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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Conceptual Framework

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- Education
- Mental disorders

- Cognition impairment
- Adverse events: conflicts; family issues.

Direct

- Heat stress/Fetal brain formation

Indirect

- Prenatal temperature shocks
- Mother’s health: prevalence of disease, nutritional deprivation

Pregnancy period

Later-life (aging)
Data Sources


   - Cognition score derives from assessments: orientation, word recall, forward count, number skip pattern.

2. **Weather Data**: from University of Delaware air temperature and precipitation dataset (UDEL).

3. **Final Data**: Merge HAALSI and UDEL based on month and municipality of birth for individuals born in South Africa (3,212 out of 5,059).
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Municipality of Birth–South Africa
Identification Strategy

OLS FE: causal effect of prenatal temperature

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

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

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

![Graphs showing the impact of gender and age-group on cognitive aging](image)
Mechanism

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

Table: Prenatal temperature effects on quality of sleep

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Hours of sleep</th>
<th>Sleep quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Before conception (0-3 months)</td>
<td>-0.01174**</td>
<td>-0.00490*</td>
</tr>
<tr>
<td></td>
<td>(0.00555)</td>
<td>(0.00267)</td>
</tr>
<tr>
<td>First Trimester</td>
<td>-0.02337***</td>
<td>-0.00206*</td>
</tr>
<tr>
<td></td>
<td>(0.00116)</td>
<td>(0.00062)</td>
</tr>
<tr>
<td>Second Trimester</td>
<td>0.06306***</td>
<td>0.00898**</td>
</tr>
<tr>
<td></td>
<td>(0.00530)</td>
<td>(0.00376)</td>
</tr>
<tr>
<td>Third Trimester</td>
<td>-0.00718</td>
<td>0.00472*</td>
</tr>
<tr>
<td></td>
<td>(0.01215)</td>
<td>(0.00790)</td>
</tr>
<tr>
<td>After birth (0-3 months)</td>
<td>0.02691*</td>
<td>-0.00245</td>
</tr>
<tr>
<td></td>
<td>(0.01535)</td>
<td>(0.00385)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,171</td>
<td>3,029</td>
</tr>
<tr>
<td>R²</td>
<td>0.23631</td>
<td>0.26279</td>
</tr>
</tbody>
</table>

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!


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.
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).