

# Object Shift and Event-Related Brain Potentials

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## 1. Introduction

SWEDISH pronominal objects can either precede or follow a sentence adverb, as shown in example (1). In (1a), the pronominal object *den* 'it' precedes the sentence adverb *inte* 'not', whereas in (1b), the order is the reverse.

- (1) a. Vi köpte inte den  
We bought not it  
b. Vi köpte den inte  
We bought it not

This word order variation is referred to as 'Object Shift' (Holmberg, 1986), and is similar to German and Dutch 'scrambling'. Whereas German scrambling can apply to all NP arguments, however, only unstressed pronouns may precede sentence adverbs in Swedish, as in (1b). Although full NPs are generally not accepted before sentence adverbs in Swedish, Object Shift with indefinite full NPs, such as *färg* 'paint' in (2a) is intuitively worse than Object Shift with definite objects, such as *färgen* 'the paint' in (2b).

- (2) a. \*Vi köpte färg inte  
We bought paint not  
b. \*Vi köpte färgen inte  
We bought the paint not

The shift of object position entails a change in discourse interpretation and prosodic prominence. Objects that follow sentence adverbs (1a) are by default prominent and express new information. Objects preceding sentence adverbs (1b), conversely, are by default non-prominent and express given information. Indefinite full NPs are inherently prominent and associated with new information. Definite full NPs may express both given and new information, and may be prosodically reduced to some extent.

We monitored the online processing of adverbs illicitly following full indefinite and definite NPs to see how the discourse structure-integration of sentence adverbs differed after indefinite and definite objects (Roll et al., In press). Rösler et al. (1998); Bornkessel et al. (2002); Schlesewsky et al. (2003) found a mostly left-anteriorly distributed negativity 300-450 ms after scrambled full NPs in German. Such a negativity could be expected at sentence adverbs following full NPs in Swedish. Alternatively, an N400 effect reflecting increased discourse structure-processing load could be expected. Discourse structure manipulation has been shown to give rise to earlier effects than local semantic relations (Camblin et al., 2007; Polse et al., 2007).

## 2. Method

**Subjects:** 17 right-handed native Swedish speakers, one excluded due to excessive noise. **EEG recordings:** 64 channel Quick Cap, SynAmps 2, sampling rate 250 Hz, online band-pass filter 0.05/70 Hz.

**Data analysis:** 30 Hz lowpass filter off-line. Eye artifact reduction using ICA in EEGLAB. 6 Regions of Interest (Figure 1).

**Stimulus presentation:** Visual word-by-word presentation, 400 ms, 100 ms ISI.

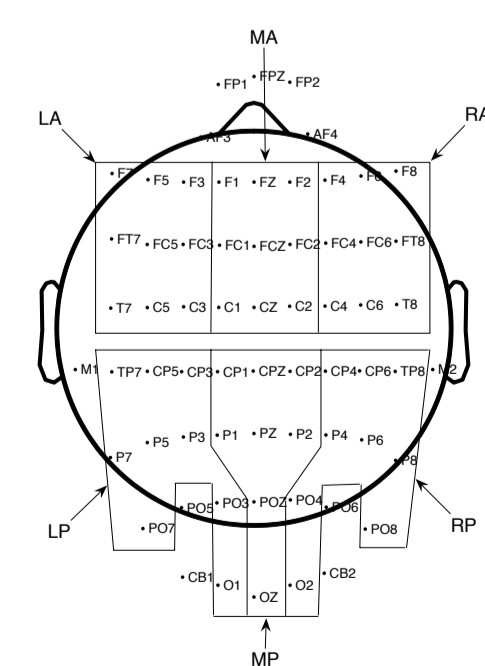


Figure 1: Channel locations and Regions of Interest.

**Stimuli:** 126 test sentences, 126 fillers. All experimental conditions consisted of a main clause in which the object has undergone OS, and a conjoined adversative clause. In

Condition Ind (3a), the word category restriction on OS was violated by a shifted indefinite full NP object. In Condition Def (3b), the word category restriction was violated by a shifted definite full NP. Condition Pron (3c) was the control condition and did not violate the word category restriction, since the shifted object was a pronoun.

- (3) a. *Ind:* \*Ni köpte färg inte men ni målade ändå  
You bought paint not but you painted anyway  
'You didn't buy paint but you painted anyway'  
b. *Def:* \*Ni köpte färgen inte men ni målade ändå  
You bought the paint not but you painted anyway  
c. *Pron:* Ni köpte den inte men ni målade ändå  
You bought it not but you painted anyway

The fillers corresponded to the experimental conditions, but had legitimate adverbs after the full NPs, and illegitimate particles after the pronouns. An Ind filler is shown in (4).

- (4) Vi öppnade konto igår men med låg ränta  
We opened account yesterday but with low interest

## 3. Results

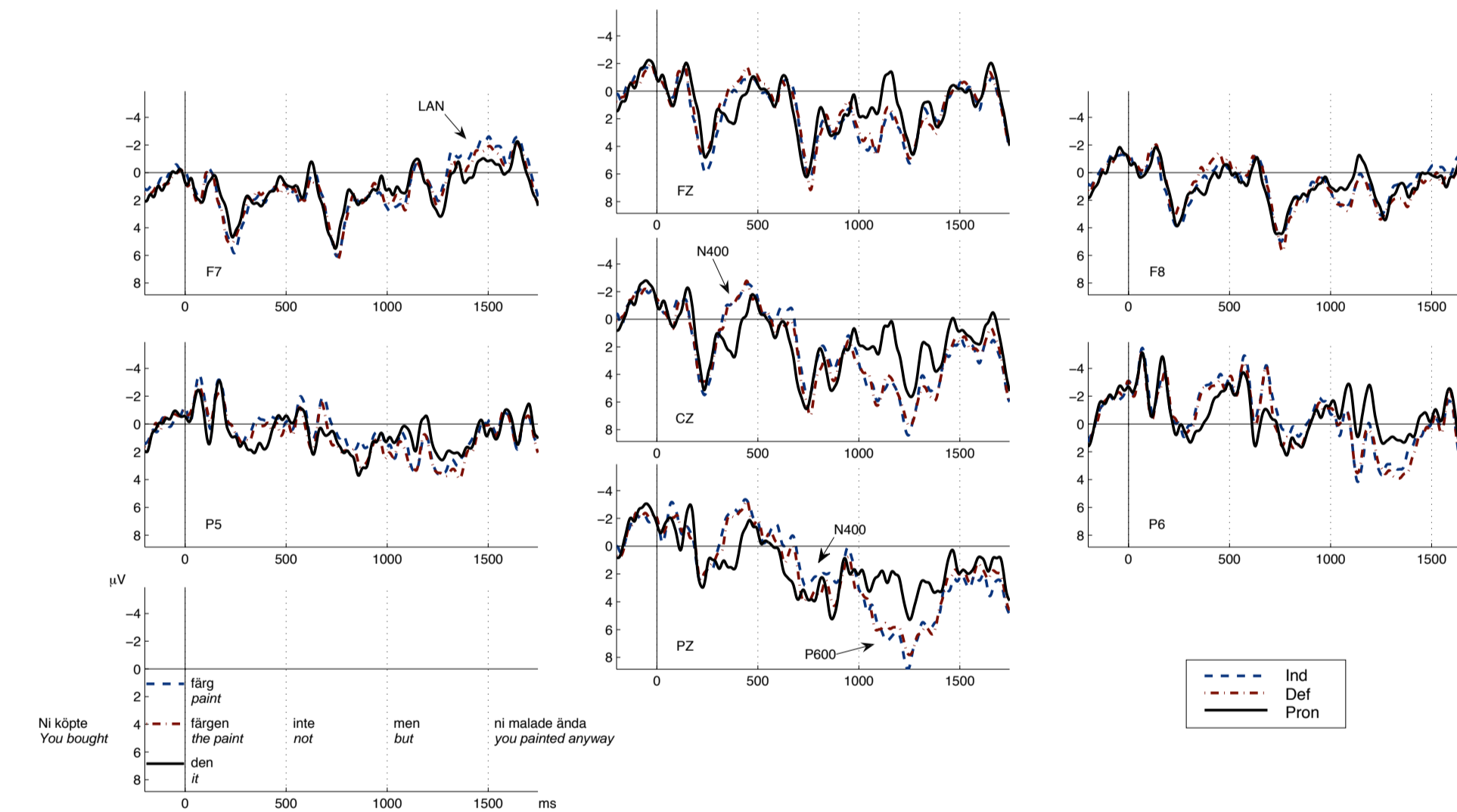


Figure 2: ERPs for Ind, Def, and Pron. There is an N400 effect after the object (here *färg/färgen* 'paint/the paint'), an enhanced negativity for Ind after *inte* 'not', followed by a P600 effect for Ind and Def, as well as a Left Anterior Negativity for Ind after *men* 'but'.

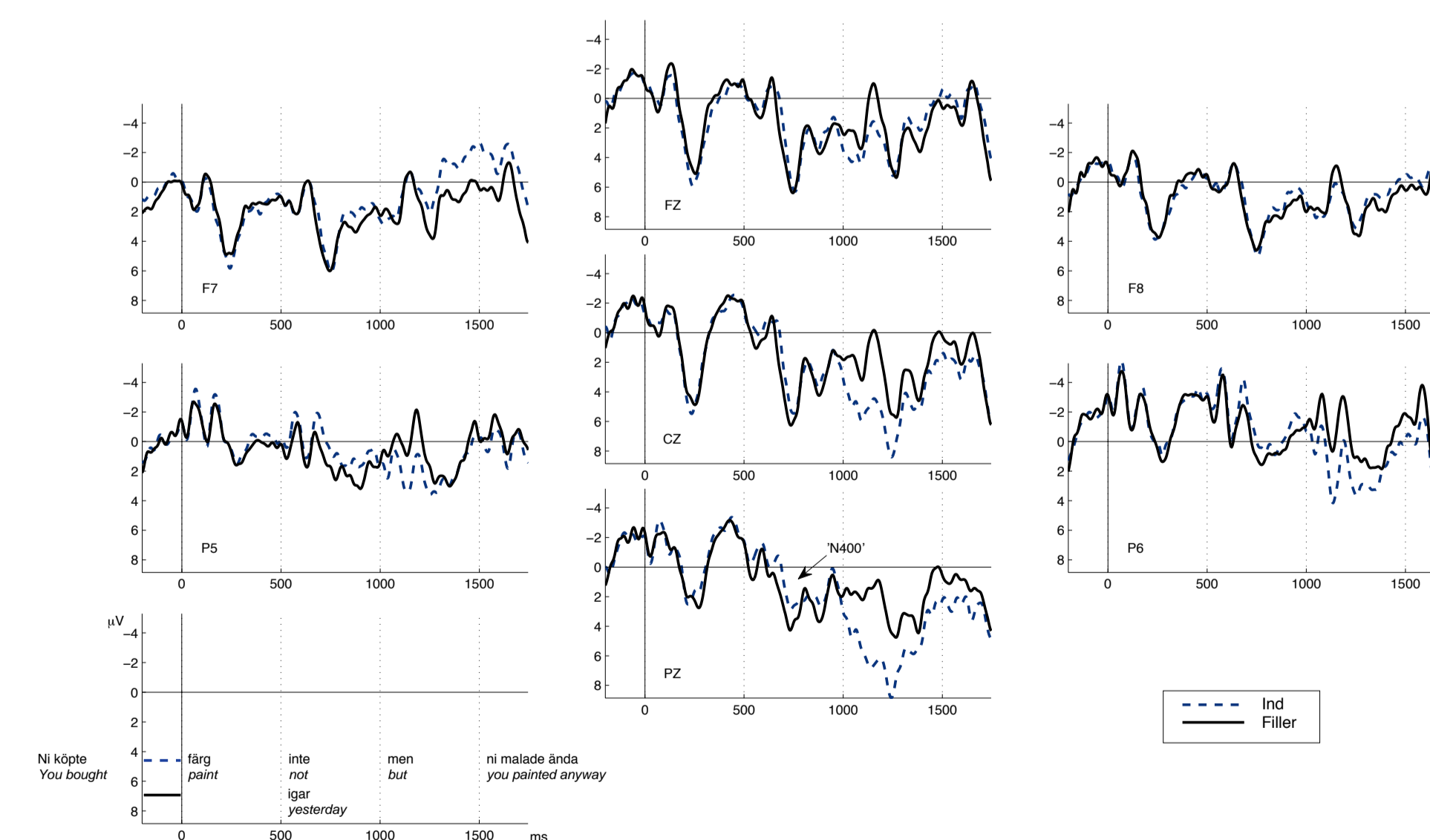


Figure 3: ERPs for Ind and its corresponding filler sentence. The two waveforms do not differ until the enhanced negativity 175 ms after the adverb *inte* 'not' / *igår* 'yesterday'.

**Behavioral results:**

- Average proportion of response accuracy: 98.4% for Ind, 98.9% for Def, and 95.1% for Pron.

**Summary of observed ERP effects:**

- Negativity 300-500 ms after full NP object as compared to pronominal object ( $p < .05$ ): N400 effect (Figures 2, 4a).
- Negativity 200-400 ms after sentence adverb (*inte* 'not') following indefinite full NPs, at posterior sites ( $p < .05$  for Word Category  $\times$  Anterior and posterior Rols) (Figures 2, 4b). Marginally larger than Def at left posterior Rol ( $p < .08$ ). Replicated as a main effect from 175 ms to 300 ms after onset of the adverb ( $p < .05$ ) when Ind was compared to the corresponding filler condition (Figure 3). N400?
- Positivity 500-1200 ms after sentence adverb in both condition Ind and Def ( $p < .05$  at all Rols 500-700 ms): P600 (Figures 2, 4c).
- Left anterior negativity 300-600 ms after conjunction *men* 'but' in Ind ( $p < .05$  for Word Category  $\times$  Ant, WC  $\times$  Hem, and left anterior Rol): LAN effect? (Figures 2, 4d).

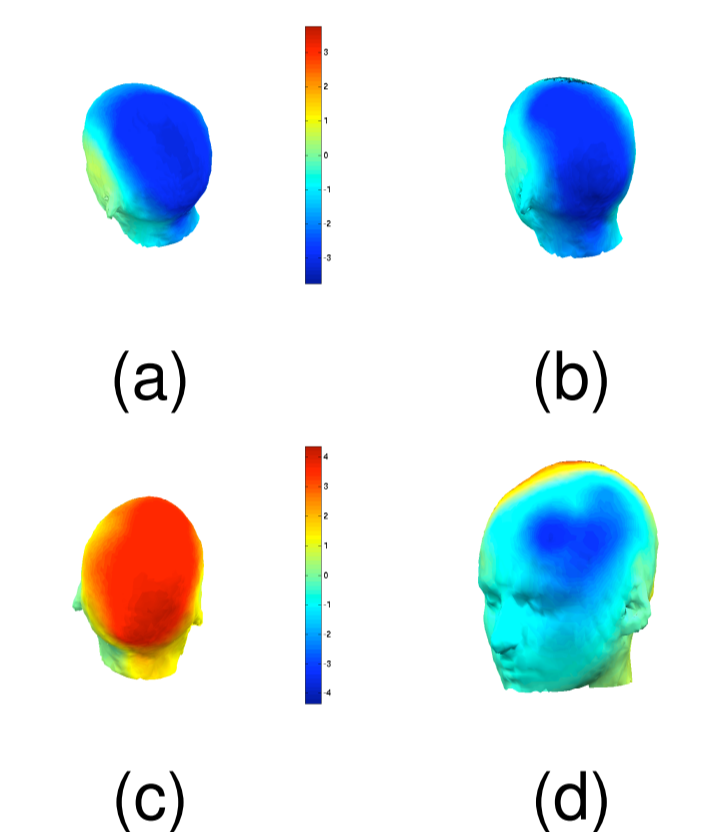


Figure 4: Distribution of N400 after Ind and Def objects (a), early negativity after sentence adverb in Ind (b), P600 after sentence adverb (c), and Left Anterior Negativity after conjunction in Ind (d).

## 4. Discussion

The enhanced negativity 200-400 ms after onset of the sentence adverb *inte* 'not' in the indefinite full NP condition resembles the scrambling negativity found by Bornkessel et al. (2002) and Schlesewsky et al. (2003). It is, however, more posterior and appears somewhat earlier. We believe that this effect is in fact an early N400 effect, showing an increased discourse structure-integration cost for a sentence adverb following an indefinite object NP, which is the prosodically and semantically most prominent of the different object forms. The early time window resembles results of Camblin et al. (2007) and Polse et al. (2007) for discourse structure manipulation.

The behavioral data did not show any difference between indefinite and definite full NP Object Shift. Both were judged to be equally ungrammatical. This judgment is reflected by the P600 effect, which is stable for both experimental conditions. P600 effects are often obtained at grammatical error detection. The negativity preceding the P600, however, was significant only for the indefinite condition, and even marginally larger in this condition than in the definite condition. This finding corresponds to the fact that indefinite Object Shift is intuitively more difficult to process than definite full NP Object Shift.

## References

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