Applying MEG in cognitive neuroscience

Lauri Parkkonen /lauri.parkkonen@aalto.fi/

Aalto University, Espoo, Finland

Although it is already four decades since the very first magnetoencephalographic (MEG) measurement, this non-invasive neuroimaging modality is still advancing at a considerable speed thanks to continuous developments in instrumentation and analysis methods but also in experimental designs and interpretation of the data (see e.g. Hari et al., 2010). The targets of the early MEG studies, such as evoked responses of the sensory systems, are still strong in the field but new ways of looking at MEG data have emerged. Functional connectivity is particularly appropriate object of study as the unique combination of high temporal resolution and decent spatial resolution of MEG makes it well-suited for tapping on, e.g., oscillatory brain activity which is considered to mediate connectivity. MEG can also be used to investigate intrinsic brain mechanisms such as memory and attention and even to characterize consciousness.

In this talk, I will illustrate important factors in experimental design that pertain to MEG studies on cognitive neuroscience (Salmelin and Parkkonen, 2010). I will show examples on the use of evoked responses (Nishitani and Hari, 2002), spontaneous brain oscillations (Caetano et al., 2007) and temporally structured, or tagged, stimuli (Parkkonen et al., 2008). Recently, real-time analysis of MEG data and on-line feedback to the subject have become feasible and they can be used to investigate cognitive processes in a novel and interesting manner (Sudre et al., 2011). For example. visual spatial attention modulates the spatial distribution of posterior alpha oscillations, which can be exploited in a brain–computer interface (Bahramisharif et al., 2010). We have studied spatial attention using frequency-tagged stimuli and real-time feedback; I will present our preliminary results. Applying machine learning algorithms to MEG data may allow decoding the stimulus class from brain activity. Such an approach has been very fruitful in fMRI even without using any temporal information about the brain activity. Decoding has not yet been widely applied to MEG but one could speculate that MEG should excel in decoding because of the wealth of temporal information in the data. I will illustrate our results on decoding single-trial visual responses for low-level visual features and for subjective awareness.

References

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