities (N400) followed by re-evaluation of content to repair meaning (P600)
- **Sentential negation:** no N400, but a negativity with a longer latency than the typical N400: negation not entirely ignored in processing but negated meaning not fully present in memory either
- **Prefual negation:** sustained anterior negativity: negated meaning needed to be retrieved from working memory, which was taxing

**Auditory:**
- **Affirmative:** N400-P600
- **Sentential negation:** no N400 but a P600: re-evaluation of content
- **Prefual negation:** late positivity (P600): re-evaluation of content

**Conclusions**

- Negated sentences were not ignored in early processing [unlike 2-3, 5], nor were they  
  
  processed the same way as affirmative sentences [unlike 6].
- We found evidence for a more nuanced processing of negation suggesting that  
  
  incongruities in negated sentences involved different processing mechanisms than  
  
  those in affirmative sentences.
- Prefual negation was the most difficult form to process in both studies, hence was  
  
  not likely to be processed the same way as affirmative forms.
- Auditory processing of negated sentences was easier (clearer ERP effects) than word-  
  
  by-word visual processing.

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### Material

- 3 pseudo-randomized lists each including 108 (visual) and 102 (auditory) items

### Procedure

**Visual**
- Test display: 200 words (205 ms each)
- Presentation of word and its meaning (300 ms), plus fixation cross (100 ms)
- Sentence context then word to be rated (100 ms)
- Sentence context, word, and fixation cross (2000 ms)

**Auditory**
- 11-msec words at 500 Hz, presented through supra-aural earphones
- Presentation of word and its meaning (300 ms), plus fixation cross (100 ms)
- Sentence context then word to be rated (100 ms)
- Sentence context, word, and fixation cross (2000 ms)

### EEG recording and processing

- Offline referenced to average of both mastoids
- ERPs of 0.01 and 40 Hz
- ICA for removing eye artefacts
- Epochs of 1000 ms (plus 100 ms baseline)
- Amplitudes for congruent and incongruent conditions analyzed for each negation type and each  
  
  time-window separately

## References


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**Method**

**Participants**
- 26 native speakers of English (18 F, mean age=29.0)

**Presentation**
- Counter-balanced, 9 and 11 ms before the critical words

**Auditory**
- Native word (300 ms), plus fixation cross (100 ms)
- Presentation of word and its meaning (300 ms), plus fixation cross (100 ms)

**Material**

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**Open questions**

- Prefual negation more difficult than sentential negation. Why? Unnatural use?
- Early positivity for prefual negation in auditory study?
- ERPs in auditory studies later than those in visual study, unlike previous research?
- Pre-N400 negativity in auditory study (affirmatives), an N250 [1,4,7]?