One size does not fit all: neural correlates of high performance are different for children in poverty

Monica E. Ellwood-Lowe
With support from:

- the massive efforts of the large team of ABCD leaders and organizers, staff and data curators, and families and children who participated
- ABCD Workshop on Brain Development and Mental Health (Award Number R25MH120869)
- National Science Foundation Graduate Research Fellowship
- Jacobs Foundation Advanced Career Research Fellowship
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Poverty Disturbs Children's Brain Development and Academic Performance

Delayed brain development predicts lower test scores in low-income children
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News > Science

Poverty changes your brain to make you less intelligent, study suggests
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Study finds poverty reduces brain power
What is “normal” brain development?

Gogtay et al., 2004, PNAS
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$n = 13$ kids

avg IQ = 126 (95th percentile)

cited by 6,000+
• $n = 11,000+$ kids
• 21 sites across the United States
• Beginning at age 9-10 years
• Will be followed through age 18

https://abcdstudy.org
Children from higher-income homes tend to score higher on cognitive tests.

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- ABCD study
- $n = 6,839$
- ages 9-10 years
- 21 sites across the United States

There is variability in test performance at every income level.

How do children in poverty achieve high performance on cognitive tests?

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$R = 0.24, p < 0.001$

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One starting point: the mismatch hypothesis

Deschenes, Cuban, & Tyack, 2001; Trueba, 1988
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Resilience = the ability to adapt to the new environment
Resting state fMRI: functional connectivity

- Regions with strong temporal coupling: high "functional connectivity"
  - Regions with a strong history of co-activation (cumulative experience)
  - Form networks of brain regions that are consistent across individuals
- Reflect prior & ongoing thought patterns (habits of mind)?

Intrinsic, spontaneous fluctuations in fMRI BOLD signal
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Intrinsic, spontaneous fluctuations in fMRI BOLD signal
Less resting state coupling between LFPN and DMN thought to be adaptive
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**LFPN**: essential for higher-level cognitive tasks like reasoning

**DMN**: essential for internally-directed cognition

Vincent et al., 2008; Raichle et al., 2001; Spreng, 2012
Less resting state coupling between LFPN and DMN thought to be adaptive

**LFPN**: essential for higher-level cognitive tasks like reasoning

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more **LFPN-DMN** segregation linked to better outcomes

Chai et al., 2014; Satterthwaite et al., 2013; Sherman et al., 2014; Whitfield-Gabrieli et al., 2020
LFPN-DMN correlates of test performance

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**PREDICTED**

Relation between LFPN-DMN connectivity and test scores

**ACTUAL**

Relation between LFPN-DMN connectivity and test scores

Estimated poverty status
- Below poverty
- Above poverty

Summed cognitive test scores

**Below poverty**:

$B = 2.11$, $SE = 1.12$; $p = 0.060$

$B = -1.41$, $SE = 0.45$; $p = 0.002$

Interaction: $X^2(1) = 8.99$, $p = 0.003$

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Potential evidence that patterns of “optimal” brain development depend on children’s environments.

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Exploring LFPN-DMN correlates of performance in the “real world” over time
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Ecologically-valid measures:
- Grades in school
- Attention problems

Ellwood-Lowe, Irving, & Bunge, 2022, *Developmental Cognitive Neuroscience*
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Longitudinally predictive for grades

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Evidences that in our sample, this is a robust and meaningful dissociation

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Children in poverty might rely on different mechanisms to perform well.
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e.g., Frankenhuis et al., 2020
Children in poverty might rely on different mechanisms to perform well

**Children's Cognitive Test Scores by Family Income**

- **Cognitive test score sum**
- **Combined family income (bins):**
  - Less than $5,000
  - $5,000 - $11,999
  - $12,000 - $17,999
  - $18,000 - $23,999
  - $24,000 - $29,999
  - $30,000 - $35,999
  - $36,000 - $41,999
  - $42,000 - $47,999
  - $48,000 - $53,999
  - $54,000 - $59,999
  - $60,000 - $65,999
  - $66,000 - $71,999
  - $72,000 - $77,999
  - $78,000 - $83,999
  - $84,000 - $89,999
  - $90,000 - $95,999
  - $96,000 - $101,999
  - $102,000 - $107,999
  - $108,000 - $113,999
  - $114,000 - $119,999
  - $120,000 and greater

**Estimated Poverty Status:**
- Below poverty
- Above poverty

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*e.g., Frankenhuis et al., 2020*
Children in poverty might rely on different mechanisms to perform well

LFPN and DMN coactivate during:

- Drawing on past experiences and planning for the future
- Directed mind-wandering and meditation
- Creative thinking

e.g., Beaty et al., 2016; Christoff et al., 2009; Dixon et al., 2014; Kucyi et al., 2021; Spreng & Turner, 2019
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