

# NIH: Learning the ABCs of childhood brain development

Growing up, the experiences you have during childhood can shape the way you act as a teenager and beyond. Certain environmental influences, including substance abuse, exercise or the use of video games, are likely responsible for this, but to what extent? Understanding this could prevent adverse behavioural-health and neuropsychiatric conditions in the future. **Dr Terry Jernigan** is hoping to do just that, coordinating a large-scale study into the development of children's brains as they progress into adulthood.

If only understanding adolescent brains was as easy as ABC, researchers such as Dr Jernigan would be laughing. Unfortunately, that is not the case, and the web of complexity that surrounds the development of the maturing brain is an area of substantial research and interest.

The National Institutes of Health are often at the forefront of this research area, investigating the effects of particular behaviours (i.e., alcohol, exercise, smoking) on childhood development. Their latest study – the Adolescent Brain Cognitive Development (ABCD) Study – focuses on determining how certain experiences affect the biology, brain development and societal outcomes of children progressing into adolescence.

Dr Terry Jernigan is the Co-Director of the Coordinating Center involved in this study, and she recently spoke to us at *Research Features* to discuss it in more detail.

*Hi Terry! Can you explain what the Adolescent Brain Cognitive Development (ABCD) Study is?*

The Adolescent Brain Cognitive Development (ABCD) Study is the largest long-term study

of brain development and child health in the United States. The ABCD Research Consortium consists of a Coordinating Center, a Data Analysis and Informatics Center, and 20 research sites across the country who are recruiting over 10,000 children between the ages of nine and ten and will follow them for ten years into early adulthood. Using cutting-edge technology, scientists will determine how childhood experiences (such as sports, video games, social media, unhealthy sleep patterns, and smoking) interact with each other, and with a child's changing biology, to affect brain development. It will then look at the ultimate effect of this on social, behavioural, academic, health, and other outcomes.

*What is special about the adolescent brain?*

Regardless of your age, the brain is constantly undergoing biological and functional changes. However, recent work has shown that adolescent behaviour may be driven by a unique phase in brain development, during which reward mechanisms in the brain are strengthened relative to those that manage risk. This mismatch during adolescent brain development may explain the increased risk-taking and exploration noted during this

period. While a new openness towards peers and novel experiences during this time paves the way for independence, it can also put young people at risk.

*What was the motivation behind the study?*

Human development is a highly complex process, and many factors influence the brains and behaviour of children. For answers to some important questions about how and why certain factors may alter development, smaller, more narrowly focused studies may not produce the answers we need. Also, the culture in the United States is changing rapidly. Along with increasing screen time and social media engagement, new policies and laws with respect to substances (e.g., new marijuana laws), the emergence of new substances (e.g., synthetic drugs) and routes of administration (e.g., vaping, dabbing) may have significant effects on health and development.

Additionally, developments in neuroimaging have increased our ability to safely study the developing brain and link information about its function to behavioural outcomes. Such studies produce a huge amount of data, and recent advances in computing and analytics now enable scientists across the country (and the world) to share and analyse this information, which rapidly expands the scientific questions that can be answered, while maintaining the research participants' privacy.

It is our mission to employ the newest scientific methodology when investigating the impact of our rapidly changing environment on the physical, emotional, and intellectual growth experienced during adolescence. The results of the ABCD Study will provide families, educators, health professionals and policymakers with practical information to promote the health, well-being, and success of the next generation.

*What are the key questions that the ABCD team will be seeking to answer?*

The ABCD Study seeks to answer many questions. The following are just a few: ▶

Several ABCD leaders attending a training event at University of California San Diego. From left to right: Susan Tapert (CC Associate Director, University of California San Diego Principal Investigator), Gaya Dowling (National Institutes of Health Program Director), Elizabeth Sowell (Children's Hospital Los Angeles Principal Investigator), Anders Dale (Data Analysis and Informatics Center Program Director), BJ Casey (Data Analysis and Informatics Center Co-Investigator, Yale Principal Investigator), Sandra Brown (CC Co-Director), Hugh Garavan (CC Associate Director, University of Vermont Principal Investigator), Linda Chang (University of Maryland Principal Investigator), Krista Lisdahl (University of Wisconsin-Milwaukee Principal Investigator), Terry Jernigan (CC Co-Director)

**The ABCD Study will provide families, educators, health professionals and policymakers with practical information to promote the health, well-being, and success of the next generation**



- What are some of the factors that contribute to achievement gaps?
- Which extra-curricular activities (e.g., athletics, music) lead to better health and educational outcomes?
- Does the use of substances such as alcohol, tobacco, or marijuana lead to the use of other substances?
- Does substance use affect learning?
- How prevalent are traumatic brain injuries (TBIs) among student athletes? Do TBIs affect educational achievement?

*You mentioned that more than 10,000 children between the ages of nine and ten will take part in the study. What will taking part involve for the participants?*  
Every other year, parents and participants will visit one of the Study Sites for a comprehensive assessment, which includes a series of interviews, questionnaires, games and puzzles, and a magnetic resonance imaging (MRI) session. In the alternate years, participants will come to the Study Site for an abbreviated assessment. Every three to six months, there will be a brief follow-up either online or by phone. Parents and participants will also be compensated for the time spent participating in the study.

*Can you tell us about some of the new assessment technologies that will be used in the study?*

The study will employ several recently developed assessments of cognition and behaviour that are computer-interactive and adaptive. The imaging studies take advantage of innovative, faster, and more sensitive MRI technologies adapted from the Human Connectome Project, as well as several new computational workflows, for reducing artifacts and distortions in the images, and for extracting new measurements of brain biology and function. Wireless and wearable devices for collecting real-time information about activity and physiology will also soon be coming to ABCD.

*A multidisciplinary approach is being used in this landmark project. Which institutes and research disciplines are involved in the study?*  
The idea for the ABCD Study originated within the Collaborative Research on Addiction at NIH (CRAN, <https://www.addictionresearch.nih.gov/>) and now has garnered the support of nine Institutes at the National Institutes of Health (NIH). These include the National Institute on Drug Abuse (NIDA), National Institute of Mental Health (NIMH), National Institute on Alcohol Abuse and Alcoholism (NIAAA), National Cancer Institute (NCI),

Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), National Institute of Neurological Disorders and Stroke (NINDS), NIH Office of Behavioral and Social Sciences Research (OBSSR), National Institute on Minority Health and Health Disparities (NIMHD) and the Office of Women's Health (OWH). We are also supported by the Centers for Disease Control and Prevention (CDC) and the National Institute of Justice.

*You are the Co-Director of the Coordinating Center (CC) for the ABCD Study. What does that role involve?*

I share this role with my colleague, Sandra Brown, and there are two Associate Directors of the CC – Susan Tapert and Hugh Garavan. Together we gather and integrate information from the workgroups, from our advisors, and from the consortium at large, and organise our teleconferences and meetings. We also monitor the progress of the study closely to ensure that we are maintaining high standards in the quality of the research. To do this, we work very closely with the Data Analysis and Informatics Center.

*How does the ABCD organising team facilitate communication between the research groups?*

The ABCD Study Consortium is comprised of a Coordinating Center, a Data Analysis and Informatics Center, NIH collaborators, and researchers at 21 data collection sites across the United States. Within the consortium, there exists an organised framework of governance communication that promotes collaborative decision-making and information dissemination. Tasks are divided into individual workgroups with a large degree of cross-representation between sites and the CC to take advantage of the expertise across sites and within focused teams. Information from the individual workgroups is consolidated and disseminated to the whole consortium via a centralised Operations Group and regular meetings of the Council of Investigators.

*What are the challenges and benefits of involving multiple institutes? Have you been involved in similar efforts in the past? What is the key to coordinating this type of multidisciplinary venture?*

The breadth of institutional support for the ABCD Study gives us the unique opportunity to address a broad range of important questions about the developing brains of adolescents. While most studies have traditionally sought to answer a limited set of



ABCD participant completing a neurocognitive reasoning task

The Matrix Reasoning Task



Dr Terry Jernigan, Co-Director for the ABCD Coordinating Center

**NIH's ABCD Study seeks to answer: what factors contribute to achievement gaps? And does the use of certain substances lead to the use of other substances?**

questions within a particular research domain (e.g., mental health, substance use, cognition), we will gather information across many domains in the same sample which will allow for comparison within and across research disciplines.

One of the biggest challenges implementing a study of this magnitude is deciding what, when and how much information to collect during each visit, to reveal the most about adolescent development while also making the protocol fun for our participants! To organise this effort, the ABCD Study is broken down into many assessment and governance workgroups that work together to move the study forward.

I, and several other members of our leadership group, have been involved in major, multi-site studies before – though none as large as ABCD. The keys to coordination of a large-scale multi-disciplinary venture are

to involve highly qualified investigators who respect the expertise of their peers, to ensure that decisions made take full advantage of the relevant expertise, and to work constantly to maintain and improve communication among the scientists and other researchers throughout the consortium.

*What impact could the ABCD Study potentially have on the adolescents of the future?*

The development of effective and personalised interventions to prevent or reduce adverse behavioural-health and neuropsychiatric conditions relies upon accurate models of the effects of genetic and environmental factors in the emergence of these conditions. Most previous studies focusing on these questions have been limited in scope, lacked statistical power to estimate multiple parameters in complex dynamic models, and have employed diverse methods that make it difficult to compare results across

studies. By collecting a plethora of data from the same sample, the ABCD initiative will overcome some of these limitations. This will make it easier for researchers and clinicians around the world to develop standards for health and development, and create new diagnostic tools and interventions to improve the quality of health and treatment for the next generation of youth.

*You are a Professor of Cognitive Science, Psychiatry, and Radiology. In your research, how do you relate these three disciplines to each other?*

Over the years, I have used brain imaging techniques to ask questions about normal brain development and brain ageing, but also about conditions and disorders that affect the mental and emotional functions of those afflicted. I hold appointments in Cognitive Science, Psychiatry, and Radiology because my work is informed by, and the results have implications for, each of these disciplines.

• To find out more information about Dr Jernigan and NIH's ABCD Study, please visit their fantastic website at [www.abcdstudy.org](http://www.abcdstudy.org).



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