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Electric field estimation in deep transcranial magnetic stimulation

V. Guadagnin[a], M. Parazzini[a], S. Fiocchi[a], I. Liorni[a,b], Y. Roth[c], A. Zangen[c], P. Ravazzani[a]
[a] Consiglio Nazionale delle Ricerche, Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni, Milano, Italy
[b] Dipartimento Elettronica, Informazione e Bioingegneria DEIB, Politecnico di Milano, Milano
[c] Department of Life Sciences, Ben-Gurion University of the Negev, Be'er Sheva, Israel

Introduction: Literature studies [Bersani et al., 2013] showed the ability to treat different neuropsychiatric disorders using H1 coil, one of the coils belongs to the Hesed (H) coils, which have been developed specifically for the Deep Transcranial Magnetic Stimulation (dTMS). Despite the clinical trials have obtained positive results, the electric field distributions inside different cerebral structures induced by these coils are not yet completely clear. This study aims to explore the electric field characteristics induced by the H1 coils in two realistic head models.
Methods: We used two human models of the Virtual Family [Christ et al., 2010] based on high resolution MRI of healthy volunteers (a 26-years-old female and a 34-years-old male). The H1 coil was modelled as current paths according to its real complex winding patterns and placed 5.5 cm anteriorly the left hemisphere motor cortex of the right hand abductor pollicis brevis. Moreover, the figure-of-8 coil was placed alternatively on the right and the left dorsolateral prefrontal cortex to compare the effect of the stimulation with the H1 coil in both hemispheres. For all simulations we used a current pulse with a frequency content of 5 kHz and a current intensity adjusted to obtain 120% of the hand motor threshold. Simulations were conducted using the magneto quasi-static low-frequency solver of the simulation platform SEMCAD X.
Results: The H1 coil induced electric field with higher amplitude and a more widespread distribution in both the dorsolateral and medial prefrontal cortex than the figure-of-8 coil. Moreover, the penetration depth of the H1 coil was much higher than the figure-of-8 coil, particularly in the amygdala and nucleus accumbens, even if the induced fields were below the neural threshold.
Discussions: This work highlighted the importance to know the field distribution to evaluate the experimental results and to optimize the therapeutic treatments.

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The role of theta and gamma oscillations in working memory

A. Pahor[a,*], N. Jaušovec[a]
[a] University of Maribor, Slovenia
*E-mail: anja.pahor1@um.si.

The relationship between working memory and theta and gamma oscillations was investigated in two experiments in which we adopted correlational and experimental research designs, respectively. In experiment 1, 80 healthy adults were asked to relax with their eyes closed while their EEG was recorded. Afterwards, the participants solved verbal and spatial tests of short term memory (STM) capacity. The EEG data was analyzed in order to obtain 3 individual values (theta/gamma cycle length ratio, theta frequency, and gamma frequency), which were averaged and correlated with performance on the STM tests. Theta/gamma cycle length ratio positively correlated with verbal STM capacity and negatively correlated with spatial STM capacity. The results also showed that individual theta and gamma frequencies represented domain-specific and global predictors of STM capacity, respectively.

In order to verify the results of experiment 1, a second experiment was conducted (N=15) in which either theta or gamma tACS was applied over parietal areas and contrasted against sham stimulation. Following sham or verum tACS, the participants solved a series of figural and verbal n-back tasks during which their EEG was recorded. To our knowledge, this was the first study to compare the effects of tACS in individual theta and gamma frequencies (and sham stimulation) on working memory performance. The results showed that both theta and gamma tACS improved performance on the working memory tasks; however the former was more effective. Specifically, theta tACS was associated with faster and more accurate performance on the n-back tasks (particularly for verbal stimuli), which was accompanied by changes in early visual processing. Collectively, these findings support the roles of theta and gamma frequencies, and a theta/gamma neural code in working memory. In addition, they provide evidence in favor of the effectiveness of tACS in improving performance on cognitive tasks.

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Multi-channel electrocorticography seizure detection method for presurgical evaluation and cortical stimulation

S.-F. Liang[a], Y.-H. Shih[a,*], Y.-L. Chen[b], Y.-L. Hsin[c]
[a] National Cheng Kung University, Taiwan
[b] Biomedical Electronics Translational Research Center, Taiwan
[c] Chung Shan Medical University and Chung Shan Medical University Hospital, Taiwan
*E-mail: doggy167@gmail.com.

Around 1% of the world's population is affected by epilepsy, and nearly 30% of patients are drug-resistant. Electrocorticography (ECoG) has been shown a useful diagnostic tool for source localization of seizure onset zone (SOZ) that is essential for surgical treatment or cortical stimulation for seizure control. However, visual inspection on multi-channel ECoG recordings is tedious and time consuming particularly for analyzing long-term recordings. There is an emerging need to develop an automatic and robust seizure detection assistant system for neuropsychology experts.

This paper proposes a two-stage method for multi-channel ECoG seizure detection. Seizure-like EEG segments are fast detected as seizure suspect by the extracted features including line length and Hjorth parameters. The seizure suspect is then confirmed by calculating the features including approximate entropy and power spectra for linear discriminant analyzer (LDA).

Source localization of SOZ can be achieved by analyzing the spatial and temporal propagation of the ECoG channels that seizures were detected. Long-term video-ECoG recordings of 5 patients implanted with intracranial electrodes for presurgical evaluation were analyzed in the experiments and the results demonstrate that the proposed method is reliable and suitable to be considered a valuable tool for presurgical evaluation and cortical stimulation.

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Naturalistic findings from an rTMS clinic for the treatment of depressive disorders, in a public health setting

G. Price[a,b], J. Lee[a,b], A. Bose[b]
[a] School of Psychiatry and Clinical Neurosciences, University of Western Australia, Perth, Australia
[b] Statewide Department of Neurophysiology, Clinical Research Centre, North Metropolitan Health Service Mental Health, Perth, Australia

Introduction: In conjunction with an rTMS research program conducting clinical trials since 2005, the North Metropolitan Mental Health Service established an "rTMS depression treatment clinic" in Perth in July 2011. We describe the operation of the rTMS service and provide naturalistic assessment of a public service based use of rTMS for treatment of depression.
Methods: The referral and assessment process are described. Pooled data from all referrals were analyzed.