ASSESSING COGNITIVE PERFORMANCE FLUCTUATIONS USING PASSIVE **CONTINUOUS WEARABLE DATA**

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Feasibility study on developing a **passive**, **ubiquitous assessment of cognitive** performance fluctuations over time



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This research explores the potential of **consumer-grade portable and wearable devices** to measure behavioral changes linked to cognitive performance variations in cognitively healthy individuals.

THE DATA POINTS

CHARACTERISTICS OF THE INDIVIDUAL

- **Cognitive reserve*** PRO
- PRO **Demographics***
- PRO Medical history*

BIOLOGICAL, PHYSIOLOGICAL VARIABLES

TechRO Heart rate levels while exercising* TechRO Sleep fragmentation* TechRO Sleep-wake cycle disturbances* TechRO Sleeping and resting heart rate*

FUNCTIONAL STATUS

This poster presents the initial step toward defining and evaluating digital biomarkers that characterize daily cognitive performance fluctuations, using only passively and ubiquitously collected TechROs data.

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Eighty-four cognitively healthy volunteers living in **Switzerland** and/or **France**. Twenty-one (25%) have/had cases of dementia in the family.

Age: between 46 and 78, mean of 57.917 (±8.624) years. **Sex at birth**: 49 (58%) Female, 35 (42%) Male, and 0 Intersex. Self-identified race: 78 (93%) White, 2 (2%) Latino, 2 Asian, and 2 undisclosed. **Education years**: between 6 and 40, mean of 17.840 (±5.269). **Body mass index**: between 18 and 41, mean of 24.668 (±4.248).

Data was collected between 10 March and 31 August 2024.

TechROs linked to PROs and PerfROs in 10 time windows:

- 3 days before (1066 samples) and 3 days after (1307) the PRO/PerfRO assessment.
- 7 days before (865) and 7 days after (1163).
- 15 days before (668) and 15 days after (1001).
- 30 days before (585) and 30 days after (728).
- 60 days before (338) and 60 days after (481).
- All samples were **free of missing data**. Calculated mean, median, standard deviation, and coefficient of variation for each sample.

TechRO Step length, width, height, time*

TechRO Diurnal napping*

TechRO Swing properties*

PerfRO Attention control**

PerfRO Activity shifting**

PerfRO Processing speed**

PerfRO and PRO **Memory****

Data for model creatior

Data for validation

PerfRO Motor actions**

Affect**

TechRO Nocturnal sleep duration*

TechRO **Physical activity levels***

TechRO Gait speed, variability*

CHARACTERISTICS OF THE ENVIRONMENT

TechRO Season* TechRO Weather* TechRO **Air quality*** TechRO **Relative location***

SYMPTOM STATUS

- PRO **Depression****
- Dysphoria** PRO
- Neuroticism** PRO
- Anxiety** PRO
- PRO Stress**
- PerfRO Performance-reported outcome
- PRO
- TechRO Technology-reported outcome

Outcomes being collected, following the Wilson and Cleary [1] model

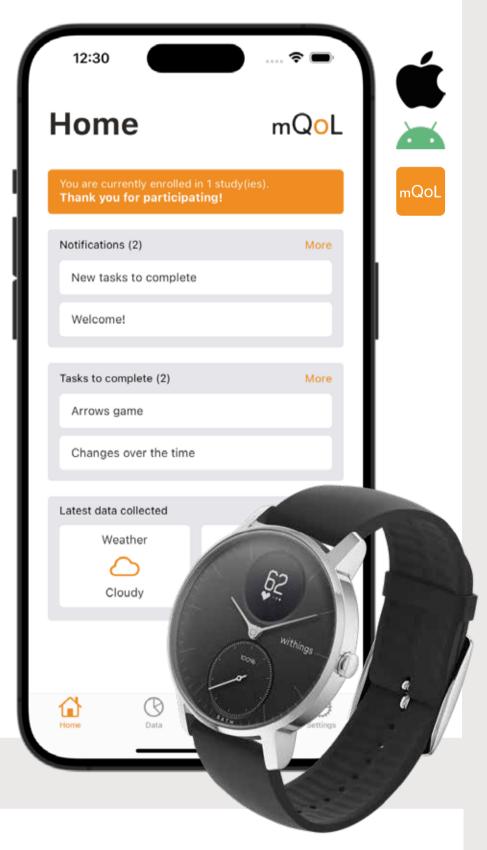
DATA COLLECTION TOOLS

PRO

Observational study of **2 years** in English, French, and Portuguese.

Collection of **active and passive data** between March 2024 and April 2026.

Using a **mobile application** (the mQoL Lab [2]) and a **clinically tested smartwatch** (Withings Steel HR).



Pearson and Spearman's partial correlations were computed, adjusting for potential **confounders** such as demographics, education, diet, lifestyle, medical history, longitudinal biometrics (e.g., midlife obesity), timezone changes, subjective age, and wearable usage time.

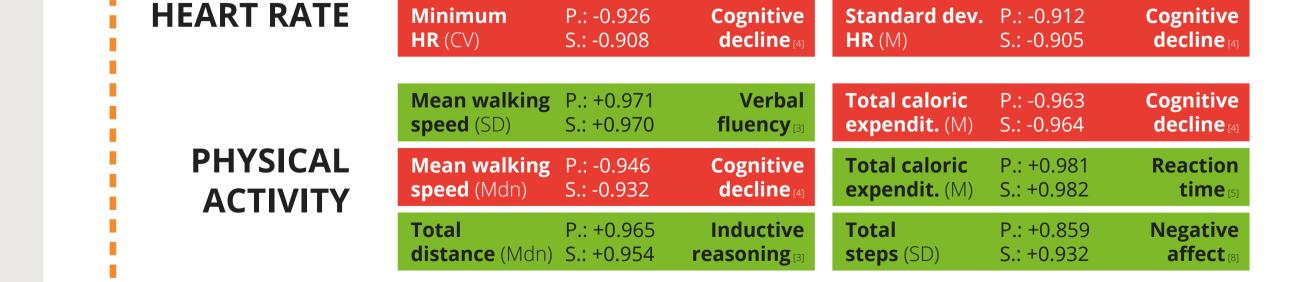
Only selected results with both Spearman and Pearson correlation coefficients simultaneously below -0.8 or above 0.8 are presented.

PROs and PerfROs are collected every three months using the mQoL app.

TechROs continuously using the app and the smartwatch.

PRO/PerfRO collected

			-60 days	S		-30 days	S		-15	-7	-3	+3	+7	7 + 1	15 +	·30		+60 da	ys
		Light sleep duration (SD)	P.: +0.975 S.: +0.973	Inductive reasoning	Sleep efficiency (M)	P.: +1.000 S.: +0.999	Working memory ଓ										Wake-up count (SD)	P.: +0.833 S.: +0.850	Motor functioning ឲ្យ
	SLEEP	Sleep onset latency (Mdn)	P.: -0.983 S.: -0.976	Long-term memory 🕄	Total time in bed (M)	P.: -1.000 S.: -1.000	Verbal fluency ଓ										Deep sleep duration (M	P.: +0.831) S.: +0.800	Motor functioning ច្រ
2					Wakeup latency (M)	P.: -0.944 S.: -0.923	Cognitive decline												
E		Min. sleep	P.: -0.952	Cognitive	Mean sleep	P.: -1.000	Long-term	Min. sleep	P.: +0.872	Short-term		All the results have p-value No significant results were obtained for the sa							
5		HR (M)	S.: -0.927	decline	HR (Mdn)	S.: -0.999	memory	HR (CV)	S.: +0.858	memory _B]							+3, -7, +7, +^	15, or +30 days.
Ÿ	SLEEP HEART RATE	Max. sleep HR (CV)	P.: +0.950 S.: +0.950	Reaction time	Mean sleep HR (CV)	P.: -0.978 S.: -0.952 -	Attention + Inhibition	Max. sleep HR (M)	P.: -0.857 S.: -0.845	Verbal fluency ଃ		HR stan M = mean; Mdn = median; SD = stai CV = coefficient of variatic							
		Median HR (Mdn)	P.: +0.972 S.: +0.977	Long-term memory	Mean HR (CV)	P.: +1.000 S.: +1.000	Prospective memory										Cv – coemciem		for the sample.
	24-HOUR	Standard dev HR (CV)	P.: -0.865 S.: -0.890	Anxiety [6]	Median HR (CV)	P.: +0.816 S.: +0.871	Attention + Inhibition						CONCI						
													CONCLUSIONS						



Strong correlations were found between behavioral data and cognitive markers. The results emphasize and prove the **usefulness of passive**, **ubiquitous** wearable data when addressing the monitoring of cognition over the lifespan. Samples of **30 and 60 days** before the PRO/PerfRO collection offer the **best** correlation.

Future research should **focus on the predictability** of PROs and PerfROs using the here-determined sample sizes and exploring intermediate lengths.

More info and other publications at **PROVIDEMUS.UNIGE.CH**.

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