Towards a Transdisciplinary and Translational Science of Human Learning

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The ABCD Study

• The Adolescent Brain Cognitive Development (ABCD) Study is the largest long-term study of brain development and child health in the U.S.
• 11,876 children, aged 9-10, have been enrolled at 21 sites across the country, and will be followed for 10 years.
  • School-focused recruitment, epidemiologically ascertained sample
  • Multimodal brain imaging
  • Extensive health and behavioral assessment
  • Activities and environments
  • Biosamples: hormones, epi/genetics, substance use
  • Novel wireless, web based, and nanoengineered assessment technologies
Study Objectives

• Measure **individual developmental trajectories** (e.g., of brain, cognitive, and emotional development), and identify the factors that can influence them (protectively or adversely) in order to identify promising strategies for improving outcomes.

• Examine the roles of **genetic vs. environmental factors** on development, as well as interactions (e.g., by analysis of data from twin cohort and genomics).

• Study the **effects of health, physical activity, sleep** as well as sports and other injuries on brain development and other outcomes.

• Study the **onset and progression of mental and behavioral disorders**, factors that influence course or severity; and the relationship between mental disorders and substance use.

• Determine how **exposure to various levels and patterns of alcohol, nicotine, cannabis, caffeine, and other substances** affect developmental outcomes and vice versa.
Progress Report

• The cohort composition largely matches the targets set for us by our epidemiology consultants.
• We have completed baseline, 6 month, and 1 Yr visits for most participants and are beginning the 2 yr comprehensive assessments now.
• Baseline data (all assessment domains) will be provided to the research community in March, 2019, following the timeline of ABCD’s open-science model.

N = 10,148, General Population Enrollments

N = 1728, Birth/Twin Registry
ABCD Open Science Model
A Unique Resource for the Entire Scientific Community

https://data-archive.nimh.nih.gov/abcd

Data Access Requires:

- Agreement to Data Use Agreement
- Institutional Ratification

Annual Curated Data Release
Annual release of curated data, including all assessment domains and computational analysis pipelines.

- 1.0 Released in **February 2018** with the first 4500+ participants
- 2.0 To be released in **March 2019** with 11,800+ participants

For more information on ABCD data sharing:

https://abcdstudy.org/scientists.html
What is missing...

• As exciting as ABCD is, we have known from the beginning that it is missing, well.....
  • the beginning.....

• While the ABCD assessment protocol includes child and parent reports, and passive measures of activities, environments, and experiences, we are missing....
  • The experiences of children in the environments where they spend the majority of their waking hours on most days.

• Standardized data on the learning and academic skills of ABCD children, or on the curriculum they receive, are not available.

• In fact, within the high-dimensional data matrix of ABCD, the classroom is a virtual black hole.
Why does this matter?

• Disparities in growth trajectories of intellectual functions and creativity achieved through education are unacceptably large in our society, and these disparities contribute not just to academic disengagement but to other adverse outcomes as well.

• Our best efforts to understand the dynamic processes that give rise to these disparities will not be sufficient to ensure more consistently positive health, mental health AND academic outcomes if our research is not conducted with the full toolbox of scientific approaches relevant to the study of these processes.

• Because human experience and human learning are highly content and context specific, the research must encompass the biological and sociocultural factors that influence the outcomes, but it must also focus directly on the experiences of children in classrooms.
How do we achieve the integration needed to improve models of such a complex process (as the education of a still biologically developing brain)?

Observing the developing mind and brain
Closely and continuously.....
A More Collaborative Approach within the Science of Learning Community Can Accelerate Progress

- A version of the “developmental population neuroscience” paradigm could be deployed to create a more definitive and fully translational science of learning, however...
- It needs to begin with the earliest classroom experiences, focus on learning, be partially embedded within classrooms, and be conducted in close collaboration with educators within Research Practitioner Teams.
- The use of sensing and observational technologies in classrooms could provide rich data resources that reveal differences in the classroom experiences of students with different learning outcomes,
- and could link them to factors measured elsewhere (e.g., brain development, genetic factors, sociocultural factors, family environments, etc) as well as factors measurable in the classroom.
- An integrated, transdisciplinary approach, conducted as an open-science collaboration, is necessary to create future classrooms with the intelligence to ensure more positive outcomes in all children.
ABCD Initiated by NIH Collaborative Research on Addiction (CRAN)

- NIDA, NIAAA, National Cancer Institute
- Many other federal collaborators are now participating

**Federal Partners:** *Teen Brains. Today's Science. Brighter Future.*
**Physical Health**
- PhenX Anthropometrics (height/weight/waist measurements)
- Snellen Vision Screener
- Edinburgh Handedness Inventory
- Youth Risk Behavior Survey: Exercise
- Pubertal Development Scale
- Menstrual Cycle Survey (pubescent girls)
- Screen Time Survey

**Biospecimens**
- Breathalyzer and Oral Fluids (subset)
- Saliva Samples for DNA, Puberty
- Blood Samples (subset)
- Hair Sample
- Baby Teeth

**Brain Imaging**
- Structural MRI
  - 3D T1 - Weighted
  - 3D T2 - Weighted
  - Diffusion Tensor Imaging
- Functional MRI (fMRI)
  - Resting State
  - Monetary Incentive Delay Task
  - Stop Signal Task
  - Emotional N-Back Task
- PhenX UPPS-P for Children Survey
- PhenX Behavioral Inhibition/Behavioral Approach System (BIS/BAS) Scales
- Prodromal Psychosis Scale
- Youth Resilience Scale

**Mental Health**
- Kiddie Schedule for Affective Disorders and Schizophrenia
  - Background Items Survey
  - Diagnostic Interview for DSM-5 (S modules)
- NIH Toolbox: Tasks:
  - Picture Vocabulary
  - Flanker Inhibitory Control & Attention
  - List Sorting Working Memory
  - Dimensional Change Card Sort
  - Pattern Comparison Processing Speed
  - Picture Sequence Memory
  - Oral Reading Recognition
- Rey Auditory Verbal Learning Task
- Cash Choice Task
- Little Man Task
- Matrix Reasoning Task
- RAVLT Delayed Recall

**Neurocognition**

**Culture & Environment**
- Prosocial Tendencies Survey
- PhenX Acculturation Survey
- Parental Monitoring Survey
- Acceptance Subscale from Children’s Report of Parental Behavior Inventory (CRPBI) - Short
- PhenX Family Environment Scale - Family Conflict
- PhenX Neighborhood Safety/Crime Survey
- PhenX School Risk & Protective Factors Survey

**Substance Use**
- For most participants:
  - Timeline Follow-Back Survey
  - PhenX Peer Group Deviance Survey
  - PATH Intention to Use Tobacco Survey
  - Caffeine Intake Survey
  - Participant Last Use Survey (PLUS) for substance use within the last 24 hrs

**Other Data Sources**
- Geocoding from Residential History
- School Records
- FitBit® (subset)
- Brief Problem Monitor - Teacher Form

*For participants with differing levels of substance use (low, moderate, heavy), follow-up items include: IQ & IQI Sipping Items; Tobacco Low-Level Use Measure; MJ Low-Level Use Measure; PhenX Acute Subjective Response to Alcohol, Tobacco, or MJ; Hangover Symptom Scale; Rutgers Alcohol Problem Index (RAPI); Nicotine Dependence (PATH); Drug Problem Index (MAPR); MJ Problem Index (MAPJ)