CRANIAL NERVE NON-INVASIVE NEUROMODULATION (CN-NINM) EFFECTS ON CORTICAL AND SUB-CORTICAL ACTIVITY AS MEASURED WITH BOLD-FMRI

Wildenberg, J.C. 1,2,3, Tyler, M.E. 4,5, Danilov, Y.P. 4, and Meyander, M.E. 1,2,6

1 Neuroscience Training Program, 2 Clinical Neuroengineering Training Program, 3 Medical Scientist Training Program, 4 Orthopedics and Rehabilitation, 5 Biomedical Engineering, 6 Medical Physics, University of Wisconsin, Madison, WI, 53792

Purpose
This study investigated the mechanisms and locations within the brain of the neuromodulation underlying the residual sensory effects following cranial nerve stimulation. We used the ‘sensory substitution’ method with CN-NINM. The design of the simulation and the stimulation were described in a prior study (wildenberg et al., 2007). Here we present the functional magnetic resonance imaging (fMRI) data from patients with CN-NINM. The aim of the experiment was to investigate the brain areas involved in processing CN-NINM and to determine the degree to which these areas are regulated by CN-NINM. We also examined healthy controls without any exposure to CN-NINM to compare the neural activity observed in patients to normal activity for people without balance disorders.

Methods
Patients: Three women and three men ranging from 46 to 86 years old were recruited from the Adult Neurology Clinic and the Neurosurgery Center. All participants were clinical patients with peripheral or central vestibular loss and were free of other neurological and psychiatric disorders. All patients underwent a complete neurological and psychiatric evaluation to rule out other neurological or psychiatric disorders. The patients were administered a standardized balance assessment battery and underwent one week and another MRI scan within three hours after completing the therapy.

Visual Stimuli: Visual stimuli were displayed to subjects on a 17” CRT monitor positioned approximately 0.938 meters (0.3 feet) in front of the subject. The monitor was mounted on a 15.24 cm (6”) diameter tripod and was controlled by an IBM compatible computer. The visual stimuli consisted of a static checkerboard as shown above. The visual stimuli were designed to activate the subject’s balance processing centers and were presented nine times during each functional scan. For each trial, the visual stimulus was presented for 10 seconds, with a 1-second black interstimulus interval. The visual stimulus included two types of checkerboards: a low-contrast checkerboard (black and white) and a high-contrast checkerboard (white and black). The visual stimuli were presented in a random order to each subject. The visual stimuli were presented in a random order to each subject.

Results
Analysis of the dorsal Pons ROI: The dorsal Pons ROI (Figure 1) showed increased activity in patients with CN-NINM compared to the Pre-CN-NINM condition. This increased activity is consistent with our theory that CN-NINM improves the ability of the brain to process sensory information, and in doing so, emphasizes the processing centers to integrate sensory information, and in doing so, emphasizes the processing centers to integrate sensory information.

Conclusions
Our results show that CN-NINM can be used to improve the processing of sensory input in patients with balance disorders. This finding is consistent with previous studies that have shown CN-NINM to be effective in improving the processing of sensory input in patients with balance disorders.

References

Support and Acknowledgements
This project was supported by grants from the National Institute on Deafness and Other Communication Disorders (R25 DC00579, P30 DC011205, U24 DC010664). The authors thank Dr. Kurt Hawkins for clinical coordination in the recent study. The Authors gratefully acknowledge Dr. Kurt Hawkins for clinical coordination in the recent study.