Paradigms of Risky Decision-Making

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Overview

- Behavioral measures to assess risky decisions
- Studying risky decisions in the fMRI environment
- How do normative maturational changes in the adolescent brain yield risky decisions?
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Risky Decisions

Decisions that are made without knowing the outcome
Assaying Risky Decisions in the Lab

- Challenging to develop ecologically-relevant tasks
- Most tasks aim to:
  - mimic the unexpected nature of real-world risk-taking
  - avoid having a “correct” answer
  - include an element of cost-benefit trade-off
Popular risky decision-making tasks

- Driving Game
- Balloon Analogue Risk Task
- Cups Decision-Making Task
- Roulette Game
- Mixed Gambles Task
- Cake Task
Driving Game (Chein)
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Driving Game (Chein)
Played The Game Alone

Chein et al 2010 *Dev Sci*
Played The Game Alone or with a Friend

Chein et al 2010 Dev Sci
The presence of a friend led to riskier decisions.
Balloon Analogue Risk-Taking (Lejuez)
Cups Task

N=108 trials
LOSE

- $2

- $10
LOSE - $10
Roulette Game

Add $2 to:

Ranged from $1.00-$2.50
Decision Strategies

- **Probability Maximizing (Pmax):** increases the overall probability of winning money compared to losing money.

- **Loss Minimizing (Lmin):** reduces the magnitude of largest monetary loss (\(-$4\) to \(-$8.50\))

- **Gain Maximizing (Gmax):** increases the magnitude of largest monetary gain (\(+$3.50\) to \(+$8.00\))
Add $2 to:

- \(+$8\)
- \(-$6.50\)
- \(+$0\)

Probability Maximizing (P_max)
Add $2 to:

- Green ($+$0)
- Red ($+$8)
- Blue ($-$0.50)
Gain-Maximizing (Gmax)

Add $2 to:

- Red
- Blue
- Green
Mixed Gambles Task
n=192 trials

Barkley-Levenson & Galván, 2014, PNAS
Barkley-Levenson & Galván, 2014, PNAS
Barkley-Levenson & Galván, 2014, PNAS
$EV = 0$

$EV = +$6

Adolescents
Adults

Disadvantageous Risk

Barkley-Levenson & Galván, 2014, PNAS
EV = +$6

Adolescents

EV = -$6

Neutral

Disadvantageous Risk

Barkley-Levenson & Galván, 2014, PNAS
Slope of EV: (β = 0.25, t(35) = 4.69, p < 0.001)
Age: (β = -0.11, t(35) = -1.98, p = 0.05)

Adolescents

Adults

Advantageous Risk

Neutral

Disadvantageous Risk

Barkley-Levenson & Galván, 2014, PNAS
Cake Gambling Task

Van Leijenhorst et al, 2008
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The brain undergoes massive development for decades!
Mystery solved: Why teens are nuts

By Susannah Cahalan

December 7, 2020

Sunday Review

CONTRIBUTING OP-ED WRITER

Why Teenagers Act Crazy

Richard A. Friedman

June 28, 2014

A CRITIC AT LARGE

THE TERRIBLE TEENS

What's wrong with them?

By Elizabeth Kolbert
What is adolescence?

A normal, adaptive, & significant period of human development characterized by substantial change, akin to early childhood in terms of opportunity to influence long-term outcomes & potential.
Puberty

Adult roles?
Adolescent paradox
Adolescent paradox

- In almost every measurable domain, this is a developmental period of vast learning, discovery, strength and resilience
- Yet, overall mortality rates increase 200%

![Leading causes of death, ages 10-18](source)

- Unintentional injury: 45.2%
- Motor vehicle accident: 31.9%
- All other causes: 31.2%
- Suicide: 9.8%
- Homicide: 13.8%
- Other unintentional injury: 13.4%


The Prefrontal Cortex Is The Last Brain Region To Mature
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- decision-making
- impulse control
- future planning
- goal-directed behavior
- understanding consequences
The Limbic System Is Responsive to Risk And Reward
The Limbic System Is Responsive to Risk And Reward
Balloon Analogue Risk-Taking (Lejuez)
Greater activation in striatum associated with risk-taking behavior

Telzer, Fuligni, Lieberman, Galván, 2013, Journal of Cognitive Neuroscience
Driving Game (Chein)
Friends excite the reward system in adolescents, leading to more risky decisions.