Poster Session 2

Balcony, Easel 118

1:00 PM to 2:30 PM

Brain Activation Changes under Anesthetics in Mice

Madison A. Bravo, Senior, Neurobiology
Annamarie Christina Lahti, Senior, Neurobiology
Innovations in Pain Research Scholar
Mentor: Pierre Mourad, Neurological Surgery

Electroencephalograms (EEGs) are commonly used for measuring electrical activity in the brain for neuroscience research. In order to better control experimental studies animals can be anesthetized, however there is minimal research done on how the anesthetics may actually change the response the brain has to stimuli. Two commonly used anesthetics are isoflurane and dexmedetomidine. It is currently hypothesized that isoflurane produces a slow wave brain state similar to sleep and dexmedetomidine produces a persistent active brain state similar to an awake animal. This study aims to determine the differences in activation from visual and focused ultrasound stimulation through intra-cranial EEG monitoring in mice. Studies were conducted with a surgery to implant intracranial electrodes in A1, S1, and V1 on both sides of the brain under 3% isoflurane. Isoflurane was then reduced to 1.5% and a recording of the brain was taken for 10 minutes. This was followed by a light stimulus in the right eye with an LED. Focused ultrasound was aimed in V1 left. After the isoflurane trials were completed, the mice were injected with dexmedetomidine and the previously mentioned trials of base line, light, and focused ultrasound were performed again for every animal. Analysis included examining the EEG traces of individual events, averages of 10 events in one animal, and averages of 60 events in an animal. Continuous wave transformation plots were also produced to determine the frequency contribution in the evoked response. Preliminary results show that there is increased activation in V1 left under each anesthesia with some activity appearing in A1 left, however this may be a result of the proximity of the areas. Further research is needed in order to determine the similarities between the brain states and fully awake animals and animals that are in a natural sleep state.

Poster Session 2

Balcony, Easel 120

1:00 PM to 2:30 PM

Virtual Environments in Stroke Rehabilitation

Alvin B. Duong, Senior, Biology (Bothell Campus)
Mentor: Pierre Mourad, Neurological Surgery
Mentor: Aaron Bunnell
Mentor: Nina LaPiana, STEM, UW Bothell

Through the use of virtual and augmented reality technology, we want to record clinical interactions within the respective environments on acute stroke patients to help us design more acceptable gaming technologies for a wide range of ages and backgrounds in future studies. With the combined efforts of the computer science and electrical engineering team, we were able to produce two games; "Dolphin Days" for the augmented reality environment and "Apollo" for the virtual reality environment. "Apollo" will be available for play during the duration of the symposium. The purpose of exposing patients to these environments is to promote neuroplasticity in the recovery process. Neuroplasticity is when the brain can reform or grow new nerve endings to reconnect with the affected areas in order to accomplish a function. Clinically, our experience has been that patient motivation is key to obtaining good clinical outcomes. Stroke rehabilitation therapies can often be tedious and difficult to maintain interest in. These types of interventions, by incorporating the desired exercises into a motivating and game-like environment, could potentially address this issue. Additionally, these systems offer the potential advantage of not requiring the immediate presence of a skilled occupational and physical therapist. Cost and insurance limitations often mean patients get a limited number of skilled therapy sessions. Therapists skilled in the rehabilitation of stroke are often less available in rural regions and patients often struggle to travel to therapy appointments. All of these factors limit the patient's overall access to skilled therapeutic interventions. Our results found the overall patient census enjoying the environments while also having them engaged with the technologies. We believe using these technologies would further motivate patients undergoing stroke therapy to continue participation and ultimately reach a state where the patient feels confident physically and mentally to resume their daily tasks pre-stroke.

Poster Session 2

Balcony, Easel 119

1:00 PM to 2:30 PM

Diagnostic Ultrasound Can Modify Perception of a Visual Target, Increasingly So as a Function of Ultrasound Exposure, When Applied Transcranially to the Visual Cortex of Healthy Test Subjects

Nels W Schimek, Junior, Biochemistry
NASA Space Grant Scholar
Mentor: Pierre Mourad, Neurological Surgery

Transcranial magnetic stimulation (TMS) of the visual cortex can induce phosphenes - highly transient, generally formless lighted areas at the periphery of the visual field - of stimulated test subjects while they look at a small visual target. Non-diagnostic ultrasound, applied to the visual cortex, can also induce phosphenes, studied while test subjects had their eyes closed during stimulation. Here, we sought to study potential visual alteration of a visual target during application of diagnostic ultrasound to the anatomical location where TMS induced phosphenes in the periphery of that visual target. First we used TMS, guided by anatomical landmarks, to stimulate the visual cortex and generate phosphenes in the periphery of a visual target. Next, we applied diagnostic ultrasound over 21 trials for 15 seconds per trial to a test subject while they looked at a white cross with a beginning baseline and a mix of random sham and treatment diagnostic ultrasound exposures. 10/11 test subjects observed TMS-induced phosphenes. Diagnostic ultrasound stimulation of the visual cortex induced visual effects in 7/10 test subjects, with no effects in 3/10 test subjects. The likelihood of the 7/10 test subjects to observe a visual effect increased as the experiment progressed, increasingly so as ultrasound exposure increased. Diagnostic ultrasound, delivered transcranially to healthy test subjects, altered the perception of a visual target and generated a lasting effect on their visual perception. This observation of a prolonged effect on visual cortex is consistent with recent work on stimulation by diagnostic ultrasound of the human motor cortex as well as earlier work on stimulation of the human amygdala. These results suggest diagnostic ultrasound may one-day find rapid application to humans for a variety of purposes, and also raises questions about the advisability of applying diagnostic ultrasound to the human brain without medical justification.

Poster Session 3

Balcony, Easel 118

2:30 PM to 4:00 PM

Assessment of Nerve Sensitivity Associated with Targeted Muscle Reinnervation Surgery

Madison Lee Selby, Junior, Earth & Space Sciences (Biology)
Chikodinaka K. (Chikodi) Ezeokeke, Recent Graduate, Biology (Physiology)
NASA Space Grant Scholar
Mentor: Pierre Mourad, Neurological Surgery
Mentor: Michael Bobola, Neurological Surgery

Anecdotal evidence suggests patients that undergo Targeted Muscle Reinnervation (TMR) surgery, an operation where nerves are implanted to muscle instead of cut and left between muscle, report less residual and phantom limb pain when compared to standard amputation patients. To our knowledge, this is the first study to investigate this claim. Based on the nature of the TMR procedure, it should facilitate higher pressure thresholds than a severed nerve from a standard amputation, resulting in less pain for the patient. The risk of neuromas, a collection of highly sensitive tissue that can develop on a damaged nerve, should also diminish. To evaluate the efficacy of TMR in relation to pain reduction, a populace upwards of 135 people (comprised of TMR amputees, standard amputees and a control cohort) will have their nerves stimulated using focused ultrasound, allowing the application of focal intense and transient pressure on the nerve and not on the surrounding tissue. In this study, diagnostic ultrasound imaging guided the application of intense focused ultrasound on intact and transected nerve endings in our test subjects. We increased the ultrasound intensity until we either elicited a sensation or reached the maximum output possible by our device. We anticipate TMR amputees to have a higher threshold for ultrasound-induced sensations than standard amputation test subjects, but a lower threshold than the control test subjects. Due to the limited availability of TMR amputees in the area, a definitive conclusion has not been made about the effect TMR has relative to the standard amputation. When analyzing results from standard amputees specifically, there are three subgroups that possess an intriguing feature that distinguish them from each other. This study can potentially influence the types of surgical techniques offered to future amputees if TMR operations do in fact reduce the amount of pain experienced by patients.