REAL-WORLD NEUROIMAGING: THE USE OF A FIBERLESS AND WEARABLE fNIRS SYSTEM TO MONITOR BRAIN ACTIVITY IN THE REAL-LIFE ON FREELY MOVING PARTICIPANTS

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INTRODUCTION

• Cognitive abilities supported by the prefrontal cortex are traditionally studied through the use of lab-based neuropsychological tests.
• However, there can be situations in which conventional lab-based tests are not sensitive enough in unveiling prefrontal cortex dysfunctions, with significant disagreement between measurement taken in everyday life and the lab1.
• This is most apparent for Prospective Memory (PM) as it requires novel and open-ended situations, which are hard to recreate successfully in the lab1.
• Monitoring brain activity to real-world tests can provide a unique insight in the processes involved in everyday life underlying PM failures.

AIM

To investigate the feasibility of a wireless and fiberless functional Near Infrared Spectroscopy (fNIRS) device to monitor prefrontal cortex hemodynamic activity during a real-world PM task conducted outside the lab on freely moving participants.

MATERIALS AND METHODS

fNIRS and Physiological Data Acquisition

• A 16-channels fiberless and wearable fNIRS system (WOT, Hitachi High-technologies Corporation, Japan; sampling frequency= 5 Hz) monitored prefrontal cortex activity (Figure 1).

![Figure 1. WOT system](image)

• Walk-related Heart Rate, Breathing Rate and Acceleration changes were measured through a monitoring belt worn on participants' chest.

Experimental Protocol

• Participants performed a PM task outside the lab2 composed by the following conditions:
  o Rest 1: cognitive task + no walking;
  o Rest 2: walking + no cognitive task;
  o Baseline: exploring the experimental area;
  o Ongoing (OG): counting items around the square;
  o Social PM: OG task + face bumping an experimenter (Figure 2 A);
  o Non-social PM: OG task + face bumping parking meters (Figure 2 B).

![Figure 2. Social (A) and Non-social (B) PM conditions](image)

• Three cameras recorded the experimental session for behavioural examinations and for the validation of the proposed method.

fNIRS signal preprocessing

• Although participants were free to walk and move the head to accomplish the task, raw fNIRS data did not present remarkable motion errors and a good Signal-to-Noise ration was achieved (Figure 4).

![Figure 4. Example of raw fNIRS data.](image)

• After a proper signal preprocessing flow, typical –but anticipated– functional activation trends can be found in close proximity to non-social (Figure 5 A) and social(Figure 5 B) PM targets.

![Figure 5. Preprocessed fNIRS signals and hemodynamic responses to non-social (A) and social (B) PM hits.](image)

• Changes in Heart rate, Breathing rate and Acceleration (Figure 6) are appreciable during the experiment and may interfere with fNIRS cortical signals.

![Figure 6. Heart rate (A), Breathing rate (B) and Acceleration (C) changes during the experiment.](image)

CONCLUSIONS

• The present study demonstrated the feasibility of fiberless fNIRS to monitor functional brain activity in real-world PM experiments conducted outside the lab and on freely moving participants.
• Anticipated hemodynamic responses suggest that event onsets recovery from video recordings can be not accurate enough and new methodologies are needed.
• Results show that walk-related physiological changes occur during this type of experiment and need to be taken into account when analysing real-world fNIRS data.