NEUROFEEDBACK REHABILITATION BASED ON FUNCTIONAL NEAR-INFRARED SPECTROSCOPY FOR POST-STROKE PATIENTS.

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Motivations

Neurological impairments such as stroke are the leading cause of disability among adults. Neuroimaging bases biofeedback, known as neurofeedback, could directly induce neuroplasticity through self-modulations. We propose a novel adaptive brain training methodology that changes motor task instructions hinge on current brain activity. This through the design and evaluation of an adaptive control algorithm based on real-time measurements of brain activity via function Near-Infrared Spectroscopy (fNIRS) neuroimaging.

The control algorithm used the input of primary motor cortex activity of the participant and across a predetermined model of the brain-behavior relationship, and the outputs instructions in a precision grid task to maintain brain activity at the desired level according to the defined therapy model.

Introduction

Defining the goal development of an effective intervention that targets neuroplasticity to benefic recovery. Targeting neuroplasticity by manipulation of neural activity is known as neuromodulation. Person-specific neuromodulation can be achieved by employing neurofeedback. The model uses non-invasive functional imaging to measure real-time brain activity in a predefined neural circuit and then visually presents it to the participant for self-modulation (Sulzer et al. 2013).

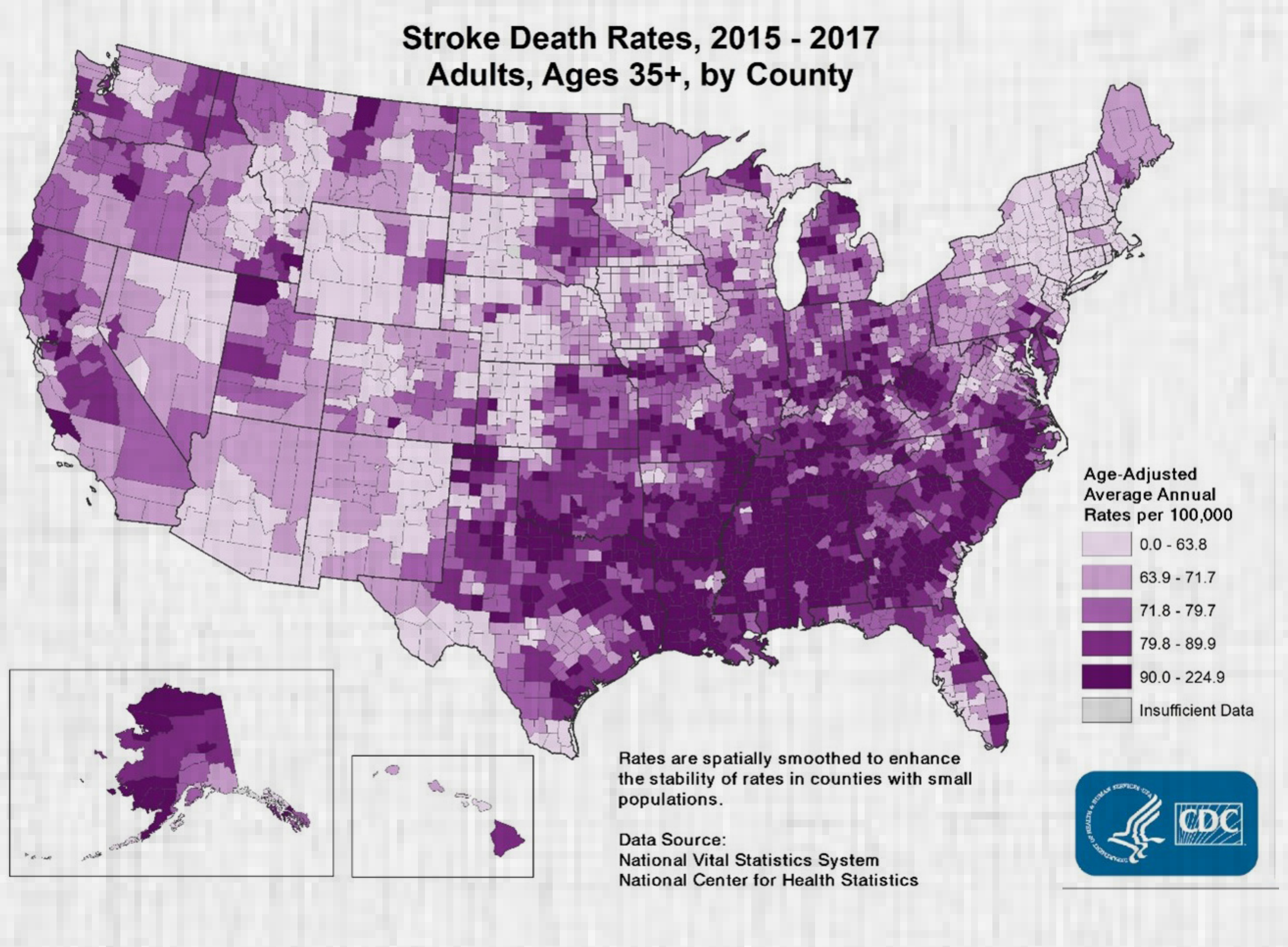

Figure 1. Stroke Death Rates in US (National Center for Chronic Disease Prevention and Health Promotion, Division for Heart Disease and Stroke Prevention, 2019).

We propose a novel neuroadaptive control algorithm capable of instructs motor tasks to maintain the desired level of cortical motor activity measured in real-time by measuring the brain signal using functional Near-Infrared Spectroscopy (fNIRS).

Hence, the task selection and modification would be developed by the algorithm instead of the participant or therapist, optimizing the desired neural response to enhance motor cortex performance (Figure 1).

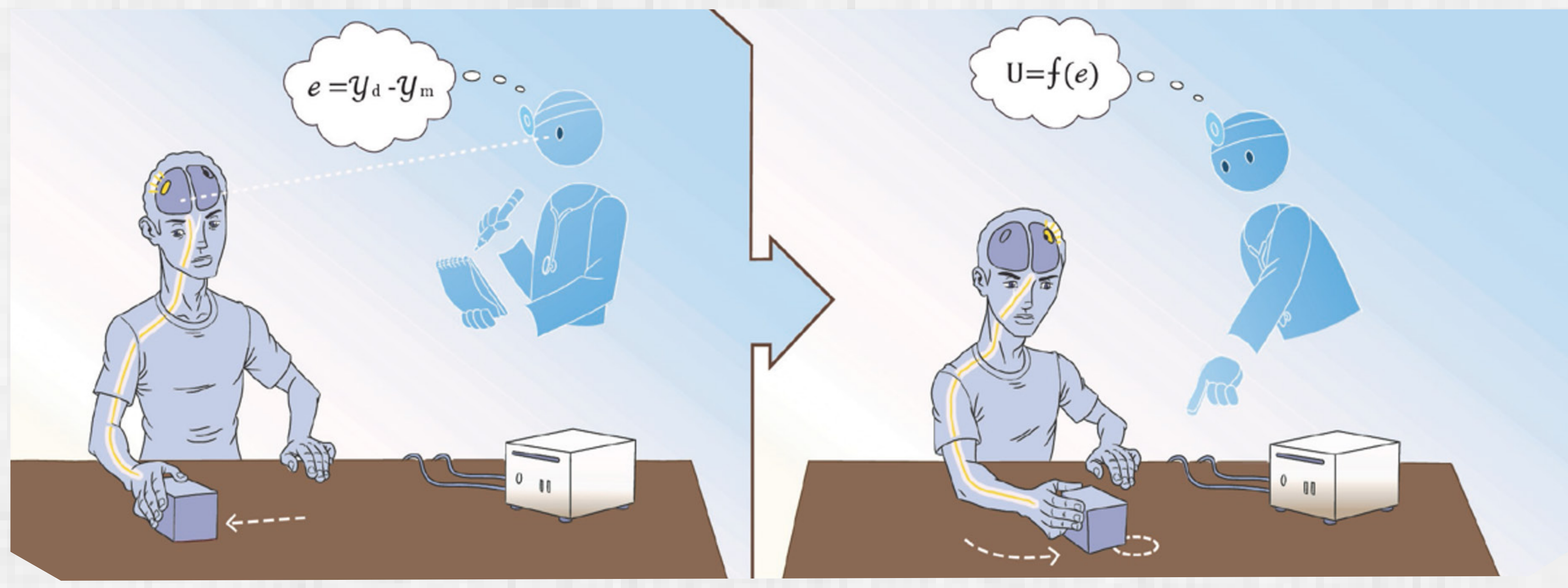

Figure 2. Conceptual image of the functionality of the control algorithm in the therapy-rehabilitation process adapting the exercise based on the brain activity observations.

Neurofeedback based on fNIRS

Functional Near-Infrared Spectroscopy, fNIRS, is a neuroscience tool that has been playing an important role in the understanding of brain systems functions at behavior and cognitive levels in the last years. The process of apply fNIRS technology starts with the irradiation of the head tissues with infrared light to obtain the raw neuroimage, it proceeds with computational and statistical analysis revealing hidden associations between pixels intensities and neural activity encoded to end up with the explanation of a particular aspect regarding brain function. (Herrera-Vega, 2017.

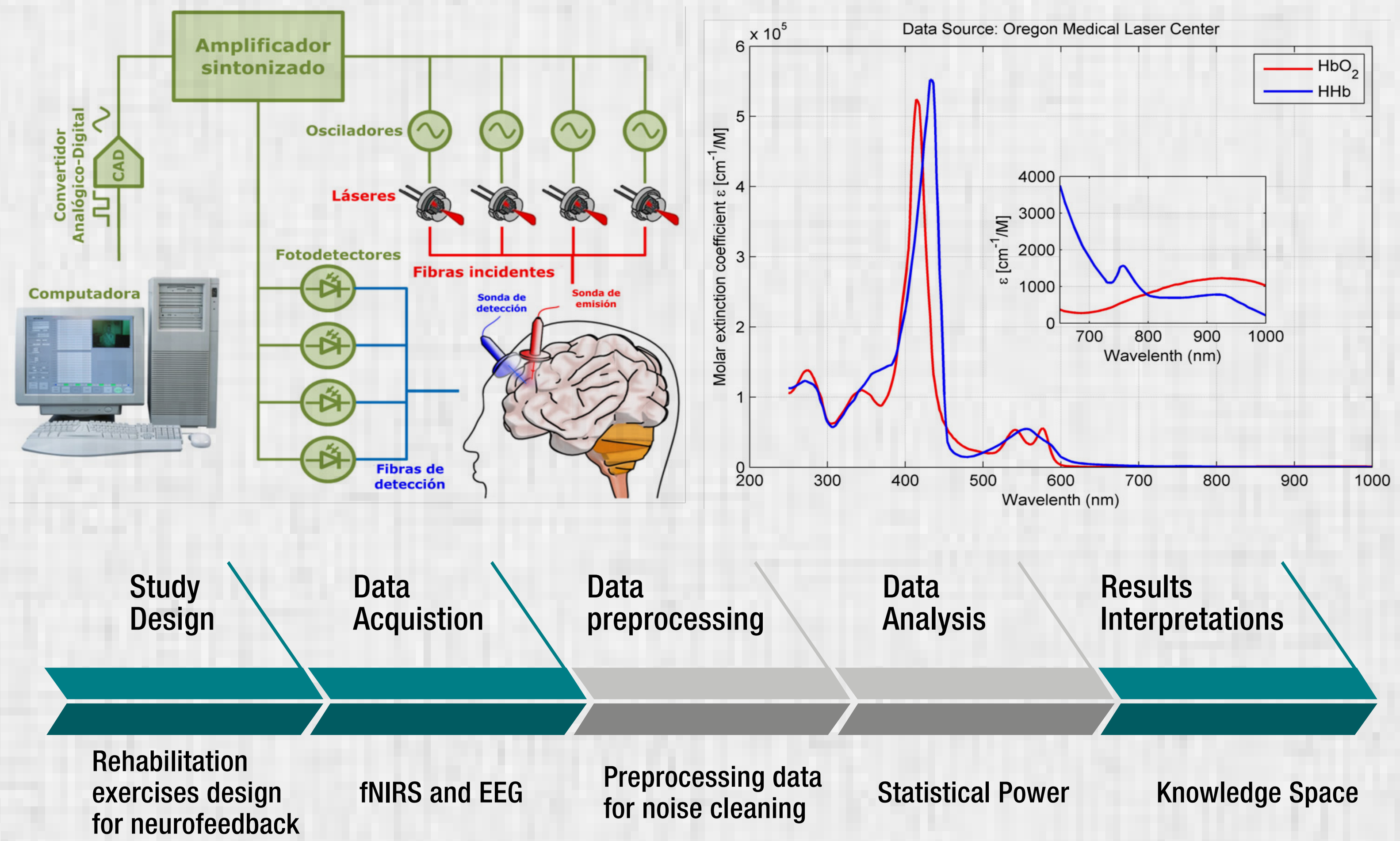

Figure 3. fNIRS pipeline.

The interpolation of Neurofeedback based on the extended fNIRS literature is the structural point of this research. The concept is a psychophysiological procedure in which online feedback of neural activation is provided to the participant for self-regulation, which is the learning control over specific neural substrates. Neurofeedback is considered a type of biofeedback in which neural activity is measured, visual, and auditory, or another representation of this activity is presented to the participant in real-time to facilitate self-regulation of the putative neural substrates that underlie a specific behavior or pathology (Sitaram, 2016).

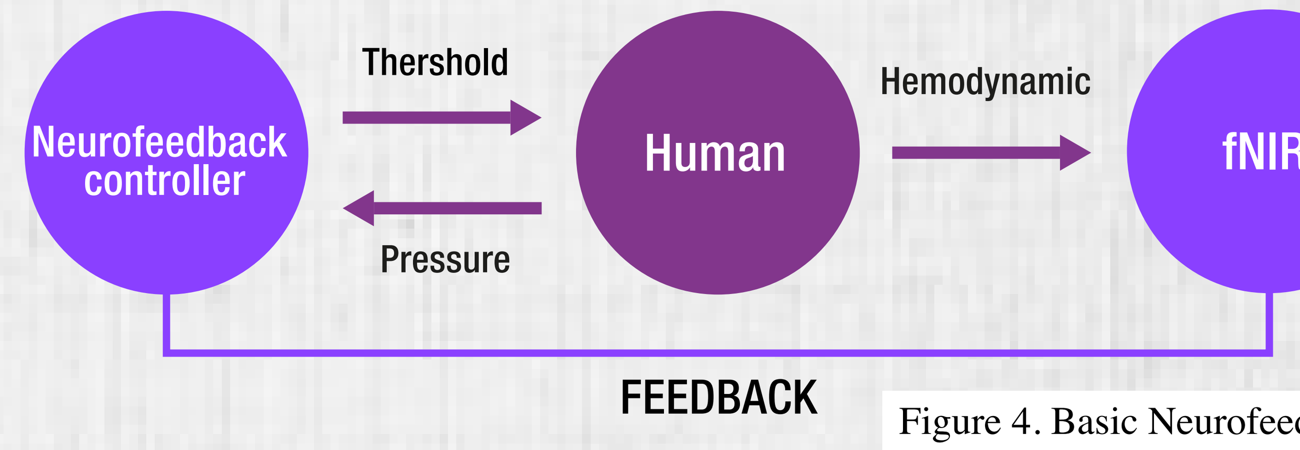

Figure 4. Basic Neurofeedback System.

Objectives

Towards the goal of an adaptive neurofeedback trainer based on fNIRS, we defined conceptual objectives for this presentation.

- Development of an adaptive control algorithm that instructs precision tasks to modulate contralateral primary motor cortical brain activation.
- Development of an fNIRS data preprocessing and a pipeline for analysis methodology suitable for real-time neurofeedback.
- Analysis of how to determine how self-modulation of collateral primary motor cortical brain activation changes the grip precision motor performance in healthy individuals.

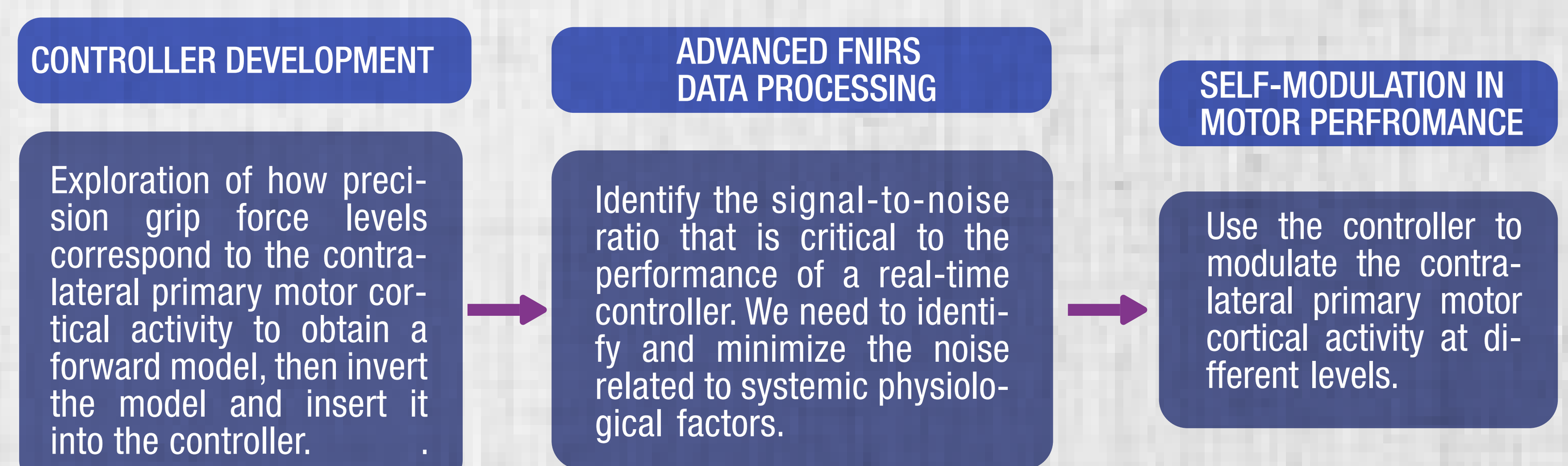

Figure 5. Methodology process.

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