Neural pathways in cranial nerve non-invasive neuromodulation (CN-NINM)

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Applied Neuro MRI Lab

TCN Lab

TCN Lab historically was deeply involved in development of theoretical and practical techniques for imaging brain, spinal cord, and peripheral nerves using a variety of advanced MRI and MEG technologies. Thanks to the expertise of Dr. J. Wildenberg, TCN Lab is now also able to provide comprehensive physical therapy services.

In 2011, our group developed the new generation of neuromodulation technology, cranial-nerve non-invasive neuromodulation (CN-NINM) for the treatment of dizziness and imbalance. CN-NINM uses transcranial magnetic stimulation (TMS) to induce neuromodulation in the brainstem, cerebellum, and pons.

METHODS

Five age and gender-matched normal controls (three men, two women) with a mean age of 38.1±12.5 years participated in this study. Patients had NINCDS criteria for probable AD. All patients had at least one criterion for the diagnosis of AD according to National Institute of Neurological and Communicative Disorders and Stroke, and were recruited from the memory clinic.

Subjects had undergone a cranial nerve examination at the University of Wisconsin Medical School, and were classified as having a normal or impaired cranial nerve function.

Spatial normalization was performed with the Statistical Parametric Mapping (SPM) software (Wellenberg et al., 2009). Functional images were obtained with a 3T GE scanner using a T2*-weighted echo-planer imaging sequence (TR/TE = 2000/30, flip angle = 90°). Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m. Functional images were collected with a T2*-weighted gradient-echo (SPGR) anatomical scans were collected with TR/TE = 10/3, 94 m.

RESULTS

We developed a new cranial nerve non-invasive neuromodulation (CN-NINM) device that excites and entrains neural activity in the brain, and tested its efficacy with 5 patients having moderate or severe balance, gait, and visual tracking deficits. All patients exhibited improved performance on all functional measures of postural and gait behavior as a result of CN-NINM training, and patient scores in self-assessments of dizziness and mobility also uniformly improved.

The new MRI signal processing techniques we developed afforded improved resolution of the brainstem and cerebellum, allowing observation of functional changes in the areas that correspond to the improvements in the sensory-motor behavioral measures. These images provide the first evidence of how and where CN-NINM is apparently changing brain function.

CONCLUSION

Based on our prior research, we postulate that CN-NINM induces recirculation of sensory-motor coordination of both head and body control, leading to improved functional balance and gait.

We believe that neuromodulation of the brainstem and cerebellum via cranial nerves that innervate the tongue (CN-V and CN-VII), exciting primarily the trigeminal nucleus complex, nucleus tractus solitarius is principally responsible for the observed functional neuromodulation.