Transcranial Low Intensity Focused Ultrasound: A novel approach to non-invasive brain mapping

Tuesday, Jun 19: 2:45 PM - 4:00 PM
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Symposium
Tuesday - Symposia PM

Neuromodulation is a crucial complement to neuroimaging approaches in understanding the relationship between brain and behavior. While established methodologies for neuromodulations do exist, transcranial Low Intensity Focused Ultrasound (LIFU) has the potential for adding new key capacities for brain mapping, as demonstrated by the recent emergence of a critical mass of scientists employing it in the context of brain mapping, in both the healthy and pathological brain. Transcranial LIFU is a non-surgical low-energy technique for safely inducing transient plasticity in sub-cortical and cortical areas with high spatial resolution and adjustable focus. LIFU can be used for probing function in individual regions including areas that fall beyond the reach of current neurostimulatory techniques such as ventral prefrontal cortices, the medial temporal lobe, and deep nuclei such as thalamus. The excitatory and inhibitory neuromodulatory effects of LIFU can also be used to assess network function connectivity, particularly when employed in conjunction with neuroimaging techniques (e.g., fMRI, EEG). Furthermore, this technique might also be used for modulating myelinated nerves/white matter tract transmission, as well as modulating neurotransmission. Finally, preliminary data suggest that LIFU can also be employed, in the clinical context, as a neurorestorative approach. As the above suggests, it is an early and exciting time in the field of sonic neurostimulation for brain mapping, which is the perfect time to host a group discussion, as a symposium at OHMB, aimed at demonstrating and bringing to a wider audience the current approaches, challenges, and future directions for this technology as a tool for neuroscience research and brain mapping and potential clinical applications.

Objective

Understanding how transcranial Low Intensity Focused Ultrasound can be employed in brain mapping.
Understanding the main advantages and limitation of the technique in the brain mapping context.

Target Audience

This symposium is aimed at both junior and established scientists interested in basic science as well as researchers/clinicians interested in translational/interventional research.

Organizer

Martin Monti, UCLA

Presentations

Noninvasive ultrasound-based neuromodulation in subcortical structures in vivo (index.cfm?do=ev.viewEv&ev=1621)

Focused ultrasound (FUS) has been demonstrated to modulate neuronal activity in both cortical and subcortical brain regions in a noninvasive and safe manner in mice, non-human primates and humans. Simulations of beam profiles in rat head models have demonstrated the formation of secondary pressure peaks due to reverberations. This may explain results showing motor responses following modulation of regions not directly responsible for motor movement. Our group has developed a system for ultrasound neuromodulation at higher resolutions in mice in order to selectively stimulate brain regions such as the somatosensory cortex and locus coeruleus. Both motor and sensory responses have been elicited and the ultrasound parametric space allows for 100% success rate in stimulation under certain conditions. All these aspects of the technologies will be presented and potential for translation in humans will be discussed.

Presenter

Elisa Konofagou, Columbia University

Transcranial focused ultrasound for cortical and sub-cortical human neuromodulation (index.cfm?do=ev.viewEv&ev=1622)

Current non-invasive electric and electromagnetic non-invasive neuromodulatory approaches have proven effective for inducing transient plastic changes in human cortex. However, these technologies have poor spatial resolution and suffer from a depth-focality tradeoff. Transcranial focused ultrasound (tFUS) is an emerging non-surgical low-energy technique for inducing transient plasticity in sub-cortical and cortical areas with high spatial resolution and adjustable focus. tFUS has been successfully employed in small and large animal preparations and our work has also demonstrated tFUS to be effective for human cortical and subcortical neuromodulation. Here, we will discuss tFUS current approaches as well as challenges and future directions for this technology as a tool for neuroscience research and human brain mapping and potential clinical applications.

Presenter

Wynn Legon, University of Virginia

Non-invasive regional brain stimulation using focused ultrasound: From small animals to humans (index.cfm?do=ev.viewEv&ev=1623)

Low-intensity Focused Ultrasound (LIFUS) provides unprecedented means to non-invasively suppress/stimulate neural substrates of the brain with exquisite spatial specificity and depth penetration. We present data to support this unique ability from small (rodents)/ large animals (sheep), and humans by stimulating their various areas of the brain, including somatosensory, motor, and visual areas. Studies on modulating the function of myelinated nerves/cranial nerves/white matter tract transmission, as well as modulation of the level of neurotransmitter by application of the LIFUS will also be presented.

Presenter

Seung-Schik Yoo, Harvard Medical School, Brigham and Women's Hospital

Thalamic Low Intensity Focused Ultrasound as an approach to recover consciousness in coma recovery (index.cfm?do=ev.viewEv&ev=1624)

In recent years an, increasing body of work has demonstrated that certain brain regions, such as thalamus, play a critical role in supporting consciousness and in allowing its re-emergence after coma-inducing brain injury. In this presentation we will discuss how Low Intensity Focused Ultrasound to thalamus can be employed beyond brain mapping, in the clinical setting, as a potential neurorestorative intervention, its advantages and limitations. In particular, we will present the case for thalamic sonication in post-coma patients as well as data demonstrating the potential of this technique in the clinical context.

Presenter

Martin Monti, UCLA