

Cognitive and Motor Behavior Impairments Across Neurodegenerative Diseases During a 3D Virtual Reality Task

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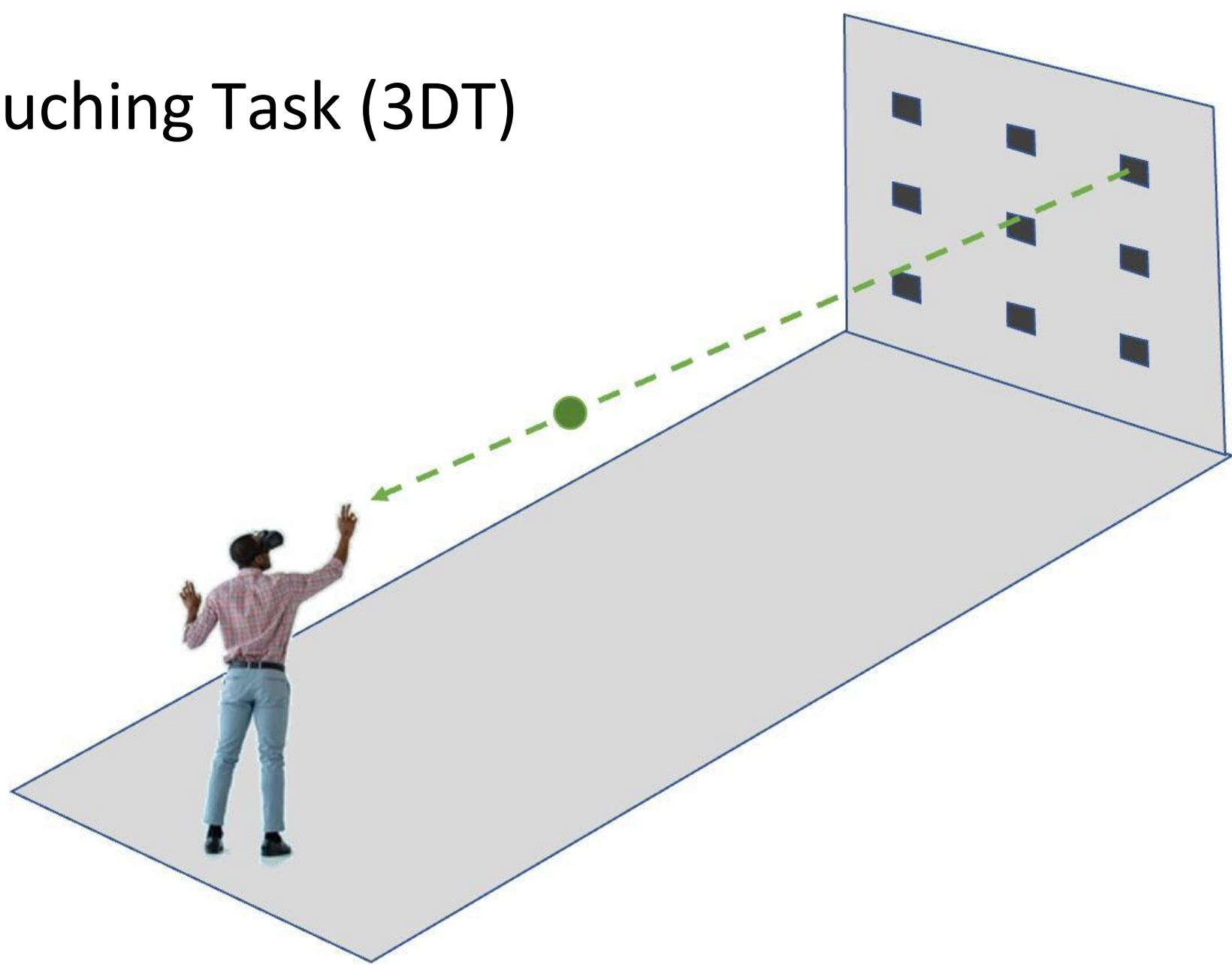
Background

Assessment of motor behaviors associated with cognitive impairments offers a tool to differentiate phenotypes of neurodegenerative diseases (e.g., Alzheimer's disease (AD), Fernández et al., 2022; Huntington's disease (HD); and Parkinson's disease (PD); Mosimann et al., 2005). We investigate whether ViewMind, a multimodal platform integrating Virtual Reality, hand-movement sensors (HMS), eye tracking (ET), and a 3D Spheres Touching Task (3DT), can distinguish cognitive and motor behavior profiles across three different neurodegenerative diseases.

Methods

We assessed patients with AD (n=18; age 37.7±9.5), PD (n=42; age 64.4±9.1), and HD (n=44; age 39.6±14.3). All performed standard neuropsychological tests and ViewMind's 3DT (Fernández et al. 2025). The task assesses the ability to detect 3D visual targets (i.e., visual/hand accuracy and reaction time) as they move from the background to the subject (Fig 1). The Percentage of Targets Reached, Prediction Time, Tracking Accuracy, and Hand and Visual Reaction Time were measured as a function of the number of targets reached in patients with AD, PD, and HD.

Figure 1. ViewMind's 3D Spheres Touching Task (3DT)



Results

AD patients reached the largest number of targets (Fig 2). Mean Prediction time followed the pattern HD > PD > AD (p < 0.01). Mean tracking accuracy followed the pattern HD > PD > AD (p < 0.01). Mean Visual Reaction Time / Target Reached Ratio followed the pattern HD > PD > AD (p = 0.01) (Fig 1C). Mean hand reaction time followed the pattern HD > PD > AD (p < 0.01) (Fig 1D).

Figure 2. (A-C) Core outcome measures drawn from the 3DT in the three groups of participants.

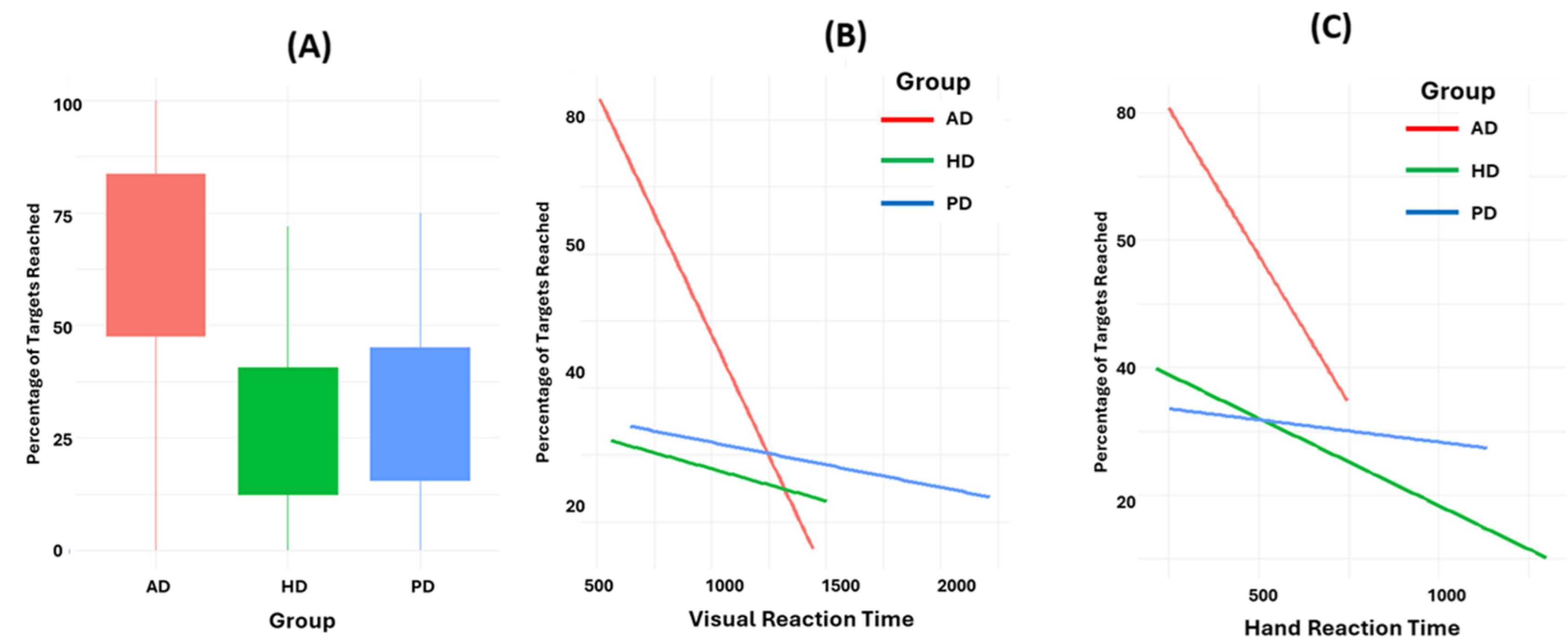


Table 1. Demographic characteristics of the sample.

Diagnosis	n	Age		Education		MMSE		Motor Assessment	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
AD	18	70.17	6.16	10.50	3.34	28.05	2.23		
PD	42	75.56	4.97	12.39	4.50	28.97	1.50	24.85	5.78
HD	44	75.6	7.87	11.93	4.26	28.12	1.66		

Table 2. Outcomes from the statistical analysis.

Variables	Df	F/R2/T	P-value
Percentage of Targets Reached	2	0.29	1.04e-08 ***
Prediction Time	2	0.50	6.97e-08 ***
Tracking Accuracy	2	0.37	2.13e-10 ***
Hand Reaction Time	2	0.38	1.00e-06 ***
Visual Reaction Time	2	0.38	2.73e-07 ***

* < 0.05; ** < 0.01; *** < 0.001

Conclusions

ViewMind's 3DT distinguishes cognitive and motor profiles across neurodegenerative diseases with (PD, HD) and without (AD) motor impairments as predominant clinical features. This overcomes the limitation of available assessments, which fail to capture the dynamic interplay between motor execution and cognitive control during ecologically valid tasks. These findings highlight the potential of this novel technology to refine both theoretical frameworks and practical applications of visuomotor integration in neurodegenerative disease.

References

Fernandez et al. (2022). Alzheimer's & Dementia, 18(S5), e066784.
Fernández et al. (2025). Alzheimer's & Dementia, 21(S2), e106668.
Mosimann et al. (2005). Brain, 128: 1267–76.