



MEMORY ACCESS AND CONTEXT INTEGRATION IN SEMANTIC PROCESSING. DIFFERENTIATION BY EVENT RELATED POTENTIALS

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Introduction

Semantic memory models propose that words are represented as network nodes, with related words represented as neighboring nodes (Collins & Loftus 1975). An access to a semantic representation should lead to a spread of activation to its neighboring nodes and facilitate the access to them. This concept is based on behavioral studies on word associations and semantic priming: When two words (usually named *prime* and *target*) are presented successively and a lexical decision about features of the second word is required, subjects respond faster (the so-called *semantic priming effect*) when word pairs are related in comparison to nonrelated word pairs.

It is hypothesized that a coactivation of network nodes should decay with time - an access to the semantic memory should benefit from spreading activation only when the target is presented briefly, i.e. when the SOA (Stimulus Onset Asynchrony) is below 400 ms (Neely 1977). In our study we aimed to investigate this *spreading activation effect* at short SOAs with Event Related Potentials (ERP) in a semantic priming task, and expected different ERP patterns for short and long SOAs.

Methods

Thirty-one male, right-handed subjects (mean age 26.7 years), divided into two SOA groups, performed a lexical decision task while a 64 channel EEG was recorded.

Subjects had to decide between real-word and pseudoword targets by pressing different mouse buttons. Semantic distance was varied using 45 direct related (DR) word pairs (e.g. table-chair), 45 indirectly related (IR) word pairs (e.g. lemon-sweet), 45 nonrelated (NR) word pairs (e.g. fish-castle), and 135 word-pseudoword (PW) pairs (e.g. picture-gerba). Presentation time was 150 ms for the prime and 3 s for the target resp. until the subject responded. SOAs (onset prime - onset target) were 150 ms resp. 700 ms.

ERP analysis: Filter DC-16 Hz, baseline 100 ms pre-prime (SOA150) resp. pre-target (SOA700). Peak and time window analysis of ERP components (amplitudes between SOAs are not comparable because of differences in baselines and component overlay).

Results

Reaction times and N400: Prolonged RTs and larger N400 amplitudes with increasing semantic distance, **independently of SOA** (Fig. 1, 2, 5).

Late Positive Component (LPC): Prolongation of peak latencies and amplitude reduction with increasing semantic distance for SOA150 only. Pseudoword LPC latencies were comparable in both SOAs (Fig. 2, 3, 5).

Fronto-central ERP pattern: Positive component peaking at 250 ms in the short SOA only. Negative component peaking around 310 ms with a larger semantic distance effect in the short SOA (Fig. 4, 5).

References

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 Rugg MD, Doyle MC: Event-related potentials and stimulus repetition in indirect and direct tests of memory. In *Cognitive Electrophysiology* (ed. Heinze H, Munte T, Mangun GR) 124-148 (Birkhauser, Boston, 1994).

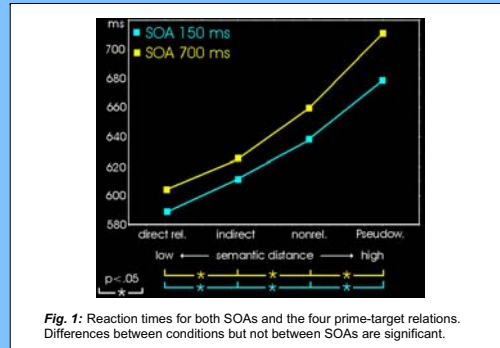


Fig. 1: Reaction times for both SOAs and the four prime-target relations. Differences between conditions but not between SOAs are significant.

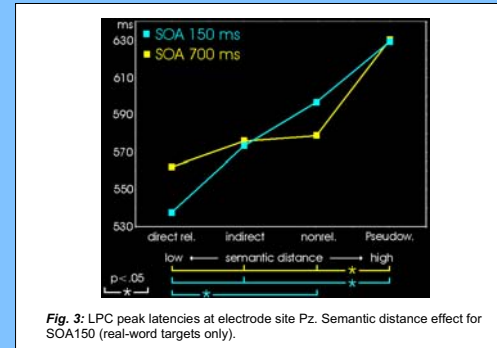


Fig. 3: LPC peak latencies at electrode site Pz. Semantic distance effect for SOA150 (real-word targets only).

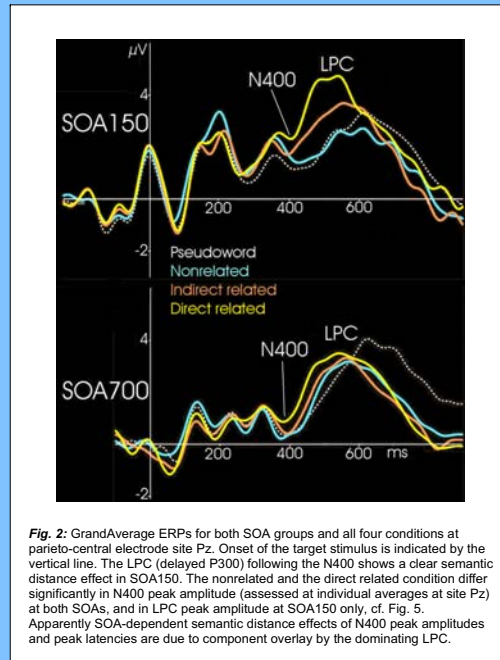


Fig. 2: GrandAverage ERPs for both SOA groups and all four conditions at parieto-central electrode site Pz. Onset of the target stimulus is indicated by the vertical line. The LPC (delayed P300) following the N400 shows a clear semantic distance effect in SOA150. The nonrelated and the direct related condition differ significantly in N400 peak amplitude (assessed at individual averages at site Pz) at both SOAs, and in LPC peak amplitude at SOA150 only, cf. Fig. 5. Apparently SOA-dependent semantic distance effects of N400 peak amplitudes and peak latencies are due to component overlay by the dominating LPC.

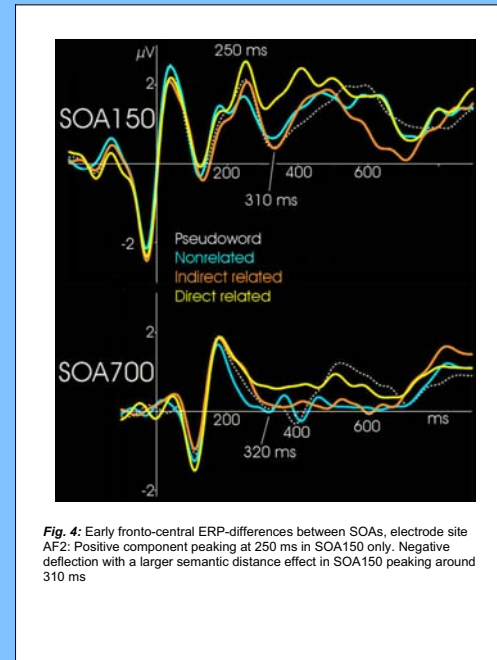


Fig. 4: Early fronto-central ERP-differences between SOAs, electrode site AF2: Positive component peaking at 250 ms in SOA150 only. Negative deflection with a larger semantic distance effect in SOA150 peaking around 310 ms

Conclusion

LPC can be classified as a delayed P300 evoked by the lexical decision. Easy detectable stimuli show a larger and earlier P300 than more difficult detectable stimuli (e.g. Polich et al. 1996). We conclude, that in the short SOA spreading activation facilitates the access to related targets and therefore lexical decision - related target words are easier to be detected than indirect and nonrelated targets. At the long SOA spreading activation mainly decays before target onset.

The pseudoword LPC is independent of SOA because pseudowords are not represented in semantic networks - therefore a facilitated access is impossible.

Probably two stages of semantic processing can be differentiated:

- 1) an access to the semantic network without the necessity of word comprehension which is indicated by the LPC differences (and probably the early frontal effects),
- 2) the integration of prime and target into a semantic context, which requires processing of word meaning. According to concepts about controlled semantic processing (e.g. Rugg & Doyle 1994, Chwilla et al. 1998), the context integration of nonrelated word pairs needs more semantic processing which is expressed in a larger N400 amplitude and prolonged RTs, as shown in our data.

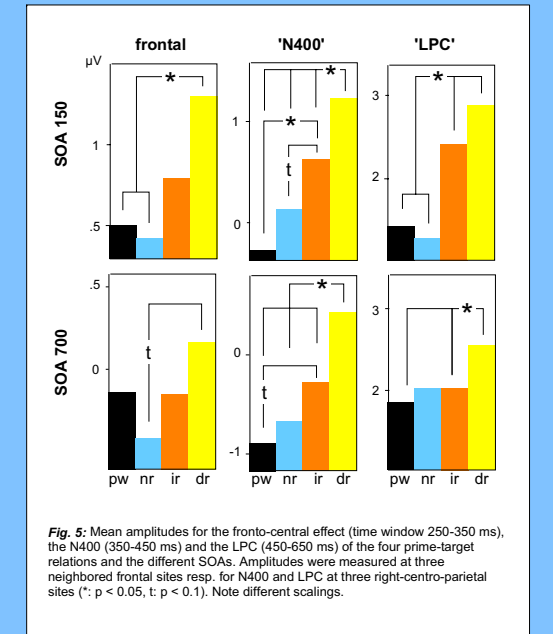


Fig. 5: Mean amplitudes for the fronto-central effect (time window 250-350 ms), the N400 (350-450 ms) and the LPC (450-650 ms) of the four prime-target relations and the different SOAs. Amplitudes were measured at three neighboring frontal sites resp. for N400 and LPC at three right-centro-parietal sites (*: $p < 0.05$, $t: p < 0.1$). Note different scalings.