**Event related analysis for continuous wave functional near infared spectroscopy (CW-fNIRS)**

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**Area**: Data analysis and signal processing.

*Aim*: To implement a tool for conducting event related analysis analysis to a CW-fNIRS dataset and apply this to a dataset from surgical neuroergonomics.

*Background*: The most common experimental design in neuroimaging is arguably the block design in which each experimental treatment is administered in isolation permitting the statistical evaluation of the effect of such treatment without major confounding effects. While simple, this approach has a set of shortcomings such as the inability to explore combined effects among others. Another well studied experimental design is event-related design. Event related analysis [1] refers to a statistical model to decouple effects corresponding to independent factors when observed under statistically dependent conditions and affords the conduction of more sophisticated experiments. But given its higher mathematical complexity, common analysis software tools in fNIRS such as Homer 3, MNE-fNIRS, ICNNA, or NIRS Toolbox among others do not offer this capability. In this project we seek to implement, validate and put to work a new tool to conduct event related analysis in fNIRS.

Methods: You will be provided with a neuroimaging dataset collected using continuous-wave functional near infrared spectroscopy (CW-fNIRS) by our colleagues at Imperial College studying surgical neuroergonomics [2]. In this dataset, brain haemodynamics of the surgeons whilst executing a simulated surgical task was collected to understand surgical skill acquisition and performance in a cohort of surgeons of different expertise under some stress condition. This project requires you to:

1. Get a thorough understanding of the general linear model (GLM) and its variant for event related analysis.
2. Replicate the implementation of an existing univariate event-related model in Matlab
3. Validate the implementation using synthetically and semi-synthetically generated CW-fNIRS data for which the ground truth is known.
4. To design and apply a reconstruction and processing pipeline to the provided fNIRS dataset to clean the raw data from major artefacts and prepare it for analysis. Existing software tools such as Homer 3, MNE-NIRS, ICNNA or NIRS Toolbox may be of use for this task.
5. To conduct an event related analysis on the dataset and report the consequent findings.
6. Validate findings against standard GLM based statistical analysis.

*Expected outcome*: Segregational statistics regarding active brain regions under different experimental condition and validation against standard GLM based statistical

analysis.

*Related literature*:

[1] Plichta, MM et al (2004). Event-related functional near-infrared spectroscopy (fNIRS): Are the measurements reliable?. NeuroImage 31:116-124.

[2] Goble, M et al (2023). Optical neuroimaging and neurostimulation in surgical training and assessment: A state-of-the-art review, Front. Neuroergon. 4:1142182. doi: 10.3389/fnrgo.2023.1142182