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A Physiological Study on the Impact of Aging on Cognitive Performance of Air Traffic Controllers

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CONTEXT

- The global trend of increasing the retirement age is a response to demographic shifts and financial strain on public pension systems. However, this increase may have a strong impact on the well-being and efficiency of workers.
- In 2022, the Swiss Federal Council requested to raise the retirement age of Air traffic controllers from 56 to 60. In response, Skyguide and HelvetiCA (Swiss ATC entities) conducted a study to determine whether this raise would have an impact on ATCOs cognitive performance, considered as a potential proxy of operational performance (Baumgartner et al., in press).
- Based on the CRUNCH model (Reuter-Lorenz and Cappell, 2008), a higher resource mobilization might be required for older people to maintain cognitive performance at a similar level to young people. This could be measured with pupil diameter measurements (Marandi and Gazerani, 2019).

MATERIAL AND METHOD

- 60 ATCO** ($M = 44.02$ years) in 4 age groups:
 - 28-36 y/o: 17
 - 37-44 y/o: 16
 - 45-54 y/o: 16
 - 55-59 y/o: 11
- Toulouse N-back Task** (Causse et al, 2017) with 3 conditions with different difficulty levels:
 - 0-back**: compare the result with 50
 - 1-back**: compare the result with the previous result
 - 2-back**: compare the result with the second-to-last result

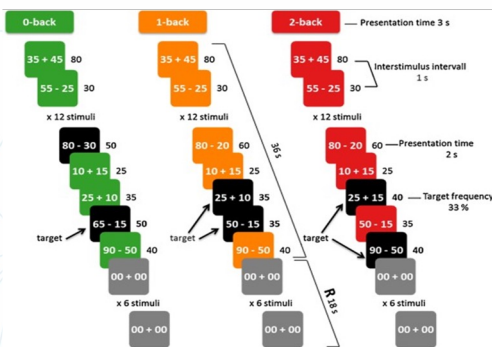


Figure 1. Toulouse N-back Task

- Eye-Tracker** :
 - Tobii Spectrum (600 Hz)
 - Mean value of pupil diameter extracted with ArGaze library (de la Hogue et al, 2024)
- Repeated-Measures ANOVA**: 3 levels of difficulty (0-back, 1-back and 2-back) and 4 levels of age (28-36, 37-44, 45-54 and 55-59)
- Linear regression to predict performance**: condition and age group in Step 1, physiological data in Step 2

RESULTS

- Accuracy**: main effect of difficulty ($p < .001$) but no main effect of age group ($p = .17$) and no interaction ($p = .10$)
- Pupil diameter**: main effect of difficulty ($p = .02$) but no main effect of aging ($p = .16$) and no interaction ($p = .80$)
- No incremental validity of pupil diameter ($p = .86$) compared to only difficulty ($R^2 = .36$)

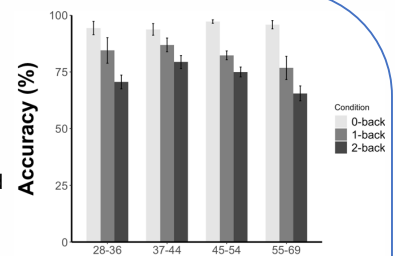


Figure 2. Accuracy according to age groups and conditions

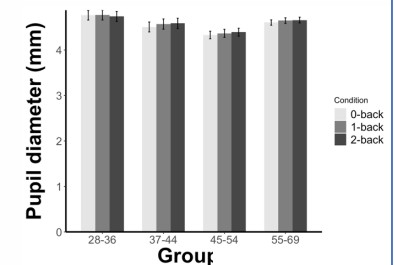


Figure 3. Pupil diameter according to age groups and conditions

DISCUSSION

- No difference between age groups and no incremental validity of pupil diameter on aging was measured.
- Difficulty manipulation was successful.
- Moderate aging did not impact cognitive performance and resources mobilization. Data is not in support of the CRUNCH model.
- It is possible that our participants are not old enough to see CRUNCH effect.
- Or pupil diameter is not the relevant biomarker.

References

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