# Results of EEG-Analyses of Mental Practice

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Mental Practice – the repeated imagination of a course of movement – is a central research topic in Sports Psychology. Training effects can be explained by simulation theory, which posits motor imagery and movement execution to activate similar neuronal structures (functional equivalence). This assumption was tested with different neurophysiological methods, but the results are inconclusive. Analyses with electroencephalography (EEG) are a promising approach for the investigation of underlying mechanisms. Employment of EEG has important advantages in (a) measurements of neuropsychological activity with high time resolution and (b) the mobility necessary for application in the realms of sports and rehabilitation.
**keywords**: mental practice, EEG, sports, rehabilitation, simulation theory

## EEG-ANALYSIS OF MENTAL PRACTICE

Mental Practice is defined as systematic and extensive rehearsal of the conscious internal reproduction of a specific motor act without actual movement execution. The intention of this rehearsal is to enhance skill learning and to optimize movements. Thus, Mental Practice is applied both in high-performance sports and in rehabilitation (Jackson, Lafleur, Malouin, Richards, & Doyon, 2001). The latest explanation of training effects is simulation theory. It posits that motor imagery activates similar neuronal structures as physical movement execution (functional equivalence; Jeannerod, 2006). Different neurophysiological techniques have been used to test this postulate. However, the results remain inconclusive (Munzert, Lorey, & Zentgraf, 2009) especially concerning the involvement of the primary motor cortex (M1) during imagination. After a detailed literature research (Frenkel, Maltese, & Schankin, *submitted*) we propose that electroencephalography (EEG) has the potential to gain a key position in bridging the gaps in the theoretical process of understanding.

## RESULTS FROM BASIC RESEARCH

The comparison of EEG-patterns recorded from (a) simple movements of upper extremities during imagination with those elicited by physical execution and from (b) more complex movements involving lower extremities, points to joint neuronal networks being activated during imagination and execution (e.g., Hashimoto, Ushiba, Kimura, Liu, & Tomita, 2010; Neuper & Pfurtscheller, 2010) – a result which underpins the postulate of functional equivalence.

Furthermore the high time resolution of the EEG allows the detailed examination of different stages during movement imagination and execution and a closer look at the transient activation of M1. Hereby, the differences regarding the activation of M1 could be traced back to the last stage of motor preparation (Caldara, Deiber, Andrey, Michel, Thut, & Hauert, 2004). Thus EEG can help to explain the inconclusive results from studies with PET and fMRI concerning the activation of M1.

## SPORTS

Groundbreaking possibilities for the application of the EEG-method in sports were advanced by recent technological developments regarding improved electrodes, portable battery-driven amplifiers and computational methods. Accordingly also highly complex movements can be pictured (Thompson, Steffert, Ros, Leach, & Gruzelier, 2008). Insight about neuronal activations during motor imagery and execution can be used to develop new effective methods to enhance performance (Nakata, Yoshie, Miura, & Kudo, 2010).

## REHABILITATION

Due to technical advances there is a growing importance of EEG in the context of rehabilitation. Thus, the imagination of movements has the potential to serve as a mental strategy to control a neuroprosthesis based on brain signals (Pfurtscheller & Neuper, 2010). Further, EEG allows the evaluation of motor imagery as a therapeutic component when movements need to be optimized or relearned after stroke and other neuronal diseases (e.g., Lim, Polych, Holländer, Byblow, Kirk, & Hamm, 2006).

## CONCLUSION

The results from different areas which examine Mental Practice by means of EEG demonstrate the advantages of this method. Combining the temporal resolution of EEG with brain imaging techniques like fMRI can help to gain further insights in neuronal activation processes during imagery and execution of movements. EEG offers promising possibilities to develop future sportive and rehabilitative procedures involving motor imagery.

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