

PROCESSING OF SEMANTIC VIOLATIONS IN RUSSIAN HEALTHY SPEAKERS AND APHASIC PATIENTS

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The method of event-related potentials (ERPs) became an important instrument for investigation of language processing mechanisms. Implementation of this method in aphasia studies allows to analyze the types of linguistic information the patients are sensitive to and observe variations in the time course of different subprocesses that underlie language comprehension. The goal of the present study was to examine processing of lexical-semantic information in Russian healthy individuals and aphasic patients grouped using aphasia diagnosis and damage localization. For this purpose ERPs effects accompanying processing semantically correct sentences and sentences containing semantic violations were studied.

The experimental materials included 40 semantically correct Russian sentences and 40 their anomalous counterparts that were created by substituting the direct object for a semantically inappropriate noun (1).

1. Мальш набирает **песок/*звонк** в ведёрко.
*child-SG.NOM fill-PRES.3SG sand/*bell-SG.ACC in bucket-SG.ACC*

*The child fills the bucket with **sand/*a bell**.*

160 fillers (80 correct and 80 with syntactic or morphosyntactic violations) were added to the materials. 8 healthy individuals and 16 aphasic patients with left hemisphere lesions (8 diagnosed as Broca's patients and 8 diagnosed as Wernicke's patients) participated in the experiment. The experimental sentences were presented auditorily. The participants were asked to listen attentively to the sentences and judge them as correct or anomalous.

The EEG was recorded using 128 electrodes mounted in an elastic net Geodesic Sensor Net (Electrical Geodesics Inc.). Data processing included following stages: filtering (40 Hz low-pass filter), segmentation (200 ms before stimulus onset – 1000 ms after stimulus onset), artifact rejection, averaging by experimental conditions (within and between subjects), baseline correction (for 200 ms preceding stimulus onset) and calculation of difference waves.

The statistic analysis was performed using repeated measures of ANOVA for three time windows: 300-500 ms, 500-700 ms and 700-1000 ms.

The results of our experiment show that, firstly, processing semantic violations in healthy speakers yields in a standard marker of semantic integration difficulties – the N400 effect (e.g., Kutas & Hillyard (1980) – on English; Friederici et al. (1993) – on German), and, secondly, processing sentences with semantic violations in patients is dependent on both aphasia diagnosis and lesion site.

Concerning aphasia diagnosis, in Broca's patients processing sentences with semantic violations compared with correct sentences elicited the N400 effect. In contrast, no N400 effect was present in patients with Wernicke's aphasia. Instead, processing semantically anomalous sentences only elicited the P600 effect in them that is usually considered to be a marker of sentence reanalysis and repair (Osterhout & Holcomb, 1992).

Regarding lesion sites, the results show that processing semantically anomalous vs. correct sentences resulted in the N400 effect in aphasic patients with parietal lesions and intact frontal and temporal lobes. In contrast, no N400 effect was observed in patients with inferior frontal and temporal lobe lesions and intact parietal region, whereas the P600 effect was found instead.

According to our results, processing semantic violations in Russian healthy individuals yields in the N400 effect. This effect was also observed in patients with Broca's aphasia, which says for a relatively intact semantic processing in this aphasia type. However, in Wernicke's aphasics integration of semantic information might involve compensatory mechanisms reflected in the P600

effect. The analysis based on damage localization indicates that parietal lobe is not critical to the generation of the N400 effect whereas left frontal and temporal lobes seem to play a crucial role in semantic integration processes that is in line with the results of Kiehl et al. (2002).

References:

- Friederici, A.D., Pfeifer, E., & Hahne, A. (1993), 'Event-related brain potentials during natural speech processing: Effects of semantic, morphological, and syntactic violations', *Cognitive Brain Research*, no. 1, pp. 183-192.
- Kiehl, K.A., Laurens, K.R. & Liddle, P.F. (2002), 'Reading anomalous sentences: An event-related fMRI study of semantic processing', *Neuroimage*, no. 17, pp. 842-850.
- Kutas, M., & Hillyard, S.A. (1980), 'Event-related brain potentials to semantically inappropriate and surprisingly large words', *Biological Psychology*, no. 11, pp. 99-116.
- Osterhout, L., & Holcomb, P.J. (1992), 'Event-related brain potentials elicited by syntactic anomaly', *Journal of Memory and Language*, no. 31, pp. 785-804.