Delinquency, Victimization, and the Developing Brain: Results from the ABCD-Social Development Study

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December 2, 2020

NIJ

Early Adolescent Delinquency and Victimization from the Adolescent Brain Cognitive Development Study

Presenter: Duncan B. Clark, M.D., Ph.D.

Delinquency, Victimization, and the Developing Brain
National Institute of Justice
December 2, 2020

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NIJ

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CDC

Chris Harper PhD

ABCD organization, faculty & staff

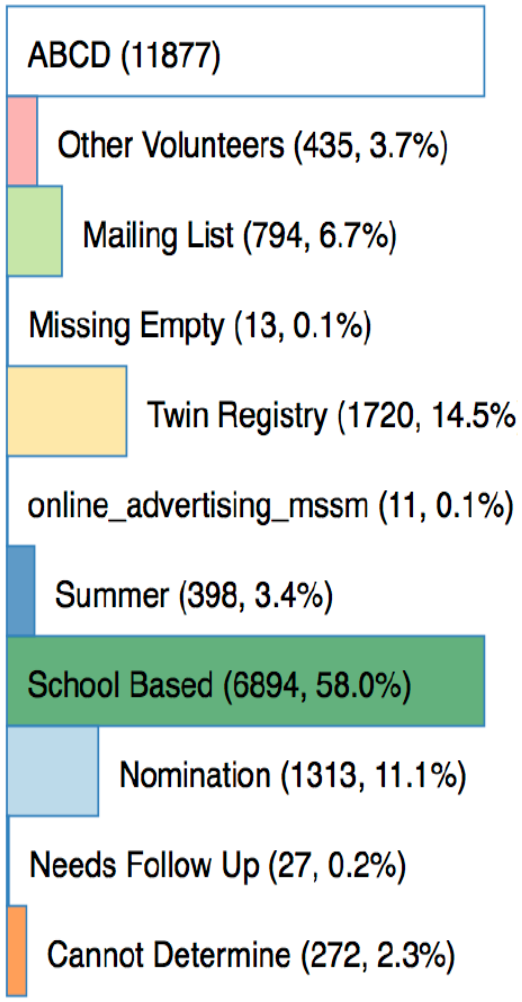
Grants: ***NIJ & CDC 2017-MU-CX-0044 & ABCD***

ABCD Study® Aims

1. Describe individual developmental pathways:
   Neural, cognitive, emotional, academic
2. National standards of healthy brain development
3. Interaction of genes and environment on development
4. Influences on brain development: Physical activity,
   sleep, screen time, traumatic brain injuries
5. Influences on mental health from childhood to young
   adulthood
6. Relationships between mental health and substance
   use
7. Substance use influences on developmental outcomes

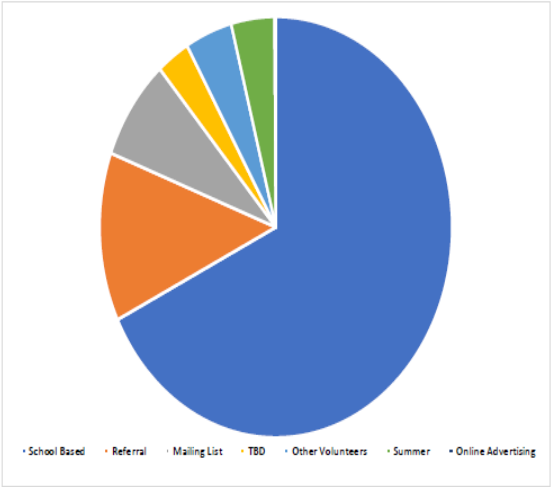
Volkow et al. (2018): ABCD Special Issue: Developmental Cognitive Neuroscience 2018 [available at abcdstudy.org]

Recruitment Sources

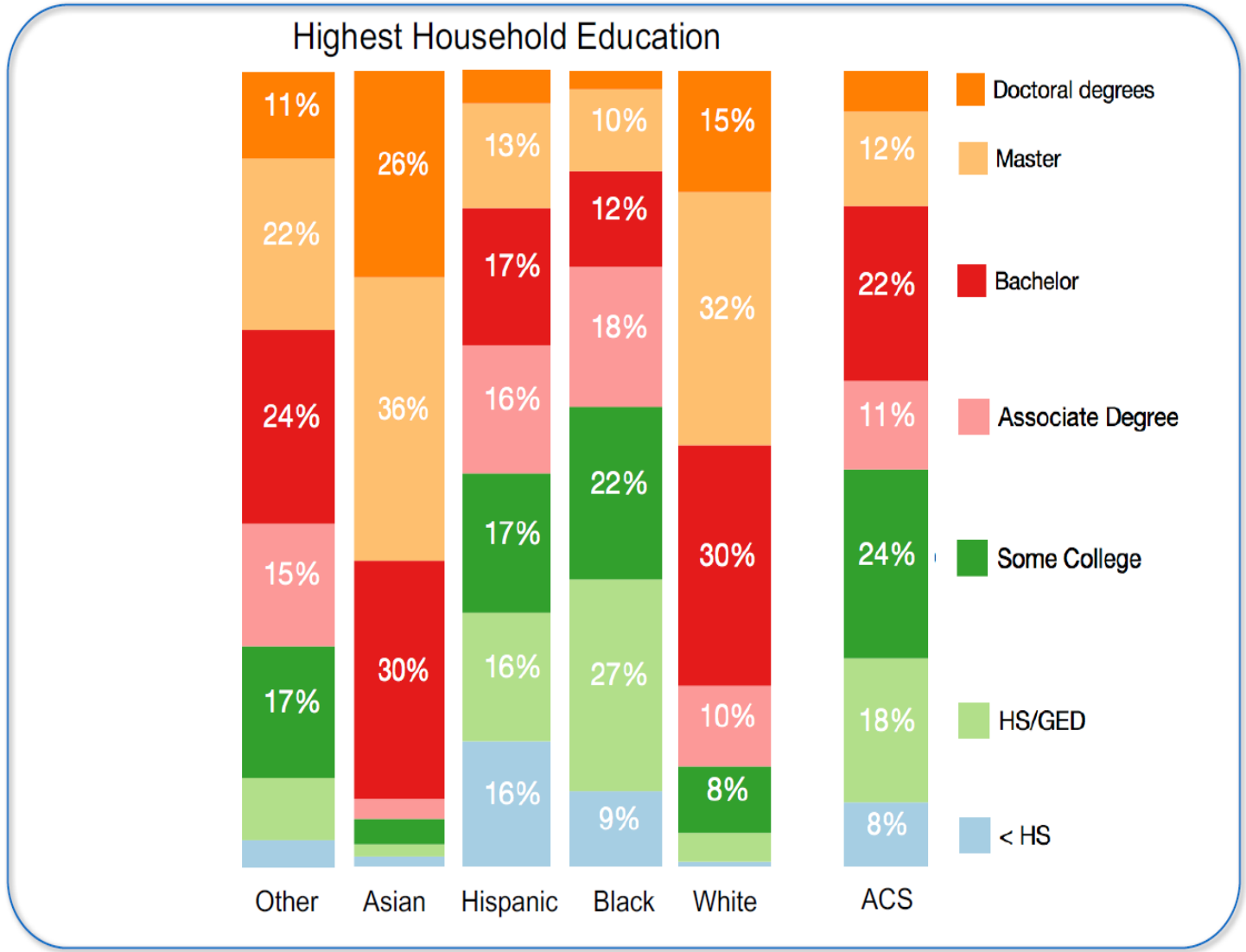


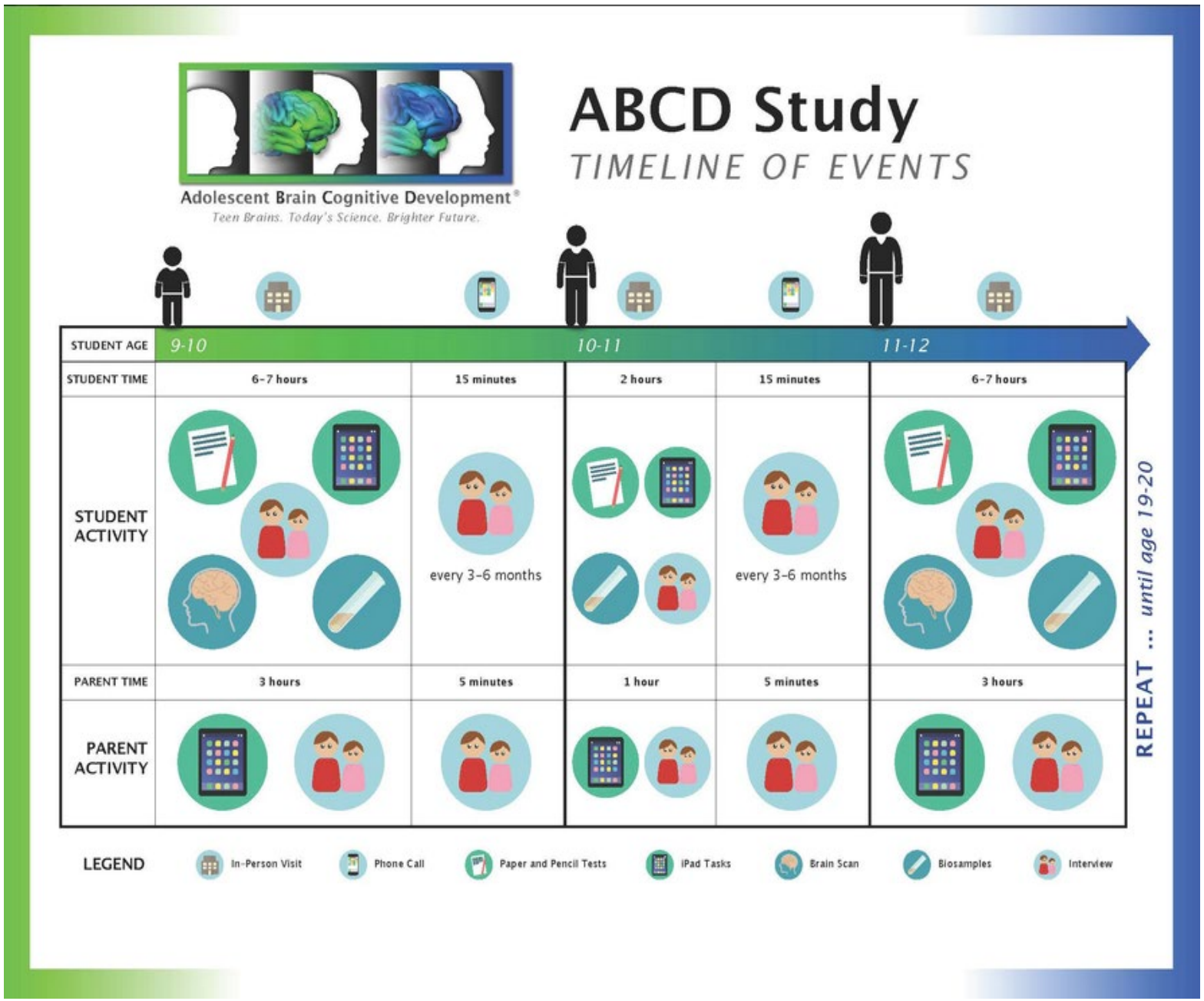
Excluding Birth Registry Twins

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



SES


Highest Household Education
11%
22%
24%
15%
17%
26%
36%
30%
13%
17%
16%
17%
16%
16%
10%
12%
18%
22%
27%
9%
15%
32%
30%
10%
8%
12%
22%
11%
24%
18%
8%
Other
Asian
Hispanic
Black
White
ACS
Doctoral degrees
Master
Bachelor
Associate Degree
Some College
HS/GED
< HS


Adolescent Brain Cognitive Development®
Teen Brains. Today's Science. Brighter Future.
ABCD Study
TIMELINE OF EVENTS
STUDENT AGE
9-10
10-11
11-12
STUDENT TIME
6-7 hours
15 minutes
2 hours
15 minutes
6-7 hours
STUDENT ACTIVITY
every 3-6 months
every 3-6 months
PARENT TIME
3 hours
5 minutes
1 hour
5 minutes
3 hours
PARENT ACTIVITY
REPEAT ... until age 19-20
LEGEND
In-Person Visit
Phone Call
Paper and Pencil Tests
IPad Tasks
Brain Scan
Biosamples
Interview

ABCD assessment protocol Visit 1 (Baseline)

Mental Health	***Y***	***P***
Total time: minutes	***30***	***105***
ABCD Higher Risk Screener		☑
DSM-5 Diagnoses and Symptoms	☑	☑
UPPS-P for Children – Short Form	☑	
BIS/BAS Scales	☑	
Achenbach scales: CBCL		☑
parent ASR		☑
Prodromal Psychosis Scale	☑	
Parent General Behavior (mania)		☑
Youth Resilience Scale (friends)		☑
Family History (psychopathology, SU)		☑

ABCD assessment protocol Visit 1 (Baseline)

Physical Health	*Y*	*P*
Total time	*15*	*63*
Anthropometrics	☑	
Snellen Vision Screen	☑	
Edinburgh Handedness	☑	
YRBS: Exercise	☑	
Sports & activities		☑
Pubertal Development	☑	☑
Screen Time Survey	☑	☑
Sleep Disturbances Scale		☑
Medical History, medications		☑
Developmental history, prenatal		☑
Ohio State TBI Screen		☑

ABCD assessment protocol Visit 1 (Baseline)

Culture & Environment	*Y*	*P*
Total time	*9*	*22*
Parental Monitoring Survey	☑	
School Risk & Protective Factors	☑	
Prosocial Behavior Survey	☑	☑
Acculturation Survey	☑	☑
FES: Family Conflict	☑	☑
Neighborhood Safety	☑	☑
Multi-Group Ethnic Identity		☑

ABCD assessment protocol Visit 1 (Baseline)

Biospecimens	***Y***	***P***
Total time	***22***	***5***
Alcohol Screen (Breathalyzer)	☑	
Drug Screen (oral fluid – Drager)	☑	
Substance Use (hair)	☑	
Pubertal hormones (oral fluid)	☑	
DNA (oral fluid/blood)	☑	
Baby teeth		☑

Other Data Sources	***P***	***T***
Total time	***8***	***2***
Residential History: Geocoding	☑	
School Records	☑	
Brief Problem Monitor (teacher)		☑

ABCD assessment protocol Visit 1 (Baseline)

Neurocognition - Y ***Total time: 60 minutes***

NIH Toolbox Tasks
Flanker Inhibitory Control
Picture Vocabulary
List Sorting Working Memory
Dimensional Change Card Sort
Pattern Comparison Processing Speed
Picture Sequence Memory
Oral Reading Recognition

Other tasks
Rey Auditory Verbal Learning Test
Cash Choice Task
Little Man Task
Matrix Reasoning Task
RAVLT Delayed Recall

ABCD assessment protocol Visit 1 (Baseline)

Brain Imaging Protocol - Y ***Total time: 120 minutes***

Pre Scan: Screen, MR Simulator, PS Questionnaire

Setup, Localizer
3D T1 (show child movie)
rs fMRI (10 minutes x 2)
Diffusion Tensor Imaging (show child movie)
3D T2 (show child movie)
fMRI Monetary Incentive Delay Task
fMRI Stop Task
fMRI Emotional N-Back Task

Post Scan: N-Back Recognition, MID Survey, Post Q

ABCD measures: Delinquency & Victimization

Mental Health

v2 Y Brief Delinquency Measure
v1 P ABCD Higher Risk Screener
v1 P KSADS Diagnoses and Symptoms
v1 P Achenbach scales: Child Behavior Checklist
v1 Y UPPS-P for Children – Short Form

Physical Health

v1 P Ohio State TBI Screen - Short

Neurocognitive

v1 Y Flanker Inhibitory Control and Attention

Culture & Environment

v1 G Area Deprivation Index
v2 P Life Events

[P: parent; Y: youth; G: geocoding; v1, v2: ABCD visit]

ABCD Brief Delinquency Measure items

Items from Self Report of Delinquency: Loeber et al. 1989

Have you hit someone with the idea of hurting them… [***assault***]
Have you been loud, rowdy, or unruly in a public place…so that people complained about it or you got in trouble [**disorderly**]
Have you ***thrown objects*** such as rocks or bottles at people…
Have you purposely ***damaged*** or destroyed ***property*** *that* did not belong to you…
Have you taken something from a ***store*** without paying for it…
Have you stolen or tried to steal things worth ***$5 or less***…
Have you stolen or tried to steal things worth between ***$5 and $50***…
Have you carried a hidden ***weapon***…
Have you been involved in a ***gang fight***…
Have you been arrested or picked up by ***police***…for other than minor traffic offense
Qualifier: "…in the past year?" ***Response options***: yes or no; # times

Piquero et al. (2002) The validity of a Self-Reported Delinquency Scale. Sociological Methods & Research 30(4), 492-529

ABCD BDM (v2 Y) psychometric analyses

Item	Rate (%)	EFA factor loadings	IRT β	α
assault	9.3	.61	2.1	1.4
disorderly	4.4	.57	2.7	1.5
thrown object	3.2	.69	2.5	2.0
property damage	1.9	.73	2.6	2.3
store theft	1.6	.88	2.5	3.1
theft <$5-$50[1]	1.4	.84	2.5	2.8
weapon	1.0	.66	3.3	1.9
gang fight	1.0	.68	3.1	2.2
police	0.3	.68	3.6	2.3

ABCD Visit 2: n=11235; 1. theft <$5 & theft $5-50 combined
EFA: Exploratory Factor Analysis, tetrachoric matrix
Eigenvalues: 4.9, 0.9, 0.8, 0.6, 0.5
IRT: β: difficulty or severity; α: discrimination

ABCD BDM: Differential Item Functioning

Candidate Items: Qualitative review: disorderly, police

Have you been loud, rowdy, or unruly in a public place…so that people complained about it or you got in trouble [**disorderly**]

Have you been arrested or picked up by ***police***…for other than minor traffic offense

BDM 10 items x BDM 8 items: r=0.95 (n=11,311; p<.001)

DIF statistical analyses

DIF: a statistical characteristic showing an item may be measuring different “abilities” in identified subgroups

Sequential DIF flexMIRT analysis conducted

ABCD BDM DIF thresholds by race

Item	white β	black β	p
assault	2.20	1.76	0.12
disorderly	3.17	2.10	0.44
thrown object	2.62	2.29	0.03
property damage	3.02	2.24	0.28
store theft	2.70	2.02	0.89
theft <$5-$50[1]	2.63	2.19	0.39
weapon	3.32	2.68	0.03
gang fight	3.47	2.69	0.03
police	3.74	3.16	0.009

disorderly: no significant differences
police: black youth showed lower “difficulty”

flexMIRT DIF analysis; DIF: β: difficulty or severity

ABCD Higher Risk Index (HR) & KSADS: parent at ABCD v1
HR items derived from Loeber et. (2018) & anxiety/depression/protective

HR Item	GAMM[1] (n=4479)		
	F	p	ΔR^2
lie or cheat	17.2	<.001	0.8%
property	26.0	<.001	1.2%
disobey	54.1	<.001	2.4%
steal	21.2	<.001	0.9%
Household smoke	12.7	<.001	0.3%
	ANOVA[2] (n=11,235)		
ABCD HR[2]	26.9	<.001	
KSADS ADHD	32.7	<.001	
KSADS ODD	48.9	<.001	
KSADS CD	75.8	<.001	

1. ABCD NDA 2.0: DEAP GAMM:
   Fixed Effects: age/sex/race/ethnicity/income/marital status
   Random Effects: family/site
   Propensity weight: American Community Survey
2: ABCD NDA 3.0: ANOVA: covariates: age/sex/race/ethnicity/income

ABCD UPPS (Yv1) **x BDM** (Yv2)

UPPS-P Short Youth Version: impulsivity as a multi-faceted, multi-dimensional construct with five impulsive personality traits; 4 items per scale [4-point: agree strongly … disagree strongly]

Subscale	ANOVA[1] (n=11,235)		GAMM[2] (n=4473)		
	F	p	F	p	ΔR^2
Negative Urgency	15.9	<.001	62.7	<.001	1.4%
Positive Urgency	12.5	<.001	63.0	<.001	1.4%
Lack of Perseverance	17.4	<.001	47.8	<.001	1.1%
Lack of Planning		9.0	<.001	99.6	<.001
2.2%					
Sensation Seeking	2.9	.001	16.3	<.001	0.3%

[1: ABCD NDA 3.0: ANOVA: covariates: age/sex/race/ethnicity/income]
[2: ABCD NDA 2.0: Data Exploration and Analysis Portal GAMM:
Fixed Effects: age/sex/race/ethnicity/income/education/marital
Random Effects: family/site
Propensity weight: American Community Survey

Reference: Watts et al. (2019) …UPPS-P… Psychological Assessment

ABCD Life Events (Pv2) **x BDM** (Yv2)

PhenX Life Events: parent at ABCD v2 (n=11,235): “ever”

		% yes
Example items:	youth was victim of crime or violence	1.4
	someone in family arrested	5.6
	caregiver went to jail	3.5

	ANOVA[1]	
	F	p
Life Events Pv2: adverse sum	2.1	.008

The Traumatic Life Events Questionnaire
Kubany et al (2000) Psychological Assessment

1. ABCD NDA 3.0: ANOVA: covariates: age/sex/race/ethnicity/income

ABCD KSADS PTSD trauma items (Pv1)

KSADS trauma history items: parent at ABCD v1 (n=11,878):

17 traumatic events: present/past (“yes” 1%)
Example items: parent about youth history

More frequent events

24%	Unexpected death of loved one
8%	Witness grownups in home push, shove or hit one another
4%	accident requiring medical attention

Less frequent events (yes ≤ 1%)
witnessed someone shot or stabbed in the community
shot, stabbed or beaten by non-family member
shot, stabbed, or beaten by grown up in the house
family/non-family member threatened to kill your child
sexual abuse (3 items)

Kauffman et al. (1997, 2000) Schedule for affective disorders and schizophrenia for school-age children (K-SADS-PL). JAACAP 36(7); 39(10)

Clark et al. (2010) Child abuse and other traumatic experiences… Journal of Pediatric Psychology 35(5), 499-510

Culture & Environment: Area Deprivation Index (ADI)

Geocoding from residential history (multiple residences)
17 census measures: weighted sum (V1 primary residence here)

Characteristics determined for area residences

- housing [multiple indicators: e.g., without complete plumbing
- income / below poverty threshold [multiple indicators]
- occupation/employment status [multiple indicators]
- marital status; education

	GAMM[1] (n=4473)		
	F	p	ΔR^2
ADI	19.5	p<.001	0.4%

ABCD NDA 2.0: DEAP GAMM: Fixed Effects: age/sex;
Random Effects: family/site; Propensity weight: American Community Survey

Singh (2003) AJPH; Kind et al. (2014) Annals of Internal Medicine

Neurocognition: Flanker (Yv1) **x BDM** (Yv2)

NIH Toolbox Flanker: youth at ABCD v1
NIH Toolbox Cognition Battery: Executive Function
Construct: inhibitory control and attention
Task: indicate left-right orientation of central stimulus
inhibit attention to incongruent surrounding stimuli

	GAMM[1] (n=4440)		
	F	p	ΔR^2
Flanker task	0.9	.38	0.0%

Zelazo et al. (2014) J Int Neuropsychol Soc

1. ABCD NDA 2.0: DEAP GAMM: flanker task (age corrected)
Fixed Effects: age/sex/race/ethnicity/income/marital status
Random Effects: family/site
Propensity weight: American Community Survey

Physical Health: TBI (Pv1) **x BDM** (Yv2)

Ohio State Traumatic Brain Injury: parent at ABCD v1

		n (11,870)	%
TBI worst:	improbable	11,414	96
	possible	322	3
	mild	127	1
	moderate	4	.03
	severe	3	.03

	GAMM[1] (n=4479)		
	F	p	ΔR^2
TBI worst	0.9	.43	0.0%

Bogner et al. (2017) J Head Trauma Rehabil

1. ABCD NDA 2.0: DEAP GAMM:
   Fixed Effects: age/sex/race/ethnicity/income/marital status
   Random Effects: family/site
   Propensity weight: American Community Survey

Summary

ABCD data overview and examples

BDM psychometric analyses

BDM risks:	impulsivity personality traits
	adverse life events
	Area Deprivation Index
negative results	Flanker inhibitory control
	TBI in ABCD sample
Future research	scale development
	BDM – brain development
	developmental outcomes
	criminal behavior
	victimization
	victimization effects

Data used in the preparation of this article were obtained from the Adolescent Brain Cognitive Development (ABCD) Study (https://abcdstudy.org), held in the NIMH Data Archive (NDA). This is a multisite, longitudinal study designed to recruit more than 10,000 children aged 9-10 years and follow them over 10 years into early adulthood. The ABCD Study is supported by the National Institutes of Health and additional federal partners under award numbers U01DA041022, U01DA041025, U01DA041028, U01DA041048, U01DA041089, U01DA041106, U01DA041117, U01DA041120, U01DA041134, U01DA041148, U01DA041156, U01DA041174, U01DA041093, U24DA041123, and U24DA041147. A full list of supporters is available at https://abcdstudy.org/nih-collaborators. A listing of participating sites and a complete listing of the study investigators can be found at https://abcdstudy.org/principal-investigators.html. ABCD consortium investigators designed and implemented the study and/or provided data but did not necessarily participate in analysis or writing of this report. This manuscript reflects the views of the authors and may not reflect the opinions or views of the NIH or ABCD consortium investigators. The ABCD data repository grows and changes over time. The ABCD data used in this report came from the ABCD Data Release 2.0 (DOI: 10.15154/1503209, March 2019) and ABCD Fix Release 2.0.1 (DOI: 10.15154/1504041, July 2019), and ABCD Data Release 3.0 (DOI: 10.15154/1519007).

ABCD Example Publications

ABCD PublicationTopics: First Author, Year

ABCD Special Issue: Developmental Cognitive Neuroscience
The conception of the ABCD Study: Volkow et al., 2018
Design: Garavan et al., 2018
Physical and mental health assessment: Barch et al., 2018
Screen for early marijuana use: Loeber et al., 2018
Imaging acquisition: Casey et al., 2018.
Neurocognition battery: Luciana et al., 2018.
Assessment of culture and environment: Zucker et al., 2018
Biomedical ethics and clinical oversight: Clark et al., 2018

Recent publications (70 in 2020 to date)
Neighborhood poverty and brain: Taylor et al., 2020
Behavior and brain substance use risks: Rapuano et al., 2020
Prenatal substance exposure: Lees et al., 2020; Paul et al., 2020
Neuroanatomy and impulsvity: Owens et al., 2020
Brain, behavior, environment: Modabbernia et al., 2020
Reward processing and disruptive behaviors: Hawes et al., 2020

Available at https://abcdstudy.org

ABCD Study ® Additional information

ABCD Study information: https://abcdstudy.org

- Study design & protocol descriptions
- Workgroups
- fMRI Tasks & Tools
- Data sharing instructions
- Publications

ABCD Special Issue:
Developmental Cognitive Neuroscience: August 2018

ABCD Data Use: https://nda.nih.gov/abcd

Contact Duncan Clark at clarkdb@upmc.edu

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The ABCD- Social Development Study

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- Investigators and staff of the data collection sites.

- Dr. Rolf Loeber who designed the SD Study together with Dr. Ahonen in 2014.

- Dr. David Farrington, Dr. Kevin Conway, Dr. Finn-Age Esbensen, Dr. Brant Hasler, Dr. Rick Rosenfeldt, & Dr. Helene Raskin-White for their initial support and guidance.

Participating ABCD-SD Sites & Faculty; NIJ & CDC support

Site	**Faculty**
Pittsburgh	Clark [PI], Ahonen [Co-PI]
Michigan	Hicks [SPI], Heitzeg, Hyde, Zucker
Maryland	Chang [SPI], Cloak
Florida	Cottler [SPI], Striley, Gurka
Yale	Casey, Baskin-Sommers: [Co-SPIs]
Scientific officers	
NIJ	Barbara Tatem Kelly
CDC	Chris Harper

Description of the Study

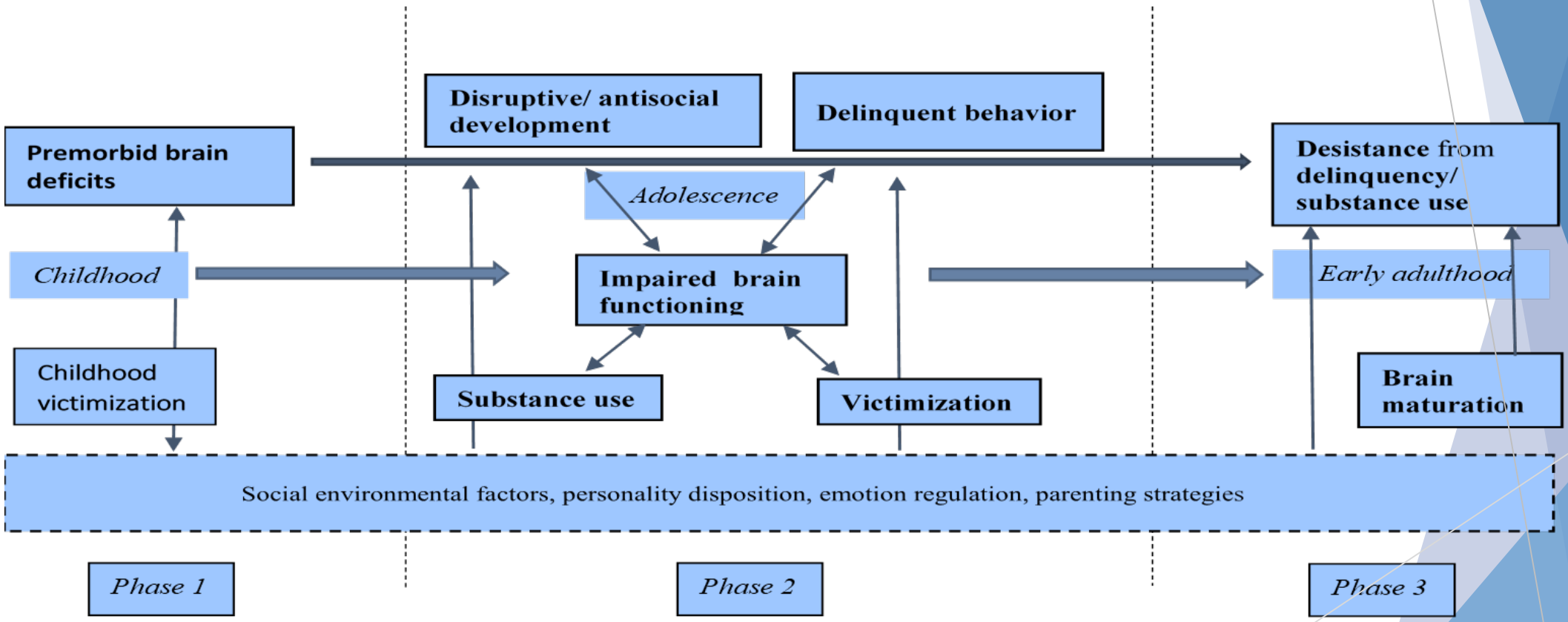
- Up to 2500 participants
- Age at first in person assessment: 10-12 (baseline)
- Planned annual assessments over 10 years
- Main constructs:
  - Delinquency
  - Victimization
  - Protective factors

Aims of the ABCD-SD study

- 1. Examine the extent to which premorbid brain structure and function deficits, expressed through neurocognitive and executive dysfunction, identify vulnerabilities for delinquency and substance use.
- 2. Investigate the adverse effects of substance use trajectories on adolescent brain and cognitive development, and whether neurodevelopmental deficits are implicated in the onset and persistence of delinquent acts, as well as the probability of victimization.
- 3. Investigate brain maturation and its associations with early forms of desistance from delinquency and cessation of victimization.

Conceptual model

Figure 1. Key elements of the ABCD-SD Study.



The assessment protocol

Was carefully developed in close collaboration with the National Institute of Justice, and Centers for Disease Control and Prevention, and all the site faculty and investigators.

The protocol is dynamic and revised annually to collect high priority data that complement the parent study, without being redundant and burdensome for the participants.

The assessment protocol

Child assessment			Parent assessment	
Instrument	Constructs	Items	Instrument	Items
Self-reported delinquency	Property crime, Violence, Internet Harassment, Police Contact	50	Parent-reported delinquency	50
Firearm carrying and access (YRBS)	Firearm access, safety	3	Firearm safety (BRFSS)	3
Victimization (JVQ)	Conventional crime, Peer and Sibling Victimization, Peer Aggression, Witnessing and Indirect Victimization, Gun Violence, School Violence and threat, Internet Victimization	32	Victimization (JVQ-P)	32
Youth Psychopathy Inventory (YPI)	Psychopathy	50	Not applicable	
CADS	Prosociality	12	CADS	12
ICU	Callous unemotional traits	17	ICU	17
Fear trait (TFQ-20)	Fearlessness	20	Not applicable	N/A
Aggression	Pro-, reactive aggression	23	Pro-, reactive aggression	23
Peer behavior profile	Peer negative and positive behavior	17	Not applicable	N/A
Emotion regulation (DERS)	Emotion regulation	36	Emotion regulation (DERS)	36
Alabama Parenting Questionnaire	Parenting	42	Parenting	42
Neighborhood Efficacy, Neighborhood disorder	Not applicable	N/A	CE-SC Scale, PND	10+15

A selection of the first descriptive data from baseline

Demographics of the sample

Social Development Study (First half of the baseline sample, n=989)	
Average age at SD baseline in years (child)	10.8
Male %	51
White %	40.6
ABCD High Risk for Marijuana use% (int. & ext).	40.5
Biological mother %	84.9
Caregiver informant age (years)	38.85 (median 38.0)
Caregiver BA degree or higher %	23.1
No High School Diploma %	7.5
Median total household income	$ 50- 75 000
Families reporting income < poverty line (2019, 2 adults, 2 children) %	26.4

SD Demographics compared to national statistics 2019.

- In comparison, the gender distribution of the SD Study and the national census survey corresponds perfectly (51% male).
- Slightly smaller proportion of white children (40.6%) compared to the national average (50%).
- The total median household income ($50-75,000) is similar to the national average ($68,703), but lower than the national average for households with children ($78,000).
- More than a quarter of the SD families (26.4%) reported incomes under the poverty line as compared to the national figures (10.5%) (4 people, $25,926).

Data Source: Population Division, U.S. Census Bureau: The Annie Casey Foundation Kids Count Data center.

Prevalence delinquency (child/parent report)

Any Delinquency % (SD combined parent/child report)						
						SD Total signif. † Chi-sq
Vandalism		31.3%	23.5%	43.9%	29.5%	< 0.001
Theft		19.9%	23.1%	43.3%	26.2%	< 0.001
Violence		76.0%	74.3%	87.3%	66.4%	0.001
Police Contact		4.5%	3.3%	14.6%	2.7%	< 0.001
Hidden Weapon Carrying						

Prevalence victimization (child/parent)

Any Victimization % (SD combined parent/child report)							
	Florida (n=130) %	Maryland (n=246) %	Michigan (n=307) %	Pittsburgh (n=157) %	Yale (n=149) %	SD Total *signif.* † Chi-sq	Total (N=989)
Conventional Crime	73.1%	67.5%	63.7%	70.1%	65.1%	0.3	67.1%
Peer & Sibling (physical) Victimization	86.2%	79.3%	86.9%	87.3%	73.8%	0.001	83.0%
Peer & Sibling (social) Intimidation	56.2%	51.6%	52.3%	55.4%	47.7%	0.6	52.4%
Witnessing /Indirect Victimization	60.0%	63.0%	40.5%	77.1%	49.7%	< 0.001	55.9%
Exposure to Gun Violence	0.8%	8.5%	2.9%	15.9%	2.7%	< 0.001	6.1%
School Violence and Threats	29.2%	22.4%	26.8%	30.6%	19.5%	0.1	25.5%
Internet Victimization	9.2%	9.8%	6.9%	13.5%	14.1%	0.08	10.0%

Personality features

- We do know that callous unemotional traits and psychopathic personality features are associated with delinquency.
- We don’t know if, and to what extent, individual emotion regulation is associated with delinquency and victimization, and if emotion regulation is qualitatively distinct from psychopathic traits.
- In the SD study we are measuring both.

Associations between delinquency and emotion regulation (ER)

ER (worst quartile)	Any Moderate Theft	Any Serious Theft	Any Moderate Violence	Any Serious Violence
Difficulties in ER (Full scale)	0.14**	0.13**	0.12**	0.21**
Non-acceptance of emotional responses	0.11**	0.11**	*ns*	0.11**
Non goal directed behavior	0.07*	*ns*	0.08*	0.10**
Impulse control diff.	0.14**	0.08*	0.15**	0.26**
Lack of emotional awareness	0.06*	*ns*	*ns*	0.12**
Lack of ER strategies	0.13**	0.12**	0.10*	0.17**
Lack of emotional clarity	0.12**	0.16**	0.10*	0.11**

Note: ** $p < .001$, * $p < .05$ Kendall's Tau b.
Delinqency= self and parent reported best estimate
Emotion regulation= self reported, worst quartile= 25% highest score.

Associations between victimization and emotion regulation

	Any victimization					
	Conventional crime	Peer or sibling				
		ns	0.10*	0.11**	0.08*	0.07*
Non-acceptance of emotional responses		*ns*	0.10*	0.12**		
Non goal directed behavior		0.11**	0.13**	0.07*		*ns*
Impulse control diff.		0.09*	0.14**	0.12**		0.12**
Lack of emotional awareness		*ns*	-0.09*	*ns*		*ns*
Lack of ER strategies						0.09*
Lack of emotional clarity	0.10*	*ns*	*ns*	0.07*	*ns*	0.05*

Note: ** $p < .001$, * $p < .05$ Kendall's Tau b.
Victimization= self and parent reported best estimate, Emotion regulation= self reported, worst quartile= 25% highest score.

Associations between emotion regulation and the YPI

	The Youth Psychopathy Inventory (worst quartile)		
Difficulties in ER (Full scale)			
Non-acceptance of emotional responses	0.15**	0.18**	0.19**
Non goal directed behavior	0.13**	ns	
Impulse control diff.	0.24**	0.22**	
Lack of emotional awareness	0.12**		
Lack of ER strategies	0.22**		0.27**
Lack of emotional clarity			0.12**

Note: ** $p < .001$, * $p < .05$ Kendall's Tau b.
ER & YPI= self reports, worst quartile= 25% highest score.

Conclusions

- The ABCD-SD Study is a unique development of the merging of life course criminology and neurodevelopment.
- The overall sample will be a decent representation of the national group of children in the overall population, with a slight skewness towards high risk and low socio-economic status.
- Personality features such as psychopathic traits are well known as a precursor of delinquency, but also emotion regulation plays an important role.
- There are important differences between data collection sites that need consideration in future analyses.

A word of caution

- The results should be used with caution. Data should not be used out of context.
- For example, there are significant differences in race in prevalence, and frequency, of delinquency as well as victimization.
- Previous studies have shown that race is not a significant independent precursor of, for example, violence, when other environmental factors were taken into account.
- The SD assessment protocol is revised annually to better reflect social justice issues, and inclusiveness.

The future

- This study has the potential to significantly contribute to our understanding of organic brain development and how this relates to delinquent or norm breaking behavior over time.
- We will learn about if, and how, early onset of Marijuana use affects both brain development and behavioral problems. This is crucial information in the current climate of legalization of Marijuana across nations.
- Data will be deposited with NIJ and the ABCD Consortium for public access.

Final words

- This is the first study on brain development, delinquency, victimization and protective factors to date, with a large enough sample to differentiate race, gender, and other demographic factors.

- This is our opportunity to carry Rolf Loeber's legacy into the future, and to celebrate all the knowledge that he and Magda Stouthamer-Loeber have contributed through their long-term collaboration and organization of longitudinal studies.

If you have any questions about this presentation or study, please contact:

Lia Ahonen ahonenl@upmc.edu

Delinquency, victimization, and the developing brain:
Results from the ABCD-Social Development study

A neurodevelopmental approach to understanding the emergence and persistence of delinquency behaviors

Ashley C. Parr, PhD
Laboratory of Neurocognitive Development (LNCD), University of Pittsburgh

Roadmap

- Adolescence is a period of heightened plasticity, and a period of vulnerability to the emergence of delinquency and exposure to victimization
  - But also a window of opportunity for rehabilitation

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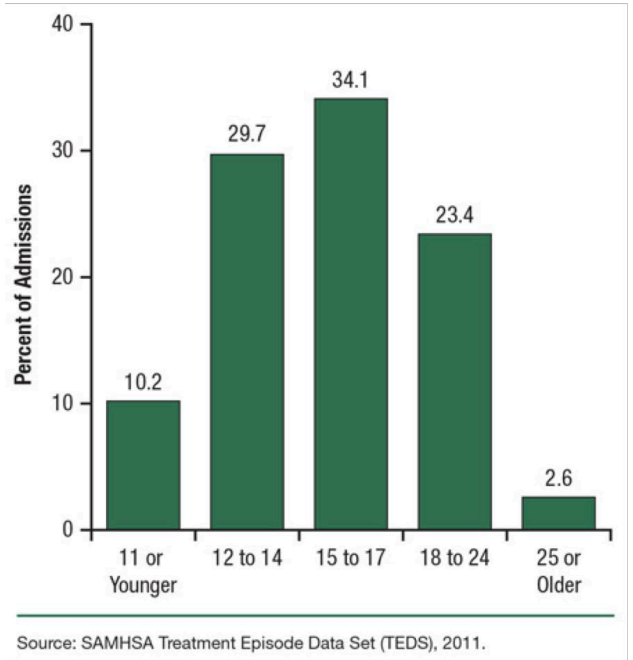
- Adolescence is a period of heightened plasticity, and a period of vulnerability to the emergence of delinquency and exposure to victimization
  - But also a window of opportunity for rehabilitation
- Changes in the brain during adolescence contribute to a normative peak in impulsive sensation seeking
- Differences in brain function may confer risk for delinquency and victimization behaviors in adolescence
  - Dopamine: The main neurotransmitter underlying reward
  - Tissue-iron: dopamine imaging using magnetic resonance imaging (MRI)
  - Sex differences

Examples of vulnerabilities in adolescence

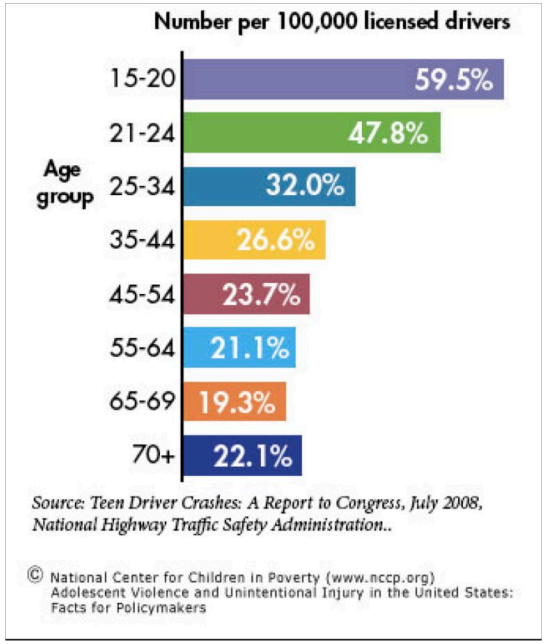
- Peak in sensation seeking that can lead to risk-taking behaviors
- Present across societies and species - ***Adaptive period to acquire skills needed to survive as an independent adult (exploration, experience-dependent plasticity)***
- Despite peak physical health, there is a twofold increase in mortality (Dahl, 2004) - *substance use, unprotected sex, extreme sports, suicide*

Substance use initiation



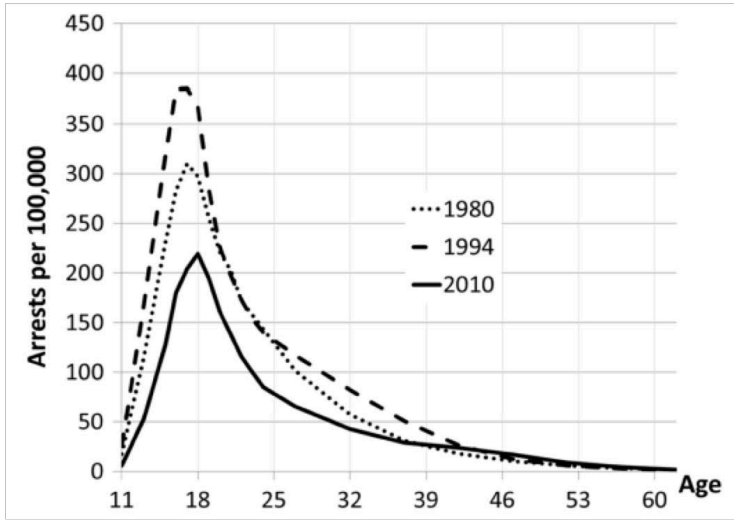
SAMHSA, 2011

Fatal car accidents

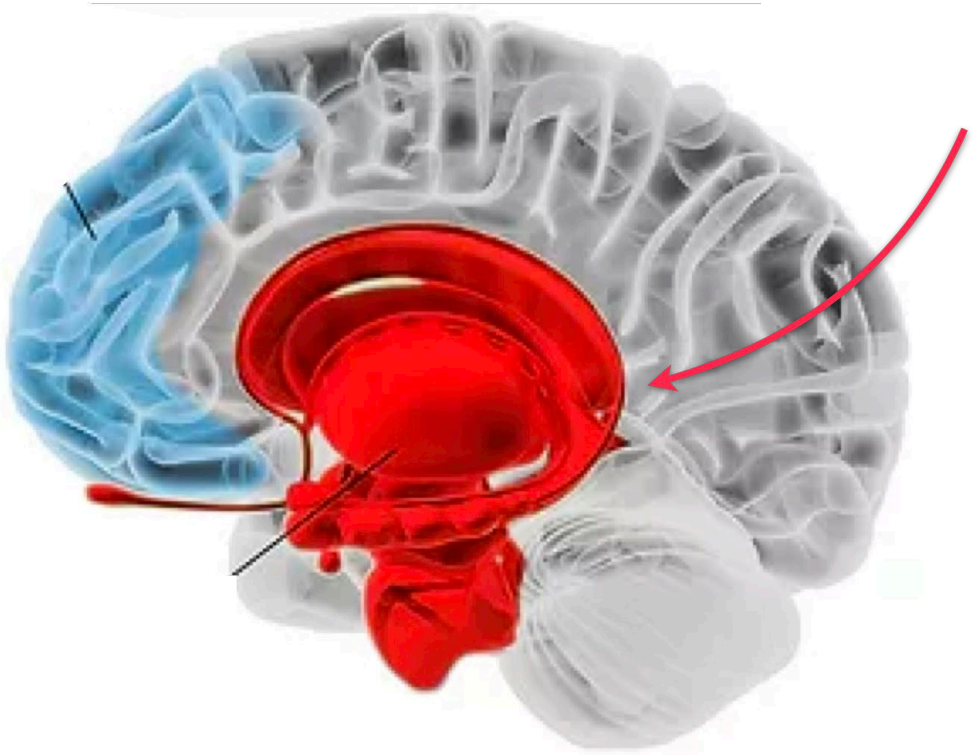


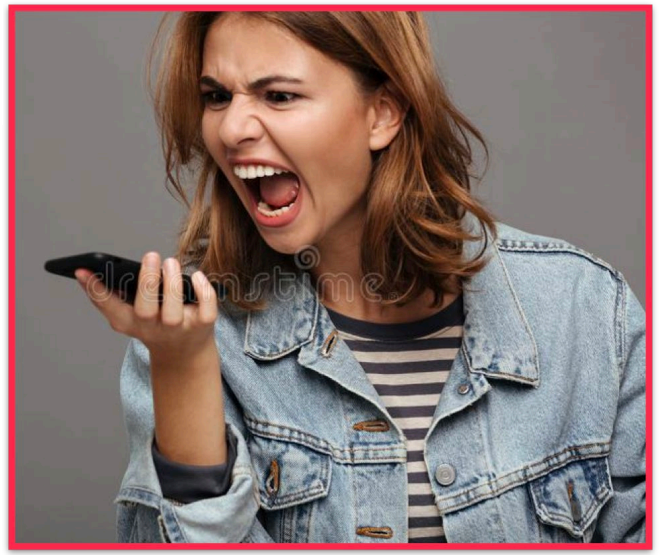
NCCP

Robberies/arrests



Farrell et al., 2015





Dopamine and development

Striatum systems

Reward processing

Elevated in adolescence

(Galvan et al., 2006; Geier et al., 2009)

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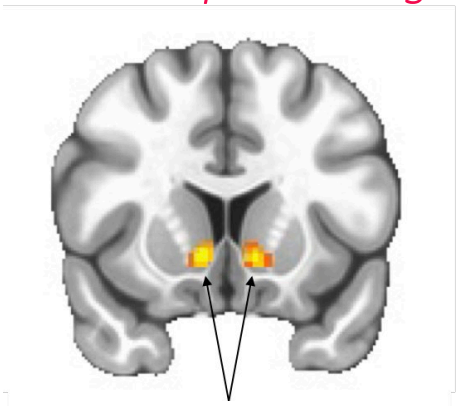

Striatum

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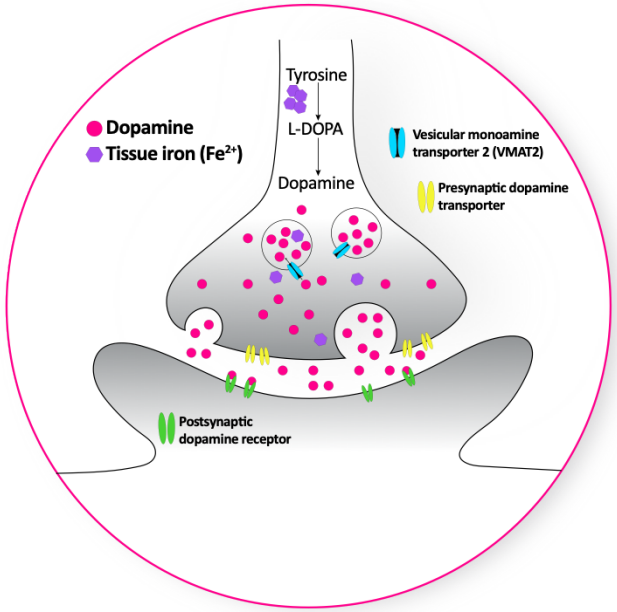

Dopamine: the main neurotransmitter underlying reward function

- ***Imaging dopamine in human adolescence has been limited by restrictions on the use of PET in pediatric populations***

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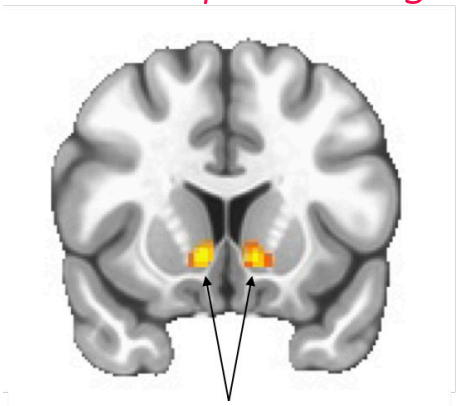

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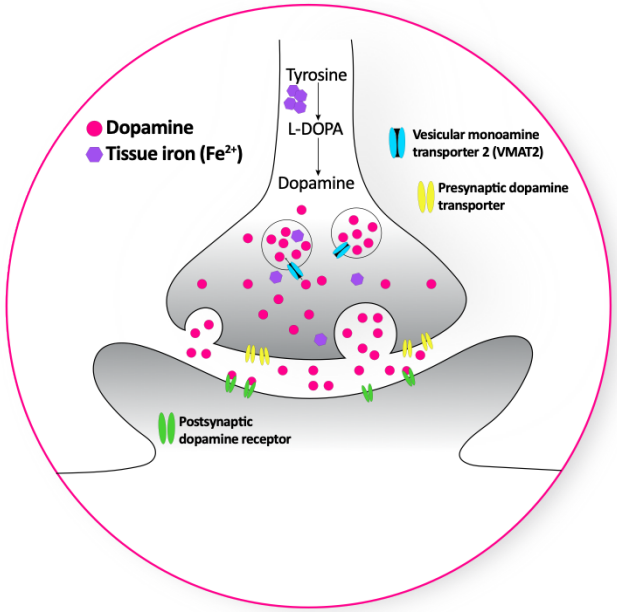

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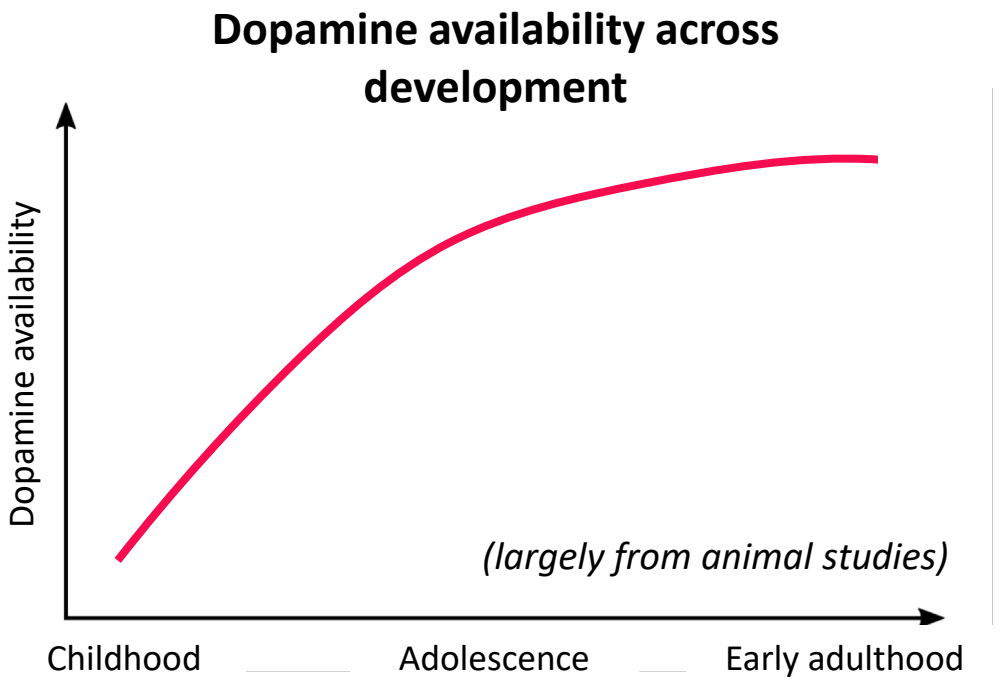

Adapted from Larsen et al., 2020

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Dopamine and development

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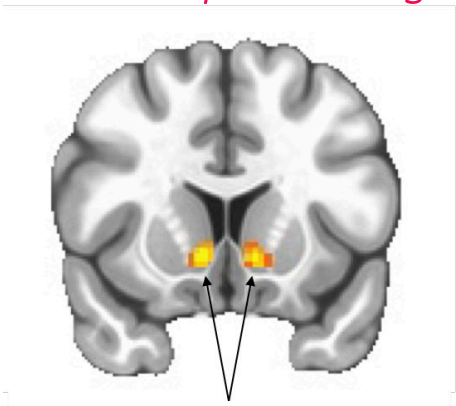

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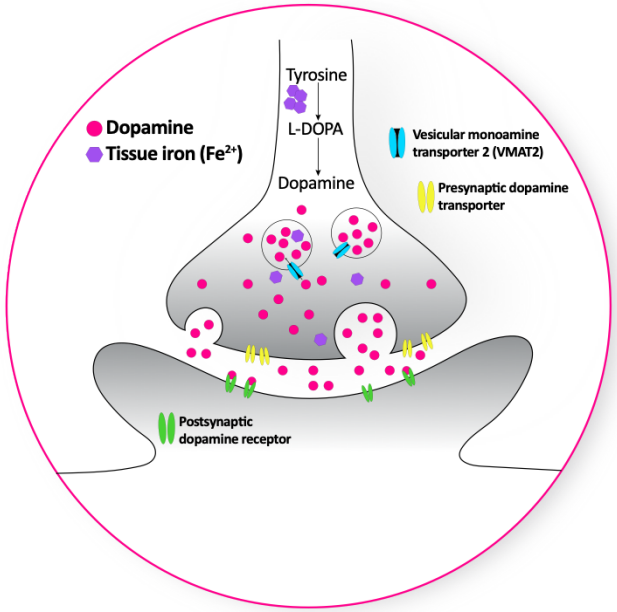

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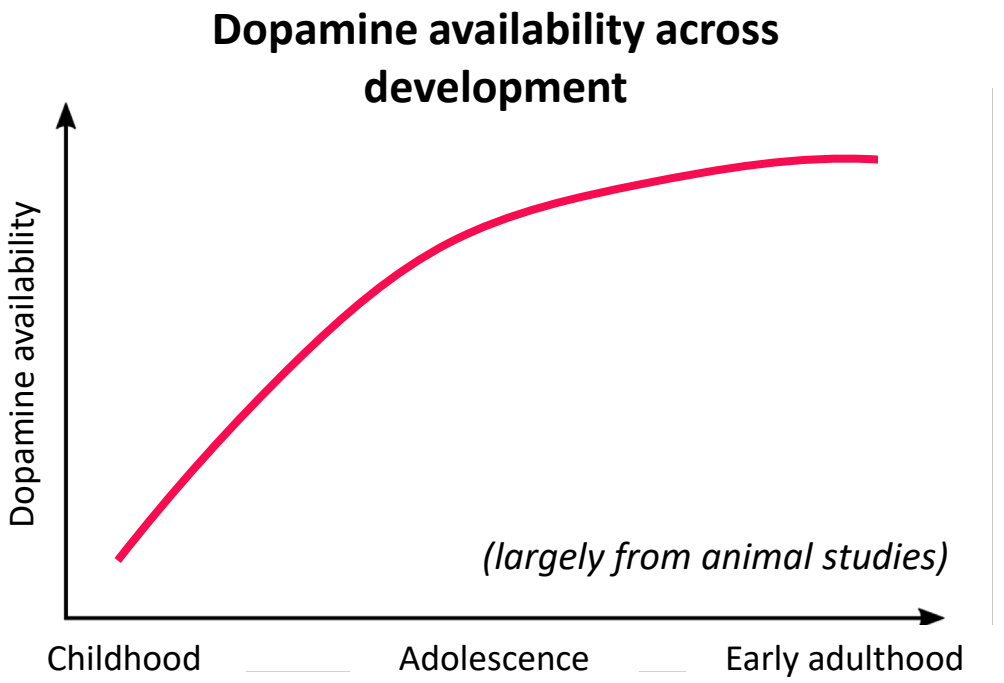
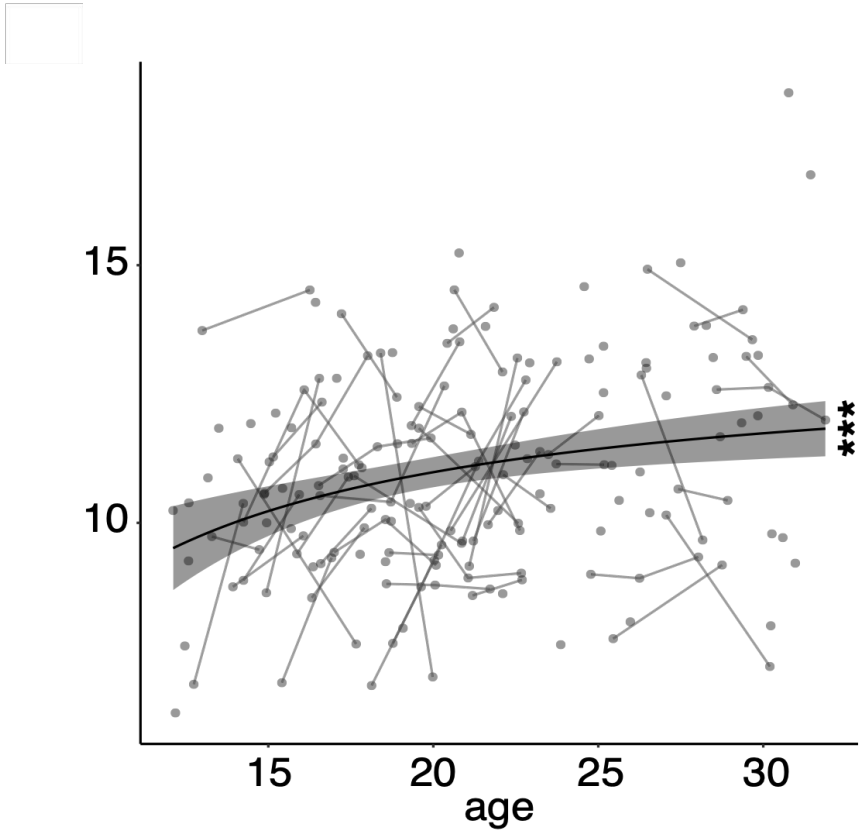


Adapted from Larsen et al., 2020

- ***Imaging dopamine in human adolescence has been limited by restrictions on the use of PET in pediatric populations***
- ***Addressing these limitations, we use brain tissue iron (Ferritin), which is critical for dopamine production, is concentrated in the striatum, and can be measured non-invasively using MRI*** ***(Ortega et al., 2007; Zucca et al., 2017; Connor et al., 1996; Ward et al., 2014)***

Tissue-iron as a marker for dopamine availability



Adolescent sample: N=177, 12-31 YO (1-3 visits each)

Parr et al., 2020, in revision

Tissue iron concentration increases through adolescence, stabilizing into adulthood.

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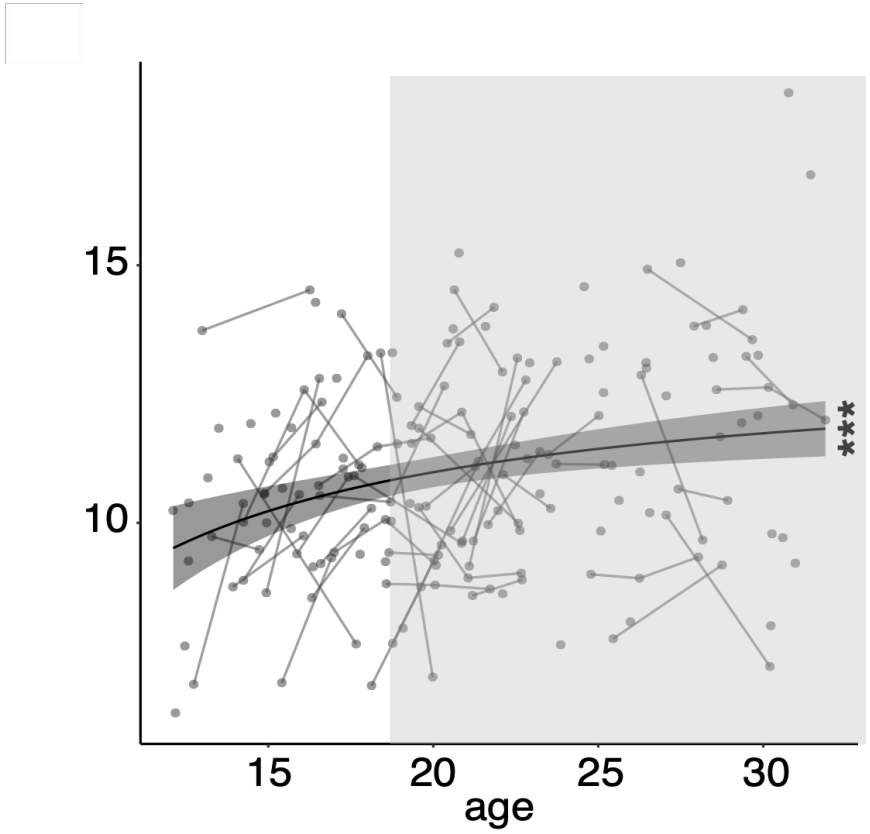

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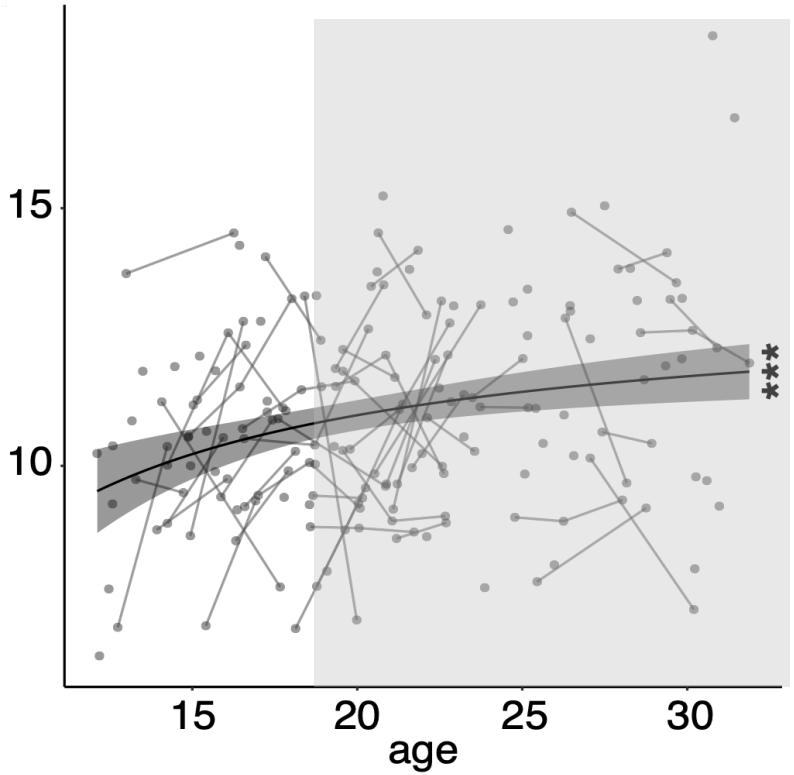

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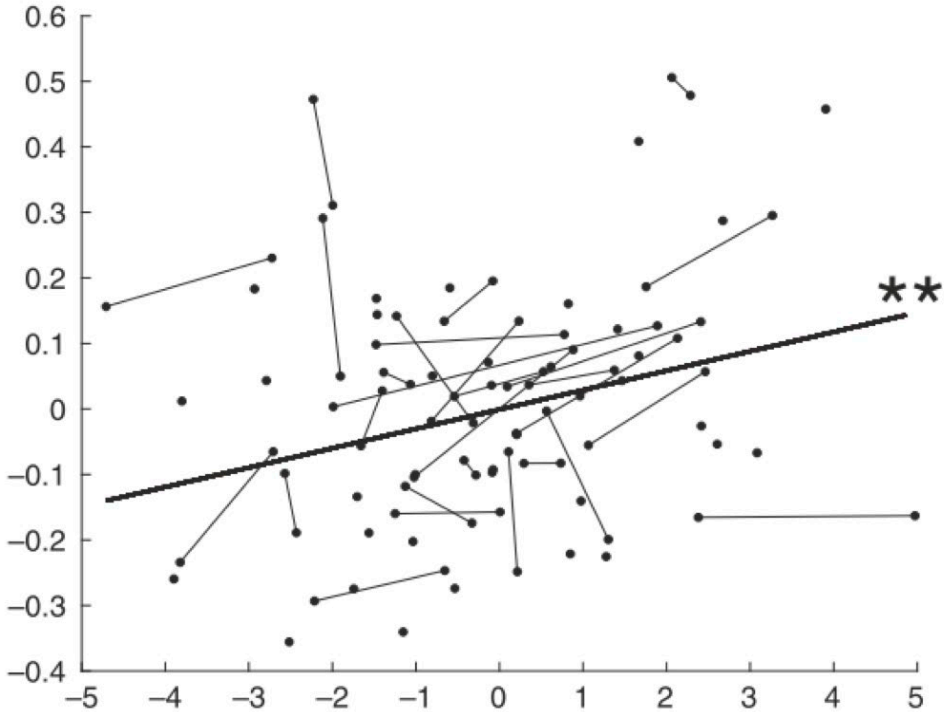

Adult sample: n=80, 18-30 YO (1-2 visits each)

Larsen et al., 2020

Tissue iron concentration increases through adolescence, stabilizing into adulthood.

Tissue iron corresponds most closely to indices of dopamine availability.

Dopamine and development: brain circuitry

- We have recently shown that striatum dopamine (tissue iron) mediates developmental changes in brain connectivity, including communication between the prefrontal cortex and the striatum, which is heightened in adolescents (Parr et al., *in revision*)

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- Increased dopamine function in adolescence, coupled with increased communication between the PFC and the striatum, may reflect a mechanism underlying sensation seeking
- Decreases into adulthood may reflect decreased influence of reward (dopamine and striatum) on prefrontal cortex cognitive function
- ***Hypothesis: Abnormally elevated dopamine function may lead to exacerbated sensation seeking behaviors, reflected as delinquency***

The Adolescent Brain and Cognitive Development Social Development Study (ABCD-SD)

Adolescent Brain Cognitive Development

Teen Brains. Today's Science. Brighter Future.

Does brain function and maturation predict delinquency?

Measure brain function prior to or at onset of delinquency

Late childhood
(9-11 years-old)

Emergence

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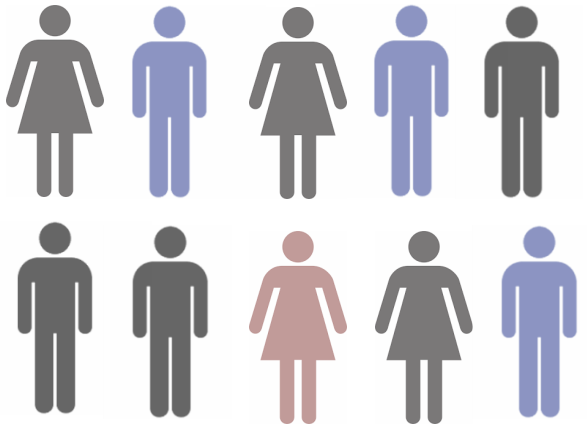

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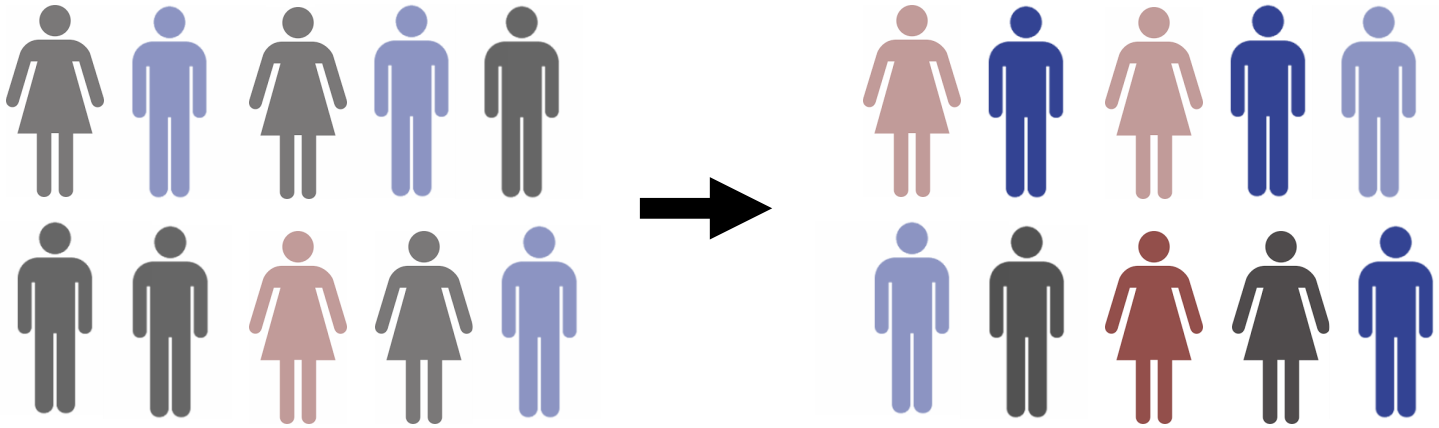

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Adolescence
(12-17 years-old)

Emergence

Potential escalation

Does brain function and maturation predict delinquency?

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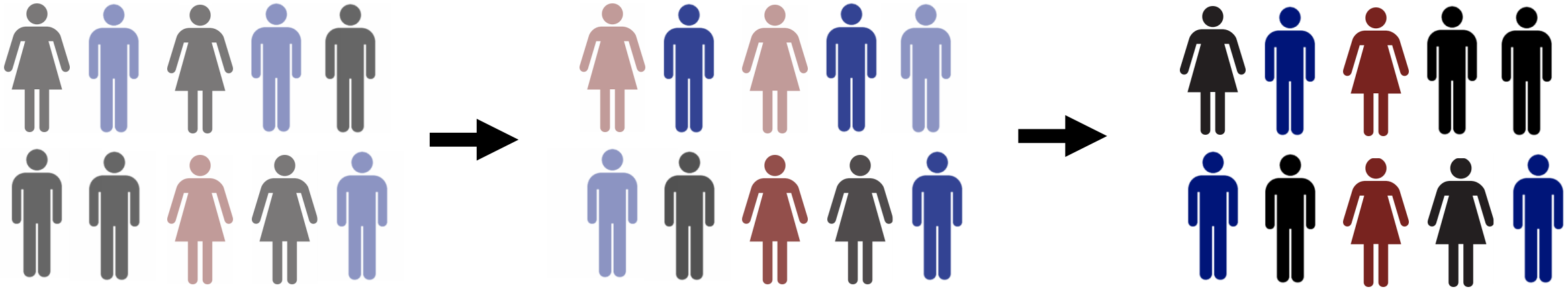
Measure brain function during adolescence

Measure brain function in early adulthood



Late childhood
(9-11 years-old)

Adolescence
(12-17 years-old)

Early adulthood
(18-19 years-old)

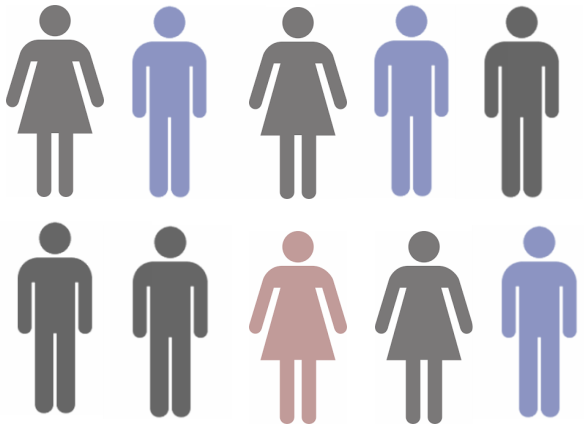
Emergence

Potential escalation

Persistence or desistance

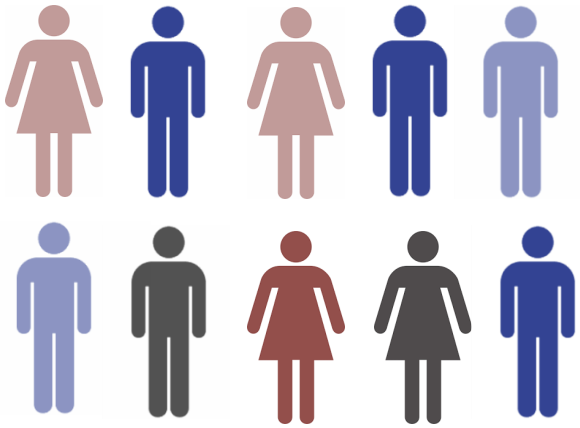
Does brain function and maturation predict delinquency?

1.Does brain function predict the onset of delinquency and victimization?



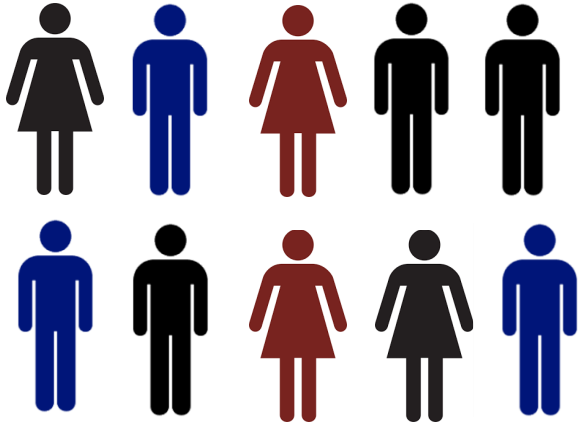
Late childhood
(9-11 years-old)

2. Do brain maturation processes in adolescence predict delinquency and desistance?



Adolescence
(12-17 years-old)

3.Do adolescent behaviors interact with the environment and impact brain maturation itself?



Early adulthood
(18-19 years-old)

Emergence | **Potential escalation** | **Persistence or desistance**

Methods: The ABCD-SD dataset

- Wave 1: Baseline data
  - 586 participants (285 f, age range, 9-11)
  - Balanced for sex and across ethnicities

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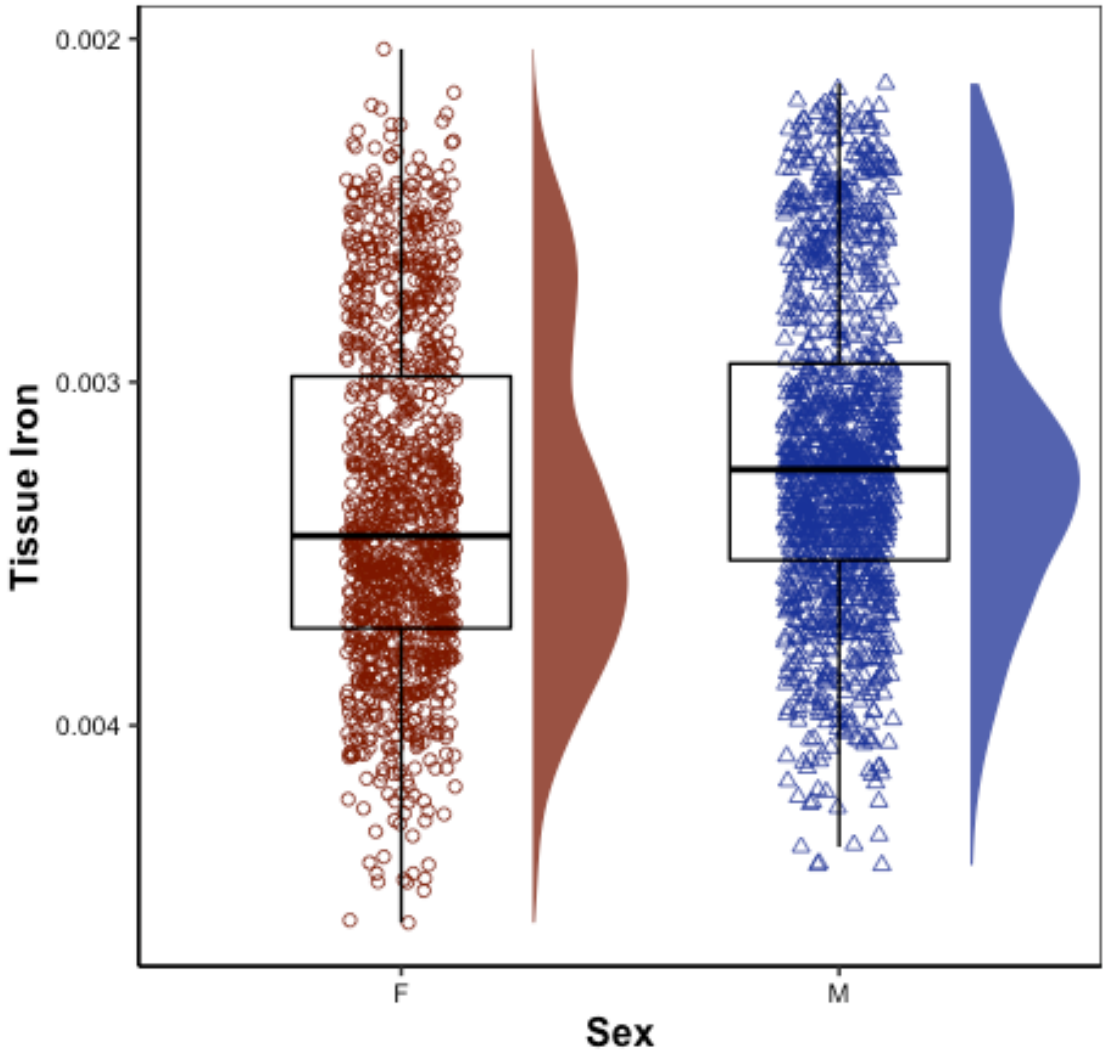
- ABCD-SD measures of delinquency, victimization, personality characteristics (prosociality, callous unemotional traits), psychopathy (YPI), emotional regulation (DERS), and demographic factors (parental education)
- Linear models (LM) included age, sex, and parental education as covariates and tested for interactions with sex

Initial Findings:
Tissue-iron distributions

Males have higher tissue iron as compared to females

* p < .05
** p < .01
*** p < .001



Consistent with Persson et al., 2015 & Bartzokis et al., 2007, but see Peterson et al., 2018

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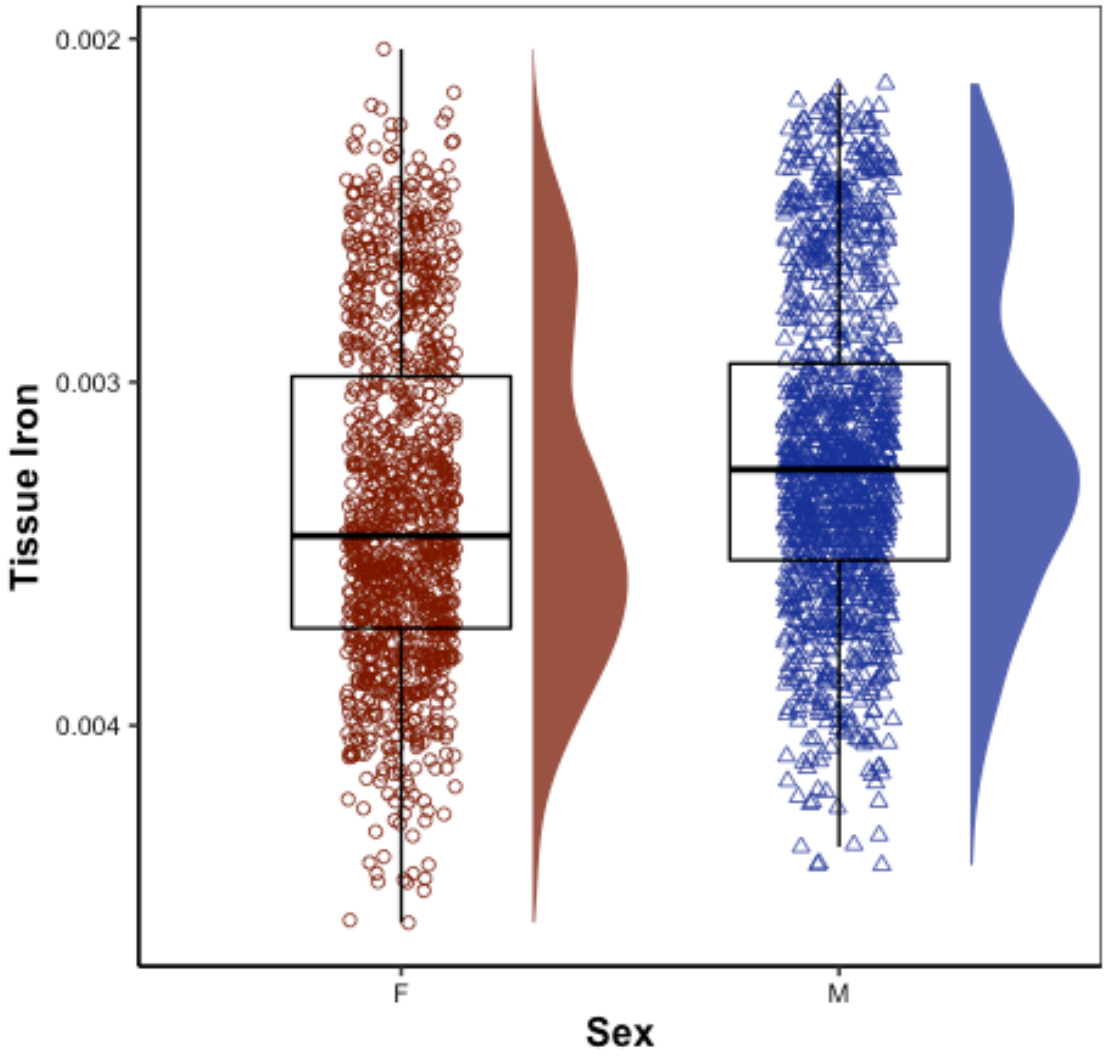

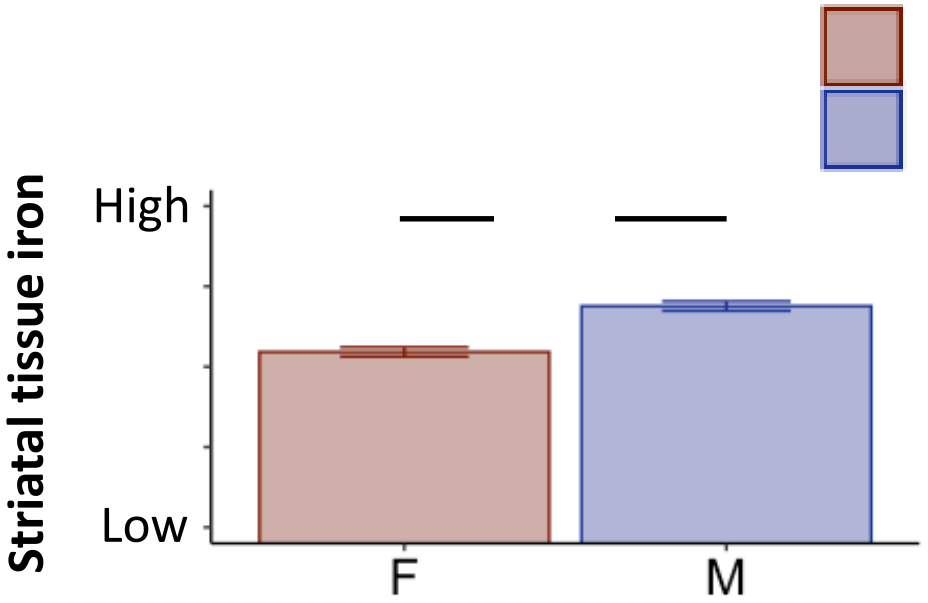

t = -7.62, *p* < .001, *Cohen's D* =.32

Consistent with Persson et al., 2015 & Bartzokis et al., 2007, but see Peterson et al., 2018

Initial Findings:
Associations between high-risk characteristics and tissue iron across genders

In **males**, **lower** striatal tissue iron is associated with **increased** delinquency, psychopathy, and fearlessness

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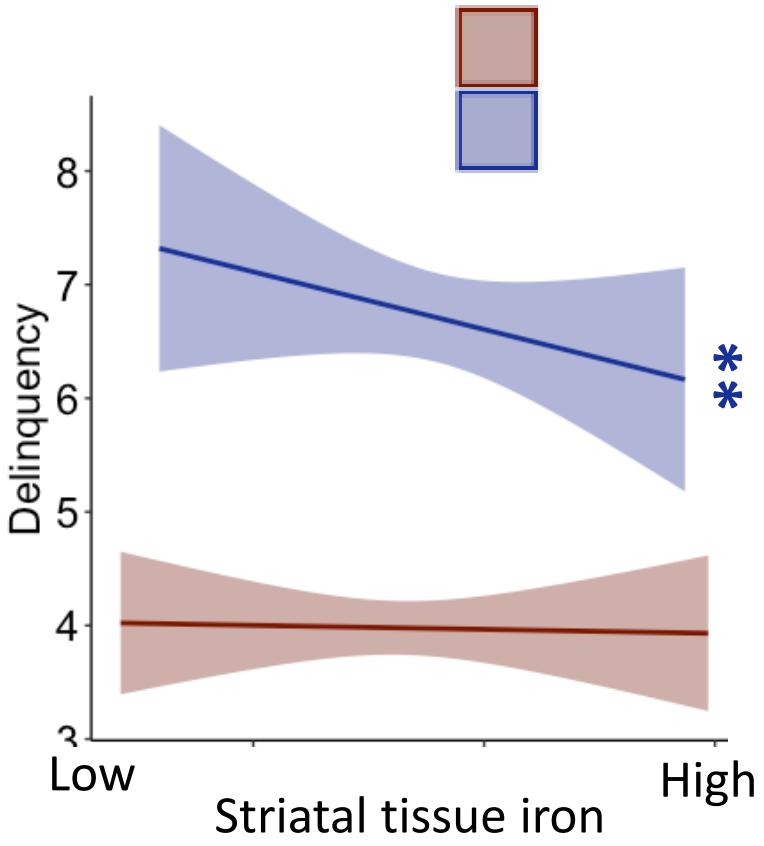

*Vertical axes reflect higher scores on the instruments used to measure each construct

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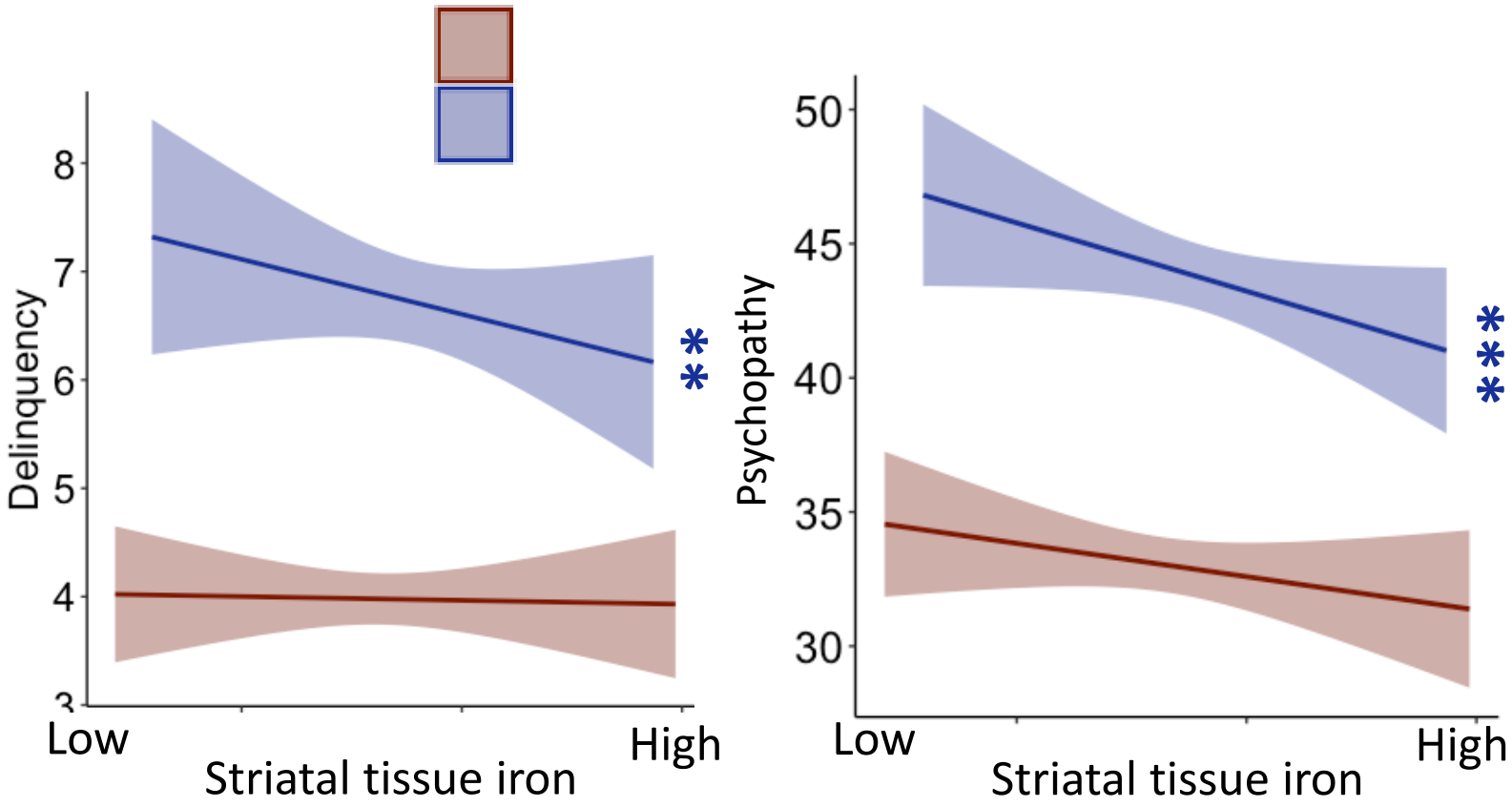

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In **males**, **lower** striatal tissue iron is associated with **increased** delinquency, psychopathy, and fearlessness. No associations found here for **females.**

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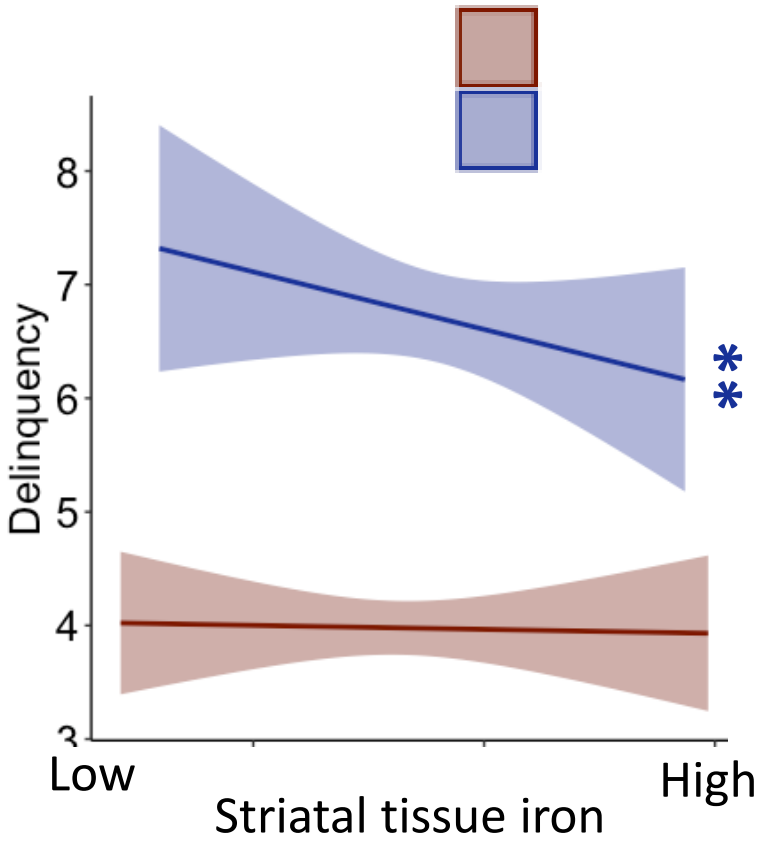
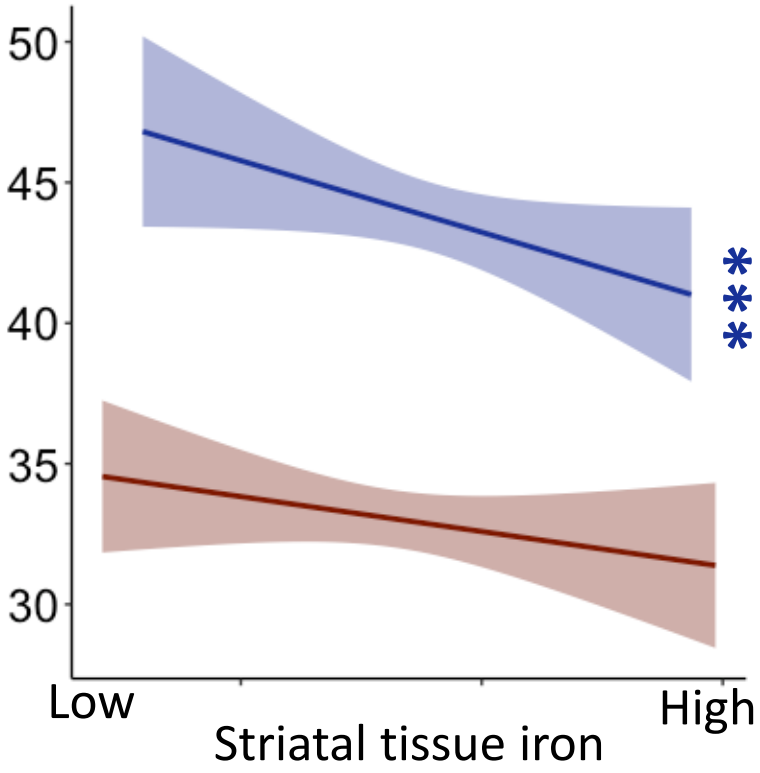
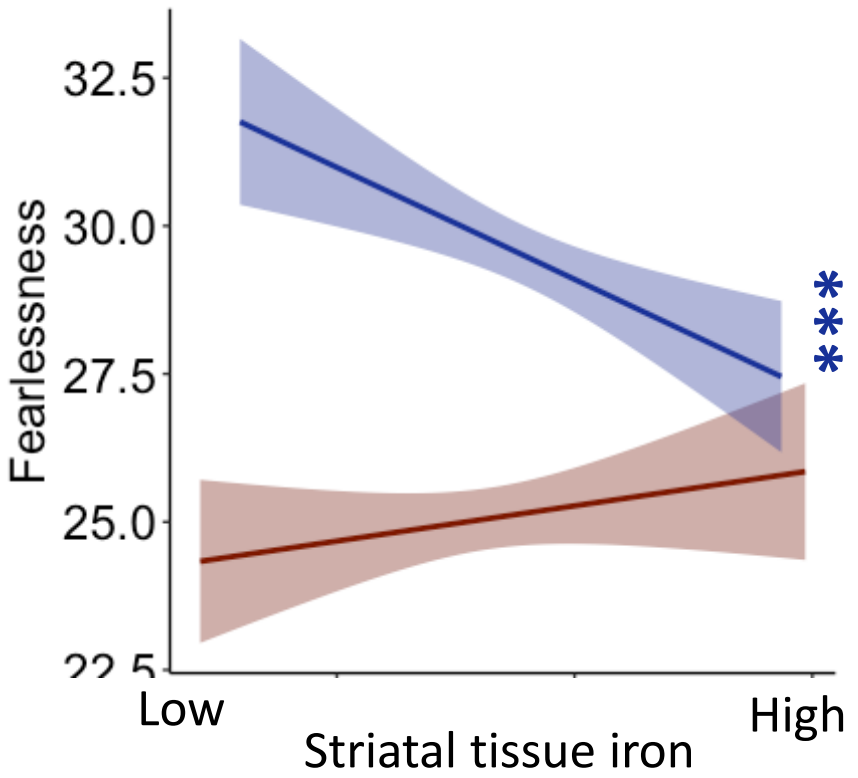


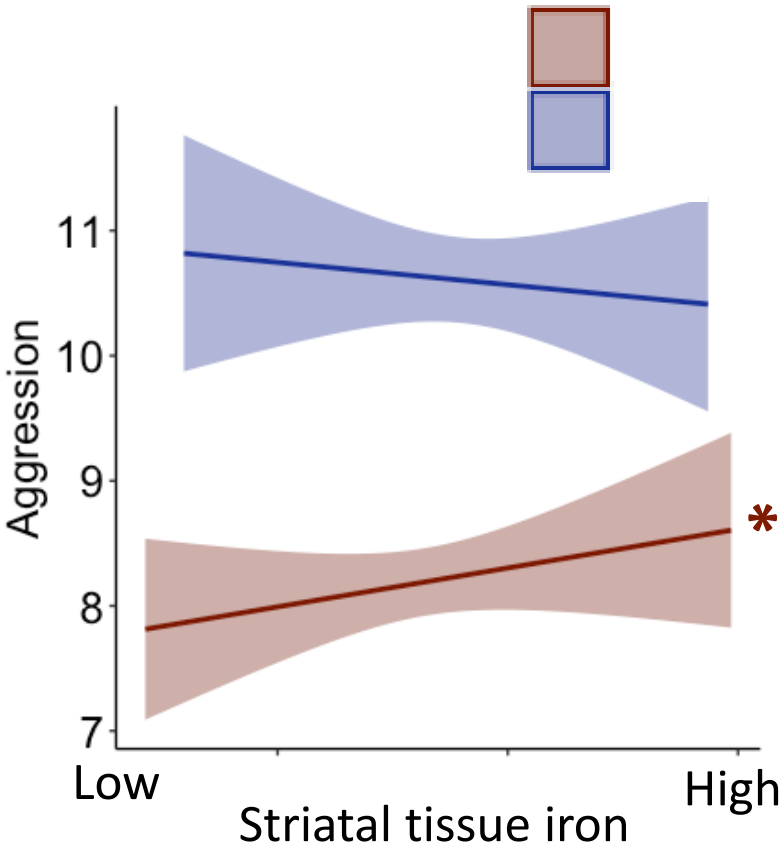




*Vertical axes reflect higher scores on the instruments used to measure each construct

In **females**, **higher** striatal tissue iron is associated with **increased** aggression, victimization, and difficulties in emotional regulation

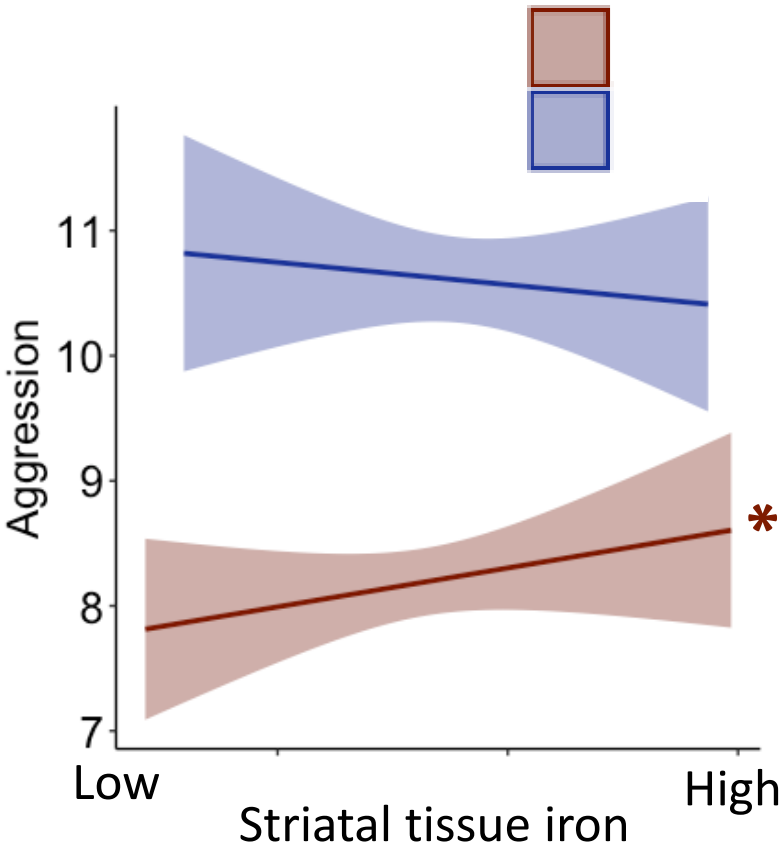
* p < .05
** p < .01
*** p < .001

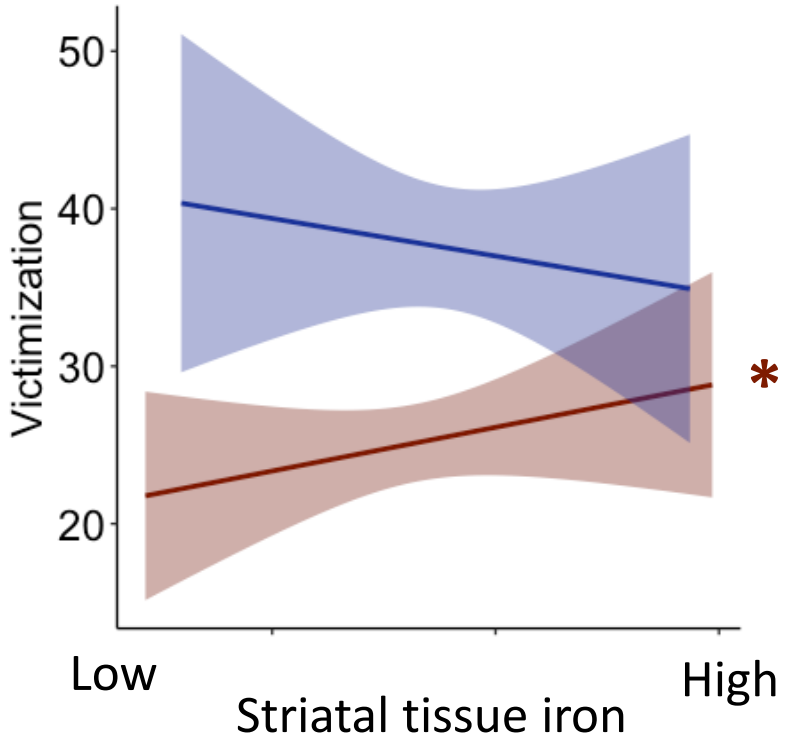


*Vertical axes reflect higher scores on the instruments used to measure each construct

In **females**, **higher** striatal tissue iron is associated with **increased** aggression, victimization, and difficulties in emotional regulation

* p < .05
** p < .01
*** p < .001





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In **females**, **higher** striatal tissue iron is associated with **increased** aggression, victimization, and difficulties in emotional regulation.
No associations found here for males.

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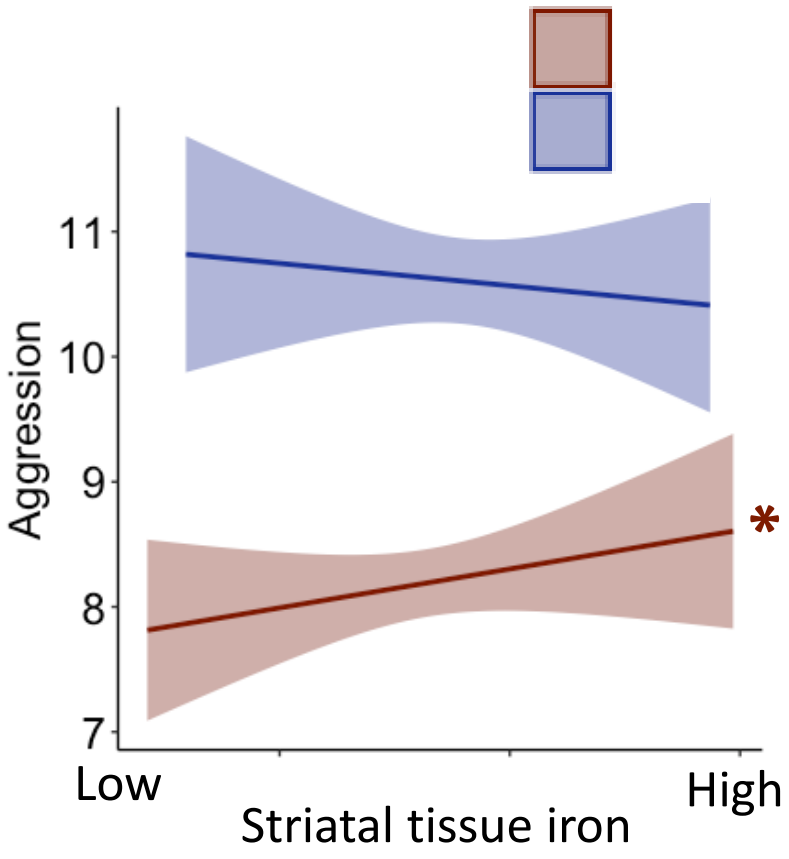

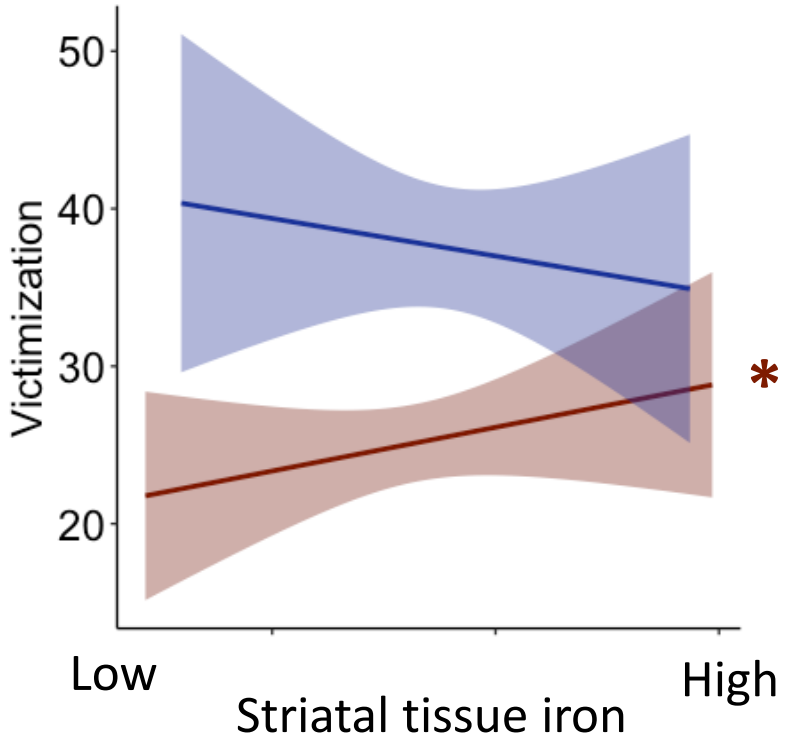

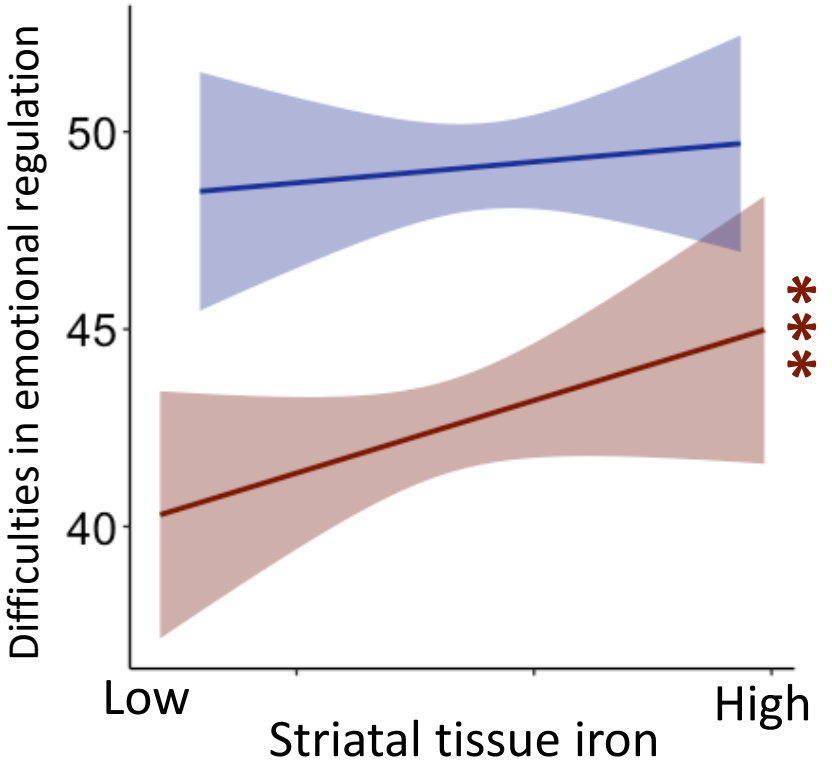

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Variation in striatal tissue iron, reflecting dopamine function, is associated with aspects of delinquency in late childhood

- Males endorse **more** high-risk behaviors (and traits), including delinquency

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- In males, **less** tissue iron corresponds to **higher risk** for:
  - Delinquency, fearlessness, and psychopathy

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*Though speculative, it is possible tissue iron plays an important role in **male delinquency, and female victimization**. Future work will interrogate the specificity of these associations*

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- The first of its kind ABCD-SD dataset will allow us to identify robust associations between brain, development, and the emergence, persistence, and desistance of delinquency and victimization
- Results from the ABCD-SD can inform how we intervene in the lives of high-risk youth, and how to better protect young people from victimization
    - Brain is amenable to change!

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THANK YOU!

Contact: acp73@pitt.edu

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CNBC
Center for the Neural Basis of Cognition

Adolescent Brain Cognitive Development
Teen Brains. Today's Science. Brighter Future.

Thank you
Questions and Answers

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Please submit questions to "**all panelists**" in the **Q&A** box and indicate which presenter the question is for.

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