ERP effects for quantifier complexity, priming, and truth-value in an auditory/visual verification task

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Objectives

We examined the processing of quantified sentences in an auditory/visual verification task to probe:

i. truth-value/quantifier-type influences on the N400 ERP response

ii. ERP markers of quantifier complexity.

Introduction

Concerning (i):

- N400 is insensitive to truth-value/negation in verification paradigms (Fischler et al. 1983; Kounios & Holcomb 1992)
- N400 modulated by subject/predicate relatedness (e.g., ROCK>BIRD in *A robin IS/IS-NOT a ROCK/BIRD*)
- **BUT**: when controlling for pragmatically unnatural uses of negation, N400 amplitude can be modulated by truth-value (False>True, Nieuwland & Kuperberg 2008).

Concerning (ii):

- additional working memory resources are recruited in the processing of proportional quantifiers (MOST > ALL/NONE/SOME, McMillan et al. 2005);
- the time-course of complexity effects has not previously been investigated using ERPs.

Methods

We presented quantified sentences auditorily while participants simultaneously viewed arrays of colored shapes. Shape/color-combinations were constructed to yield 8 conditions varying quantifier/truth-value- Visual stimuli each consisted of:

- 14 colored shapes
- even contrast ratio for ALL/NONE (7 yellow-circles/7 blue-squares)
- opposing $2:5/5:2$ ratios for MOST/SOME (e.g., 2 yellow-/5 blue-circles and 5 blue-/2 yellow-squares)
- False conditions used color/shape-predicates which were not present in the images (unprimed).

We tested adult/native English-speakers (N=10) who provided (mis)match judgments following each trial. EEG was recorded continuously (32 channels, Biosemi-Active-2) and ERP mean amplitudes for successive 100 ms windows were examined for 1200 ms epochs (-200-0 ms baseline). Signals were time-locked to (i) the predicate onset to examine quantifier-type influences on truth-value and (ii) the onset of the quantifier to test for complexity effects.

Materials

The following materials were required to complete the research:

- Curabitur pellentesque dignissim
- Eu facilisis est tempus quis
- Duis porta consequat lorem
- Eu facilisis est tempus quis

The materials were prepared according to the steps outlined below:

1. Curabitur pellentesque dignissim
2. Eu facilisis est tempus quis
3. Duis porta consequat lorem
4. Curabitur pellentesque dignissim

Important Result

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Mathematical Section

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$$E = mc^2 \tag{1}$$

Nam quis odio enim, in molestie libero. Vivamus cursus mi at nulla elementum sollicitudin. Nam quis odio enim, in molestie libero. Vivamus cursus mi at nulla elementum sollicitudin.

$$\cos^3\theta = \frac{1}{4}\cos\theta + \frac{3}{4}\cos 3\theta \tag{2}$$

Nam quis odio enim, in molestie libero. Vivamus cursus mi at nulla elementum sollicitudin. Nam quis odio enim, in molestie libero. Vivamus cursus mi at nulla elementum sollicitudin.

$$\kappa = \frac{\xi}{E_{\max}} \tag{3}$$

Methods

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Results

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Figure 1: Figure caption

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Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 1: Table caption

Results

Predicates showed opposite polarity N400 effects for ALL (False>True) relative to NONE (True>False), an earlier negativity for ALL (False>True) peaking 200 ms, and subsequent P600s (False>True) for both ALL/NONE. MOST/SOME yielded a N400/P600 profile (False>True) and an early negativity (False>True; 200 ms) obtained for SOME (but not MOST). Finally, N400 effects were larger for ALL/NONE than MOST/SOME conditions, while the opposite was true for the P600s (larger for MOST/SOME). ERPs time-locked to the onset of the quantifiers revealed a positivity for MOST relative to the three other quantifiers, beginning 350-450 ms and sustaining for 500 ms.

Discussion

In pragmatically natural contexts:

- N400s were driven by priming of the expected auditory continuation
- N400s were not modulated by truth-value, consistent with earlier findings (Fischler et al.).
- **BUT** consistent **False>True** effects were obtained for the subsequent P600 response
- Early positivity for MOST > ALL/NONE/SOME is consistent with complexity effects for MOST reflecting initial encoding and not verification load.

Conclusion

References

Acknowledgements

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