

AN EXTENDED GLM-BASED ALGORITHM FOR RECOVERING FUNCTIONAL EVENTS IN REAL-WORLD fNIRS NEUROIMAGING OUTSIDE THE LAB WITH FREELY MOVING SUBJECTS

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INTRODUCTION

- Functional Near Infrared Spectroscopy (fNIRS) represents a powerful tool to monitor brain oxygenation in ecological contexts.
- Real-world neuroimaging is particularly important for studying some mental abilities, such as prospective memory (PM), especially in case of cognitive dysfunctions and frontal lobe lesions¹.
- Statistical analyses of fNIRS data require the knowledge of the event onsets timeline², which is not known a-priori for real-world experiments conducted outside the lab on freely moving participants.
- Functional events in the real-world arise from the integration of complex and highly variable behaviours as participants are left free to accomplish the task without significant restraints.
- The identification of functional events in the real world can be extremely challenging.

AIM

To automatically disentangle functional events in the real-world and to statistically detect functional activation trends directly from fNIRS neuroimaging data in a real-world PM experiment.

MATERIALS AND METHODS

fNIRS Acquisition and Experimental Protocol

- A 16-channels fiberless and wearable fNIRS system (WOT, Hitachi High-technologies Corporation, Japan) monitored prefrontal cortex activity (Figure 1).
- Participants underwent a PM task outside the lab³, including two Ongoing conditions (OG) and a social and a non-social PM conditions (sPM and nsPM).
- Three cameras recorded the experimental session for behavioural examinations and for the validation of the proposed method.



Figure 1. WOT system

Automatic Identification of functional Events (AIDE) algorithm mathematical formulation

The AIDE algorithm identifies functional events based on the GLM-based least square fit analysis under the assumption that β -estimates are indicators of the goodness of fit between a model of functional activation and the fNIRS experimental data⁴ (Figure 2).

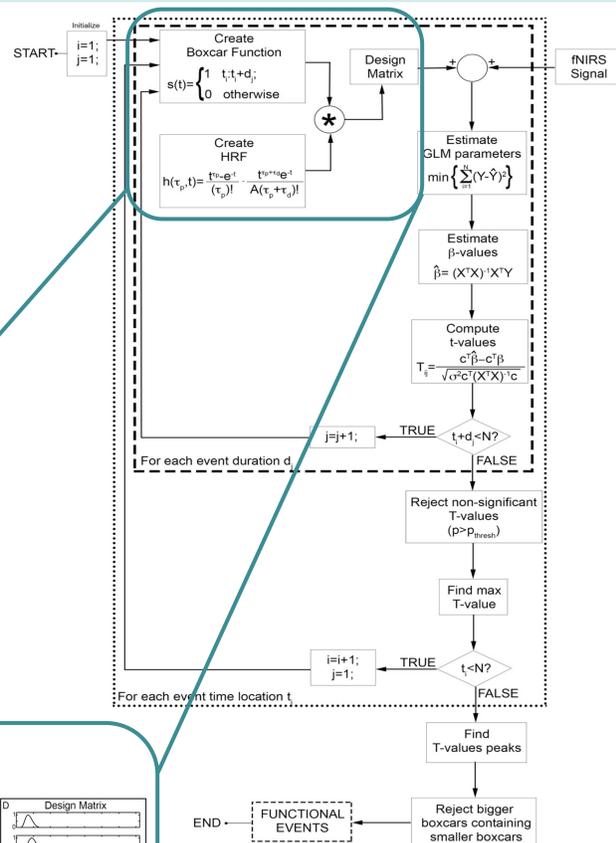


Figure 2. AIDE flow-chart

RESULTS

- Functional events were identified in close proximity to sPM cues (Figure 3).
- All the 5 functional events corresponding to the 5 sPM targets (event-based targets) were identified (Figure 3).
- The AIDE algorithm disentangled both event-based and activity-based PM targets (road crossing) from the background ongoing activity (Figure 4C).

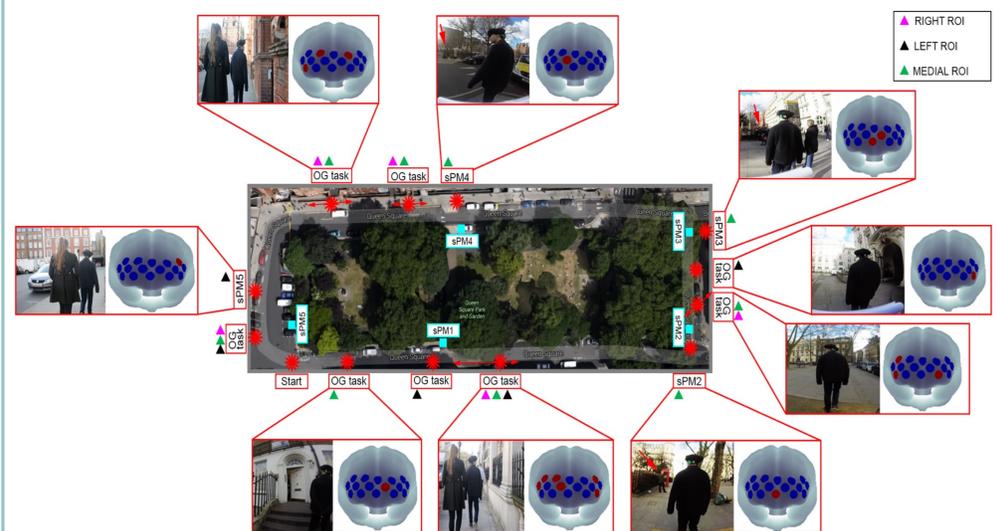


Figure 3. Behavioural meaning of the detected functional events (red asterisks) for one participant overlapped onto the map of the experimental area. Magenta, green and black triangles indicate the involved ROIs. Light blue squares indicate the positions of the social PM targets. Binary maps represent the channels involved in each event.

- In agreement with previous computer-based neuroimaging PM studies⁵, we observed a major involvement of medial BA 10 during the performance of OG tasks compared to PM tasks (Figure 4).
- The medial ROI was mostly involved in the reaching of sPM cues (Figure 4A).
- For the nsPM condition, all the three ROIs were almost equally responding (Figure 4A).
- For the execution of the four OG tasks, medial ROI was consistently and mainly involved while the right and left ROIs were implicated in a lesser extent (Figure 4B).
- No responses from the medial ROI were found for the identified road crossing events (Figure 4C).

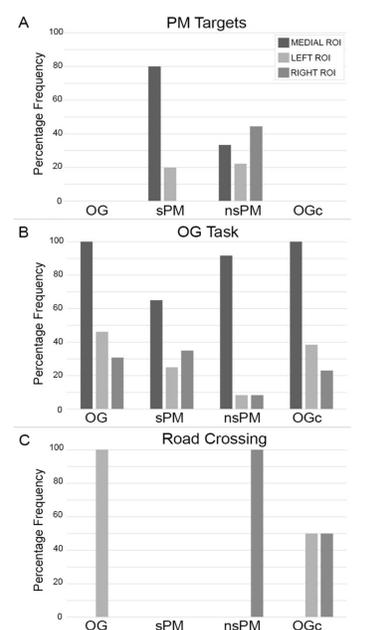


Figure 4. ROI analysis results

CONCLUSIONS AND FUTURE DIRECTIONS

- The present method is the first attempt to recover functional brain events from fNIRS data recorded during a naturalistic task.
- Results suggest that “brain-first” rather than “behaviour-first” analysis is in principle possible.
- Group analyses will be conducted to assess and identify particular activations patterns across the fNIRS channels in response to the assigned real-world PM task.

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4. Friston, K. J., et al. "Statistical parametric maps in functional imaging: a general linear approach." *Human brain mapping* 2.4 (1994), 189-210.

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