The gamma band activity and relational reasoning

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Several studies using similar tasks and neuroimaging techniques have shown that reasoning is associated with bilateral prefrontal (PFC) and posterior parietal cortices activation. Here, we investigated the brain EEG activity (with special interest on gamma band) during two types of cognitive tasks –memory task and memory with reasoning. The first task required the subjects to memorize three pairs of unrelated elements (e.g. D and S; F and C; E and R), whereas in the second the subjects had to infer about relations between presented elements (e.g. after presentations of: A > B; B > C; C > D; subject was requested to answer questions concerning relationship between elements which were not previously presented, e.g. A > C?). The first phases of both tasks, in which subjects were required to only maintain the information (memory task) or to create the linear order (reasoning task), were used for this analysis. The ICA algorithm was applied to the data and resulted with 61 components, which were later clustered using k-means method. Two clusters revealed significant differences between memory and reasoning tasks in gamma band. The first of these clusters was located in frontal sites. The localization of the second cluster was more distributed and covered parietal as well as frontal sites. The first cluster showed increased gamma band activity (as shown by event related spectra perturbation, ERSD) in working memory tasks comparing to reasoning task. In the second cluster the gamma band activity was higher during the reasoning task. These results are in line with previous findings from studies with brain-damaged patients and neuroimaging experiments showing that logical reasoning is implemented in cortical networks consisting of parts of the fronto-temporal cortex and the posterior parietal cortex. It was found that during relational and conditional reasoning, an occipital-parietal-frontal network was activated. This suggests that spatial processing of relations might be a key information in mental models constructed during reasoning. We hypothesize also that the two clusters appearing in frontal and parietal locations represent the results of the activity of different information processing streams.

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