Test-retest Reliability of Diffuse Optical Tomography in a VR set-up in Neurodiverse Children

Giulia Serino[1], Siofra Heraty[1,2], Silvia Dalvit-Menabe[3], Samuel Powell[4], Nicholas Everdell[4], Nadine Aburumman[5], Tony Charman[6], Essi Viding[7], Antonia Hamilton[8], Paola Pinti[1], & Chiara Bulgarelli[1]

[1]Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London, London, UK; [2]Child and Family Centre, Meath Primary Care Services, Our Lady's Hospital, Navan, Co. Meath, Ireland; [3]BabyBrains Limited, 33 Eastgate Street, ST16 3EL Stafford, UK; [4]Gowerlabs Limited; [5]Department of Computer Science, Brunel University; [6]King's College London; [7]Clinical, Educational, and Health Psychology Research Department, University College London; [8]Institute of Cognitive Neuroscience, University College London.

Introduction

- **Test-retest reliability** quantifies the consistency of a measurement across repeated measures
- It is crucial to confidently investigate the relationship between our measure and other variables of interest, thereby influencing the validity of the measure itself.
- Good reliability constitutes one of the core principles in cognitive neuroscience, especially when studies results will inform strategies of intervention for neurodivergent children.
- Despite the significant increase of fNIRS studies over the past years, reproducibility assessments, particularly in studies with developmental populations, is limited to two experimental works (Blasi et al., 2014; Gemignani et al., 2023).

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This study aims to assess the replicability of of diffuse optical tomography (DOT) implemented in a VR set-up in neurodevelopmental populations, with particular attention to neurodiverse children.

Design & Methods

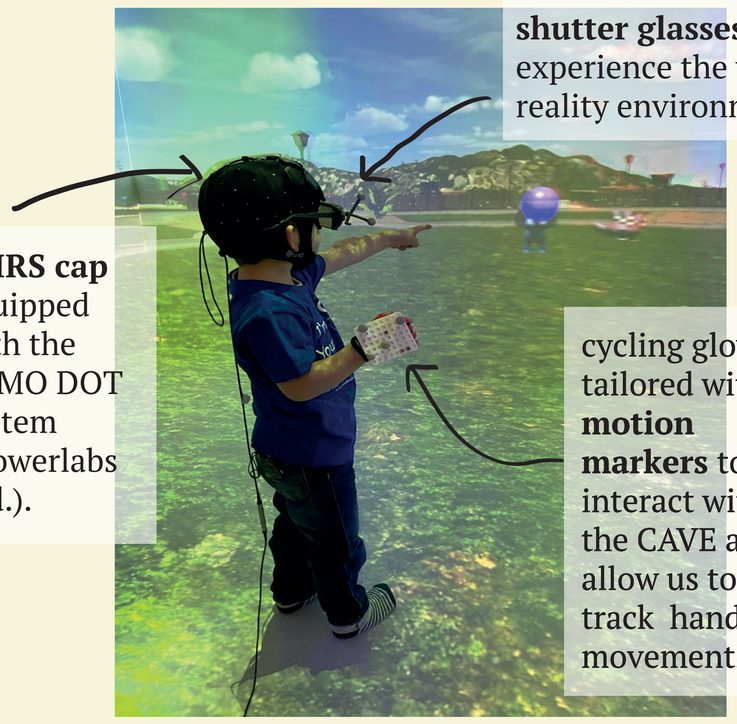

Figure 1: Participant playing the Go/NoGo task in the ToddlerLab CAVE.

60, 3-to-6-year-old children, either neurotypical or neurodiverse (ASD, ADHD, low-empathy traits), are invited to participate in a Go/NoGo task within the ToddlerLab Cave (Fig. 1) -a child friendly Virtual Reality (VR) room.

Brain activity from the frontal cortex, which has previously been implicated in inhibition tasks, is recorded using the LUMO DOT system (Gowerlabs Ltd.).

Each child performs the task twice, with a gap of 1 to 2 weeks between sessions.

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Preliminary findings & Analysis plan

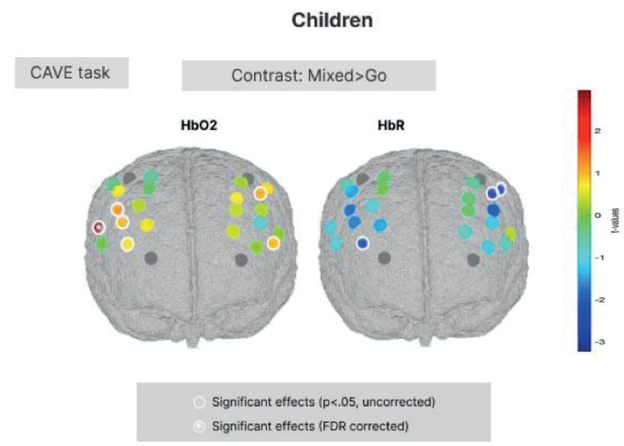

Figure 2: From Dina et al. (2024). Results with 36 neurotypical children showed a greater response in the left inferior frontal gyrus during NoGo blocks compared to Go-only blocks in the novel Go/NoGO Cave task.

1 The task has been sucesfully implented in the CAVE by Dima et al. (2024) (fig.2).

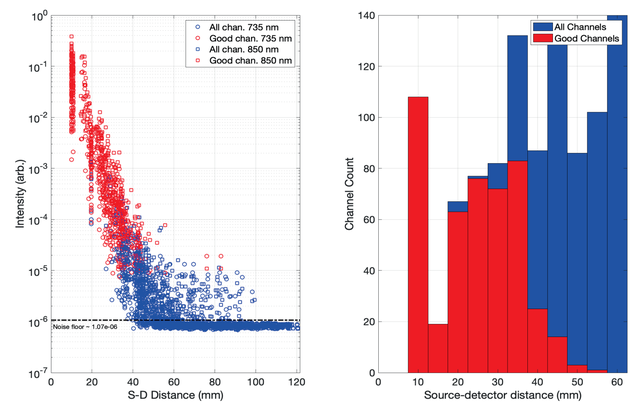

Figure 3: (up) example of channel data quality assessment in N=1. (left) reconstruction of sources (red) and detectors (blue) on a 5-year-old MNI template

- Define a DOT analysis pipeline that considers some challenging of our set-up (i.e. more motion, less trials, etc.) (fig. 3).
- Replicate the findings of Dima et al. (fig. 2) using the new Lumo DOT system, with a particular focus on neurodiverse children.

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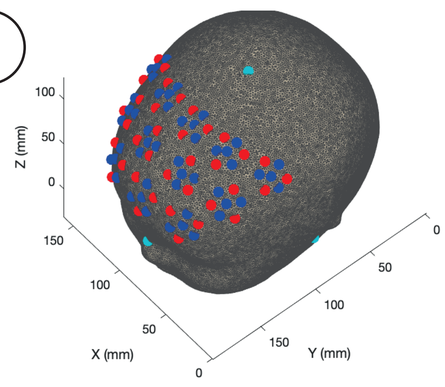

3 Perform test-retest reliability measures on the DOT data collected (fig.4).

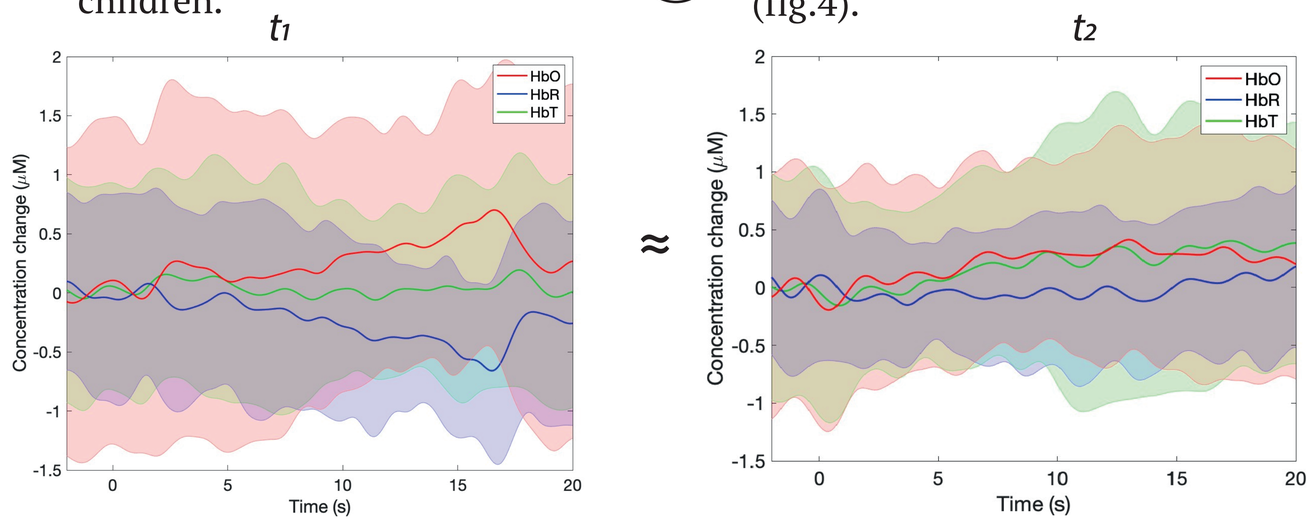

Figure 4: Average HRF during NoGo blocks from one channel over the frontal cortex at time t_1 and t_2 in one participant at elevated likelihood of ADHD.

Behavioural factors that might impact test-retest reliability*

Preliminary findings with 29 children—10 neurotypical children, 10 children diagnosed with ADHD or at a higher likelihood of ADHD, and 9 children diagnosed with ASD or at a higher likelihood of ASD—showed that:

- Children in the neurodiverse group tend to move around more and explore the environment more than neurotypical children.
- Children in the neurodiverse group—especially those in the ASD group—tend to tolerate the equipment better during the second visit.
- Children in the neurodiverse group—especially those in the ASD group—tend to play for longer during the second visit.
- Children in the ASD group tend to seek physical contact with researchers especially during the second visit.

** See Fr-085, Tailoring fNIRS and Virtual Reality for Use with Neurodiverse Children, for more details.*

Blasi, A., Lloyd-Fox, S., Johnson, M. H., & Elwell, C. (2014). Test–retest reliability of functional near infrared spectroscopy in infants. *Neurophotonics, 1(2),* 025005-025005.

Gemignani, J., de la Cruz-Pavía, I., Martinez, A., Nallet, C., Pasquini, A., Lucarini, G., ... & Gervain, J. (2023). Reproducibility of infant fNIRS studies: a meta-analytic approach. Neurophotonics, 10(2), 023518-023518.

Dina, LM., Pinti, P., Smith, T.J. (2024). Measuring neurodevelopment of inhibitory control in children using naturalistic virtual reality. PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-4593989/v1]