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fNIRS and Facial Thermography to Assess Mental Workload

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Estimating Mental Workload is crucially important for the safety critical domain [1], and potentially valuable in broader Human-Computer Interaction. In this paper, we present our ongoing research exploring non-invasive techniques for mental workload estimation, in increasingly natural work environments. We focus on two particular techniques – 1) facial thermography and 2) fNIRS, where its portability and higher tolerance of movement artefacts make it a stronger candidate than other brain measurement techniques. Both measurements have been independently shown to correlate with workload and performance measures [1,2], and our current collaboration aims to compare them in more detail.

The study below was conducted in laboratory conditions and required participants to perform a custom-designed visual-motor task that imposed varying levels of demand. The task consisted of aiming at the target (red) balls using a joystick and shooting using a button on the joystick as soon as possible. Demand (the number of balloons to shoot) naturally increased for the first 6 stages, and decreased back to the original level in the last 6 stages for each of the 3 times participants played the task, hence the curves in Figure 1 following the same pattern. At the end of each stage, participants self-reported their perceived Mental Workload on a 5-point ISA scale. Participants repeated the 13-stage (45s per stage) task three times; the total duration of the study was approximately 30 minutes.

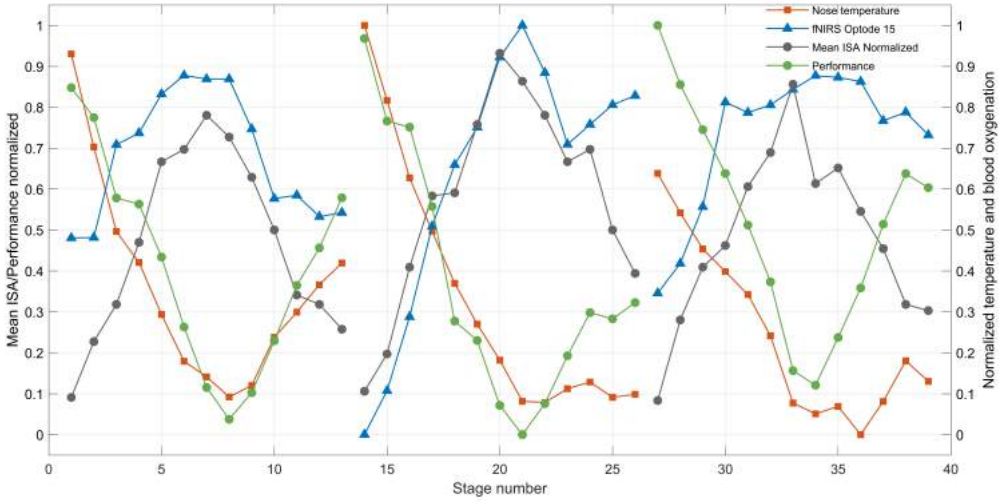

Figure 1. Relationship between subjective workload scores (ISA), fNIRS, Facial Thermography and Performance (an example from one participant).

Our results provide a comparison between the physiological techniques used and their relationship with performance and the experienced workload. As a well established measure, ISA correlated strongly with performance for 11/11 participants. fNIRS correlated strongly for 7/7 (data loss), and facial thermography for only 4/11. Analysis is ongoing.

References

[1] Marinescu, A., Sharples, S., Ritchie, A. C., López, T. S., McDowell, M., & Morvan, H. (2016). Exploring the Relationship between Mental Workload, Variation in Performance and Physiological Parameters. *IFAC-PapersOnLine*, *49*(19), 591-596.
[2] Maior, H. A., Wilson, M. L., & Sharples, S. (2018). Workload Alerts—Using Physiological Measures of Mental Workload to Provide Feedback During Tasks. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *25*(2), 9.