Relating Pressure to fNIRS Optical Signal Quality

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Objective

Find and quantify the relationship between pressure and functional near- infrared spectroscopy (fNIRS) signal quality using a commercial force sensing resistor (FSR).

Background

- fNIRS is a noninvasive optical imaging technique that estimates the oxygenation of hemoglobin of the brain from changes in absorption of the near infrared light.
- FSRs are flexible, polymeric, piezoresistive sensors that can be used to measure force.

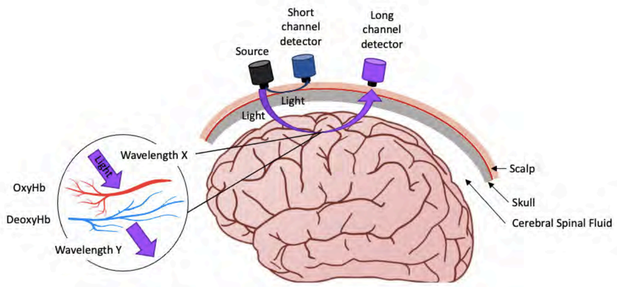

Figure 1. Visual representation of fNIRS

Methods

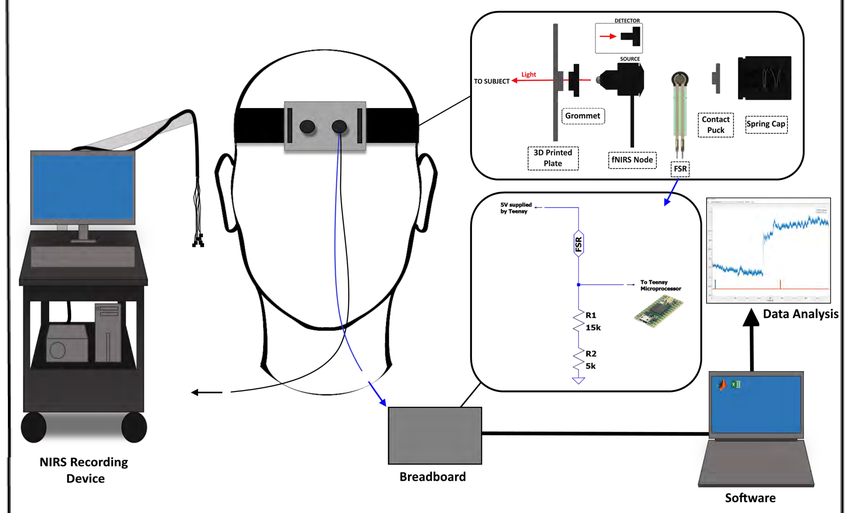

Figure 2. Schematic of methods used for experiment

- **Elastic Headband Setup** includes 1-channel fNIRS nodes and FSR in spring cap housing fitted into 3D printed plate.
  - Elastic allows adjustment between 'no pressure' (NP) and 'pressure' (P) conditions.
  - Interlink FSR 400 measures pressure from detector node.
  - Two configurations of 3D printed plate – Long Channel (LC) & Short Channel (SC)
- **Circuitry** to collect analog to digital converter (ADC) values from FSR.
  - Teensy 4.0 microcontroller and Voltage Divider circuit
- **Software** used to obtain and process data.
  - NIRStar15.3, Arduino, MATLAB/Simulink, and Excel

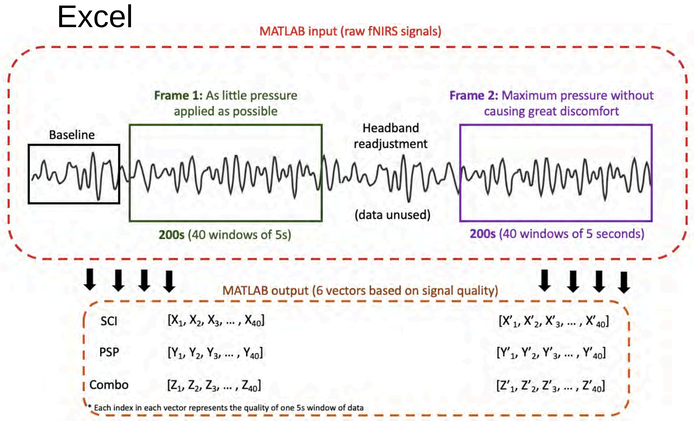

Figure 3. Block diagram of MATLAB code used for assessment of fNIRS signal quality

Results

- Addition of pressure from the detector node to the forehead resulted in signals with higher Scalp Coupling Index (SCI) and smaller error bars compared to NP condition (Fig. 4, left column).
- FSR ADC readout values increased significantly after headband tightening in LC configuration and decreased significantly in SC configuration (Fig. 4, right column).
- Two-tailed T-test: 2 out of 3 subjects for LC SCI comparison exhibit statistical significance (p-value <0.05) between NP and P conditions.

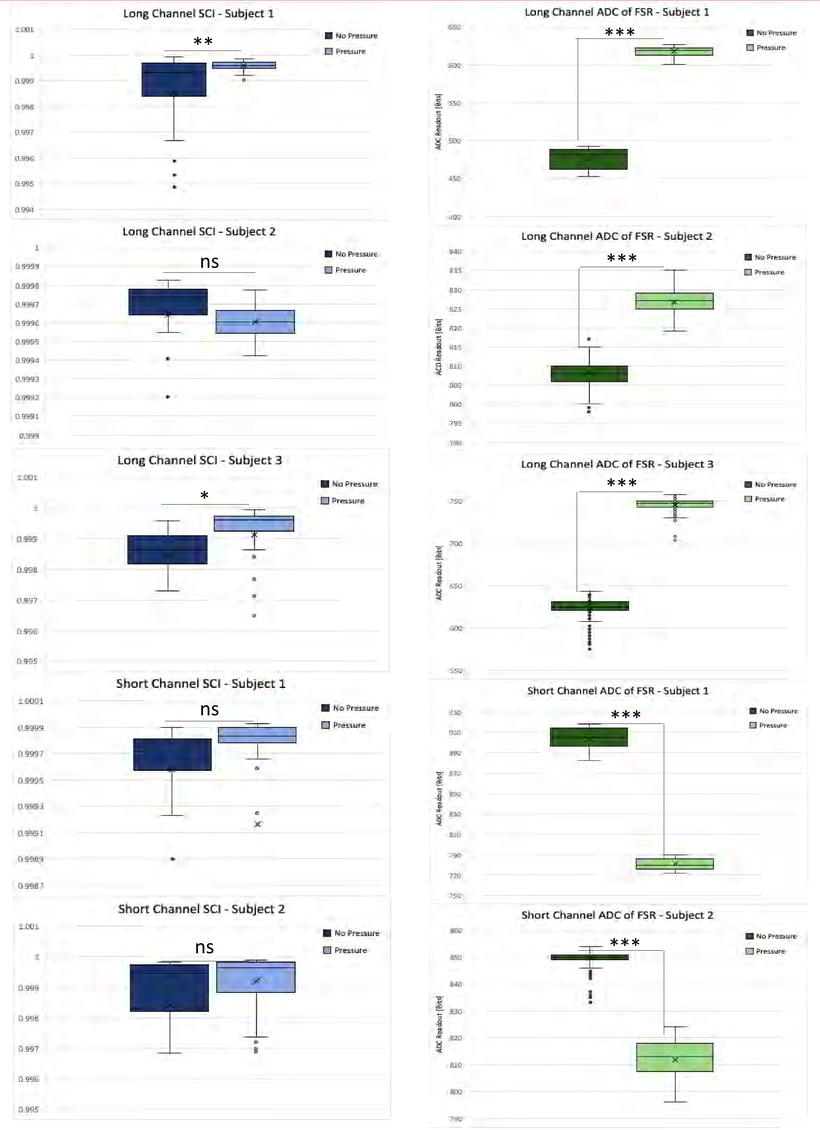

Figure 4. Plots of results from signal quality assessment (left) and FSR ADC readouts (right)

Conclusions

- **Pressure applied to forehead exhibits positive correlation to increased signal quality as quantified by SCI of signals and ADC of FSR.**
- **Structural differences between LC and SC plates may contribute to negative ADC change in short channel FSR readings during adjustment.**
- **FSR material characteristics demand a cooldown period between recordings.**