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Improvement of Brain Source Modeling Based on Multichannel EEG Recordings after Pain Stimulation

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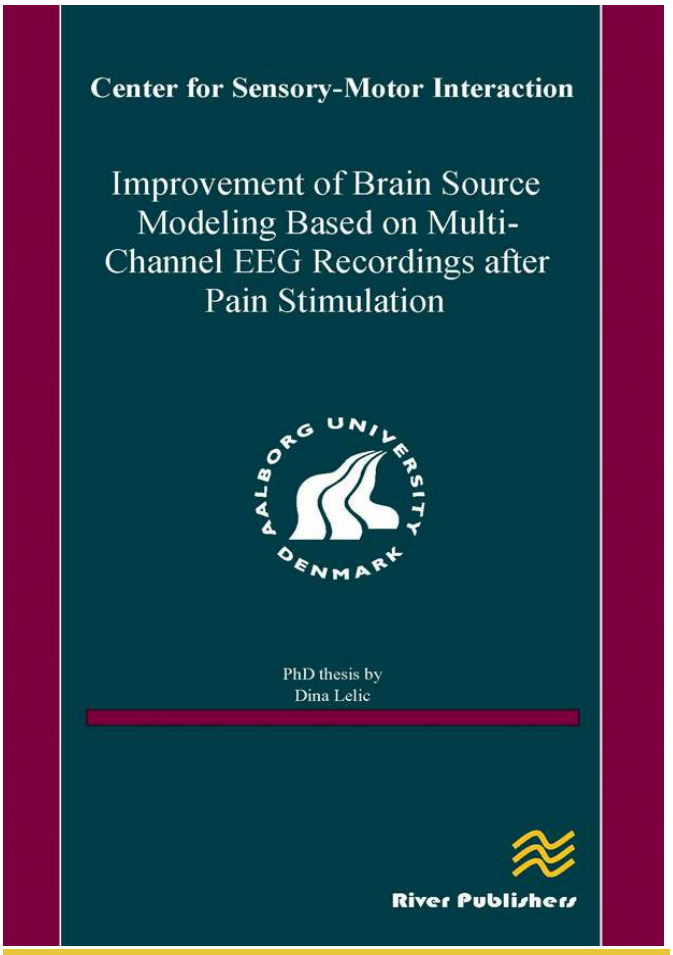
In order to understand and better treat pain patients, understanding of brain?s processing of pain is necessary. Most information regarding brain?s processing of pain comes to us from imaging studies such as fMRI and PET. The main disadvantage of these methods is the poor temporal resolution. As the signal from periphery arrives to brain within a few milliseconds, methods with better time resolution to look at the brain activity are needed. Evoked potentials (EPs) recorded on the scalp measure the brain activity on millisecond time scale, but in contrast to fMRI and PET have poor spatial resolution. However, mathematical methods to look at the brain sources of EPs exist and this is called ?inverse modeling.? Inverse modeling is typically applied to instantaneous EP data with a number of shortcomings including its instability to model multiple and deep brain sources. Furthermore, the interference of background noise may hamper the inverse solution. In this thesis, to overcome these shortcomings, decomposition of EPs prior to inverse modeling is proposed. Multichannel matching pursuit (MMP) is the proposed method for decomposition and was shown to be superior to more frequently used decomposition methods for EP analysis, independent component analysis and second order blind identification. MMP was also shown to be superior to instantaneous EP analysis. Furthermore, a clustering method for automation of MMP analysis is proposed, implemented, and validated on both simulated and empirical somatosensory and brainstem auditory EP data. Finally, the proposed methods were applied to visceral pain EP data in order to study the effects of morphine on the brain. The proposed methods showed to be effective and valid for pain EP studies.



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