Brain Injury Diagnostics

Open-Source Software for Improved Diagnosis of Mild Traumatic Brain Injury and Posttraumatic Stress Disorder and Discrimination of the Two

Symptoms associated with posttraumatic stress disorder (PTSD) and mild traumatic brain injury (mTBI) frequently overlap and can be both subtle and transient. There is currently no objective way of definitively diagnosing each of these injuries other than self-report or clinician administered assessments. This research addresses these critical gaps in the diagnosis and treatment of Service members by using an emerging, non-invasive neuroimaging technology, magnetic resonance spectroscopy (MRS) (Figure 1). Using widely available magnetic resonance imaging platforms, MRS can be used to compare relative concentrations of chemicals in the brain that have been used for the accurate diagnosis of neurological diseases such as brain tumors, Alzheimer's disease, and chronic pain.

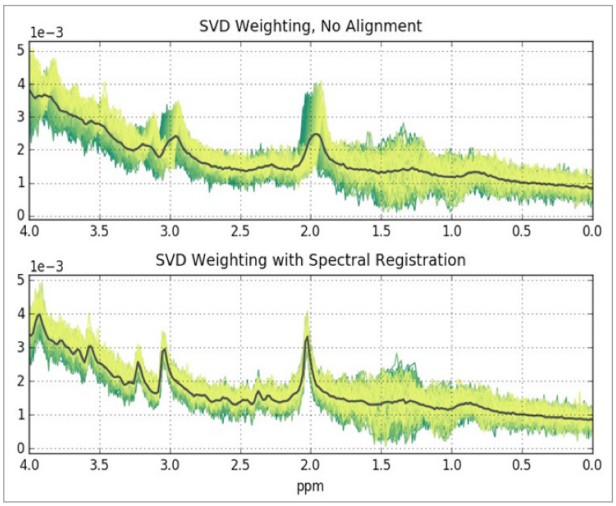

FIGURE 1: Diagnostic figures depicting effects of processing steps using Open MRSLab, an open-source software repository for MRS data analysis tools (https://github.com/openmrslab) (Figure used with permission from the authors)

Recent advances in MRS data analysis have been conducted by researchers at the Draper Laboratory (Cambridge, Massachusetts) and Brigham and Women's Hospital, Inc. (Boston, Massachusetts). These techniques have allowed for the identification of biomarkers using statistical signal processing algorithms and advanced pattern recognition methods that enable biomarker discovery and classification algorithms capable of revealing discriminating metabolic markers in MRS measurements. This project is using a multi-parametric approach using conventional one-dimensional spectroscopy as well as major advances in two-dimensional correlated spectroscopy to identify biomarkers that can be used to distinguish between PTSD, traumatic brain injury (TBI), and their comorbidity.

To accomplish the study aims, the research team has developed methods to improve the processing of MRS images. They addressed how to correct for temporal variation in repeated MR scans, which are required for this type of analysis (*Rowland et al. 2017*). In addition, they have developed robust statistical methods for analyzing raw data to reduce the level of noise and artifacts in MRS signals as well as control for the disparity across data sets acquired from different devices (*Irvine, Mariano, and Rowland 2016*).

Reproducibility of MRS methods in the scientific literature is hampered by the use of home-grown tools and often a lack of detail of how those tools are utilized. Therefore, there is a need for a freely available set of tools for spectroscopy post-processing open to the whole MRS community, which would allow for improved rigor and transparency of MRS data analysis and provide the necessary standardization that has so far eluded the field of MRS. A goal of this project is to provide a completely open-source environment for the development and sharing of MRS data analysis and signal processing methods. The team has made their post-processing tools freely available to the research community at OpenMRSLab: https://github.com/openmrslab (*Rowland, Mariano, and Irvine 2016*). This effort will improve diagnosis of mTBI and PTSD and discrimination of the two.

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