

Impaired behavioral synergic control between postural, visual, and subjective mental load in individuals affected by Parkinson's Disease.

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Introduction

Background: Parkinson's disease (PD) is a neurodegenerative disease that causes postural¹, visual² and cognitive³ impairments.

Goal: To investigate impairments in the triangular relationship between eye movements, postural movements and subjective mental load in using the behavioral synergic model⁴.

Hypothesis: To observe a PD-related impairment in this triangular synergic control.

Methods

Participants

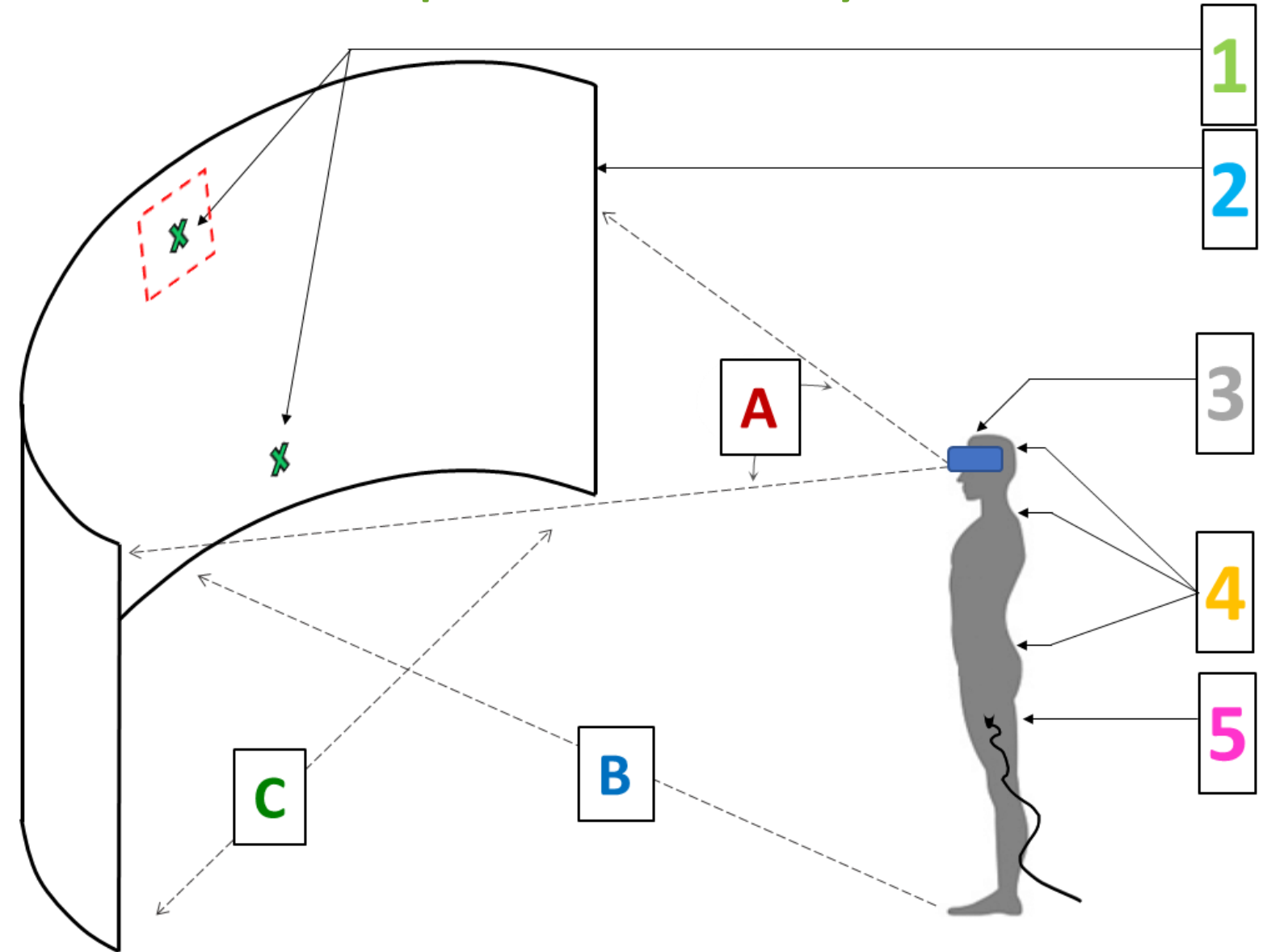
19 individuals affected by Parkinson's Disease

Age: 58.5 ± 8.1 years; Weight: 77.9 ± 11,05 Kg; Size: 1.8 ± 0.8 m; Hoen & Yahr: 2.2±0.3; MOCA: 27.7 ± 0,99; UPDRS-score : 23.4 ±9,5

20 Healthy elderly controls

Age: 62.2 ± 6,9 years; Weight: 84.0 ± 12,2 Kg; Size: 1.7 ± 0.6 m

Experimental layout



1 : Target; 2 : Curved panoramic screen; 3 : SMI oculometer; 4 : Polhemus markers; 5 : Mouse; A: 100° visual angle; B: 3.72 meters; C: 4.08 meters.

Home scenes in virtual reality



Experimental task

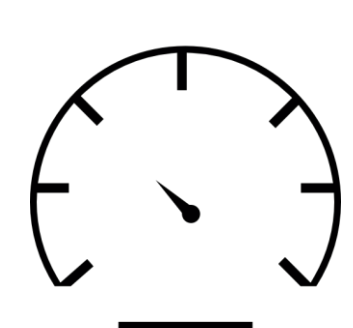
Free-viewing task

« Visually explore the scene without any instruction. »

Search task

« Locate as many objects as possible in the scene. »

Measures



Velocity

Centimeters/s "cm,s-1"



Performance

Number of target found



Range of motion

Centimeters "cm"



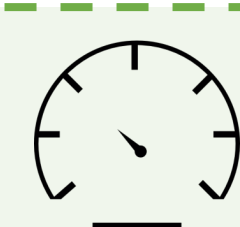
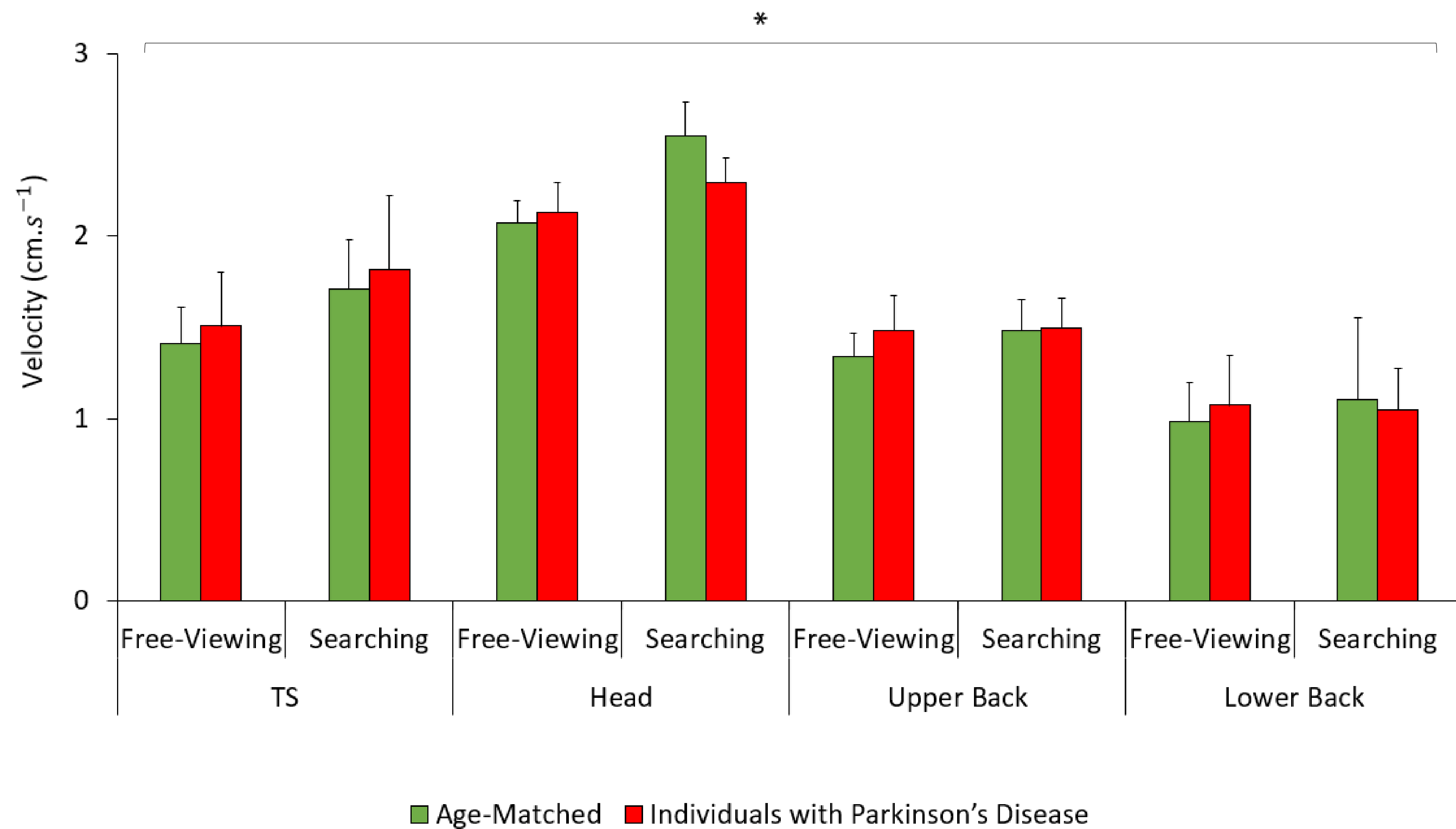
Workload

NASA-TLX subjective scale

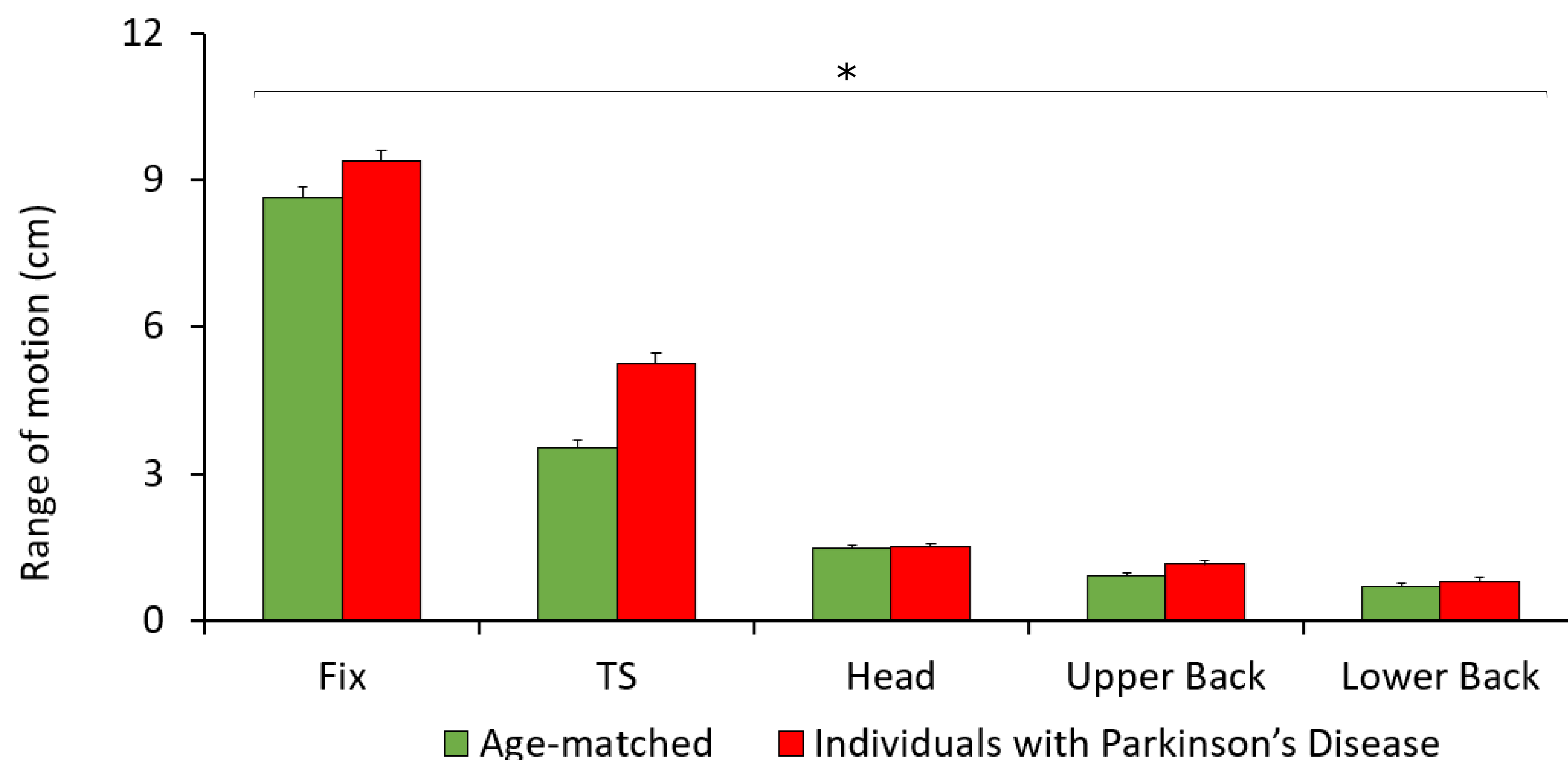
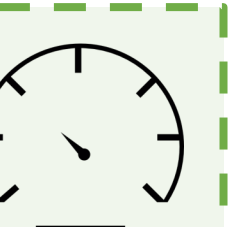
Results

Multivariate Analysis of Variance

MANOVA



MANCOVA: significant Task*Group interaction effect (p=0.002).
The change in velocity was lower in PD.



Individuals with Parkinson's disease had greater eye movements and less postural sway (p<0.001).



NASA-TLX score is higher for individuals affected by Parkinson's Disease for all conditions (p<0.01).



Performance score is lower for individuals affected by Parkinson's Disease for all conditions (p<0.001).



Discussion - Conclusion

PD results in decreased adaptation of eye and postural range of motion and velocity. This PD-related synergic impairment exists despite an increased use of attentional resources. This impairment led to a decrease in functional efficiency for individuals affected by Parkinson's Disease. The hypothesis of a PD-related impairment in synergistic triangular control is thus validated.

References

- Boisgontier, M. P., Beets, I. A., Duysens, J., Nieuwboer, A., Krampe, R. T., & Swinnen, S. P. (2013). *Neuroscience & Biobehavioral Reviews*, 37(8), 1824-1837.
- Haworth, J. L., Vallabhajosula, S., & Stergiou, N. (2014). *Experimental brain research*, 232(9), 2797-2806.
- Redgrave, P., Rodriguez, M., Smith, Y., Rodriguez-Oroz, M. C., Lehericy, S., Bergman, H., Agid, Y., DeLong, M. R., & Obeso, J. A. (2010). *Nature Reviews Neuroscience*, 11(11), 760-772.
- Nonnekes, J., Růžička, E., Nieuwboer, A., Hallett, M., Fasano, A., & Bloem, B. R. (2019). *JAMA neurology*, 76(6), 718-725.