Functional brain organisation during ocular and oculo-manual pursuit: an fNIRS study

Lénaïc Borot & Simon J. Bennett
RISES, Liverpool John Moores University, Liverpool, UK

Introduction

- When pursuing a moving object, gaze is often momentarily shifted to an eccentric location. This alters vision of the pursuit object, thereby placing emphasis on extra-retinal input to update a spatio-temporal representation of the object trajectory.
- It has been suggested that predictive processes operating in pre-frontal cortex (PFC) provide extra-retinal input when a pursuit object is occluded [1].
- Efferent and/or afferent input from upper limb movements also help overcome a loss of visual input and thereby facilitate pursuit eye movements [2].
- Here, we will examine the functional organization of the human brain following a change in visual and/or extra-retinal input from upper limb movement.

Task and Procedures

- Dual-pursuit task in which participants pursue a moving object, momentarily shift gaze to a stationary target at different vertical eccentricities, and then resume pursuit (fig1 A + B).

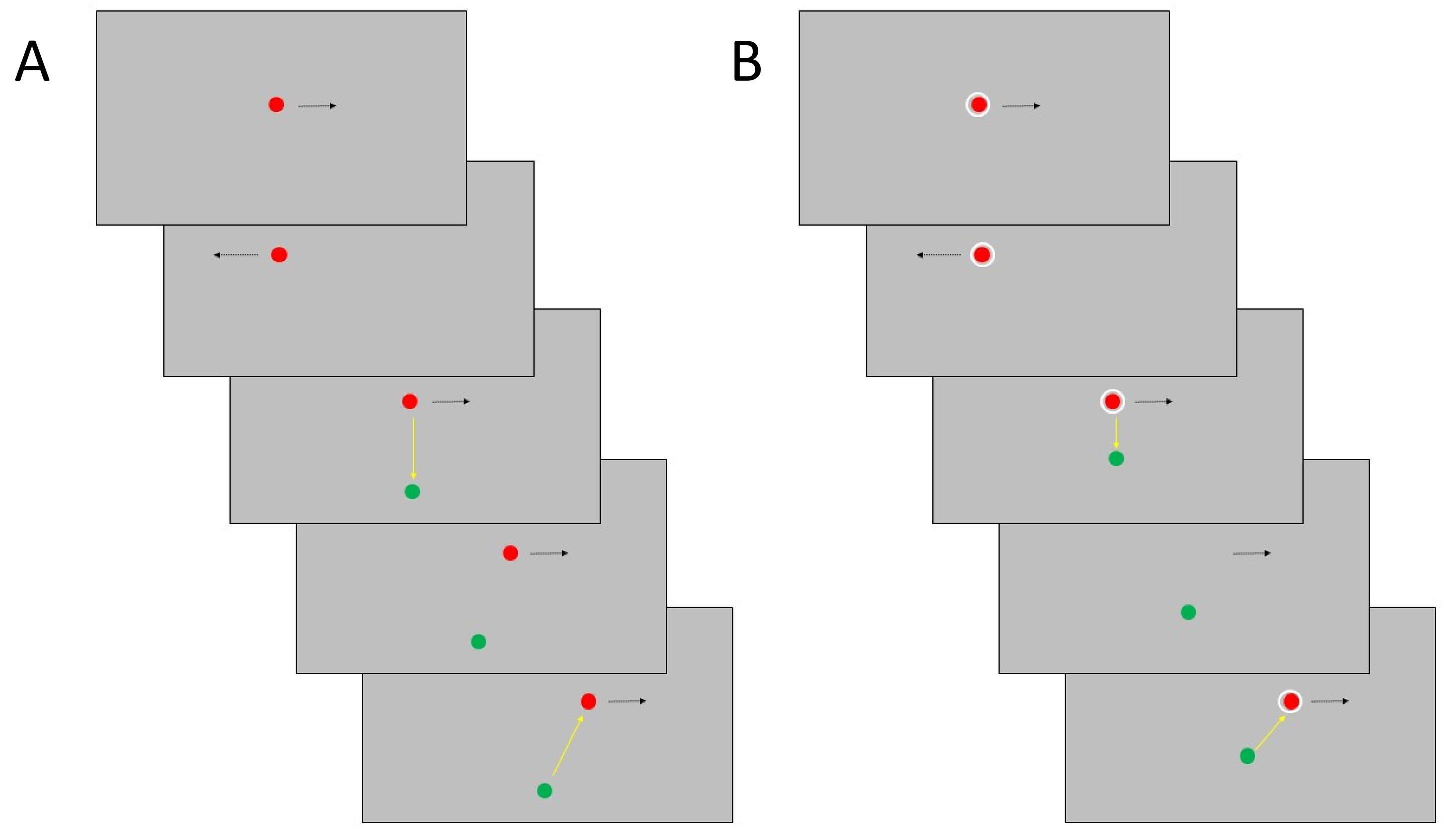

Fig. 1: Time line of dual-pursuit task. **A.** Ocular condition: the participant pursues an object (red circle) moving across the screen, then makes a saccade (yellow arrow) to a secondary target (green circle), and finally resumes pursuit. **B.** Oculomanual condition with occlusion: participants attempt to place the white annulus around the pursuit object throughout trial. After fixating on the secondary target, the pursuit object (and annulus) is occluded and then reappears further in its trajectory. Black arrows represent object motion direction and were not visible to the participant at any part of the trial.

- The task will be performed in ocular and oculo-manual conditions, with and without visual occlusion. The 4 conditions will be performed 6 times (35s trial duration and 30s inter-trial duration) in a randomised-block order.

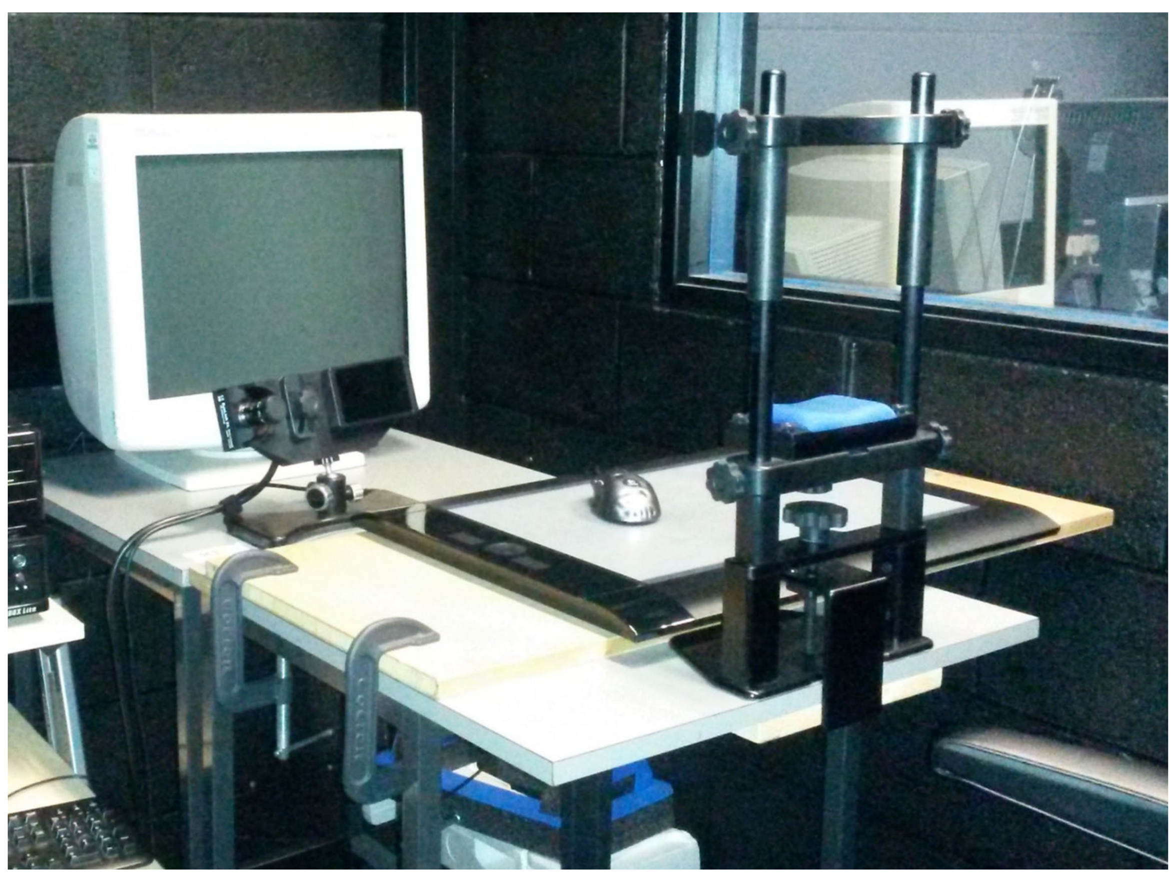

Fig. 2: Picture of the experimental room. The EyeLink camera is located beneath the monitor at 90cm from the chinrest. Limb movement is measured with a digitising tablet.

- **Eye Movement Analysis:**

  Ocular activity will be recorded using an EyeLink 1000, with the desktop camera and adjustable chinrest (fig2)

  Ocular and manual pursuit (e.g., number and amplitude of saccades, smooth pursuit gain) will be measured during specific epochs surrounding the alteration of visual input (i.e., occlusion, secondary target presentation).

- **Near Infrared Spectroscopy (fNIRS) Analysis:**

  Brain activity will be recorded using near infrared spectroscopy (Brainsight, CW).

  A 12-channel template (fig3) with optodes located above the left PFC and frontal cortex, motor cortex and parietal cortex (and 4 short distance channels, one by aera).

  Brodmann areas covered by the different channels were extracted using the NFRI function [3].

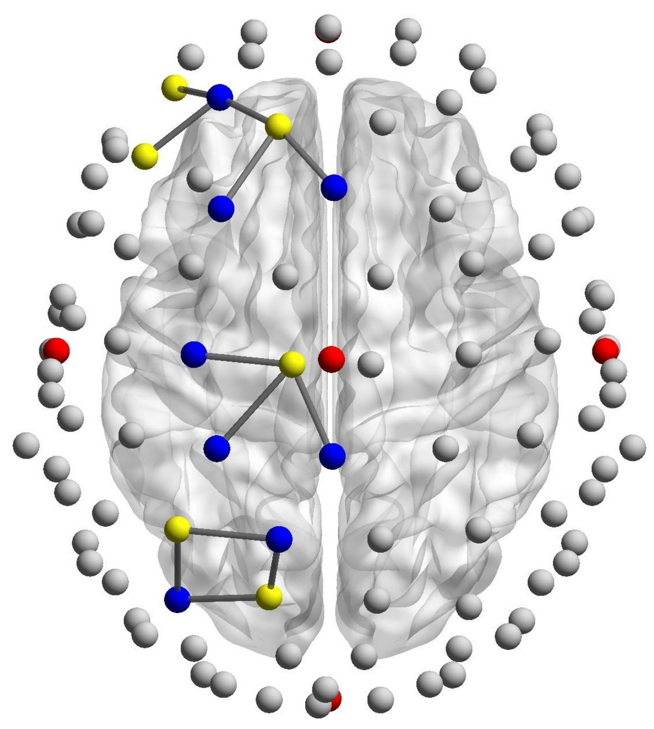

Fig. 3: Representation of the organization of optodes. In blue the receivers, in yellow the transmitters and in red the EEG reference points (Nz, Iz, AR, AL). The gray edges represent the channels.

  Haemodynamic changes and functional connectivity (e.g. mean, area under the curve, correlation, coherence) will be determined from the fNIRS data

- **Technical issue:**

  To limit the possible cross talk between EyeLink and fNIRS (both use near infrared light), black material will be placed on the optodes.

References

[1] Bennett, S. J., O'Donnell, D., Hansen, S., & Barnes, G. R. (2012). Facilitation of ocular pursuit during transient occlusion of externally-generated target motion by concurrent upper limb movement. *Journal of Vision*, *12*(13), 17-17.

[2] Lencer, R., Nagel, M., Sprenger, A., Zapf, S., Erdmann, C., Heide, W., & Binkofski, F. (2004). Cortical mechanisms of smooth pursuit eye movements with target blanking. An fMRI study. *European Journal of Neuroscience*, *19*(5), 1430-1436.

[3] Singh, A. K., Okamoto, M., Dan, H., Jurcak, V., & Dan, I. (2005). Spatial registration of multichannel multi-subject fNIRS data to MNI space without MRI. *Neuroimage*, 27(4), 842-851.

Conclusion

Our results could lead to a better understanding of the brain activity involved during complex oculo-manual behaviour of neurotypical and neuroatypical adults.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 801604

University Alliance
Doctoral Training Alliance