

Visual proprioception manipulation with virtual reality for the treatment of pathological tremor

Alejandro Pascual Valdunciel¹, Marcos Sacristán Moraleda, Juan Marín Lahoz², Jaime Ibáñez¹, Daniel Martín³

¹ BSiCoS Group, Aragon Institute of Engineering Research (I3A), IIS Aragon, Universidad de Zaragoza

² Neurology Department, Miguel Servet University Hospital, Zaragoza, Spain

³ Graphics and Imaging Lab, Aragon Institute of Engineering Research (I3A), Universidad de Zaragoza



Contact: pvaldunciel@unizar.es

BACKGROUND

The problem: Pathological tremor is one of the most prevalent and disabling movement disorders, imposing a significant personal and social burden¹.

The gap: The pathophysiology of tremor remains incompletely understood. Sensory (afferent) integration is involved in tremor generation and propagation, driving interest in non-invasive neuromodulation approaches to recruit afferent pathways and interrupt tremor propagation to the muscles².

Key insight: In tremor, visual processing and motor output are intricately linked, opening a therapeutic window³. By manipulating visual sensory inputs pathways, it may be possible to disrupt aberrant sensorimotor integration and suppress tremor. Virtual reality (VR) emerges as a powerful tool to exploit this mechanism non-invasively.

VR PLATFORM VALIDATION

Can a VR system suppress tremor visual display in a virtual environment?



Meta Quest 3

Activities of Daily Living (ADL)

- Postural task
- Pinch and move a mug
- Finger To Nose
- Grab and move a mug
- Spoon Feeding
- Hold a phone

- **Real World (RW):** ADL with very light items
- **Virtual World (VR):** ADL with hand tracking
- **Virtual World Tremor (VR_{FES}):** ADL with hand tracking while Functional Electrical Stimulation (FES) on the wrist flexors and extensors [4,9] Hz

15 healthy adults

Hand kinematics estimated with Kinematics (x-IMU3) and VR system

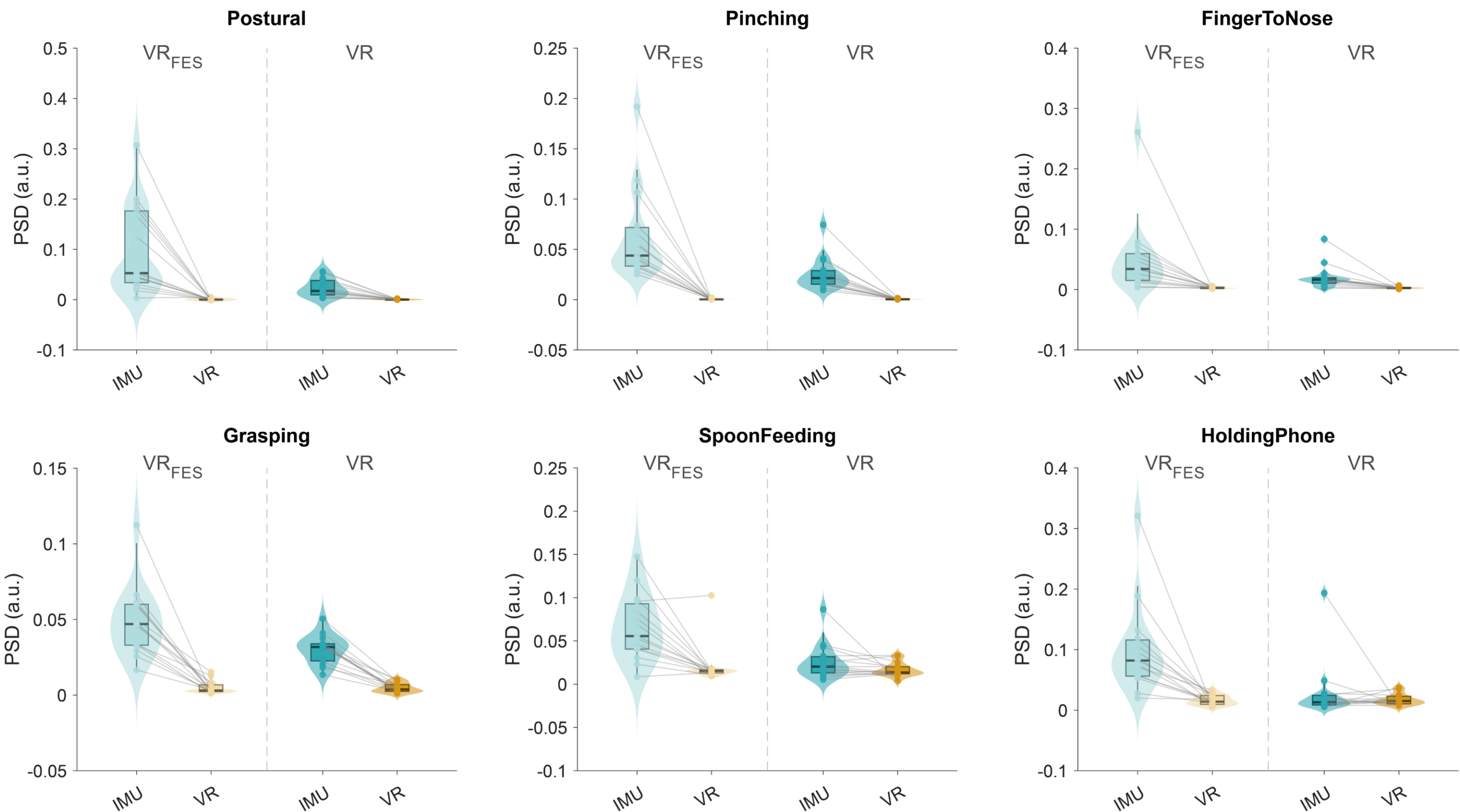


Grab and move a mug

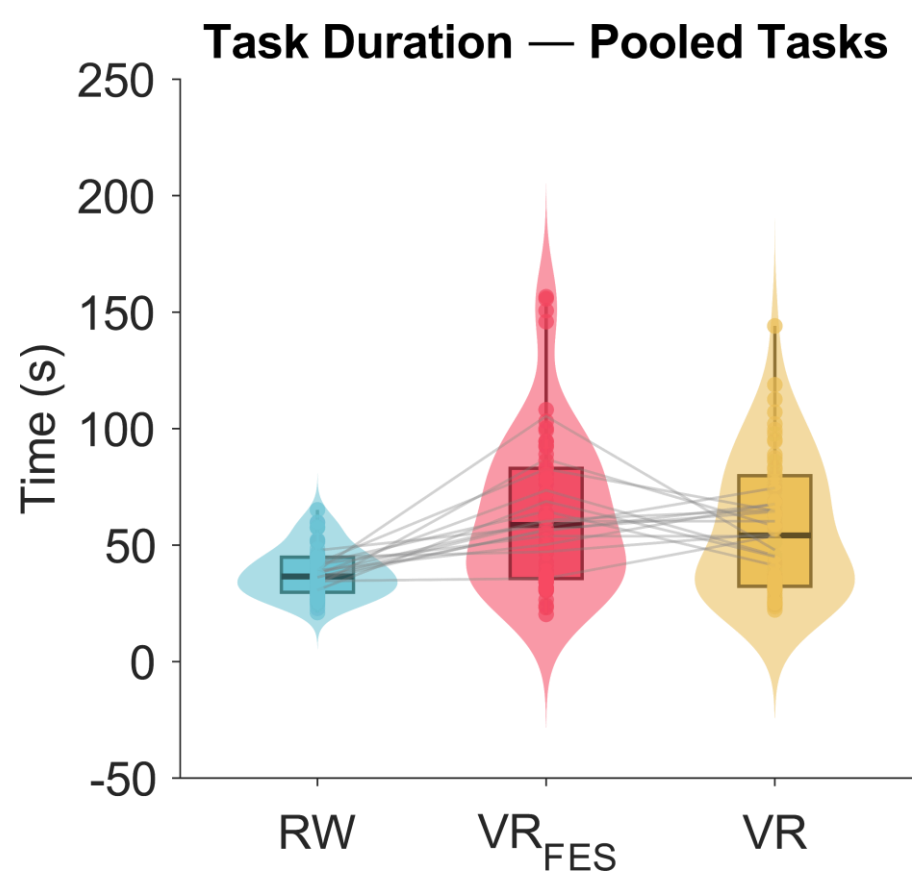


Spoon Feeding

VR platform suppress visual tremor display



Th VR hand-tracking system attenuates oscillations >3Hz across postural and dynamic tasks.



Healthy controls can successfully complete ADL in the VR world without previous training.

VR task execution times are longer compared to ADL in the real world.

TREMOR PATIENT CASE STUDIES

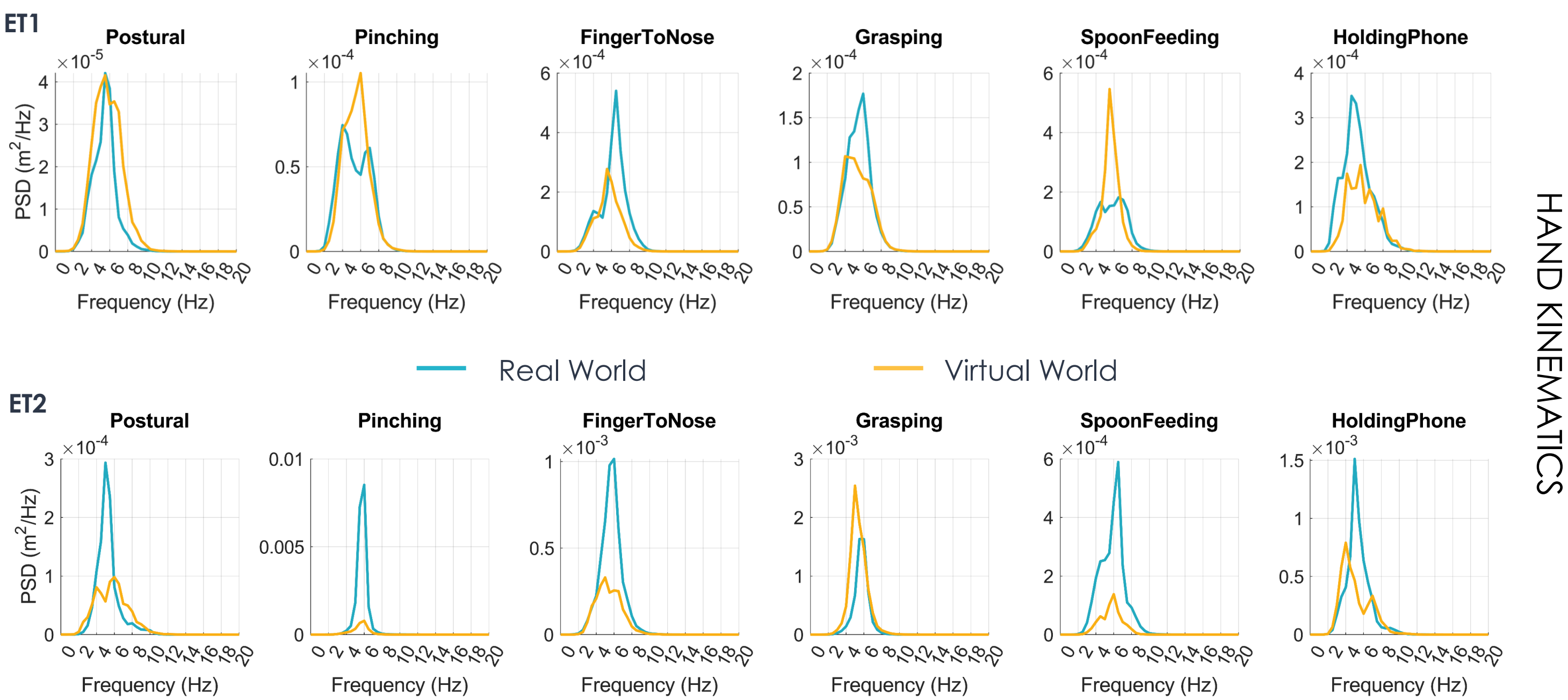
Is a VR environment capable of altering pathological tremor?

2 ET patients: ET1, 67y, male, mild tremor; ET2, 85y, female, mild-severe tremor

- **Real World (RW):** ADL with very light items
- **Virtual World (VR):** ADL with hand tracking

Hand kinematics estimated with Kinematics (x-IMU3)

Muscle activity measured with HDsEMG: FDI, FCR and ECR muscles

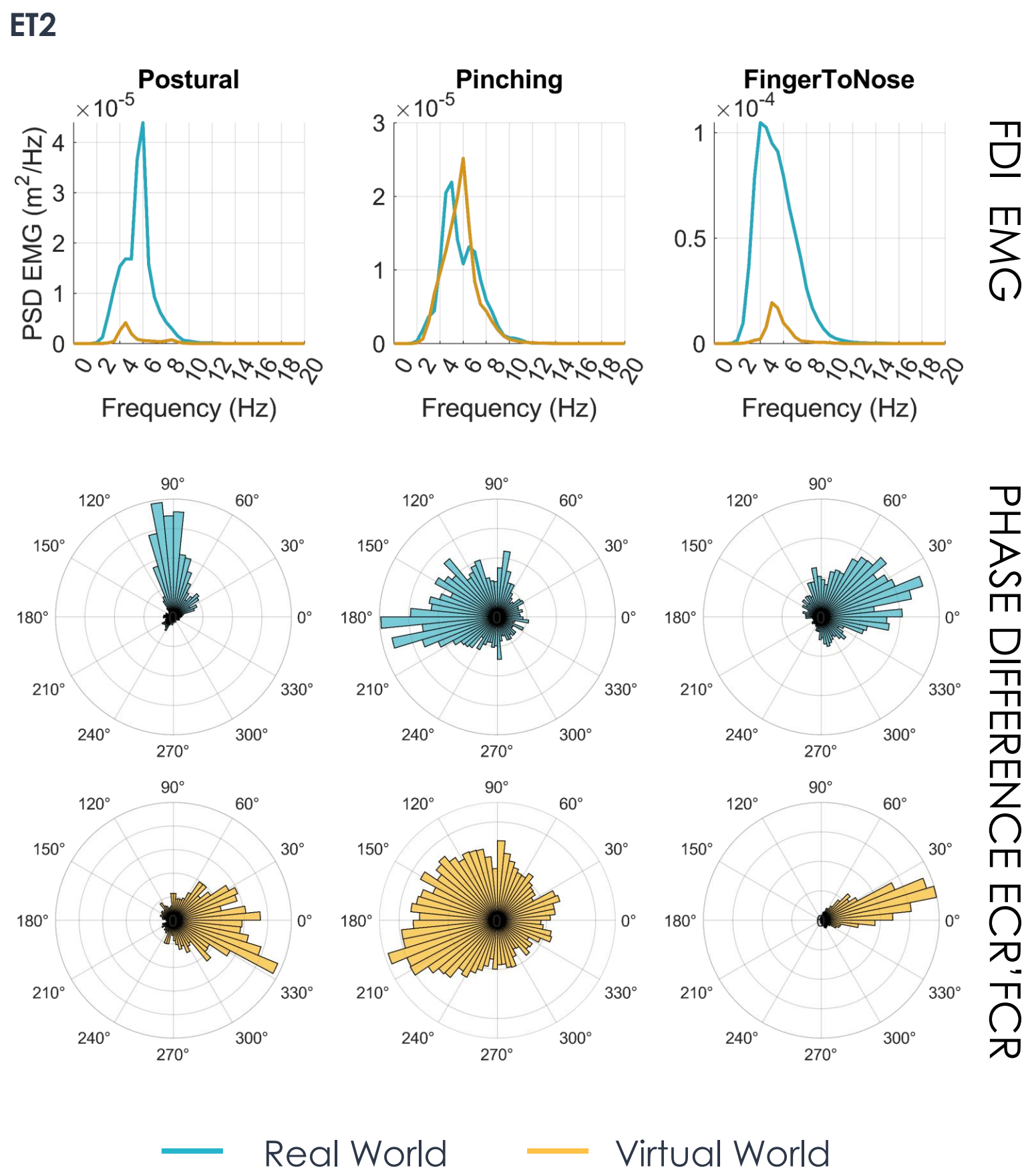


Tremor can be modified in a VR environment.

Inter- and intra-subject tremor variability must be considered when interpreting results.

Neural tremorigenic drive to the muscle does not linearly explain mechanical tremor.

Users reported the in performance in the VR world similar or superior to the real world.



CONCLUSIONS

Healthy subjects and tremor patients can complete ADL in a VR environment without significant detriment.

The VR hand-tracking system effectively filters out tremor oscillation and can be used to modify tremor visual inputs.

Further tests are needed to confirm whether the manipulation of visually perceived tremor can disrupt tremor generation/propagation circuits.

REFERENCES

¹ Louis, E. D., & Ferreira, J. J. (2010). How common is the most common adult movement disorder? Update on the worldwide prevalence of essential tremor. *Movement disorders*, 25(5), 534–541.

² C. Montero-Pardo et al., "Emerging Noninvasive Approaches for the Suppression of Pathological Tremor," in *IEEE Reviews in Biomedical Engineering*, vol. 19, pp. 65-85, 2026.

³ Liu, X., Tubbesing, S. A., Aziz, T. Z., Miall, R. C., & Stein, J. F. (1999). Effects of visual feedback on manual tracking and action tremor in Parkinson's disease. *Experimental brain research*, 129(3), 477–481.