IS12
Auditory neuroelectronic interfaces

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Auditory neuroelectronic interfaces represent a branch of medical bionics, a rapidly growing research and technology field that can effectively connect electronic systems such as computer chips with nervous systems. The two most successful examples of such interfaces are the cochlear implant (CI) and the auditory brainstem implant (ABI), which allow direct stimulation of the auditory nerve and the cochlear nucleus in the brainstem. These devices may evoke partial hearing and even establish full-fledged auditory communication in a completely deaf person. Nevertheless, today's fundamental limitations of non-selectivity and widespread electrical stimulation lead to considerable variability in the success of the implants.
We intend to “attack” this fundamental limitation using -high-dense microelectrode arrays and nanostructured materials, such as graphene and hBN, which possess a whole range of intriguing physical and chemical properties, theoretically enabling this full integration and intimate interaction with the neural tissue. In particular, we are assessing the suitability of graphene and hBN for in-vitro growth of cell cultures of spiral ganglion neurons (SGN). Furthermore, to evaluate the quality of the auditory neuro-electronic interface, parametrization of the biomedical protocol for in-vitro culturing of auditory neurons is necessary, and the identification of design specifications of graphene and hBN to be used as stimulation and recording platform.
In this talk, I will first overview the state-of-the-art auditory neuroelectronic interfaces and present the morphological analyses of in-vitro SGN cultures extracted from neonatal rat pups and grown on graphene and h-BN substrates previously coated with poly-L-ornithine and laminin. The cultures were immunocytochemically stained at seven days in vitro (7DIV), and the subsequent fluorescence images were analyzed with the custom-made machine learning-based image processing allowing successful segmentation and classification of neurons. Neurons were examined for various morphological properties, including cell density, neurite length, and cell dispersion as a measure of cellular clusterization.

IS13
Artificial intelligence in recognition of retinal conditions; Pros and Cons

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Artificial intelligence in ophthalmology has been emerging over the last decade. The current theoretical knowledge and technical abilities led to development of artificial intelligence-based systems able to recognise different retinal conditions based on colour fundus photographs or optical coherence tomography scans. Our collaborative research group applied a novel deep learning architecture to a clinically heterogeneous set of three-dimensional optical coherence tomography scans. The group demonstrated a performance in making a referral recommendation that reaches or exceeds that of experts on a range of sight-threatening retinal diseases after training on only 14,884 scans. Moreover, we demonstrate that the tissue segmentations produced by our architecture act as a device-independent representation; referral accuracy is maintained when using tissue segmentations from a different type of device. Our work removes previous barriers to wider clinical use without prohibitive training data requirements across multiple pathologies in a real-world setting. Furthermore, for conversion from dry to exudative form of age-related macular degeneration, our deep learning-based system combines prediction models on both 3D optical coherence tomography images and their corresponding automatic tissue maps generated by a segmentation network. The system predicts conversion within a clinically actionable time window of 6 months. We achieve a per-scan sensitivity of 80% at 55% specificity, and 34% sensitivity at 90% specificity. Nowadays, the current AI models shown a significant improvement in accuracy. However, there are a few main questions which should be considered; whether the current accuracy is sufficient to implement the AI based systems in real-life clinical practices and what may be medico-legal implications of using AI based systems in standard care of patients.