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A Preliminary Study on the Predictive Validity of Neural Efficiency for the Air Traffic Controllers Selection

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CONTEXT

- Air traffic controllers (ATCO) ensure air traffic safety and efficiency. Their training is complex and costly. French ATCO are civil servants and their training lasts several years (two-year period for initial training, and duration of on-the-job training according to center complexity). The training cost for a French ATCO amounts to several hundred thousand euros.
- ATCO are commonly selected by cognitive abilities assessment (Mouratille et al, 2022). Best predictors are work sample, working memory, composite score etc. But an important part of variance is always unexplained (10% of explained variance with cognitive predictors).
- Other constructs could be relevant such as stress tolerance or neural efficiency (Neubauer and Fink, 2009). Based on the integrated control hypothesis, students with higher potential should modulate their resource allocation pattern during difficult tasks (Lu et al., 2022).

MATERIAL AND METHOD

- **27 ATCO students** ($M = 20.12$ years).
- **Dual-task paradigm** integrated in Laby Microworld (Imbert et al, 2014):
 - **ATC task**: send CFL instructions to both blue aircraft.
 - **Auditory N-back Task**: click on the callsign heard X positions earlier and situated somewhere in yellow.

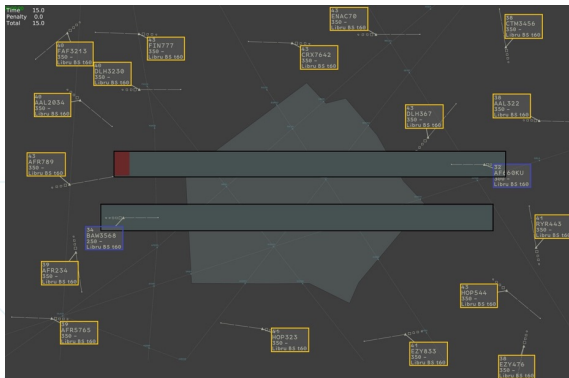


Figure 1. LABY Microworld

- **Difficulty manipulation** with the auditory n-back task:
 - **1-back**: click on aircraft callsign heard 1 pos. earlier.
 - **3-back**: click on aircraft callsign heard 3 pos. earlier.
 - **EEG**:
 - Brain actiCHamp Plus (1024Hz) with 32 electrodes.
 - Coherence analysis in the theta band.
 - μ index (Kang et al, 2017) computed on this coherence analysis (0% for inefficient-performers, 100% for efficient-performers).
- $$\mu = \frac{\# \text{ of sig. common electrode pairs between (1back vs baseline) and (3back vs baseline)}}{\# \text{ of sig. common electrode pairs for (3 - back vs baseline)}}$$
- **Cluster analysis** with performance and μ index.
 - **Exact logistic regression** to predict initial training difficulties with cluster classes.

RESULTS

- Three distinct classes:
 - « Efficient »: excellent performance and a high μ index.
 - « All-in »: excellent performance and a low μ index.
 - « Flop »: average performance and a low μ index.
- No predictive validity of training difficulties ($p = .46$).

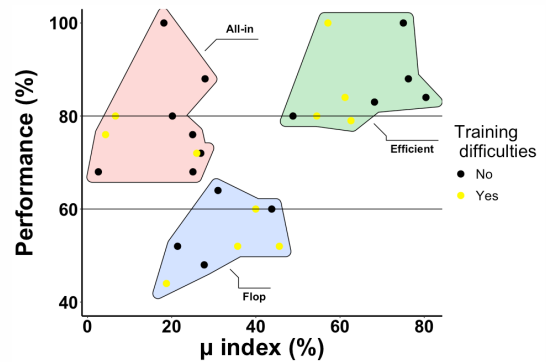


Figure 2. Cluster classes

DISCUSSION

- Discrimination of three distinct classes: manipulation of difficulty is successful but lack of predictive validity.
- Neural efficiency might be not useful in a highly sample of selected students .
- Initial training difficulties observed were weak, no interruption or reputation of training. On-the-Job training prediction is more relevant.
- It is possible that the sample size is too limited.
- μ index is new and literature on it is scarce. μ index might be not adapted.

References

Imbert, J. P., Hodgetts, H. M., Parise, R., Vachon, F., & Tremblay, S. (2014, September). The LABY microworld: A platform for research, training and system engineering. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting. Kang, J. S., Ojha, A., Lee, G., & Lee, M. (2017). Difference in brain activation patterns of individuals with high and low intelligence in linguistic and visuo-spatial tasks: An EEG study. *Intelligence*, 61, 47-55.
 Lu, R., Bao, N., Zhang, X., & Shi, J. (2022). Attentional resource allocation among individuals with different fluid intelligence: The integrated control hypothesis and its evidence from pupillometry. *Neuropsychologia*, 169, 108190.
 Mouratille, D., Amadiou, F., & Matton, N. (2022). A meta-analysis on air traffic controllers selection: cognitive and non-cognitive predictors. *Journal of Vocational Behavior*, 138, 103769.
 Neubauer, A. C., & Fink, A. (2009). Intelligence and neural efficiency. *Neuroscience & Biobehavioral Reviews*, 33(7), 1004-1023.