Socioeconomic status in childhood influences exploratory risk-taking and learning

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Sixth grade academic achievement

Source: “The Geography of Racial/Ethnic Test Score Gaps”, by Sean F. Reardon, Demetra Kalogrides and Kenneth Shores of Stanford
What children learn

How children learn
How children learn
Exploration and risk-taking

Tymula et al., 2012; Lucas et al., 2014; van den Bos & Hertwig, 2017; Gopnik et al., 2017; Plebanek & Sloutsky, 2019; Sumner et al., 2019; Blanco & Sloutsky, 2021; Liquin & Gopnik, 2022; Blanco et al., 2023
Exploring (secure known rewards)

- e.g., taking a familiar class

Exploring

- e.g., taking a new class
Exploiting (secure known rewards)

- e.g., taking a familiar class
  - ✓
  - ✖ Less learning

Exploring

- e.g., taking a new class
  - ✓ New Learning
  - ✖ Immediate costs & uncertain rewards
Fewer resources means less protection from the costs of exploring (e.g., car trouble taking time of work etc) (Amir, Jordan, & Rand, 2018).

Uncontrollability might make deferred rewards feel unattainable.
Do poorer children take fewer exploratory risks?
How does this impact learning?
Exploratory risk-taking and learning task
Participants ($N = 125$; 12-14 years old)
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Measured SES using parental income and education
Combined into a composite score
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Measured SES using parental income and education
Combined into a composite score

Household income

Annual income

[Graph showing household income distribution with income ranges from 10,000 to 1,000,000]
Participants \((N = 125; 12-14 \text{ years old})\)

Measured SES using parental income and education
Combined into a composite score

**Household income**

- Annual income
- Maternal and paternal education (years)
Exploratory risk-taking task

**Exploratory risk taking** = More pumping and explosions

**Learning** = points earned in the last phase of the task

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Long balloon = explodes after 19 pumps

Short balloon = explodes after 7 pumps

Unreliable balloon = explodes after variable number of pumps

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Total score: 2

$n = 54$ trials
Is socioeconomic status associated with exploratory risk-taking?
Socioeconomic status and risk taking

Mean # of pumps before 'securing' points

Poorer children sampled less to the balloon explosion limits
Socioeconomic status and risk taking

Poorer children **sampled less** to the balloon explosion limits.

\[ p = .003 \]

Mean # of pumps before 'securing' points

\[ p = .004^{**} \]

\[ p = .005^{**} \]
Does exploratory risk-taking benefit later performance?

Earlier risk-taking  More points later

<table>
<thead>
<tr>
<th>First third</th>
<th>Second third</th>
<th>Last third</th>
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Does exploratory risk-taking benefit later performance?

Earlier risk-taking → More points later

- First third
- Second third
- Last third
Is socioeconomic status related to performance in the last task phase?
Socioeconomic status and final performance outcomes
Exploration explained SES differences in performance.
Socioeconomic status and academic skills
In-task risk-taking and academic skills
In-task risk-taking and academic skills

- Interaction: $p = 0.005^{**}$
- $p = 0.007$

- Higher SES
- Lower SES

[Graph showing relationship between Academic Skills and Pumping, with separate lines for Higher SES and Lower SES.]
In-task risk-taking and academic skills
How children are learning
Having less might mean exploring less

Might be adaptive for ensuring welfare when resources are scarce

Exploiting secures immediate rewards
Does exploratory behavior fluctuate based on reward availability in our changing environments?

… Does the brain track reward availability in the environment?
12-14 year old adolescents

SES

Lower

Higher

Decker et al., 2024
Gambling task

**Reward trial**
- 1.5s
- 8
- 500ms
- + $1
- 500ms

**Loss trial**
- 1.5s
- 4
- 500ms
- - $.50
- 500ms

Decker et al., 2024
"Reward state" = $\alpha \times r_t + (1 - \alpha) \times \text{EWMA}_{t-1}$

(how much reward recently)

Decker et al., 2024
People exploit by repeating previously rewarded actions

Are people more likely to exploit (repeat previously rewarded action) when rewards are scarce?

Decker et al., 2024
People exploit by repeating previously rewarded actions

Decker et al., 2024
More exploitation in states of scarcity

Decker et al., 2024
More exploitation in states of scarcity

Decker et al., 2024
More exploitation in states of scarcity

People track environmental rewards across time and adapt behavior

Decker et al., 2024
Is the **brain tracking** fluctuations in the reward state across time?

... differently by SES?
The striatum

Activates to reward

Goal-driven motivation, exploration, risk-taking

In animals, tracks reward fluctuations
Having less might mean *greater* responses to rewards

Having less might mean *reduced* responses to rewards
SES and how well striatum tracks reward state

Decker et al., 2024
Poorer children took fewer exploratory risks and secured points earlier.

Task manipulation: Reward availability influences explore/exploit behavior.

Being poorer was linked to less reward tracking in the striatum.

QR code to paper
Gambling task

**Reward trial**
- 1.5s
- 8
- + $1
- 500ms

**Loss trial**
- 4
- - $.50
- 500ms

Bigger than 5!
SES and reward responses

Socioeconomic status

More

Less

Lower

Higher

Decker et al., 2024