Adolescent Brain Cognitive Development

Teen Brains. Today's Science. Brighter Future.

Joanna Jacobus, Ph.D.
Assistant Professor, UC San Diego Department of Psychiatry
Investigator, ABCD at UC San Diego

Overview

1. Does cannabis use affect the adolescent brain?

2. The largest US study of brain maturation (ABCD)

3. Emerging substance use patterns (TOCAN)

MENU

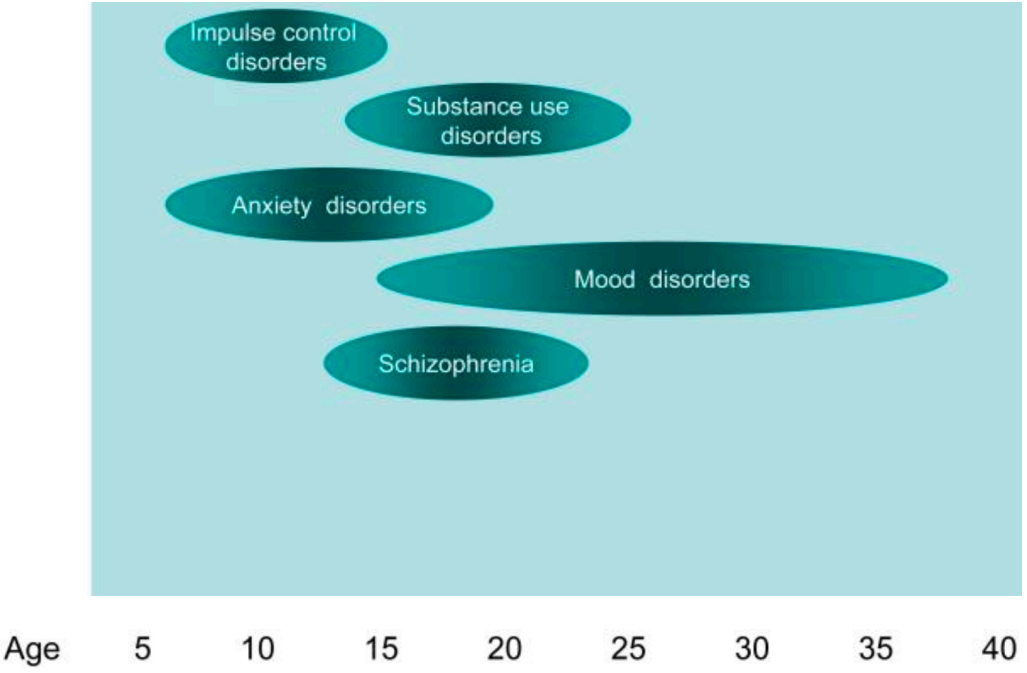
nature reviews neuroscience

Opinion | Published: 12 November 2008

Why do many psychiatric disorders emerge during adolescence?

Tomáš Paus, Matcheri Keshavan & Jay N. Giedd

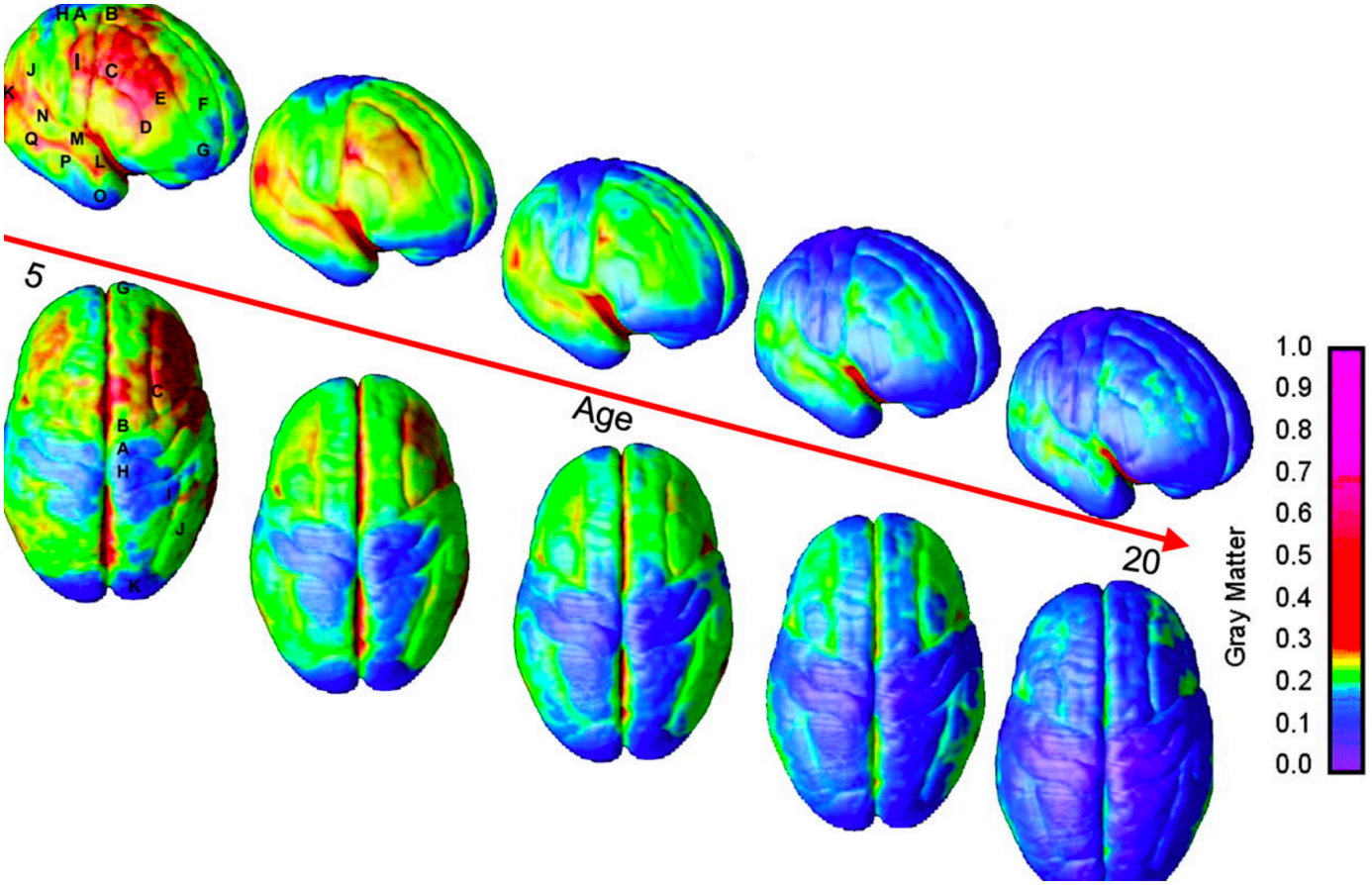
Nature Reviews Neuroscience **9**, 947–957(2008) | Cite this article



Dynamic mapping of human cortical development during childhood through early adulthood

Nitin Gogtay*†, Jay N. Giedd*, Leslie Lusk*, Kiralee M. Hayashi‡, Deanna Greenstein*, A. Catherine Vaituzis*, Tom F. Nugent III*, David H. Herman*, Liv S. Clasen*, Arthur W. Toga‡, Judith L. Rapoport*, and Paul M. Thompson‡

*Child Psychiatry Branch, National Institutes of Mental Health, National Institutes of Health, Bethesda, MD 20892; and ‡Laboratory of Neuro Imaging, Department of Neurology, University of California School of Medicine, Los Angeles, CA 90095-1769



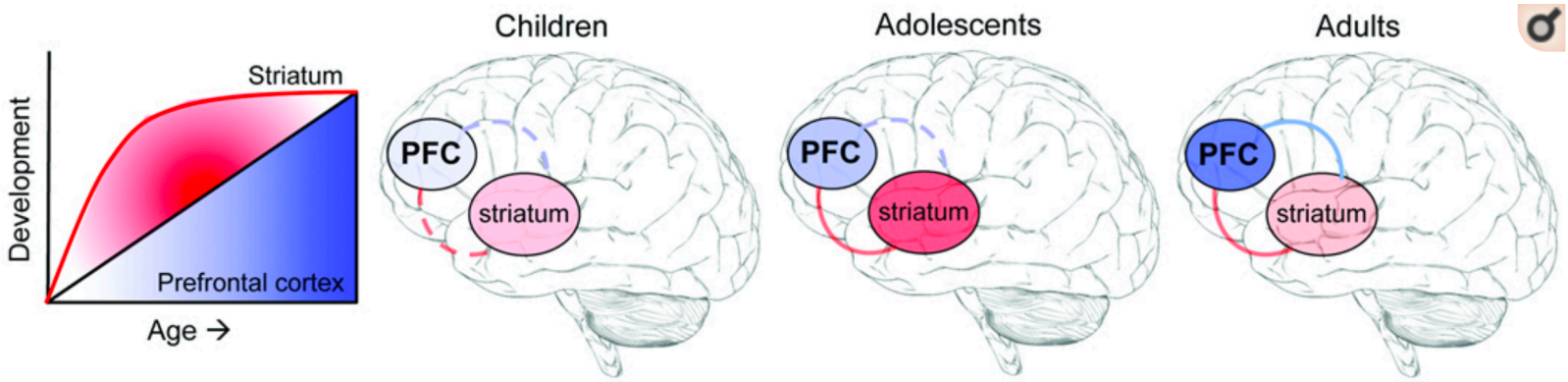
Journal of the American Academy of Child & Adolescent Psychiatry
Volume 49, Issue 12, December 2010, Pages 1189-1201

Review

Neurobiology of the Adolescent Brain and Behavior: Implications for Substance Use Disorders

B.J. Casey Ph.D., Rebecca M. Jones M.S.

Show more



Cartoon model of ventral striatal and prefrontal cortex (PFC) interactions across development. Deeper color indicates greater regional signaling. Line represents functional connectivity, with solid line indicating mature connection and dotted line indicating immaturity (from [128]).

Birth Defects Research

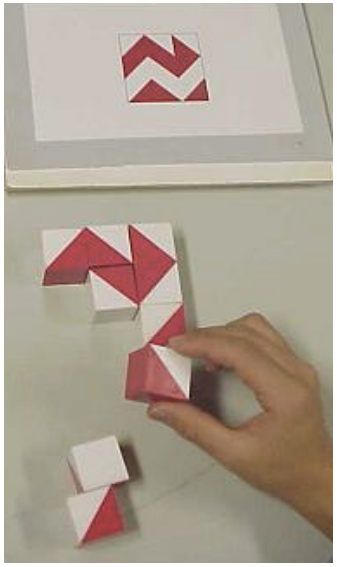
Society for Birth Defects Research & Prevention
EST. 1960 AS THE TERATOLOGY SOCIETY

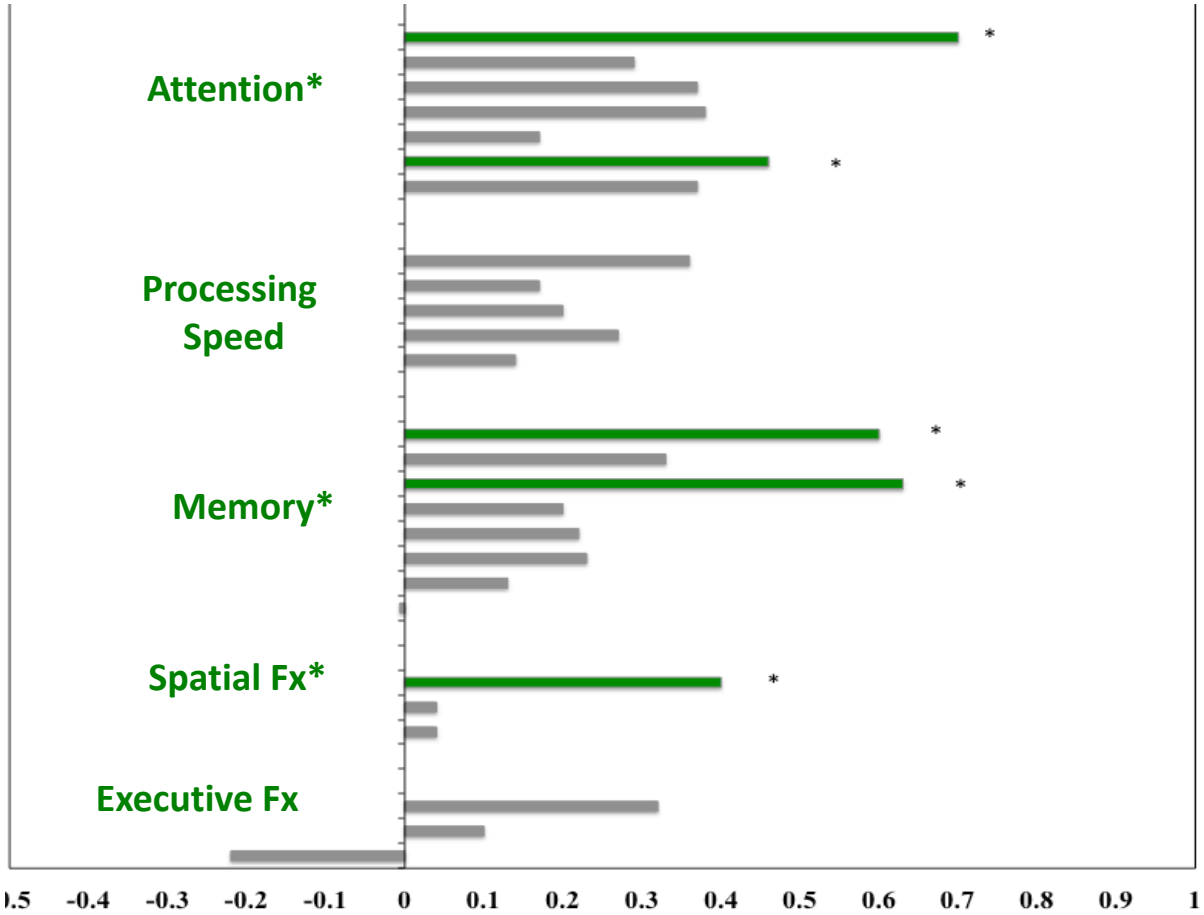
REVIEW ARTICLE | Free Access

Cannabis and the developing brain: What does the evidence say?

Joanna Jacobus, Kelly E. Courtney, Elizabeth A. Hodgdon, Rachel Baca

First published: 05 August 2019 | https://doi.org/10.1002/bdr2.1572





Original Paper

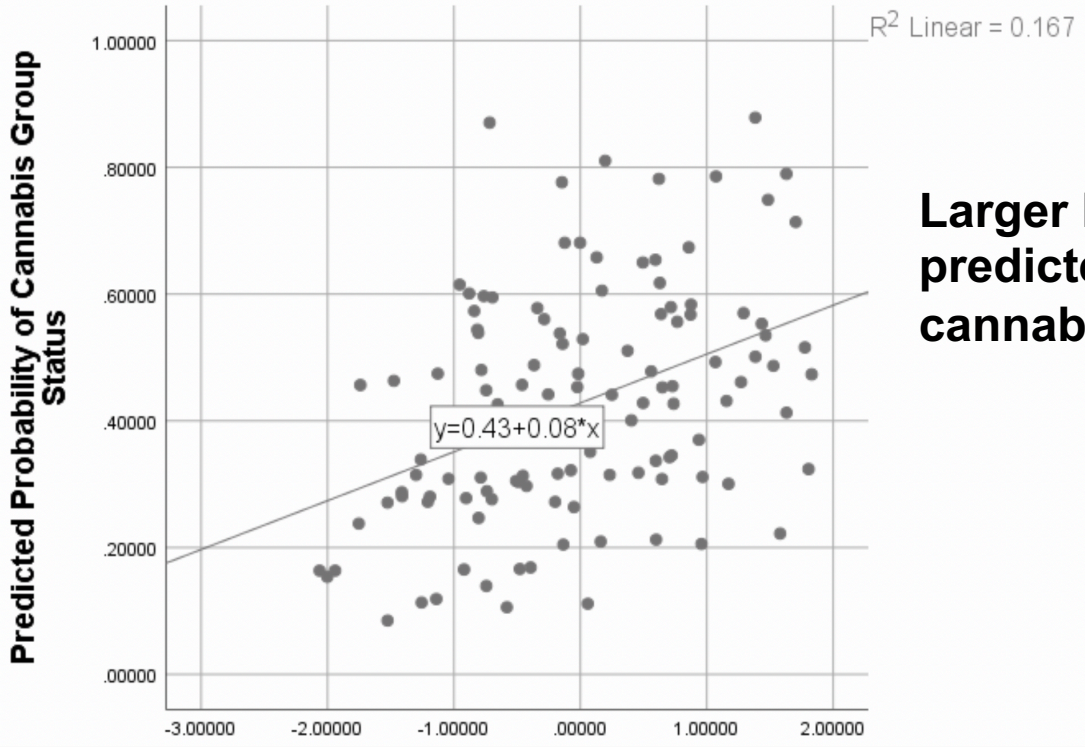
Orbitofrontal cortex volume prospectively predicts cannabis and other substance use onset in adolescents

Natasha E Wade[1], Kara S Bagot[1], Claudia I Cota[1], Aryandokht Fotros[2], Lindsay M Squeglia[3], Lindsay R Meredith[3] and Joanna Jacobus[1]

Psychopharm

Journal of Psychopharmacology
1–8

DOI: 10.1177/0269881119855971
journals.sagepub.com/home/jop
SAGE

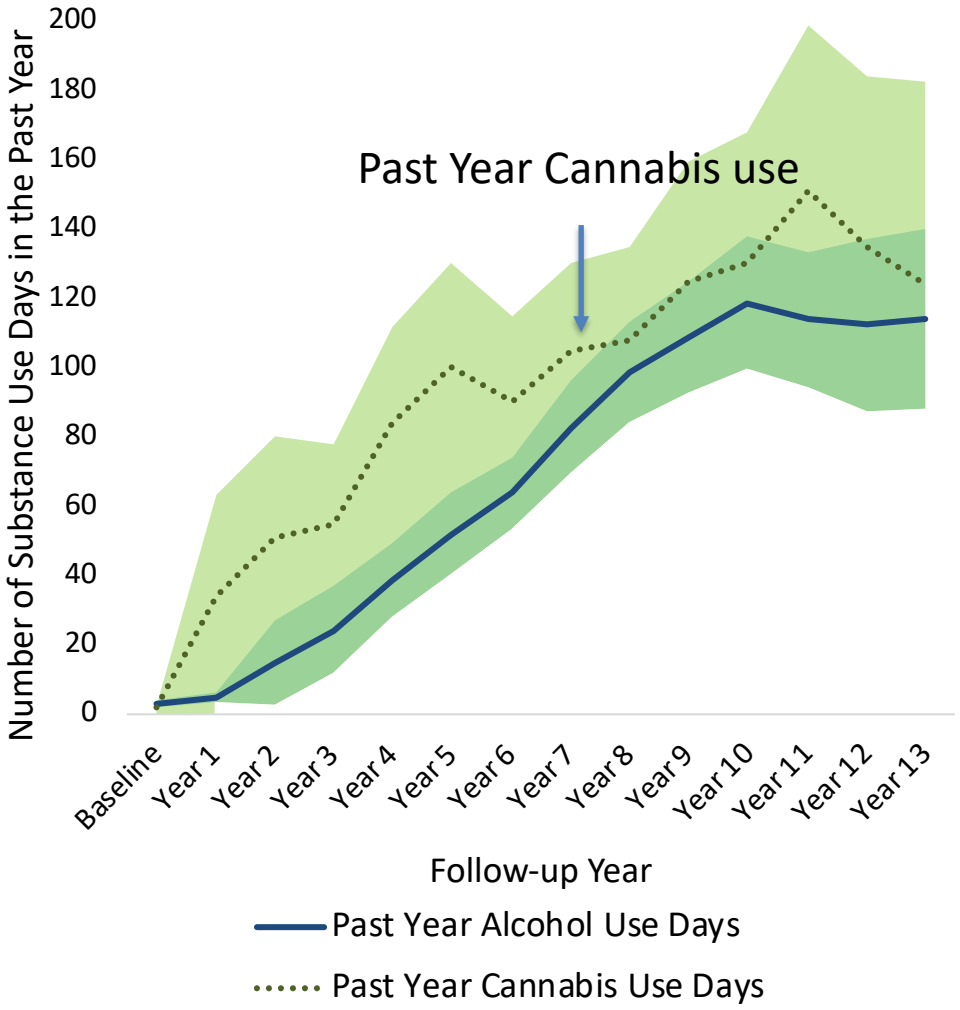


Larger left brain volume at age 12-15 predicted classification as lifetime cannabis user by age 22

Ages 12-28
N=175

More lifetime cannabis use = decreased inhibitory control

14-Year Study

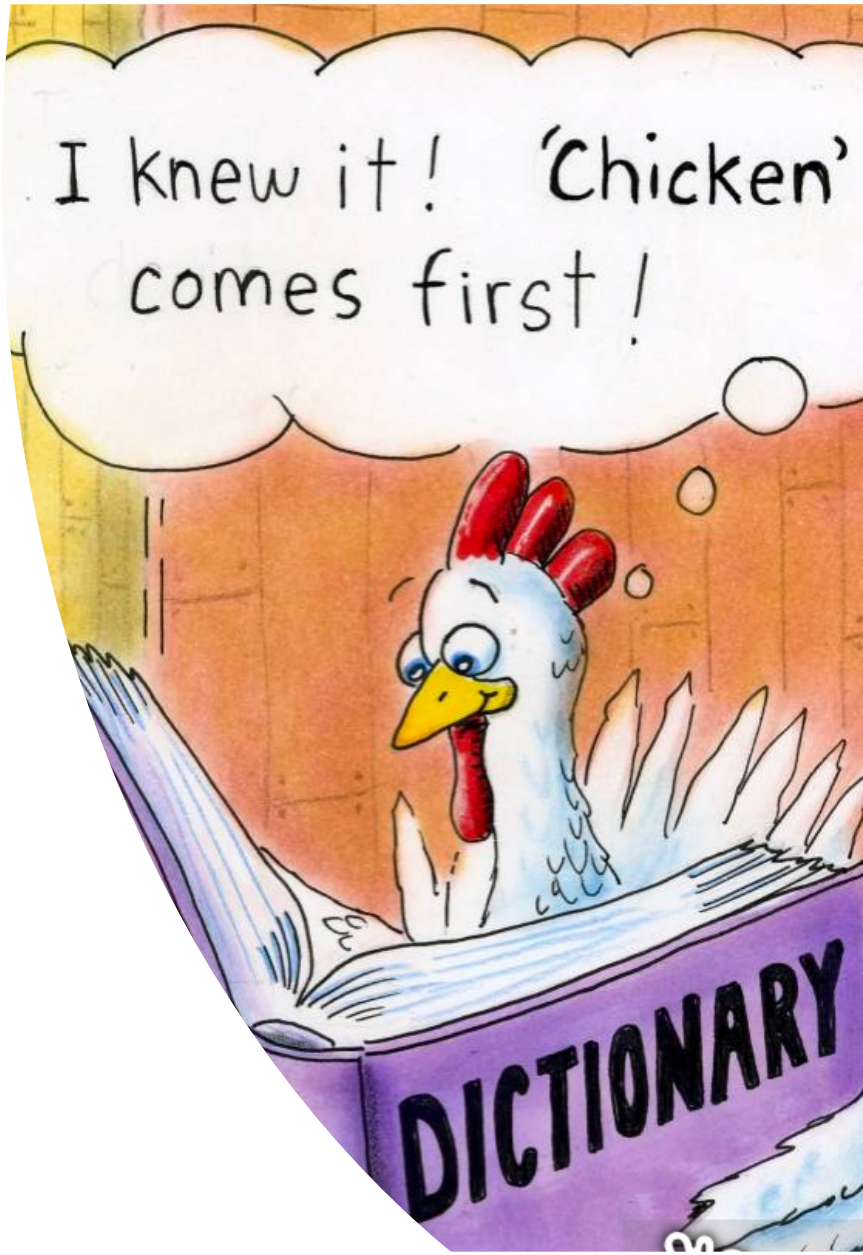


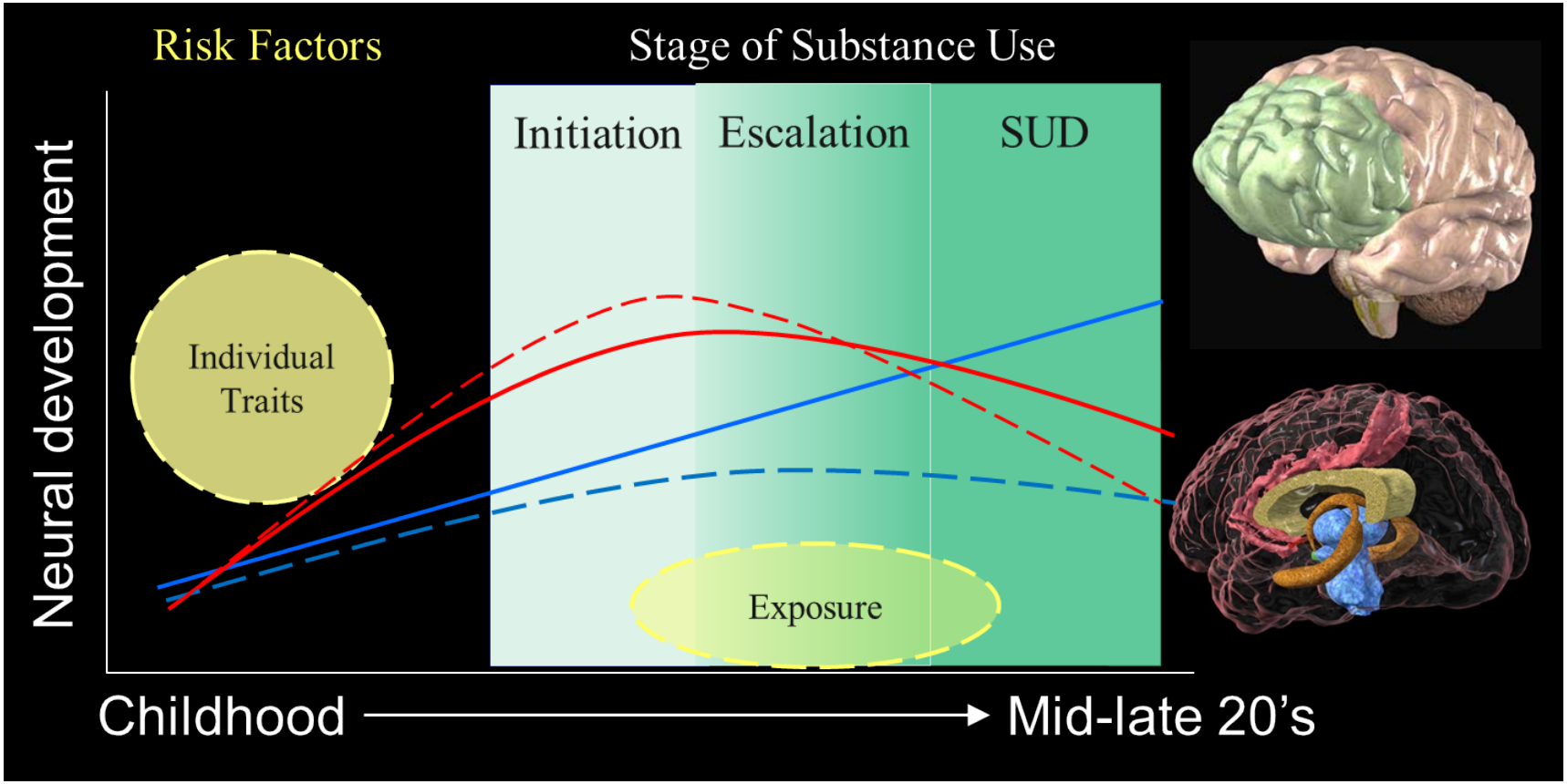
Neural differences emerge **before** or **after** use?

Chicken vs. egg question

prevents us from having firm evidence of what substances do to the developing brain

What is the journey?
When & how = better prevention/intervention





Adapted from: Heitzeg, MM and Casey, BJ: Brain Development and the Risk for Substance Abuse. Neurobiology of Mental Illness, 5th edition, Eric Nestler and Dennis Charney (Eds.) Oxford University Press, New York, NY, In Press.

Adolescent Brain Cognitive Development

Teen Brains. Today's Science. Brighter Future.

A longitudinal study of 11,875 children from ages 9-10 through early adulthood to assess factors that influence individual brain development trajectories and functional outcomes

Locations of ABCD Study Sites in the United States

Coordinating Center	University of California, San Diego
Data Analysis and Informatics Center	University of California, San Diego
Research Sites	Children's Hospital of Los Angeles Florida International University Laureate Institute for Brain Research Oregon Health & Science University SRI International University of California, Los Angeles University of California, San Diego University of Colorado University of Florida University of Maryland University of Michigan University of Minnesota University of Pittsburgh University of Rochester Medical University of South Carolina University of Utah University of Vermont Virginia Commonwealth University Washington University in St. Louis University of Wisconsin-Milwaukee Yale University

Research Objectives

- Identification of individual developmental trajectories (e.g., brain, cognitive, emotional, academic)
- Development of national standards of normal brain development
- The role of genetic vs. environmental factors on development, enriched by comparisons of twin participants (800 pairs).
- The effects of physical activity, sleep, screen time, as well as sports and other injuries on brain development and outcomes.
- The onset and progression of mental disorders, factors that influence their course or severity, and the relationship between mental disorders and substance use.
- How exposure to different substances like alcohol, marijuana, nicotine, caffeine, and others, individually or in combination, affect various developmental outcomes and vice versa.

Design and Recruitment Protocol

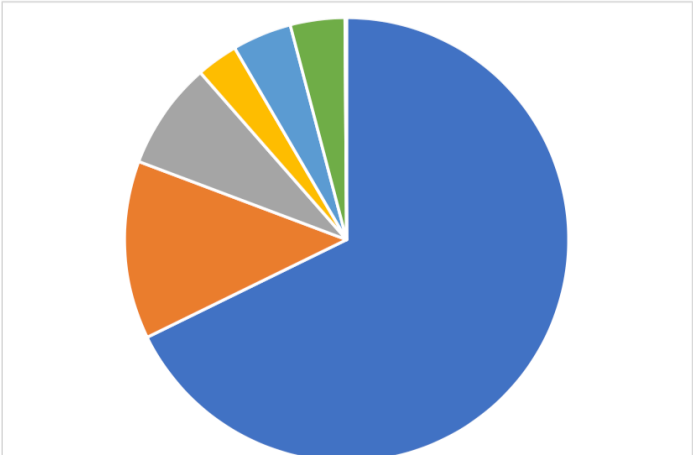
School Based | Referral | Mailing List | TBD | Other Volunteers | Summer | Online Advertising

- Begin by engaging schools for their support.
- Schools do initial mailshot to families of 9/10 year olds.
- Interested families contacted by site.
- Screen with parent/guardian.
- Screen for inclusion/exclusion criteria
  - very inclusive

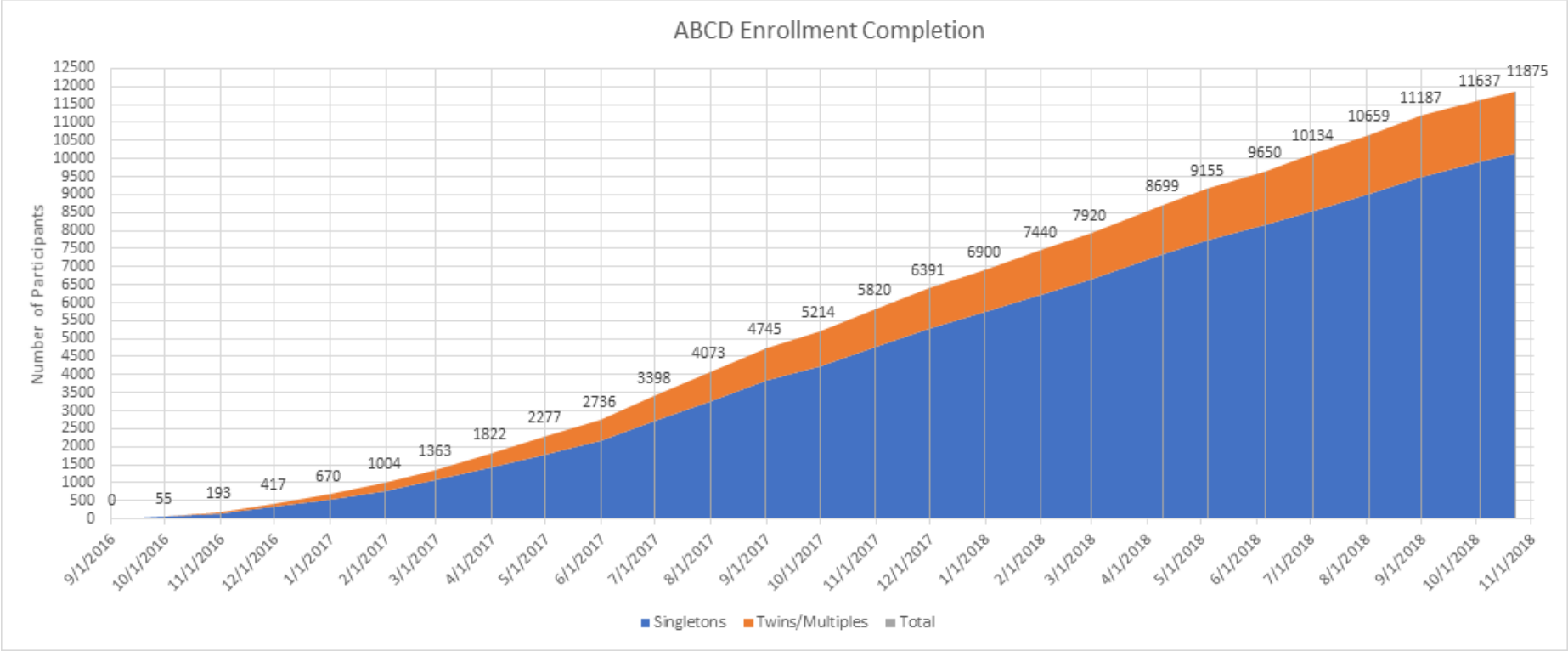
Recruitment Source	%
School Based	67.8
Referral	13.0
Mailing List	7.8
Other Volunteers	3.0
Summer	4.3
TBD	4.0
Online Advertising	0.1

Twin Cohort (1727 twins)

- Four sites:
  - Colorado, Minnesota, Missouri, Virginia
- Birth registry records



ABCD Enrollment 2016-2018



Contents lists available at ScienceDirect

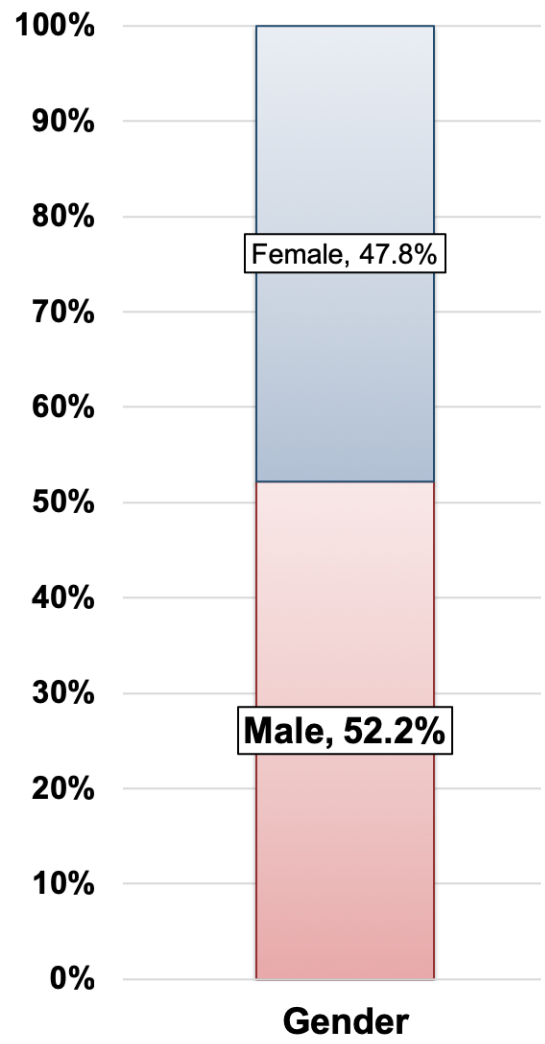
Developmental Cognitive Neuroscience

journal homepage: www.elsevier.com/locate/dcn

Recruiting the ABCD sample: Design considerations and procedures

H. Garavan[a,*], H. Bartsch[b], K. Conway[c,1], A. Decastro[b], R.Z. Goldstein[d], S. Heeringa[e], T. Jernigan[f], A. Potter[a], W. Thompson[g], D. Zahs[e]

Population-based Demographically Diverse Sample
N=11,875

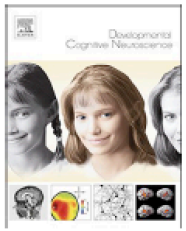

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Female, 47.8%
Male, 52.2%
Gender

Developmental Cognitive Neuroscience 32 (2018) 23–29

Contents lists available at ScienceDirect

Developmental Cognitive Neuroscience

journal homepage: www.elsevier.com/locate/dcn



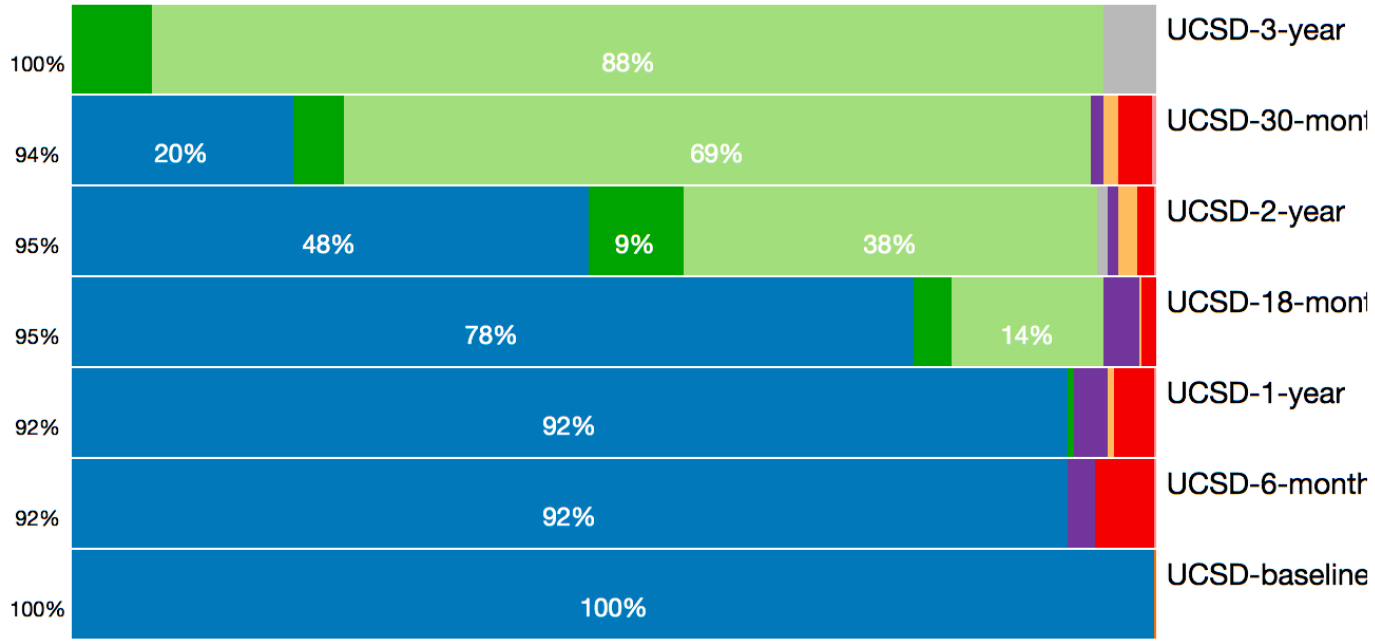
A brief validated screen to identify boys and girls at risk for early marijuana use

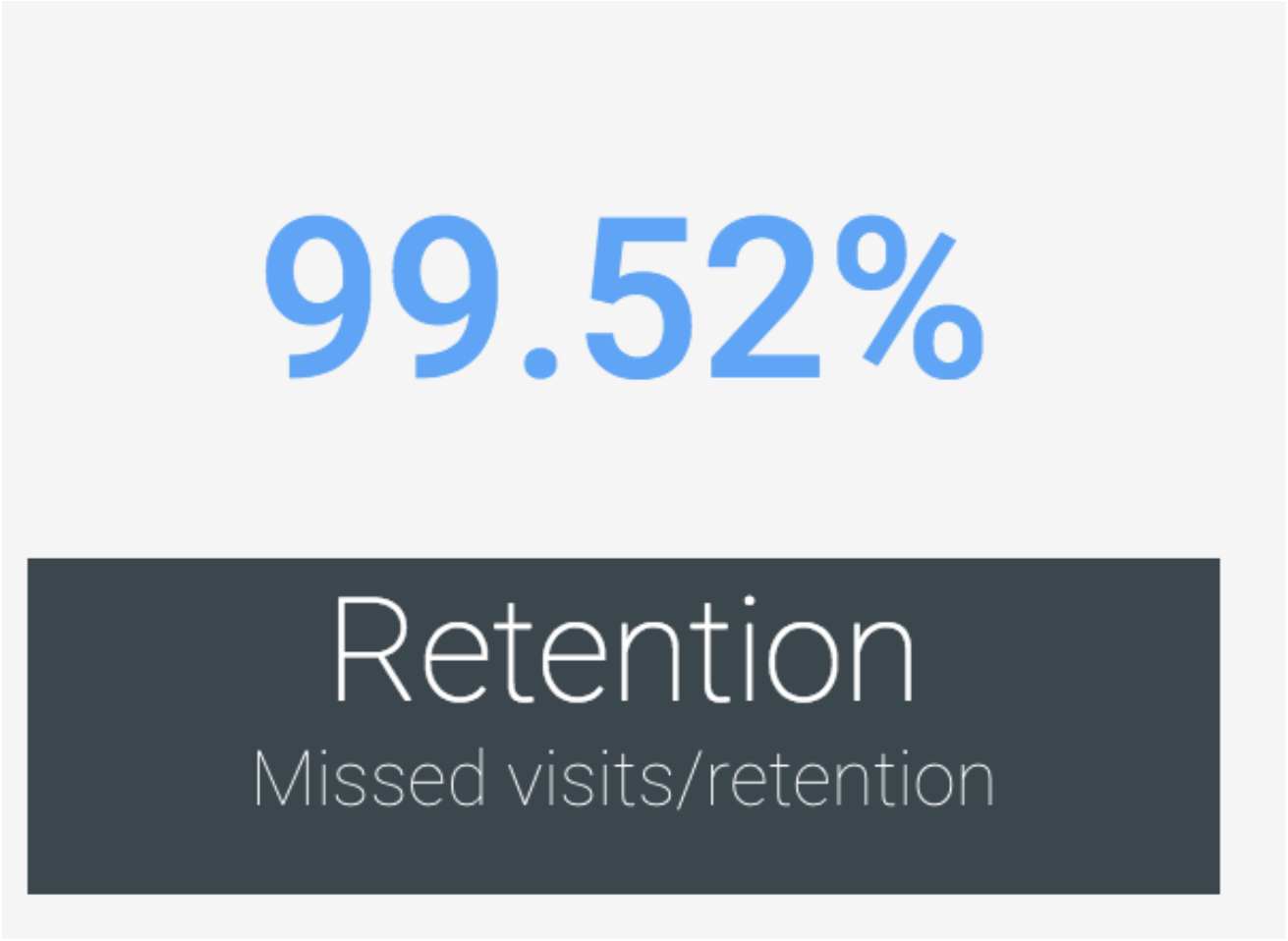
Rolf Loeber[a], Duncan B. Clark[a,*], Lia Ahonen[a], Douglas FitzGerald[a], Elisa M. Trucco[b], Robert A. Zucker[c]

- Externalizing behavioral problems
- Negative mood
- Smoking at home

>50% of the ABCD Sample is "Higher Risk"

1, 2, and 3-Year Protocols In-Progress!




99.52%
Retention
Missed visits/retention

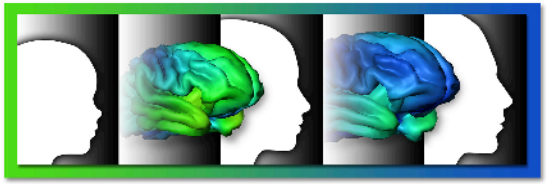
Community Liaison Boards

Bring together leadership in the local community to ensure:

--- Understanding of the project by the local community

---Clarify details of the protocol and policies if questions arise

---Regularly update the community on local and national progress.



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ABCD Study

TIMELINE OF EVENTS

STUDENT AGE	9-10		10-11		11-12	
STUDENT TIME						
STUDENT ACTIVITY		every 3-6 months		every 3-6 months		
PARENT TIME						
PARENT ACTIVITY						

REPEAT ... until age 19-20

LEGEND

In-Person Visit | Biosamples | Phone Call | Brain Scan | iPad Tasks | Interview

Baseline

Time 2: 2-year follow-up

Assessment Areas

1. Substance Use
2. Neurocognition
3. Mental Health & Health
4. Culture & Environment
5. Biospecimens
6. Mobile Technologies

Assessment Protocols

Neurocognition	Attention, learning, memory, information processing, verbal IQ, motivation, impulsivity
Substance Use	Parental rules, peer influences, intention to use, use, sensitivity, consequences
Mental Health, Health, & Demography	Physical activity, mental health, puberty, sleep, TBI, screen time, family history, sports participation, food insecurity
Culture & Environment	Ethnic identity, acculturation, discrimination, religiosity, neighborhood safety, parental monitoring, school environment
Biospecimens	Breath, saliva, hair (subsample), blood (subsample), baby teeth (optional)
Mobile Tech & Passive Data	Fitbit, school records, pediatrician records, geocoding
Structural MRI	Shape, size, integrity of brain structures
rs- and task-based fMRI	Functional organization of the brain at rest or when doing a task

Developmental Cognitive Neuroscience xxx (xxxx) xxx–xxx

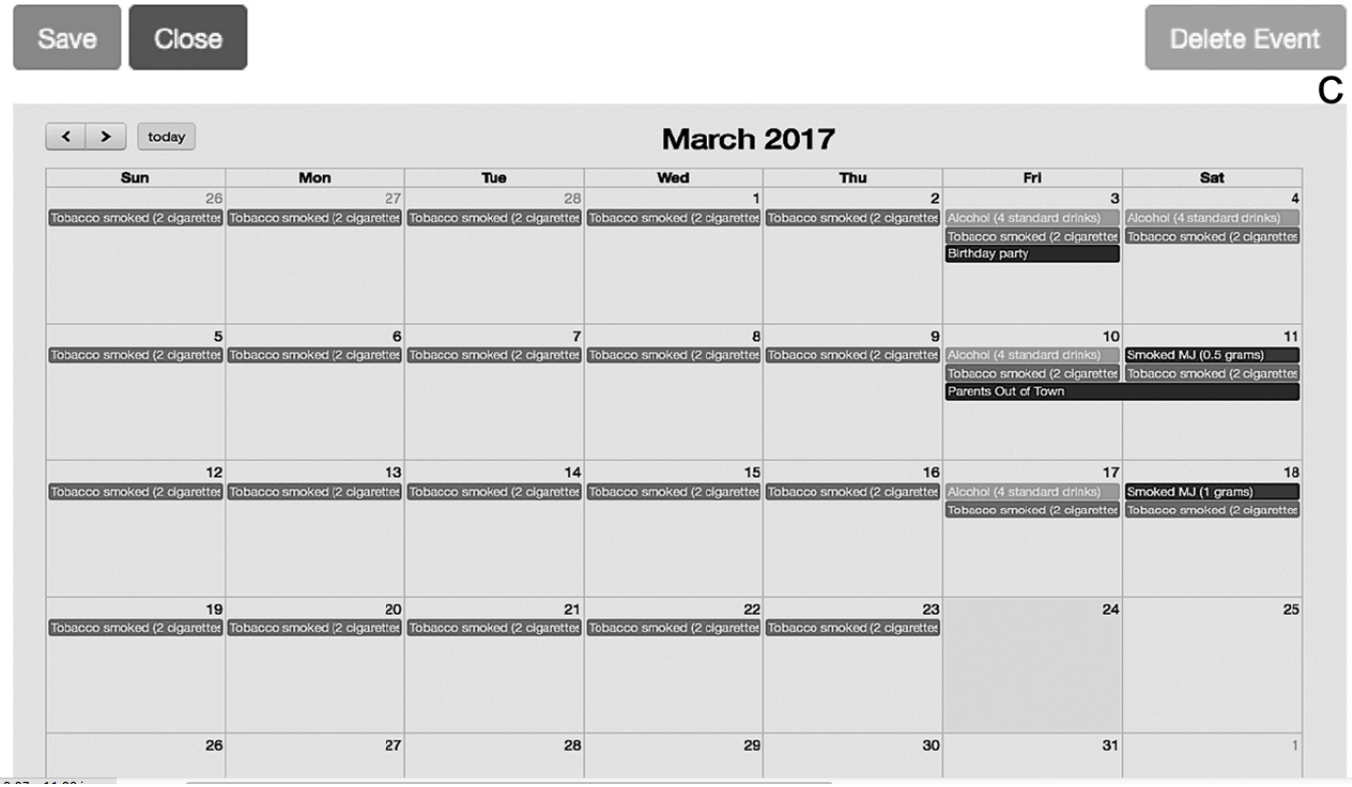
Contents lists available at ScienceDirect

Developmental Cognitive Neuroscience

journal homepage: www.elsevier.com/locate/dcn

Adolescent brain cognitive development (ABCD) study: Overview of substance use assessment methods

Krista M. Lisdahl[a,*], Kenneth J. Sher[b], Kevin P. Conway[c], Raul Gonzalez[d], Sarah W. Feldstein Ewing[e], Sara Jo Nixon[f], Susan Tapert[g], Hauke Bartsch[h], Rita Z. Goldstein[i], Mary Heitzeg[j]



Bubble hash

Wax

Budder

Shatter

The ABCD Study Open Science Model – A Unique Resource for the Entire Scientific Community

Sharing ABCD data will allow scientists worldwide to conduct analyses, pool resources, and enrich the value of this study. Visit the NIMH Data Archive for more information at https://data-archive.nimh.nih.gov/abcd.

Fast-track Imaging Data Release

The ABCD Study, in partnership with the NIMH Data Archive (NDA), is releasing fast-track data containing unprocessed neuroimaging data from ABCD Study participants to date, as well as basic participant demographics (age, sex), including:

- High-resolution structural data (3D T1 - and T2 - weighted scans)
- Advanced diffusion MRI (multiple b-values and directions)
- Resting State fMRI
- Task fMRI (Monetary Incentive Delay, Stop-Signal), and Emotional N-Back), along with raw E-Prime task files for each fMRI run

Annual Curated Data Release

Curated data, including all assessment domains and computational analysis pipelines, are released annually through the NDA, starting in February 2018.

Adolescent Brain Cognitive Development ®

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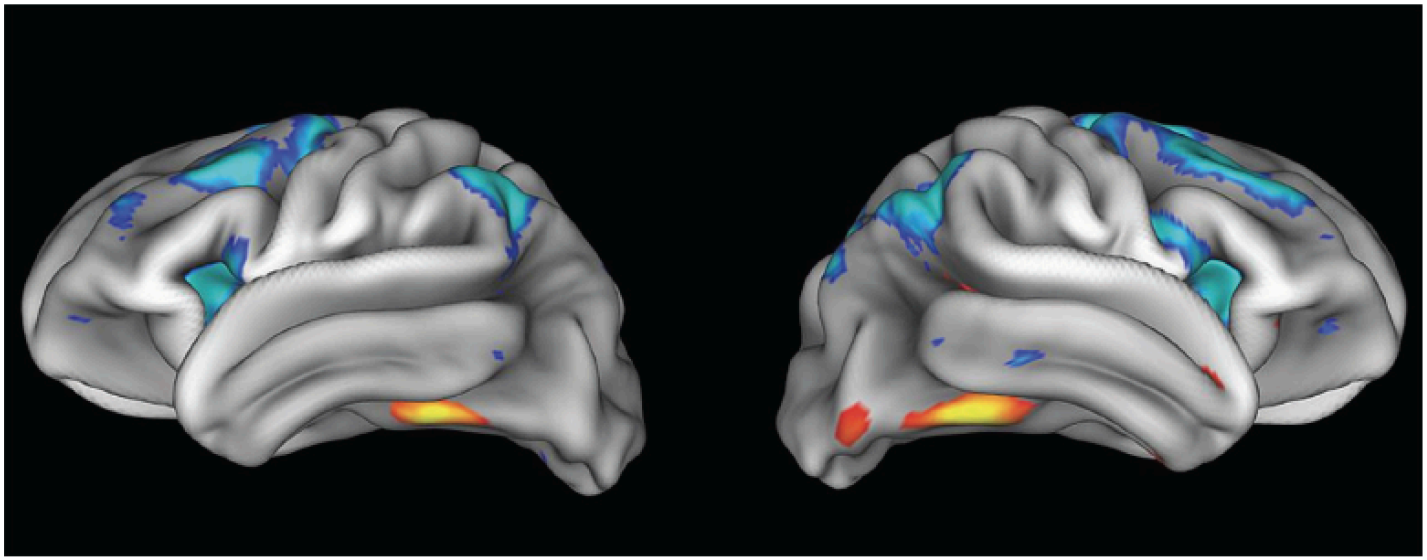
NEWS RELEASES

Tuesday, February 13, 2018

NIH releases first dataset from unprecedented study of adolescent brain development

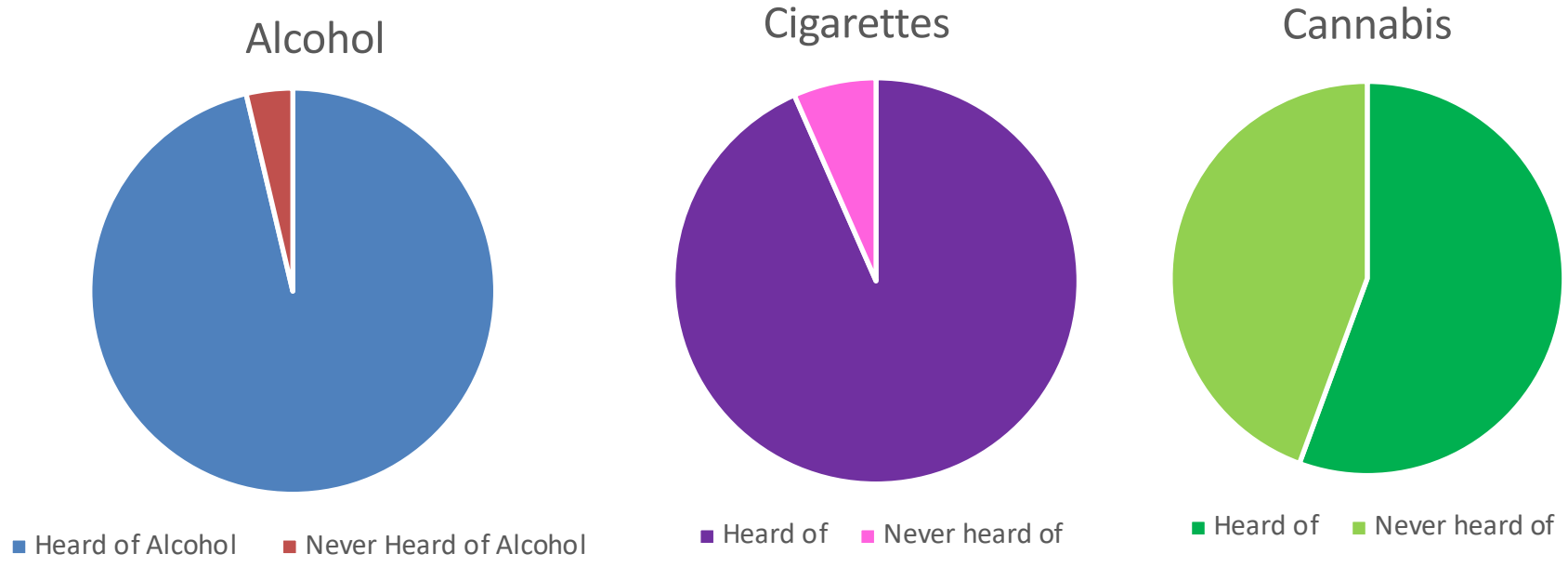
More than 7,500 children recruited for study to date; data available for first 4,500



MRI of adolescent brains activated during a memory task in ABCD study. *Dr. Richard Watts and ABCD/Univ. of VT P.I. Dr. Hugh Garavan*

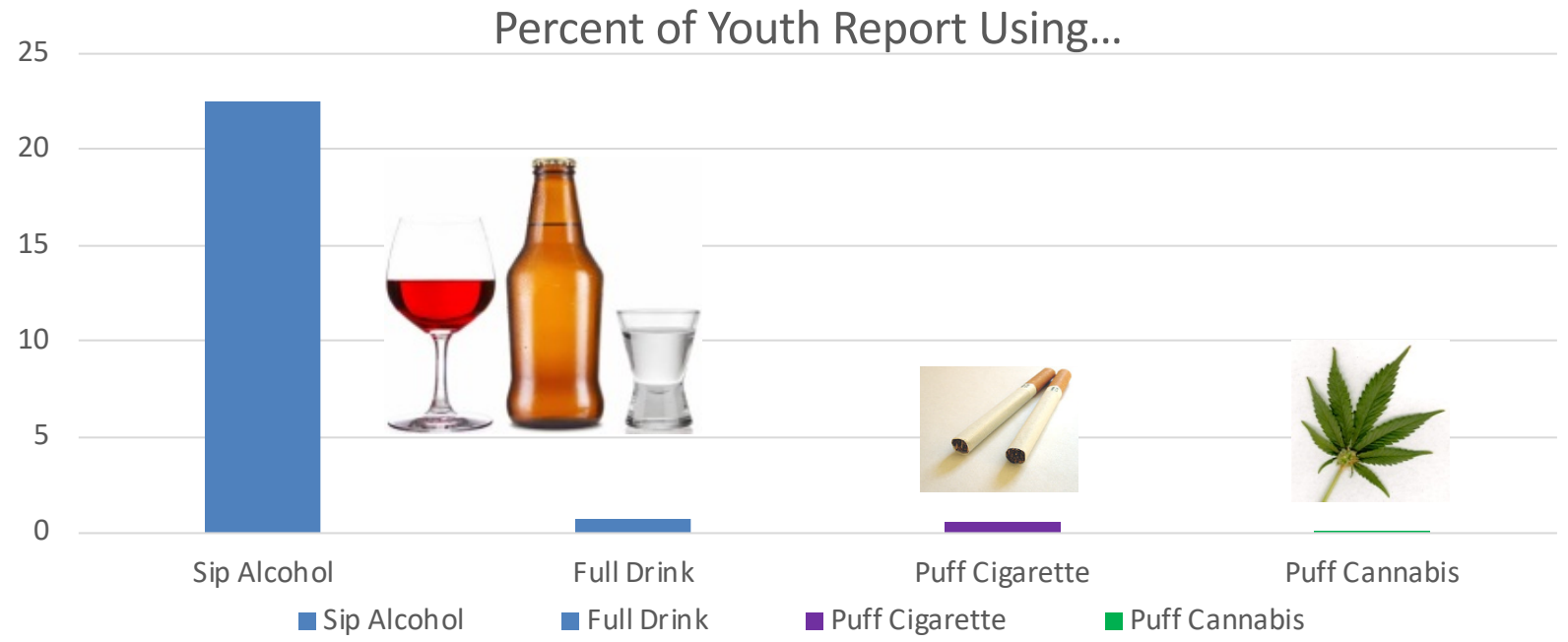
Heard Of (n=11,857)…

- The **vast majority of youth** in the sample endorsed having heard of alcohol (96.3%), cigarettes (93.4%), caffeine (95.3%);
- Majority heard of cannabis (55.6%)
- Fewer youth had heard of prescription drug misuse (36.6%) and (25.6%) inhalants
- Minority heard of any other illicit drug
  - Cocaine/crack (5.4%); Heroin, opium (1.8%), meth (1.3%)



Substance Use?

- Vast majority have not tried ANY substance (74%)
- 22.5% reporting sipping alcohol
  - Boys (24.3%) > Girls (20.5%) had a sip ($p<.05$)
- 0.7% puffed a cigarette, pipe, ENDS, or hookah (n=81)
  - 0.4% BOTH sipped and puffed nicotine (n=48)
- 0.1% puffed cannabis (n=12); n=5 had more than a puff
  - Majority who used cannabis also sipped alc (n=11, 92%)



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Developmental Cognitive Neuroscience

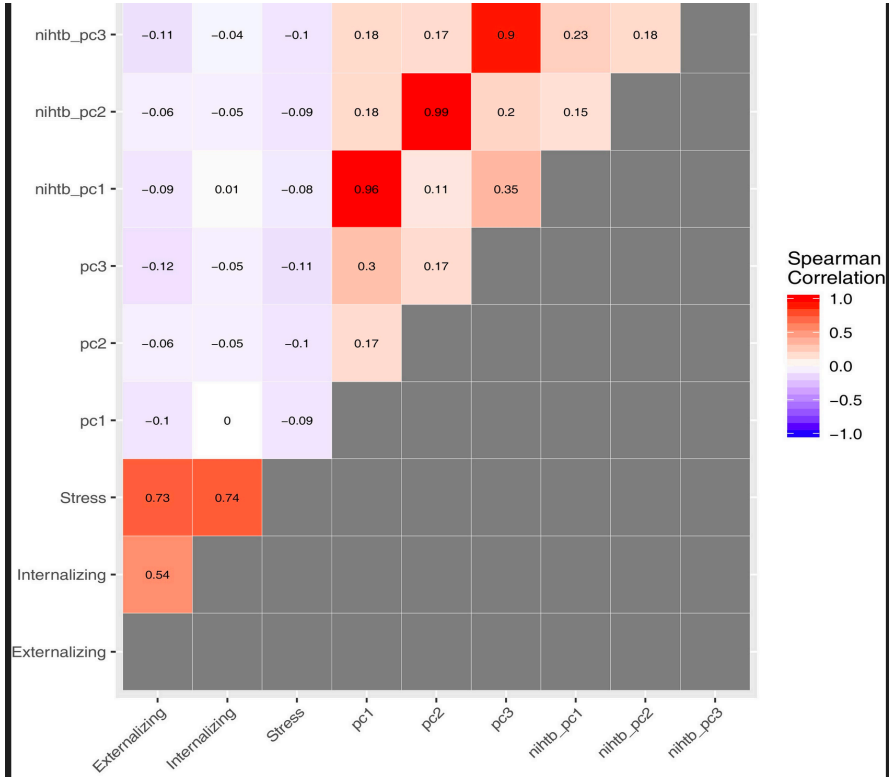
journal homepage: www.elsevier.com/locate/dcn

The structure of cognition in 9 and 10 year-old children and associations with problem behaviors: Findings from the ABCD study's baseline neurocognitive battery

Wesley K. Thompson[a], Deanna M. Barch[b], James M. Bjork[c], Raul Gonzalez[d], Bonnie J. Nagel[e], Sara Jo Nixon[f], Monica Luciana[g,*]

Better cognitive abilities associated with *less report of*

- Stress
- Externalizing symptoms
- Internalizing symptoms



The Lancet Child & Adolescent Health
Volume 2, Issue 11, November 2018, Pages 783-791

Articles

Associations between 24 hour movement behaviours and global cognition in US children: a cross-sectional observational study

Jeremy J Walsh PhD [a], Joel D Barnes MSc [a], Jameason D Cameron PhD [a], Gary S Goldfield PhD [a, b, c, d], Jean-Philippe Chaput PhD [a, b, c], Katie E Gunnell PhD [e], Andrée-Anne Ledoux PhD [f], Roger L Zemek MD [c, f], Prof Mark S Tremblay PhD [a, c]

- 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.

Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/neuroimage

Screen media activity and brain structure in youth: Evidence for diverse structural correlation networks from the ABCD study

Martin P. Paulus [a,b,*], Lindsay M. Squeglia [c], Kara Bagot [b], Joanna Jacobus [b], Rayus Kuplicki [a], Florence J. Breslin [a], Jerzy Bodurka [a], Amanda Sheffield Morris [a,e], Wesley K. Thompson [d], Hauke Bartsch [f], Susan F. Tapert [b]

Some screen media activity associated brain structures are related to poorer cognitive performance, others are related to better cognitive performance.

"This diversity of findings provides an important public health message, i.e. screen media activity is not simply "bad for the brain" or "bad for brain related functioning". Instead, future investigations will need to examine how various forms of screen media activity influence specific psychopathology and cognitive functions, and how this influences changes throughout development"

Journal of the American Academy of Child & Adolescent Psychiatry
Available online 18 October 2019
In Press, Uncorrected Proof

New research

Brain Volume Abnormalities in Youths at High Risk for Depression: Adolescent Brain and Cognitive Development Study

David Pagliaccio PhD [a, b], Kira L. Alqueza BA [a, b], Rachel Marsh PhD [a, b], Randy P. Auerbach PhD, ABPP [a, b, c]
Show more

- Family history of depression linked to different brain architecture
- Family history of depression linked to more depressive symptomatology
  - Maternal
  - Paternal

Association of Prenatal Cannabis Exposure With Psychosis Proneness Among Children in the Adolescent Brain Cognitive Development (ABCD) Study

Jeremy D. Fine[1]; Allison L. Moreau, BA[1]; Nicole R. Karcher, PhD[2]; et al
Author Affiliations | Article Information

JAMA Psychiatry. 2019;76(7):762-764. doi:10.1001/jamapsychiatry.2019.0076

- Cannabis exposure after, but not before, knowledge of pregnancy may increase in psychosis proneness
- Prenatal cannabis exposure may increase offspring psychosis risk

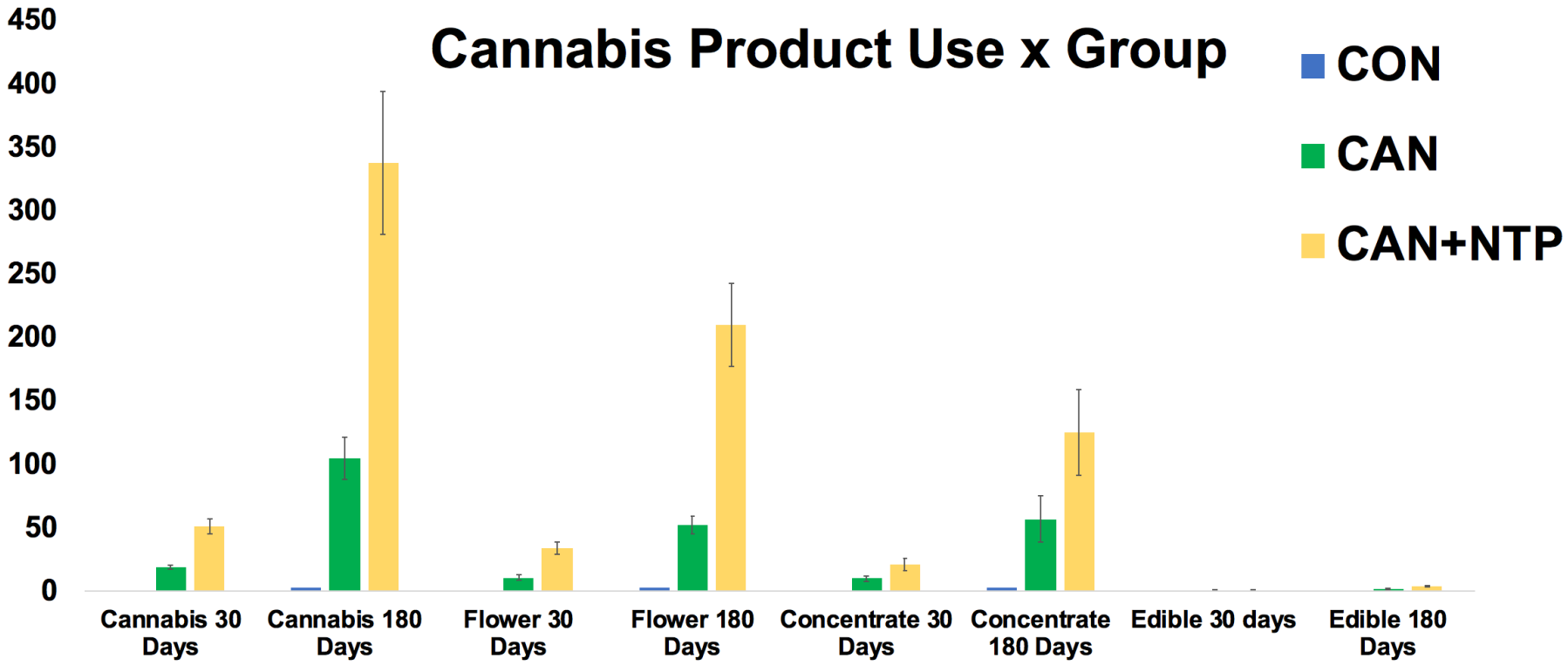
Coming Soon…

- ↓Perceived Risk = ↑ Curiosity about Use
- Substance-naïve children with a family history of substance use disorder may show different neural activation patterns
- Prenatal exposure linked to different brain architecture patterns

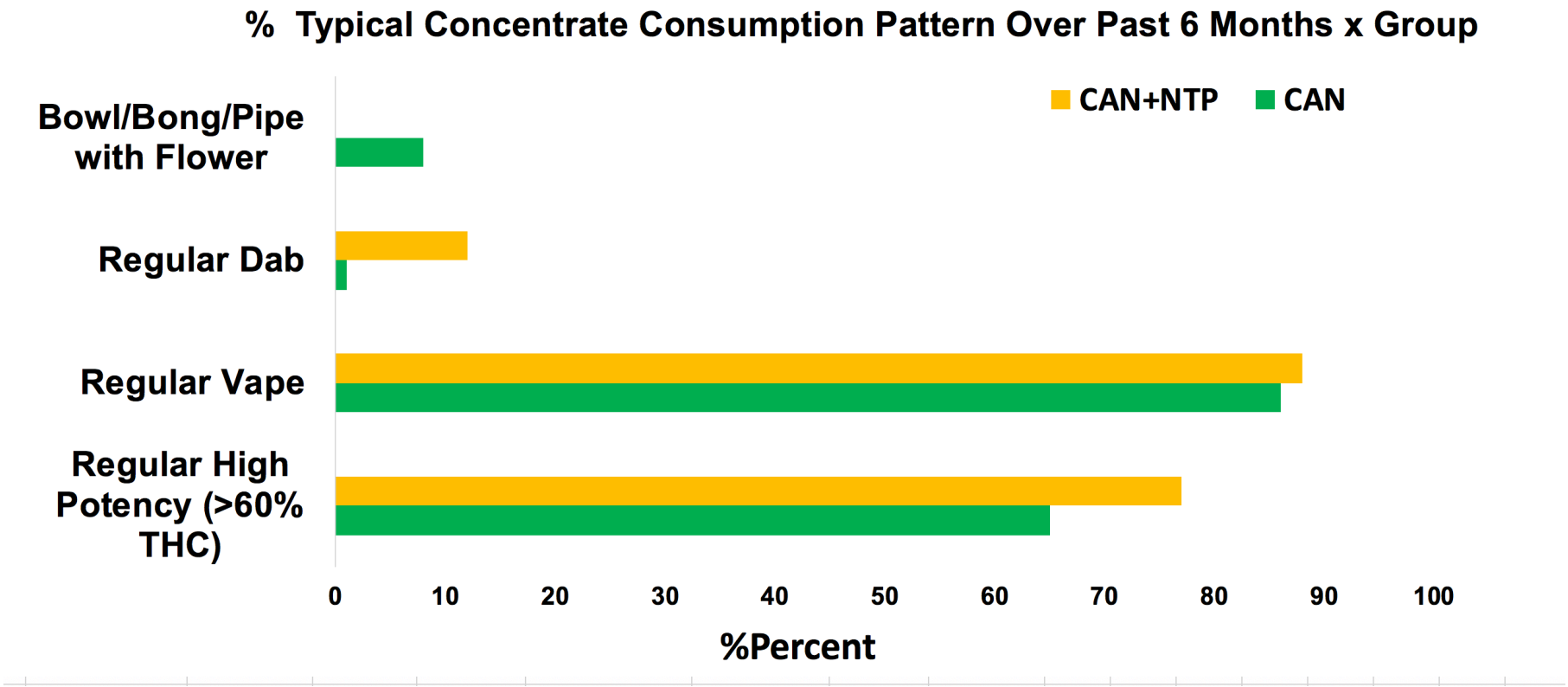
Cannabis + Nicotine and Tobacco-Related Products

- **TOCAN Study**
- Ages 16-22
- Goal N=300 by 2021
- Focused on simultaneous use & brain integrity

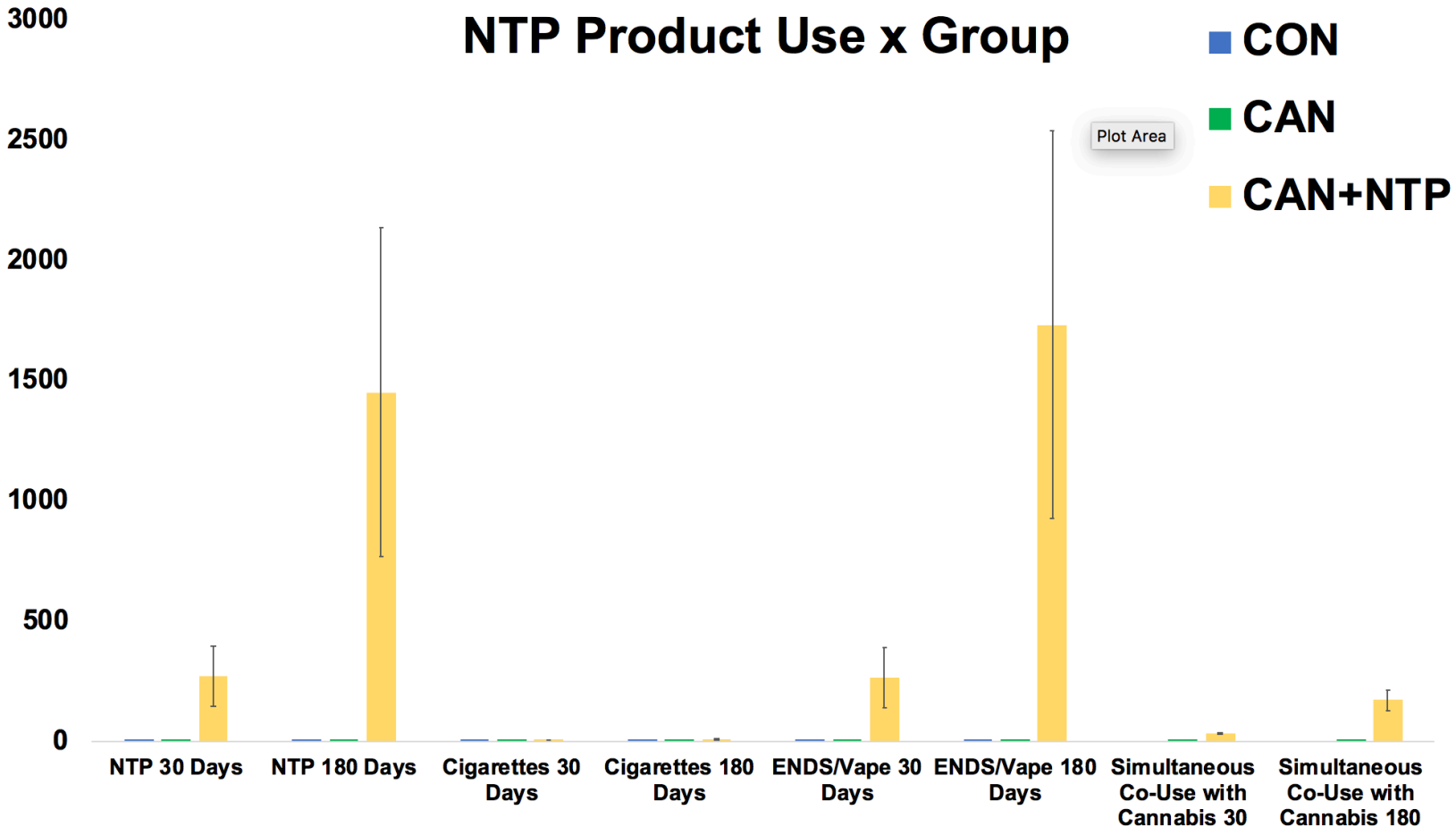
TOCAN STUDY


Cannabis Product Use x Group
CON
CAN
CAN+NTP
450
400
350
300
250
200
150
100
50
0
Cannabis 30 Days
Cannabis 180 Days
Flower 30 Days
Flower 180 Days
Concentrate 30 Days
Concentrate 180 Days
Edible 30 days
Edible 180 Days

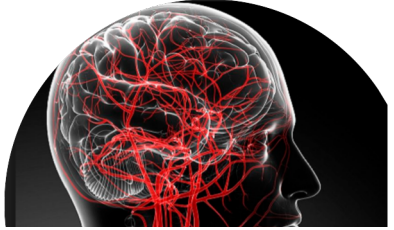
TOCAN STUDY

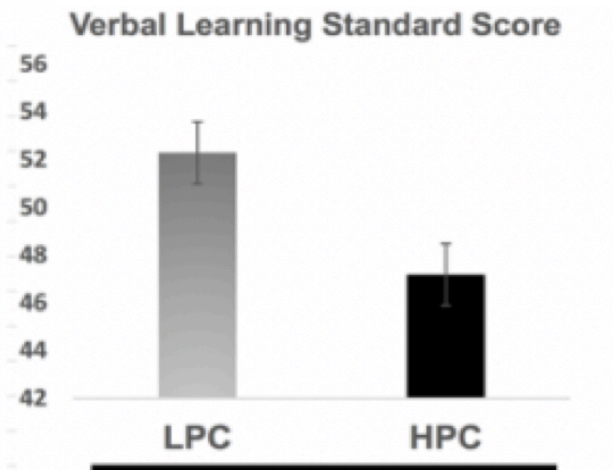

% Typical Concentrate Consumption Pattern Over Past 6 Months x Group
CAN+NTP
CAN
Bowl/Bong/Pipe with Flower
Regular Dab
Regular Vape
Regular High Potency (>60% THC)
0
10
20
30
40
50
60
70
80
90
100
%Percent

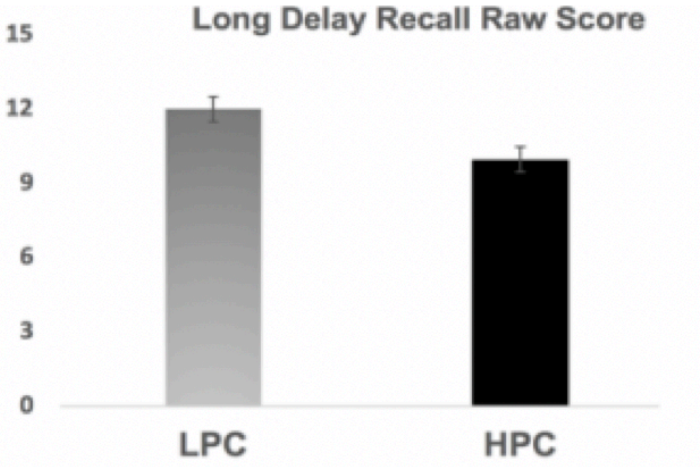
TOCAN STUDY


NTP Product Use x Group
CON
CAN
CAN+NTP
Plot Area
3000
2500
2000
1500
1000
500
0
NTP 30 Days
NTP 180 Days
Cigarettes 30 Days
Cigarettes 180 Days
ENDS/Vape 30 Days
ENDS/Vape 180 Days
Simultaneous Co-Use with Cannabis 30
Simultaneous Co-Use with Cannabis 180

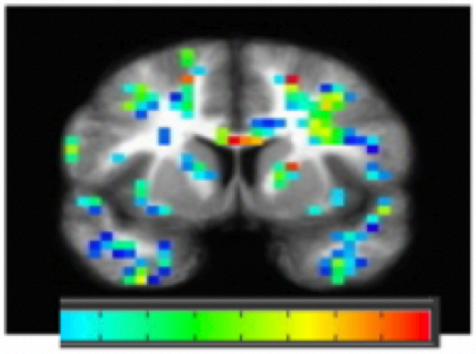
TOCAN STUDY







LPC = ≤35%THC
HPC = ≥60% THC



Increased regular use of HPC related to decreased CBF in white matter

Increasing between group (LPC>HPC) effect sizes (Cohen's d) for WM CBF

Thanks!

Questions?

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