Respiratory Event-Related Potentials in Patients with Spinal Cord Injury: Introduction and Overview

Andrew Harver, PhD¹, and Jesse A. Lieberman, MD, MSPH²
¹ Department of Public Health Sciences, University of North Carolina at Charlotte, USA
² Physical Medicine and Rehabilitation/Spinal Cord Injury Medicine, Carolinas Rehabilitation, Charlotte, NC, USA

Purpose and Hypothesis

Dyspnea is “a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity.” Previous research demonstrates that sensory information from the respiratory system activates regions of the cerebral cortex to produce the perception of dyspnea but far less is known about the neurophysiology of dyspnea than about vision, hearing, or pain. On the other hand, pathways that transmit somatosensory signals to the central nervous system (i.e., brain and spinal cord) are well described (Fig. 1).

Event-related potentials have been used to measure respiratory somatosensation with high temporal resolution. Event-related potentials (ERPs) are time-locked cortical signals that are measured non-invasively from the surface of the scalp in response to brief (< 200 msec) presentations of respiratory stimuli during normal breathing. When EEG samples are averaged over trials (Fig. 2) a discrete set of waveforms emerge (Fig. 3). We have shown previously, for example, that respiratory-related ERPs vary systematically as a function of age (Fig. 4).

The goal of this project is to examine neurophysiological mechanisms underlying respiratory sensations. We will evaluate the extent of sensory loss evident in persons with increasingly severe spinal cord injury on respiratory ERPs to test the hypothesis that respiratory sensations vary systematically as a function of somatosensory input from chest wall and intercostal muscle mechanoreceptors (Fig. 5).

Method

Our protocol is approved by IRBs at both Carolinas HealthCare System and UNC Charlotte. Twenty adults between 20 and 60 years of age with motor complete spinal cord injuries between the levels of C3 and T12 will be recruited from a registry of approximately 200 individuals with spinal cord injury who have received rehabilitative services through Carolinas Rehabilitation. For comparative purposes, 20 age-matched healthy volunteers will also be recruited to participate in the project. At an initial session we conduct general and lung health interviews; and measure lung function, expired nitric oxide, and quality of life (SF-36). Participants also complete a line length judgment task. At a second session electrodes will be attached at Fz, Cz, and Pz. ERPs will be recorded to brief presentations of inspiratory and expiratory resistive loads (Fig. 6).

Results and Discussion

We have piloted our procedures in both spinal cord injury and age-matched control participants; registered our project on clinicaltrials.gov; and embarked on data collection activities. Results from the first session for initial participants are presented in Table 1. Differences are evident between controls and patients in lung function (FVC) and for SF-36 Physical Functioning and General Health Perceptions subscales.

We are positioned for intensive recruitment activities and aggressive scheduling for both initial and ERP recording sessions.