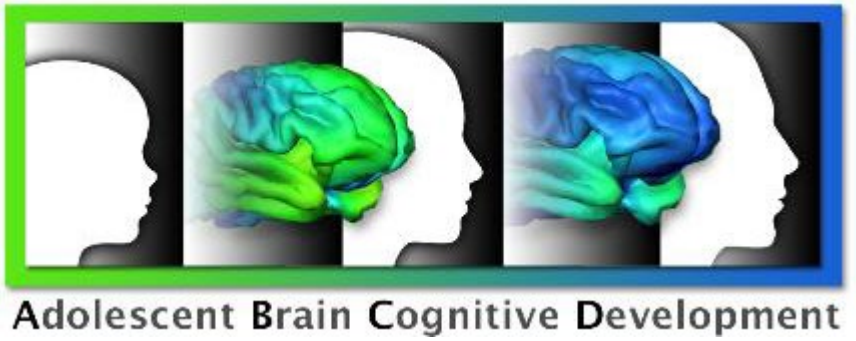
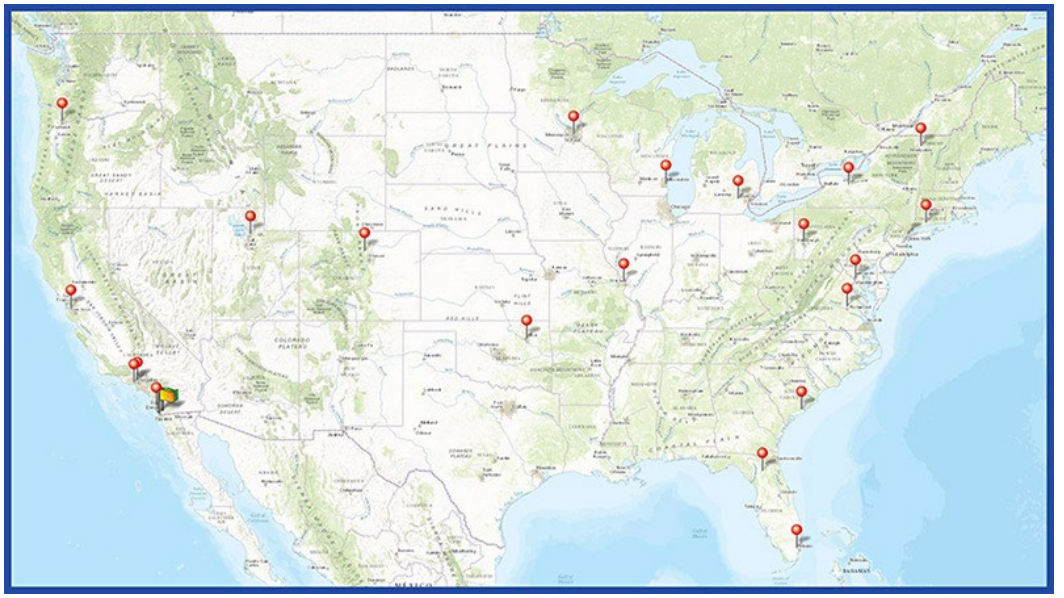
Towards a Transdisciplinary and Translational Science of Human Learning

Terry Jernigan

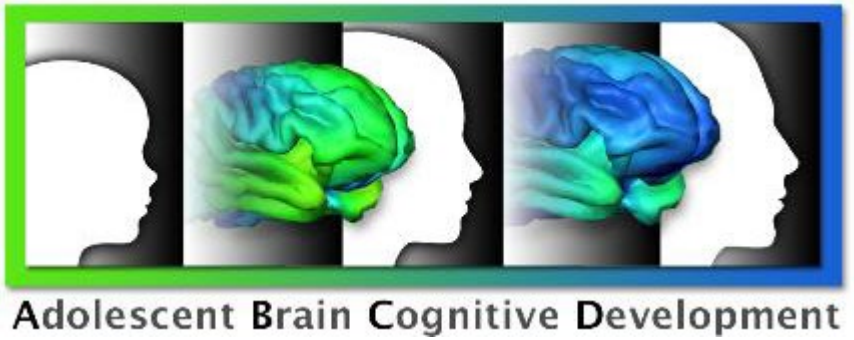
The ABCD Study



- 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



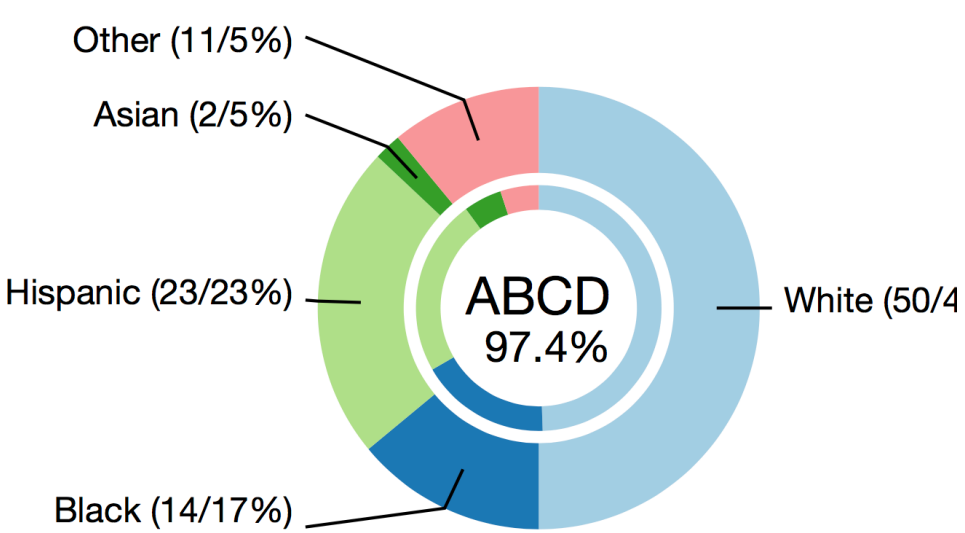
- Measure **individual developmental trajectories** (e.g., of brain, cognitive, and emotional development), and identify the factors that can influence them (protectively or adversely) in order to identify promising strategies for improving outcomes.
- Examine the roles of **genetic vs. environmental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

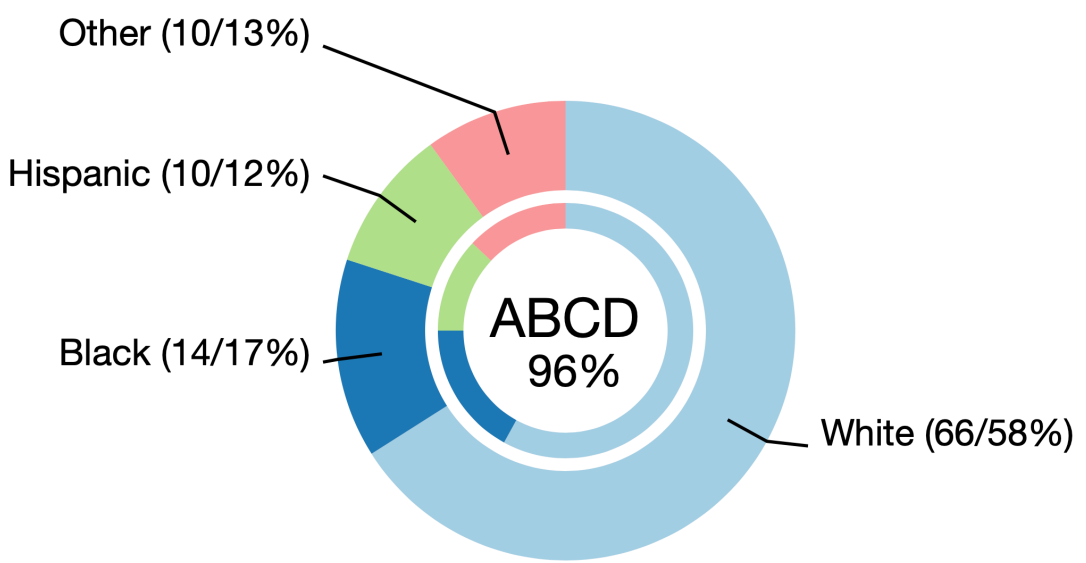
Adolescent Brain Cognitive Development

- 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

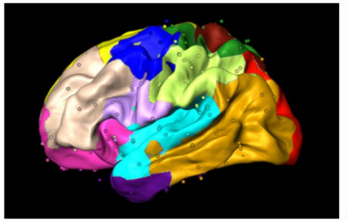
Annual Curated Data Release

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

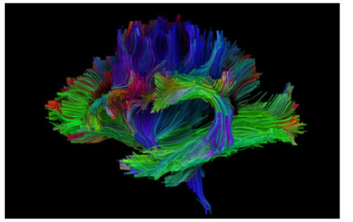
- 1.0 Released in **Febuary 2018** with the first 4500+ participants
- 2.0 To be released in **March 2019** with 11,800+ participants

For more information on ABCD data sharing:

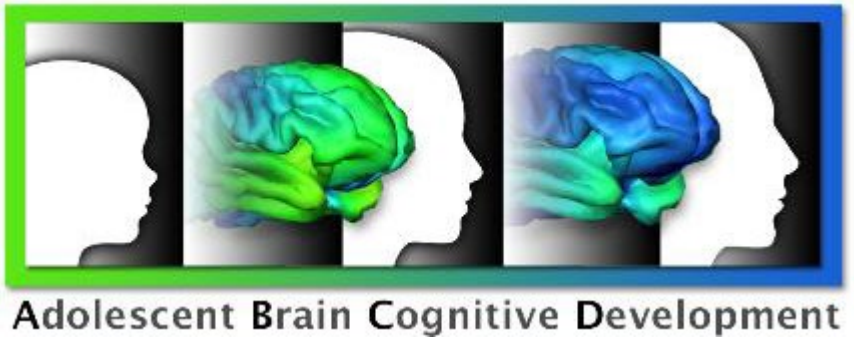
https://abcdstudy.org/scientists.html



Scientists



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.***

National Institute on Drug Abuse	National Institute on Alcohol Abuse and Alcoholism	National Cancer Institute	National Institute of Mental Health	*Eunice Kennedy Shriver* National Institute of Child Health and Human Development
National Heart, Lung, and Blood Institute	National Institute of Neurological Disorders and Stroke	National Institute on Minority Health and Health Disparities	NIH Office of Behavioral and Social Sciences Research	NIH Office of Research on Women's Health
Centers for Disease Control and Prevention - Division of Adolescent and School Health	National Institute of Justice	Centers for Disease Control and Prevention - Division of Violence Prevention	National Science Foundation	National Endowment for the Arts

ABCD Youth Protocol Summary: Baseline

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

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

Biospecimens

Breathalyzer and Oral Fluids (subset)

Saliva Samples for DNA, Puberty

Blood Samples (subset)

Hair Sample

Baby Teeth

Mental Health

Kiddie Schedule for Affective Disorders and Schizophrenia

- Background Items Survey
- Diagnostic Interview for DSM-5 (5 modules)

PhenX UPPS-P for Children Survey

PhenX Behavioral Inhibition/Behavioral Approach System (BIS/BAS) Scales

Prodromal Psychosis Scale

Youth Resilience Scale

Neurocognition

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

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

Adolescent Brain Cognitive Development

Teen Brains. Today's Science. Brighter Future.

*For participants with differing levels of substance use (low, moderate, heavy), follow-up items include: iSay II Q2 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 (MAPI); MJ Problem Index (MAPI)

ABCD Parent Protocol Summary: Baseline

Physical Health

PhenX Demographics Survey

Medical History Questionnaire

Developmental History Questionnaire

PhenX Medications Survey

Menstrual Cycle Survey

Sleep Disturbances Scale for Children

Sports and Activities Involvement Questionnaire

Screen Time Survey

Ohio State TBI Screen - Short

Mental Health

Kiddie Schedule for Affective Disorders and Schizophrenia

- Background Items Survey
- Diagnostic Interview for DSM-5

Child Behavior Checklist

General Behavior Inventory - Mania

Adult Self Report Survey

Family History Assessment Survey

Substance Use

Parent Rules Survey

PhenX Community Risk and Protective Factors

Participant Last Use Survey (PLUS) for substance use within the last 24 hrs.

Culture & Environment

Vancouver Index of Acculturation - Short Survey

Multi-Group Ethnic Identity Measure-R Survey

Prosocial Tendencies Survey

Mexican American Cultural Values Scale

PhenX Acculturation Survey

PhenX Family Environment Scale - Family Conflict

PhenX Neighborhood Safety/ Crime Survey

Native American Acculturation Scale

Adolescent Brain Cognitive Development

Teen Brains. Today's Science. Brighter Future.

ABCDStudy.org

*For participants with differing levels of substance use (low, moderate, heavy), follow-up items include: iSay II Q2 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 (MAPI); MJ Problem Index (MAPI)