Thinking, Fast and Slow: How Response Times Can Predict Cognitive Decline and (Bad) Financial Decision-Making at Older Ages

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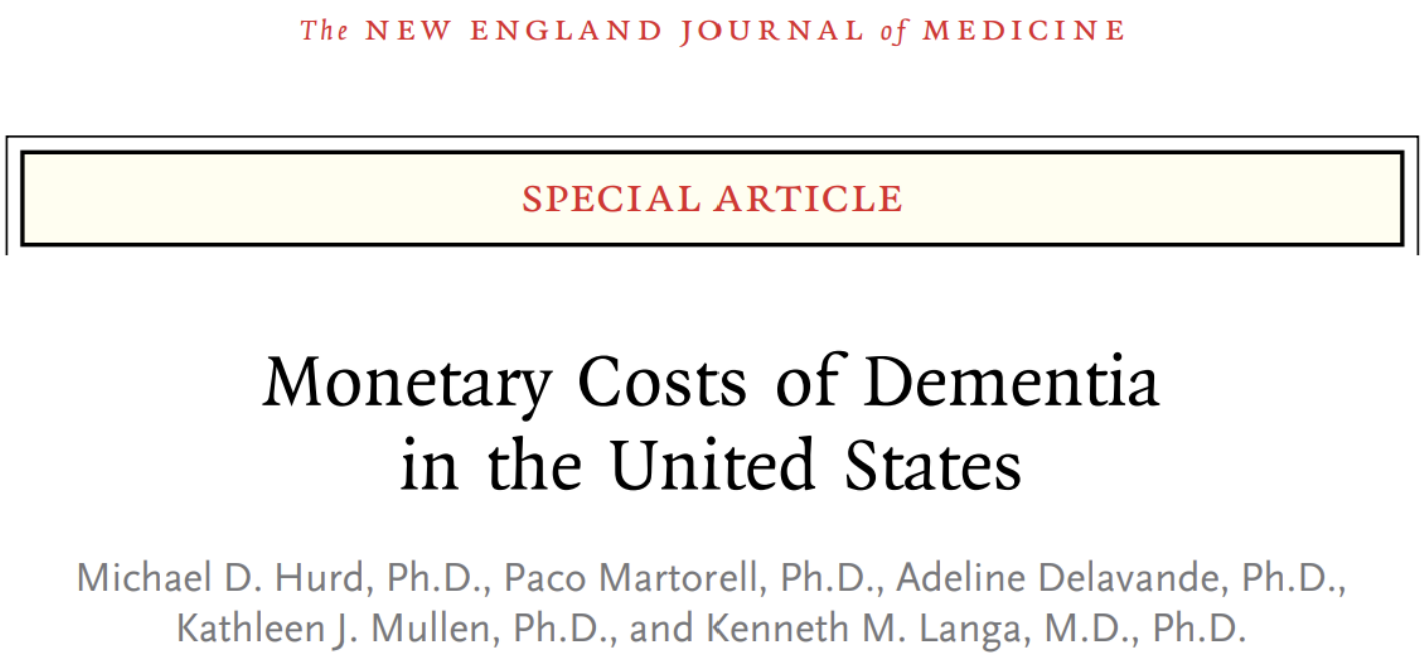

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- Cognitive decline can impair crucial decisions regarding health, autonomy, and personal finances.
- Early detection is essential for timely interventions. We learn a lot with traditional surveys about cognition. But can we learn more?

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- Test-based measures of cognitive assessment focus on **accuracy** (e.g., number of words recalled).

- A more hidden dimension of cognitive performance: the **speed of decision-making**, measured by **Response Time (RT)**.
- RTs might provide an **additional layer of information** on cognitive processes not fully captured by accuracy scores.
- This makes RT a powerful and **low-cost** tool, as it is an automatic byproduct of CAPI surveys.

Research Questions

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2. Do RTs also predict decline in broader **health outcomes**, such as frailty and mortality?
3. Crucially, do RTs predict adverse **financial outcomes**, specifically wealth loss?
4. Can RTs help identify individuals who are **unaware** of their own cognitive decline – a particularly high-risk group?

Previous Literature & Our Contribution

- **RTs as a predictor of cognitive performance.**
  Pioneering work in psychology and neuroscience (*Ratcliff, 1978; Smith, 2000*) and more recently in large-scale surveys (*Sanders et al., 2017*) established this link.
  - **Our Contribution 1:** We validate these findings in the pan-European SHARE data and explore a broader range of health outcomes.

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  - **Our Contribution 1:** We validate these findings in the pan-European SHARE data and explore a broader range of health outcomes.

- **Cognitive health and wealth trajectories.**
  Established literature links cognitive ability to wealth (*Banks et al., 2010; Smith et al., 2010*). *Mazzonna & Peracchi (2024)* show that *unawareness* of decline is a key driver of wealth loss in the US.
  - **Our Contribution 2:** We show that **RTs predict wealth loss** even after controlling for standard cognitive scores.
  - **Our Contribution 3:** We replicate the "unawareness" finding in a European context and show that **RTs help predicting this unawareness**.

Data and Sample

Data Source: SHARE

- Survey of Health, Ageing and Retirement in Europe (SHARE).
- A large-scale, multi-country survey across 28 European countries.
- We focus on **Wave 8 (2019-20)** and **Wave 9 (2021-22)**.
  - These are the first waves with detailed, accessible **time stamp data** from CAPI interviews.

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Analysis Sample

- We construct a balanced panel of **18,782 individuals**.
- *Selection Criteria:*
  - Aged 60+ at baseline (Wave 8).
  - Re-interviewed in Wave 9.
  - Excludes proxy interviews to ensure RTs reflect the respondent's own cognition.
  - For wealth analysis: additional age restriction (less than 80+ + Only Financial Respondents.

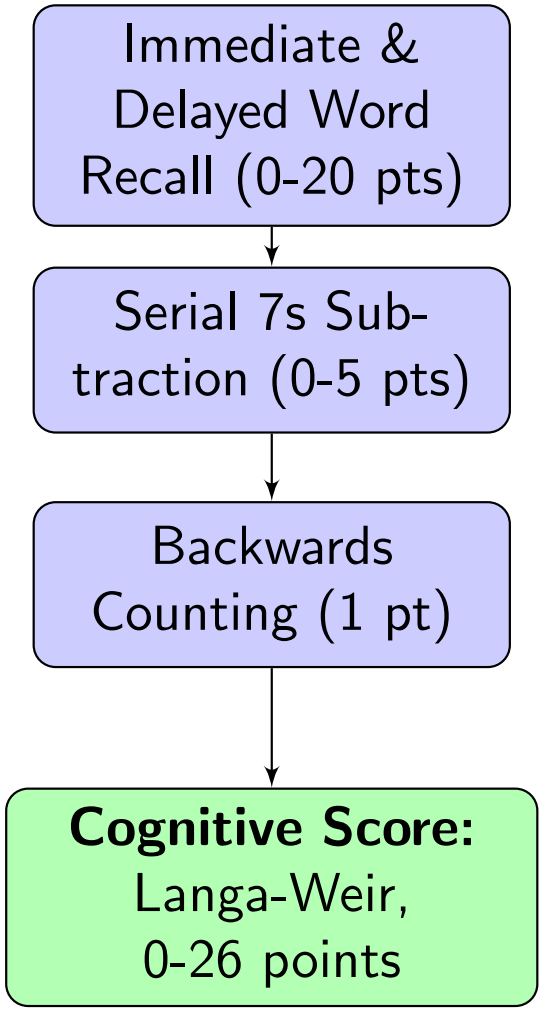
Key Variables & Measurement

Key Predictor Variable

- **Cognitive Response Time (RT):** Standardized time to complete the core cognitive tasks. More

Key Outcome Variables

- **Cognitive Score:** Langa-Weir 26-point index More
- **Health:** Frailty, Mobility, ADL/IADL, Depression, Mortality More
- **Financial:** Δ Net Worth, (Un)awareness More



Descriptive Statistics: The Link Between RT and Cognition

- In our sample, about 15% of individuals have some cognitive impairment (score 7-11) and 1.2% have dementia-level scores (score below 7).

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Response Times by Cognitive Status (Wave 8)

Cognitive Status	**Mean RT (sec)**	**St.dev.**	**N**
Normal Cognition	120.2	35.8	16,036
CIND (Impaired)	129.8	42.1	2,524
Dementia	144.0	48.2	222

Notes: Based on SHARE W8 data. Cognitive status based on Langa et al. (2020).

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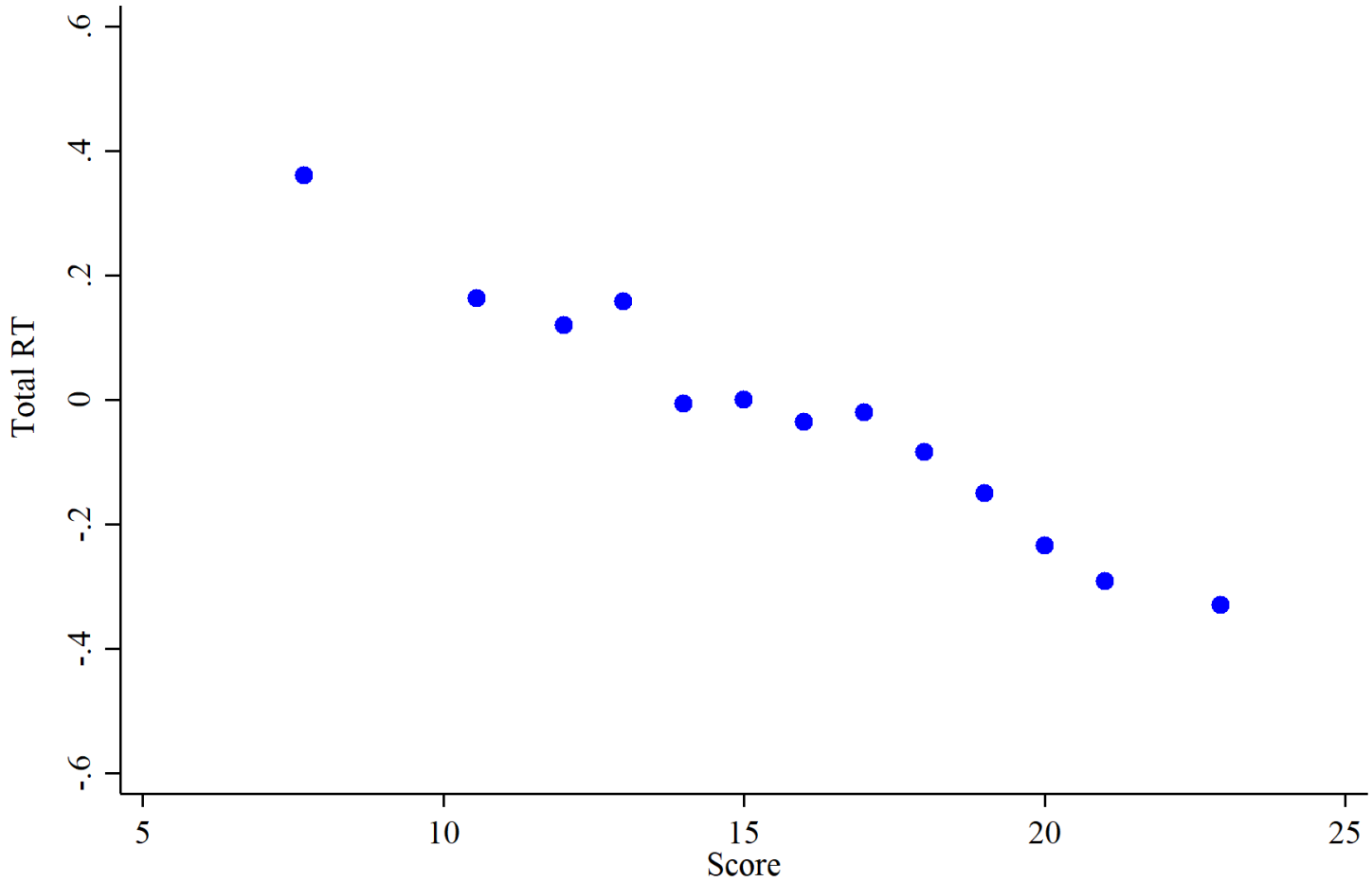
- **Key Takeaway:** Slower and more variable RTs are strongly associated with worse cognitive status.

The Nuances of Response Time



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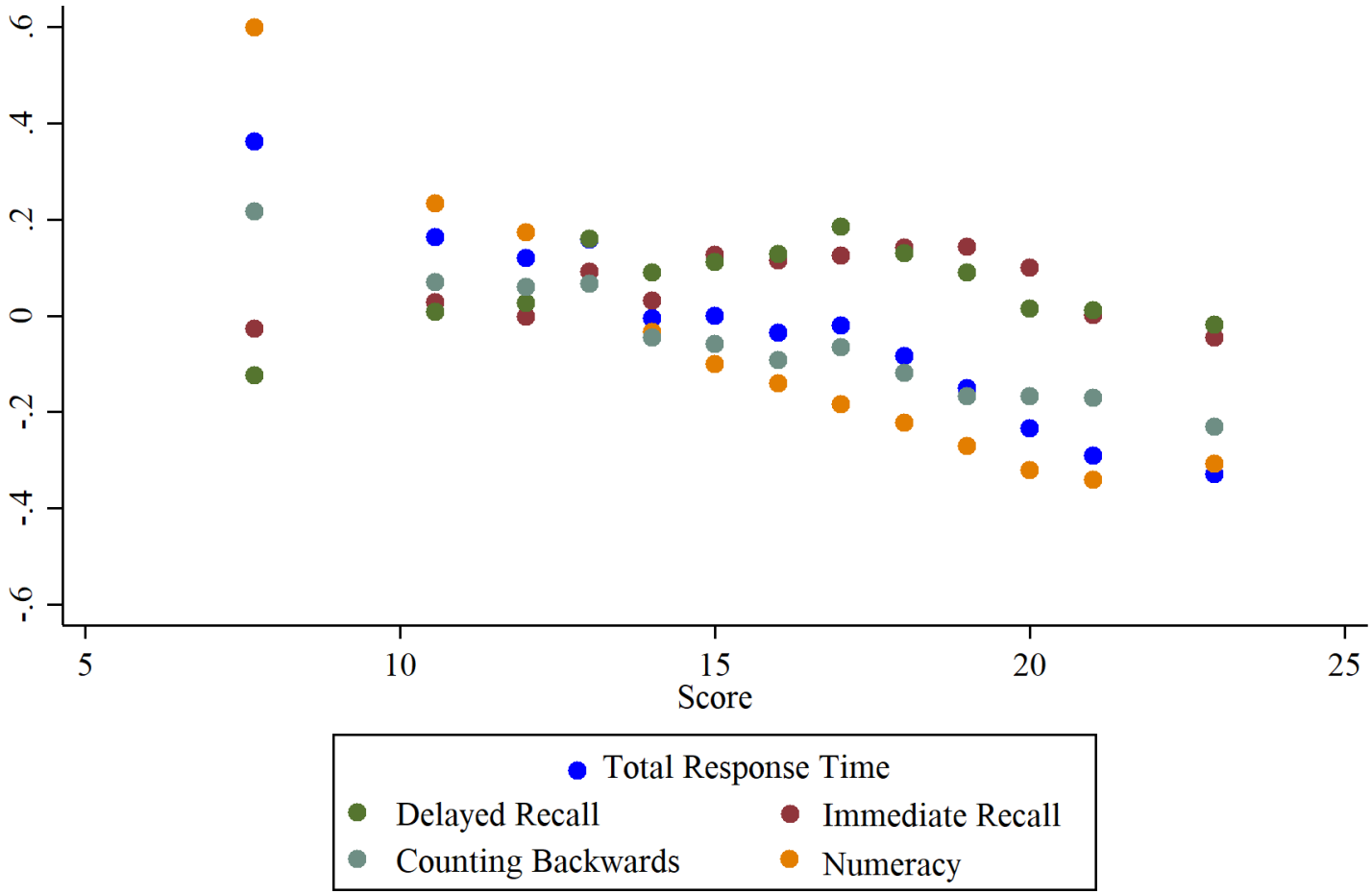

- When we break this down by task, the relationship is **task-specific**:
  - For simpler tasks (Numeracy, Counting), faster is clearly better.
  - For complex tasks (Recall), the relationship can be **non-monotonic**.

Empirical Strategy: Cognitive & Health Outcomes

1. Contemporaneous Association (Wave 8)

$$\text{CogScore}_i = \beta_0 + \beta_1 \textbf{Time}_i + \beta_2 X_i + \delta_k + \epsilon_i$$

- $CogScore_i$: 26-point cognitive score (CS) of respondent i at Wave 8
- $Time_{it}$: Standardized response time in Wave 8.

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- $Time_{it}$: Standardized response time in Wave 8.

2. Predicting Future Outcomes (Wave 8 $\rightarrow$ Wave 9)

$$Y_{i,t+1} = \alpha_0 + \alpha_1 \textbf{Time}_{it} + \alpha_2 X_{it} + \alpha_3 Y_{it} + \gamma_{kt} + \epsilon_{i,t+1}$$

- $Y_{i,t+1}$: Cognitive score or a health outcome (frailty, ADL, etc.) in Wave 9.
- Y_{it}: Crucially, we control for the **lagged outcome** to isolate the effect of RT on the *change* in the outcome.

Empirical Strategy: Wealth Outcomes

Does Response Time predict future wealth (de-)accumulation?

$$\Delta W_{it} = \beta_0 + \beta_1 \textbf{Time}_{it} + \beta_2 X_i + \beta_3 Z_{it} + \psi_c + \epsilon_{it}$$

- ΔW_{it}: Change in household net worth from Wave 8 to Wave 9.
- $\textbf{Time}_{it}$: The respondent's cognitive Response Time in Wave 8.
- X_i: Time-invariant controls (gender, education, migration status).
- Z_{it}: Time-varying controls at baseline (age, labor force status, wealth, and the **cognitive score**).

Empirical Strategy: The Role of Awareness

How does awareness of decline mediate the link between RT and wealth?

We augment the model to include our awareness classification:

$$\begin{aligned}\Delta W_{it} = \beta_0 + \beta_1 \textbf{Time}_{it} \\ + \beta_2 \textbf{Aware}_{it} + \beta_3 \textbf{Unaware}_{it} + \beta_4 \text{Pessimist}_{it} \\ + \beta_5 X_i + \beta_6 Z_{it} + \psi_c + \epsilon_{it}\end{aligned}$$

- **Aware, Unaware, Pessimist**: Indicators for the respondent's perception of their cognitive decline, relative to their objective change.
  - *Omitted category: "No cognitive decline and correct assessment of it"*

- **Key Insight:** This allows us to test if RTs still predict wealth loss *after* accounting for both objective decline and the respondent's awareness of it.

Results: RT and Cognitive Health (Contemporaneous)

Dependent Variable: **Cognitive Score at Wave 8**

	(1)	(2)	(3)	(4)
Z-time	**-0.569*** **	**-0.472*** **	**-0.496*** **	**-0.515*** **
	(0.028)	(0.026)	(0.027)	(0.027)
Age		-0.155***	-0.167***	-0.043
		(0.004)	(0.003)	(0.057)
Age controls	No	Yes	Yes	Yes
Interviewer FE	No	No	Yes	Yes
Other controls	No	No	No	Yes
Observations	18,782	18,782	18,782	18,782
R^2	0.024	0.117	0.357	0.366

Notes: Based on SHARE data. Other controls include age-squared, sex, and migration status.

- Slower Response Time is strongly and significantly associated with lower cognitive scores.
- Col. (3): An effect comparable to **3 years of aging**.

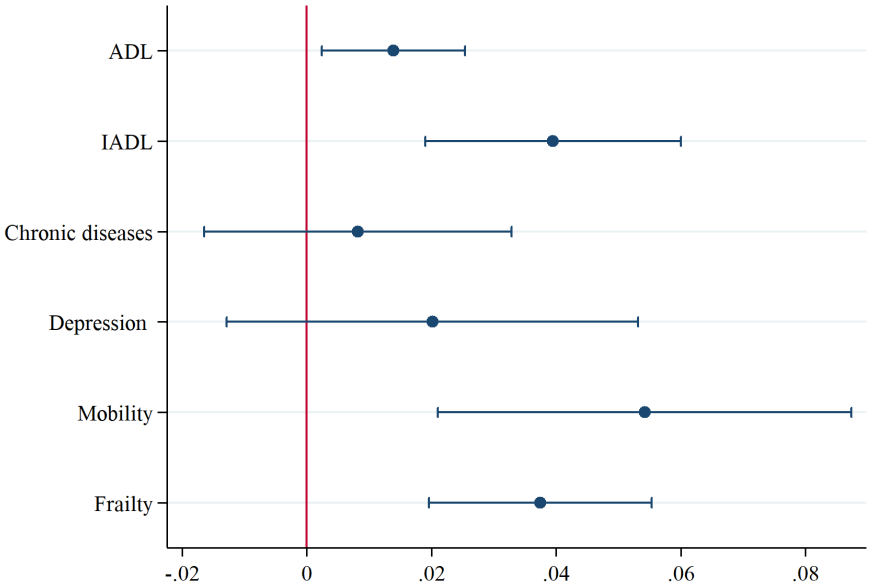
Results: Predicting Future Cognitive Health

Dependent Variable:	(1) **Cognitive Score at Wave 9**	(2)
Z-time$_t$	**-0.167*** **	**-0.177*** **
	(0.025)	(0.025)
Score$_t$	0.583***	0.576***
	(0.008)	(0.008)
Age$_t$	-0.104***	0.042
	(0.003)	(0.054)
Interviewer FE	Yes	Yes
Other controls	No	Yes
Observations	18,782	18,782
R^2	0.542	0.543

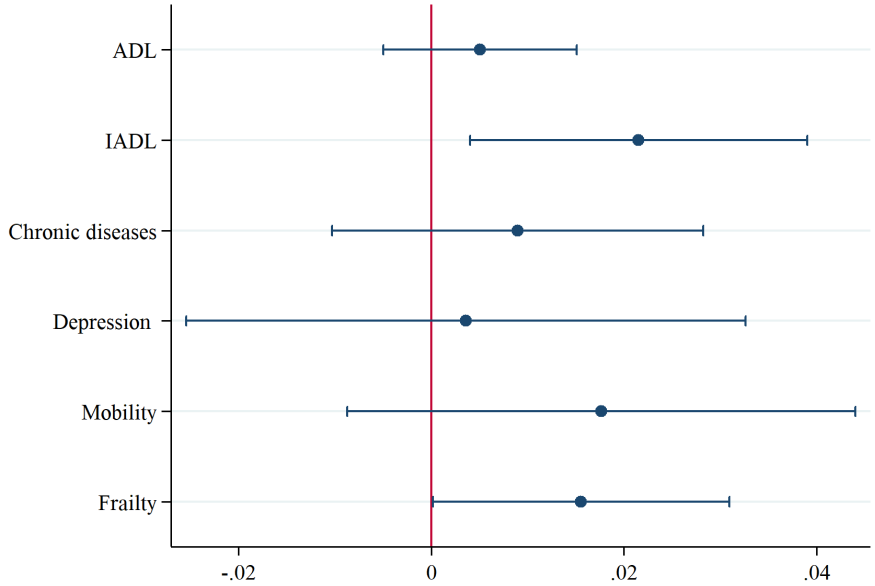
- Slower RTs in Wave 8 predict a lower cognitive score in Wave 9, **even after controlling for the initial score**.
- The effect is comparable to an additional **1.6 years of aging**.

Results: Predicting Broader Health Outcomes

Not controlling for baseline outcome



Controlling for baseline outcome



- Slower RTs predict worse future health, especially **IADL limitations** and **Frailty**.
- The effect remains significant even after controlling for baseline health, indicating RTs predict **health deterioration**.

Results: Predicting Mortality

Dependent Variable:	(1) **Deceased in Wave 9**	(2)
Z-time$_t$	**0.003****	**0.003****
	(0.001)	(0.001)
Score$_t$	-0.004***	-0.003***
	(0.000)	(0.000)
Controls	Age, Sex, Migrant, SAH	Full Controls + Interviewer FE
Observations	22,992	22,996
R^2	0.032	0.126

- Slower response times are a statistically significant predictor of **all-cause mortality** between waves.
- This highlights that RTs capture systemic health risks beyond what is measured by the cognitive score alone.

Results: RTs, Awareness, and Wealth Accumulation

Dep. Var.:	(1)	(2)	(3)	(4)
		Δ Net Worth		
Score$_t$	24.72**			
	(9.65)			
Z-time$_t$				
Cognitive Loss				
Unaware				
Aware				
Pessimistic				
Interviewer FE	Yes	Yes		
Observations	11,906	11,906		
R^2	0.249	0.249		

Results: RTs, Awareness, and Wealth Accumulation

Dep. Var.:	(1)	(2)	(3)	(4)
		Δ **Net Worth**		
Score$_t$	24.72**	22.52**		
	(9.65)	(9.67)		
Z-time$_t$		**-58.11***		
		(32.14)		
Cognitive Loss				
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		Δ Net Worth		
Score$_t$	24.72**	22.52**	24.51**	
	(9.65)	(9.67)	(9.75)	
Z-time$_t$		**-58.11***	-56.28*	
		(32.14)	(32.18)	
Cognitive Loss			**-98.38**	
			(65.68)	
Unaware				
Aware				
Pessimistic				
Interviewer FE	Yes	Yes	Yes	
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Score$_t$	24.72**	22.52**	24.51**	24.55**
	(9.65)	(9.67)	(9.75)	(9.64)
Z-time$_t$		**-58.11***	-56.28*	**-56.16***
		(32.14)	(32.18)	(32.18)
Cognitive Loss			**-98.38**	
			(65.68)	
Unaware				**-123.93***
				(73.62)
Aware				-64.42
				(112.97)
Pessimistic				-19.77
				(87.40)
Interviewer FE	Yes	Yes	Yes	Yes
Observations	11,906	11,906	11,906	11,906
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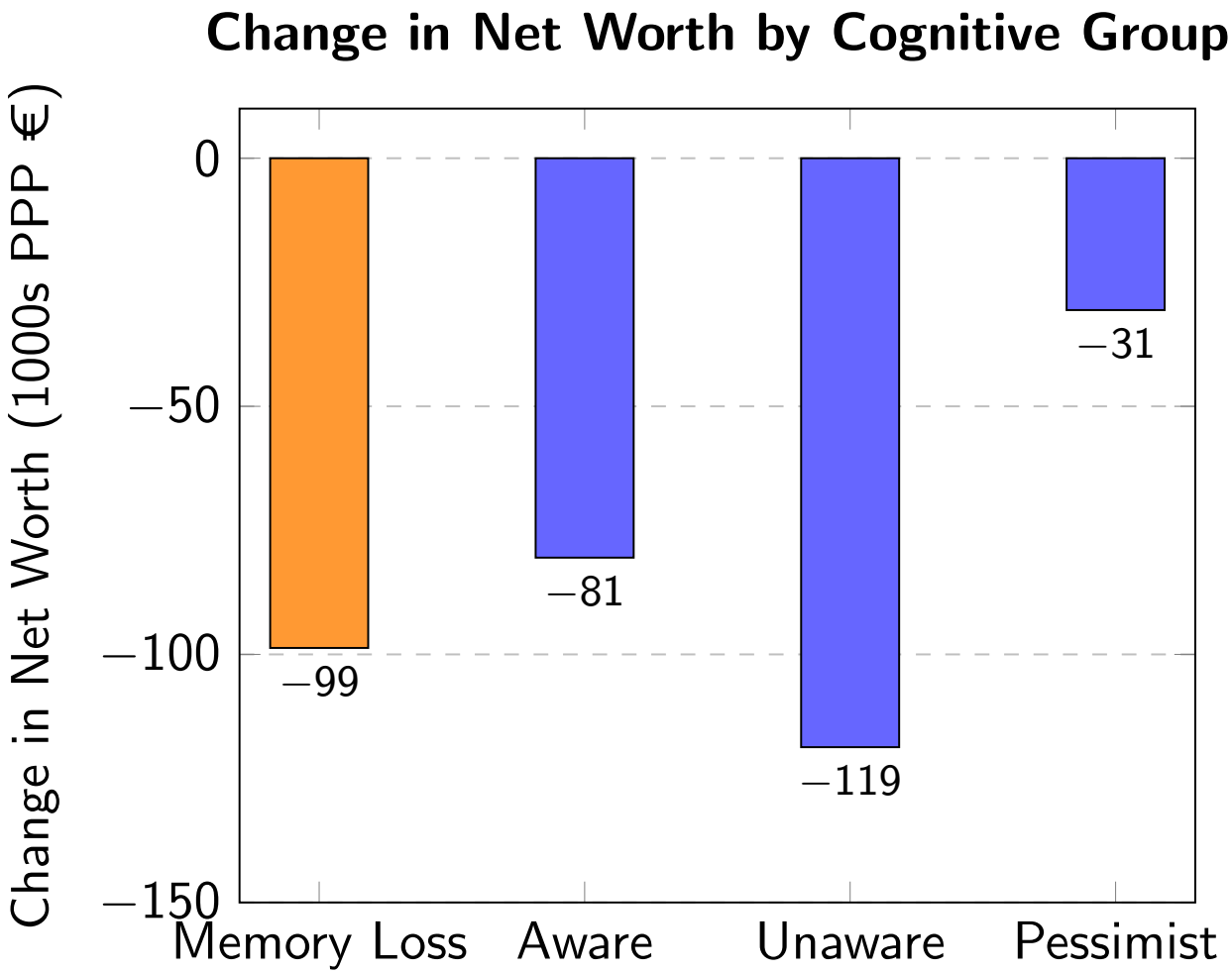
Results: The Role of Awareness in Wealth Loss



- Replicating Mazzonna & Peracchi (2024) in a European context:
- A severe **Memory Loss** event is associated with a large wealth decline of **€98,700** (orange bar).
- This wealth loss is almost **entirely concentrated** among those who are **unaware** of their decline (**€118,700 loss**).
- Those who are **aware** do not experience a statistically significant loss.

Results: RTs and Unawareness

Multinomial Logit: Predicting Awareness Status (Base: No Decline)

	(1) Pessimistic	(2) Aware	(3) **Unaware**
Z-time	0.0120	0.0469	**0.0592****
	(0.0268)	(0.0383)	**(0.0270)**

Results: RTs and Unawareness

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Summary of Key Links

- **Finding 1:** Being **Unaware** of cognitive decline is strongly associated with wealth loss (from previous slide).
- **Finding 2:** Slower **Response Times** are a significant predictor of being **Unaware**.

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- **Finding 1:** Being **Unaware** of cognitive decline is strongly associated with wealth loss (from previous slide).
- **Finding 2:** Slower **Response Times** are a significant predictor of being **Unaware**.

- **Conclusion:** RTs help identify a financially vulnerable group that is otherwise difficult to observe.

Key Findings

RTs → Later Outcomes

- Cognitive decline
- Health: ↑ IADLs, ↑ frailty, ↑ mortality risk
- Results net of baseline cognition/health

RTs → Wealth

- Slower RTs ⇒ faster wealth draw-down
- Effect survives controls for cognition & "awareness"
- RT–wealth link larger when men are financial decision-makers

RTs signal "Unaware" decline

- Identify seniors blind to their own impairment
- Group suffers largest financial losses

Take-aways & Next Steps

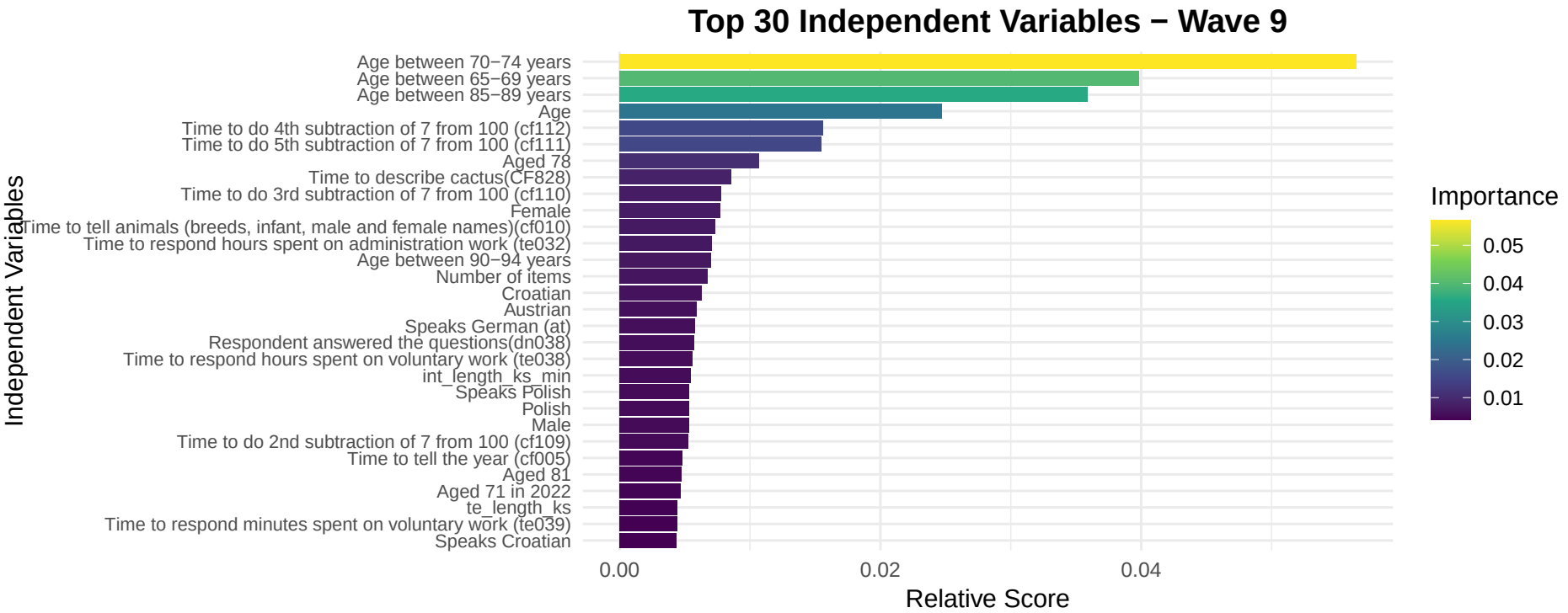
Conclusion

- RTs already stored in CAPI *free, non-intrusive, scalable*.
- Response latency is not mere "noise"; it reflects cognitive speed and predicts cognitive and health decline and wealth draw-down.
- Adds predictive power beyond test scores; useful early-warning flag.

Future work

- Use HCAP-validated classification of cognitive status instead of US-calibrated one (Borsch-Supan et al,2025)
- Cross-country heterogeneity: welfare systems, 3rd-pillar pensions.
- Gender norms & household roles.
- ML ranking of the *most informative* time-stamps—incl. non-cognitive items.

Which RTs flag the "26" Langa Weir score?



Note: Importance scores include CF108 to CF112 but not their summed values.

Variable-importance (Random-Forest) for predicting the 26-point Langa–Weir score. Bars = share of total MSE-reduction contributed by each time-stamp.

Variable-importance results (predicting 26-point LW score)

Recipe

1. **Goal** – predict each person's 26-pt Langa–Weir score.
2. **Ingredients** – every available time-stamp (RT) + age/sex/edu into tree-based algorithms (Random-Forest, Gradient Boosting).
3. The model learns to guess each person's score. After learning, we ask: "which questions' RTs mattered most for the guesses?"
4. "Mattered most" =
   - **Gini/MSE gain**: how much a split on that RT reduces the model's prediction error.
   - **Permutation drop**: how badly accuracy falls if we shuffle that RT.

Main findings

- Age effects dominate: the three categorical dummies (65-69,70-74,75+) top the variable-importance ranking.
- Cognitive-function RTs matter: serial-7s latencies (CF109–CF112) come immediately after the age variables.

Thank you!

Questions?

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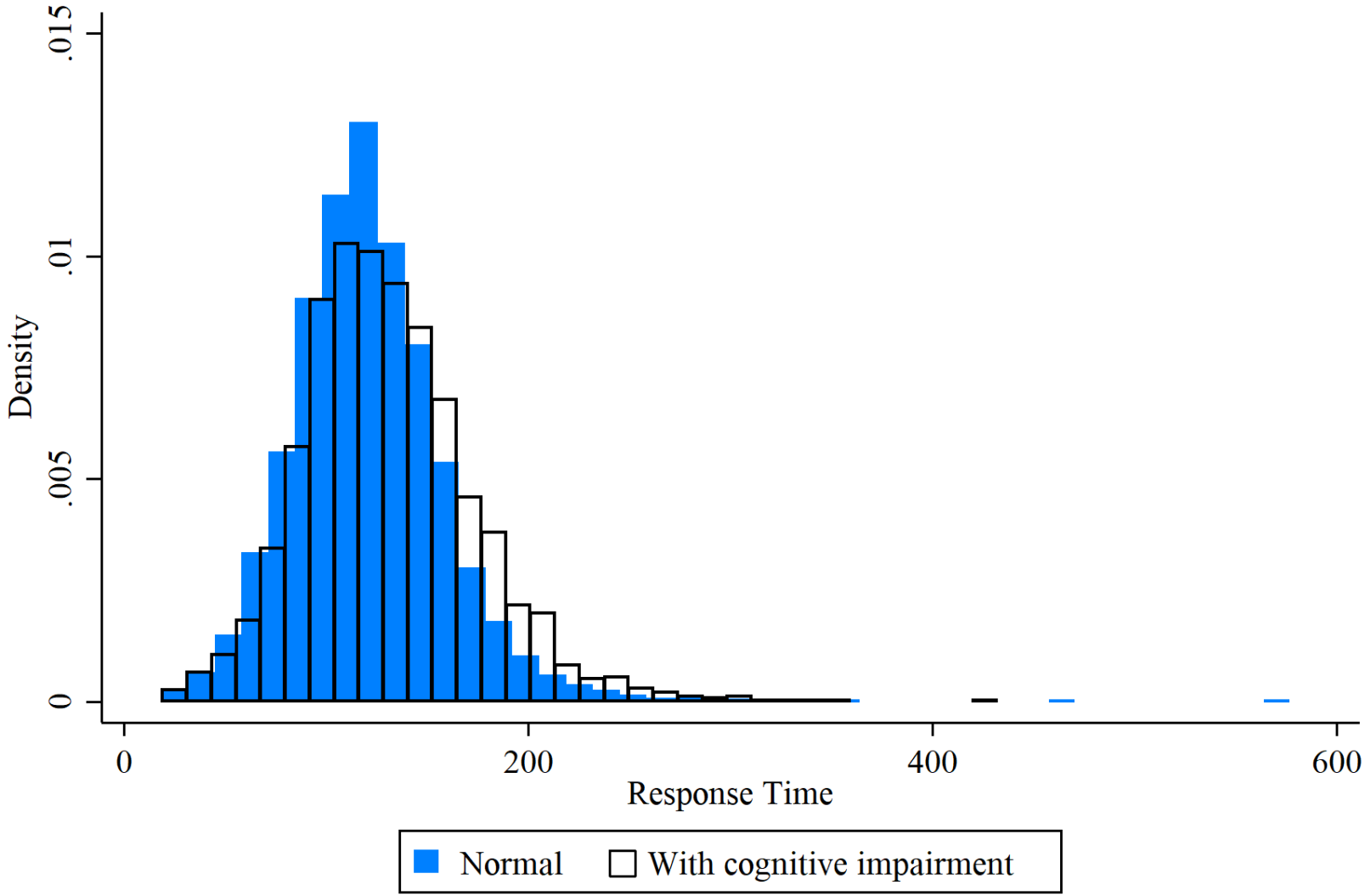
Distribution of Response Times



Back

Cognitive Score: Langa-Weir Classification

Descriptive Statistics for the Score, Langa-Weir Classification

	Wave 8		Wave 9	
	Mean	St. Dev.	Mean	St. Dev.
Cognitive Score	15.294	3.644	14.907	3.922
Fraction normal	0.854	0.353	0.817	0.386
Fraction with CIND	0.134	0.341	0.159	0.365
Fraction with Dementia	0.012	0.108	0.024	0.154

Notes: The data come from SHARE. Summary statistics for the cognitive score of the 18,782 respondents who completed the cognitive module in waves 8 and 9. The scale and classification are based on Langa et al. (2020).

Back

ADLs and IADLs

ADLs (0–6)

- Dressing
- Walking across a room
- Bathing/showering
- Eating
- Getting in/out of bed
- Using the toilet

IADLs (0–8)

- Using a map
- Preparing hot meals
- Shopping
- Making phone calls
- Taking medications
- House/garden work
- Managing money
- Leaving house independently

Back

Multimorbidity

Number of the following conditions:

- Heart disease
- Stroke
- Hypertension
- High cholesterol
- Diabetes
- Cancer
- Chronic lung disease
- Ulcers
- Parkinson's disease
- Cataracts
- Hip fracture
- Other fractures
- Dementia or memory impairment
- Arthritis
- Rheumatic conditions
- Depression
- Anxiety or emotional disorders

Back

EURO-D Depression Scale (0–12)

Count of depressive symptoms:

- Sadness
- Hopelessness
- Suicidal thoughts
- Guilt
- Trouble sleeping
- Less interest in things
- Irritability
- Appetite loss
- Fatigue
- Concentration issues
- No enjoyment
- Tearfulness

Back

Mobility Limitations (0–10)

Limitations in:

- Walking 100 meters
- Sitting for about two hours
- Getting up from a chair after sitting
- Climbing several flights of stairs
- Climbing one flight of stairs
- Stooping, kneeling, crouching
- Reaching or extending arms
- Pulling or pushing large objects
- Lifting or carrying weights over 5 kg
- Picking up a small coin from a table

Back

Frailty Index (0–5)

Number of symptoms:

- Weak grip strength
- Exhaustion
- Unintentional weight loss or appetite reduction
- Slowness in walking or climbing stairs
- Low frequency of moderate physical activity

Back

Self-Rated vs Assessed Memory Loss

Severe Memory Loss	No	Yes	Total
Self-Rated Memory Change			
Better now	0.86	0.31	1.17
About the same	54.23	18.16	72.39
Worse now	18.42	8.02	26.44
Total	73.51	26.49	100.00

Notes: Based on SHARE. "Severe relative memory loss" is defined as a decline of 20% or more in the memory score.

Back