

The Consequences Of The Temporal Interaction Between Syntactic And Semantic Processes For Haemodynamic Studies Of Language

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Electrophysiological (ERP) research on language has found at least two distinct ERP effects related to sentence processing. One is the N400-effect. It reflects the ease of semantic integration of a lexical item in its sentence context. A qualitatively different effect is the Syntactic Positive Shift (SPS), also known as the P600. The SPS is elicited by syntactic violations. In this study we used the qualitative difference between these two ERP effects to address the following questions: (a) How do semantic and syntactic processes interact during on-line language processing; (b) What is the time frame of the interaction between semantic and syntactic processes?

Experiment

Subjects were presented with sentences containing (i) a syntactic violation, (ii) a semantic violation, or (iii) a combined syntactic and semantic violation. The syntactic violation concerned the grammatical gender agreement between the article and the noun in Dutch (i.e., wrong gender). The semantic violation concerned the pragmatic implausibility of adjective-noun combinations. This resulted in the following four conditions:

Correct: "De kapotte paraplu staat in de garage." ("The broken umbrella is in the garage.")

Syntactic Violation: "Het kapotte paraplu staat in de garage." ("The ^(wrong gender) broken umbrella is in the garage.")

Semantic Violation: "De eerlijke paraplu staat in de garage." ("The honest umbrella is in the garage.")

Combined Violation: "Het eerlijke paraplu staat in de garage." ("The ^(wrong gender) honest umbrella is in the garage.")

Sentences were presented word-by-word on a computer screen. The SOA between the words was 600 ms.

Results

N400: Significant N400 effects were obtained on the noun *umbrella* for the Semantic Violation and the Combined Syntactic/Semantic Violation. The Combined Violation resulted in a larger N400-effect than the Semantic Violation.

SPS:

A significant SPS was obtained on the noun *umbrella* for the Syntactic Violation, as well as for the Combined Syntactic/Semantic Violation. However, in contrast to the N400-effect, the mean amplitude of the SPS for the Syntactic Violation was not different from the SPS for the Combined Violation.

Conclusions

1) The N400-effect to semantic anomalies is enhanced by an additional syntactic violation. It occurs within a latency range of 300-500 ms.

2) The SPS (latency range: 500-900 ms) to a syntactic violation is not affected by an additional semantic anomaly.

3) Semantic integration during sentence processing becomes more difficult in the presence of a syntactic processing problem. Semantic integration is thus open to syntactic influences.

4) For haemodynamic studies of syntactic processing, this result implies that the time constant of these methods does not (easily) allow to completely separate activations due to syntactic processes from activations due to semantic processes, given the immediate consequence of syntactic processes for semantic interpretation. The increased activations in PET/fMRI studies that manipulated syntactic complexity (Just & Carpenter, 1996; Stromswold et al., 1996) can therefore not be unambiguously ascribed to syntactic processes alone.

References

- Just, M. A., Carpenter, P. A., Keller, T. A., Eddy, W. F., and Thulborn, K. R. (1996). Brain activation modulated by sentence comprehension. *Science*, 274, 114-116.
- Stromswold, K., Caplan, D., Alpert, N., and Rauch, S. (1996). Localization of syntactic comprehension by positron emission tomography. *Brain and Language*, 52, 452-473.