Preregistration - Resting-state fNIRS in people with Parkinson's disease

3/1/24

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1 Data collection

For fNIRS resting-state measurements, we re-invite people with Parkinson's disease (PD) and elderly of the cohort included for the "fNIRS study complex walking" study of the "Park-MOVE" trial (https://doi.org/10.48723/vscr-eq07). The Park-MOVE cohort consists of 42 younger adults (18-50 years), 49 older adults ($\geq$ 60 years), both free from cognitive impairments and medical conditions affecting gait and balance as well as 42 people PD ($\geq$ 60 years, clinical diagnosis $\geq$ 6 months prior to enrollment).

Data collection takes place at the uMOVE core facility, Karolinska University Hospital, Solna, Stockholm. All data is collected during a single experimental session.

Data collected consists of resting-state fNIRS data, cognitive screening data (MoCA), and a clinical test of balance (Mini-BESTest). Self-report questionnaires related to health status are

also filled out by participants using REDCap. The questionnaires include: Walk12G, WHO-DAS, HADS, and for the PD group also MDS-UPDRS part 1b & 2. Participants are also asked about their physical activity to assess a physical activity score (Frändin-Grimby). Participants from the PD group are also asked about their medication and time when medication was last taken.

As of the date of pre-registration, 4 participants have been collected since the data collection start on 10.11.2023.

2 Resting-state fNIRS setting

The fNIRS system is a NIRSport2 (NIRx) with 16 sources and 16 detectors, with 8 short-separation detectors. The optodes transmit light at 760 and 850 nm. Sampling frequency is 7.6 Hz. Two montages are used to cover the left and right brain hemispheres (Fig 1). Two resting-state measurements of 10 minutes each are performed, one for each hemisphere.

The resting-state measurement takes place in a calm, dimly lit room, with participants seated in an office chair, legs placed on a leg rest to decrease movement. Eyes are closed and participants are blindfolded as well. Ear plugs are used to shield from distracting noise. Participants are instructed not to focus on a special thought, let the mind wander, and to not fall asleep.

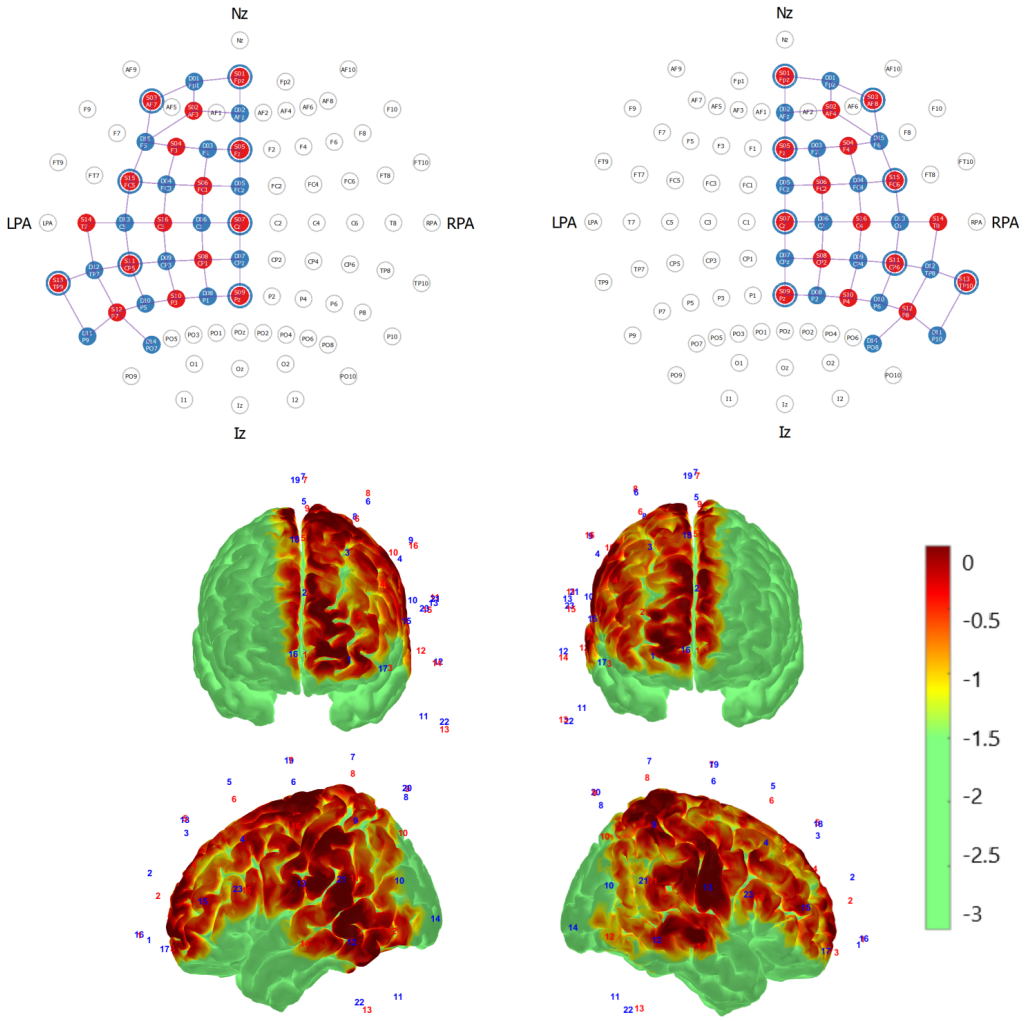

Figure 1: Montage used for the resting-state fNIRS measurement, showing optode configuration and sensitivity profiles generated in AtlasViewer for left and right hemispheres.

3 Data analysis

For quality control of fNIRS data, the scalp-coupling index (SCI) as well as peak spectral power (Pollonini, Bortfeld, and Oghalai 2016; Hernandez, Pollonini, and Pollonini 2020) of the fNIRS signal will be calculated.

Pre-processing and analysis of fNIRS data will be performed in the MATLAB-based NIRS Brain AnalyzIR toolbox. Raw data will be trimmed at the start and end of the measurement with 10 seconds on each side to avoid noise from position adjustments and similar. The raw optical density fNIRS data will be converted into ΔHbO2 and ΔHHb using the modified Beer-Lambert law (Delpy et al. 1988) with the differential path-length factor (DPF) dependent on age (Scholkmann and Wolf 2013). Connectivity analyses will use correlation models with pre-whitening (Barker, Aarabi, and Huppert 2013) and robust correlation computation (Santosa et al. 2017). From the correlation model, graph metrics of eigenvector centrality will be calculated.

4 Hypotheses

Hypotheses are based on a resting-state fMRI study (Ballarini et al. 2018) comparing PD with and without their usual dopaminergic medicine to healthy controls (HC), which found differences between the three different groups in eigenvector centrality values. Hypotheses are also based on an activation likelihood meta-analysis of resting-state fMRI studies (Tahmasian et al. 2017) which also compared PD with and without their usual dopaminergic medicine to HC, finding differences between the groups. For this resting-state fNIRS study, participants are on their usual dopaminergic medicine and findings from the corresponding group compared to HC in the articles are considered.

- **H1** There is a difference in eigenvector centrality between PD and HC (Ballarini et al. 2018)
- **H2** There is a lower eigenvector centrality in the PD group than in HC
  - **H2.1** Lower values will be found in the channels most closely corresponding to the MNI coordinates (48 17 -13) in the superior temporal gyrus (STG) and (-63 -25 38) in the supramarginal gyrus (SMG) (Ballarini et al. 2018)
  - **H2.2** Lower values will be found in the channels most closely corresponding to the MNI coordinates (46 -64 26) in the inferior parietal lobe (IPL) (Tahmasian et al. 2017)
- **H3** Eigenvector centrality in the PD group is negatively correlated with:
  - **H3.1** Disease severity (MDS-UPDRS III) (Ballarini et al. 2018)
  - **H3.2** Levodopa equivalent daily dose (Ballarini et al. 2018)
  - **H3.3** Disease duration (Ballarini et al. 2018)
  - **H3.4** MoCA score

5 Exploratory analyses

- How does eigenvector centrality correlate with balance ability (Mini-BESTest- score)?

- How does eigenvector centrality correlate with the number of falls within the last 12 months?
- Is eigenvector centrality different in people who fall versus people who do not fall?
- How does eigenvector centrality correlate with subjective activity levels (Frändin-Grimby score)?

References

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