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Poster presentation

Modeling selective attention using EEG data

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Introduction

Perceptual abilities in humans are shaped by attention. Assessing the underlying mechanisms is barely possible due to the distributed nature of cognitive processing. One of the gateways to selective attention is negative priming (NP), a slowdown of the reaction to previously ignored stimuli in a range of 10 to 40 milliseconds. Variants of NP reveal the active processing of irrelevant stimuli up to a semantic level. The occurrence of the effect is, however, sensitive to details of the experimental conditions, making it difficult to vary parameters experimentally. Due to the sparse insight, modeling remains to some stage arbitrary. To formulate a well-grounded model, we focus on (1) detailed computational modeling, (2) a psychophysical view in the brain with EEG-recordings, (3) elaborated data analysis.

Computational model

One of the aims of this study is the test of the imago-semantic-action model, a general model for decision making in action planning. It explains priming effects both positive in the case of stimulus repetition and negative in the case of ignored repetition, with only one general mechanism accounting for selective attention. A global adaptive threshold defines the actual action alternatives and finally the decision between them. The model computes activation strengths in a semantic space.

Psychological experiment

We recorded about 40 minutes of 64-channel EEG-data from 9 female and 7 male persons between 22 and 42 years, average 25 years. Subjects were shown a total of 840 trials each consisting of a display of two superimposed pictograms out of eight different stimuli. The target stimulus appeared in green, whereas the distractor stimulus was shown in red. Subjects had to name the target and reaction time was determined via microphone. The reoccurrence of stimuli of the precedent display defined the priming condition. A repetition of the target led to a speedup, whereas the change of a stimulus from distractor to target resulted in a slowdown. All effects resulted in significant reaction time differences.

Results

Performing standard event-related-potential (ERP) analysis as well classification by machine learning algorithms and independent component decomposition, we could narrow neural correlates in time and in space. Frontal processes are believed to mediate other brain functions, but may not show any amplitude dependency on the priming condition. Left-hemispheric parietal electrodes showed visually strong evidences. This agrees with the fact that a multilayer perceptron taking tenfold cross validation was able to correctly classify more than 90% of the ERPs by time series of 25 parietal electrodes, whereas 25 frontal electrodes only produced a correct classification of 68%. Additionally independent component analysis revealed for several subjects a strongly localized dipole in

the left hemispheric parietal region that is only present in negative priming trials. These results question inhibition based models in favor of retrieval based models in terms of classical explanations of priming effects. The imago-semantic-action model asserts its position as a comprehensive model as regards concrete brain activity.

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