Neurophysiological and Perceptual Evaluation of Adaptive Augmented Reality-Based Training

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LEARNER

PURPOSE

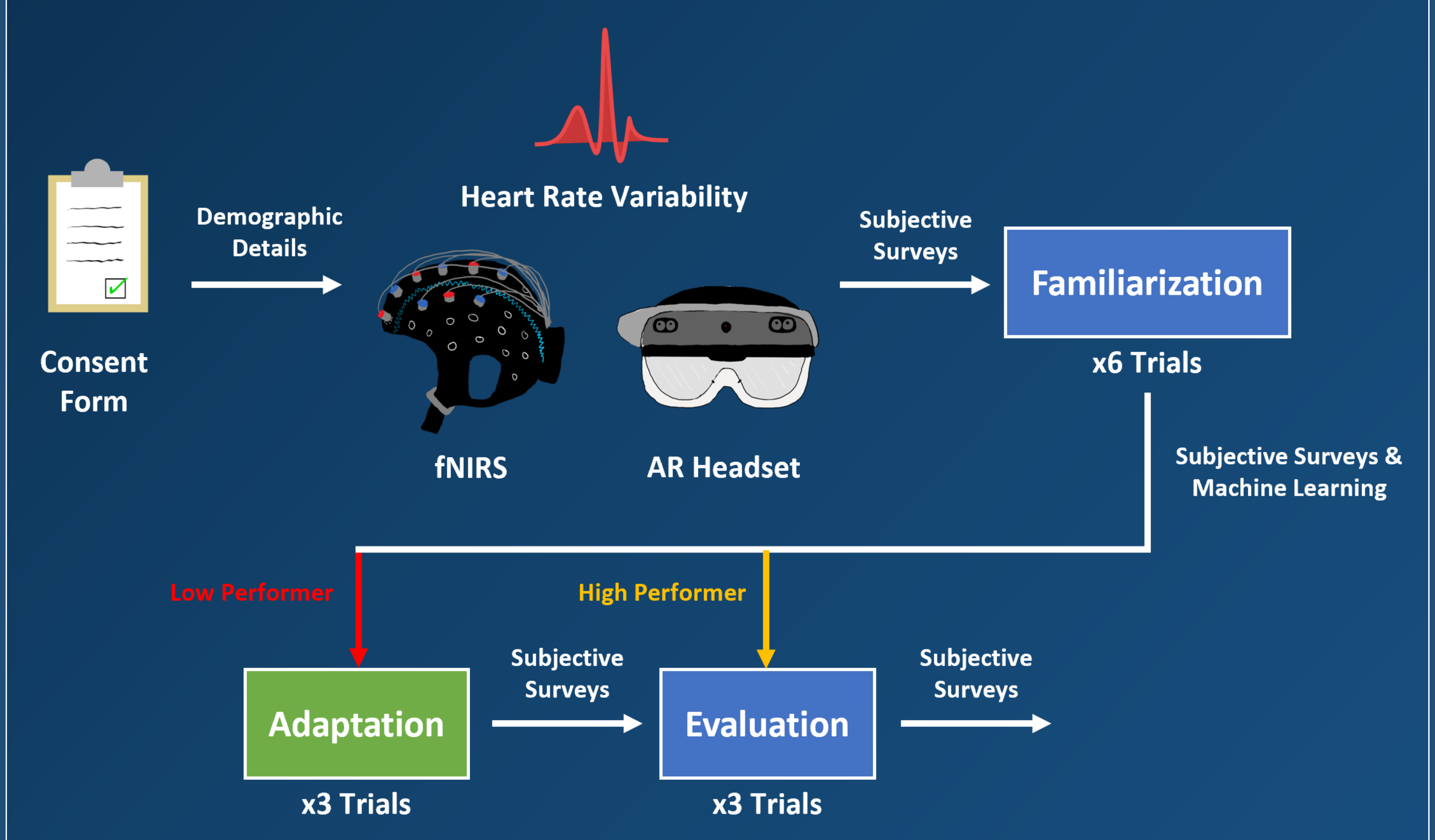
1) To evaluate a novel adaptation model for personalized augmented reality (AR) based training.
2) To identify characteristics of low and high performers.

INTRODUCTION

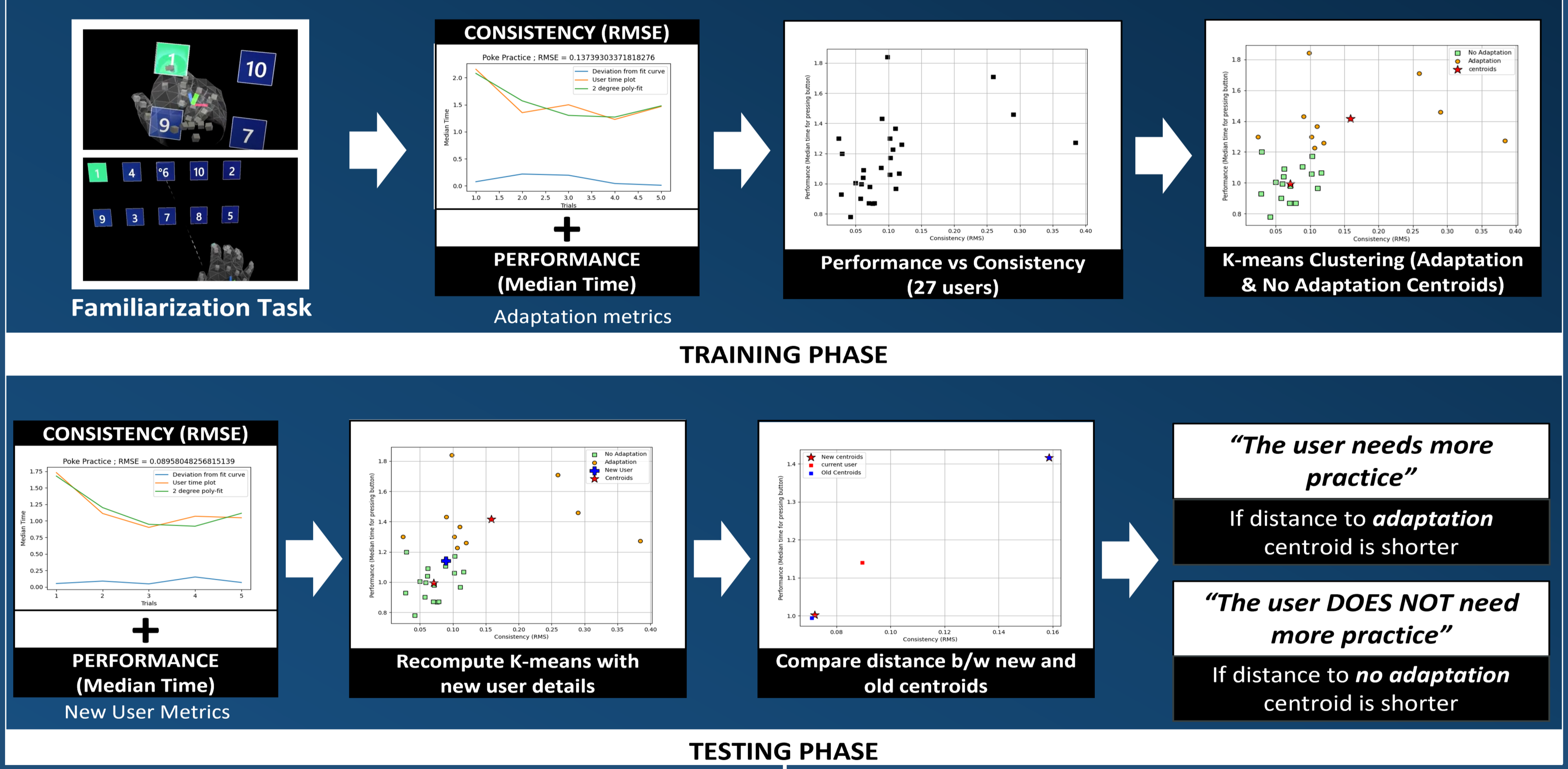
Traditional instructor-led methods of training often do not account for the cognitive abilities of each trainee (Marienko, Maiia et al., 2020). Even personalized training models using AR that have been developed to train industrial workers (Albayrak, M.S. et al.,2019), surgical and medical doctors (Shuhaiber, Jeffrey H.,2004), and educators (Tkachuk et al., 2017) mostly consider performance-based metrics to provide feedback rather than measuring cognitive load distribution and user engagement (Huang, Gaoping, et al., 2021). A few studies (Singh, Ankit et al.,2021; Fidan, and Tuncel, 2019) account for fatigue due to repeated tasks during training in AR; however, there is limited literature on how the learning curve is affected by fatigue (Asadayoobi, N. et al., 2021) and, in turn, affects personalized training. Therefore, we develop a novel adaptation model which accounts for performance as well as consistency in performance.

METHODS

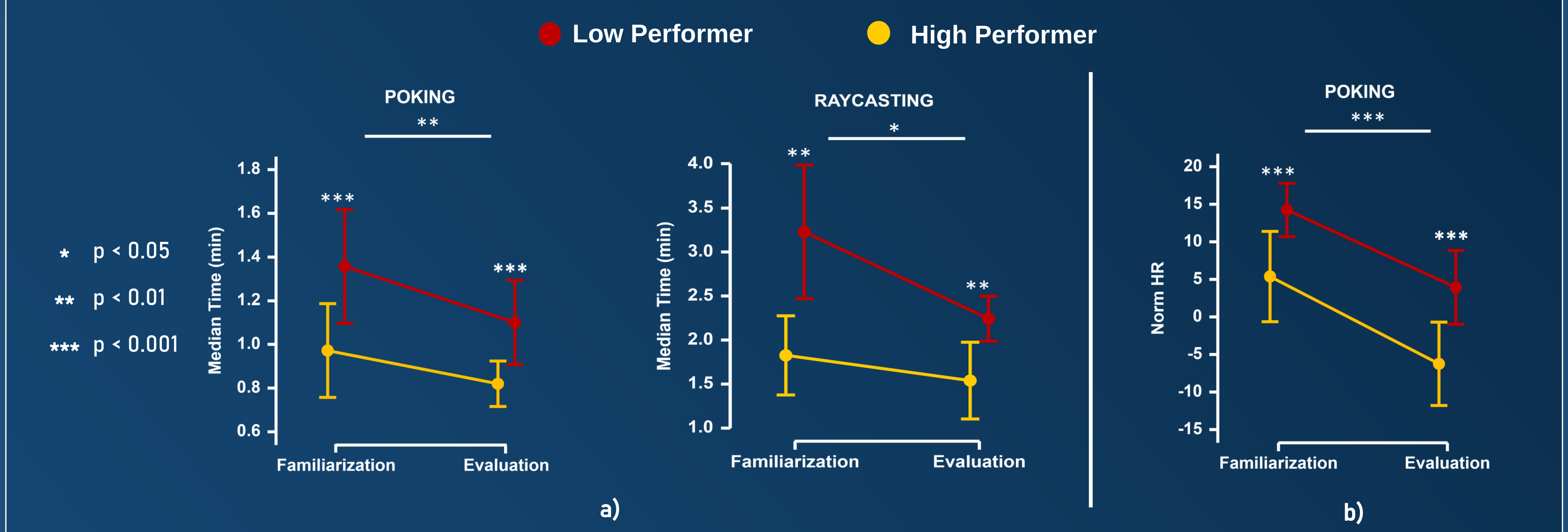
1) 12 users (50% female)
2) Training and evaluation of AR interactions
- Training group: low performer (n=7) and high performer (n=5)
3) Metrics: performance, heart rate variability (HRV), subjective surveys, and brain functional connectivity
4) Two-way ANOVA ($p<0.05$): Training Group (Low vs High Performer) x Phase (Familiarization vs Evaluation)



ADAPTATION MODEL

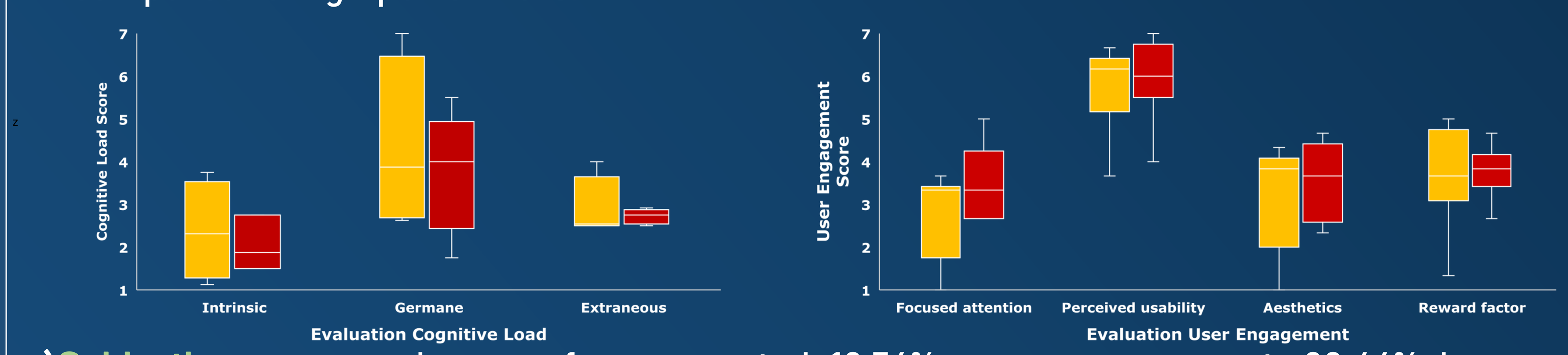


RESULTS

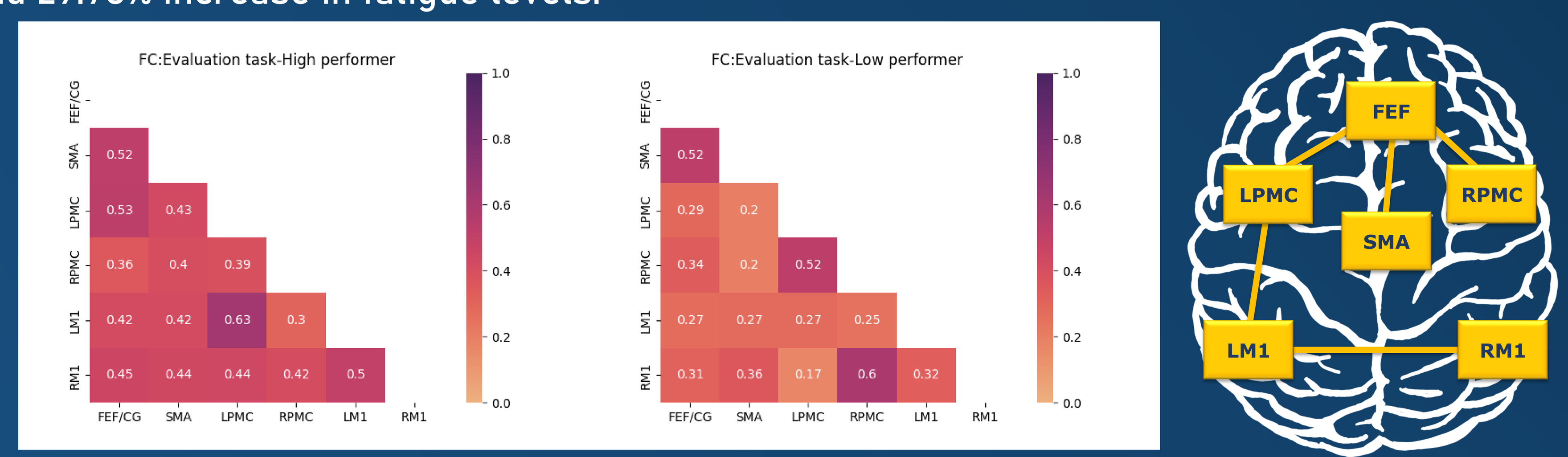


a) **Performance:** The adaptation model effectively determined whether a user was a low or high performer and typically lead to a higher performance improvement in low performers.

b) **HRV:** As seen in the HR difference, low performers experienced a higher physiological load compared to high performers.

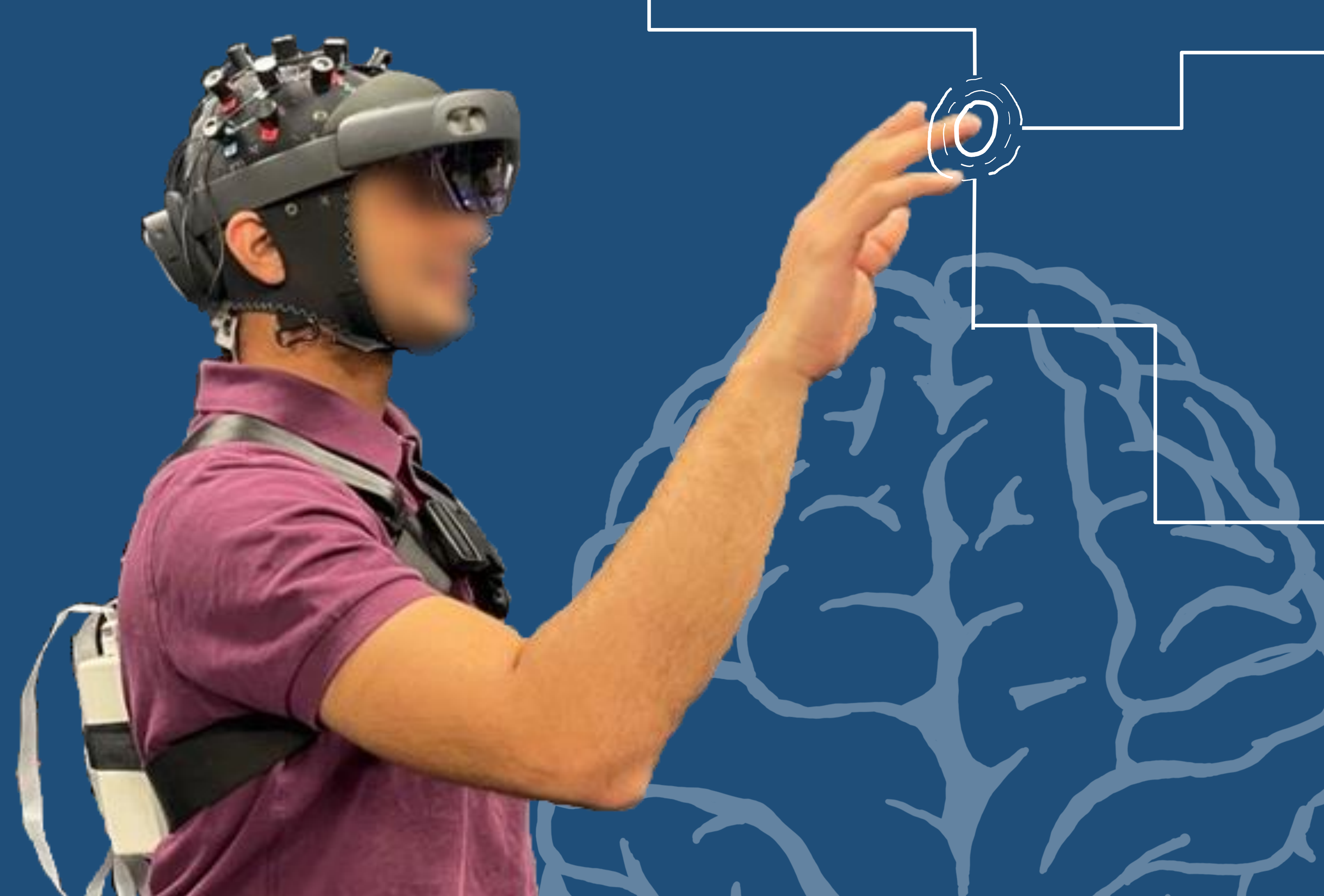


c) **Subjective surveys:** Low performers rated 19.76% more engagement, 33.46% increase in workload, 8.4% more germane load, 16.84% more extraneous load, 14.79% more intrinsic load, and 29.98% increase in fatigue levels.



d) **Brain functional connectivity:** Pearson correlation coefficient revealed that during evaluation functional connectivity differed in high and low performers where high performers exhibited stronger fronto-motor connections than the low performers.

The adaptation model can be improved by using the neurophysiological feedback by *inclusion of fatigue, cognitive workload, and its effect on performance* to provide better training experience in AR.



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