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# Non-invasive detection of neural sources underlying ECoG-based P300 speller performance

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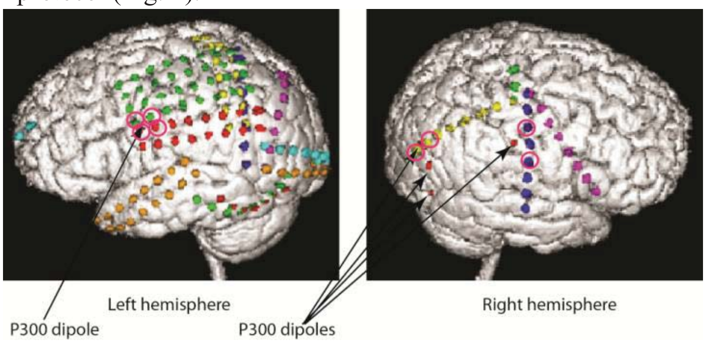
*Introduction:* There is evidence to suggest that surgically-implanted intracranial BCIs might be more efficient than scalp-based BCIs, especially for severely disabled patients. However, before moving into invasive implantation of BCIs, the important question must be addressed – localization of the areas for implantation, which might vary dependent on the BCIs type used as well as on individual person's characteristics. In our previous study [1], we concluded that specific approaches must be developed to identify and extract the data of interest from intracranial brain signal recordings in order to achieve desired BCI performance. Among several suggested approaches, the most promising has been proposed the use of magnetoencephalography (MEG). Therefore, the aim of our current study was to evaluate possibility for non-invasive navigation of subdural electrode implantation with MEG needed for high accuracy performance of P300 speller.

*Material, Methods:* The study was performed in a right-handed female patient (17 yo) with intractable epilepsy, undergoing evaluation for epilepsy surgery. We used MEG source localization to navigate the choice of electrodes for using invasive P300 speller.

*1.1. Non-invasive localization of P300 generators with MEG*. During this test, visual evoked fields were recorded in response to the letter (O and X) stimuli presented in an "odd-ball" paradigm manner, with 76% of NON-TARGET (letter "O") and 24% of TARGET stimuli (letter "X"). Altogether, 76 of frequent and 24 of deviant stimuli were presented. The patient was instructed to count all infrequent stimuli. The source of P300 speller was localized by using equivalent current dipole (ECD) in right central and occipital as well as left frontal and central areas (Fig. 1).

*1.2. Merging information from subdural electrode location and MEG results*. After the patient was implanted with subdural electrodes, the 3-D-rendered map of cortical patient's surface was created with co-registered and overlaid on it subdural electrodes. The localized P300 ECDs were overlaid with the 3-D-rendered cortical and grid map. Eight electrodes in a close proximity with localized P300 sources were selected for P300 speller protocol (Fig. 1).




*Results:* The accuracy of intracranial P300 speller was compared for 8 electrodes identified with MEG after creating a classifier with 10 letter phrases. The accuracy of P300 speller for MEG-identified sites was 80%.

***Figure 1.*** *3D-rendered cortical surface of patient's brain with overlaid subdural grids, P300 dipoles localized with MEG. Locations of 8 electrodes selected by using MEG for intracranial P300 speller are presented in cyan circles.*

*Discussion:* Our preliminary data suggest that neural sources underlying performance of P300 speller can be successfully and non-invasively identified with MEG. Therefore, MEG has a strong potential to serve as a non-invasive tool for navigating electrode implantation of P300 speller-based BCI in patients, who are in need for communication via intracranial P300 speller. Further studies are recommended to explore this approach.

*Significance:* These results can contribute to clinical application of P300 speller for disabled patients, e.g., those with late stages of amyotrophic lateral sclerosis (ALS) or locked-in syndrome.

*References*

[1] Korostenskaja M, Kapeller C, Prueckl R, Ortner R, Chen PC, et al. Improving ECoG-based P300 speller accuracy. In *Proceedings of the 6th International Brain-Computer Interface Conference 088: 1-4, 2014.*