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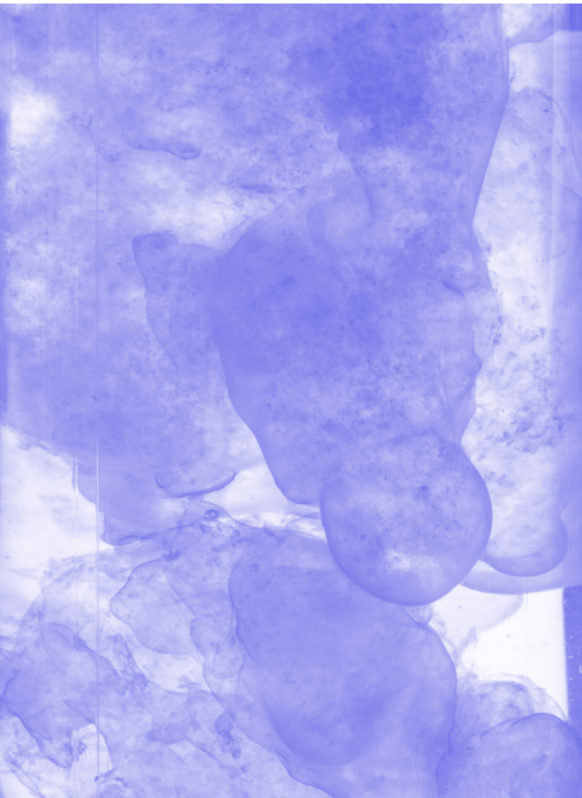
Applied Neuroscience and Neural Engineering



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Section Information

This Section is open to high-quality papers in the field of neuroscience, including fundamental research, engineering techniques, and applications. These studies will enable the scientific community to gain more knowledge and enlightenment regarding how the brain's nerve cells develop, grow, and interact to form (human) thought and action, and how to use engineering technology to interact with, understand, repair, replace or enhance the nervous systems.

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Selected Papers

Effect of an Adjustable Hinged Carbon Fiber Operating Table on Sagittal Alignment of the Lumbar Spine

Authors: Masato Tanaka, Dhvanit Desai, Yoshihiro Fujiwara, Shinya Arataki, Kajetan Latka, Naveen Sake, Wang Liang, Yuya Kodama, Yoshiaki Miyamoto and Taro Yamauchi

Abstract: This is a prospective study that has been done to assess the lumbar sagittal alignment of patients positioned prone over an adjustable hinged carbon fiber operating table. The following three variations of table position have been considered: neutral, 20° convex, and 20° concave bending. A total of 33 patients who underwent lumbar disc herniation and lumbar canal stenosis surgery were enrolled. Patients who presented with spinal deformity akin to lumbar scoliosis or spondylolisthesis were excluded. For the surgical procedure, following the induction of endotracheal general anesthesia, patients were positioned prone on the adjustable hinged carbon fiber operating table. Radiographs of the lateral view of the lumbar spine were acquired for the three table positions, i.e., neutral, 20° convex, and 20° concave. The lumbar lordosis was measured on radiographs. The lumbar lordosis presented divergently in all three variations of the table ($p < 0.01$): 45.2 ± 11.0° in neutral; 52.0 ± 10.7° in 20° lumbar extension bending; and 35.9 ± 10.8° in 20° lumbar flexion bending. The efficacy of table bending was 46.5% in convex and 34.0% in concave bending. In conclusion, the lumbar lordosis in three different table positions were 35.9° in 20° convex bending, 45.2° in neutral, and 52.0° in concave bending. The efficacy of table bending was 46.5% in convex and 34.0% in concave bending.

https://doi.org/10.3390/app13010138

Asynchronous and Slow-Wave Oscillatory States in Connectome-Based Models of Mouse, Monkey and Human Cerebral Cortex

Authors: Maria Sacha, Jennifer S. Goldman, Lionel Kusch and Alain Destexhe

Abstract: Thanks to the availability of connectome data that map connectivity between multiple brain areas, it is now possible to build models of whole-brain activity. At the same time, advances in mean-field techniques have led to biologically based population models that integrate biophysical features such as membrane conductances or synaptic conductances. In this paper, we show that this approach can be used in brain-wide models of mice, macaques, and humans.We illustrate this approach by showing the transition from wakefulness to sleep, simulated using multi-scale models, in the three species. We compare the level of synchrony between the three species and find that the mouse brain displays a higher overall synchrony of slow waves compared to monkey and human brains. We show that these differences are due to the different delays in axonal signal propagation between regions associated with brain size differences between the species. We also make the program code—which provides a set of open-source tools for simulating large-scale activity in the cerebral cortex of mice, monkeys, and humans—publicly available.

https://doi.org/10.3390/app14031063

Bibliometric and Visual Analysis of the Scientific Literature on Percutaneous Electrical Nerve Stimulation (PENS) for Pain Treatment

Authors: Federica Monaco, Sergio Coluccia, Arturo Cuomo, Davide Nocerino, Daniela Schiavo, Gilda Pasta, Francesca Bifulco, Pasquale Buonanno, Vittorio Riccio, Marianna Leonardi, Francesco Perri, Alessandro Ottaiano, Francesco Sabbatino, Alessandro Vittori and Marco Cascella

Abstract: Percutaneous electrical nerve stimulation (PENS) is a minimally invasive peripheral neuromodulation approach implemented against chronic neuropathic and mixed pain. This bibliometric study aims to quantitatively evaluate the output of PENS for pain treatment in the scientific literature. The main purpose is to stimulate research in the field and bridge potential scientific gaps. rticles were retrieved from the Web of Science (WOS) database. The search key term was “percutaneous electrical nerve stimulation (All Fields) and pain (All Fields)”. Year of publication, journal metrics (impact factor and quartile, Q), title, document type, topic, and citations were extracted. The join-point regression was implemented to assess differences in time points for the publication output. The software tool VOSviewer (version 1.6.17) was used for the visual analysis. One thousand three hundred and eighteen articles were included in the knowledge visualization process. A linear upward trend for annual new publications was found....

https://doi.org/10.3390/app13010636

Novel Deep-Learning Approach for Automatic Diagnosis of Alzheimer’s Disease from MRI

Authors: Omar Altwijri, Reem Alanazi, Adham Aleid, Khalid Alhussaini, Ziyad Aloqalaa, Mohammed Almijalli and Ali Saad

Abstract: This study introduces a novel deep-learning methodology that is customized to automatically diagnose Alzheimer’s disease (AD) through the analysis of MRI datasets. The visual diagnosis of mild to very mild stages of AD is challenging due to the MRI similarities observed between a brain that is aging normally and one that has AD. Deep-learning techniques have recently been shown to be significantly more effective than human detection in identifying various stages of AD, enabling early-stage diagnosis. The aim of this research is to develop a deep-learning approach that utilizes pre-trained convolutional neural networks (CNNs) to accurately detect the severity levels of AD, particularly in situations where the quantity and quality of available datasets are limited. In this approach, the AD dataset is preprocessed via a refined image processing module prior to the training phase. The proposed method was compared to two well-known deep-learning algorithms (VGG16 and ResNet50) using four Kaggle AD datasets: one for the normal stage of the disease and three for the mild, very mild, and moderate stages, respectively. This allowed us to evaluate the effectiveness of the classification results....

https://doi.org/10.3390/app132413051

Evaluating the Efficacy of Transcranial Magnetic Stimulation in Symptom Relief and Cognitive Function in Obsessive–Compulsive Disorder, Substance Use Disorder, and Depression: An Insight from a Naturalistic Observational Study

Authors: Andrea Stefano Moro, Daniele Saccenti, Alessandra Vergallito, Regina Gregori Grgič, Silvia Grazioli, Novella Pretti, Sofia Crespi, Antonio Malgaroli, Simona Scaini, Giovanni Maria Ruggiero, Sandra Sassaroli, Mattia Ferro and Jacopo Lamanna

Abstract: The utilization of non-invasive neurostimulation techniques, such as transcranial magnetic stimulation (TMS), is increasingly prevalent in psychiatry due to their efficacy and safety. This within-subjects study examined the impact of TMS on cognitive and symptomatic outcomes in patients with obsessive–compulsive disorder (OCD), substance use disorder (SUD), and major depressive disorder (MDD). A total of 44 patients underwent cognitive tests and symptom assessments before and after an intensive four-week TMS treatment phase, followed by a four-week maintenance phase. Cognitive assessments included Raven's matrices, verbal fluency, and digit span tests, while symptom severity was measured using the Italian version of the SCL-90-R. Decision-making performance was also evaluated by administering a delay discounting (DD) test. Principal component analysis was used to generate a dimensional characterization of subjects along cognitive and symptom-related axes before and after treatment. The results indicated that TMS significantly improved symptom scores, but no significant cognitive enhancement was observed. Statistical analysis based on linear mixed-effects models confirmed these findings, showing a significant fixed effect of TMS treatment on symptoms but not on cognitive performance. DD metrics remained unchanged. These findings suggest that while TMS effectively alleviates clinical symptoms, it does not produce consistent or appreciable enhancement of cognitive functions in these protocols. This study highlights the need for more personalized and combined therapeutic approaches to maximize the benefits of TMS, potentially incorporating cognitive enhancement strategies. Future studies will be useful to explore whether the results we obtained are valid for other pathologies, cognitive tests, and stimulation protocols.

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