

# The Fetal Origins of Cognitive Aging

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# Motivation

- Cognition is a fundamental component of **labor productivity** and **healthy aging**.
- Neurological literature documents the brain's sensitivity of fetus to temperature shocks (Bowler and Tirri, 1974; Schiff and Somjen, 1985; Hocking et al., 2001)
  - ▶ Yet, little research has examined the **long-term** impacts of prenatal temperature shocks on cognition during aging.

## Research Question

- How does exposure to prenatal temperature shocks affect cognitive function during aging?

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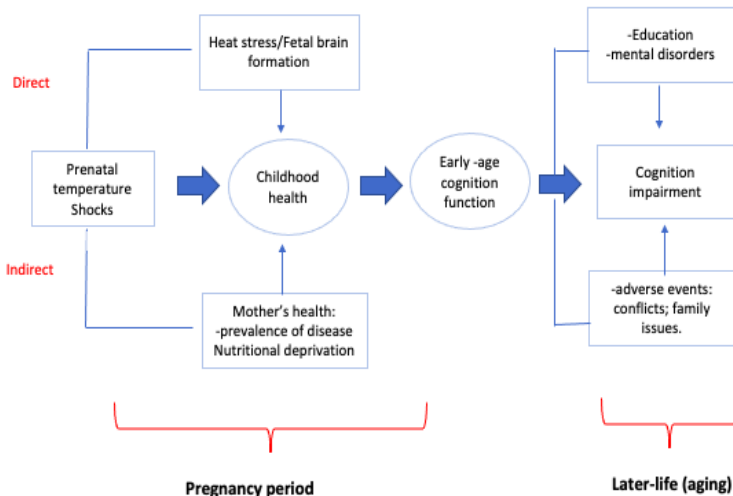
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# Conceptual Framework



# Data Sources

- 1 **Health and Aging in Africa: Longitudinal Study of an INDEPTH Community” (HAALSI) – 2015:** Population based-study of 5,059 individuals in rural Agincourt South Africa, aged above 40 years, and born between 1915-1985. data
  - ▶ **Cognition score** derives from assessments: **orientation, word recall, forward count, number skip pattern.** measure
- 2 **Weather Data,** from University of Delaware air temperature and precipitation dataset (UDEL).
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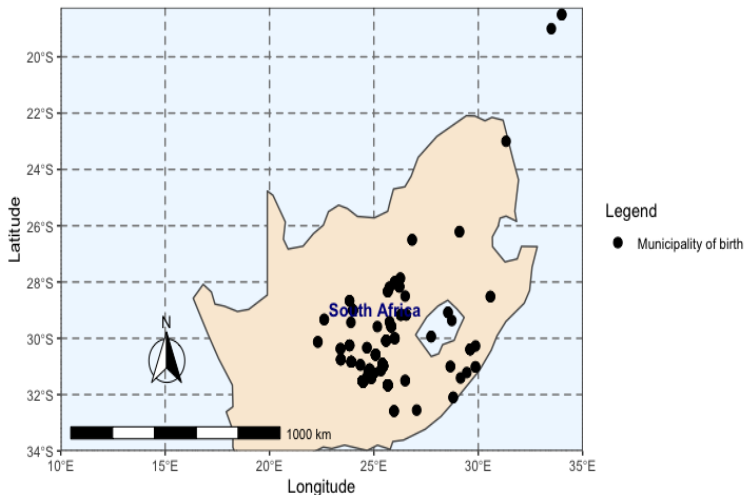
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# Municipality of Birth–South Africa



## Identification Strategy

### OLS FE: causal effect of prenatal temperature

$$Cognition_{ijmt} = \sum_{k=0}^4 \alpha_k * Temp_{ijmt}^k + CW_i + X_i\beta + \mu_j + \lambda_m + \eta_t + \epsilon_{ijmt} \quad (1)$$

where,  $k \in 0, 1, 2, 3, 4$ , for trimesters before conception ( $k = 0$ ), during pregnancy ( $k = 1, 2, 3$ ), and the first trimester after birth ( $k = 4$ ), respectively.

- $Temp_{ijmt}$  average temperature at the  $k$ th trimester during and around the pregnancy period
- $\mu_j$  and  $\lambda_m$ ; municipality and month of birth fixed effects
- $\eta_t$  year of birth fixed effect
- $CW_i$  contemporaneous weather variables
- $X_i$  controls for individual characteristics, sex, age, ethnicity, religion.

# Main results

Table: Temperature effects on cognition score by trimester of pregnancy

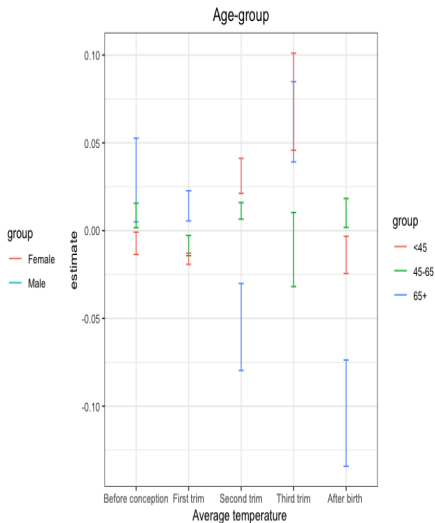
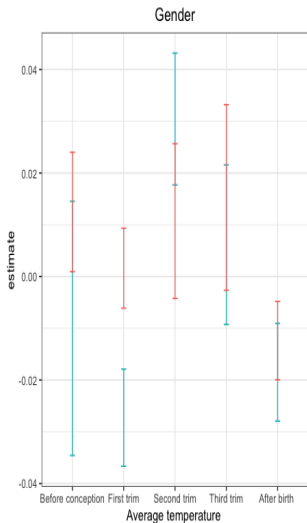
	<i>Dependent variable:</i>				
	<b>Cognition Score</b>				
	before conception (0-3 months)	first trimester	second trimester	third trimester	after birth (0-3 months)
	(1)	(2)	(3)	(4)	(5)
Temp	-0.00033 (0.00604)	-0.01337*** (0.00281)	0.02314*** (0.00477)	0.00314 (0.00594)	-0.01357*** (0.00256)
Municipality	Y	Y	Y	Y	Y
Month of Birth	Y	Y	Y	Y	Y
Current location	Y	Y	Y	Y	Y
Individual Characteristics	Y	Y	Y	Y	Y
Contemporaneous weather variables	Y	Y	Y	Y	Y
Year of interview	Y	Y	Y	Y	Y
Observations	3,106	3,106	3,106	3,106	3,106
R <sup>2</sup>	0.31919	0.32233	0.32107	0.32269	0.32269

Notes: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01.

**Interpretation:** A one standard deviation increase in temperature during the first trimester leads to a **20** percent decrease in the cognition z-score.

hypothesis

# Heterogeneity in the impacts



# Mechanism

- Childhood health
- Early-life investments
- Educational attainment
- Sleep quality

Table: Prenatal temperature effects on quality of sleep

	<i>Dependent variable:</i>	
	<b>Hours of sleep</b>	<b>Sleep quality</b>
	(1)	(2)
Before conception (0-3 months)	-0.01174** (0.00555)	-0.00490* (0.00267)
First Trimester	-0.02337*** (0.00116)	-0.00206* (0.00062)
Second Trimester	0.06306*** (0.00530)	0.00898** (0.00376)
Third Trimester	-0.00718 (0.01215)	0.00472* (0.00790)
After birth (0-3 months)	0.02691* (0.01535)	-0.00245 (0.00385)
Observations	3,171	3,029
R <sup>2</sup>	0.23631	0.26279

Notes: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01.

**Interpretation:** A one standard deviation increase in temperature during the first trimester leads to a 16 percent decrease in the cognition z-score.

# Conclusion

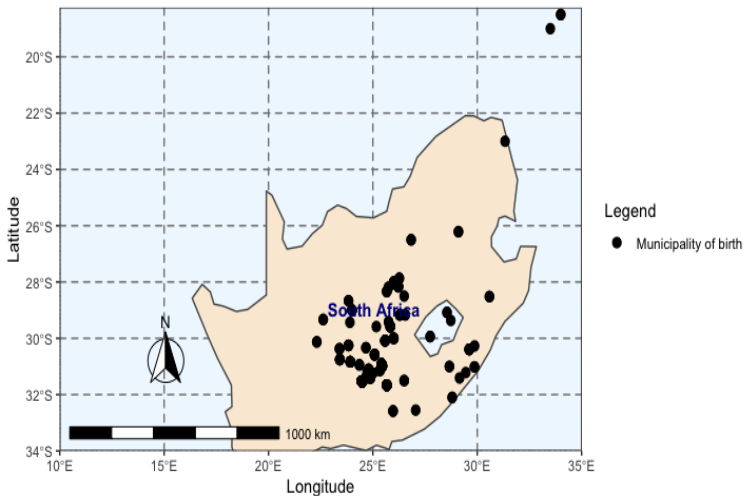
- **Research question:** How does exposure to prenatal temperature shocks affect cognition during aging?
- **Main finding:** A one standard deviation from average temperature experienced in the first trimester of pregnancy decreases the cognition (z-score) during aging.
  - ▶ Effect larger for men and older individuals.



# Thank You!

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- Hocking, C., Silberstein, R. B., Lau, W. M., Stough, C., and Roberts, W. (2001). Evaluation of cognitive performance in the heat by functional brain imaging and psychometric testing. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, 128(4):719–734.
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- Schiff, S. J. and Somjen, G. G. (1985). The effects of temperature on synaptic transmission in hippocampal tissue slices. *Brain research*, 345(2):279–284.
- Weinstock, M. (2008). The long-term behavioural consequences of prenatal stress. *Neuroscience & Biobehavioral Reviews*, 32(6):1073–1086.

# South Africa–Rural Agincourt



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## Measure of Cognition

- Participants completed a battery of assessments designed to evaluate the ability to learn, remember, and make judgments.
  - ▶ **orientation** (ability to state the present year, month, date, and name of the current president)
  - ▶ **immediate and delayed word recall** (the number of words correctly recalled, out of ten, from a list read aloud by the interviewer)
  - ▶ **forward count** (the ability to count correctly from 1 to 20)
  - ▶ **number skip pattern** (the ability to complete the final digit of the number skip pattern beginning with 2, 4, 6, 8.)
- **Cognition score**: average of points.

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## Fetal programming

The **biology literature** documents that the first trimester and the neonatal period are critical for fetal programming and cognitive function development, respectively (Ramírez-Vélez, 2012; Weinstock, 2008).

