Adolescent Brain Cognitive Development


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What is the ABCD study?

www.ABCDstudy.org

- 11,878 children (including 2,100 twins and 30 triplets) aged 9-10.
  - 700+ in San Diego County!
- Annual assessments (biennial MRI) for ten years.
- Extensive neuroimaging, genotyping, psychometrics, hormone analysis, geocoding ...
- Data publicly available:
  https://data-archive.nimh.nih.gov/abcd
ABCD Study Objectives:

- Determine how childhood experiences interact to affect outcomes.

**Experiences:**
- *For example...*
- Sports
- Social media
- Sleep
- Substance use

**Outcomes:**
- Brain development
- Neurocognition
- Academics
- Behaviors
- Health
- Other outcomes

- Results will provide families, schools, health professionals, and policymakers with practical information to promote health, well-being, and success of children.
Why so large a sample?

• Gives sufficient **statistical power** to detect small effects, the cumulative impacts of multiple influences, interactions among variables, …

• Allows for rigorous **data analysis** (e.g., complex analytics)

• With sufficient individual variation, we can disentangle demographics that are often confounded (e.g., urbanicity, SES).

• Can reveal if effects vary with subpopulations – for example, sex/race-specific risk factors for, and consequences of, substance use or psychopathology.
How was the sample recruited?

Excluding Birth Registry Twins

<table>
<thead>
<tr>
<th>Recruitment Source</th>
<th>%</th>
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<tbody>
<tr>
<td>School Based</td>
<td>67.8</td>
</tr>
<tr>
<td>Referral</td>
<td>13.0</td>
</tr>
<tr>
<td>Mailing List</td>
<td>7.8</td>
</tr>
<tr>
<td>Other Volunteers</td>
<td>3.0</td>
</tr>
<tr>
<td>Summer</td>
<td>4.3</td>
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<tr>
<td>TBD</td>
<td>4.0</td>
</tr>
<tr>
<td>Online Advertising</td>
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</tr>
</tbody>
</table>

[Pie chart showing the distribution of recruitment sources]
The Sample

Female : Male

Age

Age 9: 52%
Age 10: 48%
The Sample

General Population

Twins Population
The Sample

ACS
American Community Survey is a large scale survey of approximately 3.5 million households conducted annually by the U.S. Census Bureau
Study Timeline
<table>
<thead>
<tr>
<th>Assessment Protocols</th>
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<tbody>
<tr>
<td><strong>Neurocognition</strong></td>
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<tr>
<td><strong>Substance Use</strong></td>
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<tr>
<td><strong>Mental Health, Health, &amp; Demography</strong></td>
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<tr>
<td><strong>Culture &amp; Environment</strong></td>
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<td><strong>Biospecimens</strong></td>
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<td><strong>Mobile Tech &amp; Passive Data</strong></td>
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<tr>
<td><strong>Structural MRI</strong></td>
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<td><strong>rs- and task-based fMRI</strong></td>
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How is it going?

Now that we have baseline data the primary emphasis is on retention.

A dedicated retention working group focuses on monitoring retention, identifying trends in who is withdrawing or missing assessments, building predictive models for who withdraws, sharing best practices, working with sites, etc.
How is it going?

Four years in and retention rates remain very high: 98.7%
COVID Adjustments

- ABCD moved quickly to virtual (on-line, at home) assessments and is now transitioning to hybrid (at-home + lab-based) and fully in-person assessments.

- Some missing data will be inevitable.

- One silver lining: Reduced sociodemographic bias in who fails to do assessments!
What are we learning?
Substance use patterns in 9-10 year olds: Baseline findings from the adolescent brain cognitive development (ABCD) study


We succeeded in recruiting a substance-naïve sample

- 22.5% reported alcohol sipping
- 0.2% full alcohol drink
- 0.7% used nicotine
- <0.1% used any other drug of abuse
Risk factors associated with curiosity about alcohol use in the ABCD cohort

Perceptions that alcohol use causes little harm and having peers with similar beliefs is related to curiosity about alcohol use among substance-naïve 10-11-year-olds.

• Same for general mental health, parent history of AUD, and adverse life events

Briana Lees, BPysch (Hons)¹, Laika Aguinaldo, PhD², Lindsay M. Squeglia, PhD³, M. Alejandra Infante, PhD², Natasha E. Wade, PhD², Margie Hernandez Mejia⁴, Joanna Jacobus, PhD²

Youth with family history of alcohol use disorder show different brain activation patterns in response to cognitive inhibition tasks.
Children reporting low-level alcohol sipping at ages 9-10 have a two-fold increase in their odds of suicidality
Cognition skills were best among children who got between
- 9-11 hours sleep,
- <2 hours recreational screen time
- At least an hour’s exercise daily.
Better cognitive abilities associated with less report of
• Stress
• Externalizing symptoms
• Internalizing symptoms
What are we learning?

Stratification

We can also empirically derive groups. For example, three groups of participants were identified from brain activation alone, during successful inhibition in the Stop Signal Task, by data spectroscopic clustering (Shi et al., 2009).

[Allgaier et al., In Prep.]
What are we learning?

Data Exploration and Analysis Portal (DEAP ABCD)

New Features:
- ROI level Image Analyses
- Interactive download of data using Explore
- Population weighting in Analyze
What are we learning?

**Big Data and Small Effects**

- Small samples + Publication bias = inflated effect sizes.

- Analyses of the large ABCD dataset is revealing small effects ($r<0.1$) to be the norm.

[Thompson et al., 2021]
Substance Use Assessment
Overview
ABCD Goal: Understand the biological and environmental building blocks that best contribute to successful, resilient young adults.

Substance use

• Can be considered an “environmental” influence on youth outcomes
  • Influences on brain development
  • Influences on mental health
• As well as an outcome itself
  • Substance use problems
  • Addiction
Substance Use & ABCD: Overview and Rationale

Therefore, the data collected in the Substance Use module is critical to the goals of the ABCD Study. This includes:

1. Detailed information about substance use
2. Factors impacting risk for substance use
3. Consequences of substance use
Detailed information about substance use

- Includes low-level use questions, TLFB, hair samples
- Provides detailed information to associate with mental health, neurocognition and brain development.
  - Is co-use more harmful to the brain than the use of one substance?
  - How does early substance use impact risk for depression?
- Provides substance use outcomes:
  - What are the brain predictors of early initiation of substance use?
  - What are the environmental protective factors that keep high-risk youth from using substances?
Factors impacting risk for substance use

- Includes availability of substances (in neighborhood and at home), peer use and attitudes, parent rules, youth attitudes (expectancies, intention to use)

- Provides detailed information to associate with substance use outcomes.
  - For example, if we can identify youth who have risk factors for substance use, but do not go on to have problem substance use, we can isolate **protective factors**.
Some Data: Annual Alcohol Sipping

Increased from 9.6% in Year 1 to 15.7% in Year 4

Percent Youth Sipping Alcohol

- 11 years old
- 12 years old
- 13 years old
- 14 years old
Some Data: Alcohol Full Drink

Increased from 0.07% in Year 1 to 2.8% in Year 4

Percent Youth Consumed Full Drink
Some Data: Tried Nicotine Product

Increased from 0.4% in Year 1 to 3.4% in Year 4

Electronic Nicotine Device (ENDs) use by far the most common every year
Some Data: Used ENDS

Increased from 0.14% in Year 1 to 3.3% in Year 4
Some Data: Tried Cannabis

Increased from 0.11% in Year 1 to 2.75% in Year 4

Percent Youth Tried Cannabis

Smoked/Vaped MJ flower are most common every year
Scattered use of other drugs is also increasing, and types of drugs are shifting a bit from prescription/inhalants to stimulants/club drugs/hallucinogens.

Overall, alcohol use remains most common reported substance, followed by ENDS use.
Data Presentation: COVID-19 & Substance Use

Original article

Early Adolescent Substance Use Before and During the COVID-19 Pandemic: A Longitudinal Survey in the ABCD Study Cohort

William E. Pelham III, Ph.D. a, Susana F. Tapert, Ph.D. a, Marybel Robledo Gonzalez, Ph.D. a, Connor J. McCabe, Ph.D. a, Krista M. Lisdahl, Ph.D. b, Elisabet Alzueta, Ph.D. c, Fiona C. Baker, Ph.D. c, Florence J. Breslin, M.S. d, Anthony Steven Dick, Ph.D. e, Gayathri J. Dowling, Ph.D. f, Mathieu Guillaume, Ph.D. g, Elizabeth A. Hoffman, Ph.D. f, Andrew T. Marshall, Ph.D. h, i, Bruce D. McCandliss, Ph.D. k, Chandni S. Sheth, Ph.D. l, Elizabeth R. Sowell, Ph.D. m, Wesley K. Thompson, Ph.D. n, Amandine M. Van Rinsveld, Ph.D. o, Natasha E. Wade, Ph.D. p, and Sandra A. Brown, Ph.D. q
Youth and parent invited to complete 4 surveys during pandemic

Youth reported on substance use in the past 30 days:

- Alcohol
- Nicotine (cigarettes, e-cigarettes, cigar/hookah/pipe)
- Cannabis (flower, concentrate, edible)
- Inhalants
- Prescription drugs (in a way not prescribed)
- Other drugs

Median age = 12.4 years, IQR = [11.8, 13.1], range = [10.5, 14.6]
Rates of use were stable (ns) across four surveys completed during the pandemic.
Among those who reported use:
- Most (79%) used on 1-2 days in past month
- Very few youth use any substance regularly
1. Most use was of **alcohol** or **nicotine**

2. Typically endorsing just **one** substance (87%)

3. Moderate overlap in users of alcohol/nicotine
Linked data from $N = 1079$ youth who completed a pre-pandemic assessment

(Linked subsample skews younger)

Significant **decrease** in alcohol use ($p < .05$)

Significant **increase** in nicotine use and prescription drug misuse ($p < .05$)

No other statistically significant changes

cf. Dumas et al. (2020) and Gaiha et al. (2020) finding reductions in nicotine use among older adolescents
Thanks!

Questions?
For More Information, Please Visit: ABCDStudy.org