

Reach-to-Grasp Spatiotemporal Metrics From Wearables Distinguish Mild Neurocognitive Disorder From Controls

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BACKGROUND

- **Impairment in action planning** is common in individuals with **Mild Neurocognitive Disorder (Mild-NCD)**¹.
- **Reach-to-grasp (RG)** movements are **goal-directed actions** whose kinematics **reflect** motor planning and **cognitive control**².
- **Quantitative analysis of RG movements may provide an objective, ecological, and low-burden approach for detecting early motor-cognitive alterations**³.

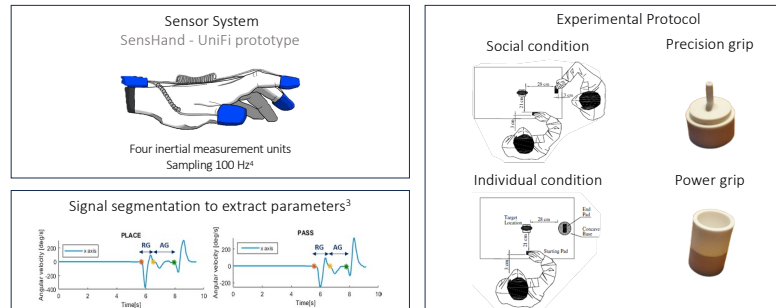
METHODS

PARTICIPANTS

	HC	Mild-NCD	p-value
n.	14	19	-
Age	71.6±9.3	73.4±8.1	0.567
Female (%)	57.1	57.9	1.000
Right-handed (%)	100	84.2	0.244

Participant characteristics. Demographic characteristics of HC and individuals with Mild-NCD. Values are reported as mean ± standard deviation or n (%), as appropriate. Group differences in age were assessed using an independent-samples Student's t-test after verification of normality and homogeneity of variance. Sex and handedness distributions were compared using Fisher's exact tests

Materials and Methods



Parameters

Parameter	Definition
Acceleration	Mean Acceleration Magnitude. It summarizes the overall intensity of the linear acceleration profile during the reach, computed as the average of $\ a(t)\ $
Angular velocity	Mean Angular Velocity Magnitude. It summarizes the overall rotational dynamics of the wrist during the reach, computed as the average of $\ \omega(t)\ $
Peak acceleration	Peak Acceleration Magnitude. It captures the highest instantaneous linear-acceleration demand of the movement: $\max\ a(t)\ $
Peak angle	Peak Angular Velocity Magnitude. It captures the highest instantaneous rotational rate of the wrist: $\max\ \omega(t)\ $
Time-to-vel peak	Time to the dominant peak in the filtered velocity magnitude $\ v(t)\ = \int \ a(t)\ $. It reflects the reach temporal organization.

CONCLUSION & FUTURE PERSPECTIVES

- Individuals with **Mild-NCD** showed **altered RG** performances compared with **HC**.
- **Group differences** in the studied parameters (except peak angle) were largely **independent of grip type and social context**.
- **RG performance may represent a promising marker of early cognitive decline**.
- Investigate **additional spatiotemporal and kinematic variables**, including measures from **other body segments**.
- **Validate these findings in larger cohorts** to improve robustness and clinical applicability.

REFERENCES

- 1) Mancio et al., (2025). Sensorized Motor and Cognitive Dual Task Framework for Dementia Diagnosis: Preliminary Insights From a Cross-Sectional Study. *Journal of Medical Internet Research*, 27, e64255.
- 2) Castiello, (2005). The neuroscience of grasping. *Nature Reviews Neuroscience*, 6(9), 726-736.
- 3) Rovini et al., (2021). A wearable ring-shaped inertial system to identify action planning impairments during reach-to-grasp sequences: a pilot study. *Journal of NeuroEngineering and Rehabilitation*, 18(1), 118.
- 4) Elisa Rovini et al. (2020). A Wearable System to Objectify Assessment of Motor Tasks for Supporting Parkinson's Disease Diagnosis. *Sensors*, 20(9), 2630.

AIMS

- **Primary Aim:** investigate if **spatiotemporal characteristics of RG movements differ** between **Healthy Controls (HC)** and individuals with **Mild-NCD**.
- **Secondary Aim:** identify the task conditions (grip and context) that maximize the differences between HC and individuals with Mild-NCD.

RESULTS



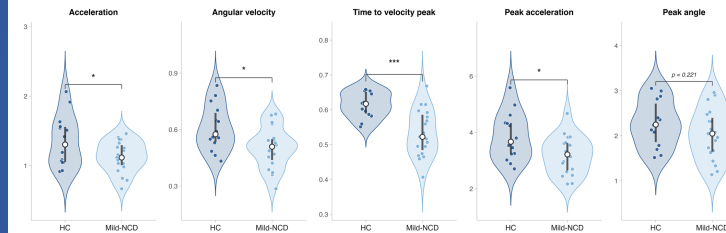
Primary Aim Repeated-measures ANOVA

p-values shown in each cell

	Group	Grip	Context	Group × Grip	Group × Context	Grip × Context	Group × Grip × Context
Acceleration	0.037 *	<.001 ***	0.047 *	0.152	0.784	0.626	0.978
Angular velocity	0.014 *	<.001 ***	0.729	0.819	0.117	0.240	0.254
Time-to-vel peak	<.001 ***	0.004 **	0.332	0.357	0.812	0.174	0.845
Peak acceleration	0.016 *	0.014 *	0.745	0.340	0.198	0.751	0.750
Peak angle	0.221	<.001 ***	0.334	0.432	0.190	0.848	0.033 *

Reach-to-grasp kinematics: HC vs Mild-NCD

Subject means across conditions. Bar inside violin: mean ± SD. Significance from repeated-measures ANOVA (Group effect).



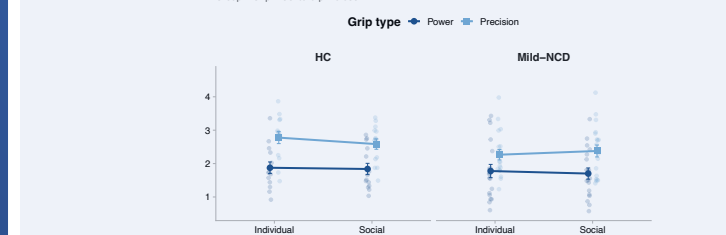
HC = Healthy Controls; Mild-NCD = Mild Neurocognitive Disorder. *p < .05. **p < .01. ***p < .001



Secondary Aim

Peak angle: Group × Grip × Context interaction

Group × Grip × Context: p = 0.033 *



- HC and Mild-NCD showed **significant differences in four of five kinematic parameters**.
- **Grip type influenced all parameters**, whereas **social context had a limited effect**.
- No significant 2-way interactions were found. A **3-way interaction was observed for peak angle** (p = .033).

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