Electrical language of the brain - how EEG helps us to understand the brain understanding languange

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EEG records electrical activity elicited mainly by the cerebral cortex. Using techniques such as event-related potentials (ERP) one is able to relate specific brain activity with cognitive processing in the brain, which used in carefully planned psychophysiological experiments gives us a chance for better understanding how the brain works. This technique, due to its excellent time resolution, is especially well suited to explore how the brain "understands" language.

During last 30 years a few ERP components directly related to language processing were identified. N400 component is related with semantic processing (Kutas & Hillyard, 1980). It appears, for example, in reaction to words semantically unexpected in a given context. It is also an index of how much the preceding context is semantically constraining possible continuations of the sentence. LAN component is related to morphosyntactic processing, and appears in reaction to violations of words' morphology, mainly violations of some kind of agreement (e.g. Barber & Carreiras, 2005). Another set of experiments shows its sensitivity to storage of linguistic information in the working memory, for example during resolving long-distance dependencies, such as between a filler and a gap (e.g. Kluender & Kutas, 1993). The last of reviewed components, P600, is sensitive to a wide range of violations (mostly grammatical), but also to correct, but containing a non-intuitive syntactic structures (e.g. Osterhout, Holcomb, & Swinney, 1994).

Analysis of the language-specific ERP components can be a valuable tool, often giving more information than standard for psycholinguistics behavioural measurement methods, such as analysis of reaction times. They allow to find answers for questions central to psycholinguistics, such as when and in what way do processing of semantical and grammatical information interact, in what extent nonsyntactic information takes part in syntactic processing, or whether Fodor's modularity hypothesis (1983) is correct within the domain of language perception.

References:

Barber, H., & Carreiras, M. (2005). Grammatical gender and number agreement in Spanish: an ERP comparison. Journal of Cognitive Neuroscience, 17(1), 137-153.

Fodor, J. A. (1983). Modularity of Mind: An Essay on Faculty Psychology. Cambridge, MA: MIT Press.

Kluender, R., & Kutas, M. (1993). Bridging the gap: Evidence from ERPs on the processing of unbounded dependencies. Journal of Cognitive Neuroscience, 5(2), 196-214.

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: brain potentials reflect semantic incongruity. Science, 207(4427), 203-205.

Osterhout, L., Holcomb, P. J., & Swinney, D. A. (1994). Brain potentials elicited by garden-path sentences: Evidence of application of verb information. Journal of Experimental Psychology / Learning, Memory & Cognition, 20(4), 786.