RECEIVED by MSC 9/27/2024 8:39:40 PM

State of Michigan
In the Supreme Court

The People of the State of Michigan

Plaintiff-Appellee,

v.

Andrew Michael Czarnecki

Defendant-Appellant.

MSC No. 166654

COA No. 348732

Wayne County Circuit Court
Case No. 16-10813-01 FC

Appendix to
Andrew Michael Czarnecki's
Supplemental Brief

Maya Menlo (P82778)
Steven Helton (P78141)
Assistant Defenders

Counsel for Andrew Michael Czarnecki

State Appellate Defender Office 3031
West Grand Boulevard, Suite 450
Detroit, Michigan 48202
Phone: (313) 256-9833
mmenlo@sado.org

Date: September 27, 2024

RECEIVED by MSC 9/27/2024 8:39:40 PM

Index of Appendices

Appendix A Judgment of Sentence

Appendix B Register of Actions for *People v Andrew Czarnecki*, Wayne County Circuit Court Case No. 16-10813-01 FC

Appendix C Register of Actions for *People v Hameer Alkotiat*, Wayne County Circuit Court Case No. 17-004516-01-FC

Appendix D Register of Actions for *People v John Hall*, Wayne County Circuit Court Case No. 67-134610

Appendix E Insel, Tabashneck, et al., *White Paper on the Science of Late Adolescence*, Center for Law, Brain & Behavior (2022)

Appendix F Fair and Just Prosecution, *Young Adults in the Justice System* (2019)

Appendix G Casey et al., *Making the Sentencing Case: Psychological and neuroscientific evidence for expanding the age of youthful offenders*, 5 Ann Rev Criminology 321, 337 (2022)

Appendix H Arain et al, *Maturation of the Adolescent Brain*, 9 Neuropsychiatric Disease & Treatment 449, 450 (2013)

Appendix I National Academies of Sciences, Engineering, and Medicine, *The Promise of Adolescence: Realizing Opportunity for All Youth* (Washington, DC: The National Academies Press, 2019)

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix A
Judgment of Sentence

Approved, SCAO Original – Court Original Court Copy- Corrections Copy- Corrections (for return) 3rd copy – Michigan State Police CJIC 4th copy – Defendant 5th copy - Prosecutor

STATE OF MICHIGAN THIRD JUDICIAL CIRCUIT WAYNE COUNTY	JUDGMENT OF SENTENCE COMMITMENT TO DEPARTMENT OF CORRECTIONS ☐ Amended	CASE NO. 16-010813-01-FC

ORI MI – 821095J Court Address 1441 St. Antoine, Detroit, MI 48226 Courtroom 704 Court Telephone No. 313-224-2120

Police Report No.

THE PEOPLE OF THE STATE OF MICHIGAN

v

Defendant name, address, and telephone no.
Andrew Michael Czarnecki
Alias(es) -
1905 Beard

CTN/TCN	SID	DOB
14702675-01		03/29/1994

Prosecuting attorney name: Jaimie Powell Horowitz Bar no.: 67466

Defendant attorney name: David R. Cripps Bar no.: 34972

THE COURT FINDS:

1. The defendant was found guilty on 12/05/2018 of the crime(s) stated below:

	CONVICTED BY			DISMISSED BY*	CRIME	CHARGE CODE (S) MCL citation/PACC Code
Count	Pleas*	Court	Jury			
1			G		HOMICIDE- MURDER FIRST DEGREE- PREMEDITATED	750.316A
3			G		ROBBERY ARMED	750.529
4			G		DEAD BODIES- DISINTERMENT AND MUTILATION	750.160

*Insert "G" for guilty plea, "NC" for nolo contendere, or "MI" for guilty but mentally ill, "D" for dismissed by court or "NP" for dismissed by prosecutor/plaintiff.

☐ 2. The conviction is reportable to the Secretary of State under MCL 257.625(21)(b).

☐ 3. HIV testing and sex offender registration are completed.

☒ 4. The defendant has been fingerprinted according to MCL 28.243.

☒ 5. A DNA sample is already on file with the Michigan State Police from a previous case. No assessment is required.

Defendant's driver license number _____

IT IS ORDERED:

☐ 6. Probation is revoked.

7. Participating in a special alternative incarceration unit is ☐ prohibited. ☐ permitted.

8. Defendant is sentenced to custody of Michigan Department of Corrections. This sentence shall be executed immediately.

Count	SENTENCE DATE	MINIMUM			MAXIMUM			DATE SENTENCE BEGINS	JAIL CREDIT		OTHER INFORMATION
		Years	Mos.	Days	Years	Mos.	Days		Mos.	Days	
1	12/19/2018	Life without Parole						12/19/2019		750	
3	12/19/2018	11			20			12/19/2018		750	
4	12/19/2018	4 1/2			10			12/19/2018		750	

☐ 9. Sentence(s) to be served consecutively to: (if this item is not checked, the sentence is concurrent)
☐ each other. ☐ case numbers _____

10. The Defendant shall pay:

State Minimum	Crime Victim	Restitution	DNA Assess.	Court Costs	Attorney Fees	Fine	Other Costs	Total
$ 68.00 x 4	$ 130	$	$	$ 1,300	$ 400	$	$	$ 2,102

The due date for payment is **DEC. 19, 2018**. Fine, costs, and fees not paid within 56 days of the due date are subject to a 20% late penalty on the amount owed.

11. The concealed weapon board shall ☐ suspend for ☐ days ☐ permanently revoke the concealed weapon license, permit number _____ issued by _____ County.

☐ 12. The defendant is subject to lifetime monitoring pursuant to MCL 750.520n.

13. **Court recommendation: COUNT 2 VACATED AT SENTENCING. COUNTS 1, 3, & 4 ARE CONCURRENT WITH EACH OTHER.**

DEC. 19, 2018
Date

Judge Michael M. Hathaway 14744
Bar no.

I certify that this is a correct and complete abstract from the original court records. The sheriff shall, without needless delay, deliver defendant to the Michigan Department of Corrections at a place designated by the department.

(SEAL)

Deputy court clerk

MCL 765.15(2), MCL 769.1k, MCL 769.16a, MCL 775.22, MCL 780.766 MCR 6.427

CC 219b-3CC – (6/15) JUDGMENT OF SENTENCE, COMMITMENT TO DEPARTMENT OF CORRECTIONS

RECEIVED by MSC 9/27/2024 8:39:40 PM

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix B
Register of Actions for *People v Andrew Czarnecki*, Wayne County Circuit Court Case No. 16-10813-01 FC

Skip to Main Content Logout My Account Search Menu New Case Search Refine Search Back Location : Criminal Cases Images Web Access Instruction Manual

RECEIVED by MSC 9/27/2024 8:39:40 PM

Register of Actions

Case No. 16-010813-01-FC

State of Michigan v Andrew Michael Czarnecki

Case Type:	**Capital Felonies**
Date Filed:	**12/19/2016**
Location:	**Criminal Division**
Judicial Officer:	**Hathaway, Cynthia Gray**
Case Number History:	**16062124-01**
	14702675-01
Case Tracking Number:	**14702675-01**
CRISNET/Incident No.:	**1307200309**

Related Case Information

Related Cases
17-004516-01-FC (Co Defendant)

Party Information

			Lead Attorneys
Appellate Attorney	**Office, Appellate Defenders**		
Defendant	**Czarnecki, Andrew Michael**	Male Black DOB: 03/29/1994	**David R. Cripps** *Court Appointed* (313) 963-0210(W)
Plaintiff	**State of Michigan**		**Jaimie Powell Horowitz** (248) 691-7440(W)

Charge Information

Charges: Czarnecki, Andrew Michael	**Statute**	**Level**	**Date**
1. Homicide - Murder First Degree - Premeditated	750/316-A	.	07/20/2013
2. Homicide - Felony Murder	750/316-B	.	07/20/2013
3. Dead Bodies - Disinterment & Mutilation	750/160	.	07/20/2013
4. Carjacking	750/529A	.	07/20/2013
5. Robbery - Armed	750/529	.	07/20/2013

Events & Orders of the Court

DISPOSITIONS

11/30/2016 **Plea** (Judicial Officer: Anderson, Charles W., III)
1. Homicide - Murder First Degree - Premeditated
Defendant Stand Mute: Plea of Not Guilty Entered by Court

11/30/2016 **Plea** (Judicial Officer: Anderson, Charles W., III)
2. Homicide - Felony Murder
Defendant Stand Mute: Plea of Not Guilty Entered by Court

11/30/2016 **Plea** (Judicial Officer: Anderson, Charles W., III)
3. Dead Bodies - Disinterment & Mutilation
Defendant Stand Mute: Plea of Not Guilty Entered by Court

11/30/2016 **Plea** (Judicial Officer: Anderson, Charles W., III)
4. Carjacking
Defendant Stand Mute: Plea of Not Guilty Entered by Court

11/30/2016 **Plea** (Judicial Officer: Anderson, Charles W., III)
5. Robbery - Armed
Defendant Stand Mute: Plea of Not Guilty Entered by Court

12/05/2018 **Disposition** (Judicial Officer: Hathaway, Michael M.)
1. Homicide - Murder First Degree - Premeditated
Found Guilty by Jury
2. Homicide - Felony Murder
Found Guilty by Jury
3. Dead Bodies - Disinterment & Mutilation
Found Guilty by Jury
4. Carjacking
Not Guilty by Jury
5. Robbery - Armed

RECEIVED by MSC 9/27/2024 8:39:40 PM

Found Guilty by Jury

12/19/2018 **Sentence** (Judicial Officer: Hathaway, Michael M.)
1. Homicide - Murder First Degree - Premeditated
State Confinement:
Agency: Michigan Department of Corrections
Effective 12/19/2018
Term: Natural Life
Comment: WITHOUT PAROLE

12/19/2018 **Sentence** (Judicial Officer: Hathaway, Michael M.)
3. Dead Bodies - Disinterment & Mutilation
State Confinement:
Agency: Michigan Department of Corrections
Effective 12/19/2018
Term: 4 Yr 6 Mo to 10 Yr
Credit for Time Served: 750 Days

12/19/2018 **Sentence** (Judicial Officer: Hathaway, Michael M.)
5. Robbery - Armed
Fee Totals:

- Crime Victims Fee - (FEL)	$130.00
- State Minimum Cost (FEL)	$204.00
Attorney Fees	$400.00
Court Costs	$1,300.00
Fee Totals $	$2,034.00

State Confinement:
Agency: Michigan Department of Corrections
Effective 12/19/2018
Term: 11 Yr to 20 Yr

12/19/2018 **Amended Disposition** (Judicial Officer: Hathaway, Michael M.) Reason: Other
2. Homicide - Felony Murder
Dismissed

OTHER EVENTS AND HEARINGS

11/23/2016 **Recommendation for Warrant**
11/30/2016 **Arraignment on Warrant** (9:00 AM) (Judicial Officer Anderson, Charles W., III)
Result: Defendant Stands Mute; Plea Of Not Guilty Entered By Court
11/30/2016 **Warrant Signed**
12/07/2016 **Pre Exam Hearing** (9:00 AM) (Judicial Officer Langston, Deborah L)
Result: Held
12/13/2016 **Preliminary Examination** (9:00 AM) (Judicial Officer Langston, Deborah L)
Result: Adjourned at the Request of the Court
12/19/2016 **Preliminary Examination** (9:00 AM) (Judicial Officer Langston, Deborah L)
Result: Held: Bound Over
12/19/2016 **Bound Over**
12/19/2016 **Order For Production Of Exam Transcript Signed and Filed**
Sandra Wilson, 12/19/16 Cap case
12/28/2016 **Arraignment On Information** (9:00 AM) (Judicial Officer Walker, Shannon N.)
Parties Present
Result: Held
12/28/2016 **Disposition Conference** (9:00 AM) (Judicial Officer Walker, Shannon N.)
Parties Present
Result: Held
01/09/2017 **Calendar Conference** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Held
01/09/2017 **Refer To Pre-Trial Services For a Bond Review**
DUE DATE SID# BOND TYPE: BOND AMOUNT: $
01/09/2017 **Order Signed and Filed** (Judicial Officer: Hathaway, Cynthia Gray)
for supplemental discovery S/F
01/26/2017 **Motion Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Held
01/26/2017 **Bond**
Reduction H/ Denied
02/10/2017 **PE PDF Transcript, filed**
Sandra Wilson, 12/19/16 Cap case
Vol./Book 1 254 pages
02/22/2017 **Motion**
02/23/2017 **Motion To Quash Information**
02/23/2017 **Praecipe, Filed** (Judicial Officer: Hathaway, Cynthia Gray)
02/23/2017 **Praecipe, Filed** (Judicial Officer: Hathaway, Cynthia Gray)
02/27/2017 **Final Conference** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: In Progress
02/27/2017 **Motion Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Defendant - DEFENDANT S MOTION FOR ADDITIONAL DISCOVERY

RECEIVED by MSC 9/27/2024 8:39:40 PM

Parties Present
Result: In Progress
02/27/2017 **Motion Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Defendant - Defendant's Motion to Quash and Dismiss
Parties Present
Result: In Progress
03/14/2017 *CANCELED* **Jury Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Adjourned:At The Request Of The Court
Adjourned:At The Request Of The Court
03/16/2017 **Witness List, Filed**
03/16/2017 **Motion in Limine**
03/17/2017 **Motion Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Held
03/17/2017 **Final Conference** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Held
03/17/2017 **Motion To Quash Information**
H/ Denied
03/17/2017 **Motion in Limine**
H/ Granted
04/21/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
Result: In Progress
04/28/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
Result: Held
05/03/2017 **Witness List, Filed**
05/18/2017 **Motion To Adjourn**
05/22/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
Result: Held
08/04/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
Result: In Progress
08/04/2017 **Motion To Consolidate**
w/ 17-4516 (Alkotiat) H/ Granted
08/04/2017 **Motion To Sever Case Or For A Separate Trial**
by APA with 17-4516 (Alkotiat) H/ Granted
09/08/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Held
09/14/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
09/13/2017 Reset by Court to 09/14/2017
Result: Held
09/20/2017 **Notice Of Defense Of Insanity**
09/25/2017 **Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
06/05/2017 Reset by Court to 09/25/2017
Result: Adjourned at the Request of the Defense
09/25/2017 **Order For A Competency Evaluation, Signed and Filed**
09/25/2017 **Order For Criminal Responsibility, Signed and Filed**
01/04/2018 **Competency Report Received**
Forwarded to courtroom.
01/10/2018 **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
11/17/2017 Reset by Court to 12/08/2017
12/08/2017 Reset by Court to 01/26/2018
01/26/2018 Reset by Court to 01/10/2018
Result: In Progress
01/10/2018 **Order For A Competency Evaluation, Signed and Filed**
Independent/ Granted
01/26/2018 *CANCELED* **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Scheduling Error
Scheduling Error
03/02/2018 **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Found Competent
03/02/2018 **Defendant Competent To Stand Trial - Order Signed and Filed**
03/02/2018 **Competency Report Received**
03/15/2018 **Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Result: Adjourned at the Request of the Court
04/13/2018 **Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present

RECEIVED by MSC 9/27/2024 8:39:40 PM

	Result: Held
04/18/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
	Parties Present
	Result: Held
04/18/2018	**Heard And Granted - Order Signed and Filed** (Judicial Officer: Hathaway, Cynthia Gray)
	MOTION TO SCHEDULE A WITNESS
07/30/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
	Parties Present
	Result: Held
10/26/2018	*CANCELED* **Pre-Trial** (9:00 AM) (Judicial Officer Kenny, Timothy M.)
	Adjourned:At The Request Of The Court
	Adjourned:At The Request Of The Court
11/07/2018	**File Sent**
	JD LILLARD FOR M. HATHAWAY TO HEAR CASE
11/13/2018	**Motion**
11/13/2018	**Proof of Service, Filed**
11/16/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Before Judge Michael Hathaway
	Parties Present
	Result: Held
11/16/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Kenny, Timothy M.)
	Parties Present
	Result: Held
11/16/2018	**Motion**
	Motion to adjourn trial denied
11/27/2018	**Jury Trial** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Before Judge Michael Hathaway
	Parties Present
	11/13/2018 Reset by Court to 11/27/2018
	Result: In Progress
11/28/2018	**Jury Trial in Progress** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: In Progress
11/29/2018	**Jury Trial in Progress** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: In Progress
12/03/2018	**Jury Trial in Progress** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: In Progress
12/04/2018	**Jury Trial in Progress** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: In Progress
12/05/2018	**Jury Trial in Progress** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: Held
12/05/2018	**Found Guilty By Jury**
12/19/2018	**Sentencing** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	BEFORE JUDGE MICHAEL HATHAWAY
	Parties Present
	Result: Sentenced
12/19/2018	**Sentenced to Prison Order Signed and Filed**
	LIFE WITHOUT PAROLE ON COUNT 1
04/04/2019	**Motion**
04/22/2019	**Order For Production Of Trial And Sentence Transcript**
	Sherry Scott, PT 11/16/18, JT 11/27/18 - 11/29/18, JT 12/3/18- 12/5/18, SE 12/19/18
04/22/2019	**Stenographer Certificate Required**
	Sherry Scott, PT 11/16/18, JT 11/27/18 - 11/29/18, JT 12/3/18- 12/5/18, SE 12/19/18
04/22/2019	**Order For Production Of Transcript**
	Melissa Harding, CC 1/9/17, MO 1/26/17, MO 2/27/17, MO 3/17/17, PT 4/28/17, PT 5/22/17, PT 8/4/17, PT 9/14/17, PT 9/25/17, CH 1/10/18, CH 3/2/18, PT 3/15/18, PT 4/13/18, PT 4/18/18, PT 7/30/18
04/22/2019	**Stenographer Certificate Required**
	Melissa Harding, CC 1/9/17, MO 1/26/17, MO 2/27/17, MO 3/17/17, PT 4/28/17, PT 5/22/17, PT 8/4/17, PT 9/14/17, PT 9/25/17, CH 1/10/18, CH 3/2/18, PT 3/15/18, PT 4/13/18, PT 4/18/18, PT 7/30/18
04/22/2019	**Order For Production Of Transcript**
	Dorothy Miller, PT 4/21/17
04/22/2019	**Stenographer Certificate Required**
	Dorothy Miller, PT 4/21/17
04/22/2019	**Order For Production Of Transcript**
	Athalia Cargile, AR 12/28/16
04/22/2019	**Stenographer Certificate Required**
	Athalia Cargile, AR 12/28/16
04/22/2019	**Appointment for Claim of Appeal (Circuit)**
	Michael McCarthy appointed
04/25/2019	**Stenographers Certificate Filed**
	Melissa Harding, CC 1/9/17, MO 1/26/17, MO 2/27/17, MO 3/17/17, PT 4/28/17, PT 5/22/17, PT 8/4/17, PT 9/14/17, PT 9/25/17, CH 1/10/18, CH 3/2/18, PT 4/13/18, PT 4/18/18, PT 7/30/18. There is no record to be transcribed 3/15/18.
04/26/2019	**Stenographers Certificate Filed**
	Dorothy Miller, PT 4/21/17

RECEIVED by MSC 9/27/2024 8:39:40 PM

04/29/2019	**Order For Production Of Transcript** *Shedria Blackman, PT 11/16/18*
04/29/2019	**Stenographer Certificate Required** *Shedria Blackman, PT 11/16/18*
04/29/2019	**Stenographers Certificate Filed** *Richard Josephs for Sherry Scott, PT 11/16/18, JT 11/27/18 - 11/29/18, JT 12/3/18- 12/5/18, SE 12/19/18*
05/06/2019	**Stenographers Certificate Filed** *Shedria Blackman, PT 11/16/18*
05/09/2019	**Notice of Transcript Filed** *Shedria Blackman, PT 11/16/18* Vol./Book 1 7 pages
05/14/2019	**Stenographers Certificate Filed** *Athalia Cargile, AR 12/28/16*
05/30/2019	**Notice of Transcript Filed** *Athalia Cargile, AR 12/28/16* Vol./Book 1 6 pages
06/06/2019	**Stenographers Certificate Filed** *Athalia Cargile, AR 12/28/16 Amended to add correct Judge's name*
07/03/2019	**Motion to Withdraw Appellate Counsel & Substitute Granted**
07/03/2019	**File Sent** *File ordered and sent to Court Reporting Services*
07/09/2019	**Notice of Transcript Filed** *Melissa Harding, CC 1/9/17, MO 1/26/17, MO 2/27/17, MO 3/17/17* Vol./Book 4 45 pages
07/09/2019	**Notice of Transcript Filed** *Melissa Harding, 4/28/17 PT, 5/22/17 PT, 8/4/17 PT, 9/14/17 PT, 9/25/17 PT, 1/10/18 PT, 3/2/18, 4/13/18 PT, 4/18/18 PT, 7/30/18 PT* Vol./Book 10 70 pages
07/10/2019	**Attorney Removed - New Attorney Assigned** *Michael McCarthy removed SADO appointed*
07/22/2019	**Stenographers Certificate Filed** *Dorothy Miller, PT 4/21/17 for SADO*
07/29/2019	**Order For Production Of Transcript** *Sandra Wilson, PREXM 12/7/16*
07/29/2019	**Stenographer Certificate Required** *Sandra Wilson, PREXM 12/7/16*
08/02/2019	**Notice of Transcript Filed** *Richard Josephs for Sherry Scott, JT 11/27/18* Vol./Book 1 267 pages
08/02/2019	**Notice of Transcript Filed** *Dorothy Miller, PT 4/21/17* Vol./Book 1 5 pages
08/06/2019	**Notice of Transcript Filed** *Richard Josephs for Sherry Scott, JT 11/28/18* Vol./Book 1 157 pages
08/14/2019	**Notice of Transcript Filed** *Richard Josephs for Sherry Scott, JT 11/29/18* Vol./Book 1 215 pages
08/21/2019	**Stenographers Certificate Filed** *Sandra Wilson, PREXM 12/7/16*
08/28/2019	**Notice of Transcript Filed** *Richard Josephs for Sherry Scott, JT 12/03/18* Vol./Book 1 135 pages
09/05/2019	**Notice of Transcript Filed** *Richard Josephs for Sherry Scott, PT 11/16/18, JT 12/4/18, 12/5/18, SE 12/19/18* Vol./Book 4 194 pages
09/16/2019	**PE PDF Transcript, filed** *Sandra Wilson, PREXM 12/7/16* Vol./Book 1 11 pages
03/17/2020	**Documents Prior to eFiling**
10/30/2023	**Opinion/Order Higher Court Signed and Filed (COA)**

Financial Information

	Defendant Czarnecki, Andrew Michael			
	Total Financial Assessment			2,442.00
	Total Payments and Credits			2,442.00
	Balance Due as of 09/26/2024			**0.00**
12/19/2018	Transaction Assessment			2,034.00
02/14/2019	Transaction Assessment			340.00
06/23/2020	Mail Payment	Receipt # 2020-41757	Czarnecki, Andrew Michael	(117.59)
12/14/2020	Mail Payment	Receipt # 2020-94691	Czarnecki, Andrew Michael	(89.29)
01/12/2021	Mail Payment	Receipt # 2021-03112	Czarnecki, Andrew Michael	(3.28)
01/21/2021	Mail Payment	Receipt # 2021-06057	Czarnecki, Andrew Michael	(23.53)
11/03/2021	Mail Payment	Receipt # 2021-86527	Czarnecki, Andrew Michael	(25.00)
11/19/2021	Mail Payment	Receipt # 2021-94735	Czarnecki, Andrew Michael	(30.00)
11/19/2021	Mail Payment	Receipt # 2021-94751	Czarnecki, Andrew Michael	(58.08)
11/19/2021	Mail Payment	Receipt # 2021-94845	Czarnecki, Andrew Michael	(700.02)
12/07/2021	Mail Payment	Receipt # 2021-100026	Czarnecki, Andrew Michael	(172.48)
01/28/2022	Mail Payment	Receipt # 2022-07406	Czarnecki, Andrew Michael	(103.10)
03/23/2022	Mail Payment	Receipt # 2022-21065	Czarnecki, Andrew Michael	(149.60)

05/17/2022	Mail Payment	Receipt # 2022-35656	Czarnecki, Andrew Michael	(131.76)
05/28/2022	Mail Payment	Receipt # 2022-38327	Czarnecki, Andrew Michael	(109.17)
09/21/2022	Mail Payment	Receipt # 2022-66973	Czarnecki, Andrew Michael	(121.11)
04/12/2023	Mail Payment	Receipt # 2023-24633	Czarnecki, Andrew Michael	(111.51)
05/10/2023	Mail Payment	Receipt # 2023-32016	Czarnecki, Andrew Michael	(114.32)
09/18/2023	Mail Payment	Receipt # 2023-64849	Czarnecki, Andrew Michael	(115.42)
01/16/2024	Mail Payment	Receipt # 2024-03435	Czarnecki, Andrew Michael	(102.99)
05/23/2024	Mail Payment	Receipt # 2024-37223	Czarnecki, Andrew Michael	(138.50)
05/29/2024	Mail Payment	Receipt # 2024-38312	Czarnecki, Andrew Michael	(25.25)

Payment Link www.allpaid.com

RECEIVED by MSC 9/27/2024 8:39:40 PM

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix C
Register of Actions for *People v Hameer Alkotiat*, Wayne County Circuit Court Case No. 17-004516-01-FC

Skip to Main Content Logout My Account Search Menu New Case Search Refine Search Back Location : Criminal Cases Images Web Access Instruction Manual

RECEIVED by MSC 9/27/2024 8:39:40 PM

Register of Actions

Case No. 17-004516-01-FC

Related Case Information

Related Cases
16-010813-01-FC (Co Defendant)

Party Information

Defendant	**Alkotiat, Hameer**	**Attorneys** **Amir I. Makled** *Retained* (313) 788-8888(W) Attorney Unreported *Retained* Lillian F. Diallo *Court Appointed* (313) 965-6633(W)
Plaintiff	**State of Michigan**	**Jaimie Powell Horowitz** (248) 691-7440(W)

Charge Information

Charges: Alkotiat, Hameer	**Statute**	**Level**	**Date**
1. Homicide - Murder First Degree - Premeditated	750/316-A	.	07/20/2013
1. Homicide - Murder - Second Degree	750317	.	07/10/2013
2. Homicide - Felony Murder	750/316-B	.	07/20/2013
3. Dead Bodies - Disinterment & Mutilation	750/160	.	07/20/2013
4. Robbery - Armed	750/529	.	07/10/2016
5. Carjacking	750/529A	.	07/10/2016

Events & Orders of the Court

DISPOSITIONS

04/26/2017 **Plea** (Judicial Officer: Anderson, Charles W., III)
1. Homicide - Murder First Degree - Premeditated
Defendant Stand Mute: Plea of Not Guilty Entered by Court

04/26/2017 **Plea** (Judicial Officer: Anderson, Charles W., III)
2. Homicide - Felony Murder
Defendant Stand Mute: Plea of Not Guilty Entered by Court

04/26/2017 **Plea** (Judicial Officer: Anderson, Charles W., III)
3. Dead Bodies - Disinterment & Mutilation
Defendant Stand Mute: Plea of Not Guilty Entered by Court

04/26/2017 **Plea** (Judicial Officer: Anderson, Charles W., III)
4. Robbery - Armed
Defendant Stand Mute: Plea of Not Guilty Entered by Court

04/26/2017 **Plea** (Judicial Officer: Anderson, Charles W., III)
5. Carjacking
Defendant Stand Mute: Plea of Not Guilty Entered by Court

02/19/2019 **Disposition** (Judicial Officer: Hathaway, Michael M.)
1. Homicide - Murder First Degree - Premeditated
Dismissed - Plea Reduction
2. Homicide - Felony Murder
Dismissed
3. Dead Bodies - Disinterment & Mutilation
Dismissed
4. Robbery - Armed
Dismissed
5. Carjacking
Dismissed

02/19/2019 **Disposition** (Judicial Officer: Hathaway, Michael M.)
1. Homicide - Murder - Second Degree
Pled Guilty

RECEIVED by MSC 9/27/2024 8:39:40 PM

03/06/2019 **Sentence** (Judicial Officer: Hathaway, Michael M.)
1. Homicide - Murder - Second Degree

Fee Totals:	
- Crime Victims Fee - (FEL)	$130.00
- State Minimum Cost (FEL)	$68.00
Court Costs	$1,300.00
Fee Totals $	$1,498.00

State Confinement:
Agency: Michigan Department of Corrections
Effective 03/06/2019
Term: 18 Yr to 20 Yr
Credit for Time Served: 679 Days

OTHER EVENTS AND HEARINGS

11/23/2016 **Recommendation for Warrant**
11/30/2016 **Warrant Signed**
04/26/2017 **Arraignment on Warrant** (9:00 AM) (Judicial Officer Anderson, Charles W., III)
Result: Defendant Stands Mute; Plea Of Not Guilty Entered By Court
05/09/2017 **Pre Exam Hearing** (9:00 AM) (Judicial Officer Langston, Deborah L)
Result: Held
05/16/2017 **Preliminary Examination** (9:00 AM) (Judicial Officer Langston, Deborah L)
Result: Adjourned at the Request of the Court
05/25/2017 **Preliminary Examination** (9:00 AM) (Judicial Officer Langston, Deborah L)
Result: Held: Bound Over
05/25/2017 **Bound Over**
06/01/2017 **Arraignment On Information** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
Result: Held
06/01/2017 **Calendar Conference** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
Result: Held
06/02/2017 **Order For Production Of Exam Transcript Signed and Filed**
07/10/2017 **Motion**
07/10/2017 **Motion**
07/19/2017 **PE PDF Transcript, filed**
Vol./Book 1 153 pages
08/04/2017 **Final Conference** (9:00 AM) (Judicial Officer Roberson, Dalton A)
Parties Present
07/20/2017 Reset by Court to 08/04/2017
Result: In Progress
08/04/2017 **Motion To Consolidate**
08/04/2017 **Motion To Sever Case Or For A Separate Trial**
09/07/2017 **Final Conference** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
09/01/2017 Reset by Court to 09/08/2017
09/08/2017 Reset by Court to 09/07/2017
Result: In Progress
09/14/2017 **Final Conference** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Adjourned at the Request of the Defense
09/14/2017 **Order For A Competency Evaluation, Signed and Filed**
09/14/2017 **Order For Criminal Responsibility, Signed and Filed**
09/25/2017 *CANCELED* **Jury Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Adjourned:At The Request Of The Court
01/09/2018 **Report Received**
01/09/2018 **Competency Report Received**
01/10/2018 **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
10/30/2017 Reset by Court to 11/16/2017
11/16/2017 Reset by Court to 12/06/2017
12/06/2017 Reset by Court to 01/26/2018
01/26/2018 Reset by Court to 01/10/2018
Result: In Progress
01/10/2018 **Order For A Competency Evaluation, Signed and Filed**
01/26/2018 *CANCELED* **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Scheduling Error
03/02/2018 **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Continued
03/15/2018 **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
Parties Present
Result: Adjourned at the Request of the Court
04/13/2018 **Competency Hearing** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)

RECEIVED by MSC 9/27/2024 8:39:40 PM

	Parties Present
	Result: Held
04/13/2018	**Defendant Competent To Stand Trial - Order Signed and Filed**
04/13/2018	**Waiver of Trial By Jury - Order Signed and Filed** (Judicial Officer: Hathaway, Cynthia Gray)
04/13/2018	**Competency Report Received**
07/11/2018	**Witness List, Filed**
07/11/2018	**Proof of Service, Filed**
07/30/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
	Parties Present
	Result: Held
07/30/2018	**Attorney Stand In**
10/19/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Viviano, Antonio P)
	Parties Present
	Result: Held
10/23/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Kenny, Timothy M.)
	Result: Adjourned at the Request of the Court
10/26/2018	*CANCELED* **Pre-Trial** (9:00 AM) (Judicial Officer Kenny, Timothy M.)
	Adjourned:At The Request Of The Court
11/07/2018	**File Sent**
11/16/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: Held
11/16/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Kenny, Timothy M.)
	Parties Present
	Result: Held
11/16/2018	**Motion**
11/27/2018	*CANCELED* **Jury Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
	Adjourned:At The Request Of The Court
	11/13/2018 Reset by Court to 11/27/2018
12/19/2018	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	12/14/2018 Reset by Court to 12/19/2018
	Result: Held
12/19/2018	**Appearance By A Retained Attorney Filed**
02/19/2019	**Pre-Trial** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	02/06/2019 Reset by Court to 02/19/2019
	Result: Plea Entered and Accepted
02/19/2019	**Plea of Guilty Accepted**
02/19/2019	**Refer to Probation For Pre-Sentence Report**
03/06/2019	*CANCELED* **Jury Trial** (9:00 AM) (Judicial Officer Hathaway, Cynthia Gray)
	Case Disposed/Order Previously Entered
03/06/2019	**Sentencing** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
	Parties Present
	Result: Sentenced
03/06/2019	**Sentenced to Prison Order Signed and Filed**
07/14/2020	**Motion**
07/22/2020	**Heard And Granted - Order Signed and Filed** (Judicial Officer: Williams-Claybourne, Darnella D.)
12/14/2020	**Order For Production Of Transcript**
12/14/2020	**Order For Production Of Transcript**
12/14/2020	**Order For Production Of Transcript**
12/16/2020	**Stenographers Certificate Filed**
01/12/2021	**Notice of Transcript Filed**
	Vol./Book 2 20 pages
01/12/2021	**Notice of Transcript Filed**
	Vol./Book 10
01/13/2021	**File Sent**
03/08/2021	**Motion**

Financial Information

To pay on Adult Criminal cases CLICK HERE

	Defendant Alkotiat, Hameer			
	Total Financial Assessment			2,111.50
	Total Payments and Credits			2,111.50
	Balance Due as of 09/26/2024			**0.00**
03/06/2019	Transaction Assessment			1,498.00
05/02/2019	Transaction Assessment			260.00
05/30/2019	Mail Payment	Receipt # 2019-44921	Alkotiat, Hameer	(100.00)
11/08/2019	Mail Payment	Receipt # 2019-93240	Alkotiat, Hameer	(181.00)
01/06/2020	Mail Payment	Receipt # 2020-01275	Alkotiat, Hameer	(138.50)
02/04/2020	Mail Payment	Receipt # 2020-10593	Alkotiat, Hameer	(163.00)
04/02/2020	Mail Payment	Receipt # 2020-26278	Alkotiat, Hameer	(175.50)
06/10/2020	Mail Payment	Receipt # 2020-38402	Alkotiat, Hameer	(1,000.00)

06/25/2020	Transaction Assessment			198.50
06/25/2020	Mail Payment	Receipt # 2020-42541	Alkotiat, Hameer	(198.50)
07/14/2020	Transaction Assessment			155.00
07/14/2020	Mail Payment	Receipt # 2020-46966	Alkotiat, Hameer	(155.00)

RECEIVED by MSC 9/27/2024 8:39:40 PM

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix D
Register of Actions for *People v John Hall*, Wayne County Circuit Court Case No. 67-134610

Skip to Main Content Logout My Account Search Menu New Case Search Refine Search Back Location : Criminal Cases Web Access Instruction Manual

RECEIVED by MSC 9/27/2024 8:39:40 PM

Register of Actions
Case No. 67-134610

Party Information

Defendant	**Hall, John Sam**	**Attorneys** **Valerie R. Newman** *Retained* (313) 967-2684(W)
Plaintiff	**State of Michigan**	**Eric Sterbis** (313) 456-0085(W)

Charge Information

Charges: Hall, John Sam	**Statute**	**Level**	**Date**
1. First Degree Murder	750316	.	01/13/1967

Events & Orders of the Court

DISPOSITIONS

11/22/1967 **Disposition** (Judicial Officer: Kaufman, Charles)
1. First Degree Murder
Found Guilty by Jury

11/22/1967 **Sentence** (Judicial Officer: Kaufman, Charles)
1. First Degree Murder
State Confinement:
Agency: Michigan Department of Corrections
Effective 11/22/1967
Term: Life

09/16/2016 **Amended Sentence** (Judicial Officer: Kaufman, Charles) Reason: Re Sentence
1. First Degree Murder
State Confinement:
Agency: Michigan Department of Corrections
Effective 09/16/2016
Term: 40 Yr to 60 Yr

OTHER EVENTS AND HEARINGS

06/19/2013 **Motion For Relief From Judgment**
10/15/2013 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
10/16/2013 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
10/18/2013 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
11/08/2013 **Order Signed and Filed** (Judicial Officer: Hathaway, Michael M.)
12/19/2013 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
02/21/2014 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
02/27/2014 *CANCELED* **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Adjourned:At The Request Of The Court
03/06/2014 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
03/20/2014 *CANCELED* **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Adjourned:At The Request Of The Court
06/13/2014 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
05/02/2014 Reset by Court to 06/13/2014
Result: Adjourned at the Request of the Court
06/20/2014 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Result: Adjourned at the Request of the Court
07/11/2014 *CANCELED* **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Adjourned:At The Request Of The Court
07/31/2014 **Order Denying Motion for Relief from Judgment - S/F** (Judicial Officer: Hathaway, Michael M.)
08/29/2014 *CANCELED* **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Case Disposed/Order Previously Entered
09/16/2016 **Post Conviction** (9:00 AM) (Judicial Officer Hathaway, Michael M.)
Parties Present
Result: Held

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix E
Insel, Tabashneck, et al., *White Paper on the Science of Late Adolescence*, Center for Law, Brain & Behavior (2022)

RECEIVED by MSC 9/27/2024 8:39:40 PM

White Paper on the Science of Late Adolescence

A Guide for Judges, Attorneys, and Policy Makers

Neuroscience continues to be a rapidly evolving domain of research. This document reflects at the time it was produced the mainstream of developmental neuroscience of adolescence, late adolescence, and emerging young adulthood.

Contact
Robert Kinscherff, Ph.D., J.D., CLBB Executive Director
MGH Center for Law, Brain & Behavior
Department of Psychiatry
55 Fruit Street, Bulfinch 351
Boston, Massachusetts 02114

CLBB contact information: (617) 237-0656, contact@clbb.org, clbb.mgh.harvard.edu

© All rights reserved 2022

Note
This document and portions of this document may be used with proper attribution and without prior CLBB permission for use in legal briefs, policy briefing documents, professional articles,educational materials, or other professional purposes.

CENTER FOR LAW BRAIN & BEHAVIOR
MASSACHUSETTS GENERAL HOSPITAL
Mass General Brigham
HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

RECEIVED by MSC 9/27/2024 8:39:40 PM

Authorship and Acknowledgements

Center for Law, Brain & Behavior White Paper Project Team

Catherine Insel,* PhD
Postdoctoral Research Fellow, Zuckerman Institute, Columbia University

Stephanie Tabashneck,* PsyD, JD
Forensic Psychologist; 2022 Senior Fellow in Law and Applied Neuroscience, joint Fellowship of CLBB and Petrie Flom Center, Harvard Law School

Francis X. Shen, JD, PhD
Professor of Law and McKnight Presidential Fellow, University of Minnesota Law School; CLBB Faculty Member

Judith G. Edersheim, JD, MD
Attending Psychiatrist, Massachusetts General Hospital; Assistant Professor of Psychiatry, Harvard Medical School; CLBB Founder and Co-Director

Robert T. Kinscherff, PhD, JD
Professor, Doctoral Clinical Psychology Program at William James College; CLBB Executive Director

***First authors**

Manuscript Reviewers

Arielle Baskin-Sommers, PhD
Associate Professor of Psychology and of Psychiatry, Yale University

Mariah Bellamoroso
Student, Harvard Law School

Lisa Feldman Barrett, PhD
University Distinguished Professor of Psychology, Northeastern University; CLBB Chief Scientific Officer

Hon. Jay D. Blitzman, JD
First Justice-Massachusetts Juvenile Court, Middlesex Division (Ret.); CLBB Faculty Member

BJ Casey, PhD
Professor of Psychology, Affiliated Professor of the Justice Collaboratory and Interdepartmental Neuroscience Program, Director of the Fundamentals of the Adolescent Brain Laboratory, Yale University

Alexandra Cohen, PhD
Postdoctoral Fellow, Department of Psychology and Center for Neural Science, New York University

Adriana Galván, PhD
Professor, Jeffrey Wenzel Term Chair in Behavioral Neuroscience, Department of Psychology, University of California at Los Angeles

Melanie Grad-Freilich, BS
Lab Manager for the Affective Neuroscience and Development Lab, Harvard University

Hon. Nancy Gertner, JD, MA
Senior Lecturer on Law, Harvard Law School; Judge (Ret.), United States District Court for the District of Massachusetts; CLBB Managing Director

Adam Haar Horowitz, PhD Candidate
Massachusetts Institute of Technology Media Lab; CLBB Advisory Board Member

Marsha Levick, Esq
Chief Legal Officer, Juvenile Law Center

Shobha L. Mahadev, JD
Children and Family Justice Center, Bluhm Legal Clinic at Northwestern Pritzker School of Law

Bruce H. Price, MD
Chief, Department of Neurology, McLean Hospital; Associate Professor in Neurology at Harvard Medical School; CLBB Founder and Co-Director

Leah H. Somerville, PhD
Professor of Psychology and Director of the Affective Neuroscience and Development Laboratory, Harvard University; CLBB Faculty Member

Elyssa A. L. Spitzer, JD
2021 Senior Fellow in Law and Applied Neuroscience, joint Fellowship of CLBB and the Petrie-Flom Center, Harvard Law School

RECEIVED by MSC 9/27/2024 8:39:40 PM

Center for Law, Brain & Behavior
Research Assistants

Elizabeth Escalante, BS
Cognitive Science, Tufts University

Katherine Fang
Student, Yale Law School

Ian Hayes
Student, Harvard College

Annie Ilsley
Student, Duke University

Shreyas Iyer
Student, Harvard College

Clarissa Kimmey
Student, Yale Law School

Sarah Lagan, BA
Neuroscience, Harvard College

Layla Malamut
Student, Yale Law School

Fenella McLuskie
Student, Harvard Law School

Najet Miah, BA
Psychology, Queens College, City University of New York

Madeleine Muller, BA
Psychology, Northwestern University

Jennifer Near
Student, Harvard College

Kailey Nicholson
Student, Harvard College

Job Okeri
Student, University of Minnesota Law School

Ifeoma Okoli, BA
Psychology, Harvard College

Erin Shortell, JD, MPH
Student, Harvard Law School and Harvard T.H. Chan School of Public Health

Leonard Alexander Walker III
Student, Harvard Law School

Special thanks to members of the Research Network on Law and Neuroscience, supported by the John D. and Catherine T. MacArthur Foundation, and others who participated in the working meeting: “The Science of Emerging Adulthood: What do we know and how might this knowledge be appropriately applied in the law?” virtually convened at Harvard on September 30, 2020. We are particularly grateful to those who offered their consultation and review during drafting this document.

Grateful acknowledgement to the CLBB Advisory Board whose support made this project possible. We especially thank Jim Joslin who has generously contributed to support CLBB and its work to advance juvenile and emerging adult justice.

Finally, our thanks to Emily Rehmet, BA, Cognitive Neuroscience and Public Policy, Brown University; Project Manager, Massachusetts General Hospital Center for Law, Brain and Behavior, whose organizational skills, patience, input and supports in keeping us focused substantively contributed to completion of this project.

Cite as:
Center for Law, Brain & Behavior at Massachusetts General Hospital (2022). White Paper on the Science of Late Adolescence: A Guide for Judges, Attorneys and Policy Makers (January 27th, 2022). https://clbb.mgh.harvard.edu/white-paper-on-the-science - of-late-adolescence/

Errata Corrected: February 2, 2022

RECEIVED by MSC 9/27/2024 8:39:40 PM

Table of Contents

1 Executive Summary
5 Introduction

10 **Section I: Miller Factor 1 Immaturity, Impetuosity, Risk-taking**
12 A. Executive Functioning
13 B. Hot/Cold Cognition and Reward Sensitivity
14 C. Long-term Planning and Future Oriented Decision-making
17 **Section II: Miller Factors 2 and 3 Family and Home, Peer Influence**
17 A. Impact of Adversity on Late Adolescent Brain Development
20 B. Impact of Adversity on Late Adolescent Behavioral and Health Outcomes
22 C. Social Determinants of Late Adolescent Wellbeing
24 D. Late Adolescent Sensitivity to Peer Influence
26 E. Summary
27 **Section III: Miller Factor 4 Understanding Legal Proceedings**
28 A. Neurocognitive Processes Underlying Late Adolescent Decision-making
28 1. Future Oriented Decision-Making
29 2. Decision-making Under Stress
31 B. Decision-making in Legal Contexts
32 C. False Confessions
32 1. False Self-Incrimination
33 2. False Memory and Peer Influence
34 3. Contextual Influences and Individual Differences.
36 **Section IV: Miller Factor 5 Greater Potential for Rehabilitation**
36 A. Adolescent Brains Are Poised for Learning
37 B. Middle and Late Adolescent Behavior Patterns and Emerging Personality Features Are More Malleable Than Those of Adults
38 C. Adolescence Gives Rise to Developmentally Expectable Changes in Behavior
40 D. Personality Continues to Change Across the Lifespan

42 Conclusion and Recommendations

46 Appendix: Introduction to Middle and Late Adolescent Brain Development
47 A. Fundamentals of Late Adolescent Brain Development
47 1. Structural Development
48 2. Grey Matter Development
50 3. White Matter Development
51 4. Functional Development
52 B. Emotional Influences on Cognition in the Late Adolescent Brain
54 C. Development of the Brain's Learning and Reward Systems
56 D. Social Influence Impacts Late Adolescent Brain Responses
58 E. Summary

RECEIVED by MSC 9/27/2024 8:39:40 PM

Executive Summary

The United States Supreme Court decision in *Jones v. Mississippi* (2021)[1] almost certainly signals the end of further expansion at this time by SCOTUS of Eighth Amendment protections to juveniles.[2] *Jones v. Mississippi* held that a sentencing court need not make a specific finding that a youth is "permanently incorrigible" or even articulate a specific *Miller v. Alabama* rationale for a sentencing decision guided by factors provided in *Miller v. Alabama*.[3] It was enough that the sentencing judge understood that he or she had discretion to consider the *Miller* factors and made an individualized sentencing decision—a very low bar.[4]

In addition, the legal framework established by the *Roper-Graham-Miller-Montgomery* line of SCOTUS cases in barring execution for juvenile capital offenses,[5] Life Without Parole (JLWOP) for juvenile non-homicide cases,[6] and mandatory LWOP for juvenile homicide cases[7] has been incorporated to varying degrees into state statutes and case law and offers at least the possibility for a more robust application of *Miller*. The *Miller* approach also remains viable for pursuing expansion of those categorical protections to age 18 and beyond, and perhaps for raising the age of full criminal culpability.

The *Miller* framework's focus on "transient immaturity" also offers a way of asserting protections for young offenders in individual cases.[8] Arguably, shifting the focus from "permanent incorrigibility" (which cannot be predicted in a scientifically reliable manner) to "transient immaturity" (which is already established by robust developmental research and neuroscience) may provide opportunities for counsel and courts at trial/sentencing phases and upon appellate review. It may also encourage prosecutors to consider research-based diversion and community-based intervention programs as alternatives to traditional charging decisions and sentencing recommendations.

Similarly, the explicit reliance in these SCOTUS cases upon developmental neuroscience and behavioral science offers models for using science to advance broad evidence-based law and policy reforms regarding juveniles and emerging young adults. This White Paper reports the latest developmental and brain science to inform judges, attorneys, and policy makers about

1 *Jones v. Mississippi*, 141 S. Ct. 1307 (2021).
2 For purposes of this White Paper, the following terms are used to describe young people of different ages: (a) *juveniles*: broadly, persons between 13–17; (b) *early adolescents*: persons ages 10–13; (c) middle adolescents: persons ages 14–17; (d) *late adolescents:* persons ages 18–21; and (e) *young adults*: persons ages 22–25.
3 *Jones*, 141 S. Ct. at 1311.
4 *Id*.
5 *Roper v. Simmons*, 543 U.S. 551 (2005).
6 *Graham v. Florida*, 560 U.S. 48 (2010).
7 *Miller v. Alabama*, 567 U.S. 460 (2012); *Montgomery v. Louisiana*, 577 U.S. 190, 211 (2016) (extending *Miller* retroactively).
8 *Miller*, 567 U.S. at 479.

RECEIVED by MSC 9/27/2024 8:39:40 PM

critical research developments.[9] This White Paper is intended to facilitate science-informed decision-making and application of updated research findings in law and public policy bearing upon adolescence and criminal proceedings.

In the landmark case *Miller v. Alabama* (2012), the United States Supreme Court eliminated mandatory life-without-parole sentences for murders committed by youth under age 18.[10] This decision was informed by an evolving understanding of adolescent brain development and behavioral research. Since then, scientific research has emerged which reinforces the reasoning of the *Miller* decision and, if its implications are accepted, extends much of the science that resonated with the *Miller* court to late adolescents (ages 18–21).

Maturation of brain structure, brain function, and brain connectivity continues throughout the early twenties.[11] This ongoing brain development has profound implications for decision-making, self-control and emotional processing. For example, new neuroscience research reveals that during emotionally charged situations, late adolescents (ages 18–21) respond more like younger adolescents (ages 13–17) than like young adults (ages 22–25) due to differences in brain maturation.[12]

Compared to young adults above age 21, late adolescents (ages 18–21) also take more risks and engage in more sensation-seeking behavior.[13] Due to differences in brain development, late adolescents are more likely than young adults to respond to immediate outcomes and are less likely to delay gratification.[14] The presence of peers can intensify these behaviors, and the brains of late adolescents are more responsive to peer involvement than those of young adults.[15] Late adolescents are also more easily swayed by adult influence and coercion than their adult counterparts.[16] These developmental differences in behavior have direct implications for legal decision-making, including waiving *Miranda* rights, susceptibility to false confessions, and making ill-advised trial decisions (e.g., plea decisions).

9 *See* Appendix A for a foundational review of the science. For an extensive review of brain and socio-behavioral research and its policy implications, *see also* National Academies of Sciences, Engineering, and Medicine, The Promise of Adolescence: Realizing Opportunity for All Youth. (2019), https://doi.org/10.17226/25388; Institute of Medicine and National Research Council, Investing in the Health and Well-Being of Young Adults (2015), https://doi.org/10.17226/18869.

10 *Miller,* 567 U.S. at 480.

11 Leah Somerville, *Searching for Signatures of Brain Maturity: What Are We Searching For?*, 92 Neuron 1164, 1164–67 (2016).

12 Alexandra O. Cohen et al., *When Is an Adolescent an Adult? Assessing Cognitive Control in Emotional and Nonemotional Context*s, 27 Psych. Sci. 549 (2016); Marc D. Rudolph et al., *At Risk of Being Risky: The Relationship Between "Brain Age" Under Emotional States and Risk Preference*, 24 Developmental Cognitive. Neurosci., 93, 93–106 (2017); B. J. Casey et al, *Development of the Emotional Brain*, 29 Neurosci. Letters 693 (2019).

13 Laurence Steinberg, *Adolescent Brain Science and Juvenile Justice Policymaking*, 23 Psych., Pub. Pol'y, & L. 410 (2017).

14 Michelle Achterberg et al, *Frontostriatal White Matter Integrity Predicts Development of Delay of Gratification: A Longitudinal Study*, 36 J. Neurosci. 1954 (2016); Samuel Hawes et al, *Modulation of Reward-Related Neural Activation on Sensation Seeking Across Development*, 147 Neuroimage 763 (2017).

15 Dustin Albert, Jason Chein & Laurence Steinberg, *The Teenage Brain: Peer Influences on Adolescent Decision-Making*, 22 Current Directions Psych. Sci. 114 (2013); Ashley Smith et al, *Age Differences in the Impact of Peers on Adolescents' and Adults' Neural Response to Reward*, 11 Developmental Cognitive Neurosci. 75 (2015).

16 Hayley Cleary, *Applying the Lessons of Developmental Psychology to the Study of Juvenile Interrogations: New Directions for Research, Policy, and Practice*, 23 Psych., Pub. Pol'y, & L., 118, 118–130 (2017).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Adversity, racism, and poverty also have a profound impact on health, quality of life, and criminal justice involvement.[17] As discussed below, adolescents who have experienced adversity, racism, and poverty are significantly overrepresented in juvenile and criminal justice systems. However, while these experiences pose developmental challenges, they do not dictate fate, as late adolescents are also remarkably resilient, and their developing brains are poised for positive learning through interventions and rehabilitation.[18]

For late adolescents engaged in criminal behavior, research consistently indicates that most will not continue to offend and become adult repeat offenders through their twenties, thirties, and beyond.[19] This has significant implications for both policy and the legal system. For example, this high rate of desistance from even serious or persistent adolescent offending as youth move into their early to mid-twenties renders it impossible to reliably predict, based on current science, which individual youth will continue to offend into adulthood and which will desist as they mature. There is certainly no basis in science to reliably determine that an individual youth at the time of sentencing in adolescence is incapable of rehabilitation (or even unlikely to achieve it) over the course of a lifetime.

While *Jones v. Mississippi* (2021) held that a sentencing court need not make a formal finding of "permanent incorrigibility" in considering a JLWOP sentence,[20] the *Miller* factors remain applicable and key to articulating the "transient" nature of adolescence generally and applying those factors in the individual case before the court. Science cannot divine which "rare" adolescent may be "permanently incorrigible," but it can identify the characteristically "transient characteristics" of adolescence.

One inherent challenge to incorporating science into litigation and decision-making lies in the application of research developed in studies on groups of subjects to the circumstances, conduct, and developmental trajectories of individual persons before the court. This is sometimes referred to as the "Group to Individual" conundrum. For example, developmental brain science can provide "on average" group-level descriptions of brain development and maturation which can be supplemented by consideration of the specific individual characteristics at issue in the legal context. This, of course, is a challenge that is familiar in the practice of medicine, where physicians must apply research based upon groups to diagnose and treat individuals.

In cases involving adolescents and late adolescents, research applied in individual cases must be derived from studies in multiple domains including neuroscience, social determinants of misconduct, peer affiliations and social networks, developmental trajectories, and individual characteristics (e.g., cognitive capacities, physical maturation, emotional charac-teristics, learning style, family dynamics).

17 Scott Lorch & Elizabeth Enlow, *The Role of Social Determinants in Explaining Racial/Ethnic Disparities in Perinatal Outcomes* 79 Pediatric Rsch. 141 (2016).

18 B.J Casey et al, *Making The Sentencing Case: Psychological and Neuroscientific Evidence for Expanding the Age of Youthful Offenders,* 5 Ann. Rev. Criminology (forthcoming 2022).

19 Off. Juv. Just. Delinq. Prot., *Law Enforcement & Juvenile Crime: Arrests by Offense, Age, and Gender,* U.S. Dept. Just. (Oct. 21, 2019), https://www.ojjdp.gov/ojstatbb/crime/ucr.asp?table_in=1 [https://perma.cc/T6H7–3LWX].

20 *Jones v. Mississippi*, 141 S. Ct. 1307, 1309 (2021).

RECEIVED by MSC 9/27/2024 8:39:40 PM

This Guide is intended to support attorneys and judges in familiarizing themselves with the contours of the relevant science and how it can be applied to individual cases. A working knowledge of developmental and brain science allows attorneys and judges to make best use of what a juvenile defendant's life course, circumstances of an alleged offense, and expert evaluations and opinions can tell them to assist in understanding a defendant.[21] For attorneys, this facilitates preparing a case, educating the legal finder of fact, and making optimal use of expert testimony. For judges, this facilitates science-informed decision-making at all trial and appellate phases of a case involving a juvenile or young adult.[22]

The goal is to position each individual young defendant within a developmental trajectory comprised of biological, psychological, and social domains. A significant majority of cases will ultimately reflect "transitory immaturity," a feature of adolescence which will resolve as adolescents mature, resulting in desistance from criminal misconduct. Science-informed decision-making and evidence-based interventions can guide rehabilitation and reduce recidivism (thereby improving community safety) while avoiding or minimizing the negative impact of common responses (such as overuse of detention and incarceration) that can inadvertently compromise positive youth development and increase recidivism.

A better understanding of late adolescent brain and behavioral development can transform how the legal system and policy makers respond to late adolescents who offend. By educating decision-makers and advocates, this White Paper informs the criminal justice system and policy makers through providing an updated research perspective on late adolescence and supporting public safety by reducing recidivism through developmentally aligned accountability and empirically based processes and interventions.

21 Readers conducting forensic evaluations or using these evaluations in legal proceedings can find guidance in generating or relying upon them from sources including Antoinette Kavanaugh & Thomas Grisso, Evaluations for Sentencing of Juveniles in Criminal Court (2020).

22 For a review of aspects of "developmental evidence" and application of the *Miller* factors, see Thomas Grisso & Antoinette Kavanaugh, *Prospects for Developmental Evidence in Juvenile Sentencing Based on Miller v. Alabama,* 22 Psych. Pub. Pol'y & L. 235, 235–249 (2016); *See also* Thomas Grisso, *Three Opportunities for the Future of Juvenile Forensic Assessment,* 46 Crim. Just. & Behav. 1671 (2019), https://doi.org/10.1177/0093854819883671

RECEIVED by MSC 9/27/2024 8:39:40 PM

Juveniles	Ages 13–17
Early Adolescence	Ages 10–13
Middle Adolescence	Ages 14–17
Late Adolescence	Ages 18–21
Young Adults	Ages 22–25

Age Ranges Defined for Purposes of this White Paper

Introduction

In a series of landmark decisions starting in 2005, the United States Supreme Court ruled that no one can be put to death,[23] receive a sentence of Life Without Parole for a non-homicide offense,[24] or receive a sentence of mandatory Life Without Parole for an offense committed prior to age 18.[25]

In drawing the line at age 18, the Supreme Court continued a tradition of raising the age at which Eighth Amendment protections against cruel and unusual punishment are applied. As Justice Stevens recognized in his concurring opinion in *Roper v. Simmons*, the holding reaffirmed the principle that "evolving standards of decency … have driven [the Court's] construction of this critically important part of the Bill of Rights," and recognized that "[i]f the meaning of that Amendment had been frozen when it was originally drafted, it would impose no impediment to the execution of 7-year-old children today."[26]

Jones v. Mississippi (2021) held that the requirements of *Miller v. Alabama* (2012) are satisfied if a juvenile's sentence of Life Without Parole (JWOP) is imposed after an individualized hearing. Notably, the *Jones* majority did not reinforce the *Miller* court's view that this sentence should be "uncommon" and reserved for the "rare" youth deemed "permanently incorrigible." Indeed, the *Jones* decision held that a sentencing judge need not make a specific finding that a juvenile is "permanently incorrigible" or even make formal findings of fact in support of a discretionary sentencing decision. However, SCOTUS did not explicitly strike down the *Miller* factor framework, acknowledged that states may set their own standards and protections more stringently than the *Jones* approach[27] (which many states have), and left undisturbed the concept of the "transient immaturity" of youth reflected in decisions from *Roper* (2005) through *Montgomery v. Louisiana* (2016).[28]

23 *Roper v. Simmons*, 543 U.S. 551 (2005).
24 *Graham v. Florida*, 560 U.S. 48 (2010).
25 *Miller v. Alabama,* 567 U.S. 460 (2012).
26 *Roper*, 543 U.S. at 1205.
27 *Jones v. Mississippi*, 141 S. Ct. 1307, 1322 (2021).
28 *Montgomery v. Louisiana,* 136 S. Ct. 718 (2016)

RECEIVED by MSC 9/27/2024 8:39:40 PM

The *Jones* court abandoned any consideration of "evolving standards of decency" that might lead to the abolition of JLWOP outright, although case law and statutes in many states since *Miller* have taken that step. Other states have established minimum sentences[29] to be served before juvenile homicide offenders are afforded the requirement set by the *Miller* court for a "meaningful" opportunity to demonstrate that they have achieved rehabilitation.

The *Jones* court paid scant attention to the scientific foundations of the *Roper* through *Montgomery* line of cases. By contrast, prior to the dilution by *Jones* of protections afforded to juvenile offenders, SCOTUS Eighth Amendment rulings about sentencing youthful offenders had drawn heavily from advances in social sciences and neurodevelopmental research.[30] The Court cited scientific publications when it ruled that the Eighth Amendment prohibits the death penalty for those under age 18 at the time of their capital offense;[31] prohibits life without the possibility of parole (LWOP) for non-homicide offenders under age 18 at the time of their offense;[32] and prohibits *mandatory* life imprisonment without parole for those under age 18 at the time of the offense, even for homicide offenses.[33]

From those scientific studies it cited, the Court reached the conclusion that youth are less morally culpable, more susceptible to peer pressure, and more amenable to positive change. Indeed, SCOTUS had absolutely barred for juveniles as a class both execution and life without possibility of parole for non-homicide offenses, reflecting a strong "children are different" approach to Eighth Amendment constitutional doctrine.

The *Miller* majority stepped back from this categorical "children are different" approach when it barred mandatory LWOP but permitted it for a presumably very small number of "permanently incorrigible" youth based on a judge's discretion following an individualized sentencing hearing. In doing so, however, the *Miller* Court reaffirmed the law's recognition that "relevance of youth as a mitigating factor derives from the fact that the signature qualities of youth are transient; as individuals mature, the impetuousness and recklessness which may dominate in younger years can subside."[34]

Although the *Jones* majority did not focus upon the "transient immaturity" of youth, legislative and case law developments among the states implementing *Miller* suggest the concept of "transient immaturity" may be central to incorporating into litigation and policy advocacy the continuing developments in science. While there is no scientifically reliable basis to predict that a youthful offender is "permanently incorrigible," there is a robust scientific basis, as described

29 Litigation continues to clarify at what point a lengthy minimum mandatory sentence for a juvenile offender violates the *Miller* requirement there be afforded a "meaningful" opportunity to demonstrate achievement of rehabilitation. The disparity among states of minimum mandatory terms to be served range from less than two decades to four or more decades, resulting in a problematic "justice by geography" situation where sentenced youthful offenders may serve sentences for the same offenses that differ by decades before a putatively "meaningful" case review.

30 *See, e.g., Miller*, 567 U.S. at 471 (noting relevance of studies in Am. Psychologist and other journals for the reasoning in *Roper* and *Graham*).

31 *Roper v. Simmons*, 543 U.S. 551 (2005).

32 *Graham v. Florida*, 560 U.S. 48 (2010). *Graham* held that states must provide "meaningful opportunity to obtain release based on demonstrated maturity and rehabilitation." *Id.* at 75.

33 *Miller* 567 U.S. at 460.

34 *Id.* at 1195–96 (internal citations omitted).

RECEIVED by MSC 9/27/2024 8:39:40 PM

in this Guide, to identify the "transient immaturity" of youth and emerging young adults and the normal process of self-desistence from criminal misconduct that occurs with maturation. The *Miller* factors still serve as a framework for organizing and explaining this research and as a means for accounting for the hallmarks of youthful immaturity, the circumstances of their offenses, and their greater prospects for self-desistence with maturation alone or with the support of empirically-based interventions.

This White Paper reviews recent scientific research establishing that these same "signature qualities of youth" extend into the period of *late adolescence* (ages 18–21). Since the Supreme Court decided *Miller v. Alabama* in 2012, more than one hundred new publications have explored the brain's development throughout late adolescence. Over 1,000 legal cases have referenced the same or similar neuroscience to that discussed in *Miller*, with many citing newer scientific articles as well.[35] Roughly half of these cases concerned individuals who were 18 years old or older at the time of the offenses for which they were charged.

In addition to their implications for legal challenges, the scientific findings reported in this White Paper are relevant for criminal justice policy. Late adolescents (ages 18–21) and young adults (ages 22–25) make up approximately 10–12% of the U.S. population,[36] yet this age group accounts for 23% of all arrests.[37] Late adolescents also make up 20% of incarcerated persons.[38] Youth of color are disproportionately represented,[39] as half of incarcerated 18–24

35 Francis X. Shen, et al., *Justice for Emerging Adults after* Jones: *The Rapidly Developing Use of Neuroscience to Extend Eighth Amendment Miller Protections to Defendants Ages 18 and Older*, 97 N.Y.U. L. Rev. Online (forthcoming 2022) (examining how the science proffered in *Miller* has been cited in subsequent cases).

36 Population estimates vary depending upon demographic data sources and years the samples were derived. *See* Just. Policy Inst., Improving Approaches to Serving Young Adults in the Justice System 3 (2016) (9.9% of U.S. population); *see also* Annie E. Casey foundation, *Kids Count Data Center https://datacenter.kidscount.org/* (last visited April, 17, 2021) (similar). Alternatively, one could calculate this percentage by combining population data sources: for example, the U.S. Census Bureau projected a total U.S. population of 326,971,407 on January 1, 2018. U.S. Census Bur., *Census Bureau Projects U.S. and World Populations* (Dec. 28, 2017), https://www.census.gov/newsroom/press-releases/2017/new-years-2018.html [https://perma.cc/8MKP-FUHU]. The Center for Education Statistics estimated a population of 30,600,000 18- to 24-year-olds for the same date. Nat'l Ctr. For Ed. Statistics, *Indicator 1: Population Distribution* (Feb. 2019), https://nces.ed.gov/programs/raceindicators/indicator_RAA.asp [https://perma.cc/9XZQ-YRY9] (last visited Dec. 12, 2020). 30,600,000 divided by 326,971,407 equals about 9.36%.

37 *See* Office of Juvenile Justice and Delinquency Prevention, *Estimated number of arrests by offense and age group*, U.S. Dep't of Justice (2019), https://www.ojjdp.gov/ojstatbb/crime/ucr.asp?table_in=1 [https://perma.cc/T6H7–3LWX] (last visited Apr. 18, 2021). To calculate the percentage of offenses committed by those between 18 and 24 for each year between 2015 to 2019, add total offenses for the 18 to 20 age group and the total offenses for the 21 to 24 age group, then divide that total by the total number of offenses for all ages. Results are (rounded to the hundredths place): 19.88% for 2019, 21.69% for 2018, 23.15% for 2017, 24.62% for 2016, and 25.67% for 2015. Averages for the past five years of data were derived by adding these five percentages together and then dividing by 5 to get 23.002%. A five-year annual average was used to reflect continuity. Worth noting, however, is the declining trend: Each year from 2015 to 2019, the percentage of crimes committed by those between 18 and 24 decreased. Alternatively put, in 2019, 19.88% of all arrests in the U.S. were for offenses committed by individuals from 18 to 24 years old, a percentage slightly less than in the previous four years. This arrest data was cross-checked with FBI data available for 2016 (last available year) which also resulted in an arrest rate calculation of 24.62%. *See* Crim. Just. Servs. Div., *2016 Crime in the United States*, Fed. Bur. Investigation (2016), https://ucr.fbi.gov/crime-in-the-u.s/2016/crime-in-the-u.s.-2016/tables/table-20 [https://perma.cc/NWQ2-HYGW] (last visited Dec. 12, 2020).

38 Just. Policy Inst., *Improving Approaches to Serving Young Adults in the Justice System* 1 (2016), http://www.justicepolicy.org/uploads/justicepolicy/documents/jpi_report_summary_improving_approaches_to_serving_young_adults_in_the_justice_system.pdf [https://perma.cc/NPU6-YUYR] (last visited Apr. 18, 2021).

39 *Id.* at 2 ("The data show … that young adults of color are disproportionately impacted by the justice system.").

RECEIVED by MSC 9/27/2024 8:39:40 PM

year-olds are people of color.[40] Additionally, many of these incarcerated late adolescents and young adults face long sentences. Almost 40% of the individuals serving the longest prison sentences in the United States were incarcerated before age 25, and 56% of those serving the longest sentences are Black.[41]

Research in neuroscience, psychology, and law have contributed to an evolving understanding of both behavioral and brain development during adolescence. This contemporary research has direct implications for juvenile justice policy and practice.[42] This White Paper assembles and synthesizes both foundational and recent scientific developments to provide an updated overview of the science of late adolescence.

Foundational background information summarizing contemporary research on adolescent brain development is presented in Appendix A for readers who would benefit from a primer or refresher on the basic neuroscience.[43] This paper presents a synthesis of the brain and behavioral science most relevant for understanding legal and policy implications of these areas of research. The science is organized by the distinguishing characteristics of youth identified as critical factors by SCOTUS in *Miller* and is subsequently reflected, further developed, or limited.

Post-*Miller* activity involving juvenile defendants[44] and defendants ages 18 and older largely reflects actions taken by state courts and legislatures.[45] We anticipate that, particularly following the *Jones* decision in Spring 2021, most legal and legislative activity in this area will continue to occur at the state rather than federal level. The *Miller* factors have made their way into state case law and policy debates and so continue to be relevant. The *Miller* factors that serve as the organizing factors for the science presented in this paper are:

Immaturity, Impetuosity, and Risk-taking The "hallmark features" of adolescence include "immaturity, impetuosity, and a failure to appreciate risks and consequences."

40 *Id.* at 1.

41 Urban Inst., *A Matter of Time: The Causes and Consequences of Rising Time Served in America's Prisons* (2017), https://apps.urban.org/features/long-prison-terms/demographics.html [https://perma.cc/CQ6V-QP3L] (last visited Apr. 18, 2021).

42 B.J. Casey et al, *Healthy Development as a Human Right: Insights from Developmental Neuroscience for Youth Justice,* 16 Ann. Rev. L. & Soc. Sci. 9.1 (2020); B.J. Casey et al, *Making the Sentencing Case: Psychological and Neuroscientific Evidence for Expanding the Age of Youthful Offenders*, 5 Ann. Rev. Criminology (forthcoming 2022); Leark, R. A. (2021). *An Introduction to the Special Issue on the Death Penalty Among Teen-Aged Offenders.* 7 J. Pediatric Neuropsych. 1–2 (2021).

43 The authors acknowledge that contemporary neuroscience increasingly focuses upon neural circuit connections and extraordinarily complex interactions among brain regions rather than merely attribution of functions to "lobes" or other specific brain areas. However, the published research often references structure and function of specific brain areas and so the reporting of brain research will often make references to specific brain areas.

44 By 2020, courts or legislatures in at least 19 states had barred Life Without Parole for juvenile defendants. *See, e.g.*, *Diatchenko v. Dist. Att'y for Suffolk Dist.*, 1 N.E.3d 270 (Mass. 2013); *State v. Bassett*, 428 P.3d 343 (Wash. 2018). For a review of post-*Miller* actions by state courts and legislatures, see Gina Kim, *State-by-State Abolition of Juvenile Life without Parole Sentences in the United States since Miller v. Alabama (2012)*, (2019) (Ph.D. dissertation, Columbia University; available through Academic Commons, Columbia University Libraries).

45 For a review of post-*Miller* use of neuroscience in litigation involving late adolescents, see Francis Shen et al, *Justice for Emerging Adults after* Jones*: The Rapidly Developing Use of Neuroscience to Extend Eighth Amendment Miller Protections to Defendants Ages 18 and Older,* 97 N.Y.U. L.Rev. Online (forthcoming 2021).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Peer Involvement/Influence "[T]he family and home environment that surrounds him—and from which he cannot usually extricate himself—no matter how brutal or dysfunctional . . . the circumstances of the homicide offense, including the extent of his participation in the conduct and the way familial and peer pressures may have affected him."

Understanding Legal Proceedings Deficits in legal understandings were described as: "the incompetencies associated with youth" including an "inability to deal with police officers or prosecutors (including on a plea agreement)" and "incapacity to assist his own attorneys."

Greater Potential for Rehabilitation The greater potential of adolescents for rehabilitation was first recognized in *Roper.* This greater potential for positive change and the absence of a scientific basis to reliably identify that "rare" youth whose "permanent incorrigibility" warrants LWOP continue to present a challenge to sentencing courts.

Jones v. Mississippi (2021) held that a separate finding of "permanent incorrigibility" is not required in a discretionary sentencing to LWOP.[46] However, opportunities to inform sentencing procedures and decisions with the science presented in this White Paper remain due to: (a) the long-standing recognition of the "transient immaturity" of youth" resulting in diminished culpability; (b) the common self-desistance from misconduct as youth mature; and, (c) law requiring analysis using the so-called *Miller* factors in these cases. The science is also relevant to adolescents older than the current "bright line" of age 18 for criminal culpability.

Especially in state cases, there are opportunities to inform legislatures, sentencing procedures, and individual case sentencing decisions with the science presented in this White Paper, particularly in state proceedings. Each of these distinguishing characteristics are discussed below for middle to late adolescents in light of broadly accepted leading research.

Readers who want further description of foundational neuroscience are directed to Appendix A at page 47 for a summary.

46 *Jones v. Mississippi*, 141 S. Ct. 1307, 1311 (2021).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Section I: Miller Factor 1 Immaturity, Impetuosity, Risk-taking

First Miller factor: The "hallmark features" of adolescence include "immaturity, impetuosity, and a failure to appreciate risks and consequences."

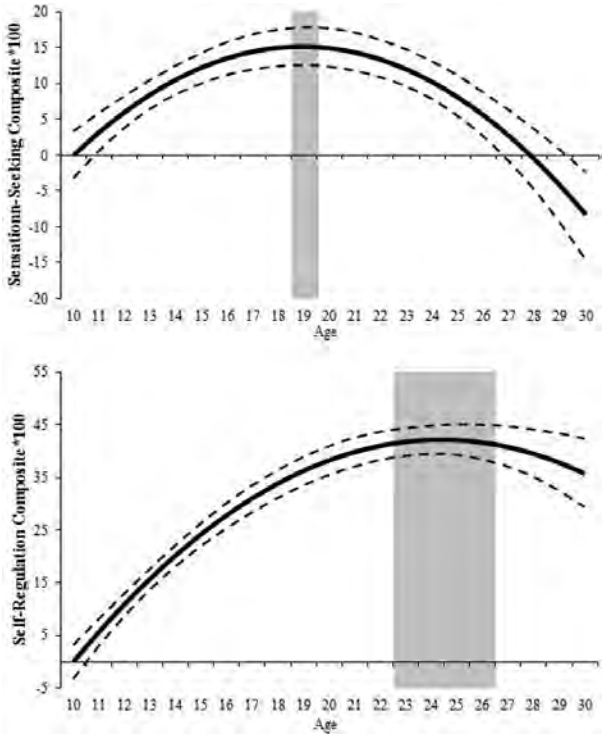


Figure 1: Steinberg et al. 2017. Age differences in sensation seeking (top) and self-regulation (bottom). Sensation seeking peaks in late adolescence. Self-regulation stabilizes in young adulthood.

Adolescence is a dynamic lifespan period characterized by changes in brain structure and brain function. In *Miller v. Alabama*, the United States Supreme Court explicitly referenced adolescents' tendency toward immaturity, impetuosity, and irresponsibility.[47] The predisposition for sensation seeking, hypersensitivity to immediate rewards, and present-focused decision-making peaks in middle to late adolescence and then declines in young adulthood. Further, capacities for self-regulation also improve with age and stabilize in young adulthood (Figure 1).[48] This is in part due to changes in brain function and connectivity and to improved executive functioning as the prefrontal cortex matures.

47 *Miller v. Alabama,* 567 U.S. 460, 472 (2012).

48 Laurence Steinberg et al, *Around The World, Adolescence Is a Time of Heightened Sensation Seeking and Immature Self-Regulation* 21 Developmental Sci. 10.1111 (2018).

RECEIVED by MSC 9/27/2024 8:39:40 PM

The brain continues to be malleable throughout the lifespan, and this malleability may be enhanced during adolescence as compared to adulthood. This means that the adolescent brain can change in response to experiences and is developmentally primed to do so. When an adolescent is subjected to positive influences, this can have advantageous implications for brain development and for positive personal development as manifested by enhanced sensitivity to social and emotional information that promotes learning about oneself, one's peers, and societal norms.[49]

Adolescents exhibit increased impulsivity and risk-taking, as compared to adults. Elevations in risk-taking decisions and behaviors are found among adolescents across cultures. Enhanced risk-taking is developmentally normative and can be adaptive in certain contexts.[50] For example, risk-taking in academic or social contexts can promote positive outcomes such as exploring new intellectual pursuits, skills and interests, or forming new healthy friendships. However, enhanced risk-taking can also lead to negative outcomes such as health risk behaviors or legal risks.

Compared to adults, middle adolescents and late adolescents are more likely to engage in behaviors that risk their lives and wellbeing.[51] Many health risk behaviors peak in late adolescence and young adulthood. This includes risk-taking behaviors and risk-related outcomes such as reckless driving, unprotected sex, and unintentional injuries.[52] Further, overdose deaths and substance misuse peak in late adolescence and early adulthood.[53]

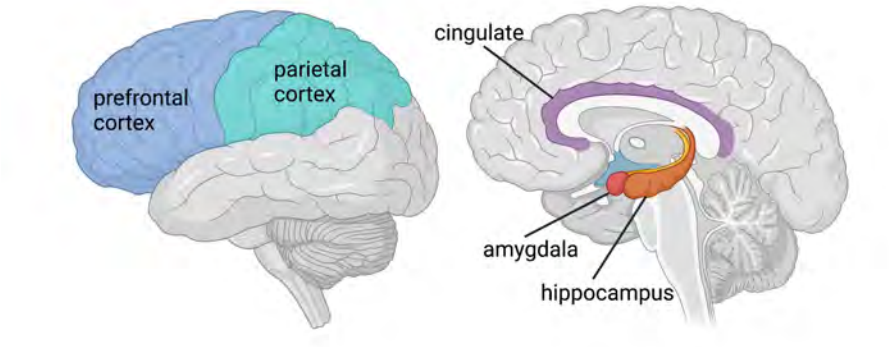


Figure 2: Brain Anatomy. Left image depicts a lateral view of the brain (side view from the outside). Right image depicts a medial view of the brain (side view from the middle inside).

49 Crone, E. A., & Dahl, R. E. *Understanding Adolescence as a Period of Social–Affective Engagement and Goal Flexibility*, 9 Nature Rev. Neurosci. 636, 636–650 (2012).

50 Natasha Duell & Laurence Steinberg, *Positive Risk-Taking in Adolescence,* 13 Child Development Perspectives 48, 48–52 (2019).

51 Laurence Steinberg, *A Social Neuroscience Perspective on Adolescent Risk-Taking*, 28 Development Rev. 78 (2008).

52 Teena Willoughby et al, *Examining the Link Between Adolescent Brain Development and Risk-Taking From a Social–Developmental Perspective (Reprinted)*, 89 Brain & Cognition 70 (2014).

53 Andrea Stone et al, *Review of Risk and Protective Factors of Substance Use and Problem Use in Emerging Adulthood,* 37 Addictive Behav. 747, 747–775 (2012).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Executive Functioning

The term "executive function" is used to describe the cognitive processes of controlling and regulating behavior and encompasses working memory, inhibitory control, and cognitive flexibility.[54] Connections within the prefrontal cortex and across more distributed brain networks (including the parietal cortex and subcortical regions) facilitate executive function, self-control, and emotion regulation. These connections continue to develop through early adulthood.[55] Therefore, behaviors associated with executive functions continue to develop throughout the transition from adolescence and into adulthood. This explains why late adolescents can be more impulsive in certain contexts and why their self-control abilities are vulnerable to disruption from emotional cues or heated contexts.[56]

"Working memory" is a type of executive function which continues to develop during adolescence. Working memory is a type of short-term memory that allows individuals to actively hold information in mind. It is important for remaining cognizant of present actions, past actions, and future actions. It is also important for processing conversations and social contexts, understanding instructions, creative thinking, charting a course of action, decision-making, and problem-solving.[57] Working memory allows us to take in new information and incorporate that information when devising a plan and considering alternatives to a plan. Parts of the prefrontal cortex (including the middle and inferior frontal regions) and regions within distributed brain networks (including subcortical regions), support working memory. The developmental fine-tuning of this circuitry facilitates improvements in working memory over time.[58]

Basic working memory abilities mature before adolescence, but more complex and challenging working memory capacities associated with continued brain development continue to mature through late adolescence[59] and into young adulthood. Compared to adults, working memory capacities are still developing through late adolescence, which can create vulnerabilities to interference and disruption. Specifically, emotional contexts can transiently disrupt working memory in late adolescence and young adulthood.[60] Research findings demonstrate that

54 In scientific and medical literatures, the terms "executive function" and "cognitive control" are both used to describe higher order behaviors that are important for self-control, decision-making, and complex thinking. We use the phrase "executive function" in this White Paper because the term is used regularly expert testimony and appears in hundreds of legal cases. *See* Akira Miyake et al, *Assessment of Executive Functions In Clinical Settings: Problems And Recommendations,* 21 Sem. Speech & Language 0169 (2000).

55 Jennifer Silvers et al, *vlPFC–vmPFC–amygdala Interactions Underlie Age-Related Differences in Cognitive Regulation of Emotion*, 27 Cerebral Cortex 3502 (2017).

56 B. J. Casey, *Beyond Simple Models of Self-Control to Circuit-Based Accounts of Adolescent Behavior*, 66 Ann. Rev. Psych. 295 (2015).

57 Working memory: The state of the science (Robert Logia, Valeria Camos, & Nelson Cowan eds., 2020).

58 Monica Rosenberg et al, *Behavioral and Neural Signatures of Working Memory in Childhood*, 40 J. Neurosci. 5090 (2020).

59 Theodore Satterthwaite et al, *Functional Maturation of the Executive System During Adolescence*. 33 J. Neurosci. 16249, 16249–16261 (2013).

60 Madeline Lee Pe et al, *Interference Resolution Moderates the Impact of Rumination and Reappraisal on Affective Experiences in Daily Life*, 27 Cog. & Emotion 492, 492–501 (2013); Lanciano Curci et al, *Negative Emotional Experiences Arouse Rumination and Affect Working Memory Capacity.* 13 Emotion 867, 867–880 (2013); Alan Anticevic et al, *Resisting Emotional Interference: Brain Regions Facilitating Working Memory Performance During Negative Distraction*, 10 Cog., Affective, & Behav. Neurosci. 159, 159–173 (2010)

RECEIVED by MSC 9/27/2024 8:39:40 PM

individuals ages 20–30[61] have more disrupted working memory during periods of emotional stimulation, suggesting that emotional contexts can compromise their cognition, but the influence of emotional context is less disruptive for older adults.[62]

Hot/Cold Cognition and Reward Sensitivity

Decision-making Middle adolescents and late adolescents are more likely than adults to change how they make decisions when they are faced with emotional contexts as compared to more neutral conditions where they are given time to think through a problem. Adolescents are cognitively similar to adults in certain contexts, like how by age 16 they perform comparably to adults when they are given adequate time for reasoned and thoughtful deliberation to consider consequences and make decisions.[63] However, during adolescence, youth experience a hypersensitivity to emotional content while still developing the purposeful problem-solving that comes with adulthood. Because adolescents exhibit different responses in the brain during decision-making, while exerting self-control, and when engaging emotion regulation, adolescent behavior is highly sensitive to emotional contexts. This renders adolescents susceptible to emotionally driven decisions, impulsive behavior, and poor judgment.[64]

Self-Control Behavioral studies demonstrate that adolescents are hypersensitive to emotional contexts, and this sensitivity to emotional information can interfere with self-control. Researchers have tested the ability of adolescents and adults to engage in self-control in emotional contexts by utilizing the Emotional Go/NoGo test. The Emotional Go/NoGo test is a test of cognitive control in which participants are instructed to press a button in response to target images (e.g., calm faces) but withhold responses to other types of images (e.g., happy faces). Research shows that adolescents are worse than adults at inhibiting responses to emotional stimuli, but they perform similarly to adults when neutral stimuli are presented.[65] Adolescents, more so than children and adults, show impaired self-control when inhibiting responses to negative and positive emotional cues.[66] For example, adolescents are more likely to make a self-control error when seeing a happy smiling face, compared to a neutral calm face. Notably, emotional cues continue to influence self-control through the mid-twenties.[67]

61 The age ranges for the sample group were 20–30 years and 60–75 years.

62 Susanne Scheibe & Fredda Blanchard-Fields, *Effects of Regulating Emotions on Cognitive Performance: What Is Costly for Young Adults Is Not So Costly for Older Adults*, 24 Psych. & Aging 217 (2009).

63 Brend Figner et al, *Affective and Deliberative Processes in Risky Choice: Age Differences in Risk-Taking in the Columbia Card Task,* 35 J. Experimental Psych.: Learning, Memory & Cog. 709 (2009).

64 Steinberg, *supra* note 51 ("This account is consistent with a growing body of work on structural and functional changes in the prefrontal cortex, which plays a substantial role in self-regulation, and in the maturation of neural connections between the prefrontal cortex and the limbic system, which permits the better coordination of emotion and cognition. These changes permit the individual to put the brakes on impulsive sensation-seeking behavior and to resist the influence of peers, which, together, should diminish risk-taking.").

65 Leah Somerville et al, *Frontostriatal Maturation Predicts Cognitive Control Failure to Appetitive Cues in Adolescents*, 23 J. Cog. Neurosci. 2123, 2123–2134 (2011); Nim Tottenham et al, *Behavioral Assessment of Emotion Discrimination, Emotion Regulation, and Cognitive Control in Childhood, Adolescence, and Adulthood*, 2 Frontiers Psych. 39 (2011).

66 Casey, *supra* note 12.

67 Dienke Bos et al, *Distinct and Similar Patterns of Emotional Development in Adolescents and Young Adults,* 62 Development Psychobiology 591, 591–500 (2020).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Research also indicates that middle adolescents and late adolescents are more sensitive to sustained emotional arousal states than older adults. This vulnerability to emotional context has been found to persist through early adulthood.[68] In research studies, late adolescents had diminished cognitive abilities under sustained negative emotional arousal relative to adults age 22–25, but late adolescents performed similarly to 22–25 year-olds in neutral and positive emotional arousal conditions.[69] For example, during "threat states" in which individuals anticipated the possibility of hearing an aversive sound, late adolescents (ages 18–21) exhibited patterns of brain activity that were more similar to the adolescent group (ages 13–17) than the adult group (ages 22–25). This included reduced connectivity between distributed brain regions that are activated when exerting self-control, including the prefrontal cortex.[70]

Social and Emotional Regulation The impact of enhanced emotional influence on adolescent behavior is also observed within the context of peer interactions. As adolescents mature, they are better able to inhibit emotionally-driven impulses that arise in the presence of peers.[71] This means adolescents are more likely to react impulsively when faced with potential social rewards or friendly peers. This can be seen, for example, in middle and late adolescents' more frequent unprotected sex. [72]

The ability to use effective cognitive strategies to regulate emotion in social situations increases with age into the mid-twenties and helps to explain why the ability to regulate emotions for social cues develops over time.[73] Studies of explicit emotion regulation ask participants to use cognitive strategies to change their emotional responses, such as by reinterpreting a situation or imagining the situation to be farther away in time or space. These studies have reported developmental differences in the use of effortful self-regulatory strategies to manage strong feelings. Research indicates that the strategies individuals use to regulate their emotions change throughout development, and that adolescents use less beneficial or less helpful emotional regulation strategies than adults.[74]

Long-term Planning and Future Oriented Decision-making

Middle and late adolescents evaluate risks and benefits differently than those in their late twenties and thirties. While adults tend to integrate potential consequences of decisions, middle adolescents and late adolescents exhibit less future-oriented decision-making. These age-related differences in behavior are associated with ongoing development of structural and functional connectivity between the prefrontal cortex, a region important for self-control, and the striatum, a region important for reward processing.

68 *See, e.g.,* Cohen, *supra* note 12.

69 The three comparison groups included adolescents (age 13–17), late adolescents (age 18–21), and young adults (age 22–25). *Id.*

70 For a more complete discussion of functional connectivity, *see infra*, Section II on page 18.

71 For additional information on the effect of peer influence, *see infra*, Section IV page 38.

72 Willoughby, *supra* note 52.

73 Jennifer Silvers et al, *Age-Related Differences in Emotional Reactivity, Regulation, and Rejection Sensitivity in Adolescence*, 12 Emotion 1235 (2012).

74 Kalee De France & Tom Hollenstein, *Emotion Regulation and Relations to Well-Being Across the Lifespan*, 55 Development Psych. 1768 (2019).; Oliver John & James Gross, *Healthy and Unhealthy Emotion Regulation: Personality Processes, Individual Differences, and Life Span Development*, 72 J. Personality 1301 (2004).

RECEIVED by MSC 9/27/2024 8:39:40 PM

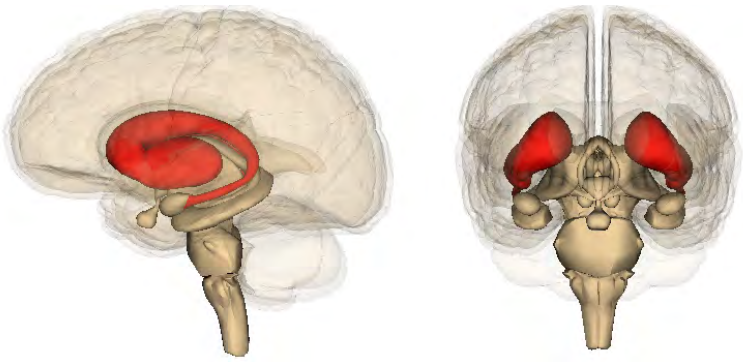


Figure 3: Striatum. The striatum is illustrated in red, showcasing a view from the side (left) and from the front (right) of the brain.

Relative to adults, late adolescents tend to plan for the short-term rather than the future. Future orientation increases with age. However, compared to adults both middle adolescents and late adolescents are more focused on immediate gains and rewards rather than potential long-term consequences.[75] These age groups are also less likely than adults to identify and consider potential future consequences of their actions.[76] Late adolescents are especially susceptible to making poor decisions due to privileging short-term rewards over future risks.

To explore the capacity to delay gratification, researchers ask individuals to decide between receiving a small reward sooner or a larger reward later. This measures how much a person devalues a reward based on how long they must wait to receive it. The tendency to delay gratification (choose larger but later rewards) increases with age.[77] Middle and late adolescents particularly often struggle with delaying gratification. A large-scale study of 900 individuals found that adolescents are more likely to prioritize immediate rewards over long-term outcomes, and delay of gratification improves continuously from age 14 to 22.[78]

Adolescents who are worse at delaying gratification are more prone to real world risk-taking, such as experimentation with drugs like tobacco, alcohol, and marijuana.[79] This may also account for why middle adolescents and late adolescents are more likely to engage in risky behaviors that lead to immediate rewards, such as reckless driving, unprotected sex, and dangerous behavior resulting in unintentional injuries.[80] [81]

This age-related preference for more immediate rewards is associated with developmental differences in brain function. In a research study conducted in individuals ages 11–31, delay of gratification increased with age and middle and late adolescents were more likely to choose

75 Laurence Steinberg et al, *Age Differences in Future Orientation and Delay Discounting*, 80 Child Development 28 (2009).
76 Daniel Read & Nicoleta Read, *Time Discounting Over the Lifespan*, 94 Org. Behavior. & Human Decision Proc. 22, 22–32 (2004).
77 Steinberg, *supra* note 75.
78 Daniel Romer et al, *Can Adolescents Learn Self-Control? Delay of Gratification in the Development of Control Over Risk-Taking*, 11 Prevention Sci. 319, 319–330 (2010).
79 *Id.*
80 Steinberg, *supra* note 51.
81 Willoughby, *supra* note 52.

RECEIVED by MSC 9/27/2024 8:39:40 PM

immediate rewards than adults. Older individuals (ages 25–31) were more likely to simultaneously activate both the striatum and prefrontal cortex, which was associated with a decreased tendency to prefer immediate rewards.[82]

One interpretation of this effect is that the development of the prefrontal cortex is associated with reduced impulsivity, which, in turn, enhances the ability to make decisions that adequately weigh future outcomes. Developing connectivity between the striatum and prefrontal cortex may also influence future-oriented decision-making. For example, adults ages 25–30 exhibit enhanced brain connectivity between regions in the prefrontal cortex and striatum, and they are better at delaying gratification than both middle and late adolescents.[83] Longitudinal research testing of individuals ages 8–26 demonstrates that the strengthening of white matter connections between the prefrontal cortex and striatum may also account for why individuals are better able to delay gratification as they age.[84]

As a result of strengthening connections, adults may be more likely than adolescents or late adolescents to use the prefrontal cortex to regulate reward-related regions and decrease impulsive responses to reward. Ongoing development of functional and structural connectivity can also explain why future-oriented decision-making increases with age from ages 10 to 25.[85] The ability to delay gratification continues to develop during adulthood.

While adolescents typically privilege immediate rewards over long-term consequences, there are cases where adolescents can be more patient than adults. For example, when faced with a decision that requires an individual to integrate evidence over time, adolescents are more willing to wait for information before making a choice when a high-value reward is at stake.[86] This suggests that reward motivation may actually render adolescents less impulsive in certain situations.

82 Anastasia Christakou et al, *Maturation of Limbic Corticostriatal Activation and Connectivity Associated With Developmental Changes in Temporal Discounting*, 54 Neuroimage 1344 (2011); Wouter van den Bos et al, *Adolescent Impatience Decreases with Increased Frontostriatal Connectivity*, 112 Proc. Nat'l Acad. Sci. E3765 (2015).

83 Christakou, *supra* note 82.

84 Michelle Achterberg et al, *Frontostriatal White Matter Integrity Predicts Development of Delay of Gratification: A Longitudinal Study*, 36 J. Neurosci. 1954 (2016).

85 Bos, *supra* note 82.

86 Theresa Teslovich et al, *Adolescents Let Sufficient Evidence Accumulate Before Making a Decision When Large Incentives Are at Stake*, 17 Development Sci. 59, 59–70 (2014).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Section II: Miller Factors 2 and 3 Family and Home, Peer Influence

Second and third Miller factors: "the family and home environment that surrounds him—and from which he cannot usually extricate himself—no matter how brutal or dysfunctional . . . the circumstances of the homicide offense, including the extent of his participation in the conduct and the way familial and peer pressures may have affected him."

Impact of Adversity on Late Adolescent Brain Development

A growing body of research demonstrates that the early life environment significantly influences the developing brain. Middle and late adolescents involved in the criminal justice system have experienced childhood adversity and trauma at higher rates than the general population.[87] Some research estimates that up to 90% of justice-involved youth have experienced at least one adverse experience and that more than 20% meet criteria for post-traumatic stress disorder (PTSD).[88] This far exceeds the prevalence of PTSD in the general population in which approximately 5% of adolescents and 3.6% of adults meet criteria for post-traumatic stress disorder.[89]

These experiences influence behavioral development and have consequences for brain development.[90] Additionally, environmental social determinants, including racism and poverty, have a profound impact on health, quality of life, and criminal justice involvement.[91] For example, while nearly 4 out of every 10 children are poor for one year or more before they reach the age of 18, justice-involved youth are even worse off and are much more likely to be raised in poverty.[92] While many youth are resilient and childhood adversity does not set a determined destiny, exposure to stress and adversity during childhood and adolescence can produce long-term changes in both brain and behavior.[93]

87 Jessica Craig et al, *A Little Early Risk Goes a Long Bad Way: Adverse Childhood Experiences and Life-Course Offending in the Cambridge Study*, 53 J. Crim. Just. 34 (2017); Michael Baglivio et al, *The Prevalence of Adverse Childhood Experiences (ACE) in the Lives of Juvenile Offenders*, 3 J. Juv. Just. (2014).

88 Carly Dierkhising et al, *Trauma histories among justice-involved youth: Findings from the National Child Traumatic Stress Network*, 4 Eur. J. Psychotraumatology 20274 (2013).; Karen Abram, et al, *PTSD, Trauma, and Comorbid Psychiatric Disorders in Detained Youth*. OJDP Juv. Just. Bulletin (U.S. Dept. Just. Off. Juv. Justice & Delinquency Prev., Washington, D.C.), June 2013.

89 Nat'l Inst. Health, *Post-Traumatic Stress Disorder (PTSD)* (2019), https://www.nimh.nih.gov/health/statistics/post-traumatic-stress-disorder-ptsd [https://perma.cc/M53J-QDD7].

90 Jenifer Siegel et al, *Exposure to Violence Affects the Development of Moral Impressions and Trust Behavior in Incarcerated Males*, 10 Nature Comm. 1 (2019).

91 Lorch & Enlow, *supra* note 17.

92 Caroline Ratcliffe, *Child Poverty and Adult Success* (Urban Inst., Washington, D.C.) September, 2015 at 855–902.

93 Panagiota Pervanidou & George Chrousos, *Metabolic Consequences of Stress During Childhood and Adolescence*. *Metabolism,* 61 Clinical & Experimental 611, 611–619 (2012); Lisa Eiland & Russel Romeo, *Stress and the Developing Adolescent Brain*. 249 Neuroscience 162, 162–171 (2013); Lovallo, W. R. (2013). *Early Life Adversity Reduces Stress Reactivity and Enhances Impulsive Behavior: Implications for Health Behaviors.* 90 Int. J. Psychophysiology 8*,* 8–16.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Neurobiological changes during adolescence enhance vulnerability to the maladaptive effects of stress and adversity, and these effects can influence cognitive processes such as emotion regulation, impulsivity, and executive function.[94] Early life stress can impact the development of emotional regions, including the amygdala and striatum, and self-control regions, such as the prefrontal cortex. Exposure to early adversity is also associated with impaired reward processing, and youth who report early life adversity exhibit differences in the brain's structural connections that are important for learning from rewards.[95]

However, while adversity results in increased risk of poor outcomes, exposures to adversity do not dictate a fate.[96] Adolescence is a dynamic period of the lifespan that is shaped by interactions with both environmental and social factors.[97] Most adolescents' brain and behavioral responses can adapt to the many challenges that they face.[98] Moreover, the effects of psychosocial stress on the brain are not permanent, and these temporary changes in brain function can be reversed after reductions of stress occur.[99] As discussed further below, many young adults positively adapt despite adversity during childhood because they also have individual characteristics (e.g., intelligence, adaptability, ready engagement with others) or access to social circumstances (e.g., family stability and care, access to quality education, medical and behavioral health care, positive community activities) that buffer them from exposures to adversity and/or support a high degree of resilience.

Adversity comes in many forms and can result in psychological trauma, violence, poverty, neglect, and maltreatment.[100] These negative experiences during development increase the risk for psychopathology in late adolescence.[101] The extent of the impact on brain and behavioral development depends on the number and severity of adverse events that an individual encounters during early life.[102]

94 Nim Tottenham & Adriana Galván, *Stress and the Adolescent Brain: Amygdala-Prefrontal Cortex Circuitry and Ventral Striatum as Developmental Targets*, 70 Neuroscience & Biobehavioral Rev. 217 (2016).

95 Bryan Kennedy et al, *Accumbofrontal Tract Integrity is Related to Early Life Adversity And Feedback Learning.* 46 Neuropsychopharmacology 2288, 2288–2294 (2021).

96 *See generally* Emmy Werner, *What Can We Learn about Resilience from Large-Scale Longitudinal Studies?, in* Handbook of Resilience in Children 87–102 (S. Goldstein & R. B. Brooks ed., 2013).; Caitlin Cowan et al, *The Lasting Impact of Early-Life Adversity on Individuals and Their Descendants: Potential Mechanisms and Hope for Intervention*. 15 Genes, Brain, & Behavior 155, 155–168 (2015).

97 Courtney Simmons et al, *Responsible Use if Open-Access Developmental Data: The Adolescent Brain Cognitive Development (ABCD) Study*. 32 Psych. Sci. 866 (2021).

98 *Id.*

99 Conor Liston et al, *Psychosocial Stress Reversibly Disrupts Prefrontal Processing and Attentional Control.* 106 Proc. Nat. Acad. Sci. 912, 912–917 (2008).

100 Ronald Kessler et al, *Childhood Adversities and Adult Psychopathology in the WHO World Mental Health Surveys*, 197 Brit. J. Psychiatry 378 (2010); Lucy Fitton et al*, Childhood Maltreatment and Violent Outcomes: A Systematic Review and Meta-Analysis of Prospective Studies.* 21 Trauma, Violence, & Abuse 754, 754–768 (2020).

101 R. C. Kessler, K. A. McLaughlin, J. G. Green, M. J. Gruber, N. A. Sampson, A. M. Zaslavsky & C. Benjet, *Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys*, 197 Brit. J. Psych. 378 (2010).

102 Joan Luby et al, *Association Between Early Life Adversity and Risk for Poor Emotional and Physical Health in Adolescence: A Putative Mechanistic Neurodevelopmental Pathway*, 171 JAMA Pediatrics 1168, 1168–1175 (2017).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Contemporary psychological models[103] have classified early life adversity along two dimensions: exposure to *threat* and exposure to *deprivation*. Exposure to threat includes exposure to violence or abuse. Exposure to deprivation encompasses exposure to poverty, lack of resources, lack of access to mental stimulation and/or diminished parental or social support.[104] These different types of adversity (threat and deprivation) are associated with distinct effects on brain development and behavior.

Exposure to threat has the greatest impact on the brain processes that are involved in detecting threats, learning from emotional information, and regulating emotions.[105] This includes subcortical regions (such as the amygdala and striatum) as well as connections between subcortical systems and the prefrontal cortex. A 2019 study assessed differences between adolescents who were and were not exposed to child abuse.[106] When viewing emotional images, children who had been abused exhibited enhanced co-activation between the amygdala and the ventromedial prefrontal cortex, regions important for emotional regulation. Differences in brain activity in abused children also predicted the presence and severity of psychiatric symptoms two years later.

Exposure to deprivation most often influences the development of brain systems important for language development and executive function, such as the prefrontal and parietal cortex. Deprivation can be a result of growing up in an impoverished environment. Researchers found that youth growing up in poverty tended to display differences in the development of brain structure. Youth living in low socioeconomic environments are more likely to have smaller volume in subcortical regions such as the hippocampus (a region important for memory formation).[107]

A large-scale study of individuals ages 3–20 found that cortical development is also influenced by parental education and family income.[108] Adolescents from disadvantaged backgrounds have less cortical surface area in regions important for language, memory, and executive function. These differences in the brain could account for why underprivileged youth as a group exhibit worse cognitive performance than peers from high-resource backgrounds. Socioeconomic status also relates to differences in functional recruitment of the prefrontal cortex during tasks testing executive function.[109]

103 Katie McLaughlin et al, *Childhood Adversity and Neural Development: A Systematic Review*, 1 Ann. rev. Developmental psych. 277 (2019). *But see* Karen Smith & Seth Pollak, *Rethinking Concepts and Categories for Understanding the Neurodevelopmental Effects of Childhood Adversity,* 16 Persp. psych. sci. 67, 67–93 (2021) (presenting an alternative neurodevelopmental model of early life adversity).

104 McLaughlin, *supra* note 103.

105 Katie McLaughlin et al, *Mechanisms Linking Childhood Trauma Exposure and Psychopathology: A Transdiagnostic Model of Risk and Resilience*, 18 BMC Med. 1 (2020).

106 Matthew Peverill et al, *Atypical Prefrontal–Amygdala Circuitry Following Childhood Exposure to Abuse: Links with Adolescent Psychopathology*, 24 Child Maltreatment 411 (2019).

107 Natalie Brito & Kimberly Noble, *Socioeconomic Status and Structural Brain Development*, 8 Frontiers in Neuroscience 276 (2014).

108 Kimberly Noble et al, *Family Income, Parental Education and Brain Structure in Children and Adolescents*, 18 Nat. Neurosci. 773 (2015).

109 Emily Merz et al, *Socioeconomic Inequality and the Developing Brain: Spotlight on Language and Executive Function*, 13 Child Development Persp. 15 (2019).

RECEIVED by MSC 9/27/2024 8:39:40 PM

It is critical to note that these changes in the brain may actually serve *adaptive* purposes which help adolescents function in their current environment.[110] Therefore, certain changes may be beneficial for adapting to a low-resource environment, but these same changes may pose challenges when individuals are placed in different contexts or are faced with new circumstances.[111] It is also important to appreciate there are many complexities surrounding the relationships between brain development and socioeconomic status. For example, external factors such as nutrition, exposure to toxins, safety, and even the frequency of verbal conversations in the home may contribute to these effects.[112] This means that many of the conditions affecting brain development that arise from poverty may be transient or remediable.

When early life adversity leads to psychological trauma, it has profound effects on brain and behavioral development. However, there is considerable individual variability.[113] A new frontier of research is investigating what factors foster childhood resilience in the face of adversity. For example, there is evidence that capacities for emotion regulation can buffer the effects of adversity. Individuals with a history of maltreatment who exhibit better emotion regulation skills, and who exhibit enhanced activity in the frontoparietal regions of the brain, are less likely to report symptoms of depression.[114]

The social environment can also confer resilience in youth. The presence of supportive caretakers/mentors and an emotionally warm and supportive family context can buffer the effects of stress and adversity in youth.[115] The research on resilience, while in its infancy, offers potential targets for intervention to support the healthy development of children and adolescents exposed to adversity.

Impact of Adversity on Late Adolescent Behavioral and Health Outcomes

Trauma is a potential consequence of adversity,[116] and there are many definitions of trauma. For example, one definition of trauma includes events that pose a "significant threat (physical, emotional, or psychological) to the safety of the victim or loved ones/friends and are overwhelming and shocking."[117] The Diagnostic and Statistical Manual of Mental Disorders provides the following threshold definition of trauma as Criteria A of post-traumatic stress disorder: "The person was exposed to: death, threatened death, actual or threatened serious injury, or actual

110 *Roper v. Simmons*, *supra* note 97.
111 *Id*.
112 Brito, *supra* note 107.
113 Emily Cohodes et al, *Influences of Early-Life Stress on Frontolimbic Circuitry: Harnessing a Dimensional Approach to Elucidate the Effects of Heterogeneity in Stress Exposure*, 63 Developmental Psychobiology 153 (2020).
114 Alexandra Rodman et al, *Neurobiological Markers of Resilience to Depression Following Childhood Maltreatment: The Role of Neural Circuits Supporting the Cognitive Control of Emotion*, 86 Biological Psych. 464 (2019).
115 Adriana Leak & Jennifer Silvers, *Neurobiological Markers of Resilience to Early Life Adversity During Adolescence*, 6 Biological Psych. Cog. Neurosci. & Neuroimaging 238, 238–247 (2020).
116 Valery Krupnik, *Trauma or adversity?* 25 Traumatology 256, 256–261 (2019).
117 Am. Psychl. Ass'n, *Clinical Practice Guideline for Treatment of Posttraumatic Stress Disorder (PTSD) in Adults,* February 24, 2017 https://www.apa.org/ptsd-guideline/ptsd.pdf (last visited December 20, 2021).

RECEIVED by MSC 9/27/2024 8:39:40 PM

or threatened sexual violence, in the following way(s): direct exposure; witnessing the trauma; learning that a relative or close friend was exposed to trauma; indirect exposure to aversive details of the trauma, usually in the course of professional duties (e.g., first responders such as police or medics)."[118] As we've learned over the past several decades, adverse events that can overwhelm the individual and become psychologically traumatic events are not confined to clearly catastrophic contexts like war or natural disaster but can and do occur in everyday settings including schools, families, and communities.[119]

The Adverse Childhood Experiences Study (ACES) was a landmark study of over 17,000 individuals with health insurance through their employers and showed how adverse (e.g., potentially traumatic) events early in life have profound long-term deleterious effects on the physical and mental health of adults. The ACES study was limited to ten categories of trauma. These included caretaker maltreatment as a child, parental substance abuse or serious psychiatric illness, family violence, and parental incarceration.

However, other difficult childhood adversities such as exposure to community violence are associated with increased risk of emotional and behavioral dysregulation, learning difficulties, conduct problems, court involvement (child protection, status offender, delinquency, early criminal justice involvement), and future violence.[120] Even among this relatively well educated and employed population, exposure to childhood adversity was linked to increased risk of poor life outcomes including earlier onset of risk-taking behaviors, substance misuse, psychiatric diagnoses, smoking, earlier onset of medical conditions and earlier death, and sexual practices resulting in early or unintended pregnancy.[121] This study clearly demonstrated that the greater the number of childhood exposures, the greater the risks of negative life outcomes.

118 American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders 5 (2013); Trent et al, *The Impact of Racism on Child and Adolescent Health*. 144 Pediatrics 2144 e20191765 (2019).

119 Jeong-Kyun Choi et al, *Neighborhood Disadvantage, Childhood Adversity, Bullying Victimization, and Adolescent Depression: A Multiple Mediational Analysis*, 279 J. Affective Disorders 554, 554–562 (2021).

120 Kristen McCabe et al, *The Relation Between Violence Exposure and Conduct Problems Among Adolescents: A Prospective Study.* 75 Am. J. Orthopsychiatry 575, 575–584 (2005); Suzanne Estrada et al, *Individual And Environmental Correlates of Childhood Maltreatment and Exposure to Community Violence: Utilizing a Latent Profile and a Multilevel Meta-Analytic Approach.* 51 Psychol. Med. 1 (2021).

121 *See, e.g.*, Robert Anda et al*, The Enduring Effects of Abuse and Related Adverse Experiences in Childhood: A Convergence of Evidence from Neurobiology and Epidemiology*. 256 Eur. Archives Psych. & Clinical Neurosci 174 (2011); Centers for Disease Control and Prevention, *About the CDC-Kaiser ACE study: Homepage.* https://www.cdc.gov/violenceprevention/aces/about.html (last visited December 20, 2021).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Social Determinants of Late Adolescent Wellbeing

Compared to earlier generations, late adolescents today face more challenges when removing themselves from difficult home environments.[122] While late adolescents who come from resource-rich families are often able to remove themselves from the family environment by pursuing a college education and living away from home, disadvantaged late adolescents (ages 18–21) are more likely to have fewer options when deciding where and with whom to reside. This can be disadvantageous when the home environment is high conflict or inattentive, criminogenic, dangerous, or otherwise toxic.

Like nearly all children in mid-adolescence who have limited choice about where and with whom they live, disadvantaged late adolescents may have no other option but to remain in a dysfunctional family environment[123] or in a turbulent neighborhood. Multilayered environmental stressors, including poverty, lack of access to resources and education, and unstable housing all contribute to a lack of agency. These factors work to substantially diminish or preclude an adolescent's ability to "extricate" oneself from a negative home or community situation. Each of the factors identified above has significant consequences for behavior, brain development, and future life outcomes.[124]

Racism, a social determinant[125] of poverty and health/educational inequality, also influences how youth of color are treated by the criminal justice system and society at large. For example, research indicates that beginning at age 10, youth who are Black are more likely to be mistakenly viewed as being older.[126] This can have significant implications for interactions with law enforcement and subsequent treatment by the court. Studies indicate that discrimination and racism also contribute to negative mental health for late adolescents,[127] including increased symptoms of anxiety and depression[128] and increased alcohol use.[129]

122 Jeffrey Arnett, *Emerging Adulthood: A Theory of Development from the Late Teens Through Early Twenties.* 55 Am. Psych. 69, 69–480 (2000); Jeffrey Arnett, *Does Emerging Adulthood Theory Apply Across Social Classes? National Data on a Persistent Question.*" 4 Emerging Adulthood 227, 227–35 (2020); Seth Schwartz, *Turning Point for a Turning Point: Advancing Emerging Adulthood Theory and Research,* 4 Emerging Adulthood 307, 307–17 (2016); James Côté, *The Dangerous Myth of Emerging Adulthood: An Evidence-Based Critique of a Flawed Developmental Theory*, 18 Applied Developmental Sci. 177, 177–88 (2014); Sara Sandberg-Thoma et al, *Exiting and Returning to the Parental Home for Boomerang Kids,* 77 J. Marriage & Family 806 (2015); Lei, Lei & Scott J. South, *Racial and Ethnic Differences in Leaving and Returning to the Parental Home: The Role of Life Course Transitions, Socioeconomic Resources, and Family Connectivity*, 34 Demographic Rsch. 109, 109–42 (2016).

123 Alison De Marco & Stephanie Berzin, *The Influence of Family Economic Status on Home-Leaving Patterns During Emerging Adulthood.* 89 Families in Society 208, 208–218 (2008).

124 Despite the challenges faced by disadvantaged adolescents, most young people are resilient and largely overcome adversity as they mature into early young adulthood, particularly if they are in environments or relationships that buffer them from long-term impact of adversities and foster resilience.

125 Social determinants may be highly contextual such as whether or not a youth resides in an area heavily surveyed by law enforcement or in a school system where school resource officers more commonly respond to students in crisis with arrest as opposed to de-escalation.

126 Phillip Goff et al, *The Essence of Innocence: Consequences of Dehumanizing Black Children.* 106 J. Personality & Soc. Psych. 526 (2014).

127 Donte Bernard et al, *Making The "C-ACE" for a Culturally-Informed Adverse Childhood Experiences Framework to Understand the Pervasive Mental Health Impact of Racism on Black Youth*. 14 J. Child & Adolescent Trauma 233, 233–247 (2020).

128 Regina Miranda et al, *Perceived Discrimination, Ruminative Subtypes, and Risk for Depressive Symptoms in Emerging Adulthood*. 19 Cultural Diversity & Ethnic Minority Psych. 395 (2013).

129 Noelle Hurd et al, *Does Perceived Racial Discrimination Predict Changes in Psychological Distress and Substance Use Over Time? An Examination Among Black Emerging Adults.* 50 Developmental Pscyh. 1910 (2014).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Further, discrimination has implications for physical health outcomes. A study of Black adolescents found that individuals who experienced higher levels of discrimination between the ages of 16–18, had higher levels of stress hormones[130] (e.g. cortisol, epinephrine, and norepinephrine), higher blood pressure, more inflammation, and higher body mass index by the age of 20.[131] Structural racism compounds difficulties for Black and Latino adolescents who are more likely to lack equal access to high quality education, employment (especially higher income jobs), safe housing, credit, and good health care.[132]

Specifically, Black children are less likely to be given the benefit of the doubt with regards to perceptions or judgments about their innocence and are more likely to be viewed as adults while White children are more often granted the presumption or privilege of innocence and are viewed as less culpable. In one study, perceptions of innocence for Black children ages 10–13 were equal to those for non-Black children ages 14–17 while perceptions of innocence for Black children ages 14–17 equaled those for non-Black subjects ages 18–21. In another study, Black felony suspects were perceived as being 4.5 or more years older than their actual age.[133] A similar disparity was also found in a study of police officers, where officers tended to overestimate the ages of Black and Latino children but not overestimate the ages of White children.[134]

Racial bias also influences the perception of threat.[135] In a study examining threat detection, researchers found that study participants were worse at correctly perceiving threat and neutral cues in Black faces as compared to White faces.[136] In a study of prospective teachers, Black children were incorrectly perceived as angry more often than White children.[137] This is consistent with other research which found that, while young age in general may moderate general threat associations, race-based threat associations persist throughout the lifespan, even when the individual is a young Black child.[138] Overall, these disparities together with research consistently finding disproportionate rates of arrest and incarceration of Black and Latino youth indicate that these youth do not receive the same community responses or protections as White children from the severity of juvenile and young adult consequences for misconduct.

130 Cortisol is a "stress hormone" that regulates the body's metabolic and immune responses, and high levels enhance alertness during stress. Epinephrine is a hormone that cues up the sympathetic nervous system by increasing heart rate and respiration rate during stress. Norepinephrine is released during times of stress, and its release stimulates action, arousal, and alertness.

131 Gene Brody et al, *Perceived Discrimination Among African American Adolescents and Allostatic Load: A Longitudinal Analysis With Buffering Effects*. 85 Child Development 989, 989–1002 (2014).

132 David Williams et al, *Racism and Health: Evidence and Needed Research.* 40 Ann. Rev. Pub. Health 105, 105–125 (2019).

133 Goff, *supra* note 126.

134 *Id.*

135 Jason Okonofua et al, *A Vicious Cycle: A Social-Psychological Account of Extreme Racial Disparities in School Discipline.* 11 Persp. Pscyh, Sci. 381, 381–398 (2016); Jason Okonofua & Jennifer Eberhardt, *Two Strikes: Race and the Disciplining of Young Students*. 26 Psych. Sci. 617, 617–624 (2015); Jennifer Eberhardt, Biased: Uncovering the Hidden Prejudice That Shapes What We See, Think, and Do (2020). Jennifer Eberhardt et al, *Seeing Black: Race, Crime, and Visual Processing*. 87 J. Personality & Soc. Pscyh 876, 876–893 (2004).

136 Glasgow, S., Imbriano, G., Jin, J., & Mohanty, A, *Is Threat Detection Black and White? Race Effects in Threat-Related Perceptual Decision-Making*. 20 Emotion 1495 (2020).

137 Amy Halberstadt et al, *Racialized Emotion Recognition Accuracy and Anger Bias of Children's Faces.* 8 Emotion (2020).

138 Andrew Todd et al, *Does Seeing Faces of Young Black Boys Facilitate the Identification of Threatening Stimuli?* 27 Psych. Sci. 384, 384–393 (2016).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Late Adolescent Sensitivity to Peer Influence

In addition to environmental influences, social influences in general and specifically peer involvements are more powerful for adolescents than adults. This has significant implications for adolescent decision-making, impulse control, and risk-taking behavior. In general, late adolescents are more likely to take risks in the presence of peers than when they are alone or when an adult is watching.[139] This is why many crimes committed by adolescents involve peers.

Why are adolescents more likely to engage in criminal behavior in the presence of peers?[140] Peer involvement results in greater risk-taking behavior and is associated with changes in brain responses during adolescence.[141] For example, middle and late adolescents elicit more brain activity in reward centers when receiving monetary incentives if a peer is present, compared to when they are alone. Specifically, peer presence enhances responses in a brain region that is important for motivation and reward processing (striatum). However, peer presence does not modulate neural responses to reward in adults ages 25–35.[142] This effect of peer presence on reward-related activity in the brain relates to enhanced risk-taking behavior. During a risk-taking task, adolescents ages 14–19 showed more activity in the striatum while peers were present than when they were alone, and this boost in brain activity was related to increased risk-taking behavior.[143]

Sensitivity to peer influence has direct consequences for real world behavior. Peer presence and social influence can contribute to risk of substance misuse during late adolescence. For example, when in a bar-like setting, late adolescents are more likely to imitate the drinking habits of their peers even without direct pressure to do so.[144] Similar effects have been reported for cigarette smoking—merely observing a peer smoke increased the chances that an individual would also smoke more than if they were explicitly asked to smoke.[145] This demonstrates that mere peer presence can result in imitative behavior which can be adaptive when modeling positive behavior or decision-making or maladaptive when involving health risks or poor decision-making.

139 Karol Silva et al, *Adolescents in Peer Groups Make More Prudent Decisions When a Slightly Older Adult is Present*, 27 Psych. Sci. 322 (2016); Raymond Bingham et al, *Peer Passenger Norms and Pressure: Experimental Effects on Simulated Driving Among Teenage Males.* 41 Transportation Rch. Part F, Traffic Psych & Behaviour 124, 124–137 (2016).

140 F. E. Zimring, American youth violence. (Oxford University Press on Demand 2020).

141 Albert, *supra* note 15.

142 Ashley Smith et al, *Age Differences in the Impact of Peers on Adolescents' and Adults' Neural Response to Reward*, 11 Developmental Cognitive Neurosci. 75 (2015).

143 Jason Chien et al, *Peers Increase Adolescent Risk-Taking by Enhancing Activity in the Brain's Reward Circuitry*, 14 Developmental Sci. F1 (2011).

144 Sander Bot et al, *Sociometric Status and Social Drinking: Observations of Modelling and Persuasion in Young Adult Peer Groups*. 35 J. Abnormal Child Psych. 929, 929–941 (2007).

145 Zeena Harakeh & Wilma Vollebergh, *The Impact of Active and Passive Peer Influence on Young Adult Smoking: An Experimental Study.* 121 J. Drug & Alcohol Dependence 220, 220–223 (2012).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Studies of decisions made during simulated driving exercises demonstrate that late adolescents and young adults take more risks when driving with peers.[146] The presence of peers at one point while driving persists in increasing risk-taking even when a participant later drives alone.[147] This sensitivity to peer influence is more pronounced in late adolescents than in adults. In a study of individuals ages 18–22, research participants were significantly more likely to engage in risk-taking when a peer was present, even if the participant was told the peer was unknown to them and observing from another room.[148] In another study, 18-year-olds were more likely to increase speeding behavior based on peer influence and peer pressure than individuals in their late twenties.[149] Digital communication can also influence risk-taking among late adolescents. Late adolescents were more likely to make risky decisions when exchanging brief, text-like communications with a peer than when alone or when a peer was passively observing them.[150]

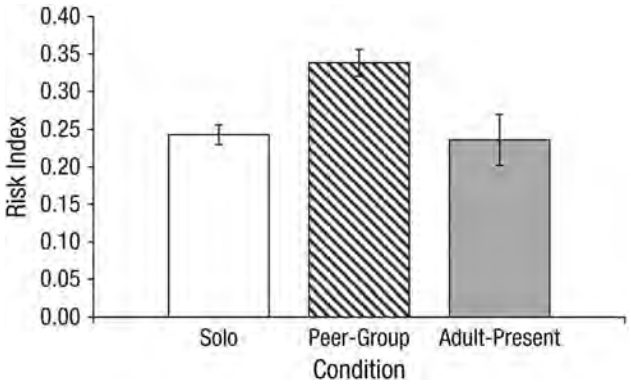


Figure 4: Silva et al. 2016. Risk-taking behavior when the late adolescent was alone (Solo), with four age 18-22 peers (Peer-Group), or with 3 18-22 peers and one young adult age 25-30 (adult present).

The specific composition of peer groups also influences risk-taking behavior. Notably, the presence of adults can reduce risky decision-making for late adolescents.[151] In a study testing late adolescent males ages 18–22, participants completed a set of risk-taking tasks either alone, in the presence of four 18–22 year old peers, or in the presence of three 18–22 year old peers and

146 Bruce Simons-Mortion et al, *The Observed Effects Of Teenage Passengers on the Risky Driving Behavior of Teenage Drivers*, 37 Accident Analysis & Prevention 973 (2005); Rui Pei et al, *Neural processes during adolescent risky decision-making are associated with conformity to peer influence*. 44 Developmental Cognitive Neuroscience 100794 (2020); Bingham, *supra* note 139; Christopher Cascio et al, *Buffering Social Influence: Neural Correlates of Response Inhibition Predict Driving Safety in the Presence of a Peer*. 27 J. Cognitive Neurosci, 83, 83–95 (2015). Marie Claude Ouiment et al, *The Effect of Male Teenage Passengers on Male Teenage Drivers: Findings From a Driving Simulator Study.* 58 Accident Analysis & Prevention 132, 132–139 (2013).

147 J. L. Shepherd et al, *Susceptible to Social Influence: Risky "Driving" in Response to Peer Pressure 1*, 41 J. Applied Soc. Psych.773 (2011).

148 Alexander Weigard et al, *Effects of Anonymous Peer Observation on Adolescents' Preference for Immediate Rewards*, 17 Developmental Sci. 71 (2014).

149 Mette Møller & Sonja Haustein, *Peer Influence on Speeding Behaviour Among Male Drivers Aged 18 and 28*, 64 Accident Analysis & Prevention 92 (2014).

150 R. Ross MacLean et al, *Digital Peer Interactions Affect Risk-Taking in Young Adults.* 24 J. Rsch. Adolescence 772, 772–780 (2014).

151 Silva, *supra* note 139.

RECEIVED by MSC 9/27/2024 8:39:40 PM

one adult between ages 25–30. When only similarly aged peers were present, late adolescents exhibited more risk-taking behavior than when they were alone or when an older adult was present (Figure 4)[151]. Specifically, when peers were present, individuals made riskier decisions on a delay discounting task, meaning they were less likely to delay gratification.

While peer influence can promote maladaptive risk-taking behaviors, the presence and influence of peers can also reduce risk-taking or serve a prosocial function. For example, when presented with risky economic decisions, adolescents are just as likely to conform to peers whether they make risky or safe decisions.[152] Moreover, late adolescents as compared to early adolescents are more prosocial (sharing, giving) towards their friends than with less familiar peers.[153]

Notably, both health-risk behaviors (such as substance misuse) and prosocial behaviors (such as giving to or helping a peer) peak in late adolescence.[154] Together these findings demonstrate that peer influence can have both positive and negative impacts on decision-making.

Summary

Late adolescents are more influenced by their environment and by peers than are adults. Adolescents facing difficult circumstances in their home and community face challenges to their emotional and physical wellbeing, which can influence behaviors such as decision-making and self-control. These factors can lead to involvement with the criminal justice system. Despite these challenges, the vast majority of individuals over time will be successful and demonstrate resilience as they grow and mature (please see Section II at page 18 for additional discussion on resilience). This is most likely to be the case for late adolescents who are given positive social supports and have access to adequate resources (social, community, housing, health, educational, leisure, vocational).

152 Barbara Braams et al, *Developmental Patterns of Change in the Influence of Safe and Risky Peer Choices on Risky Decision-Making*, Developmental Sci. e12717 (2018).

153 Berna Güroğlu et al, *Sharing and Giving Across Adolescence: An Experimental Study Examining the Development of Prosocial Behavior,* 5 Frontiers Psych. 291 (2014).

154 Neeltje Blankenstein et al, *Behavioral and Neural Pathways Supporting the Development of Prosocial and Risk-Taking Behavior Across Adolescence*, 91 Child Development e665-e681 (2020).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Section III: Miller Factor 4 Understanding Legal Proceedings

Fourth Miller factor: "the incompetencies associated with youth" including an "inability to deal with police officers or prosecutors (including on a plea agreement)" and "incapacity to assist his own attorneys."

The decision of whether to invoke *Miranda* rights is often critical to the trajectory of a criminal case.[155] In 2019, law enforcement conducted more than 10 million arrests.[156] Many of these arrested individuals were subject to police interrogation. Decades of research suggests that many children and adolescents do not fully comprehend their *Miranda* rights or the implications of waiving *Miranda* rights.[157] For those in the age range of 18–21, the "temporal discounting" discussed in the previous sections may lead late adolescents to waive their rights in the heat of the moment, without fully appreciating the resulting consequences.[158] For example, despite future ramifications, a late adolescent may elect to waive their right to counsel and then provide or agree with information or statements consistent with an officer's expectations during interrogation in an attempt to end the interrogation.

Research indicates that like early/middle adolescents, late adolescents are more easily swayed by adult influence and coercion than their adult counterparts.[159] This vulnerability has unique implications for late adolescents' ability to effectively navigate interactions with law enforcement, including decisions about whether to assert *Miranda* rights and whether to disclose information or make a statement during police interrogation. Both susceptibility to adult influence and developmentally-based future discounting has implications for how late adolescents interface with the legal system, including judgments during plea bargaining and the extent to which they are able to meaningfully assist their defense attorneys. Additionally, due to racial profiling and cultural stereotypes that promote inaccurate perceptions of Black criminality, late adolescents who are Black are more likely to have had negative experiences with law enforcement and expect to be treated unfairly during interrogation, which can alter the decisions they make during interrogation.[160]

155 *Miranda* rights are 5th Amendment rights that attach when a person is taken into police custody and during custodial interrogation, including the right to remain silent and the right to an attorney.

156 Federal Bureau of Investigation, *FBI Releases: 2019 Crime Statistics* (2020) https://www.fbi.gov/news/pressrel/press-releases/fbi-releases-2019-crime-statistics., FBI (last visited Sep. 28, 2020) [https://perma.cc/V76M-QNZ6].

157 *See* Thomas Grisso, *Juveniles' Capacities to Waive* Miranda *Rights: An Empirical Analysis*, 68 Calif. L. Rev. 1134, 1166 (1980).

158 Late adolescents with cognitive or learning impairments are at heightened risk of misunderstanding *Miranda* rights. A review of over 350 juvenile *Miranda* warnings across the United States found over half of *Miranda* warnings required an eighth grade reading level or above. Richard Rodgers et al, *Juvenile Miranda Warnings: Perfunctory Rituals or Procedural Safeguards?* 39 Crim. Just. & Behavior 229, 229–249 (2012).

159 Cleary, *supra* note 16.

160 Cynthia Najdowski et al, *Stereotype Threat and Racial Differences in Citizens' Experiences of Police Encounters*, 39 L. & Human Behavior 463 (2015).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Neurocognitive Processes Underlying Late Adolescent Decision-making

Future Oriented Decision-Making

Compared to adults, late adolescents are more likely to prioritize immediate outcomes over long-term consequences.[161] Overvaluing immediate consequences has direct implications for waiving *Miranda* rights, making plea decisions, and susceptibility to falsely confessing.[162] As discussed in Section I (page 10), neuroscientists and psychologists have studied how future-oriented decision-making changes with age. Researchers measured a form of future-oriented decision-making, referred to as temporal discounting, by asking individuals to decide between accepting a smaller reward sooner or waiting longer to receive a larger reward (e.g., $5 today or $25 in four weeks). The ability to delay gratification and prioritize later outcomes continues to develop during adolescence and through young adulthood.[163]

Age-related changes in temporal discounting have been linked to the development of the prefrontal cortex,[164] a brain region that is important for thinking abstractly and making decisions about future outcomes. Future-oriented decision-making is associated with enhanced communication between the prefrontal cortex and subcortical regions that are responsive to rewards. Importantly, these connections continue to strengthen during late adolescence,[165] which can account for why late adolescents prioritize immediate outcomes and make more impulsive decisions.[166]

Because of this preference for immediate reward, adolescents may be more likely to comply with an authority figure with the goal of escaping an uncomfortable situation as quickly as possible. These differences in adolescent future orientation have implications for police interrogations.[167] For example, because adolescents may perceive the ability to go home as an immediate reward, adolescents may face increased pressure to make both true and false confessions,[168] including situations in which officers assure the youth or young adult that they will be permitted to go home if they will "just tell the truth" or "help us understand your involvement" in an alleged offense.

161 Grace Icenogle et al, *Adolescents' Cognitive Capacity Reaches Adult Levels Prior to Their Psychosocial Maturity: Evidence for a "Maturity Gap" in a Multinational, Cross-Sectional Sample,* 43 L. & Human Behavior 69 (2019).

162 Scientist Action and Advocacy Network, *Scientific Support for a Developmentally Informed Approach to Miranda Rights* (May 2, 2018) https://scaan.net/docs/20180607-MirandaReport.pdf (last visited December 20, 2021).

163 Eveline Crone & Nikolaus Steinbeis, *Neural perspectives on cognitive control development during childhood and adolescence.* 21 Trends in Cognitive Sci. 205*,* 205–215 (2017); Christopher Holmes et al, *Peer Influence, Frontostriatal Connectivity, and Delay Discounting in African American Emerging Adults,* 14 Brain Imaging & Behavior 155, 155–163 (2020).

164 Laurence Steinberg & Jason Chein, *Multiple Accounts of Adolescent Impulsivity*. 112 Proc. Nat. Acad. Sci. 8807, 8807–8808 (2015).

165 Michelle Achterberg et al, *Frontostriatal White Matter Integrity Predicts Development of Delay of Gratification: A Longitudinal Study.* 36 J. Neurosci. 1954, 1954–1961 (2016).

166 Bos, *supra* note 82.

167 Cleary, *supra* note 16.

168 Lindsay Malloy et al, *Interrogations, Confessions, and Guilty Pleas Among Serious Adolescent Offenders,* 38 L. & Human Behavior 181 (2014).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Decision-making Under Stress

A large body of research has demonstrated that acute stress impairs decision-making.[169] For example, evidence across multiple studies has shown that future-oriented decision-making is significantly impaired during highly stressful situations, and this effect is heightened in late adolescents and young adults.[170] The effect of stress on decision-making is especially pronounced when individuals are faced with social stressors, and when they are required to make decisions about uncertain outcomes.[171] For example, an adolescent or young adult defendant's capacities for considering likely future outcomes may be compromised in situations where police insist "that you talk with us right now and we'll put in a good word for you with the prosecutor" or they are informed that "the plea deal needs to be done right now" or the offer will be withdrawn and harsh sentencing recommendations will be offered to the court if the defendant is later convicted after a trial.

Interactions with law enforcement and authorities induce heightened stress and arousal in youth.[172] Research has demonstrated that adolescents experience heightened physiological stress responses when speaking in front of authorities or when being evaluated by adults.[173] When feeling stressed, both middle and late adolescents are more likely to make risky decisions.[174] A study evaluated risky decision-making and self-control performance when adolescents ages 14–21 were experiencing low and high stress life events. Results indicated that when adolescents were highly stressed, they made more risky decisions when they were presented with choices about uncertain financial outcomes. This suggests that when stressed, adolescents are more likely to pursue immediately rewarding outcomes without factoring in the potential costs of their actions and less likely to weigh the consequences of their decisions. This research again demonstrates the vulnerability of adolescents when making substantive decisions during arrest, interrogation, or high-stress moments throughout subsequent legal proceedings.

Stress influences activity in the prefrontal cortex,[175] and stress can alter communication between the prefrontal cortex and subcortical regions that are responsive to emotional and salient information.[176] A recent study testing adolescents and young adults found that the extent of structural connectivity between the prefrontal cortex and the striatum, a region

169 Anthony Porcelli & Mauricio Delgado, *Stress and Decision-Making: Effects on Valuation, Learning, and Risk-Taking,* 14 Current Opinion Behavioral Sci .33, 33–39 (2017).

170 Sherecce Fields et al, *The Relationship Between Stress and Delay Discounting: A Meta-Analytic Review*. 25 Behavioural Pharmacology 434, 434–444 (2014).

171 Oriel FeldmanHall et al, *The Effects of Social Context and Acute Stress on Decision-Making Under Uncertainty,* 26 Psych. Sci 1918, 1918–1926 (2015).

172 Cleary, *supra* note 16.

173 Jessica Seddon et al, *Meta-Analysis of the Effectiveness of the Trier Social Stress Test in Eliciting Physiological Stress Responses in Children and Adolescents*. 116 Psychoneuroendocrinology 104582 (2020).

174 Adriana Galván & Kristine McGlennen, *Daily Stress Increases Risky Decision-Making in Adolescents: A Preliminary Study*, 54 Developmental Psychobiology 433, 433–440 (2012).

175 Reinoud Kaldeqaij et al, *Frontal Control Over Automatic Emotional Action Tendencies Predicts Acute Stress Responsivity,* 4 Biological Psych.: Cognitive Neurosci. & Neuroimaging 975, 975–983 (2019).

176 J. Van Oort et al, *How the Brain Connects in Response to Acute Stress: A Review at the Human Brain Systems Level.* 83 Neurosci. & Biobehavioral Rev. *281,* 281–297 (2017).

RECEIVED by MSC 9/27/2024 8:39:40 PM

responsive to rewards, was associated with risky decision-making during stressful conditions.[177] Individuals with weaker connectivity were more likely to make risky decisions during highly stressful situations. Because these connections continue to develop during adolescence and into young adulthood, the late adolescent brain may be especially vulnerable to the effects of acute stress.[178]

Development of the prefrontal cortex can also influence how late adolescents respond in vigilant states when they are anticipating potential threats.[179] When faced with acute threats, late adolescents (ages 18–21) respond more impulsively than young adults (ages 22–25). This enhanced impulsivity is associated with decreased recruitment of the prefrontal cortex. Notably, late adolescents' brain responses look more like those of middle adolescents (ages 13–17) than those of young adults (ages 22–25). Together, these findings demonstrate that adolescent decision-making and impulsivity may be more vulnerable to psychosocial stress than young adults, which can have implications for how late adolescents proceed when faced with interrogation. This includes impulsively confessing during an interrogation or providing information in the heat of the moment that an adult would be less likely to disclose.

Interrogation also uniquely impacts the physiological and biological arousal of late adolescents when confronted with coercive interrogation techniques. For example, the condition of *actual* innocence produced "immediate and fundamental" differences in suspects when examining systolic and diastolic blood pressure and various respiratory measures.[180] This translated to a significantly lower level of physiological arousal. Researchers hypothesized that this lower level of arousal contributed to the failure of innocent suspects to perceive the potential dangers of continuing to participate in an interrogation.

This, in turn, increased the likelihood that innocent participants would waive their *Miranda* rights because they naively believed that they would be able to convince police of their innocence. This physiological under-arousal and failure to assert their *Miranda* rights contributed to prolonged interrogation and increased the risk of false confession. For late adolescents, interrogation of both suspects who are innocent and who are guilty prompt different but powerful physiological responses which increase likelihood of false confession. Innocent subjects often fail to appreciate the jeopardy they are in and continue interrogation in the misguided belief that they can convince the interrogators of their innocence. Guilty subjects may fail to assert *Miranda* rights due to a stress-driven desire to promptly get out of an acutely anxiety-provoking encounter by appearing cooperative and perhaps acknowledging aspects of the allegations in an effort to mollify the interrogators.

177 Jessica Uy & Adriana Galván, *Individual Differences in Accumbofrontal Tract Integrity Relate to Risky Decisions Under Stress in Adolescents and Adults,* 45 Developmental Cognitive Neuroscience 100859 (2020).

178 Tottenham, *supra* note 94.

179 Cohen, *supra* note 12.

180 Max Guyll et al, *Innocence and Resisting Confession During Interrogation: Effects on Physiologic Arousal*. 37 L. & Human Behavior 366–75 (2013).

181 *J.D.B. v. North Carolina*, 564 U.S. 261 (2011).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Decision-making in Legal Contexts

The United States Supreme Court acknowledged age-related susceptibility to adult influence within the context of *Miranda* rights and in the landmark case *J.D.B. v. North Carolina*.[181] At the time of the interrogation, 13-year-old special education student J.D.B. was suspected of two break-ins. Without being provided with his *Miranda* warnings, J.D.B. was questioned by a uniformed police officer at school behind closed doors. While J.D.B. initially denied involvement in the burglaries, J.D.B. confessed after the officer encouraged him to tell the truth and threatened him with the possibility of juvenile detention. It was only then that the officer informed the student that he could refuse to answer questions or leave. Over the course of 30 to 45-minutes, J.D.B. verbally and in writing provided details of the crimes.

In remanding the case to state court, Justice Sotomayor observed:

"It is beyond dispute that children will often feel bound to submit to police questioning when an adult in the same circumstances would feel free to leave. Seeing no reason for police officers or courts to blind themselves to that commonsense reality, we hold that a child's age properly informs the *Miranda* custody analysis."[182]

In broadening the "in custody" test to include a consideration of the suspect's age, the majority reasoned that children and adults experience their surroundings differently and that certain settings are inherently more coercive to youth. This was a significant shift in the *Miranda* custody analysis. Post-*J.D.B.*, a child's age can be an important factor in determining whether a juvenile suspect was "in custody" and thus entitled to *Miranda* protections. However, despite the developmental similarities between late adolescents and middle adolescents, thus far, state appellate courts and the United States Supreme Court have declined to extend *J.D.B.*'s consideration of age to late adolescents.[183, 184]

182 *Id*. at 264–65.

183 *See, e.g., United States v. Eaton*, No. CR1801795TUCJGZBGM, 2019 WL 2135878, at *7 (D. Ariz. May 16, 2019) ("Defendant points to his age as a factor noting that 'a reasonable child subjected to police questioning will sometimes feel pressured to submit when a reasonable adult would feel free to go.' Mr. Eaton was twenty-one (21) at the time of the incident, and although a young adult he was not a child. In fact, Mr. Eaton is a father. The Court finds that Mr. Eaton's age is not a factor invalidating his consent.") (citations omitted); *People v. McCullough*, No. 311083, 2013 WL 195607, at *5 (Mich. Ct. App. 2013); *United States v. Hunter*, 912 F. Supp. 2d 388, 399 (E.D. Va. 2012); *State v. Wentzel*, No. A15–1495, 2016 WL 3884417, at *2 (Minn. Ct. App 2016).

184 Some courts have determined that both youth and race must be taken into account in determining reasonableness under the 4th Amendment seizure principles. *See, e.g., Commonwealth v. Tykorie Evelyn*, 485 Mass. 691, 152 N.W.3d 108 (Mass. 2020). ("Going forward, however, the age of a juvenile suspect, if known to the officer or if objectively apparent to a reasonable officer, will be part of the totality of the circumstances relevant to whether the juvenile was seized under art. 14 of the Massachusetts Declaration of Rights....With respect to the defendant's arguments on race, we have examined the continued relevance of our reasoning in *Commonwealth v. Warren*, 475 Mass. 530, 540 (2016), on the question of reasonable suspicion. In that case, we concluded that an innocent African-American man in an urban area might flee from police for fear of racial profiling, and therefore the weight of the inference properly given to flight should be less when the individual is African-American. *See id.* We conclude that this reasoning remains pertinent to the reasonable suspicion analysis and should be extended to other types of nervous or evasive behavior in addition to flight.")

RECEIVED by MSC 9/27/2024 8:39:40 PM

False Confessions

As indicated previously, late adolescents are less equipped to appreciate long-term consequences and make complicated decisions when in emotionally-driven contexts where they are given very limited time to decide on a course of action.[185] These deficits are exacerbated in high stress situations. Arguably, few experiences are more stressful than interrogation by armed uniformed police officers. Research has established a connection between coercive techniques, such as feigned eyewitnesses and promises of leniency, and false confessions.[186] According to the National Registry of Exonerations, the false confession rates for adolescents are three times higher than the rates for adults.[187]

Many of the developmental factors discussed in earlier sections also contribute to increased risk of false confessions in late adolescents. Due to the impact of peer influence and heightened allegiance to peers, as discussed in Section II (page 18), late adolescents may be more likely to be hesitant to expose a peer's behavior even if the disclosure mitigates the extent of their own involvement in the crime or exonerates them. They may even take responsibility for acts they did not commit out of misplaced loyalty to a peer.

There are two main causes of false confessions. The first category emanates from coercive interrogation techniques including coercive questions, comments, and conduct. The second category includes mental states where the defendant's mental status creates vulnerabilities to suggestibility or disruptions of deliberative decision-making due to mental illness, cognitive impairment, or substance use.[188]

False Self-Incrimination

In 1996, the first experimental study on false confessions was conducted using late adolescent college students who were instructed not to hit the ALT key on a computer keyboard.[189] In this study, after being accused of having hit the ALT key, nearly 70% agreed to sign a confession falsely admitting they had hit the ALT key while typing. Approximately 39% were led to believe they had actually pressed the key and nearly 10% offered corroborating facts and details. Notably, in a test condition where participants were instructed to type at a more rapid speed and where confederate witnesses were present to support the accusation, 100% of

185 Casey, *supra* note 12; Willoughby, *supra* note 52; Bernd Figner et al, *Affective and Deliberative Processes in Risky Choice: Age Differences in Risk-Taking in the Columbia Card Task*. 35 J. Exp. Psych: Learning, Memory & Cognition 709 (2009); Erik de Water, et al, *Distinct age-related differences in temporal discounting and risk-taking in adolescents and young adults*, 85 Child Development 1881, 1881–1897 (2014).

186 *See, e.g.,* Melissa Russano et al., *Investigating True and False Confessions Within a Novel Experimental Paradigm*, 16 Psychol. Sci. 481, 482 (2005).

187 Samuel Gross & Rob Warden, *Exonerations in the United States, 1989 through 2012,* Rep. from Nat.l Reg. Exonerations (U. Mich./Nw U. L. Center on Wrongful Convictions), 2012; *see generally* Barry Field, Kids, Cops, and Confessions: Inside the Interrogation Room (2012).

188 There are significant ethical barriers to conducting comparison research studies of coerced false confessions, as inducing harm to research subjects is prohibited and inhibits the research replication of strong-arm tactics. As researchers over the years have attempted to move away from theoretical study and replicate the psychological pressure of the interrogation room while avoiding harm to research subjects, they have developed alternative ways to study coercion.

189 Saul Kassin & Katherine Keichel, *The Social Psychology of False Confessions: Compliance, Internalization, and Confabulation*, 7 Psychol. Sci. 125, 125 (1996).

RECEIVED by MSC 9/27/2024 8:39:40 PM

participants gave a false confession. This experiment, and subsequent studies, demonstrated that when late adolescent populations are confronted with false incriminating evidence, a common technique used by police, individuals may falsely confess to actions and may even come to believe they had acted in ways they did not.

This pattern of false confessions was observed again when researchers conducted a study of late adolescents that created an environment more analogous to police interrogation. Social scientists orchestrated a "cheating" experiment where 330 undergraduate students were assigned to complete individual and joint problem-solving activities with a confederate who posed as a participant.[190] Each undergraduate student was then told they had identical wrong answers on a problem and that a professor had been made aware of the situation and was upset about the sharing of answers and so was weighing appropriate consequences. Research subjects were then interrogated and given a statement to sign that indicated they had cheated. They were also told that if they did not sign the statement, the professor would be called into the laboratory to address the situation with the implication being this would make things worse for the student.

Without interrogation, confession rates were 46% for guilty participants and 6% for innocent participants. The use of two interrogation techniques—promises of leniency ("Things could probably be settled pretty quickly") and minimization ("I'm sure you didn't realize what a big deal it was")—elevated the confession rate to 87% for guilty participants and 43% for innocent participants. The high rate of confessions by innocent participants offered leniency demonstrated that people without mental illness or cognitive impairment, and particularly those in the late adolescent age range, can be led to confess when they believe that asserting their innocence could lead to a potentially worse outcome.

False Memory and Peer Influence

Late adolescents are also more vulnerable to false memory formation than adults. Researchers compared youth ages 16–23 with adults ages 29–58 using a classic false memory task.[191] Compared to adults ages 29–58, youth ages 16–23 were more likely to report recalling that they saw a word that had just been implied but never actually shown to them previously. This study suggests that late adolescents and young adults are more likely to form false memories than adults. Similar research showed that the tendency to report false memories increases during adolescence from ages 11 to 21.[192] This body of research indicates that late adolescents are more prone to false memory formation. This also has implications for statements made by late adolescents during interrogation, particularly when inaccurate information is intentionally or inadvertently introduced or implied during interrogation.

190 Melissa Russano et al., *Investigating True and False Confessions Within a Novel Experimental Paradigm*, 16 Psychol. Sci. 481, 482 (2005).

191 L. Meusel et al, *Youth Are More Vulnerable to False Memories Than Middle-Aged Adults Due to Liberal Response Bias.* 21 J. Can. Acad. Child & Adolescent Psych. 289 (2012).

192 Katherine McGuire, Kamala London & Daniel Wright, *Developmental Trends in False Memory Across Adolescence and Young Adulthood: A Comparison of DRM and Memory Conformity Paradigms*, 29 Applied Cognitive Psych. 334, 334–344 (2015).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Adolescent memory is also susceptible to peer influence. When late adolescents are given information attributed to a friend, they are more likely to be influenced by the friend's statement.[193] In one research study, the impact of social influence was consistent from ages 11 to 21. This demonstrates that late adolescents are just as susceptible to peer influence as early to middle adolescents.

During interrogation, adolescents are also more likely to selectively share information to protect their friends. This tendency is especially strong in late adolescence and can have implications for false confessions. Middle and late adolescents are more prone to prosocial risk-taking than young adults, but they are also more likely to take a risk to benefit a peer because they underweight the personal risks at stake.[194] For example, middle and late adolescents (ages 16–21) are more likely to engage in high-cost prosocial behaviors to defend friends and family members compared to strangers.[195] Further, research on late adolescence has demonstrated that friendship closeness can predict the willingness of an individual to take the blame for a friend's offense.[196] This means that late adolescents are willing to compromise their own reputations and perhaps even their liberty to benefit their close friends despite negative personal consequences.

Contextual Influences and Individual Differences

Lastly, an additional consideration is that late adolescents held in jail pending trial are more likely to face a difficult environmental context, which could lead them to be at increased risk of falsely confessing to a crime as a means of being released from jail. Incarceration challenges for this population include increased exposure to potentially traumatizing adversities including rape and physical assault.[197] This population is also more likely to be held in solitary confinement, which is uniquely emotionally stressful for late adolescents due to this population's heightened need for social interaction.[198] This may lead to individuals within this age group (more so than adults) confessing to crimes or accepting plea bargains when they otherwise would maintain their innocence.

193 Katherine McGuire, Kamala London & Daniel B. Wright, *Peer Influence on Event Reports Among Adolescents and Young Adults,* 19 Memory 674, 674–683 (2011).

194 Kathy Do et al, *But Is Helping You Worth The Risk? Defining Prosocial Risk-Taking in Adolescence.* 25 Developmental Cognitive Neurosci. 260, 260–271 (2017).

195 Laura Padilla-Walker et al, *Longitudinal Change in High-Cost Prosocial Behaviors of Defending and Including During the Transition to Adulthood,* 47 J. Youth & Adolescence 1853, 1853–1865 (2018).

196 Willard, J., & Burger, C. (2018). *Willingness to Falsely Take Blame Among Friends: Closeness, Reporting Wrongdoing, and Identity,* 39 Deviant Behavior 981 (2018).

197 Listwan, S. J., Daigle, L. E., Hartman, J. L., & Guastaferro, W. P. (2014). *Poly-victimization Risk in Prison: The Influence of Individual And Institutional Factors.* 29 J. Interpersonal Violence 2458 (2014).

198 *See, e.g.,* J. Lee, *Lonely Too Long: Redefining and Reforming Juvenile Solitary Confinement*. 85 Fordham L. Rev. 845 (2016).

Overall, developmental neuroscience, social science, and behavioral health research over recent decades has established that late adolescents as a group can make sound decisions when in circumstances supporting calm reflection with opportunities to communicate with others about the decisions to be made. However, when they are exposed to certain coercive and/or emotionally charged circumstances where they feel pressured to make specific statements or acknowledgements, feel as though they have limited options, and are under time pressures to decide or take action, late adolescents are vulnerable to making decisions that undermine their exercise of fundamental Constitutional protections.[199]

199 *See, e.g.,* Field, *supra* note 188.

RECEIVED by MSC 9/27/2024 8:39:40 PM

RECEIVED by MSC 9/27/2024 8:39:40 PM

Section IV: Miller Factor 5 Greater Potential for Rehabilitation

Fifth Miller factor: The greater potential for rehabilitation of youth, the limits of risk assessment, and the high likelihood of desistance from misconduct with maturation

Adolescent Brains Are Poised for Learning

Late adolescents exhibit enhanced neural sensitivity to rewards, as compared to children and adults,[200] which enhances the vulnerabilities for risk-taking described above, but also creates a window of opportunity for prosocial learning and adaptation.[201] A longitudinal learning study tested individuals ages 8–25 and found that increased activity in a key reward region in the brain (striatum) that receives inputs from dopamine centers supports learning improvements during late adolescence.[202] Developmental changes in the dopamine system increase plasticity in the brain. "Plasticity" is the term describing the brain's ability to change and adapt in response to experience. The prolonged period of plasticity during adolescence through young adulthood is also a time during which youth are neurologically primed to learn from experience.[203,204]

During late adolescence, connections between the striatum and prefrontal cortex strengthen. These developing connections support goal-directed behavior,[205] and stronger connections between the prefrontal cortex and the striatum are associated with adaptive learning strategies. Relative to children and early-middle adolescents, late adolescents ages 18–21 are more likely to update and refine their decision-making strategies after receiving rewards for "successful" decisions. This change in learning strategy is associated with enhanced connectivity between

200 Barbara Braams et al, *Longitudinal Changes in Adolescent Risk-Taking: A Comprehensive Study of Neural Responses to Rewards, Pubertal Development, and Risk-Taking Behavior.* 35 J. Neurosci 7226, 7226–7238 (2015).

201 Samantha DePasque & Adriana Galván, *Frontostriatal Development and Probabilistic Reinforcement Learning During Adolescence*, 143 Neurobiology Learning & Memory 1 (2017); Juliet Davidow et al, *An Upside to Reward Sensitivity: The Hippocampus Supports Enhanced Reinforcement Learning in Adolescence,* 92 Neuron 93 (2016).

202 Sander Peters & Eveline Crone, *Increased Striatal Activity in Adolescence Bene its Learning*, 8 Nature Communications 1 (2017).

203 Surjeet Mastwal et al, *Phasic Dopamine Neuron Activity Elicits Unique Mesofrontal Plasticity in Adolescence*, 34 J. Neuroscience 9484 (2014).

204 Vishnu Murty, Finnegan Calabro & Beatriz Luna, *The Role of Experience in Adolescent Cognitive Development: Integration of Executive, Memory, and Mesolimbic Systems*, 70 Neurosci. & Biobehavioral Rev. 46 (2016).

205 Catherine Insel et al, *Development of Corticostriatal Connectivity Constrains Goal-Directed Behavior During Adolescence,* 8 Nature Comm. 1 (2017); Juliet Davidow, Catherine Insel & Leah Somerville, *Adolescent Development of Value-Guided Goal Pursuit,* 22 Trends Cognitive Sci. 725 (2018).

RECEIVED by MSC 9/27/2024 8:39:40 PM

the striatum and prefrontal cortex.[206] When learning from feedback, research indicates that late adolescents are more responsive to positive feedback (including both material rewards and social rewards such as praise and recognition) than to punishments.[207]

The neuroscience and behavioral research indicate that late adolescents are particularly well suited to learning from experience given the right circumstances and contexts. Further, positive reinforcement may be especially beneficial for adolescent learning, as late adolescents are more responsive to learning from reward than punishment. This has direct consequences for intervention and rehabilitation, as the research demonstrates that late adolescents are more likely to learn from the outcomes of their experiences to change their behavior[208] unless their capacities for social and other learning are compromised by psychiatric, developmental, or cognitive challenges. This, of course, has direct bearing for how to best promote positive behavioral change in youths.

Middle and Late Adolescent Behavior Patterns and Emerging Personality Features Are More Malleable Than Those of Adults

As noted by the United States Supreme Court in *Roper, Graham,* and *Miller,* the frequency of criminal offending increases in late adolescence and then tapers off in early adulthood.[209] Most late adolescents who are chronically involved in the criminal justice system and/or commit violent acts are likely to self-desist from or "age out" of crime as they enter into adulthood, with or without punitive intervention.[210] As discussed in Section I (page 10), middle and late adolescence is a time where individuals are predisposed to impulsive decision-making, preferring immediate over delayed rewards (future discounting), and peer influence.

In 2019, there were more than 10 million crimes committed in the United States. Individuals ages 18–20 accounted for 8% of all offenses and 8.76% of all violent offenses.[211] In a criminal trajectory study, which included individuals who were classified as persistent and serious

206 Wouter can den Bos et al, *Striatum–Medial Prefrontal Cortex Connectivity Predicts Developmental Changes In Reinforcement Learning*, 22 Cerebral Cortex 1247 (2012).

207 Dorothea Hämmerer et al, *Life Span Differences In Electrophysiological Correlates Of Monitoring Gains And Losses During Probabilistic Reinforcement Learning*, 23 J. Cognitive Neuroscience 579 (2011); Katherine Luking et al, *Do Losses Loom Larger for Children than Adults?* 16 Emotion 338 (2016).; Catherine Insel & Leah Somerville, *Asymmetric Neural Tracking of Gain and Loss Magnitude During Adolescence*, 13 Soc Cognitive & Affective Neurosci. 785 (2018).

208 Arielle Baskin-Sommers et al, *Towards Targeted Interventions: Examining the Science Behind Interventions for Youth Who Offend.* 5 Ann. Rev. Criminology (forthcoming 2022).

209 Natsuaki Misaki, Xioajia Ge & Ernst Wenk, *Continuity and Changes in the Developmental Trajectories of Criminal Career: Examining the Roles of Timing of First Arrest and High School Graduation*, 37 J. Youth & Adolescence 431, (2008).

210 Terrie Moffit, *Male Antisocial Behaviour in Adolescence and Beyond*, 2 Nature Human Behaviour 177 (2018); Georg Kessler, *Delinquency in Emerging Adulthood: Insights into Trajectories of Young Adults in a German Sample and Implications for Measuring Continuity of Offending*. 6 J. Developmental & Life-Course Criminology 424, 424–447 (2020); Maryann Davis et al, *Reducing Recidivism and Symptoms in Emerging Adults with Serious Mental Health Conditions and Justice System Involvement*. 42 J. Behavioral Health Services & Rsch. 172, 172–190 (2015).

211 *See* Off. of Juvenile Justice and Delinquency Prevention, *Estimated number of arrests by offense and age group*, U.S. Dep't Just. (2019), https://www.ojjdp.gov/ojstatbb/crime/ucr.asp?table_in=1 [https://perma.cc/T6H7–3LWX].

RECEIVED by MSC 9/27/2024 8:39:40 PM

delinquents, most individuals who committed serious crimes at 17 and 18 (including armed robbery and felony assault) did not continue to engage in antisocial behavior into adulthood, following court involvement.[212]

Violent crime peaks at ages 17–19 and decreases in the early twenties.[213] While counterintuitive, a robust body of research indicates that committing a violent crime before age 20 is not a strong predictor of a persistent criminal trajectory.[214] While there are no research studies involving solely late adolescents, research indicates that early and middle adolescents who commit homicides have similar rates of desistance from misconduct to youth who commit other kinds of less serious offenses, and committing a homicide in adolescence is not itself a predictor of either future violent or non-violent recidivism .[215]

This is in part, because—as discussed in Section I (page 10)—characteristics such as impulsivity, poor decision-making in "hot cognition" contexts and susceptibility to peer influence diminish as the brain continues to develop. However, while *most* late adolescents who commit crimes do not significantly penetrate the adult criminal justice system, pre-adolescent onset of criminal behavior is associated with a higher likelihood of persistent criminal offending behavior [216] and greater exposure to childhood adversities.[217] Versatility of criminal offending is also more likely among those who continue to commit more serious crimes into adulthood.[218] However, as previously noted, *most* chronic and repeat offenders in youth do not persist into adulthood.

Adolescence Gives Rise to Developmentally Expectable Changes in Behavior

Adolescence is characterized by evolving identity, fluctuating family and social relationships, changing motivations and goals, and maturing physical characteristics and cognitive abilities.[219] Adolescent brains continue to develop as they amass life experience. Brain development also responds to the characteristics of the specific physical and social environment within which the adolescent is maturing. Their decision-making, relationships, their ways of understanding the world they navigate, emotional regulation, and behaviors will necessarily change with age as

212 Edward Mulvey et al, *Trajectories of Desistance and Continuity in Antisocial Behavior Following Court Adjudication Among Serious Adolescent Offenders*, 22 Development & Psychopathology 453 (2010).

213 *See, e.g.*, Off. Juv. Just. Delinq. Prot., *Law Enforcement & Juvenile Crime: Arrests by Offense, Age, and Gender,* U.S. Dep't of Justice (Oct. 21, 2019), https://www.ojjdp.gov/ojstatbb/crime/ucr.asp?table_in=1 [https://perma.cc/T6H7–3LWX]; Alex Piquero, et al, *Criminal Career Patterns*, *in* From Juvenile Delinquency to Adult Crime: Criminal Careers, Justice Policy, and Prevention 14 (Rolf Loeber & David P. Farrington eds., 2012).

214 *See* Piquero, *supra* note 215.

215 Elizebth Cauffman & Laurence Steinberg, *(Im)Maturity of Judgment in Adolescence: Why Adolescents May Be Less Culpable Than Adults*, 18 Behav. sci. & l. 741 (2000); M. DeLisi, A.R. Piquero & S. M. Cardwell, *The unpredictability of murder: Juvenile homicide in the pathways to desistance study*, 14 Youth Violence & Juv. Just. 26 (2000).

216 Terrie Moffitt, *Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy*, 100 Psychol. Rev. 674 (1993).

217 Michael Baglivio et al, *The Relationship Between Adverse Childhood Experiences (ACE) and Juvenile Offending Trajectories in a Juvenile Offender Sample*, 43 J. Crim. Just. 229, 229–241 (2015).

218 Moffit, *supra* note 218.

219 Casey, *supra* note 18.

RECEIVED by MSC 9/27/2024 8:39:40 PM

each person transitions across adolescence and young adulthood. For example, development of the prefrontal cortex is accompanied by improvements in self-control and decision-making[220] that are reflected in desistance of misconduct, diminished impulsivity and risk-taking, and long-term planning towards goals.

This is developmentally to be expected. It is currently not possible to reliably predict an individual adolescent's future developmental trajectory based upon current presentation and past history. This is partly because of the high rates of desistance from antisocial conduct as youth mature into young adulthood and partly because behavioral, emotional, and attitudinal changes are expected components of adolescent development.[221] It is also currently scientifically impossible to reliably predict how much or how quickly an individual will change with age based on their presumed brain development, history, or current behavioral profiles.[222]

While adolescents, as compared to adults, may exhibit increased impulsivity and riskier decision-making, these behaviors are ordinarily temporary and developmentally expected.[223] In certain situations, enhanced risk-taking tendencies can be adaptive to promote learning and exploration.[224] These changing behaviors help adolescents navigate the world as they seek to establish autonomy and self-efficacy in society, including risk-taking to achieve positive goals. However, this developmental brain-based behavioral profile also increases risk for problematic behaviors during adolescence.[225] Risk-taking and impulsivity peak during childhood and adolescence and then decrease with age.[226] This developmental trajectory is reflected in age-related changes in delinquent and criminal misconduct (primarily property, substance possession, and other non-violent misconduct), which surges from early through late adolescence and then declines during young adulthood.[227]

220 Catherine Insel et al, *Development of Corticostriatal Connectivity Constrains Goal-Directed Behavior During Adolescence,* 8 Nature Comm. 1 (2018); Davidow, *supra* note 207.

221 Brief of Amici Curiae Professional Organizations, Practitioners, and Academics in the Fields of Neuroscience, Neuropsychology, and Other Related Fields in Support of Petitioner, *Wardlow v. State of Texas*, 141 S. Ct. 190 (2020) (No. 19–8712), https://www.supremecourt.gov/DocketPDF/19/19–8712/145983/20200619160740671_19–8712%20-%20Wardlow%20v.%20Texas%20-%20Professional%20Organizations%20et%20al.%20cert.%20amicus.pdf; Monahan et al., *Trajectories of Antisocial Behavior and Psychosocial Maturity from Adolescence to Young Adulthood*, 45 Developmental Psychol. 1654, 1655 (2009).

222 Violence and Serious Theft: Development and Prediction from Childhood to Adulthood 333 (Rolf Loeber, David Farrington, Magda Stouthamer-Loeber & Helene Raskin White, eds., 2008).

223 Gail Rosenbaum & Catherine Hartley, *Developmental Perspectives on Risky and Impulsive Choice*, 374 Phil. Transactions Royal Soc'y 1766 (2019).

224 Duell, *supra* note 50.

225 Whitney Fosco et al, *The Development of Inhibitory Control in Adolescence and Prospective Relations with Delinquency*, 76 J. Adolescence 37 (2019).

226 Natasha Duell et al, *Age Patterns in Risk-Taking Across The World*. 47 J. Youth & Adolescence 1052 (2018).

227 David Farrington, Rolf Loeber & James Howell, *Young Adult Offenders: The Need for More Effective Legislative Options and Justice Processing*, 11 Crim. & Pub. Pol'y 729 (2012).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Personality Continues to Change Across the Lifespan

Research has long demonstrated that personality is not firmly established in adolescence. Indeed, the 20s are a time of significant evolution of many personality traits, including growth in conscientiousness, self-discipline, and emotional stability.[228] Similarly, adolescence is characterized by continuous changes in personality as adolescents work to form a sense of identity.[229] Personality traits are influenced by environmental and contextual factors such as changing social roles and relationships. [230] Adolescents are uniquely attuned to their social world, and they are highly influenced by the perceptions and behaviors of their peers.[231]

On average, as adolescents age, they exhibit decreases in neuroticism[232] and increases in agreeableness, conscientiousness, openness, and extraversion.[233] Self-control and emotional stability also increase with age, with continued changes in the third and fourth decades of life.[234] As with most developmental research, studies of personality rely upon group averages so research cannot reliably predict whether or how a particular individual's personality will change with age.

Converging research from psychological science simply does not support a view that most youth offenders are incorrigible.[235] In fact, as described above, the science supports a view that (a) the significant majority of adolescent offenders will self-desist from misconduct with maturation, (b) that misconduct typically reflects the "transient immaturity" of youth, and (c) that it is not currently possible to reliably identify the "rare" juvenile who will fail at rehabilitation efforts over the course of a lifetime.

Research on personality and identity formation in late adolescents indicates that behavioral or temperamental traits change significantly through maturation. In other words, personality traits that once were believed to be fixed are actually subject to change over time. This is the case even for adolescents who display callous-unemotional traits and psychopathic traits, which

228 Cohen, *supra* note 12; Brent Roberts & Daniel Mroczek, *Personality Trait Change in Adulthood*, 17 Current Directions Psych. Sci 31 (2008); Brent Roberts, Kate Walton, Wolfgang Viechtbauer, *Patterns of Mean-Level Change in Personality Traits Across the Life Course: A Meta-Analysis of Longitudinal Studies.* 132 Psych. Bulletin 1 (2006); Brent Roberts & Dustin Wood, *Personality Development in the Context of the Neo-Socioanalytic Model of Personality, in* Handbook of Personality Development 11–39 (2006).

229 Theo Klimstra, *Adolescent Personality Development and Identity Formation*, 7 Child Development Perspectives 80, 80–84 (2012).

230 Brent Roberts, Dustin Wood & Jennifer Smith, *Evaluating Five Factor Theory and Social Investment Perspectives on Personality Development*, 39 J. Rsch. Personality 166, 166–184 (2005).

231 Sarah Blakemore & Jathryn Mills*, Is Adolescence a Sensitive Period for Sociocultural Processing?* 65 Ann. Rev. Psych, 187, 187–207 (2014); Leah Somerville*, Special Issue on the Teenage Brain: Sensitivity to Social Evaluation.* 22 Current Directions Psych. Sci 121, 121–127; Braams, *supra* note 152; Lisa Knoll et al, *Social Influence on Risk Perception During Adolescence*, 26 Psych. Sci. 583, 583–592 (2015).

232 Neuroticism is a trait characterized by a tendency to experience intense negative emotions and emotional instability in response to various forms of stress.

233 Theo Klimstra et al, *Maturation of Personality in Adolescence*, 96 J. Personality & Soc. Psych. 898, 898–912 (2009).

234 Casey, *supra* note 12; Roberts BW, Mroczek D. 2008. Personality Trait Change in Adulthood. *Curr Dir Psychol Sci* 17: 31–35

235 Casey, *supra* note 12.

RECEIVED by MSC 9/27/2024 8:39:40 PM

turn out not to be confidently predictive of life-course-persistent offending into adulthood.[236] For example, in a longitudinal study of middle and late adolescents, ages 17–24, researchers found that previously identified psychopathic personality traits[237] decreased over time in late adolescents until age 24.[238]

For late adolescents who engage in criminal behavior, relying upon approaches that build on buttressing individual strengths and resiliencies, at a time when the brain's plasticity facilitates new learning from experience, can promote positive growth and prevent further penetration into the criminal justice system.[239] These approaches must be able to take into account the contributions to rehabilitation or continued criminality of the typically large number of social systems: family, peers, schools, their neighborhood and community, and public agencies.

Consistent interpersonal relationships with young and older adults and social engagement that supports positive prosocial relationships and activities are important for:

- fostering resilience and self-efficacy
- bolstering coping strategies and emotional self-regulation
- building on strengths
- improving prosocial competencies
- increasing a sense of personal responsibility
- establishing goals for the future
- providing opportunities for prosocial engagement and a sense of meaning, and
- establishing healthy and adaptive attitudes, values, and beliefs (norms)[240] that are inconsistent with continuing criminal misconduct.

236 Jennifer Skeem et al, *Psychopathic Personality: Bridging the Gap Between Scientific Evidence and Public Policy*, 12 Psych. Sci Pub. Interest, 95, 95–162 (2011); Matthew Harris et al, *Personality Stability from Age 14 to Age 77 Years*, 31 Psych. & Aging, 862 (2016).

237 Psychopathic personality traits include, for example, a lack of empathy, immoral behavior, and limited emotional responses.

238 Samuel Hawes et al, *Structural Coherence and Temporal Stability of Psychopathic Personality Features During Emerging Adulthood*, 123 J. Abnormal Psych. 623 (2014).

239 Anderson Moore, *Why Positive Youth Development Works*, Child Trends (2016) https://www.childtrends.org/why-positive-youthdevelopment-works [https://perma.cc/9CVX-JVSA]; Family & Youth Services Bureau, *Positive Youth Development,* Admin. For Children & Families, https://www.acf.hhs.gov/fysb/positive-youth-development; [https://perma.cc/NS47-DTVQ] (last visited Dec 20, 2021); Arielle Baskin-Sommers, *Towards Targeted Interventions: Examining the Science Behind Interventions for Youth Who Offend*. 5 Ann. Rev. Crim. (forthcoming 2022).

240 Moore, *supra* note 241.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Conclusion and Recommendations

The United States Supreme Court cases of *Roper* (2005), *Graham* (2010), and *Miller* (2012) drew attention to adolescent and young adult brain and social development by clearly articulating a "children are different" Eighth Amendment jurisprudence. In *Montgomery* (2016), SCOTUS maintained this line of jurisprudence and clarified that *Miller* was to be applied by states retroactively as mandatory Life Without Parole juvenile sentences (JLWOP) are substantive violations of the Eighth Amendment.

The *Jones* (2021) decision held that sentencing courts are not required to articulate findings that a juvenile is "irreparably corrupt" or even required to make findings on the specific "*Miller* factors" previously outlined. However, the *Jones* opinion left undisturbed the position of the prior cases that even serious crimes committed by persons under age 18 reflect the "transient immaturity" of youth" but for "rare" cases. The challenges of reliably identifying these "rare" youth required barring execution for crimes committed as a minor (*Roper)* and presumably would render discretionary JLWOP sentencing "uncommon" (*Miller).* Even then, a sentenced youth must be provided at least one "meaningful opportunity" to demonstrate rehabilitation as an adult.

Between 2005–2021, states have responded through case law and legislative action to craft frameworks consistent with the SCOTUS line of cases. The variability of the state responses has resulted in a patchwork of "justice by geography" with disparate outcomes for similarly situated cases. However, it also affords an opportunity by clarifying that the focus has shifted from whether a sentencing court must make findings of "irreparable corruption" to a focus on the undisturbed acknowledgement of the "transient immaturity" of youth—even for those who have committed heinous crimes as minors. While *Jones* does not impose a federal Constitutional requirement on sentencing judges to make findings regarding "irreparable corruption" or the *Miller* factors, some states have already incorporated these steps in their state statutes and/or case law. Even where states have not incorporated these steps in their legal framework, there is nothing in *Jones* or state law that bars submitting evidence relevant to the "transient immaturity" of a youthful defendant or the *Miller* factors.

Moreover, the focus in this line of cases upon the dispositive "bright line" drawn at age 18 for imposing accountability through the adult criminal legal system has raised the question: Is there a reasonable basis found in brain science and developmental research (social, behavioral, criminology) for drawing this line at age 18? Put another way, is there a basis in science for drawing this life-altering line between mid-adolescence (ages 16–17) and late adolescence (ages 18–21)? The neuroscience and social-behavioral science summarized in this document indicates there is no solid basis in science for a line drawn at age 18 for criminal jurisdiction.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Indeed, drawing this line at age 18 will lead most late adolescents who offend (and most will *not* offend with serious crimes against persons) to penetrate the criminal justice system just before the time when the significant majority of middle and late adolescent youth will self-desist (the "age-crime curve" occurring at ages 19–20) even if they have been violent and persistent offenders when younger.

From a public policy perspective, this means that young offenders highly likely to desist with maturation—especially if provided with meaningful non-criminal opportunities—will instead accrue the collateral consequences of criminal justice involvement (e.g., criminal records, social labeling, forced affiliation with adult criminals if in prolonged detention or incarcerated). These collateral consequences over time actually *increase* risk of criminal recidivism among young offenders who with maturation are otherwise highly likely desist from continuing criminal misconduct.

From a criminal justice perspective, research indicates that continuing traditional supervision and sentencing practices inadvertently tend to increase recidivism, fail to foster diversion from unwarranted penetration into the criminal justice system, and continue the pattern of disproportionate entanglement of young persons of color. Parole practices focused primarily on "supervision"—rather than "engagement" and individualized case planning—will persist. Younger offenders will continue to be processed at least as harshly (and arguably more harshly) than adult offenders.

This is not to suggest that younger offenders (ages 18–21) should not be accountable for criminal conduct. Indeed, accountability for decisions and conduct is essential for positive development and maturation. Rather, it is to observe that the science exists to guide policy and individual case practice (for judges and probation officers, prosecutors and defense counsel, and others) towards *proportional* and *developmentally aligned* accountability for middle and late adolescent offenders. Our currently worrisome rates of recidivism among younger offenders can be lowered—thereby contributing to community safety—by adopting a developmentally-informed approach to young offenders.

At a policy level, our currently dismal criminal justice outcomes could be improved for this age cohort by designing and implementing evidence-based processes for diversion, preventing unwarranted penetration (including pre-trial detention and avoiding harsh sentencing), and resourcing developmentally specialized intervention for late adolescent offenders which supports prosocial activities (including non-criminal social networks, education, and jobs). Corrections policy may look to evidence-based models in the United States and elsewhere which improve recidivism outcomes by separating younger offenders from older adult offenders, placing them into their own units with developmentally aligned programming, and using

RECEIVED by MSC 9/27/2024 8:39:40 PM

developmentally-trained correctional, educational, pre-vocational, and behavioral health staff to utilize less punitive approaches and support positive community re-entry, thus increasing the likelihood of avoiding future criminal involvement.[241]

Judges can support local implementation of these kinds of policy measures while also informing themselves about the relevant brain and developmental science, considering science offered in briefs and expert testimony, encouraging processes (including plea agreements) which take the developmental status of younger offenders into account, and taking into account the inadvertent consequences of harsh sentencing or more punitive supervision practices. Judges may also look to emerging court-based models of deferred sentencing or innovative sentencing that may be adaptable to the local circumstances and resources of their jurisdiction.

Prosecutors can measure their success by metrics other than convictions and lengths of sentences imposed. For example, metrics can include cases successfully diverted from arraignment without subsequent recidivism, or cases where incarceration was precluded because of successful community-based and developmentally aligned services (e.g., education, vocation, prosocial interpersonal engagement, and behavioral health treatment) as part of initial diversion or subsequent plea bargaining.

Defense counsel can take a broader developmental view (taking into account biological, psychological, and social domains) of who the defendant is and what criminogenic needs must be addressed to lower recidivism risk. They can also learn how to create a complete trial record that includes successful and unsuccessful efforts to bring scientific and/or developmental information before the court in briefs, expert testimony, and oral argument. Appellate counsels are often disadvantaged by incomplete or unartful trial records and efforts are increasingly underway to train trial counsel on how to develop the best records possible.

241 Group-level research that yields “on average” data is a ready fit for guiding broad policy and program development and implementation. For example, policy and law can result in increased community safety if aligned with research finding that “on average” adolescents or youth adults diverted from unnecessary penetration into juvenile or criminal justice systems have lower recidivism rates than those who become entangled in these systems for relatively minor misconduct or misconduct that is likely to remit with maturation. The policy impact can be achieved without specifically assessing the likelihood that a given young person will desist, as the policy anticipates that a significant majority of young persons will desist from delinquent or criminal misconduct with maturation. This is similar to medical practice where decisions and practices are made for identified patient populations because they ordinarily work—such as prescribing antibiotics for certain kinds of infections although there may be some patients for whom the standard practice will not be as effective and alternatives may be considered.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Pre-trial and post-conviction probation staff can take a developmentally and trauma-informed approach to intake, recommendations made to the court, and supervision practices. These can include: (a) avoiding conditions of release/probation likely to result in violation but unlikely to contribute to public safety threat even if not fully complied with by the person under supervision; (b) advocating for conditions of release/probation that are likely to contribute to the person's stabilization and avoiding new arrests; (c) creating highly individualized supervision plans that are informed by the science of normal mid-late adolescent development, adversity/trauma, addictions, and mental health disorders; and (d) case planning that directly addresses each person's most significant criminogenic needs while building upon strengths and protective factors.

Behavioral health professionals likely to conduct forensic evaluations, provide forensic expert testimony, or provide clinical testimony about behavioral health needs/interventions for defendants can strive to be currently informed of relevant research domains. These include brain and developmental research about mid-late adolescents, the "age-crime curve," evidence-based assessment methods (clinical and forensic, including violence and recidivism risk), and evidence-based treatment and intervention approaches for younger offenders. Standard clinical training is ordinarily insufficient to provide proficiency in working with younger offenders, and, in any event, the continuing development of research in this area requires an ongoing process of professional development and learning.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix: Introduction to Middle and Late Adolescent Brain Development

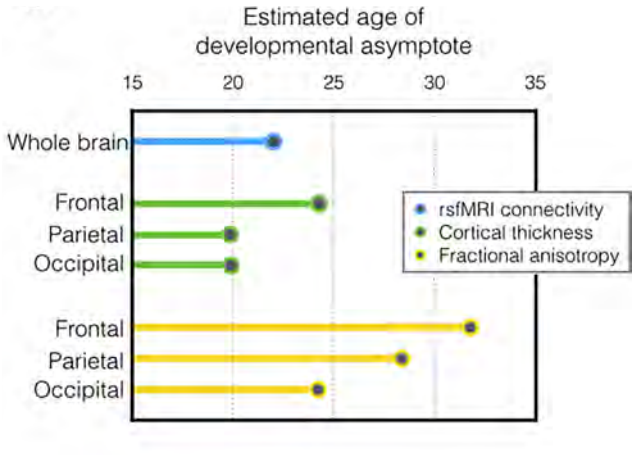


Figure 5: Somerville 2016. Age of developmental asymptote (plateau) for different brain measures. rsfMRI is a measure of whole brain connectivity; cortical thickness is a measure of grey matter development; fractional anisotropy is a measure of white matter development.

Brain development is a dynamic process that continues throughout the life course. Throughout early, middle, and late adolescence,[242] brain systems and the connections between them undergo a period of prolonged refinement.

Since *Miller* (2012), there have been a wealth of new research studies on adolescent brain development that have enhanced our understanding of how the brain matures and how this maturation impacts behavior. Scientists have begun using new approaches to measure brain development. Many newer studies include more individuals (large sample size), and some studies follow the same individuals over time (longitudinal research).[243] With this type of data, researchers can model a "growth curve"[244] of how the brain changes across development by averaging the brain changes of many individuals across different ages and time points. Researchers can measure the age at which the changes of different brain systems level off or plateau. Researchers can also estimate when a brain system reaches a point of stable

242 Because brain development does not rigidly conform to chronological boundaries, there is some disagreement in the field as to how to precisely define the stages of adolescence and adulthood. For clarity, in this document, we define early adolescence as 10–13, middle adolescence as 14–17, late adolescence as 18–21, and young adulthood as 22–25. For discussion of changing age definitions, *see* Susan Sawyer et al, *The Age of Adolescence*. 2 Lancet Child & Adolescent Health 223, 223–228 (2018).

243 A longitudinal study is a study that tracks individuals over time.

244 A "growth curve" is a graphical depiction of change over time. A "growth curve" of brain development depicts changes in brain processes as a function of age.

RECEIVED by MSC 9/27/2024 8:39:40 PM

development.[245] It is important to note that different systems develop at different rates, and the brain never "stops developing," as brain development continues throughout the lifespan. Additionally, development does not occur at the same rate in all areas of the brain. Rather, different brain systems follow different developmental trajectories and time windows.

Dynamic changes in brain development continue well beyond the age of 18 (Figure 5).[245] This extended window of brain maturation is paralleled by prolonged social, emotional, and cognitive development during late adolescence.[246] As a result, late adolescents (ages 18–21) as a group, exhibit unique brain and behavioral profiles that are distinct from both younger adolescents and young adults (ages 22–25).

Fundamentals of Late Adolescent Brain Development

Structural Development

Late adolescence is accompanied by continued development of brain structure. Multiple brain regions and the connections between them continue to mature during this period. The last region to structurally mature is the prefrontal cortex, which guides "executive functions" such as complex decision-making, self-control, and higher-order cognitions.[247]

245 Somerville, *supra* note 11.

246 Laurence Steinberg & Grace Icenogle, *Using Developmental Science to Distinguish Adolescents and Adults Under the Law*, 1 Ann. Rev. Developmental Psych. 21 (2019).

247 "Higher order cognitions" include abilities to consider situations from the perspective of another person, identify and assess the likelihood of future alternate outcomes of decisions made now, and systematic and evaluative problem-solving that is also sufficiently flexible to effectively apply past experiences to novel situations (creativity).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Grey Matter Development

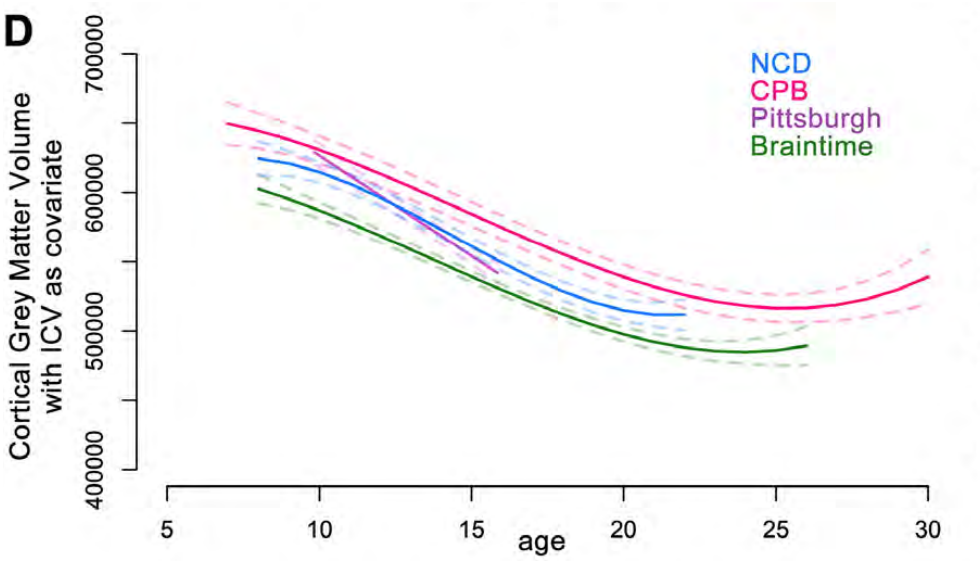


Figure 6: Mills et al. 2016. Age models for cortical grey matter across four research sites. Each line represents a different research site. This study included 852 scans for 391 individuals age 8 to 30. Note that the upturn from age 25 to 30 is not statistically significant.

Grey matter is tissue in the brain that is responsible for information processing. Grey matter volume normatively thins during adolescence, and thinning persists through young adulthood.[248] This decrease in grey matter results from a brain refinement process called synaptic pruning. Synaptic pruning is an experience-dependent process that weeds out underused synapses (connections between neurons). This developmental process sculpts a more efficient

248 Rhoshel Lenroot et al, *Sexual Dimorphism of Brain Developmental Trajectories During Childhood and Adolescence*, 36 Neuroimage 1065 (2007).

RECEIVED by MSC 9/27/2024 8:39:40 PM

and specialized brain.[249] [250] Pruning during late adolescence is more pronounced in regions that support higher-level cognition, including the prefrontal cortex, which is among the last regions to mature. Prefrontal synaptic pruning persists well beyond adolescence and continues into young adulthood.[251]

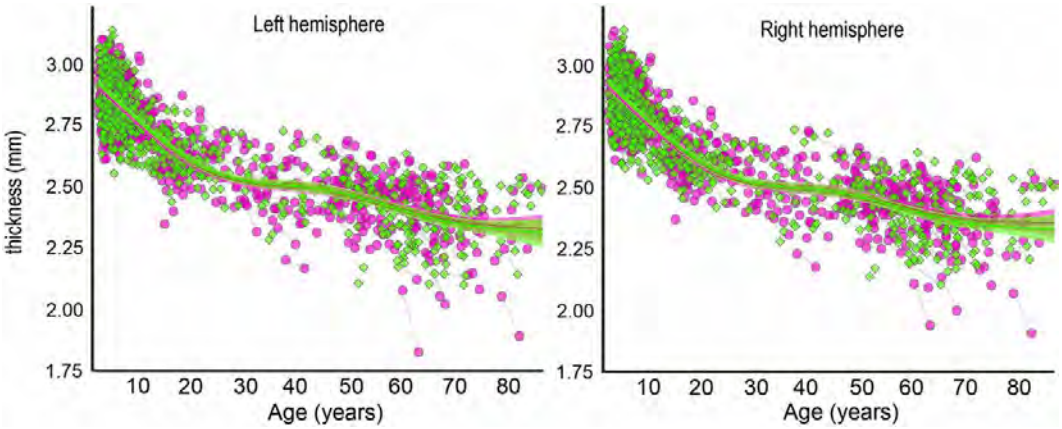


Figure 7: Fjell et al. 2015. Global changes in cortical thickness. Longitudinal study testing 974 participants ages 4–89. Green is female, pink is male.

Converging evidence across multiple studies and institutions demonstrates that grey matter thinning continues throughout the twenties (Figure 6).[252] Research examining structural development across the lifespan found that cortical thinning begins to plateau between ages 25 and 30 (Figure 7).[253] The prefrontal cortex in particular shows dramatic thinning, with a 17% reduction in prefrontal grey matter volume between the ages of 6 and 26.[254]

249 Zdravko Petanjek et al, *Extraordinary Neoteny of Synaptic Spines in the Human Prefrontal Cortex*, 108 Proc. Nat'l Acad. Sci. Acad. Sci. 13281 (2011).

250 Budhachandra Khundrakpam et al, *Brain Connectivity in Normally Developing Children and Adolescents*. 134 Neuroimage 192 (2016).

251 Zdravko Petaniek et al, *Extraordinary Neoteny of Synaptic Spines in the Human Prefrontal Cortex*, 108 Proc. Nat'l Acad. Sci. 13281 (2011).

252 Kathryn Mills et al, *Structural Brain Development Between Childhood and Adulthood: Convergence Across Four Longitudinal Samples*, 141 Neuroimage 273 (2016); Christian Tamnes et al, *Development of the Cerebral Cortex Across Adolescence: A Multisample Study of Inter-Related Longitudinal Changes in Cortical Volume, Surface Area, and Thickness*, 37 J. Neuroscience 3402 (2017).

253 Hugo Schnack et al, *Changes in Thickness and Surface Area of The Human Cortex and Their Relationship with Intelligence*, 25 Cerebral Cortex 1608 (2015); Anders Fjell et al, *Development and Aging of Cortical Thickness Correspond to Genetic Organization Patterns*, 112 Proc. Nat'l Acad. Sci. 15462 (2015).

254 Kathryn Mills et al, *The Developmental Mismatch in Structural Brain Maturation During Adolescence*, 36 Developmental neuroscience 147 (2014).

RECEIVED by MSC 9/27/2024 8:39:40 PM

White Matter Development

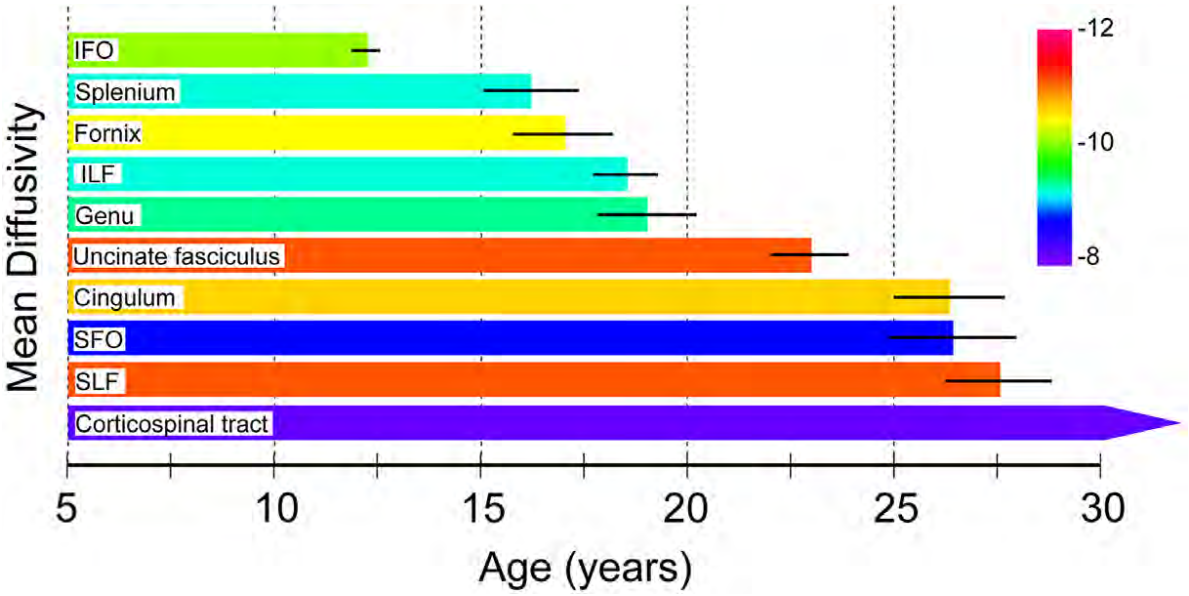


Figure 8: Lebel et al. 2019. Plot showing white matter development from age 5 to 30 in different white matter tracts of the brain (colored bars). Decreases in mean diffusivity provide an approximation of strengthening white matter connections. The end of each bar represents the age at which the measure reaches 90% of its developmental plateau. IFO: inferior fronto-occipital fasciculus; ILF: inferior longitudinal fasciculus; SFO: superior fronto-occipital fasciculus; SLF: superior longitudinal fasciculus.

White matter is tissue that is composed of tracts, which are bundles of myelinated axons in the brain that can relay information between brain regions. White matter connections facilitate efficient communication across the brain. Developmental changes in white matter are thought to reflect myelination. Myelin is a substance that surrounds neuron axons and serves an insulating function for the brain's wiring, which facilitates more rapid communication between brain regions. The process of myelination increases the amount of myelin in the brain, which speeds up communication between different brain regions. During late adolescence, myelination strengthens communication between brain regions that are far apart from one another in the brain. During this period, myelination progresses in the prefrontal cortex, which strengthens connections that are important for reasoning, decision-making, and self-control.[255]

Longitudinal studies have demonstrated that the development of white matter continues throughout the twenties and into the thirties (Figure 8).[256] Notably, connections between the prefrontal cortex and subcortical regions[257] continue to develop past age 18. Maturation of

255 Daniel Miller et al, *Prolonged Myelination in Human Neocortical Evolution*, 109 Proc. Nat'l Acad. Sci. 16480 (2012).

256 Catherine Lebel, Sarah Treit & Christian Beaulieu, *A Review of Diffusion MRI of Typical White Matter Development from Early Childhood to Young Adulthood*, 32 NMR Biomedicine E3778 (2019).

257 Subcortical regions include the hippocampus, amygdala, and striatum. These regions are important for reward processing, processing of emotionally arousing and salient information, and learning and memory.

RECEIVED by MSC 9/27/2024 8:39:40 PM

these white matter connections is associated with improved self-control.[258] Connections between the prefrontal cortex and subcortical regions continue to develop through the twenties.[259] This means that communication and integration within brain networks continue to refine through late adolescence and young adulthood to support higher-order cognition.

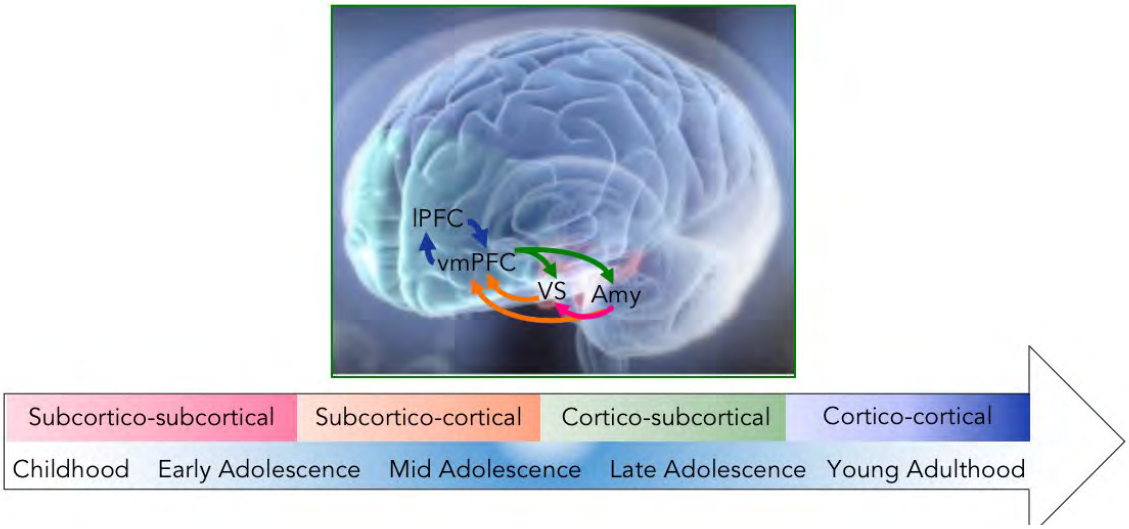


Figure 9: Casey 2020. Illustration of hierarchical development of brain circuitry. Amy is amygdala; VS is ventral striatum; vmPFC is ventromedial prefrontal cortex; lPFC is lateral prefrontal cortex.

Functional Development

While structural development reflects changes in the physical architecture of the brain, functional development reflects changes in the activity in brain regions and the communication between them in response to stimuli in the environment. In other words, functional development describes changes in how the brain's elements communicate with one another to produce cognitions and emotion. During adolescence, functional activity in brain regions and the functional connections between brain networks exhibit changes with age, which suggests that some regions and connections develop at different rates. This means that the development of distinct brain processes stabilizes at different ages (Figure 9).[260] Therefore, the development of some regions and connections stabilizes earlier in adolescence, whereas others continue to mature well into the twenties and early thirties.[261] [262]

258 Daniel Simmonds et al, *Developmental Stages and Sex Differences of White Matter and Behavioral Development Through Adolescence: A Longitudinal Diffusion Tensor Imaging (DTI Study*, 92 Neuroimage 356 (2014).

259 *Id.*

260 Casey, *supra* note 42.

261 B. J. Casey, Rebecca Jones & Leah Somerville, *Braking and Accelerating of the Adolescent Brain,* 21 J. Rsch. on Adolescence 21 (2011).

262 Leah Somerville & B.J. Casey, *Developmental Neurobiology of Cognitive Control and Motivational Systems*, 20 Current Op. Neurobiology 236 (2010).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Subcortical regions have earlier structural development in adolescence than cortical regions.[263] Subcortical regions include the striatum and amygdala, which are important for emotional and motivational processes like responding to rewards, emotionally salient information, and faces. In contrast, the prefrontal cortex, which guides self-control and complex decision-making, continues to mature throughout late adolescence. This extended window of prefrontal maturation supports the development of executive functioning, a set of mental processes that help with concentration, attention, cognitive flexibility, and self-control.[264]

The development of the prefrontal cortex, which guides self-control, exhibits a more protracted trajectory than the development of subcortical regions which are responsive to rewards and salient cues. As a result, late adolescents exhibit unique behavioral responses in reward-driven or emotionally heated situations. On the one hand, because the prefrontal cortex is more developed than it was during earlier periods in their lives, late adolescents have better cognitive control and decision-making skills than they did when they were younger. On the other hand, because the motivational and emotional systems in the brain are hyper-responsive during adolescence, middle and late adolescents as a group are more vulnerable than adults to lapses in self-control or impulsive decision-making—especially when in emotionally heated situations.[265]

Functional connectivity reveals which regions show synchronous activation. In other words, two regions are functionally connected if they show similar patterns of activity over time during a task or when at rest. Functional connectivity measures characteristics of the pathways the brain uses to communicate. The functional connections between brain regions continue to refine through late adolescence as connectivity patterns shift with age. Younger individuals exhibit more connections between regions that are closer together. However, during adolescence, connections strengthen among regions that are farther apart.[266] This enhanced integration supports the development of executive functions[267] which support complex reasoning and emotional regulation.

Emotional Influences on Cognition in the Late Adolescent Brain

Adolescents' cognitive abilities continue to strengthen as they age. However, adolescent self-control is more vulnerable to disruption than the self-control of adults. Specifically, adolescents are vulnerable to temporarily dampened self-control when in emotionally charged or high-stress situations. This occurs because the prefrontal cortex is still developing during adolescence, but subcortical systems in the brain are hyperresponsive to emotional information during this developmental period.

263 Kathryn Mills et al, *The Developmental Mismatch in Structural Brain Maturation During Adolescence*, 36 Developmental Neurosci. 147, 147–160 (2014).

264 Eveline Crone & Nikolaus Steinbeis, *Neural Perspectives on Cognitive Control Development During Childhood and Adolescence*, 21 Trends Cognitive Sci. 205 (2017); Adele Diamond, *Executive Functions*, 64 Ann. Rev. Psych. 135 (2013).

265 Casey, *supra* note 56. For a more detailed summary, see Section B (infra).

266 Damien Fair et al, *Functional Brain Networks Develop from a "Local to Distributed" Organization*, 5 PLoS Computational Biology e1000381 (2009); Nico Dosenbach et al, *Prediction of individual brain maturity using fMRI*, 329 Science 1358, 1358–1361 (2010).

267 Scott Marek et al, *The Contribution of Network Organization and Integration to the Development of Cognitive Control,* 13 PLoS Biology e1002328 (2015).

RECEIVED by MSC 9/27/2024 8:39:40 PM

The prefrontal cortex and subcortical regions are connected to one another, and these connections strengthen during adolescence. The stronger connectivity between cortical and subcortical systems can account for the developmental differences in how people behave in emotional situations. Maturing connectivity between the prefrontal cortex and subcortical regions has been linked to improved cognitive performance in emotional scenarios.[268] Due to the refinement of communication between cortical and subcortical brain systems, emotion regulation abilities improve with age.[269] [270] Connections within the prefrontal cortex also facilitate self-control and emotion regulation. These connections continue to develop through late adolescence and into young adulthood.[271]

At the time of the *Miller* (2012) decision, most developmental research examining how emotionally heated situations influence behavioral and brain responses did so by comparing groups of individuals under age 18 to groups of individuals older than 18. However, research since 2012 has examined continuous changes in brain development throughout adolescence and beyond age 18 into late adolescence and young adulthood. This approach has revealed new insights about how the late adolescent brain responds to emotionally charged situations. Notably, this research shows that, when faced with certain emotional contexts, late adolescents exhibit situational disruptions in self-control. These suboptimal changes in behavior are related to differences in patterns of brain activity and connectivity. For example, these differences are reflected in the relative vulnerability of late adolescents to transient dampening of self-control when anticipating potential threats.[272] [273]

Relative to young adults (ages 22–25), late adolescents (ages 18–21) exhibit poorer self-control when anticipating a potential threat. Research found that during threat vigilance states, late adolescents exhibited patterns of brain activity more like the middle adolescent group (ages 13–17) than the young adult group (ages 22–25). Specifically, middle and late adolescents exhibited reduced connectivity between prefrontal regions and reduced activity in regions that guide successful self-control (lateral prefrontal cortex, the parietal cortex, and the dorsal anterior cingulate).

268 Somerville, *supra* note 65.

269 Dylan Gee et al, *A Developmental Shift from Positive to Negative Connectivity in Human Amygdala–Prefrontal Circuitry*, 33 J. Neuroscience 4584 (2013).

270 Aaron Heller et al, *Changes in Cortico-Subcortical and Subcortico-Subcortical Connectivity Impact Cognitive Control to Emotional Cues Across Development*, 11 Soc. Cognitive & Affective Neuroscience 1910 (2016).

271 Silvers, *supra* note 55.

272 Cohen, *supra* note 12.

273 One brain imaging study tested whether vulnerability to emotional scenarios persists through late adolescence by comparing brain activity and connectivity between adolescents (age 13–17), late adolescents (age 18–21), and young adults (age 22–25). Participants performed a self-control task with emotional cues during a neutral state, positive state, or a threat state. When in a positive or threat state, the participants were anticipating that something good (possibility of winning money) or bad (possibility of hearing an aversive sound) could happen at any point. Thus, the task compared behavioral and brain responses during reward and threat states to neutral states.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Related research has shown that the brain responses of late adolescents more closely resemble those of younger individuals rather than those of young adults for *both* negative and positive emotional states. When encountering both positive and negative vigilance states (such as anticipating potential rewards or threats), the brain responses of late adolescents (ages 18–21) look more similar to the brain responses of adolescents (ages 13–17) than those of young adults (ages 22–25).[274]

Researchers used brain measures to predict the age of an individual and examined how emotional states impacted these age predictions. The predicted "brain age" reveals how old someone's brain behaves given their connectivity pattern, independent of the actual chronological age of the individual. When in neutral states, the predicted "brain age" of adolescents was comparable to their chronological age.

However, when faced with positive (potential to win a high reward) and negative (threat of a loud noise) vigilance states, adolescents' brain connectivity patterns looked younger than their chronological age. This suggests that emotional states elicit temporary changes in patterns of activity and communication in the middle and late adolescent brain. Within the late adolescent group (ages 18–21), individuals who had "younger" patterns of brain connectivity during emotional states were more likely to self-report increased preferences for risk-taking. Therefore, late adolescents classified as having "younger" brain responses during emotional situations were deemed to be more at risk for engaging in real-world risky behavior.

Development of the Brain's Learning and Reward Systems

Developmental changes in the dopamine system increase plasticity in the brain. Dopamine is a neurotransmitter that coordinates movement and is also involved in motivational learning and reward-driven behavior.[275] Plasticity is the brain's ability to change and adapt in response to experiences. The prolonged period of plasticity during adolescence can facilitate learning from experience.[276] [277]

274 M. D. Rudolph, et al., *At Risk Of Being Risky: The Relationship Between "Brain Age" Under Emotional States and Risk Preference*, 24 Developmental Cognitive Neurosci (2017). This brain imaging study examined the effects of emotional states on brain response patterns in a sample of participants ages 10 to 25. Using a self-control task with emotional cues, the researchers compared brain responses of middle adolescents, late adolescents, and young adults. During this study, participants were exposed to different vigilance states that varied in terms of whether something good or bad could happen at any moment. Participants encountered either a sustained neutral state where they anticipated nothing would happen, a positive state where they anticipated the possibility of winning a high reward, or a threat state where they anticipated the possibility of hearing an aversive sound. This research used a neuroimaging technique that measures whole brain connectivity patterns, which reveals how brain regions simultaneously activate and communicate with each other. This approach can measure how connectivity in the brain changes when individuals experience different emotional contexts.

275 Adriana Galvan, *Adolescent Development of the Reward System*, 4 Frontiers Human Neuroscience 6 (2010).

276 Surjeet Mastwal et al, *Phasic Dopamine Neuron Activity Elicits Unique Mesofrontal Plasticity in Adolescence*, 34 J. Neuroscience 9484 (2014).

277 Vishnu Murty, Finnegan Calabro & Breatiz Luna, *The Role of Experience in Adolescent Cognitive Development: Integration of Executive, Memory, and Mesolimbic Systems*, 70 Neuroscience & Biobehavioral Rev. 46 (2016).

RECEIVED by MSC 9/27/2024 8:39:40 PM

During late adolescence, connections are strengthened between the striatum (a region within the dopamine system that is responsive to reward) and prefrontal cortex. Stronger connections between these regions promote the emergence of more adaptive learning strategies. Relative to children and younger adolescents, late adolescents (ages 18–21) are more likely to use positive feedback and less likely to use negative feedback to update and refine their decisions.[278] In other words, adolescents are primed to learn from rewards. This change in learning strategy emerges because of enhanced connectivity between the striatum and prefrontal cortex.[279] The changes in the learning system that occur during adolescence suggest that individuals in this developmental window may be more amenable to intervention and rehabilitation.[280]

During adolescence, the brain's reward system is hyper-responsive, which means that adolescents exhibit exaggerated responses in the brain's reward centers compared to both younger and older persons in response to the same rewarding stimulus. Studies in humans and animals have shown that enhanced reward sensitivity during adolescence is related in large part to changes in the dopamine system.

Researchers use brain imaging techniques to measure how the dopamine system changes during development.[281] This research reveals that dopamine concentration increases during adolescence and stabilizes during adulthood. Yet, the density of dopamine receptors continues to decrease from ages 18 to 30.[282] Therefore, refinement of the dopamine system persists beyond adolescence and continues throughout young adulthood and beyond.

This remodeling of the dopamine system has consequences for reward sensitivity and risk-seeking behavior.[283] Adolescents, relative to children and adults, show exaggerated responses to reward in a key brain region in the dopamine system (striatum).[284] The striatum is important for anticipating and responding to rewards, learning from feedback, and coordinating motivated actions. Longitudinal studies have demonstrated that reward-related activity in the striatum peaks between ages 15 and 17 and remains elevated in late adolescence.[285] [286]

278 Wouter van den Bos et al, *Striatum–Medial Prefrontal Cortex Connectivity Predicts Developmental Changes in Reinforcement Learning*, 22 Cerebral Cortex 1247 (2012).

279 *Id.*

280 *See, e.g.*, David Yeager & Carol Dweck, *Mindsets that Promote Resilience: When Students Believe that Personal Characteristics Can Be Developed*, 47 Educ. Psych. 302 (2012).

281 Bart Larsen et al, *Maturation of the Human Striatal Dopamine System Revealed by PET and Quantitative MRI,* 11 Nature Comm. 1 (2020).

282 *Id.*

283 Tamara Fitzwater et al, *Motivational Systems in Adolescence: Possible Implications for Age Differences in Substance Abuse and Other Risk-Taking Behaviors*, 72 Brain & Cognition 114 (2010).

284 Merav Silverman, Kelly Jedd & Monica Luciana, *Neural Networks Involved in Adolescent Reward Processing: An Activation Likelihood Estimation Meta-Analysis of Functional Neuroimaging Studies*, 122 Neuroimage 427 (2015).

285 Braams, *supra* note 202.

286 Elisabeth Schreuders et al, *Contributions of Reward Sensitivity to Ventral Striatum Activity Across Adolescence and Early Adulthood*, 89 Child Development 797 (2018).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Adolescents show hyper-sensitivity in the striatum to a broad range of reward information. For example, adolescents, relative to adults, show more activity in the striatum when receiving positive feedback during learning,[287] when tasting sweet liquid,[288] when viewing smiling faces,[289] and when receiving "likes" on social media.[290]

This enhanced sensitivity to reward can promote adaptive behaviors during adolescence, such as healthy exploration, novelty seeking, and feedback processing.[291] During adolescence, enhanced brain sensitivity to rewards creates a window of opportunity for learning.[292] For example, a longitudinal learning study tested individuals ages 8–25 and found that increased activity in the striatum supports learning improvements during middle and late adolescence.[293] However, enhanced responses to reward in the brain have also been linked to increased sensation seeking and risk-taking behavior.[294] [295] Taken together, this research suggests that the adolescent brain is remarkably—and perhaps uniquely—attuned to what it identifies as rewarding cues in the environment. Enhanced brain responses to reward support the emergence of adaptive behaviors that promote learning and independence. Yet, this brain responsivity is also reflected in the adolescent propensity for maladaptive behaviors, impulsivity, and risky decision-making.

Social Influence Impacts Late Adolescent Brain Responses

Adolescents are hyper-attuned to their social worlds. In particular, the influence of peers is more powerful during this period than any other point in the lifespan.[296] Adolescents are more likely to conform to the expectations and behaviors of peers, especially when seeking peer approval. This can be adaptive as it promotes social exploration and novelty-seeking.[297] However, peer influence can also result in suboptimal self-control and decision-making. For example, adolescents typically make more cautious decisions when they are alone but riskier decisions when peers are present.[298]

287 Jessica Cohen et al, *A Unique Adolescent Response to Reward Prediction Errors*, 13 Nature Neuroscience 669 (2010).

288 Adriana Galván & Kristina McGlennen, *Enhanced Striatal Sensitivity to Aversive Reinforcement in Adolescents Versus Adults*, 25 J. Cognitive Neuroscience 284 (2013).

289 Somerville, *supra* note 65.

290 Lauren Sherman et al, *Peer Influence Via Instagram: Effects on Brain and Behavior in Adolescence and Young Adulthood*, 89 Child Development 37 (2018).

291 Juliet Davidow et al, *An Upside to Reward Sensitivity: The Hippocampus Supports Enhanced Reinforcement Learning in Adolescence.* 92 Neuron 93 (2016). (Citation: Davidow, *supra* note 203); Juliet Davidow, Catherine Insel & Leah Somerville, *Adolescent Development of Value-Guided Goal Pursuit,* 22 Trends Cognitive Sci. 725 (2018). (Citation: Davidow, *supra* note 207); Sabine Peters & Eveline Crone, Increased Striatal Activity in Adolescence Benefits Learning, 8 Nature Communications 1 (2017). (Citation: Sanders, *supra* note 204); Kate Nussenbaum & C. Hartley, *Reinforcement learning across development: What insights can we draw from a decade of research?* 40 Developmental Cognitive Neurosci. (2019).

292 Samantha DePasque & Adriana Galván, *Frontostriatal Development and Probabilistic Reinforcement Learning During Adolescence*, 143 Neurobiology Learning & Memory 1 (2017).

293 Peters, *supra* note 204.

294 Adriana Galvan et al, *Risk-Taking and the Adolescent Brain: Who Is at Risk?*, 10 Developmental Sci. F8 (2007).

295 Samuel Hawes et al, *Modulation of Reward-Related Neural Activation on Sensation Seeking Across Development*, 147 Neuro Image 763 (2017).

296 Eric Nelson et al, *The Social Re-Orientation of Adolescence: A Neuroscience Perspective on the Process and Its Relation to Psychopathology*. 35 Psych. Med. 163, 163–174 (2005).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Sensitivity to social influence uniquely impacts brain responses in adolescents, and the late adolescent brain is particularly sensitive to the presence of peers. This sensitivity is related to differences in brain responses in regions that are important for social and emotional processing.[299] Social influence can modulate brain responses in reward regions like the striatum, and in regions in the prefrontal cortex that support social cognitive functions such as thinking about self and others. Research shows that the mere presence of a peer can elicit exaggerated activity in the brains of middle and late adolescents, although this effect is tempered in younger children.

For example, a study examined brain activity when individuals thought a peer was observing them.[300] When a peer was watching, middle and late adolescents exhibited increased activity in a region within the prefrontal cortex that is important for social cognition and self-conscious awareness (medial prefrontal cortex). Middle and late adolescents also displayed increased connectivity between reward processing regions like the striatum and the medial prefrontal cortex. This suggests that the brains of middle and late adolescents are especially sensitive to social evaluation.

The presence of peers also modulates reward-related responses in the brain during middle and late adolescence, and this heightened reward response has direct implications for risk-taking behavior.[301] Neuroscience researchers found that when receiving rewarding outcomes, individuals ages 14–19 exhibited enhanced activity in reward-processing regions (including the striatum) when peers were present relative to when they were alone. However, peer presence did not modulate neural responses to reward in adults ages 25–35.[302] Peer modulation of reward-related activity in the brain has also been linked to enhanced risk-taking. For example, while completing a driving simulation task, adolescents ages 14–19 showed more activity in the striatum while in the presence of peers than when performing the task alone, and this difference was attributed to increased risk-taking behavior.[303]

297 Albert, *supra* note 15.
298 *Id.*
299 Laurence Steinberg, *A Social Neuroscience Perspective on Adolescent Risk-Taking*, 28 Developmental Rev. 78 (2008).
300 Leah Somerville et al, *The Medial Prefrontal Cortex and the Emergence of Self-Conscious Emotion in Adolescence*, 24 Psych. Sci. 1554 (2013).
301 Albert, *supra* note 15.
302 Ashley Smith, Laurence Steinberg, & Nicole Strang, *Age Differences in the Impact of Peers on Adolescents' and Adults' Neural Response to Reward*, 11 Developmental Cognitive Neuroscience 75 (2015).
303 Jason Chein et al, *Peers Increase Adolescent Risk-Taking by Enhancing Activity in the Brain's Reward Circuitry*, 14 Developmental Sc. F1 (2011).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Summary

Advances in contemporary psychology and neuroscience research provide converging evidence that adolescence is a period of dynamic brain development that persists beyond the age of 18. The vast majority of research has charted brain and behavioral development by averaging across groups of individuals and charting changes with age. However, moving forward, newer approaches in the field will allow scientists to quantify, and thus better understand, individual differences in brain and behavioral developmental trajectories.[304] New innovations in research methods have allowed scientists to take new approaches to measure brain development, and ongoing initiatives with large-scale sample sizes and longitudinal data collection will reveal a more nuanced and complex picture of brain development.

304 Simmons, *supra* note 97; B.J. Casey et al, *The Adolescent Brain Cognitive Development (ABCD) Study: Imaging Acquisition Across 21 Sites,* 32 Developmental Cog. Neurosci. 43. 43–54 (2018), Leah Somerville et al, *The Lifespan Human Connectome Project In Development: A Large-Scale Study of Brain Connectivity Development in 5–21 Year Olds,* 183 Neuroimage 456, 456–468 (2018).

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix F
Fair and Just Prosecution, *Young Adults in the Justice System* (2019)

FAIR AND JUST PROSECUTION
Promoting justice through leadership and innovation

RECEIVED by MSC 9/27/2024 8:39:40 PM

ISSUES AT A GLANCE

Young Adults in the Justice System

Fair and Justice Prosecution (FJP) *brings together recently elected district attorneys[1] as part of a network of like-minded leaders committed to change and innovation. FJP hopes to enable a new generation of prosecutive leaders to learn from best practices, respected experts, and innovative approaches aimed at promoting a justice system grounded in fairness, equity, compassion, and fiscal responsibility. In furtherance of those efforts, FJP's "Issues at a Glance" briefs provide district attorneys with information and insights about a variety of critical and timely topics. These papers give an overview of the issue, key background information, ideas on where and how this issue arises, and specific recommendations to consider. They are intended to be succinct and to provide district attorneys with enough information to evaluate whether they want to pursue further action within their office. For each topic, Fair and Just Prosecution has additional supporting materials, including model policies and guidelines, key academic papers, and other research. If your office wants to learn more about this topic, we encourage you to contact us.*

SUMMARY

This FJP "Issues at a Glance" brief presents a summary of the latest thinking on best practices for young adult criminal justice policies.[2]

Sociological and neuroscience research has increasingly found young adults aged 18 to 24 to be a distinct developmental group with unique needs and challenges. Across the country, jurisdictions are implementing age-appropriate policies and programs to better serve this population. Young-adult-specific courts, detention facilities, and caseloads are emerging — and new laws are being proposed or enacted — as a means of tailoring interventions and improving outcomes for young people and their communities.

This brief provides an overview of research on the young adult brain, current trends in young adult justice, legal precedent supporting a differentiated approach, and developmentally-appropriate interventions. It concludes by recommending strategies for elected prosecutors both to improve their offices' responses to young adult criminal activity and to lead broader justice system reforms that can better address this population's unique challenges and needs.

[1] The term "district attorney" or "DA" is used generally to refer to any chief local prosecutor, including State's Attorneys, prosecuting attorneys, etc.

[2] In different jurisdictions "young adults" are sometimes called "emerging adults" or "transition aged youth."

"Not only do we know that adolescent brains are different, we now know that adolescents and young adults often age out of crime."

— WASHINGTON D.C. ATTORNEY GENERAL KARL RACINE, FJP EXECUTIVE DIRECTOR MIRIAM KRINSKY, AND GEORGETOWN CENTER FOR JUVENILE JUSTICE REFORM DIRECTOR SHAY BILCHIK

RECEIVED by MSC 9/27/2024 8:39:40 PM

BACKGROUND AND DISCUSSION[3]

In recent years, new research and program innovation has increasingly sought to address the unique attributes and needs of young adults. While some research examines *adolescents* broadly — a range which generally includes individuals as young as 9-10 and as old as 25-26[4] — this brief will focus on 18-24-year-old "young adults."[5]

A. The Young Adult Brain and Social Development

Research in neuroscience, developmental psychology, and sociology has yielded considerable evidence that young adults represent a population distinct from children and adults. More independent than children and less cognitively developed than older adults, young adults display certain characteristics that can lead them to engage in inappropriate behavior that puts them in contact with the criminal justice system.

While laws and societal norms typically treat those who are over 18 (or in some cases over 21) as full-fledged adults, research relating to adolescent brain development reveals that in many ways young adults are actually developmentally more like teenagers than adults. Notably:

1. **Greater Risk-Seeking:** In the young adult stage of brain development, individuals are more attracted to risk-seeking behavior — from driving fast to engaging in violent misconduct.[6]
2. **Susceptibility to Peers, Stress, and Excitement:** Young adults have particular challenges regulating emotion and controlling risk-seeking behavior when surrounded by peers or when in stressful or exciting situations. At the same time, young adults tend to resist authority, particularly when they view that authority as unfair or inconsistent.[7]
3. **Diminished Capacity for Self-Control:** While research shows that young adults are aware of the risks certain actions entail, they often struggle to resist the rewards such behaviors appear to offer.[8] For the same reason, young people respond more positively to justice system rewards than to negative sanctions.[9]

While brain development is a key factor affecting young adult behavior, so too are social considerations. Criminologists have found that the process of adopting "adult" routines and roles — such as marriage and stable employment — is associated with desistance from criminal behavior and maturity.[10] Yet in recent decades, this process has begun to occur later in life for young adults, as good jobs increasingly require a college education, housing costs have grown

---

[3] Thanks to Adam Schaffer for his contributions to this brief during his internship with FJP; portions of this brief draw from the Harvard Kennedy School graduate thesis work by Adam Schaffer and Marie Lawrence on young adult justice.

[4] Curtis, A.C. (2015), *Defining Adolescence*, Journal of Adolescent and Family Health (2015), 7(2), Article 2, https://scholar.utc.edu/cgi/viewcontent.cgi?article=1035&context=jafh.

[5] This age group was chosen because much, though not all, literature and practice regarding young adults focuses on this particular age demographic and because those who are under 18 are generally considered juveniles by most court systems.

[6] Steinberg, L. (2004), *Risk Taking in Adolescence: What Changes, and Why?*, Annals of the New York Academy of Sciences, 1021(1), 51–58, https://doi.org/10.1196/annals.1308.005.

[7] Steinberg, L. (2015), *Age of Opportunity: Lessons from the New Science of Adolescence*, First Mariner Books, 69.

[8] *Id.* at 69. For additional review of brain research, *see also* Schiraldi, V., Western, B., and Bradner, K., (2015), *Community-Based Responses to Justice-Involved Young Adults*, National Institute of Justice, 3, https://www.ncjrs.gov/pdffiles1/nij/248900.pdf.

[9] Steinberg, *Age of Opportunity*, *supra* note 7, at 72.

[10] Schiraldi, et al., *supra* note 8, at 4.

RECEIVED by MSC 9/27/2024 8:39:40 PM

substantially, and young people are marrying at older ages, if at all. A growing number of young adults, particularly males, are "disconnected" — out of work and out of school.[11] Researchers argue that "[t]hese levels of demographic disconnectedness and the increasing need for higher education to compete meaningfully in the labor market add to the neurobiological findings, compounding the challenges for this age cohort."[12]

Significant numbers of justice-involved young adults may also have a history of trauma, though existing data is limited. There is research, however, indicating that as many as 90 percent of those under 18 in the criminal justice system have experienced a traumatic event, and 30 percent meet the criteria for post-traumatic stress disorder.[13] More information on the implications of trauma and strategies to address these concerns can be found in FJP's Issue Brief on Trauma-Informed Juvenile Justice.[14]

B. Young Adults in the Criminal Justice System

Despite comprising only about 10 percent of the U.S. population, in 2016, 18-to-24-year-olds accounted for 24.6 percent of people arrested for all crimes, and 26 percent of people arrested for burglary, robbery, and aggravated assault.[15] These age disparities are compounded by even greater racial disparities. Black males, for example, represented 40 percent of all young adults (18-24) admitted to state and federal prisons.[16]

It is also clear that current justice system responses to young adults are not promoting public safety. According to national data released from the U.S. Department of Justice's Bureau of Justice Statistics (BJS) in 2014, 78.2 percent of individuals aged 24 or younger were re-arrested within three years of release from custody, compared to 71 percent of all released prisoners.[17] These figures suggest that existing incarcerative approaches for young adults are failing to deter future criminal behavior or address the underlying causes of that behavior.

For many justice-involved young adults, criminal behavior is a phase they will grow out of. Property crimes, on average, hit a peak at age 16, and violent crimes at 17.[18] The evidence is clear that most young people will desist from criminal behavior without intensive justice-system involvement.[19] By better addressing the unique needs and behavior of young adults, justice systems can develop responses that limit the risk youth pose to themselves and others during this transitory life stage.

---

[11] The percentage of disconnected white male young adults increased from 9.8 percent in 1960 to 14 percent in 2012; among African-American young men, that number rose from 20 percent to 27 percent. *See* Schiraldi, et al., *supra* note 8, at 6. Schiraldi, et al. cite data from the U.S. Census and the American Communities Survey.

[12] *Id.*

[13] Fair and Just Prosecution (2017), *Juvenile Justice and Young Adult Issues: Promoting Trauma-Informed Practices*, https://fairandjustprosecution.org/wp-content/uploads/2017/09/FJPBrief.TraumaPractices.9.25.pdf.

[14] *Id.*

[15] Federal Bureau of Investigation (2017), *2016 Crime in the United States*, https://ucr.fbi.gov/crime-in-the-u.s/2016/crime-in-the-u.s.-2016/tables/table-20/table-20.xls.

[16] Council of State Governments (2015), *Reducing Recidivism and Improving Other Outcomes for Young Adults in the Juvenile and Adult Criminal Justice Systems*, https://csgjusticecenter.org/wp-content/uploads/2015/11/Transitional-Age-Brief.pdf.

[17] Durose, M.R., Cooper, A.D., and Snyder, H.N. (2014), *Recidivism of Prisoners Released in 30 States in 2005: Patterns from 2005 to 2010*, Special Report, United States Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, https://www.bjs.gov/content/pub/pdf/rprts05p0510.pdf. Note, however, that arrest is an admittedly problematic indicator for recidivism, because it is not evidence of guilt and can be the result of biased policing policies. The Bureau of Justice Statistics does not track recidivism based on charge or conviction.

[18] Steinberg, *Age of Opportunity*, *supra* note 7, at 68–69.

[19] Mulvey, E.P. (2011), *Highlights from Pathways to Desistance: A Longitudinal Study of Serious Adolescent Offenders*, Office of Juvenile Justice and Delinquency Prevention, U.S. Department of Justice, https://www.ncjrs.gov/pdffiles1/ojjdp/230971.pdf.

RECEIVED by MSC 9/27/2024 8:39:40 PM

C. Supreme Court Recognition of Age as a Relevant Consideration in Sentencing and Punishment

In three landmark rulings — *Roper v. Simmons*,[20] *Graham v. Florida*,[21] and *Miller v. Alabama*[22] — the Supreme Court has held that young people under 18 have a reduced culpability as well as a particularly strong potential to grow and change, based on their lack of mature brain development and psychological immaturity.[23] In *Roper*, the Court held that, in part because children and teenagers' brains are not fully developed, the death penalty cannot be imposed on minors per the Eighth and Fourteenth Amendments.[24] *Roper* noted that "[a] lack of maturity and an underdeveloped sense of responsibility are found in youth more often than in adults and are more understandable among the young. These qualities often result in impetuous and ill-considered actions and decisions."[25]

Similarly, in *Graham*, the Court held that the Constitution does not permit sentencing someone who was under 18 at the time of the offense to life imprisonment without parole for non-homicide offenses.[26] The decision in *Graham* reflects the Court's view that an individual's young age is relevant to considering whether a sentence of life without the possibility of parole "serves legitimate penological goals," such as deterrence, incapacitation, and rehabilitation.[27] Young people have a greater likelihood of growing and maturing,[28] so the Eighth Amendment "forbid[s] States from making the judgment at the outset that [juveniles] never will be fit to reenter society" and requires that they have the chance to show they have been rehabilitated.[29] Similarly, in *Miller*, the Court held that the Eighth Amendment prohibits a sentencing scheme mandating life without parole for juvenile homicide offenders, in part because "[s]uch a scheme prevents those meting out punishment from considering a juvenile's 'lessened culpability' and greater 'capacity for change.'"[30] In sum, in *Roper*, *Graham*, and *Miller*, the Court used science and other considerations to hold that young people should be treated differently in our criminal justice system when considering appropriate punishment.

Although the *Roper*, *Graham*, and *Miller* decisions apply to those who are under 18, the same analysis should be considered in devising policies for young adults, who share many of the exact

---

[20] *Roper v. Simmons*, 543 U.S. 551 (2005).

[21] *Graham v. Florida*, 560 U.S. 48 (2010).

[22] *Miller v. Alabama,* 567 U.S. 460 (2012).

[23] *Roper*, 543 U.S. 551; *Graham*, 560 U.S. 48; *Miller*, 567 U.S. 460.

[24] *Roper*, 543 U.S. 551.

[25] *Roper*, 543 U.S. at 569 (citing *Johnson v. Texas*, 113 S. Ct. 2658 (1993)).

[26] *Graham*, 560 U.S. 48.

[27] *Id.* at 71.

[28] *Id.* at 73.

[29] *Id.* at 75.

[30] *Miller*, 567 U.S. at 465 (citing *Graham*, 560 U.S. 48).

"I do believe in the science that young people's brains continue to grow until they are 25; young people are different than adults and must be treated that way."

— SUFFOLK COUNTY (BOSTON) DISTRICT ATTORNEY RACHEL ROLLINS

RECEIVED by MSC 9/27/2024 8:39:40 PM

same characteristics.[31] A young adult's brain is not completely matured and the prefrontal cortex that controls cognitive functioning and reasoning ability is still developing.[32] Thus, young adults are likely to have an underdeveloped sense of responsibility, a heightened vulnerability to negative influences, and a lack of maturity, as well as substantial capacity for change, and they are also still developing psychologically. The Court's recognition that age matters in considering equitable sentencing, although applicable as a legal matter only to those who are under 18, should also be relevant when prosecutors and others who implement policies evaluate the appropriate approaches and criminal justice responses that should apply to young adults.

EXAMPLES OF PROMISING PRACTICES IN YOUNG ADULT JUSTICE

Across the country, jurisdictions are developing policies that specifically address the unique needs and challenges of young adults. Broadly, these approaches seek to apply the least restrictive sanctions possible, while avoiding "net-widening" in which new programming captures young adults who otherwise would have received less restrictive (or no) supervision. Such approaches also attempt to reduce the collateral consequences of a conviction for young adults, who must bear the mark of their convictions for decades, including before they have had a chance to establish careers, complete their education, or get married. Where justice system contact occurs at all — whether that is in the court, a diversion program, or in custody — the emphasis of these promising practices is on rehabilitation, not retribution, and on resolving cases in ways that limit or reduce the severity of convictions and collateral consequences, wherever possible. While they operate at various stages in the criminal justice process, these models and innovations draw on clinical expertise to incorporate lessons from research and to assist young adults in gaining the maturity and life skills to be successful adults.

The following is a sampling of promising practices that prosecutors can directly implement or work with others to advance.

---

[31] Several recent court decisions have extended the Supreme Court's reasoning in *Miller*, *Roper*, and *Graham* to young adults. For example, the U.S. District Court for the District of Connecticut held that *Miller* applies to 18-year-olds, explaining:

> "[R]elying on both the scientific evidence and the societal evidence of national consensus, the court concludes that the hallmark characteristics of juveniles that make them less culpable also apply to 18-year-olds. As such, the penological rationales for imposing mandatory life imprisonment without the possibility of parole cannot be used as justification when applied to an 18-year-old." *Cruz v. United States*, 2018 U.S. Dist. LEXIS 52924 at 70 (2018).

In three 2017 cases, a Kentucky Circuit Court found it unconstitutional to sentence to death individuals who were under 21 years of age at the time of the offense, concluding, based on *Roper*, that the death penalty is a disproportionate punishment for young people under 21. *See Commonwealth v. Bredhold*, 14-CR-161, *1, 12 (Fayette Cir. Ct., 2017); *Commonwealth v. Smith*, 15-CR-584-002, *1, 12 (Fayette Cir. Ct., 2017); *Commonwealth v. Diaz*, 15-CR-584-001, *1, 11 (Fayette Cir. Ct., 2017). In addition, the Supreme Court of Washington held, based on the reasoning in *Miller*, *Roper*, and *Graham*, that a sentencing court must be able to consider a young adult's age as a mitigating factor in sentencing (*State v. O'Dell*, 358 P.3d 359 (2015)). Nevertheless, it is important to note that other courts have rejected this line of argument. *See*, e.g., *Otte v. State*, 96 N.E.3d 1288 (Ohio Ct. App., 8th Dist., 2017) and *Heard v. Snyder*, 2018 WL 2560414 (E.D. Mich., 2018).

[32] National Institute of Justice and Office of Juvenile Justice and Delinquency Prevention, U.S. Department of Justice (2014), *Young Offenders: What Happens and What Should Happen*, https://www.ncjrs.gov/pdffiles1/nij/242653.pdf.

RECEIVED by MSC 9/27/2024 8:39:40 PM

A. Reform Young Adult Prosecution and Sentencing Practices

In recognition of social and neurological development differences, some jurisdictions are rethinking charging, prosecution, and sentencing approaches applicable to young adults. As justice system leaders, prosecutors can work with legislatures and sentencing commissions to create policy change, or use their own charging and sentencing discretion to implement practices that acknowledge the realities of young adult development.

Some jurisdictions, including New York,[33] Washington, D.C.,[34] Michigan,[35] and Alabama,[36] have enacted legislation, sometimes referred to as **"Youthful Offender" laws**,[37] allowing courts to depart from mandatory sentences for young adults, "adjudicate" them rather than convict them, keep proceedings confidential, and/or expunge past convictions. Virginia's parole board also regularly evaluates cases involving 18-to-21-year-olds for early release.[38] California passed legislation in 2013 requiring that anyone who is incarcerated for a crime committed before age 22 receive a parole hearing after 15, 20, or 25 years of incarceration (depending on the sentence) during which developmental factors at the age of the offense are taken into consideration as mitigating the term of incarceration.[39] As of July 2017, more than 575 individuals had been released under this law; only 15 of them had been re-arrested and only two had been charged with new alleged felony crimes against a person.[40] In light of this success, in 2018, California extended eligibility for such "Youth Offender Parole" hearings through age 25.[41]

---

[33] 2015 New York Laws, *Article 720, Youthful Offender Procedure*, https://law.justia.com/codes/new-york/2015/cpl/part-3/title-u/article-720/, (allows "Youthful Offender" status to be applied to 18-year-olds).

[34] McCann, E.P. (2017), *The District's Youth Rehabilitation Act: An Analysis*, The Criminal Justice Coordinating Council, https://cjcc.dc.gov/sites/default/files/dc/sites/cjcc/page_content/attachments/District%27s%20YRA-An%20Analysis.pdf.

[35] Michigan Code of Criminal Procedure, *762.11 Criminal offense by individual between ages 17 and 24; assignment to status of youthful trainee; consent of prosecuting attorney; exceptions; employment or school attendance; electronic monitoring; definitions*, http://www.legislature.mi.gov/(S(xeuswun43mubnmhe1tg1q3cs))/mileg.aspx?page=GetObject&objectname=mcl-762-11.

[36] 2016 Code of Alabama, *Section 15-19, Youthful Offenders*, https://law.justia.com/codes/alabama/2016/title-15/chapter-19/.

[37] It is important to note, however, that in some states, the term "Youthful Offender" refers to provisions that allow young people under the age of 18 to be treated more harshly than would otherwise be permitted under juvenile law. For example, in North Carolina, "youthful offender" has been used to refer to "juveniles under the age of 18 who have been adjudicated and committed by a judge to a period of confinement in an adult facility due to a crime of a felonious nature." N.C. Department of Public Safety (2016), *Youthful Offender Program*, https://files.nc.gov/ncdps/documents/files/YouthfulOffenderProgram.pdf. Similarly, Massachusetts' "Youthful Offender" law allows people under 18 to face adult penalties. Massachusetts General Laws, c. 119, §58, *Adjudication as delinquent child or youthful offender*, https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXVII/Chapter119/Section58.

[38] Hayek, C. (2016), *Environmental Scan of Developmentally Appropriate Criminal Justice Responses to Justice-Involved Young Adults*, National Institute of Justice, U.S. Department of Justice, https://www.ncjrs.gov/pdffiles1/nij/249902.pdf.

[39] State of California Board of Parole Hearings, *Youth Offender Hearings*, https://www.cdcr.ca.gov/BOPH/youth_offender_hearings_overview.html.

[40] California Department of Corrections and Rehabilitation, Division of Internal Oversight and Research, Office of Research (2017), report provided to the office of Assembly Member Mark Stone. Report available upon request.

[41] California Legislature (2017-2018), AB-1308 *Youth offender parole hearings*, https://leginfo.legislature.ca.gov/faces/billCompareClient.xhtml?bill_id=201720180AB1308.

RECEIVED by MSC 9/27/2024 8:39:40 PM

More significant changes to young adult prosecutions and sentences can also be achieved through **raising the age of criminal responsibility**. This allows young adults to be tried in the juvenile or family court system, where rehabilitation may be prioritized over incarceration. Germany provides a powerful model, as German juvenile courts have had jurisdiction over 18- 19- and 20-year-olds since 1953.[42] For young people in this age range, the court has discretion to apply either juvenile or adult sanctions, but unlike in the U.S., the court does not make this decision based on the seriousness of the offense. Instead, it applies juvenile law if either: (a) "at the time of committing the crime the young adult in his moral and psychological development was like a juvenile" (for example, if the young person has not completed schooling, does not support him or herself, or lives with parents), or (b) "the motives and the circumstances of the offence are those of a typically juvenile crime" (for example, if it was an impulsive offense committed with peers).[43] In practice, the vast majority (more than 90 percent) of young adults who commit serious offenses such as murder, rape, and robbery are sentenced under juvenile law,[44] as German courts tend to view it as beneficial to society to keep these young people in the juvenile system, which is particularly focused on rehabilitation.[45]

Several U.S. states have increased the upper age limit of jurisdiction for juvenile or family courts in recent years.[46] While most states now include 17-year-olds in the juvenile justice system, Vermont made history in 2018 by becoming the first state in the U.S. to enact legislation to raise the age of criminal responsibility beyond 18.[47] The new law will raise the age to include 18-year-olds in the juvenile system in July 2020, and 19-year-olds by July 2022. Bills to include young adults in the juvenile justice system have been introduced in several other states as well.[48]

Even absent legislative change, prosecutors can also take steps to promote the consideration of age in their own charging, plea, and sentencing decisions. The San Francisco District Attorney's office, for example, has hired **"Sentencing Planners"** to aid assistant district attorneys in devising plea agreements that address individuals' underlying risks and needs.[49] Planners possess deep knowledge of local programs and what types of interventions work for which individuals, and are trained to carefully review case files and — with defense counsel approval — interview the young people. Importantly, as staff *inside* the DA's office, planners may be more effective than defense attorneys or social workers in persuading prosecutors or law enforcement to embrace alternative sanctions.

---

[42] Dünkel, F. (2016), *Youth Justice in Germany*, Oxford Handbook, 2.

[43] *Id.* at 24

[44] *Id.* at 25

[45] Matthews, S., Schiraldi, V., and Chester, L. (2018), *Youth Justice in Europe: Experience of Germany, the Netherlands, and Croatia in Providing Developmentally Appropriate Responses to Emerging Adults in the Criminal Justice System*, Justice Evaluation Journal, https://academiccommons.columbia.edu/doi/10.7916/D81K0TP3/download.

[46] For example, in 2017, New York and North Carolina both raised the age of criminal responsibility from 16 to 18, meaning that 16- and 17 year-olds will, in most cases, be in the juvenile justice system. NY Courts Office for Justice Initiatives, *Raise the Age*, https://www.nycourts.gov/ip/oji/raisetheage.shtml; North Carolina Department of Public Safety, *Raise the Age NC*, https://www.ncdps.gov/our-organization/juvenile-justice/key-initiatives/raise-age-nc.

[47] Vermont General Assembly (2018), *S.234 (Act 201), An act relating to adjudicating all teenagers in the Family Division, except those charged with a serious violent felony*, https://legislature.vermont.gov/bill/status/2018/S.234.

[48] *See*, for example, Illinois General Assembly Bill HB4581, An Act Concerning Juveniles, http://www.ilga.gov/legislation/fulltext.asp?DocName=&SessionId=91&GA=100&DocTypeId=HB&DocNum=4581&GAID=14&LegID=109512&SpecSess=&Session=, and Connecticut Governor's Bill 5040, *An Act Concerning Adjudication of Certain Young Adults in Juvenile Court*, https://www.cga.ct.gov/2018/TOB/h/2018HB-05040-R00-HB.htm.

[49] Office of District Attorney George Gascón, *San Francisco District Attorney's Office Sentencing Planner*, http://sfdistrictattorney.org/sentencing-planner.

RECEIVED by MSC 9/27/2024 8:39:40 PM

B. Increase Young Adult Diversion and Alternatives to Incarceration

Several jurisdictions offer robust alternatives to prosecution or incarceration for youth, and some have programs designed specifically for young adults. **Common Justice** in New York City, for example, works closely with the Brooklyn and Bronx District Attorney's Offices and uses a restorative justice framework to respond to serious crimes committed by young adults, including robbery and assault.[50]

Roca, in Massachusetts, serves high-risk 17-to-24-year-olds who are not ready, willing, or able to participate in traditional programing.[51] Almost all participating youth have previously been arrested and most have previously been incarcerated. The organization targets young people who have refused, dropped out of, or been kicked out of alternate programming. Roca's intervention model starts with intense outreach by Youth Workers who are trained to keep showing up even after being rejected by the young person. After trust has been built, Roca provides intensive programming focused on education, life skills, and employment. In partnership with Community Psychiatry PRIDE Clinic at Massachusetts General Hospital, Roca has developed a Cognitive Behavioral Theory (CBT) curriculum specifically tailored to enable high-risk young people to develop emotional literacy and overcome behavioral barriers.[52] In addition, Roca's model is designed around the understanding that behavior change is not linear; when participants stop engaging in services or engage in destructive behavior, Youth Workers strive to re-engage them rather than removing them from the program. After two years of intensive intervention, Roca continues to provide support for an additional two years to help sustain behavior change. Initial results from Roca's Young Men's Program are promising,[53] and the program is currently being evaluated through a randomized controlled trial.

Texas' **Lone Star Justice Alliance** (LSJA) takes a transformative systemic approach to addressing young adult offending. Partnering with local criminal justice stakeholders, LSJA is beginning a pilot program that connects 17-to-24-year-olds charged with felony offenses with community services.[54] LSJA integrates a panel of experts from mental health, social service, and justice systems to guide holistic case management meant to address multiple needs.[55]

Programs for young adults are sometimes coordinated in partnership with local probation departments. For example, the New York City Probation Department runs **Arches**, a mentoring program designed specifically for young adults to address the underlying attitudes and actions that contributed to participants' justice system involvement in the first place.[56] As part of the

---

[50] For more information on criminal justice reforms as well as restorative justice practices that offer promising results for young adults, *see* Fair and Justice Prosecution (2017), *Building Community Trust: Restorative Justice Strategies, Principles and Promising Practices*. https://fairandjustprosecution.org/wp-content/uploads/2017/12/FJP.Brief_.RestorativeJustice.pdf.

[51] Roca Inc. (2018), https://rocainc.org/.

[52] Baldwin, M., et al. (2018), *Cognitive Behavioral Theory, Young Adults, and Community Corrections: Pathways for Innovation*, Papers from the Executive Session on Community Corrections, Harvard Kennedy School Program in Criminal Justice Policy and Management, https://www.hks.harvard.edu/sites/default/files/centers/wiener/programs/pcj/files/cbt_young_adults.pdf.

[53] In FY 2018, Roca served 1,150 young adults and retrained 79% of them in the intervention model. Eighty-eight percent of graduates (those who completed the first two years of the four-year model) avoided arrests, and 66 percent held jobs over 6 months. Roca Inc. (2018), *Outcomes*, https://rocainc.org/impact/outcomes/.

[54] Seventeen is the age of adult court jurisdiction in Texas.

[55] Lone Star Justice Alliance, *Transformative Justice*, https://www.lonestarjusticealliance.org/transformative-justice.html.

[56] New York City Department of Probation, *Arches: A Transformative Mentoring Program*, http://home2.nyc.gov/html/prob/html/young_men/arches.shtml.

RECEIVED by MSC 9/27/2024 8:39:40 PM

program, non-profit providers work to "meet young people where they are" to promote pro-social engagement, using a group process where clients provide support for one another throughout the evidence-based curriculum. Youth also receive stipends for participating. A rigorous, independent evaluation of the Arches program found it reduced one-year felony reconviction rates by two-thirds compared to a control group, and reduced two-year felony reconviction rates by half.[57]

These programs and others are particularly cognizant of avoiding net-widening and over-programming. Whenever possible, diversion programs should be based on the individual's risks and needs; over-supervising low-risk individuals charged with their first offense is not only wasteful, but can also produce adverse outcomes. In many instances, the best response is no engagement at all.

C. Create Young Adult Courts

While the first choice should be to keep young adults out of the criminal justice system, relying on diversion or other alternatives to incarceration described above, in cases where justice system involvement is unavoidable, specialty courts for young adults offer a less punitive, age-appropriate approach. The San Francisco **Young Adult Court** (YAC) offers a "collaborative, problem-solving" model for young adults ages 18-25 charged with both violent and non-violent felonies and misdemeanors. While some exclusionary criteria exist — including the use of a firearm and prior convictions for certain serious offenses — the District Attorney's Office can and does waive these limitations on a case-by-case basis. Indeed, felony cases are prioritized over misdemeanors, and can be accepted pre-plea, as a deferred entry of judgment, or as probation (post-plea). Prioritizing more serious cases is an important safeguard against net widening, where young people who would be better off without justice system involvement are brought into specialty courts or other programs unnecessarily.

The YAC model goes beyond court proceedings and builds on the city's work establishing "collaborative" courts that coordinate responses to promote law-abiding and pro-social behavior.[58] Through collaboration among the court, the District Attorney's Office, the Public Defender's Office, the probation department, dedicated case managers, and treatment and employment providers, justice-involved young adults are supported via a holistic four-phase process:

1. **Engagement and Assessment:** Participants go through intake, assessment, and orientation. They also develop their own Wellness Care Plan, which includes steps to meet their own goals and those of their case manager. The plan can include therapy, drug treatment, and housing support, among other components.
2. **Stability and Accountability:** Participants continue their Wellness Care Plan with support from their clinical case managers and continue to appear in court.
3. **Wellness and Community Correction:** Participants additionally pursue education and/or vocational goals and connect with the broader community.
4. **Program Transition** (and graduation day): Participants prepare to transition out of the program, develop a Pre-Graduation Life Plan, and secure stable housing.

---

[57] Urban Institute, *Arches Transformative Mentoring Program An Implementation and Impact Evaluation in New York City*, 2018. https://www.urban.org/sites/default/files/publication/96601/arches_transformative_mentoring_program.pdf.

[58] Superior Court of California — County of San Francisco, *San Francisco Collaborative Courts*, http://sfsuperiorcourt.org/divisions/collaborative.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Each stage of the process includes additional activities and milestones which must be met before advancing to the next, as well as coordinated support services from city agencies and community organizations. Depending on the individual's progress, each phase will last two to five months, and the entire program lasts 12-18 months.

YAC justice system and service partners conference weekly before court to discuss individual cases and coordinate responses. Participants then regularly appear before the YAC judge to evaluate their progress, and may be rewarded or face negative consequences for specific behaviors to maintain a close feedback loop between action and reward/response.

Throughout the process, the court uses developmentally-appropriate tools to better reach participants. For example, YAC uses the term "response" over "sanction" to better influence behavior. YAC also actively empowers young adults to be involved in their Wellness Care Plan and to participate in court. Participants are provided with Dialectic Behavior Therapy, which is aligned with their developmental phase. The team identifies and leverages existing age-appropriate services, and works to fill service gaps. All YAC team members are trained in brain development and the impact of trauma on young adults.

Several other jurisdictions have young adult courts as well. The New York State court system and the Brooklyn District Attorney's office partnered to create their own Young Adult Court. Young adults charged with misdemeanors are offered both mandatory and voluntary social services in lieu of incarceration. The Center for Court Innovation's Brooklyn Justice Initiatives oversees the programming, and the court is supported by a dedicated judge, prosecutors, defense advocates, and social workers.[59] A new **Restorative Justice Community Court** in Cook County, Illinois allows young people aged 18-26 charged with non-violent offenses to participate in a restorative justice process rather than traditional court processing. The participant comes together with the victim, community members, and court staff to discuss the impact of the offense and develop a "repair of harm agreement." Participants are also connected with social service agencies. Once participants complete their repair of harm agreement, the charges are formally dropped and they have the opportunity to have their record expunged.[60]

D. Develop Specific Facilities for Young Adults Who Are Incarcerated

DAs should also advocate for young-adult-focused conditions of confinement in those instances when no other less restrictive alternatives to incarceration are possible and confinement is absolutely required. Ideally, any confinement for this population would be community-based, close to the young person's home, and in a therapeutic setting, whenever possible. It would also be attuned to the unique needs of this population.

With the assistance of the Vera Institute of Justice (Vera), Connecticut has created a young-adult-specific unit in its Cheshire state prison. Called "**T.R.U.E.**," which stands for Truthfulness (to oneself and others), Respectfulness (toward the community), Understanding (ourselves and what brought us here) and Elevating (into success),[61] the unit houses young men aged 18-25 and provides developmentally-appropriate programming throughout the day. Vera provided technical and

[59] Center for Court Innovation, *Brooklyn Young Adult Court*, https://www.courtinnovation.org/node/20116/more-info.

[60] Conway, S. (2018), *This Chicago Court Uses Peace Circles To Dole Out Justice*, WBEZ News, https://www.wbez.org/shows/wbez-news/this-chicago-court-uses-peace-circles-to-dole-out-justice/7bdcf936-6f46-4ae8-999e-23ea460ecd2c.

[61] Crowley, M. (2017), *How Connecticut Reimagines Prison for Young Men*, Vera Institute of Justice, https://www.vera.org/blog/dispatches-from-t-r-u-e/how-connecticut-reimagines-prison-for-young-men.

RECEIVED by MSC 9/27/2024 8:39:40 PM

strategic assistance to Connecticut as it developed the unit, and is now providing similar support to the South Carolina Department of Corrections.[62]

T.R.U.E. uses four principles to guide its engagement:

1. **Purpose, Not Just Programs:** Real and sustainable reform is more than implementing the "right" programs or metrics. Cultivating a culture that prioritizes fairness, choice, safety, and restoration requires systemic change that focuses on retraining talented staff and designing an entirely new model of practice.
2. **Connection to Identity, Culture, and People:** Young adults must have opportunities to sustain meaningful connections to their identities and cultures and maintain supportive relationships with their families and communities.
3. **Safety and Equity:** Vera works with agencies to ensure decisions are not vulnerable to bias and that the voices of those most impacted by the justice system — incarcerated young adults and facility line staff — are prioritized.
4. **Healing and Wellness:** All people, especially young adults, must be provided the space and support to heal, grow, and celebrate their successes based on their own unique developmental needs and strengths.[63]

Staff in the unit are specifically trained on "human development, behavioral impact, motivational interviewing, mediation, and conflict resolution for young offenders," as well as incorporating trauma-informed care into their work.[64] Individuals serving life sentences elsewhere in Cheshire have also been brought in to serve as mentors to the young adults.

Missouri has created a juvenile justice system model that is being replicated in the young adult context.[65] Missouri's model includes multiple small facilities (designed for 10 to 30 youth) located throughout the state and intended to keep young people close to their homes.[66] The facilities

---

[62] Vera Institute of Justice (2018), "Groundbreaking Young Adult Prison Reform Initiative to Expand to South Carolina," Connecticut has also developed a program for young women, called W.O.R.T.H. (Women Overcoming Recidivism Through Hard Work) that is modeled after T.R.U.E. *See* Chammah, M. (2018), *More Women Are Behind Bars Now. One Prison Wants to Change That*, The Marshall Project, https://www.themarshallproject.org/2018/10/09/more-women-are-behind-bars-now-one-prison-wants-to-change-that?utm_medium=social&utm_campaign=sprout&utm_source=facebook. The Suffolk County Sherriff's Department has started a similar program for young men in Boston, called PEACE. *See* Rios, S. (2018), *Suffolk Sheriff Sets Up Family-Oriented Cellblock To Keep Young Inmates Out Of Jail*, WBUR, https://www.wbur.org/news/2018/11/30/peace-unit-south-bay-jail-boston.

[63] Vera Institute of Justice, "Restoring Promise: Transforming Prison for Young Adults," https://www.vera.org/projects/restoring-promise-young-adult-reform-initiative/learn-more.

[64] Porter, M. (2017), *New Prison Program Pairs Mentors With Young Offenders*, Hartford Courant, https://www.courant.com/news/connecticut/hc-corrections-young-adult-unit-program-gov-tour-0314-20170313-story.html?trb=20181212.

[65] Edelman, M.W. (2010), *Juvenile Justice Reform: Making the "Missouri Model" an American Model*, Huffington Post, https://www.huffingtonpost.com/marian-wright-edelman/juvenile-justice-reform-m_b_498976.html.

[66] *Id.*

"If we hope to dig ourselves out of the hole of mass incarceration, crafting a developmentally appropriate response to offending by emerging adults is a good place to start."

— COLUMBIA JUSTICE LAB SENIOR RESEARCH SCIENTIST VINCENT SCHIRALDI

RECEIVED by MSC 9/27/2024 8:39:40 PM

are staffed by highly trained teams of employees that work with small groups of young people.[67] As opposed to traditional punitive approaches, the Missouri model uses a rehabilitative and therapeutic approach.[68] As a result, less than eight percent of youth in the Missouri system recidivate, and fewer than eight percent go to an adult prison.[69]

The Washington, D.C. Department of Youth Rehabilitation Services' **New Beginnings Youth Development facility**, located in Laurel, Maryland, has adopted the Missouri model. New Beginnings focuses on empowering youth and young adults to successfully return to the community.[70] New Beginnings is a secure residential sixty-bed facility for youth up to age 21[71] that provides supervision, rehabilitation, educational services, vocational training, substance use treatment, peer mentors, community engagement opportunities, and other age-appropriate services.[72] To help facilitate youths' successful reentry back into their communities, New Beginnings ensures that youth and young adults remain connected with their families, who are involved on an ongoing basis with the young person's treatment planning, education, and rehabilitative services.[73] Prosecutors can use their voices to advocate for funding similar facilities or diversion programs focused on rehabilitation, treatment, and educational services in their jurisdictions.

While facilities like Cheshire and New Beginnings model better approaches, it is also important that the development of innovative programs and facilities does not create pressure to fill beds and that systems continue moving *away from* incarceration of young people. As such, elected DAs should join other justice system leaders who are increasingly recognizing that the preferred result is for youth and young adults who cannot stay at home to be housed not in prisons, but rather in **community-based placements**, close to their homes and with a therapeutic starting point.

E. Promote Reentry Pathways for Young Adults

Young adults returning from incarceration face significant barriers to reentering their communities. Relationships can play a pivotal role in reentry outcomes. Reentry planning should therefore engage the young adult's family as a key partner in supporting their behavioral changes and cognitive thought processes when possible and appropriate, reduce negative peer influences by strengthening relationships with pro-social peers, and support the young person's connections in school and work.[74]

A young adult's criminal record can also undermine successful reentry into their community at a pivotal moment in a young person's transition to adulthood. Sealing or expunging one's record is often complicated, costly, or overly restrictive. Prosecutors can assist with expunging young adults' criminal records, clearing a barrier to obtaining employment, housing, education, and other opportunities critical to beginning their adult lives.[75] Specifically, prosecutors can advocate

---

[67] *Id.*

[68] *Id.*

[69] *Id.*

[70] D.C. Department of Youth Rehabilitation Services, *New Beginnings Youth Development Center*, https://dyrs.dc.gov/service/new-beginnings-youth-development-center.

[71] D.C. Department of Youth Rehabilitation Services, *Secure Facilities*, https://dyrs.dc.gov/service/secure-facilities.

[72] D.C. Department of Youth Rehabilitation Services, *New Beginnings Youth Development Center*, *supra* note 70.

[73] *Id.*

[74] D.C. Department of Youth Rehabilitation Services, *New Beginnings Youth Development Center*, *supra* note 70.

[75] Clean Slate Clearinghouse, *About the Clean Slate Clearinghouse*, https://cleanslateclearinghouse.org/about/.

RECEIVED by MSC 9/27/2024 8:39:40 PM

to make expungements automatic in certain cases and for reduced state limitations on expunging young adult records, and can educate young adults on their eligibility for expungement.

RECOMMENDATIONS

A. General "Guiding Principles" for Young Adult Justice

Based on the unique needs of young adults, the following principles can help guide interventions to maximize efficacy and should shape DAs' approaches to young adult justice.

1. **Adopt the least restrictive sanction possible, and if incarceration is absolutely necessary, couple it with meaningful rehabilitation options.** While sometimes necessary, incarceration often increases the likelihood of recidivism. The key to desistance is supporting a young adult's maturation out of adolescence and criminal behavior. That maturation requires supporting the development of decision-making skills in a context where threats are minimized and pro-social behaviors are rewarded. This starting point should factor into the existence, length and type of incarceration imposed, and any term of custody should be close to home, in as small and community-based a setting as possible, and for the least amount of time necessary to promote public safety.
2. **Recognize that "failure" is an expected step, and zero-tolerance policies are counterproductive.** Young adults — particularly justice system-involved young adults — can be expected to resist authority for reasons related to both their brain development and their histories of trauma and victimization. Responses to minor missteps should be proportionate and should build young adults' understanding of the impact of undesired behavior. Also carefully consider and limit program conditions and the length of supervision to what is absolutely necessary for public safety, accountability, and rehabilitation.
3. **Use YA research to inform program development, incentives, and responses.** For example, rely on rewards over punishment to incentivize positive behavior. Young adults are particularly responsive to rewards and can respond negatively to sanctions. Maintain a close feedback loop between actions — both positive and negative — of young adults and program/court responses to solidify the connection between behavior and consequences. Additionally, provide opportunities for pro-social decision-making to increase both compliance and maturation.
4. **From the courtroom to detention facilities to treatment providers, interactions should be respectful and trauma-informed.** Procedural justice — the practice of seeking to ensure that participants see the justice system as fair and empathetic to their concerns — is particularly important for young adults, who are primed to respond negatively to disrespectful treatment.[76]

[76] Sered, D., *Fostering Accountability Among Young Adults*, Program on Criminal Justice Policy and Management, Harvard Kennedy School, https://www.hks.harvard.edu/centers/wiener/programs/criminaljustice/research-publications/young-adult-justice/fostering-accountability-among-young-adults. *See also* Fair and Just Prosecution (2017), *Building Community Trust — Procedural Justice: Enhancing the Legitimacy of the Justice System*, https://fairandjustprosecution.org/wp-content/uploads/2017/09/FJPBrief.ProceduralJustice.9.25.pdf.

RECEIVED by MSC 9/27/2024 8:39:40 PM

B. Specific Policy and Programmatic Recommendations for Prosecutors

Building on the general principles outlined above, the following specific recommendations — grounded in research on young adult development — offer immediate steps prosecutors' offices can take to advance effective responses to young adults who come into contact with the criminal justice system.

1. **Establish diversion programs and alternatives to incarceration that respond to the unique needs of young adults.** Young adults respond particularly poorly to incarceration. Diversion programs, especially those that recognize the brain and psychological development of young adults, can reduce costs and improve outcomes.
2. **Establish restorative justice programs for young adults or refer cases to existing programs, and treat the outcome as the resolution of the charges.** Restorative justice is a process in which those accused of crimes come together with victims to develop a plan to repair the harm. Restorative justice programs tend to have greater victim satisfaction and lower rates of recidivism compared to traditional criminal justice approaches,[77] and may be a particularly effective way to promote desistance for young adults.[78] Learn more about Restorative Justice models and programs in FJP's Building Community Trust "Issues at a Glance" Brief.[79]
3. **Convene a working group to create a young adult court.** As justice system leaders, DAs can provide the impetus to create a young-adult-specific docket. Starting with a pilot and working with evaluators from an early stage can help address challenges immediately and establish effective processes for coordination across agencies and providers. Care should be taken, however, to ensure that any newly created court does not result in net widening.
4. **Support legislation and advocacy to reform young adult charging and sentencing practices and limit sentence length.** Adopt sentencing and charging reforms that acknowledge the diminished culpability of young adults and their propensity to age out of offending. As discussed above, California's "Youth Offender Parole" legislation has given individuals with lengthy sentences for offenses committed as young adults the opportunity to seek parole early, and rates of re-offense among those who have been released through this process have been extremely low. This illustrates the value in limiting sentence lengths for young adults, at least for all but the most serious cases.
5. **Advocate for raising the age of criminal responsibility beyond 18.** In many cases, the rehabilitative focus — and more limited effect on a criminal record — makes the juvenile justice system a more appropriate fit for young adults than the adult criminal system. Where discretion does exist to prosecute young adults in juvenile or adult systems, handle young adult cases in the juvenile system whenever possible.[80]

---

[77] Alliance for Safety and Justice, *Crime Survivors Speak*, https://allianceforsafetyandjustice.org/wp-content/uploads/documents/Crime%20Survivors%20Speak%20Report.pdf; Latimer, J., Dowden, C. and Muise, D. (2005), *The Effectiveness of Restorative Justice Practices: A Meta-Analysis*, The Prison Journal, 85(2), 127–44, http://www.d.umn.edu/~jmaahs/Correctional%20Assessment/rj_meta%20analysis.pdf

[78] Marder, I. (2013), *Restorative Justice for Young Adults: Factoring in Maturity and Facilitating Desistance*, Restorative Justice Council, Barrow Cadbury Trust, and The Transition to Adulthood Alliance, https://restorativejustice.org.uk/sites/default/files/resources/files/Restorative%20justice%20for%20young%20adults.pdf.

[79] Fair and Just Prosecution, *Building Community Trust: Procedural Justice: Enhancing the Legitimacy of the Justice System*, *supra* note 76.

[80] *See*, for example, the increased age of responsibility in Croatia and elsewhere in Europe. Schiraldi, V. (2018), *How Croatia's 'Off-Ramps' Keep Young Adults Out of Prison*, The Crime Report, https://thecrimereport.org/2018/04/04/how-croatias-off-ramps-keep-young-adults-out-of-prison/.

RECEIVED by MSC 9/27/2024 8:39:40 PM

6. **Consider age during plea discussions.** Prosecutors can supplement sentencing and charging reform by considering age and diminished culpability during plea bargaining.
7. **Support reforms that avoid excessive parole and probation terms and conditions.** Extensive and excessive terms and conditions of correctional supervision often unnecessarily bring young people back into the justice system for behaviors that do not require justice system involvement.[81]
8. **Fund "Sentencing Planner" positions and ensure line prosecutors are familiar with non-incarcerative options available to young adults.** Combining the clinical and local expertise of trained Sentencing Planners with a directory of alternatives to incarceration for young adults can increase the effective use of alternatives to incarceration.
9. **Train assistant district attorneys on young adult research and regularly brief staff on new programs and policies.** Education can include the rationale for addressing young adults as a distinct group, how and why special considerations for age should be incorporated into charging decisions and plea negotiations, and how to engage young adults in an effective, respectful, and age-appropriate manner.
10. **Use community-based alternatives to incarceration wherever possible and advocate for rehabilitative, community-based detention facilities.** Prosecutors should work with local leaders, corrections, and sheriffs' departments to develop community-based placements for young adults who need to be removed from their homes and also ensure that any necessary detention facilities have meaningful, holistic, and coordinated programming that is geared toward the unique needs of young adults.
11. **Track the characteristics and outcomes of young adults.** Data, particularly regarding trauma, is often limited. DAs should work with law enforcement and other system partners to ensure that young adults are screened for PTSD, substance use disorders, and other risk factors during intake to guide treatment interventions. Like children, young adults merit specific data collection to identify and respond to trends in this population's risks and needs. DAs should endeavor to track dispositions, outcomes, and trends to identify whether policies are being implemented as designed, to flag and respond to any disparities, and to target future policy, process, or programmatic changes as challenges arise.
12. **Revisit past lengthy sentences.** Where possible, re-open cases or request clemency for individuals serving long sentences for crimes committed as juveniles or young adults that are not commensurate with current understanding of culpability based on modern brain science.

[81] "Statement on the Future of Community Corrections," Harvard Kennedy School – Malcolm Wiener Center for Social Policy (2018). Available at: https://www.hks.harvard.edu/centers/wiener/programs/criminaljustice/research-publications/executive-session-on-community-corrections/publications/less-is-more-how-reducing-probation-populations-can-improve-outcomes/statement-on-the-future-of-community-corrections.

"I think we need more and better programs that offer diversion from incarceration and the problems caused by criminal records, but that also change behaviors to reduce anti-social actions."

— PRINCE GEORGE COUNTY STATE'S ATTORNEY AISHA BRAVEBOY

RECEIVED by MSC 9/27/2024 8:39:40 PM

RESOURCES

- Connie Hayek (2016), *Environmental Scan of Developmentally Appropriate Criminal Justice Responses to Justice-Involved Young Adults*, National Institute of Justice, https://www.ncjrs.gov/pdffiles1/nij/249902.pdf.
- Vincent Schiraldi, Bruce Western, and Kendra Bradner (2015), *Community-Based Responses to Justice-Involved Young Adults*, Harvard Kennedy School Program in Criminal Justice Policy and Management and the National Institute of Justice, https://www.ncjrs.gov/pdffiles1/nij/248900.pdf.
- Council of State Governments (2017), *Dos and Don'ts for Reducing Recidivism Among Young Adults in The Justice System*, https://csgjusticecenter.org/wp-content/uploads/2017/09/Dos-and-Donts-for-Reducing-Recidivism-among-Young-Adults-in-the-Justice-System.pdf.
- Mathew Lynch et al. (2018), *Arches Transformative Mentoring Program: An Implementation and Impact Evaluation in New York City*, Urban Institute, https://www.urban.org/research/publication/arches-transformative-mentoring-program.

FOR MORE INFORMATION: Contact FJP at info@fairandjustprosecution.org

FAIR AND JUST PROSECUTION

Copyright © January 2019 Fair and Just Prosecution. All rights reserved

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix G

Casey et al., *Making the Sentencing Case: Psychological and neuroscientific evidence for expanding the age of youthful offenders*, 5 Ann Rev Criminology 321, 337 (2022)

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

ANNUAL REVIEWS

Annual Review of Criminology

Making the Sentencing Case: Psychological and Neuroscientific Evidence for Expanding the Age of Youthful Offenders

B.J. Casey,[1] C. Simmons,[1] L.H. Somerville,[2] and A. Baskin-Sommers[1]

[1]Department of Psychology, Yale University, New Haven, Connecticut 06520, USA; email: bj.casey@yale.edu

[2]Department of Psychology, Harvard University, Cambridge, Massachusetts 02138, USA

Annu. Rev. Criminol. 2022. 5:321–43

First published as a Review in Advance on August 23, 2021

The *Annual Review of Criminology* is online at criminol.annualreviews.org

https://doi.org/10.1146/annurev-criminol-030920-113250

Copyright © 2022 by Annual Reviews. All rights reserved

ANNUAL REVIEWS CONNECT

www.annualreviews.org

- Download figures
- Navigate cited references
- Keyword search
- Explore related articles
- Share via email or social media

Keywords

adolescence, brain, development, juvenile, law, sentencing

Abstract

Youthful offenders convicted of serious crimes continue to be sentenced to death and life without parole in the United States based on legal arguments that cast them as incorrigible and permanent dangers to society. Yet psychological and neuroscientific evidence contradicts these arguments and unequivocally demonstrates significant changes in brain, behavior, and personality throughout the life course, especially during adolescence as it extends into the early twenties. This article (*a*) clarifies the current state of the science on typical behavioral and brain development showing robust changes into the twenties; (*b*) demonstrates that behavior, personality, and psychopathic traits are dynamic and change over time; and (*c*) underscores that reliance on prior criminal behavior only to predict later recidivism is tenuous at best. Together, these scientific insights make a case for extending juvenile protections to youthful offenders sentenced for crimes committed in their teens and early twenties.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

INTRODUCTION

On December 10, 2020, Brandon Bernard became the youngest individual on federal death row in more than 70 years to be executed. Bernard, 18 at the time, was one of five Black adolescents ranging in age from 15 to 19 who were involved in a 1999 carjacking that resulted in the death of two White victims in a national park in Texas. Bernard was convicted of first-degree murder and sentenced to death. The younger accomplices were given lesser sentences as juveniles. During his 20 years in prison, there is no record of Bernard being charged with a single violation, and jurors who supported the original sentence publicly called for his life to be spared (Hale 2020). Despite showing remorse and rehabilitation, his appeals for clemency and a stay of execution were ultimately denied.

Like Bernard, youth who commit serious offenses in their late teens and early twenties are eligible to receive the most punitive sentences in the US justice system: death or life without the possibility of parole (LWOP). These sentences are based on arguments that they are incorrigible and beyond reform for reentry into society. Yet there is robust psychological and neuroscientific evidence that personality, behavior, and the brain change throughout the life span, especially during adolescence as it extends into the early twenties. Behavior, even in extreme forms, is dynamic over the life course, especially during the extended period of adolescence. Legal arguments of full adult capacity by 18 years in the sentencing of youthful offenders contradict this science and other laws in the United States that imply that adult capacity is not reached until the twenties (e.g., age for purchasing tobacco or alcohol is 21). This, however, is not to say that the handling of youthful offenders in the US justice system has not changed with time.

Over the past two centuries, the sentencing of youthful offenders has changed largely as a function of the political and social climate of the time (Bonnie & Scott 2013, Taylor-Thompson 2003). More recently, the laws and policies of the juvenile justice system have been based on scientific evidence and advances in our understanding of adolescent behavior and brain development (Casey et al. 2020, Cauffman et al. 2018). As such, youth involved in crime are seen as distinct from adults and as more vulnerable because of immaturity and thus require special protections (Casey 2019). Nonetheless, commissioned experts (e.g., Welner et al. 2019) are promoting misinformation about the maturity of the youth's mind and brain. These claims are far too reminiscent of the erroneous predictions about the emergence of juvenile superpredators in the 1990s (Snyder 2012). This prophecy never came to fruition. In fact, violent crime among youth has declined dramatically since the 1990s, but not before the superpredator myth robbed many youths, especially Black youths, of their childhood and right to a healthy development (Casey et al. 2020).

This article highlights psychological and neuroscientific evidence to inform the treatment and sentencing of youthful offenders. Specifically, we review the scientific literature to (*a*) clarify the science on robust behavioral and brain development beyond 18 years; (*b*) show that adolescents' behavior, personality, and psychopathic traits are not stable but change with age, life experiences, and intervention; and (*c*) underscore that relying only on prior criminal behavior and psychopathic traits to predict later criminal behavior is tenuous at best. This empirical evidence is presented within a historical context of recent US Supreme Court decisions.

US Supreme Court Decisions on the Sentencing of Youthful Offenders

In the past 30 years, the Supreme Court issued six decisions that brought significant change in the sentencing of juveniles convicted of serious crimes, including the abolishment of the death penalty and mandatory LWOP for offenders 17 years and younger (**Figure 1**). Each decision reflected the Supreme Court's conclusion that imposing these harsh sentences on juveniles violates the Eighth Amendment of the US Constitution and constitutes cruel and unusual punishment.

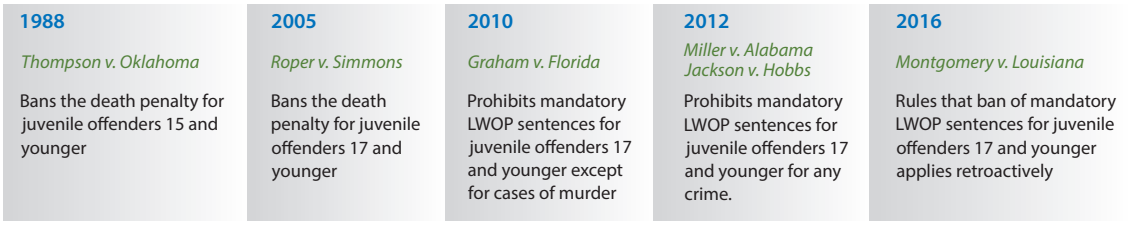


Figure 1

Timeline of US Supreme Court rulings on sentencing of youthful offenders. Abbreviation: LWOP, life without parole.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

In its opinions, the Supreme Court concluded that juveniles under the age of 18 are fundamentally different from adults in ways that diminish their culpability and enhance their amenability to rehabilitation. Arguments for diminished culpability were based on evidence that youth are less mature in their ability to consider the future consequences of their actions (Steinberg et al. 2009b) and more susceptible to external pressures from others in comparison to adults (Gardner & Steinberg 2005, Steinberg et al. 2009a). Furthermore, youths' brains are not fully formed (Cohen et al. 2016b, Rudolph et al. 2017), and thus they exhibit greater potential for change than do adults. Together, these differences require that youth receive special protections under US laws.

One of the first US Supreme Court decisions to address juveniles' diminished culpability in relation to sentencing was *Thompson v. Oklahoma* (1988), which placed a ban on the death penalty for juveniles ages 15 or younger. This case resulted in the first demarcation in the age at which a youthful offender could receive the death penalty. Nearly 20 years later, the age would shift to 18 in *Roper v. Simmons* (2005). Contrary to public concerns, the court's decision to eliminate the death penalty for youth convicted of violent crimes was not associated with an increase in violent crime. In fact, the rulings have been paralleled by a steady decline in violent crimes committed by youth (Butts 2016, Casey et al. 2020, Snyder 2012).

Building on the foundations of *Roper*, the court subsequently established a ban on mandatory LWOP sentences for youth convicted of nonhomicide offenses in *Graham v. Florida* (2010). Two years later, the court extended the ban on mandatory LWOP to homicide in *Miller v. Alabama* (2012) and *Jackson v. Hobbs* (2012). With these rulings, a youth convicted of a crime can still receive LWOP, but the sentence cannot be implemented mandatorily for any given crime. Instead, judges must weigh the circumstances and make subjective evaluations of the juvenile's culpability and incorrigibility on a case-by-case basis. The extent of subjectivity in these decisions is seen in disproportionately harsher sentencing of Black and Brown youth relative to White youth in the United States (Natl. Res. Counc. et al. 2013). Thus, the recognition of differences between youths and adults in *Miller* and *Jackson* is not applied equally to all young people (Casey et al. 2020).

Although the court rulings in *Roper*, *Graham*, *Miller*, and *Jackson* impacted several hundred individuals at the time, the ruling of *Montgomery v. Louisiana* (2016) will likely have a bigger impact. In *Montgomery*, the court ruled that its decision in *Miller v. Alabama* (2012) be applied retroactively to individuals who had received LWOP as juveniles prior to 2012. As a result, more than 2,000 individuals are entitled to resentencing hearings.

How Far Has the US Justice System Come in the Treatment of Youthful Offenders?

The *Thompson*, *Roper*, *Graham*, *Miller*, *Jackson*, and *Montgomery* cases highlight the impact of developmental science on sentencing. All the crimes were committed prior to the age of 18 and often in the presence of peers. Not to discount the impact of these violent crimes on the victims and

their families, but it is important to consider the impact of the original sentencing decisions on these youth. Where are Thompson, Simmons, Graham, Miller, Jackson, and Montgomery today?

We begin with the case of *Thompson v. Oklahoma*. William Thompson was convicted of murdering his abusive brother-in-law in 1983 in Oklahoma at the age of 15 and sentenced to death. He arrived on death row weighing less than 100 pounds and reading at a fourth-grade level (Bailey 2019). He spent four years on death row in lockdown for 23 hours a day before the US Supreme Court ruled his death sentence unconstitutional according to the Eighth Amendment prohibiting cruel and unusual punishment. Over thirty years later, Thompson remains incarcerated. Yet, his case set the stage for subsequent landmark US Supreme Court opinions that would protect even older youthful offenders (16- and 17-years-old) from execution and LWOP sentences.

In 1993, Christopher Simmons, 17 and a junior in high school, was found guilty of premeditated murder for a crime he committed with a friend and sentenced to death. He appealed his sentence to the Missouri Supreme Court, which sided with him, resentencing him to LWOP. The State of Missouri, through Warden Roper, petitioned for certiorari in the US Supreme Court. The US Supreme Court not only upheld the Missouri Supreme Court's decision but went further in stating capital punishment for 16- and 17-year-olds was unconstitutional, again based on the Eighth Amendment. Simmons is still incarcerated, but alive. Brandon Bernard, who was only a few months older than Simmons and an accomplice to a murder, is not. The *Simmons* case canceled the death sentences of 72 offenders younger than age 18 when they committed their crimes, including his own.

In 2003, three crimes were committed by youthful offenders whose cases rose to the US Supreme Court for rulings. The first of these cases was of Terrance Jamar Graham, who from ages 16 to 17 had been convicted of nonhomicide crimes, including robbery and armed burglary. The presiding judge in Graham's robbery case at age 17 sentenced him to life in prison. His legal team appealed this harsh sentence for a nonhomicide crime. In 2012, the US Supreme Court ruled on his case in *Graham v. Florida* to abolish mandatory LWOP sentences for nonhomicide crimes, thereby banning states from making the judgment at the outset that a youthful offender was incorrigible and beyond remediation for any crime other than murder. Graham was resentenced by the original trial judge to 25 years even though his record shows him as seeking a General Educational Development (GED) certificate when facing life and helping others to get their GED (Duvall 2017). Graham is still incarcerated (Fla. Dep. Correct. 2021), but his US Supreme Court case is impacting the lives of many other offenders who had been given a mandatory LWOP sentence that now have the opportunity to be resentenced, many of whom are already free, unlike Graham himself.

The second of the 2003 cases was that of Evan Miller, a 14-year-old boy who was convicted of murder during the course of an arson that Miller committed with another adolescent. He was sentenced to mandatory LWOP. The mandatory part of his sentence was struck down in *Miller v. Alabama* in 2012 when the US Supreme Court ruled that mandatory life sentences for juvenile cases, including murder, were unconstitutional. This decision provided the opportunity for the judge of that case to resentence Miller to LWOP again or to life with a chance of parole. To date, there is still no record of the judge's ruling having been made.

Finally, the third 2003 case was of Kuntrell Jackson who was 14 when he was convicted of murder and aggravated robbery after his adolescent friend killed a store clerk during the robbery. Jackson was charged as an adult and given a life sentence with no possibility of parole. His appeal ultimately resulted in the US Supreme Court opinion in *Jackson v. Hobbs* (2012), which stated that mandatory life sentences for any crime for juvenile cases were unconstitutional and entitled him to a new sentencing hearing. The US Supreme Court cases of *Miller* and *Jackson* affected hundreds of youthful offenders whose sentences did not take their age or other mitigating factors into account.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Of all the Supreme Court cases on the sentencing of youthful offenders over the past three decades, only Jackson has been released to date, after serving 16 years in prison (Assoc. Press 2017).

Based on the rulings of *Miller* and *Jackson*, Henry Montgomery, who had been sentenced to LWOP, petitioned the court for resentencing. Montgomery was found guilty of murder for a crime he committed at the age of 17 and sentenced to death. This verdict was annulled by the Louisiana Supreme Court in 1966, arguing that it was an unfair trial due to public prejudice. At his retrial in 1969, a jury again convicted Montgomery of murder, but this time it resulted in a mandatory sentence of LWOP. Montgomery petitioned for resentencing after the *Miller* decision, which was denied by the Louisiana Supreme Court but later overturned by the US Supreme Court in *Montgomery v. Louisiana* (2016). That ruling mandated that *Miller v. Alabama* be applied retroactively allowing states to undertake resentencing or offer parole to inmates sentenced to life as juveniles. Up to 2,300 cases across the United States are potentially affected by this ruling. Yet Montgomery, who became a model member of the prison community and mentored younger inmates, is now 73 years old and still incarcerated. Montgomery's parole in 2018 and 2019 was denied (Reckdahl 2019).

William Thompson, Christopher Simmons, Terrance Graham, Evan Miller, and Henry Montgomery are all still behind bars, yet their Supreme Court cases have impacted the sentencing and resentencing of hundreds of inmates and youthful offenders. These decisions prevent states from making an automatic judgment at initial sentencing that a youthful offender is incorrigible and beyond remediation and thus should have no right to an opportunity for release. Yet the cases themselves demonstrate that parole for violent crimes is rare, even in nonhomicide cases (e.g., *Graham*), and that parole decisions vary significantly within and across states and at the federal level at the discretion of judges.

Although this set of Supreme Court decisions appears to acknowledge the legal system's capacity for differentiating among offenders over and under the age of 18 during sentencing, US law in other areas draws the line differently (e.g., 21 as the pertinent age to purchase alcohol). How might developmental science inform these inconsistent policy-relevant age demarcations?

CURRENT SCIENCE ON BEHAVIORAL AND BRAIN DEVELOPMENT

Adolescence: A New Informed Definition

The US Supreme Court decisions set 18 as the age demarcation between juvenile and adult for rulings on the two most punitive sentences, death and mandatory LWOP. However, the point at which a person is considered mature and progresses from adolescence to adulthood varies by cultural, political, and social factors. Puberty typically marks the beginning of adolescence, but the end point is less obvious. National and international experts and policy groups acknowledge continued maturity gained well after the age of 18. The World Health Organization (WHO) (2019) defines adolescents as individuals in the age range of 10–19 years but defines youth as those 15–24 years and young people as 10–24 years. The United Nations also defines youth as those persons between the ages of 15 and 24 years (U. N. Dep. Econ. Soc. Aff. 2018). As such, these agencies and organizations extend the end of adolescence and onset of adulthood to between 20 and 25 years.

Sawyer and colleagues (2018) suggest that based on evidence of continued neurocognitive maturation, the age range of 10–24 years reflects a more informed definition of adolescence than prior definitions. This protracted period of development aligns with the many demands that adolescents must learn to negotiate as they transition into adult roles (e.g., physical, sexual, cognitive, psychological, and social changes). Others divide this period into separate yet important developmental stages of early, middle, and late adolescence and young adulthood (Casey et al. 2020) based on functionally significant changes in the connections and circuits of the brain across this

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

period (Casey et al. 2019, Heller et al. 2016). As such, it would be inaccurate to equate the brains of 13-year-olds to those of 19-year-olds, but both ages look significantly different from adults in important aspects of behavior (Cohen et al. 2016a, Steinberg 2008, Steinberg et al. 2009a).

Emerging or young adulthood, typically defined as 18–21, has been described as its own critical stage of life and is gaining more attention in the developmental literature. This is an important phase of developmental transition, as the individual no longer has the structured support of child- and family-oriented health and social services and often also lacks family and school structure (Sawyer et al. 2018). Arnett (2004), who coined the term "emerging adult," describes this period as an age of identity exploration, self-focus, and feeling in transition but also as an age of possibilities and opportunity. Given these differences from adulthood and the continued changes in neurocognition in the emerging adult, Sawyer et al. (2018) include this developmental period in a new and informed definition of adolescence.

The broadly defined period of adolescence and wide age range in the characterization of youth are analogous to the highly variable characterization of youthful offenders in the US justice system. When examining laws, the age at which adolescence ends and adulthood begins varies from one law, one context, and one state to the next. For example, when an individual reaches the age-of-majority in the United States (18 years), they are granted several civil rights and responsibilities of an adult by law (e.g., voting, signing legal documents, marrying, and serving in the military without parental permission). However, the age an individual can engage in other adult behaviors varies by the activity. For example, in some states, individuals can operate a motor vehicle as early as age 15 but cannot purchase alcohol, tobacco, and cannabis (where legalized) until age 21. Other US laws recognize continued maturation into the early twenties in the form of extended age eligibility for parent insurance coverage and foster care. The extended age boundaries of adolescence for the regulation of recreational substances and insurance are in sharp contrast to the age boundaries for the prosecution of juveniles. Each state sets a maximum age of juvenile court jurisdiction, which is 17 for most states. Yet laws about transfer to adult court vary wildly between crimes and between states, with no minimum age for some states. Consequently, children as young as 10 have been prosecuted and sentenced to death as adults in the United States (Streib 1987). This variability in age at which a juvenile may be charged as an adult raises the question of whether these age boundaries contradict or reflect the science on psychological and human brain development.

Defining Maturation and Adult Capacity

A question that developmental science is raising for the US legal system is whether the age demarcations between juvenile and adult are grounded in empirical evidence on behavioral and brain development. The age-of-majority model assumes that the individual generally reaches adult capacity by 18 years. Yet human development unfolds in complex ways. Not only do individuals develop cognitive competency as they mature, they also develop social and emotional competencies. Thus, reaching adult capacity is not a single process but rather consists of multiple processes that can interact in complex ways. Do all these competencies simultaneously reach adult capacity at the same age? Are we equally able to engage in controlled and flexible behavior in socially or emotionally arousing situations that involve desire, fear, or rage? Here, we clarify the current state of the science on typical behavioral and human brain development across these different domains of competency below.

When does psychological ability reach adult capacity? A large literature provides evidence of different developmental time courses for different psychological abilities. A hallmark of cognitive development is the ability to suppress competing inputs, thoughts, memories, and actions

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

(Casey et al. 2002). Cognitive abilities, as measured on simple, self-paced, nonarousing laboratory tasks, show equivalent performance to adults by early adolescence (i.e., 10–12 years) (Ridderinkhof et al. 1997, Rueda et al. 2004). These tasks include simply ignoring distracting information (Stroop 1935) or inhibiting a competing response (Eriksen & Eriksen 1974). Other tasks include recalling a series of several digits in reverse order or attending to the opposite location in a display on which a dot appears (i.e., look left if the target appears on the right and vice versa), which show continued development into mid-adolescence (i.e., 15–16 years) (Luna et al. 2004, Steinberg et al. 2009b). However, strategic behaviors and decision-making under demanding conditions of increased attentional interference, memory load, or speeded response pressures show steady improvements beyond 18 years into the early twenties (Satterthwaite et al. 2013, Weintraub et al. 2013).

Not only do cognitive abilities change throughout adolescence, but social and emotional abilities also change. Several studies have shown that relative to adults, adolescents display a heightened sensitivity to rewarding and emotional cues and context (Bos et al. 2020, Cauffman et al. 2010, Defoe et al. 2015, Figner et al. 2009, Pattwell et al. 2012, Somerville et al. 2011) and peer influences (Burnett et al. 2011, Gardner & Steinberg 2005, Steinberg & Monahan 2007, van Hoorn et al. 2019). Heightened sensitivity to this information can be distracting and bias actions and decisions in suboptimal ways for adolescents (Beardslee et al. 2018, Smith et al. 2014) but can also enhance performance if used to reinforce goal-directed behavior (Barkley-Levenson & Galvan 2014; Braams et al. 2019; Davidow et al. 2016, 2018; Geier et al. 2010; Silva et al. 2016b; Teslovich et al. 2014). One example of a task that has demonstrated suboptimal social influences on cognitive performance reliably in adolescents across multiple studies and cultures is the stoplight game (Chein et al. 2011, Duell et al. 2018, Icenogle et al. 2019, Steinberg et al. 2008). In this task, adolescents and adults are asked to decide whether or not to drive through a yellow light at an intersection when alone or with a peer. Adolescents (13–16 years) exhibited a greater propensity to make more risky decisions when monitored by peers compared to adults (24 years and older) (Gardner & Steinberg 2005). Importantly, studies employing the stoplight game also provide evidence that young adults (18–22 years) exhibit susceptibility to social influence, such that they take more risks in the presence of peers (Gardner & Steinberg 2005, Silva et al. 2016a). It is likely that adolescents' and young adults' heightened susceptibility to social influences places them at risk for criminal activity, an idea corroborated by evidence that most youths commit crimes with accomplices (McCord & Conway 2005).

To illustrate, we provide a concrete example of how emotionally charged situations can impact cognitive capacity across age. **Figure 2** shows variability in cognitive abilities among adolescents (13–17 years), young adults (18–21 years), and adults (22 years and older) in emotionally arousing versus nonarousing conditions (Cohen et al. 2016b). When we compare performance on a cognitive control task under emotionally arousing conditions (i.e., showing fearful faces that signal potential threat) versus no emotional arousal (i.e., neutral faces), we see striking differences across age groups. Adolescents and young adults exhibit less cognitive control in the arousing condition than adults (**Figure 2*b***). However, young adults do not differ from adults in the nonarousing condition (**Figure 2*a***). Thus, cognitive capacity differs under emotional arousal and does not reach adult levels on this task condition until age 22.

To further examine the differences in cognitive capacity between adolescents, young adults, and adults, we also examined age as a continuous measure (**Figure 2*c,d***). Performance remained lower for the young adults in the emotional condition similar to the adolescents (**Figure 2*d***). We also observed high variability in performance for all conditions across age, such that the variance in cognitive performance within a single age was as large as the variance between ages. Distinguishing the capacity of a 17-year-old from an 18-, 19-, 20-, or 21-year-old would be impossible for a single individual or even group of individuals, but this distinction in performance becomes more obvious

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

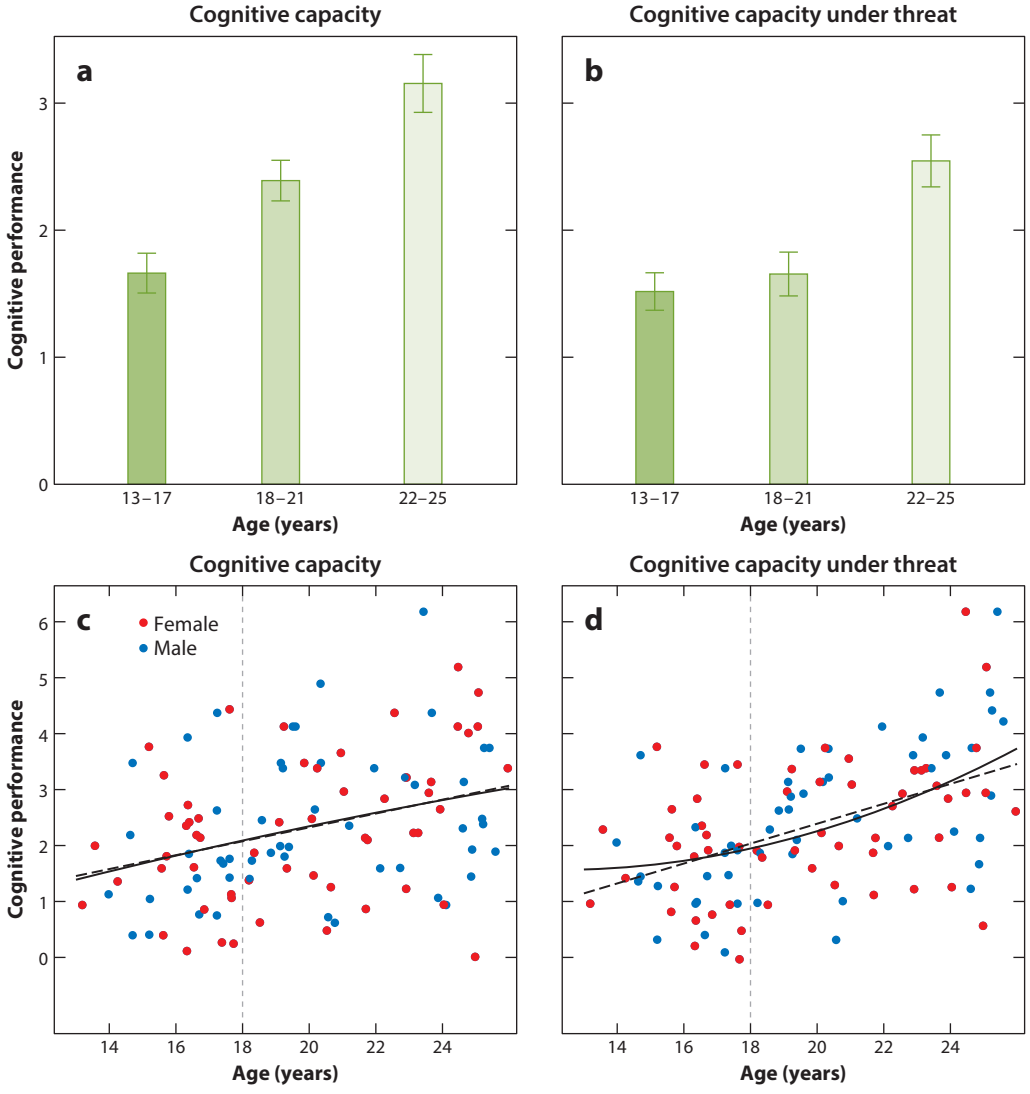


Figure 2

Cognitive capacity in nonarousing and emotionally arousing conditions by age for (*a*) a nonarousing condition and (*b*) an emotionally arousing condition. Age is plotted for the same data continuously for (*c*) a nonarousing condition and (*d*) an emotionally arousing condition. Solid and dashed black lines are quadratic and linear trends for age, respectively. Figure adapted with permission from Cohen et al. (2016b).

by the mid-twenties. Thus, the age at which cognitive ability matures depends on several factors, including the socio-emotional context and cognitive demands of the task. Together, these findings underscore that there is little difference between adolescents and young adults in cognitive capacity in emotionally charged situations, with continued improvement into the early twenties.

Overall, the literature on the development of psychological abilities reveals two key findings. The first is that adolescents and young adults as a group show immature psychological abilities relative to adults, which justifies special treatment and protection of youth. The second is that there is no one age at which an individual reaches maturity in all psychological capacities (Casey

et al. 2020). The development of cognitive, emotional, and social psychological abilities mature at different ages and this development can extend beyond 18 years. As such, an adolescent may have the capacity to make rational decisions in one context but lack the ability to engage in mature decision-making in another.

When is the brain mature? Neuroscience has demonstrated that a fundamental characteristic of the brain is plasticity, i.e., the capacity for change. The brain exhibits remarkable plasticity throughout the life course, especially during the first two decades of life (Bavelier et al. 2010, Fu & Zuo 2011), as a function of life experiences and interactions with the environment. Thus, the idea that there is a single age when the brain is mature or no longer exhibits plasticity conflicts with neuroscientific evidence of continued changes. Moreover, there is tremendous variability in the age at which changes are observed in the brain, depending on the brain region (e.g., prefrontal cortex, nucleus accumbens, amygdala) (Mills et al. 2014) and imaging modality (i.e., brain structure, function, or connectivity) (Somerville 2016). Regardless of this variability, there are reliable brain changes that occur beyond age 18 that are relevant to criminal behavior and involve brain circuitry implicated in decision-making (e.g., prefrontal cortex) (Casey et al. 2020, Somerville 2016).

There is a large neuroimaging literature that suggests that although the brain is basically intact at birth, connections between and within brain circuits show dynamic changes over the life course. Numerous studies have shown adolescent-specific changes in brain regions and circuits involved in processing information associated with reward (Braams et al. 2015, Chein et al. 2011, Cohen et al. 2016b, Davidow et al. 2016, Ernst & Paulus 2005, Galvan et al. 2006, Geier et al. 2010, Insel et al. 2017, Somerville et al. 2011, van den Bos et al. 2015, Van Leijenhorst et al. 2010), emotional reactivity (Breiner et al. 2018, Dreyfuss et al. 2014, Hare et al. 2008, Heller et al. 2016, Monk et al. 2003), and emotional regulation (Cohen et al. 2016a; Gee et al. 2013; McRae et al. 2012; Pozzi et al. 2021; Silvers et al. 2015, 2017; van Hoorn et al. 2019). These developmental changes in the brain appear hierarchical in nature, with changes at each level facilitating subsequent changes that coincide with patterns of cognitive, emotional, and social development (Casey et al. 2016). This development reflects a shift from reliance on limbic emotional circuitry to more prefrontal control circuitry, with intervening phases of development within and between subcortical (limbic) and cortical (prefrontal) circuits from early adolescence to adulthood (Cohen et al. 2016b, Casey et al. 2019). Thus, adolescent development does not involve simply one or even two changes in brain structure and function but rather a series of changes in multiple brain networks during adolescence that extend into young adulthood (Casey 2015, Casey et al. 2020).

Given these dynamic changes in subcortical and cortical circuits, as well as plasticity and the potential for change in the brain over the life course, there have been admirable attempts to develop a maturational index of the brain, similar to growth curves for height and weight (Brown et al. 2012, Campagne et al. 2016, Dosenbach et al. 2010). For example, Brown and colleagues (2012) examined MRI-based structural changes in the brain to measure maturation in more than 800 three- to twenty-year-olds who were imaged at nine different sites (**Figure 3*a***). They used multiple anatomical measures (e.g., cortical volume, cortical area, subcortical volume) together with nonlinear modeling to track brain maturation. They reported changes in brain structure that extended to 20 years. However, just as different psychological processes develop at different time points, so too do different brain measures contribute to the prediction of age at different time points, with some contributing earlier in development and others contributing later in development beyond 18 years (**Figure 3*b***). These data reinforce the claim of dynamic changes in the brain from childhood to young adulthood.

Other attempts at establishing maturational indices with human brain imaging data have emerged. These studies have focused on changes in functional connectivity of the brain with age (Dosenbach et al. 2010, Kaufmann et al. 2017). Functional connectivity is a measure of how

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

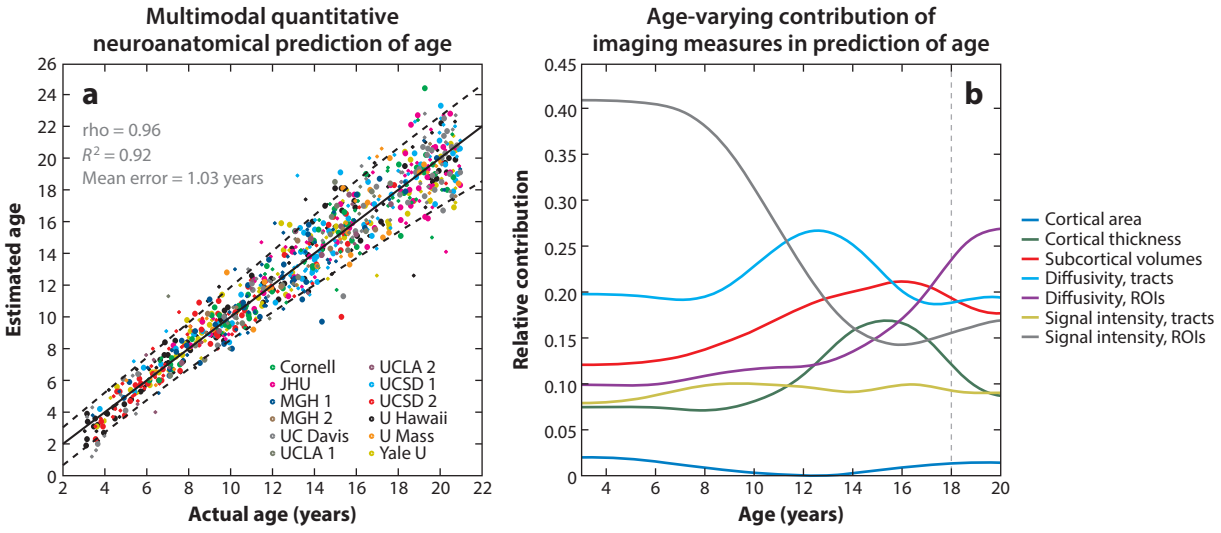


Figure 3

Anatomical prediction of age based on age-varying contributions of multimodal measures. (*a*) For 885 individuals, estimated brain age is plotted as a function of actual chronological age. (*b*) Plots of variation in the contribution of different imaging measures in the prediction of age. Colors in panel *a* correspond to different sites and scanners. Symbol size represents subject sex (larger, female; smaller, male). A spline-fit curve (*solid black line*) with 5% and 95% prediction intervals (*dashed black lines*) is also shown in panel *a*. Figure adapted with permission from Brown et al. 2012. Abbreviations: JHU, Johns Hopkins University; MGH1, Massachusetts General Hospital scanner 1; MGH2, Massachusetts General Hospital scanner 1; ROIs, regions of interest; UC Davis, University of California, Davis; UCLA1, University of California, Los Angeles scanner 1; UCLA2, University of California, Los Angeles scanner 2; UCSD1, University of California, San Diego scanner 1; UCSD2, University of California, San Diego scanner 2; U Hawaii, University of Hawaii; U Mass, University of Massachusetts; Yale U, Yale University.

activity in different regions of a brain network covaries during rest or performance of a task. Across these studies, functional connectivity changes were observed from childhood into young adulthood (Dosenbach et al. 2010) that appeared earlier in females than males (Kaufmann et al. 2017). For example, Dosenbach and colleagues (2010) examined changes in patterns of functional connectivity across brain networks in more than 300 individuals ages 7–30 years to estimate age. They found that they could predict, with some degree of certainty, differences in connectivity patterns between children relative to adults but could not confidently predict differences between 17-, 18-, 19-, and 20-year-olds. Moreover, the pattern of connectivity continued to show changes beyond 20 years before reaching asymptote by the mid-to-late twenties (**Figure 4**).

Measuring brain maturity becomes a bit more complicated when we examine brain connectivity and function in emotional states. Rudolph and colleagues (2017) attempted to predict the true age of more than 200 participants ages 10–25 years using machine learning and patterns of functional connectivity within and across brain networks in different mental states. They found that the model could predict age with some degree of certainty in nonarousing states, but the model was less accurate at predicting age in emotionally arousing states. Where the model was least accurate was in predicting the true age of adolescents (13–17 years) relative to younger and older participants during emotional states. Adolescents were predicted to be younger than they actually were based on their functional connections in these states. Thus, in emotional situations, adolescents' brains appeared less mature. Overall, less mature patterns of functional connectivity in emotional arousal were associated with self-reported risky behavioral preferences and tendencies. The highest risk preferences were reported by young adults (18–21 years)

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

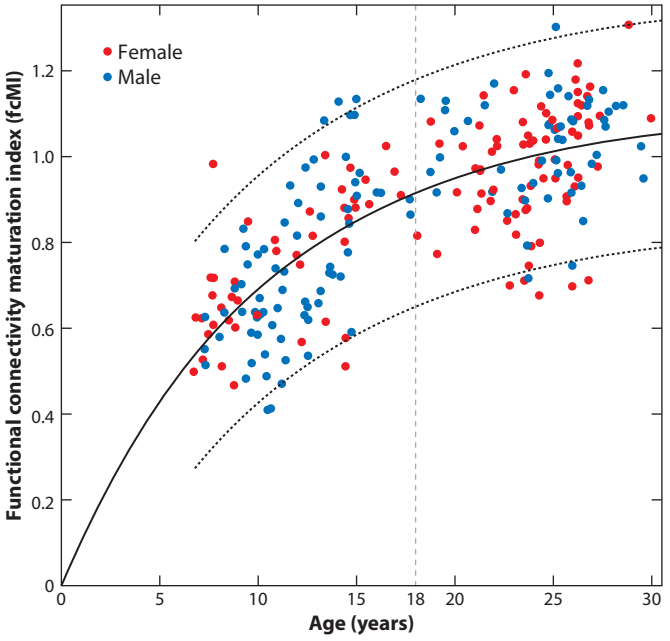


Figure 4

Brain maturation index based on functional connectivity. Cross-sectional changes in patterns of functional connectivity in the brain from 7 to 30 years ($n > 230$). The solid black line indicates best predicted fit and dashed black lines indicate 95% prediction limits. Figure adapted with permission from Dosenbach et al. (2010).

with immature functional connections under emotional arousal. These findings suggest that in emotionally charged situations the brain looks less mature during adolescence, and this shift in immature patterns of connectivity is related to risky behaviors that extend into young adulthood.

To more fully discern the impact of emotional arousal on brain function, Cohen et al. (2016b) tested the effects of emotional states on cognitive performance and brain activity. As described earlier (**Figure 2**), they found that both adolescents (13–17 years) and young adults (18–21 years) performed worse than adults (22 years and older) under emotional arousal (threat) relative to a nonarousing condition. These patterns in behavior were paralleled by less activity in prefrontal control circuitry in both adolescents and young adults relative to adults but more activity in the limbic (emotional) circuitry. The threatening condition in this experiment rather than the neutral one may best recapitulate the emotionally charged situations in which young people often find themselves when they come into contact with the law. Together, the behavioral and brain imaging findings suggest that brain function and cognitive capacity vary as a function of emotional and social contexts and that full adult capacity in these contexts is not observed until the early twenties.

CRIMINAL BEHAVIOR, PERSONALITY, AND PSYCHOPATHIC TRAITS: EVIDENCE OF CHANGE

Criminal Behavior Decreases with Age: The Age–Crime Curve

Adolescence is characterized as a period of transition from reliance on the caregiver to relative independence from the caregiver (Casey 2015). By definition, this period is transient. Behaviors

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

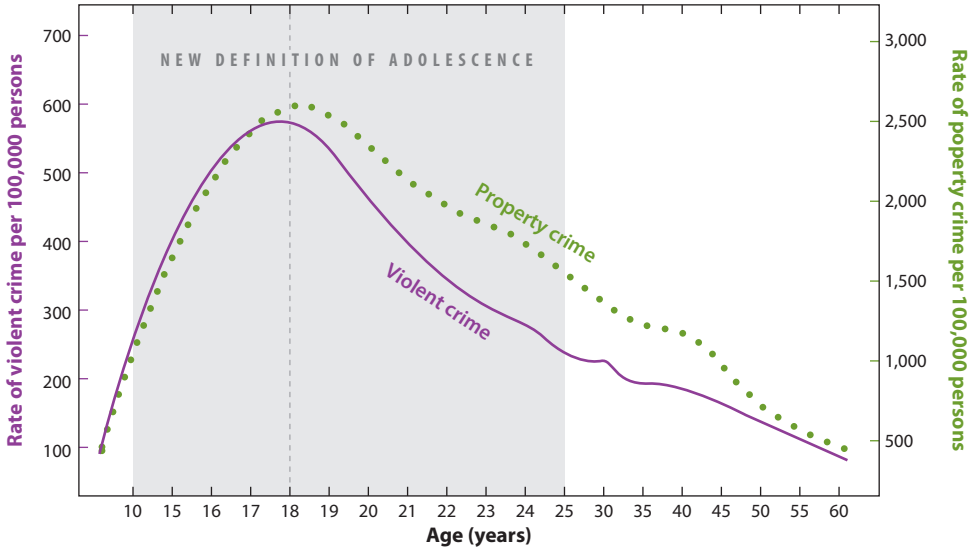


Figure 5

Age–crime curve. The gray box indicates adolescence according to Sawyer et al.'s (2018) definition. Figure adapted with permission from MacArthur Found. Res. Netw. Law Neurosci. (2017).

that emerge during this period peak and decline and are temporary. For example, risky behavior in the presence of peers and diminished cognitive performance in anticipation of reward increase during adolescence and decline in adulthood. Similarly, we see a transient pattern in criminal behavior that peaks during adolescence and subsides by the mid-twenties (**Figure 5**) (Bur. Justice Stat. 2010, Farrington 1986, Farrington et al. 2012). The majority of adolescents who commit crime desist as they mature into adulthood (Moffitt 2018). Although violent crime by youth in the United States has decreased considerably from its peak in the 1990s (Butts 2016, Casey et al. 2020), the association between age and crime has remained relatively constant (Sweeten et al. 2013). The transience of criminal behavior during adolescence and subsequent decline in adulthood suggests that the logic behind punitive life sentences, i.e., youth who commit violent crimes will inevitably commit violent crimes as adults, is not supported by these data.

Evidence of Changes in Personality Across the Life Course

The once popular idea that personality emerges early in development and is a relatively stable, distinctive way of thinking, acting, feeling, and relating to the world has been called into question. There is now strong evidence to show that personality not only develops throughout childhood and adolescence but changes throughout the entire life course (Harris et al. 2016, Roberts & Mroczek 2008, Soto et al. 2011). Research demonstrates that, on average, people show increased self-control and emotional stability as age increases, with ages 20–40 showing the greatest amount of change in key personality traits (Roberts & Mroczek 2008). For example, compared to young adults, middle-aged adults score higher on personality traits related to agreeableness (i.e., cooperative) and conscientiousness (e.g., self-control), and score lower on neuroticism (i.e., heightened negative emotion), extraversion (i.e., sociability), and openness (i.e., open to new experiences) (Srivastava et al. 2003). Unequivocal evidence of these changes in personality traits with age is provided by a comprehensive meta-analysis of more than 90 longitudinal studies covering the ages of 10 to over 100 years (Roberts et al. 2006). Changes in all personality trait domains were found

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

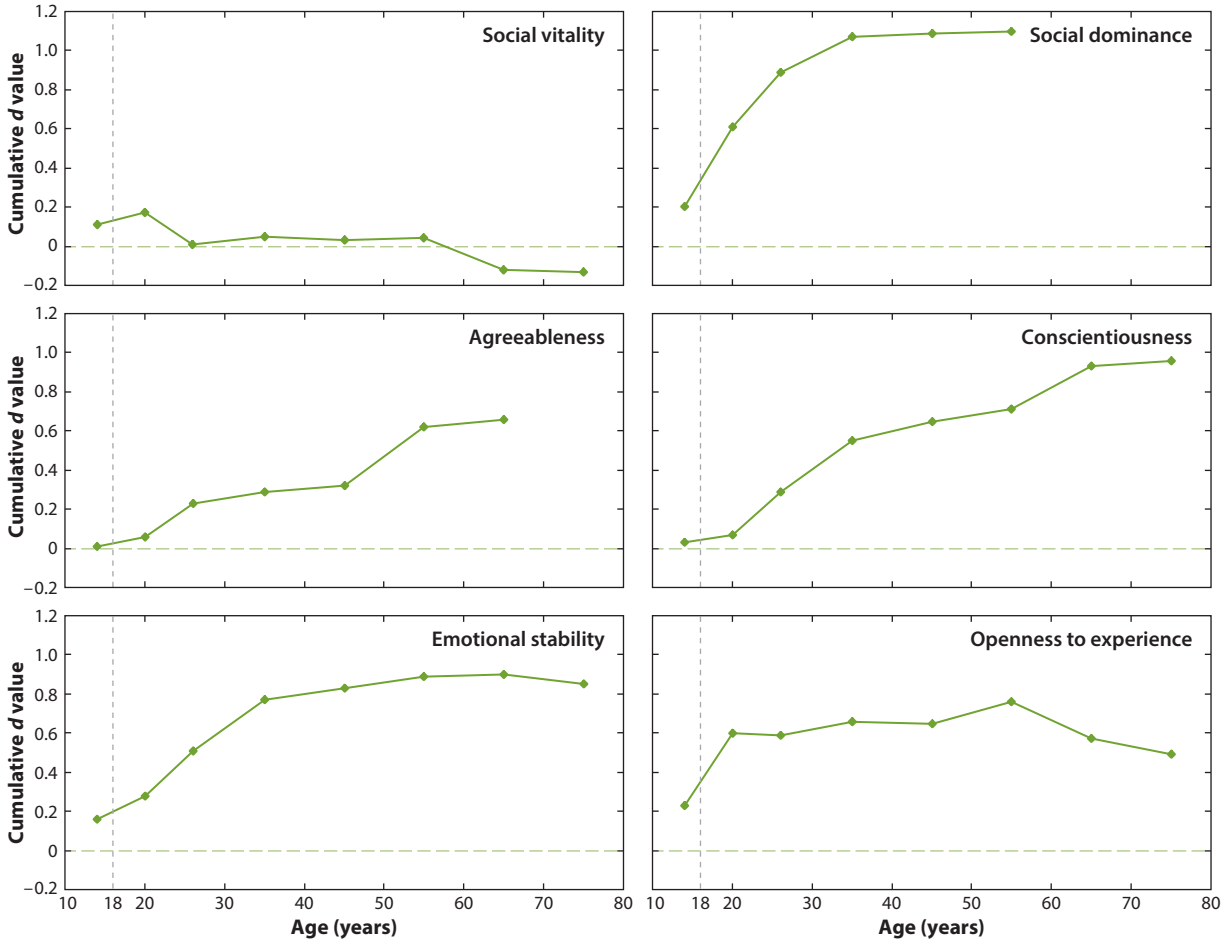


Figure 6

Changes in personality traits from childhood to old age. Abbreviation: *d*, difference between mean levels calculated cumulatively. Figure adapted with permission from Roberts & Mroczek (2008).

at different times in the life course, with changes extending into middle (40–60 years) and old age (over 60 years). Thus, personality traits are not stable but change throughout the life course.

Changes in personality from childhood to old age are illustrated in **Figure 6** (Roberts & Mroczek 2008). This figure shows cumulative changes in five key personality traits across the life course (McCrae & Costa 2008), with extroversion further subdivided into social vitality (gregariousness) and social dominance (assertiveness) (Roberts & Mroczek 2008). The majority of change in traits occurs after young adulthood. Specifically, the trait of conscientiousness characterized by being disciplined shows substantial changes from 22 to 40 years (see also Roberts et al. 2006, Roberts & Wood 2006). Likewise, emotional stability shows the biggest change after 22 years. This latter finding is reminiscent of the previously described differences between individuals under and over 22 years in patterns of brain activity and cognitive performance under emotional arousal (Cohen et al. 2016b). Thus, these findings together illustrate changes in behavior, brain, and personality that extend beyond 18 years. Moreover, this work on personality development highlights that people retain the capacity to change at all ages.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

It is important to highlight not only that there are changes in personality with age but that the environment and life experiences can influence personality development. Life experiences, like the start of a new relationship or career, may place new demands on youth that result in long-lasting personality changes (Costa et al. 2019, Damian et al. 2019). These same experiences may act as turning points for serious criminal behavior, through which youth adopt new roles, responsibilities, and attitudes that lead them to desist from crime (Sampson & Laub 2005). For youth and young adults, it is essential that opportunities for different life experiences exist to promote the development of personality. Overall, findings of personality change and development, as well as the importance of investing in the social development of youth, contradict legal arguments of youthful offenders as incorrigible, beyond reform or reentry into society, and that incarceration promotes any sort of positive change. Given that personality is constantly changing beyond 18 years, with potential for positive change even after young adulthood, to punish youthful offenders indefinitely (e.g., LWOP) and place them in environments rife with violence (i.e., prison) for actions from an earlier developmental period is not only unfounded but may stifle the potential for growth in these youth.

Callous-Unemotional and Psychopathic Traits Diminish with Age and Treatment

In the previous section, we provided evidence of dynamic changes in personality across the life course. However, what about extreme behaviors and traits such as callous-unemotional and psychopathic traits? Youth with these traits display high rates of antisocial behavior but also exhibit affective and interpersonal traits marked by callousness, low empathy, and low interpersonal emotions. These traits are important for designating a subgroup of antisocial youth who show early-onset delinquency and an increased risk for later antisocial and delinquent behavior (Frick 2009, Frick et al. 2014).

Historically, callous-unemotional and psychopathic traits have been described as emerging early with a stable course (Cleckley 1964, Frick et al. 2014, Lykken 1996). However, there is emerging empirical evidence of change in the developmental course of these traits. Hawes and colleagues (2018) examined the development of early psychopathic traits of more than 1,000 boys from childhood to adulthood and highlighted significant heterogeneity with age. Although a small group of boys showed persistently high trajectories of psychopathic traits, the majority of the boys who initially had high levels of psychopathic traits exhibited decreasing patterns during development and no longer presented with psychopathic traits in adulthood. These findings are consistent with a prior study examining the trajectories of callous-unemotional traits in a similarly large but independent sample of 1,170 justice-involved adolescent males (Baskin-Sommers et al. 2015). Three groups of youth were identified, those with low (27%), moderate (57%), and high (16%) levels of callous-unemotional traits. Youth in moderate callous-unemotional trait trajectories showed decreases in callous-unemotional traits from 16 to 24 years. Together, these studies indicate that the callous-unemotional/psychopathic traits decrease with age in the majority of youth whether justice involved or not.

The prior studies focused on developmental trajectories of callous-unemotional and psychopathic traits without the consideration of intervention or treatment. Treatment of these traits within the community, schools, or justice system is challenging. Often these youth are treated for their impulsivity, failure to follow instructions, and aggressive tendencies with pharmacological treatments, such as stimulants that help with attention-deficit/hyperactivity disorder and aggression (Connor et al. 2002). However, the impact of pharmacological interventions on the interpersonal and affective features of callous-unemotional and psychopathic traits is minimal

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

(Wilkinson et al. 2016). In terms of psychological interventions, there is mixed evidence regarding the effectiveness of treatment in youth showing callous-unemotional and psychopathic traits. Some studies report reductions in the expression of callous-unemotional traits and antisocial behavior following treatment (Bansal et al. 2019, Caldwell 2011, Caldwell et al. 2016); some report that youth with psychopathic traits show worse antisocial behavior following treatment (Wilkinson et al. 2016); and some report no relationship between these traits and changes in antisocial behavior following treatment (Wilkinson et al. 2016). Taken together, there is evidence that youth with callous-unemotional or psychopathic traits, regardless of whether they are justice involved or not, show treatment responsiveness in terms of clinical traits but mixed evidence that this responsiveness translates into any or sustained treatment outcomes (e.g., reduction in antisocial behavior) (Muratori et al. 2019). The inadequacy of traditional interventions to improve outcomes equally across levels of callous-unemotional and psychopathic traits has led to an increased focus on using knowledge on the etiology of these traits to develop innovative interventions aimed at improving outcomes.

Several possible interventions for callous-unemotional and psychopathic traits are emerging. For example, approaches involving parent training interventions delivered in early childhood appear to produce lasting reductions in callous-unemotional and psychopathic traits (Hawes et al. 2014) and antisocial behavior (Kimonis et al. 2019), particularly in younger children. For youth with callous-unemotional/psychopathic traits, a focus on increasing parental warmth, an important parenting factor related to the onset and maintenance of callous-unemotional traits, appears particularly useful in combating the unemotional expression commonly observed in youth with these traits. For youth with callous-unemotional/psychopathic traits who are ensnared in the justice system, one promising intervention comes from the Mendota Juvenile Treatment Center in Wisconsin (Caldwell 2011, Caldwell et al. 2007). This treatment was developed based on factors related to callous-unemotional and psychopathic traits (Viding & Kimonis 2018) and included a reward-oriented structure matched with specific goals, empathy skill development, and ways to appeal to the self-interests of incarcerated adolescents. Institutional behavior and post-treatment violent and general offending were assessed over 2–6.5 years in 250 youth after they were released from custody. The treatment condition was associated with improved institutional behavior and reduced post-release recidivism relative to the comparison treatment condition. Moreover, youth in the treatment condition exhibited improved behavior regardless of their psychopathic traits (i.e., interpersonal, affective, behavioral, and antisocial). Thus, it is inappropriate to say that these youth are "treatment resistant" or even "less responsive to treatment" as has been argued, but rather it is more a problem of getting the right treatment (see Baskin-Sommers 2022). Together, the findings suggest that extreme criminal behaviors and traits decrease with age from adolescence into adulthood but even more so with effective treatments. Sentencing youthful offenders to prison for extensive periods of time with few opportunities for growth only stifles their potential to change, adds to an already overcrowded prison system in the United States, and increases the economic burden on society.

PREDICTING FUTURE CRIMINAL BEHAVIOR AND RECIDIVISM

Predictive Utility of Behavioral Evidence

Punitive sentences of LWOP or death are based on legal arguments of youthful offenders as incorrigible, i.e., beyond reform or reentry into society. Likewise, the media and others (Welner et al. 2019) portray youth who murder as having mental illnesses for which there is no potential for remediation, and thus they will remain a threat to society. However, can we truly predict who will or will not commit violent crimes in the future? Can the presence of mental illness help

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

us predict which youth are more likely to commit crimes? Based on the National Comorbidity Survey–Adolescent Supplement (2001–2004) of more than 10,000 youth ages 13–17, Coker et al. (2014) found that although youth with lifetime DSM-IV-based diagnoses are more likely to report arrest-related crime than youth without a diagnosis, the majority do not. Ninety-three percent of youth with alcohol-use disorders and 80% of youth with a conduct disorder report never being arrested for a violent crime. Youth with anxiety and mood disorders reported even lower rates of crime. Moreover, 88% of those who had never been arrested report they had never committed a crime. Only youth with three or more diagnoses had higher rates of crime than those with no diagnosis. Moreover, there is some evidence that many youths who display antisocial psychopathology (e.g., conduct disorder, callous-unemotional traits) do not develop adult forms of antisocial psychopathology (e.g., antisocial personality disorder, psychopathy) commonly associated with elevated levels of criminal activity (Lynam et al. 2007, McMahon et al. 2010, Washburn et al. 2007). Thus, youth diagnoses can be informative and predictive but are not deterministic. The assumption that psychopathology in youth is a strong predictor of future behavior that warrants a life sentence or even death for those 18 and older is specious.

For those with psychopathology who commit crimes as a youth, it is difficult to predict who of them will recidivate. Recidivism depends on a host of factors related to the individual and the broader social context in which the individual develops. Even for youth showing callous-unemotional or psychopathic traits, meta-analyses suggest considerable heterogeneity when examining associations between these traits and recidivism. Associations between juvenile psychopathic traits and delinquency are only moderately related to recidivism (Asscher et al. 2011, Edens et al. 2007). Importantly, these associations are based on observational data and any claim of causality or determinism is unfounded. Therefore, evidence is modest, at best, that psychopathology is a predictor of recidivism. When considering sentencing decisions that can impact the lives of young people, the law and society should require more than modest evidence.

Statistically Significant Versus Clinically Meaningful Effects: Understanding the Difference

Although delinquency, antisocial behavior, and callous-unemotional and psychopathic traits in youth may be significantly associated with violent recidivism, it is important to distinguish between statistically significant and clinically meaningful effects. Statistical significance is often misinterpreted as clinically meaningful (Ranganathan et al. 2015). Measures of statistical significance like *p*-values quantify the probability of a study's results being due to chance, whereas clinically meaningful refers to the magnitude of the actual effect, which determines its clinical impact. Thus, a statistically significant association with $p = 0.05$ means that the results of a study are due to chance and not a real effect 1 in 20 times of performing that identical study. Clinically meaningful, in contrast, reflects whether the change observed in individuals makes a real difference to the subjects' lives and how long that difference or effect lasts (Ranganathan et al. 2015). To quantify clinical meaning, researchers often use effect size thresholds proposed by Cohen (2013), such as $d = 0.2$, which reflects a small effect size; $d = 0.5$, which reflects a medium effect size; and $d = 0.8$, which reflects a large effect size. Following this pattern, if groups differ by 0.2 or fewer standard deviations, this difference is considered trivial, even if statistically significant.

Statistical significance is heavily dependent on the sample size of the study. With large sample sizes, even small effects, which are clinically inconsequential, can be statistically significant. Any interpretation of study results should take into account the clinical meaning of a result by looking at the effect size and confidence intervals rather than basing a decision on simple statistical probabilities (e.g., *p*-value). This distinction is especially important when making subjective sentencing

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

decisions about the lifetime potential of a youthful offender's future criminal behavior. The potential for change in extreme behavior and callous-unemotional/psychopathic traits for the majority of youth, combined with only moderate associations in their past and future criminal behavior, calls into question our ability to predict with certainty and beyond a reasonable doubt who will recidivate.

CONCLUSIONS

Scientific evidence has emerged over the past several decades that shows unequivocally that there are continued changes in behavior and brain over the life span, especially during the prolonged period of adolescence. The decisions made in *Roper* and *Miller* were based largely on behavioral evidence of differences between youths and adults, with little knowledge or appreciation of the functionally significant and legally relevant brain changes throughout adolescence and into young adulthood. That evidence is now available and further confirms the behavioral science. Not only do these findings apply to *Roper*, *Miller*, and *Montgomery* but they also inform the extension of these decisions beyond 18 years.

An accumulation of evidence now shows that there are changes in personality over the life span beyond childhood and adolescence. This work contradicts the lay perspective that most personality development occurs early in life. Moreover, changes in personality later in life, on average, reflect increases in conscientiousness, emotional stability, and social maturity, indicators of a capacity to be a productive and contributing member of society. Since personality continues to change, especially beyond young adulthood in socially positive ways, life sentences based on behavior at a single developmental time point are unfounded.

Science now shows that not only are there changes in personality beyond child and adolescence but that extreme forms of behavior and traits diminish too. In fact, the majority of youth who engage in antisocial behavior and display callous-unemotional or psychopathic traits show a decrease in criminal behavior with age (Baskin-Sommers et al. 2015); with interventions, this decline is even greater (Caldwell et al. 2016). Given the potential for change in the individual and their environment throughout development, the ability to predict future criminal behavior based on prior behavior is tenuous at best. Sentencing decisions based largely on past behavior further open a door to subjective bias reflecting stigmas associated with extreme behaviors and traits as well as racial disparities that permeate the US criminal justice system.

Developmental science played a decisive role in the US Supreme Court decisions in *Roper* and *Miller* that youth should be treated differently from adults in the US criminal justice system. Now the science shows unambiguously that 18-, 19-, and 20-year-olds are more similar than different from 17-year-olds in many important aspects of behavioral and brain maturity, a conclusion that has already been drawn by the US legal system in other domains (e.g., regulation of tobacco sales to youth younger than 21). Yet individuals like Brandon Bernard continue to be severely punished for crimes committed as adolescents. Brandon is no longer with us. With his death comes the obligation to extend the age of juvenile status beyond 17, just as we extended the age from 15 years in *Thompson v. Oklahoma* (1988) to 17 years in *Roper v. Simmons* in 2005. The US justice system proclaims the importance of compelling evidence in the regulation of laws. So, let the evidence speak and prevent the opportunity for subjective bias in punitive sentencing decisions for youthful offenders and extend *Roper* and *Miller* beyond 17 to at least the 18–20 period of young adulthood, as other laws do. Let the behavior at the time of parole hearings be the defining basis for release and limit punitive death and life sentences given that the scientific evidence clearly shows the potential for change.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

This work was presented in part as a presentation on "Making the Sentencing Case: Applying Developmental and Neuroscientific Research to Youth and Emerging Adults" organized by the Juvenile Law Center and Arizona Capital Representation Project. This work was supported in part by U01 DA041174 and NIJ 2017-91727-PA-DN to B.J.C. and A.B.S. and the NSF CAREER award (BCS-1452530) to L.H.S.

LITERATURE CITED

Arnett JJ. 2004. *Emerging Adulthood: The Winding Road from the Late Teens Through the Twenties*. New York: Oxford Univ. Press

Asscher JJ, van Vugt ES, Stams GJ, Dekovic M, Eichelsheim VI, Yousfi S. 2011. The relationship between juvenile psychopathic traits, delinquency and (violent) recidivism: a meta-analysis. *J. Child Psychol. Psychiatry* 52:1134–43

Assoc. Press. 2017. Miller v. Alabama and Jackson v. Hobbs. *Associated Press*, July 31. **https://www.ap.org/explore/locked-up-for-life/Miller-v-Alabama-and-Jackson-v-Hobbs**

Bailey B. 2019. Still waiting: Oklahoma rarely paroles violent offenders. *Frontier*, April 17. **https://www.readfrontier.org/stories/still-waiting-oklahoma-rarely-paroles-violent-offenders/**

Bansal PS, Waschbusch DA, Haas SM, Babinski DE, King S, et al. 2019. Effects of intensive behavioral treatment for children with varying levels of conduct problems and callous-unemotional traits. *Behav. Ther.* 50:1–14

Barkley-Levenson E, Galvan A. 2014. Neural representation of expected value in the adolescent brain. *PNAS* 111:1646–51

Baskin-Sommers A, Chang S-A, Estrada S, Chan L. 2022. Considering exogenous and endogenous targets for effective interventions among youthful offenders. *Annu. Rev. Criminol.* In press

Baskin-Sommers AR, Waller R, Fish AM, Hyde LW. 2015. Callous-unemotional traits trajectories interact with earlier conduct problems and executive control to predict violence and substance use among high risk male adolescents. *J. Abnorm. Child Psychol.* 43:1529–41

Bavelier D, Levi DM, Li RW, Dan Y, Hensch TK. 2010. Removing brakes on adult brain plasticity: from molecular to behavioral interventions. *J. Neurosci.* 30:14964–71

Beardslee J, Datta S, Byrd A, Meier M, Prins S, et al. 2018. An examination of parental and peer influence on substance use and criminal offending during the transition from adolescence to adulthood. *Crim. Justice Behav.* 45:783–98

Bonnie RJ, Scott ES. 2013. The teenage brain: adolescent brain research and the law. *Curr. Dir. Psychol. Sci.* 22:158–61

Bos DJ, Dreyfuss M, Tottenham N, Hare TA, Galvan A, et al. 2020. Distinct and similar patterns of emotional development in adolescents and young adults. *Dev. Psychobiol.* 62:591–99

Braams BR, Davidow JY, Somerville LH. 2019. Developmental patterns of change in the influence of safe and risky peer choices on risky decision-making. *Dev. Sci.* 22:e12717

Erratum >

Braams BR, van Duijvenvoorde ACK, Peper JS, Crone EA. 2015. Longitudinal changes in adolescent risk-taking: a comprehensive study of neural responses to rewards, pubertal development, and risk-taking behavior. *J. Neurosci.* 35(18):7226–38

Breiner K, Li A, Cohen AO, Steinberg L, Bonnie RJ, et al. 2018. Combined effects of peer presence, social cues, and rewards on cognitive control in adolescents. *Dev. Psychobiol.* 60:292–302

Brown TT, Kuperman JM, Chung Y, Erhart M, McCabe C, et al. 2012. Neuroanatomical assessment of biological maturity. *Curr. Biol.* 22:1693–98

Bur. Justice Stat. 2010. Arrest data analysis tool: national estimates. *Bureau of Justice Statistics*. **https://www.bjs.gov/index.cfm?ty=datool&surl=/arrests/index.cfm**

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Burnett S, Sebastian C, Kadosh KC, Blakemore S-J. 2011. The social brain in adolescence: evidence from functional magnetic resonance imaging and behavioural studies. *Neurosci. Biobehav. Rev.* 35:1654–64

Butts JA. 2016. *Total youth arrests for violent crime still falling nationwide*. Rep., John Jay Coll. Crim. Justice Res. Eval. Cent., New York. **https://johnjayrec.nyc/2016/09/27/databit201601/**

Caldwell M, Skeem J, Salekin R, Van Rybroek G. 2016. Treatment response of adolescent offenders with psychopathy features. *Crim. Justice Behav.* 33:571–96

Caldwell MF. 2011. Treatment-related changes in behavioral outcomes of psychopathy facets in adolescent offenders. *Law Hum. Behav.* 35:275–87

Caldwell MF, McCormick DJ, Umstead D, Van Rybroek GJ. 2007. Evidence of treatment progress and therapeutic outcomes among adolescents with psychopathic features. *Crim. Justice Behav.* 34:573–87

Campagne A, Fradcourt B, Pichat C, Baciu M, Kauffmann L, Peyrin C. 2016. Cerebral correlates of emotional and action appraisals during visual processing of emotional scenes depending on spatial frequency: a pilot study. *PLOS ONE* 11:e0144393

Casey BJ. 2015. Beyond simple models of self-control to circuit-based accounts of adolescent behavior. *Annu. Rev. Psychol.* 66:295–319

Casey BJ. 2019. Healthy development as a human right: lessons from developmental science. *Neuron* 102:724–27

Casey BJ, Galvam A, Somerville LH. 2016. Beyond simple models of self-control to circuit-based accounts of adolescent behavior: a commentary. *Dev. Cogn. Neurosci.* 17:128–30

Casey BJ, Heller AS, Gee DG, Cohen AO. 2019. Development of the emotional brain. *Neurosci. Lett.* 693:29–34

Casey BJ, Taylor-Thompson K, Rubien-Thomas E, Robbins M, Baskin-Sommers A. 2020. Healthy development as a human right: insights from developmental neuroscience for youth justice. *Annu. Rev. Law Soc. Sci.* 16:203–22

Casey BJ, Tottenham N, Fossella J. 2002. Clinical, imaging, lesion, and genetic approaches toward a model of cognitive control. *Dev. Psychobiol.* 40:237–54

Cauffman E, Fine A, Mahler A, Simmons C. 2018. How developmental science influences juvenile justice reform. *UC Irvine Law Rev.* 8:21–40

Cauffman E, Shulman EP, Steinberg L, Claus E, Banich MT, et al. 2010. Age differences in affective decision making as indexed by performance on the Iowa Gambling Task. *Dev. Psychol.* 46:193–207

Chein J, Albert D, O'Brien L, Uckert K, Steinberg L. 2011. Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Dev. Sci.* 14:F1–10

Cleckley HM. 1964. *The Mask of Sanity: An Attempt to Clarify Some Issues About the So-Called Psychopathic Personality*. Maryland Heights, MO: Mosby

Cohen AO, Bonnie RJ, Taylor-Thompson K, Casey BJ. 2016a. When does a juvenile become an adult: implications for law and policy. *Temple Law Rev.* 88:769–88

Cohen AO, Breiner K, Steinberg L, Bonnie RJ, Scott ES, et al. 2016b. When is an adolescent an adult? Assessing cognitive control in emotional and nonemotional contexts. *Psychol. Sci.* 27:549–62

Cohen J. 2013. *Statistical Power Analysis for the Behavioral Sciences*. Cambridge, MA: Academic

Coker KL, Smith PH, Westphal A, Zonana HV, McKee SA. 2014. Crime and psychiatric disorders among youth in the US population: an analysis of the national comorbidity survey—adolescent supplement. *J. Am. Acad. Child Adolesc. Psychiatry* 53:888–98.e2

Connor DF, Glatt SJ, Lopez ID, Jackson D, Melloni RH Jr. 2002. Psychopharmacology and aggression. I: A meta-analysis of stimulant effects on overt/covert aggression-related behaviors in ADHD. *J. Am. Acad. Child Adolesc. Psychiatry* 41:253–61

Costa PT Jr., McCrae RR, Löckenhoff CE. 2019. Personality across the life span. *Annu. Rev. Psychol.* 70:423–48

Damian RI, Spengler M, Sutu A, Roberts BW. 2019. Sixteen going on sixty-six: a longitudinal study of personality stability and change across 50 years. *J. Personal. Soc. Psychol.* 117:674–95

Davidow JY, Foerde K, Galvan A, Shohamy D. 2016. An upside to reward sensitivity: the hippocampus supports enhanced reinforcement learning in adolescence. *Neuron* 92:93–99

Davidow JY, Insel C, Somerville LH. 2018. Adolescent development of value-guided goal pursuit. *Trends Cogn. Sci.* 22:725–36

Defoe IN, Dubas JS, Figner B, van Aken MA. 2015. A meta-analysis on age differences in risky decision making: adolescents versus children and adults. *Psychol. Bull.* 141:48–84

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Dosenbach NU, Nardos B, Cohen AL, Fair DA, Power JD, et al. 2010. Prediction of individual brain maturity using fMRI. *Science* 329:1358–61

Dreyfuss M, Caudle K, Drysdale AT, Johnston NE, Cohen AO, et al. 2014. Teens impulsively react rather than retreat from threat. *Dev. Neurosci.* 36:220–27

Duell N, Steinberg L, Icenogle G, Chein J, Chaudhary N, et al. 2018. Age patterns in risk taking across the world. *J. Youth Adolesc.* 47:1052–72

Duvall T. 2017. Jacksonville man's case led to new sentences for juvenile lifers - but he's still behind bars. *Florida Times-Union*, March 4. **https://www.jacksonville.com/news/metro/2017-03-04/jacksonville-man-s-case-led-new-sentences-juvenile-lifers-he-s-still-behind**

Edens JF, Campbell JS, Weir JM. 2007. Youth psychopathy and criminal recidivism: a meta-analysis of the psychopathy checklist measures. *Law Hum. Behav.* 31:53–75

Eriksen BA, Eriksen CW. 1974. Effects of noise letters upon the identification of a target letter in a nonsearch task. *Percept. Psychophys.* 16:143–49

Ernst M, Paulus MP. 2005. Neurobiology of decision making: a selective review from a neurocognitive and clinical perspective. *Biol. Psychiatry* 58:597–604

Farrington DP. 1986. Age and crime. *Crime Justice Rev. Res.* 7:189–250

Farrington DP, Loeber R, Howell JC. 2012. Young adult offenders. *Criminol. Public Policy* 11:729–50

Figner B, Mackinlay RJ, Wilkening F, Weber EU. 2009. Affective and deliberative processes in risky choice: age differences in risk taking in the Columbia Card Task. *J. Exp. Psychol. Learn. Mem. Cogn.* 35:709–30

Fla. Dep. Correct. 2021. Corrections offender network. Inmate population information detail: Terrance J Graham. *Florida Department of Corrections*. **http://www.dc.state.fl.us/offenderSearch/detail.aspx?Page=Detail&DCNumber=J25706&TypeSearch=AI**

Frick PJ. 2009. Extending the construct of psychopathy to youth: implications for understanding, diagnosing, and treating antisocial children and adolescents. *Can. J. Psychiatry* 54:803–12

Frick PJ, Ray JV, Thornton LC, Kahn RE. 2014. Can callous-unemotional traits enhance the understanding, diagnosis, and treatment of serious conduct problems in children and adolescents? A comprehensive review. *Psychol. Bull.* 140:1–57

Fu M, Zuo Y. 2011. Experience-dependent structural plasticity in the cortex. *Trends Neurosci.* 34:177–87

Galvan A, Hare TA, Parra CE, Penn J, Voss H, et al. 2006. Earlier development of the accumbens relative to orbitofrontal cortex might underlie risk-taking behavior in adolescents. *J. Neurosci.* 26:6885–92

Gardner M, Steinberg L. 2005. Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study. *Dev. Psychol.* 41:625–35

Gee DG, Humphreys KL, Flannery J, Goff B, Telzer EH, et al. 2013. A developmental shift from positive to negative connectivity in human amygdala-prefrontal circuitry. *J. Neurosci.* 33:4584–93

Geier CF, Terwilliger R, Teslovich T, Velanova K, Luna B. 2010. Immaturities in reward processing and its influence on inhibitory control in adolescence. *Cereb. Cortex* 20:1613–29

Graham v. Florida, 560 U.S. 48, 08–7412 (2010)

Hale G. 2020. Convicted murderer facing lethal injection asks Trump to commute sentence. *Indiana Public Media*, Novemb. 10. **https://indianapublicmedia.org/news/convicted-murdered-facing-lethan-injection-asks-trump-to-commute-sentence.php**

Hare TA, Tottenham N, Galvan A, Voss HU, Glover GH, Casey BJ. 2008. Biological substrates of emotional reactivity and regulation in adolescence during an emotional go-nogo task. *Biol. Psychiatry* 63:927–34

Harris MA, Brett CE, Johnson W, Deary IJ. 2016. Personality stability from age 14 to age 77 years. *Psychol. Aging* 31:862–74

Hawes DJ, Price MJ, Dadds MR. 2014. Callous-unemotional traits and the treatment of conduct problems in childhood and adolescence: a comprehensive review. *Clin. Child Fam. Psychol. Rev.* 17:248–67

Hawes SW, Byrd AL, Gonzalez R, Cavanaugh C, Bechtold J, et al. 2018. The developmental course of psychopathic features: investigating stability, change, and long-term outcomes. *J. Res. Personal.* 77:83–89

Heller AS, Cohen AO, Dreyfuss MF, Casey BJ. 2016. Changes in cortico-subcortical and subcortico-subcortical connectivity impact cognitive control to emotional cues across development. *Soc. Cogn. Affect. Neurosci.* 11:1910–18

Icenogle G, Steinberg L, Duell N, Chein J, Chang L, et al. 2019. Adolescents' cognitive capacity reaches adult levels prior to their psychosocial maturity: evidence for a "maturity gap" in a multinational, cross-sectional sample. *Law Hum. Behav.* 43:69–85

Insel C, Kastman EK, Glenn CR, Somerville LH. 2017. Development of corticostriatal connectivity constrains goal-directed behavior during adolescence. *Nat. Commun.* 8:1605

Jackson v. Hobbs, 567 U.S. 460, 10–9647 (2012)

Kaufmann T, Alnaes D, Doan NT, Brandt CL, Andreassen OA, Westlye LT. 2017. Delayed stabilization and individualization in connectome development are related to psychiatric disorders. *Nat. Neurosci.* 20:513–15

Kimonis ER, Fleming G, Briggs N, Brouwer-French L, Frick PJ, et al. 2019. Parent-child interaction therapy adapted for preschoolers with callous-unemotional traits: an open trial pilot study. *J. Clin. Child Adolesc. Psychol.* 48:S347–61

Luna B, Garver KE, Urban TA, Lazar NA, Sweeney JA. 2004. Maturation of cognitive processes from late childhood to adulthood. *Child Dev.* 75:1357–72

Lykken DT. 1996. Psychopathy, sociopathy, and crime. *Society* 34:29–38

Lynam DR, Caspi A, Moffitt TE, Loeber R, Stouthamer-Loeber M. 2007. Longitudinal evidence that psychopathy scores in early adolescence predict adult psychopathy. *J. Abnorm. Psychol.* 116:155–65

MacArthur Found. Res. Netw. Law Neurosci. 2017. *How should justice policy treat young offenders?* Rep., MacArthur Found. Res. Netw. Law Neurosci., Chicago. **https://www.lawneuro.org/files/adol_dev_brief.pdf**

McCord J, Conway K. 2005. *Co-offending and patterns of juvenile crime: research in brief*. Off. Justice Prog. Rep. NCJ 210360, Natl. Inst. Justice, Washington, DC. **https://www.ojp.gov/pdffiles1/nij/210360.pdf**

McCrae RR, Costa PT. 2008. The five-factor theory of personality. In *Handbook of Personality: Theory and Research*, ed. OP John, RW Robins, LA Pervin, pp. 159–81. New York: Guilford Press

McMahon RJ, Witkiewitz K, Kotler JS. 2010. Predictive validity of callous-unemotional traits measured in early adolescence with respect to multiple antisocial outcomes. *J. Abnorm. Psychol.* 119:752–63

McRae K, Gross JJ, Weber J, Robertson ER, Sokol-Hessner P, et al. 2012. The development of emotion regulation: an fMRI study of cognitive reappraisal in children, adolescents and young adults. *Soc. Cogn. Affect. Neurosci.* 7:11–22

Miller v. Alabama, 567 U.S. 460, 10–9646 (2012)

Mills KL, Goddings AL, Clasen LS, Giedd JN, Blakemore SJ. 2014. The developmental mismatch in structural brain maturation during adolescence. *Dev. Neurosci.* 36:147–60

Moffitt TE. 2018. Male antisocial behaviour in adolescence and beyond. *Nat. Hum. Behav.* 2:177–86

Monk CS, McClure EB, Nelson EE, Zarahn E, Bilder RM, et al. 2003. Adolescent immaturity in attention-related brain engagement to emotional facial expressions. *NeuroImage* 20:420–28

Montgomery v. Louisiana, 577 U.S. __, 14–280 (2016)

Muratori P, Milone A, Levantini V, Ruglioni L, Lambruschi F, et al. 2019. Six-year outcome for children with ODD or CD treated with the coping power program. *Psychiatry Res.* 271:454–58

Natl. Res. Counc., Div. Behav. Soc. Sci. Educ., Comm. Law Justice, Comm. Assess. Juv. Justice Reform, Bonnie RJ, et al. 2013. *Reforming Juvenile Justice: A Developmental Approach*. Washington, DC: Natl. Acad. Press

Pattwell SS, Duhoux S, Hartley CA, Johnson DC, Jing D, et al. 2012. Altered fear learning across development in both mouse and human. *PNAS* 109:16318–23

Pozzi E, Vijayakumar N, Rakesh D, Whittle S. 2021. Neural correlates of emotion regulation in adolescents and emerging adults: a meta-analytic study. *Biol. Psychiatry* 89:194–204

Ranganathan P, Pramesh C, Buyse M. 2015. Common pitfalls in statistical analysis: clinical versus statistical significance. *Perspect. Clin. Res.* 6:169–70

Reckdahl K. 2019. Inmate from Supreme Court case rejected for parole a second time. *Juvenile Justice Information Exchange*, April 13. **https://jjie.org/2019/04/13/inmate-from-supreme-court-case-rejected-for-parole-a-second-time/**

Ridderinkhof KR, van der Molen MW, Band GP, Bashore TR. 1997. Sources of interference from irrelevant information: a developmental study. *J. Exp. Child Psychol.* 65:315–41

Roberts BW, Mroczek D. 2008. Personality trait change in adulthood. *Curr. Dir. Psychol. Sci.* 17:31–35

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Roberts BW, Walton KE, Viechtbauer W. 2006. Patterns of mean-level change in personality traits across the life course: a meta-analysis of longitudinal studies. *Psychol. Bull.* 132:1–25

Roberts BW, Wood D. 2006. Personality development in the context of the neo-socioanalytic model of personality. In *Handbook of Personality Development*, ed. DK Mroczek, TD Little, pp. 11–39. Mahwah, NJ: Lawrence Erlbaum Assoc. Publ.

Roper v. Simmons, 543 U.S. 551, 03–633 (2005)

Rudolph MD, Miranda-Dominguez O, Cohen AO, Breiner K, Steinberg L, et al. 2017. At risk of being risky: the relationship between "brain age" under emotional states and risk preference. *Dev. Cogn. Neurosci.* 24:93–106

Rueda MR, Fan J, McCandliss BD, Halparin JD, Gruber DB, et al. 2004. Development of attentional networks in childhood. *Neuropsychologia* 42:1029–40

Sampson RJ, Laub JH. 2005. A life-course view of the development of crime. *Ann. Am. Acad. Political Soc. Sci.* 602:12–45

Satterthwaite TD, Wolf DH, Erus G, Ruparel K, Elliott MA, et al. 2013. Functional maturation of the executive system during adolescence. *J. Neurosci.* 33:16249–61

Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. 2018. The age of adolescence. *Lancet Child Adolesc. Health* 2:223–28

Silva K, Chein J, Steinberg L. 2016a. Adolescents in peer groups make more prudent decisions when a slightly older adult is present. *Psychol. Sci.* 27:322–30

Silva K, Shulman EP, Chein J, Steinberg L. 2016b. Peers increase late adolescents' exploratory behavior and sensitivity to positive and negative feedback. *J. Res. Adolesc.* 26:696–705

Silvers JA, Insel C, Powers A, Franz P, Helion C, et al. 2017. vlPFC-vmPFC-amygdala interactions underlie age-related differences in cognitive regulation of emotion. *Cereb. Cortex* 27:3502–14

Silvers JA, Shu J, Hubbard AD, Weber J, Ochsner KN. 2015. Concurrent and lasting effects of emotion regulation on amygdala response in adolescence and young adulthood. *Dev. Sci.* 18:771–84

Smith AR, Chein J, Steinberg L. 2014. Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Dev. Psychol.* 50:1564–68

Snyder HN. 2012. *Arrest in the United States, 1990–2010*. Off. Justice Prog. Rep. NCJ 239423, US Dep. Justice, Washington, DC. **https://www.bjs.gov/content/pub/pdf/aus9010.pdf**

Somerville LH. 2016. Searching for signatures of brain maturity: What are we searching for? *Neuron* 92:1164–67

Somerville LH, Hare T, Casey BJ. 2011. Frontostriatal maturation predicts cognitive control failure to appetitive cues in adolescents. *J. Cogn. Neurosci.* 23:2123–34

Soto CJ, John OP, Gosling SD, Potter J. 2011. Age differences in personality traits from 10 to 65: big five domains and facets in a large cross-sectional sample. *J. Personal. Soc. Psychol.* 100:330–48

Srivastava S, John OP, Gosling SD, Potter J. 2003. Development of personality in early and middle adulthood: set like plaster or persistent change? *J. Personal. Soc. Psychol.* 84:1041–53

Steinberg L. 2008. A social neuroscience perspective on adolescent risk-taking. *Dev. Rev.* 28:78–106

Steinberg L, Albert D, Cauffman E, Banich M, Graham S, Woolard J. 2008. Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: evidence for a dual systems model. *Dev. Psychol.* 44:1764–78

Steinberg L, Cauffman E, Woolard J, Graham S, Banich M. 2009a. Are adolescents less mature than adults?: minors' access to abortion, the juvenile death penalty, and the alleged APA "flip-flop." *Am. Psychol.* 64:583–94

Steinberg L, Graham S, O'Brien L, Woolard J, Cauffman E, Banich M. 2009b. Age differences in future orientation and delay discounting. *Child Dev.* 80:28–44

Steinberg L, Monahan KC. 2007. Age differences in resistance to peer influence. *Dev. Psychol.* 43:1531–43

Streib VL. 1987. *Death Penalty for Juveniles*. Bloomington, IN: Indiana Univ. Press

Stroop JR. 1935. Studies of interference in serial verbal reactions. *J. Exp. Psychol.* 18:643–62

Sweeten G, Piquero AR, Steinberg L. 2013. Age and the explanation of crime, revisited. *J. Youth Adolesc.* 42:921–38

Taylor-Thompson K. 2003. States of mind/states of development. *Stanf. Law Policy Rev.* 14:143–73

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Teslovich T, Mulder M, Franklin NT, Ruberry EJ, Millner A, et al. 2014. Adolescents let sufficient evidence accumulate before making a decision when large incentives are at stake. *Dev. Sci.* 17:59–70

Thompson v. Oklahoma, 487 U.S. 108, 86-6169 (1988)

U. N. Dep. Econ. Soc. Aff. 2018. Frequently asked questions. *United Nations*. **https://www.un.org/development/desa/youth/what-we-do/faq.html**

van den Bos W, Rodriguez CA, Schweitzer JB, McClure SM. 2015. Adolescent impatience decreases with increased frontostriatal connectivity. *PNAS* 112:E3765–74

van Hoorn J, Shablack H, Lindquist KA, Telzer EH. 2019. Incorporating the social context into neurocognitive models of adolescent decision-making: a neuroimaging meta-analysis. *Neurosci. Biobehav. Rev.* 101:129–42

Van Leijenhorst L, Zanolie K, Van Meel CS, Westenberg PM, Rombouts SA, Crone EA. 2010. What motivates the adolescent? Brain regions mediating reward sensitivity across adolescence. *Cereb. Cortex* 20:61–69

Viding E, Kimonis ER. 2018. Callous-unemotional traits. In *Handbook of Psychopathy*, ed. CJ Patrick, pp. 144–64. New York: Guilford Press

Washburn JJ, Romero EG, Welty LJ, Abram KM, Teplin LA, et al. 2007. Development of antisocial personality disorder in detained youths: the predictive value of mental disorders. *J. Consult. Clin. Psychol.* 75:221–31

Weintraub S, Dikmen SS, Heaton RK, Tulsky DS, Zelazo PD, et al. 2013. Cognition assessment using the NIH Toolbox. *Neurology* 80:S54–64

Welner M, Baglivio M, DeLisi M, Guilmette TJ, et al. 2019. *Homicide and criminal maturity*. Rep., Forensic Panel, New York

Wilkinson S, Waller R, Viding E. 2016. Practitioner review: involving young people with callous unemotional traits in treatment—does it work? A systematic review. *J. Child Psychol. Psychiatry* 57:552–65

World Health Organ. 2019. Adolescent health. *World Health Organization*. **https://www.who.int/health-topics/adolescent-health#tab=tab_1**

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

Annual Review
of Criminology

Volume 5, 2022

Contents

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

The Discipline

Reflections on Six Decades of Research
Delbert S. Elliott 1

Criminalization and Criminal Legal Institutions

The Justice Department's Pattern-or-Practice Police Reform Program, 1994–2017: Goals, Achievements, and Issues
Samuel Walker 21

The Slow Violence of Contemporary Policing
Rory Kramer and Brianna Remster 43

Criminal Record Stigma and Surveillance in the Digital Age
Sarah Esther Lageson 67

Bail and Pretrial Justice in the United States: A Field of Possibility
Joshua Page and Christine S. Scott-Hayward 91

Assessing the Impact of the Violence Against Women Act
Leigh Goodmark 115

The Impact of Incarceration on Recidivism
Charles E. Loeffler and Daniel S. Nagin 133

The Failed Regulation and Oversight of American Prisons
Sharon Dolovich 153

Theory and Method

Analytic Criminology: Mechanisms and Methods in the Explanation of Crime and its Causes
Per-Olof H. Wikström and Clemens Kroneberg 179

Sanctions, Perceptions, and Crime
Robert Apel 205

Don't Call It a Comeback: The Criminological and Sociological Study of Subfelonies
Issa Kohler-Hausmann 229

Green Criminology: Capitalism, Green Crime and Justice, and Environmental Destruction
Michael J. Lynch and Michael A. Long 255

The Meaning of the Victim–Offender Overlap for Criminological Theory and Crime Prevention Policy
Mark T. Berg and Christopher J. Schreck 277

Gang Research in the Twenty-First Century
Caylin Louis Moore and Forrest Stuart 299

A Focus on Youth

Making the Sentencing Case: Psychological and Neuroscientific Evidence for Expanding the Age of Youthful Offenders
B.J. Casey, C. Simmons, L.H. Somerville, and A. Baskin-Sommers 321

Toward Targeted Interventions: Examining the Science Behind Interventions for Youth Who Offend
Arielle Baskin-Sommers, Shou-An Chang, Suzanne Estrada, and Lena Chan 345

The Centrality of Child Maltreatment to Criminology
Sarah A. Font and Reeve Kennedy 371

Errata

An online log of corrections to *Annual Review of Criminology* articles may be found at http://www.annualreviews.org/errata/criminol

Annu. Rev. Criminol. 2022.5:321-343. Downloaded from www.annualreviews.org
Access provided by 2600:4040:561b:4100:719b:c050:68b8:65fb on 06/17/23. For personal use only.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix H
Arain et al, *Maturation of the Adolescent Brain*, 9 Neuropsychiatric Disease & Treatment 449, 450 (2013)

Neuropsychiatric Disease and Treatment

Dovepress
open access to scientific and medical research

Open Access Full Text Article

REVIEW

Maturation of the adolescent brain

RECEIVED by MSC 9/27/2024 8:39:40 PM

This article was published in the following Dove Press journal:
Neuropsychiatric Disease and Treatment
2 April 2013
Number of times this article has been viewed

Mariam Arain
Maliha Haque
Lina Johal
Puja Mathur
Wynand Nel
Afsha Rais
Ranbir Sandhu
Sushil Sharma

Saint James School of Medicine, Kralendijk, Bonaire, The Netherlands

Video abstract

Point your SmartPhone at the code above. If you have a QR code reader the video abstract will appear. Or use: http://dvpr.es/W6umNa

Abstract: Adolescence is the developmental epoch during which children become adults – intellectually, physically, hormonally, and socially. Adolescence is a tumultuous time, full of changes and transformations. The pubertal transition to adulthood involves both gonadal and behavioral maturation. Magnetic resonance imaging studies have discovered that myelinogenesis, required for proper insulation and efficient neurocybernetics, continues from childhood and the brain's region-specific neurocircuitry remains structurally and functionally vulnerable to impulsive sex, food, and sleep habits. The maturation of the adolescent brain is also influenced by heredity, environment, and sex hormones (estrogen, progesterone, and testosterone), which play a crucial role in myelination. Furthermore, glutamatergic neurotransmission predominates, whereas gamma-aminobutyric acid neurotransmission remains under construction, and this might be responsible for immature and impulsive behavior and neurobehavioral excitement during adolescent life. The adolescent population is highly vulnerable to driving under the influence of alcohol and social maladjustments due to an immature limbic system and prefrontal cortex. Synaptic plasticity and the release of neurotransmitters may also be influenced by environmental neurotoxins and drugs of abuse including cigarettes, caffeine, and alcohol during adolescence. Adolescents may become involved with offensive crimes, irresponsible behavior, unprotected sex, juvenile courts, or even prison. According to a report by the Centers for Disease Control and Prevention, the major cause of death among the teenage population is due to injury and violence related to sex and substance abuse. Prenatal neglect, cigarette smoking, and alcohol consumption may also significantly impact maturation of the adolescent brain. Pharmacological interventions to regulate adolescent behavior have been attempted with limited success. Since several factors, including age, sex, disease, nutritional status, and substance abuse have a significant impact on the maturation of the adolescent brain, we have highlighted the influence of these clinically significant and socially important aspects in this report.

Keywords: myelinogenesis, neurocircuitry, molecular imaging, drug addiction, behavior, social adjustment

Introduction

Significant progress has been made over the last 25 years in understanding the brain's regional morphology and function during adolescence. It is now realized that several major morphological and functional changes occur in the human brain during adolescence.[1] Molecular imaging and functional genomics studies have indicated that the brain remains in an active state of development during adolescence.[1] In particular, magnetic resonance imaging (MRI) studies have discovered that myelinogenesis continues and the neurocircuitry remains structurally and functionally vulnerable to significant increases in sex hormones (estrogen, progesterone, and testosterone) during

Correspondence: Sushil Sharma
Saint James School of Medicine,
Plaza Juliana 4, Kralendijk, Bonaire,
The Netherlands
Tel +31 599 717 7550
Fax +31 599 717 7570
Email sharma@mail.sjsm.org

© 2013 Arain et al, publisher and licensee Dove Medical Press Ltd. This is an Open Access article which permits unrestricted noncommercial use, provided the original work is properly cited.

RECEIVED by MSC 9/27/2024 8:39:40 PM

puberty which, along with environmental input, influences sex, eating, and sleeping habits. Particularly significant changes occur in the limbic system, which may impact self-control, decision making, emotions, and risk-taking behaviors. The brain also experiences a surge of myelin synthesis in the frontal lobe, which is implicated in cognitive processes during adolescence.[1]

Brain maturation during adolescence (ages 10–24 years) could be governed by several factors, as illustrated in Figure 1. It may be influenced by heredity and environment, prenatal and postnatal insult, nutritional status, sleep patterns, pharmacotherapy, and surgical interventions during early childhood. Furthermore, physical, mental, economical, and psychological stress; drug abuse (caffeine, nicotine, and alcohol); and sex hormones including estrogen, progesterone, and testosterone can influence the development and maturation of the adolescent brain. MRI studies have suggested that neurocircuitry and myelinogenesis remain under construction during adolescence because these events in the central nervous system (CNS) are transcriptionally regulated by sex hormones that are specifically increased during puberty.

Neurobehavioral, morphological, neurochemical, and pharmacological evidence suggests that the brain remains under construction during adolescence,[1,2,3,7,12,21,22,23,27,49] as illustrated in Figure 2. Thus, the consolidation of neurocybernetics occurs during adolescence by the maturation of neurocircuitry and myelination. Although tubulinogenesis, axonogenesis, and synaptogenesis may be accomplished during prenatal and immediate postnatal life, myelinogenesis remains active during adolescent life. Neurochemical evidence suggests that glutamatergic neurotransmission is accomplished during prenatal and immediate postnatal life while gamma-aminobutyric acid (GABA)ergic neurotransmission, particularly in the prefrontal cortex, remains under construction during adolescence.[2] Hence, delayed development of GABAergic neurotransmission is held responsible for neurobehavioral excitement including euphoria and risk-taking behavior, whereas dopaminergic (DA)ergic neurotransmission, particularly in the prefrontal area, is developmentally regulated by sex hormones and is implicated in drug-seeking behavior during adolescence;[3] thus, brain development in critical areas is an ongoing process during adolescence. Indeed, adolescents are risk-taking and novelty-seeking individuals and they are more likely to weigh positive experiences more heavily and negative experiences less so than adults. This behavioral bias can lead to engagement in risky activities like reckless driving, unprotected sex, and drug abuse.[1–3] In fact, most drug addictions initiate during adolescence, and early drug abuse is usually associated with an increased incidence of physical tolerance and dependence. The hormonal changes

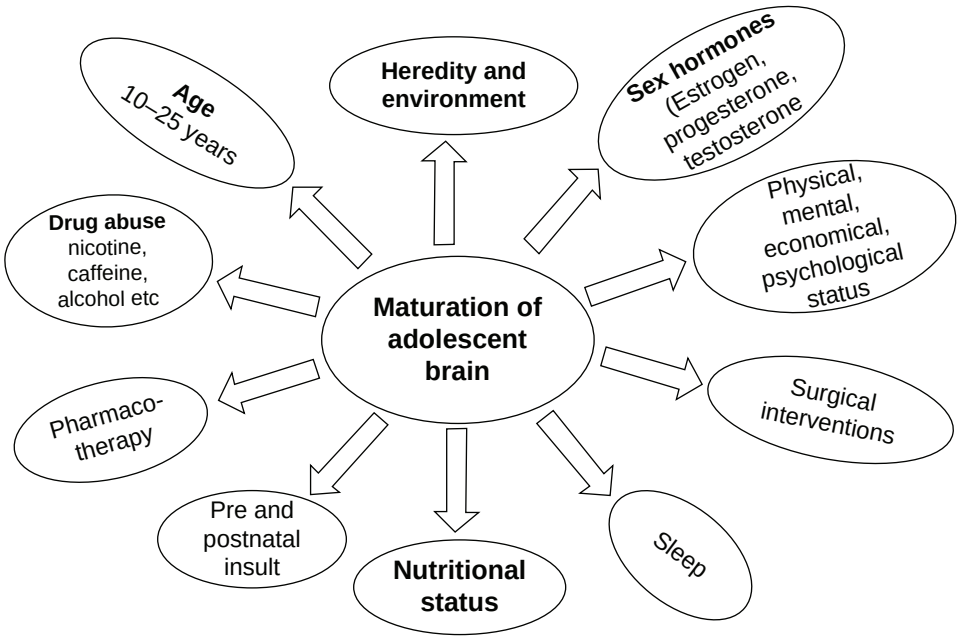


Figure 1 Factors influencing adolescent brain maturation.
Notes: Brain maturation is influenced by heredity and environment, prenatal and postnatal insult, nutritional status, sleep patterns, pharmacotherapy, and surgical interventions during early childhood. Furthermore, physical, mental, economical, and psychological stress; drug abuse (caffeine, nicotine, and ethanol); and sex hormones, including estrogen, progesterone, and testosterone influence the development and maturation of the adolescent brain. MRI studies have suggested that neurocircuitry and myelinogenesis remain under construction during adolescence because these events in the CNS depend on sex hormones that are specifically increased during puberty.
Abbreviations: CNS, central nervous system; MRI, magnetic resonance imaging.

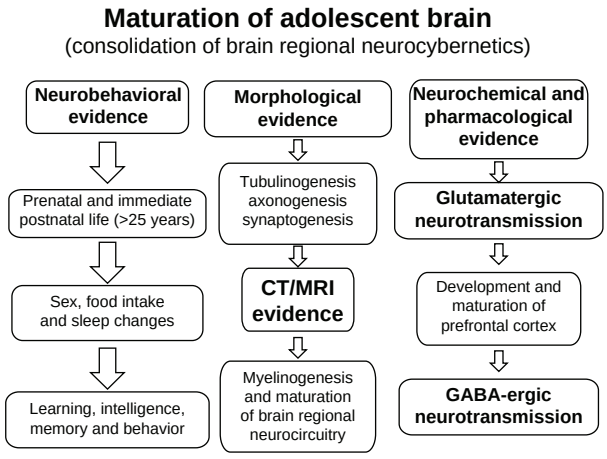


Figure 2 A diagram illustrating various stages of human brain development.
Notes: Several neurobehavioral, morphological, neurochemical, and pharmacological evidences suggest that the brain remains under construction during adolescence.[1,2,3,7,12,21,22,23,25,42] Tubulinogenesis, axonogenesis, and synaptogenesis may be accomplished during prenatal and immediate postnatal life, yet myelinogenesis remains active during adolescent life. Furthermore, glutamatergic neurotransmission is accomplished during prenatal and immediate postnatal life, while GABAergic neurotransmission in the prefrontal cortex remains under construction. Delayed development of GABAergic neurotransmission among adolescents is implicated in neurobehavioral excitement and risk-taking behavior.
Abbreviations: CT, computed tomography; GABAergic, gamma amino butyric acid ergic; MRI, magnetic resonance imaging.

in puberty contribute to physical, emotional, intellectual, and social changes during adolescence. These changes do not just induce maturation of reproductive function and the emergence of secondary sex characteristics, but they also contribute to the appearance of sex differences in nonreproductive behaviors. Physical changes, including accelerated body growth, sexual maturation, and development of secondary sexual characteristics occur simultaneously along with social, emotional, and cognitive development during adolescence. Furthermore, the adolescent brain evolves its capability to organize, regulate impulses, and weigh risks and rewards; however, these changes can make adolescents highly vulnerable to risk-taking behavior. Thus, brain maturation is an extremely important aspect of overall adolescent development, and a basic understanding of the process might aid in the understanding of adolescent sexual behavior, pregnancy, and intellectual performance issues.

There are several other crucial developmental aspects of adolescence that are associated with changes in physical, cognitive, and psychosocial characteristics, as well as with attitudes toward intimacy and independence, and these may also influence brain maturation; these will also be discussed in the present report. Furthermore, we emphasize the deleterious effects of drug abuse and the clinical significance of nutrition from fish oils and fatty acids in adolescent brain maturation.

Neuronal plasticity and neurocircuitry

The term "plasticity" refers to the possible significant neuronal changes that occur in the acquisition of new skills.[1–3] These skills initiate the process of elaboration and stabilization of synaptic circuitry as part of the learning process. Plasticity permits adolescents to learn and adapt in order to acquire independence; however, plasticity also increases an individual's vulnerability toward making improper decisions because the brain's region-specific neurocircuitry remains under construction, thus making it difficult to think critically and rationally before making complex decisions. Moreover, the neurocircuitry may be forged, refined or weakened, and damaged during plasticity. Thus, neuronal proliferation, rewiring, dendritic pruning, and environmental exposure are important components of brain plasticity during adolescence. A significant portion of brain growth and development occurring in adolescence is the construction and strengthening of regional neurocircuitry and pathways; in particular, the brain stem, cerebellum, occipital lobe, parietal lobe, frontal lobe, and temporal lobe actively mature during adolescence. The frontal lobes are involved in movement control, problem solving, spontaneity, memory, language, initiation, judgment, impulse control, and social and sexual behavior. Furthermore, the prefrontal cortex, which is implicated in drug-seeking behavior, remains in a process of continuous reconstruction, consolidation, and maturation during adolescence.

The adolescent brain

It is well established that various morphological and physiological changes occur in the human brain during adolescence. The term "adolescence" is generally used to describe a transition stage between childhood and adulthood. "Adolescence" also denotes both teenage years and puberty, as these terms are not mutually exclusive. The second surge of synaptogenesis occurs in the brain during the adolescent years. Hence, adolescence is one of the most dynamic events of human growth and development, second only to infancy in terms of the rate of developmental changes that can occur within the brain. Although there is no single definition of adolescence or a set age boundary, Kaplan[4] has pointed out that puberty refers to the hormonal changes that occur in early youth, and adolescence may extend well beyond the teenage years. In fact, there are characteristic developmental changes that almost all adolescents experience during their transition from childhood to adulthood. It is well established that the brain undergoes a "rewiring" process that is not complete until approximately 25 years of age.[5] This discovery

RECEIVED by MSC 9/27/2024 8:39:40 PM

RECEIVED by MSC 9/27/2024 8:39:40 PM

has enhanced our basic understanding regarding adolescent brain maturation and it has provided support for behaviors experienced in late adolescence and early adulthood. Several investigators consider the age span 10–24 years as adolescence, which can be further divided into substages specific to physical, cognitive, and social–emotional development.[5,6] Hence, understanding neurological development in conjunction with physical, cognitive, and social–emotional adolescent development may facilitate the better understanding of adolescent brain maturation, which can subsequently inform proper guidance to adolescents.[7]

Longitudinal MRI studies have confirmed that a second surge of neuronal growth occurs just before puberty.[1,7] This surge is similar to that noticed during infancy and consists of a thickening of the grey matter. Following neuronal proliferation, the brain rewires itself from the onset of puberty up until 24 years old, especially in the prefrontal cortex. The rewiring is accomplished by dendritic pruning and myelination. Dendritic pruning eradicates unused synapses and is generally considered a beneficial process, whereas myelination increases the speed of impulse conduction across the brain's region-specific neurocircuitry. The myelination also optimizes the communication of information throughout the CNS and augments the speed of information processing. Thus, dendritic pruning and myelination are functionally very important for accomplishing efficient neurocybernetics in the adolescent brain.

During adolescence, the neurocircuitry strengthens and allows for multitasking, enhanced ability to solve problems, and the capability to process complex information. Furthermore, adolescent brain plasticity provides an opportunity to develop talents and lifelong interests; however, neurotoxic insult, trauma, chronic stress, drug abuse, and sedentary lifestyles may have a negative impact during this sensitive period of brain maturation.[8,9]

Out of several neurotransmitters in the CNS, three play a significant role in the maturation of adolescent behavior: dopamine, serotonin, and melatonin.[3,8,9] Dopamine influences brain events that control movement, emotional response, and the ability to experience pleasure and pain. Its levels decrease during adolescence, resulting in mood swings and difficulties regulating emotions. Serotonin plays a significant role in mood alterations, anxiety, impulse control, and arousal. Its levels also decrease during adolescence, and this is associated with decreased impulse control. Lastly, melatonin regulates circadian rhythms and the sleep–wake cycle. The body's daily production of melatonin increases the requirement for sleep during adolescence.[8,9]

Behavioral problems and puberty

It is now known that hormones are not the only explanation for erratic adolescent behavior; hence, investigators are now trying to establish the exact nature of the interrelationship between pubertal processes and adolescent brain maturation. Dahl has explained three main categories of brain changes related to puberty: (1) changes that precede puberty; (2) changes that are the consequence of puberty; and (3) changes that occur after puberty is over.[9] The timing of these changes may underlie many aspects of risk-taking behavior. These changes, which are the consequence of puberty, occur primarily in the brain regions closely linked to emotions, arousal, motivation, as well as to appetite and sleep patterns. Brain changes independent of puberty are those related to the development of advanced cognitive functioning.

Animal studies have shown that sex hormones (estrogen, progesterone, and testosterone) are critically involved in myelination.[12] These studies have provided a relationship between sex hormones, white matter, and functional connectivity in the human brain, measured using neuroimaging. The results suggest that sex hormones organize structural connections and activate the brain areas they connect. These processes could underlie a better integration of structural and functional communication between brain regions with age. Specifically, ovarian hormones (estradiol and progesterone) may enhance both corticocortical and subcorticocortical functional connectivity, whereas androgens (testosterone) may decrease subcorticocortical functional connectivity but increase the functional connectivity between subcortical brain areas. Therefore, when examining brain development and aging, or when investigating the possible biological mechanisms of neurological diseases, the contribution of sex hormones should not be ignored.[10]

A recent study has described how the social brain develops during adolescence.[10] Adolescence is a time characterized by change – hormonally, physically, psychologically, and socially. Functional MRI studies have demonstrated the developmental changes that occur during adolescence among white matter and grey matter volumes in regions within the "social brain."[1,7,12] Activity in the mesolimbic brain regions also showed changes between adolescence and adulthood during social cognition tasks. A developmental clock – along with the signals that provide information on somatic growth, energy balance, and season of the year – times the awakening of gonadotropin-releasing hormone (GnRH) neurons at the onset of puberty. High-frequency GnRH release results in the disinhibition and activation of GnRH neurons at the onset

RECEIVED by MSC 9/27/2024 8:39:40 PM

of puberty, leading to gametogenesis and an increase in sex hormone secretion. Sex hormones and adrenocorticotropic hormones both remodel and activate neurocircuits during adolescent brain development, leading to the development of sexual salience of sensory stimuli, sexual motivation, and expression of copulatory behavior. These influences of hormones on reproductive behavior depend on changes in the adolescent brain that occur independently of gonadal maturation. Reproductive maturity is therefore the product of developmentally timed, brain-driven, and recurrent interactions between steroid hormones and the adolescent nervous system.[11,12]

Limbic system

The limbic system is a group of structures located deep within the cerebrum. It is composed of the amygdala, the hippocampus, and the hypothalamus. These brain regions are involved in the expression of emotions and motivation, which are related to survival. The emotions include fear, anger, and the fight or flight response. The limbic system is also involved in feelings of pleasure that reward behaviors related to species survival, such as eating and sex. In addition, the limbic system regulates functions related to memory storage and retrieval of events that invoke a strong emotional response. Neuroimaging studies have revealed that when interacting with others and making decisions, adolescents are more likely than adults to be swayed by their emotions.[12–16] In addition, adolescents often read others' emotions incorrectly. These studies involved comparing a teen brain to an adult brain determined that adolescents' prefrontal cortices are used less often during interpersonal interactions and decision making than their adult counterparts. In fact, adolescents relied more on the emotional region of their brains when reading others' emotions, which is more impulsive when compared to a logical or measured interpretation. Thus, an understanding of how the limbic system and the prefrontal cortex are used has provided a partial explanation for certain characteristics of adolescents and adolescent behaviors, such as quickness to anger, intense mood swings, and making decisions on the basis of "gut" feelings. Because adolescents rely heavily on the emotional regions of their brains, it can be challenging to make what adults consider logical and appropriate decisions, as illustrated in Figure 3.

Prefrontal cortex

Recently, investigators have studied various aspects of the maturation process of the prefrontal cortex of adolescents.[17,18] The prefrontal cortex offers an individual the capacity to exercise good judgment when presented with difficult life situations. The prefrontal cortex, the part of the frontal lobes lying just behind the forehead, is responsible for cognitive analysis, abstract thought, and the moderation of correct behavior in social situations. The prefrontal cortex acquires information from all of the senses and orchestrates thoughts and actions in order to achieve specific goals.

The prefrontal cortex is one of the last regions of the brain to reach maturation, which explains why some adolescents exhibit behavioral immaturity. There are several executive functions of the human prefrontal cortex that remain under construction during adolescence, as illustrated in Figures 3 and 4. The fact that brain development is not complete until near the age of 25 years refers specifically to the development of the prefrontal cortex.[19]

MRI studies have discovered that developmental processes tend to occur in the brain in a back-to-front pattern, explaining why the prefrontal cortex develops last. These studies have also shown that teens have less white matter (myelin) in the frontal lobes compared to adults, and that myelin in the frontal lobes increases throughout adolescence.[1,7,21] With more myelin comes the growth of important neurocircuitry, allowing for better flow of information between brain regions.[20,21] These findings have led to the concept of frontalization, whereby the prefrontal cortex develops in order to regulate the behavioral responses initiated by the limbic structures. During adolescence, white matter increases in the corpus callosum, the bundle of

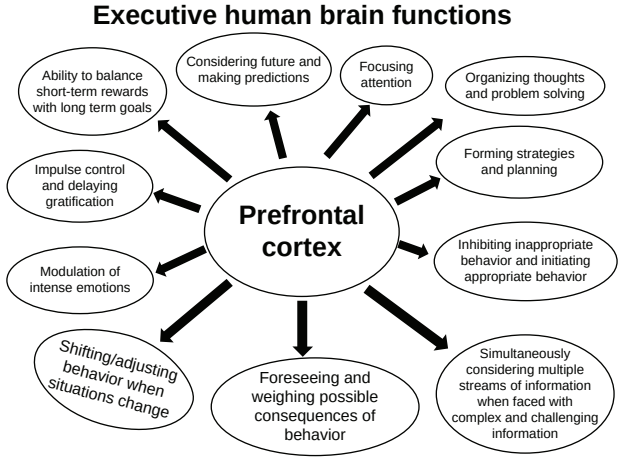


Figure 3 A diagram illustrating the developmental regulation of executive functions by the prefrontal cortex, which remains under construction during adolescence.
Notes: Several executive brain functions are governed by the prefrontal cortex, which remains in a state of active maturation during adolescence. These complex brain functions are regulated by the prefrontal cortex as illustrated in this figure (based on the original discoveries by Gedd and Steinberg).[1,21–23,25] Due to immature functional areas in the prefrontal cortex, adolescent teens may take part in risk seeking behavior including unprotected sex, impaired driving, and drug addiction.

RECEIVED by MSC 9/27/2024 8:39:40 PM

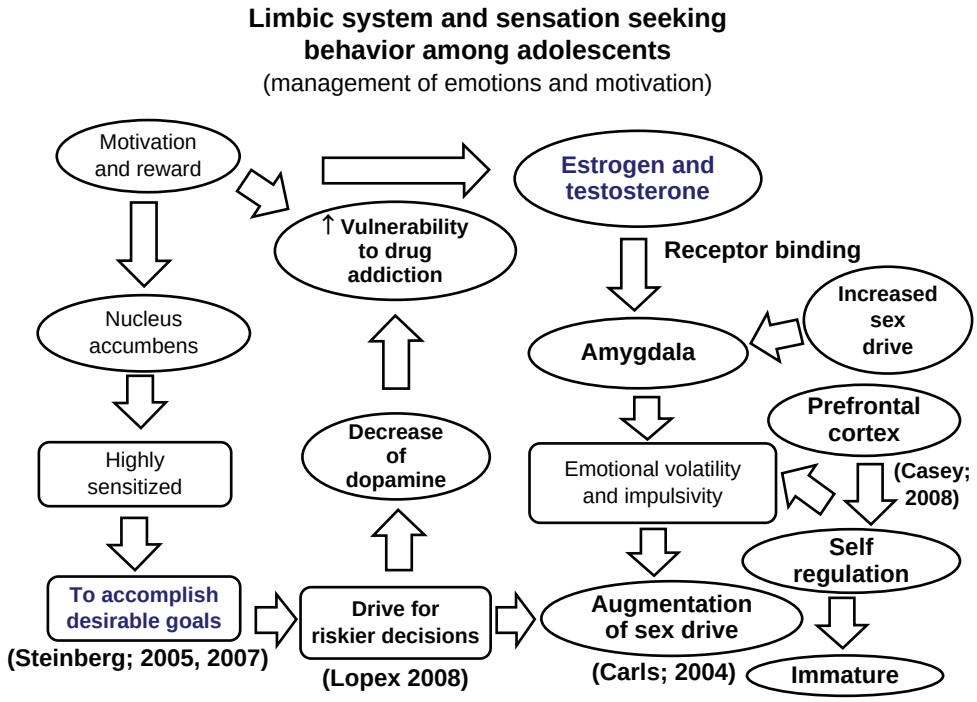


Figure 4 An algorithmic diagram illustrating the management of emotions and motivation by the limbic system in the adolescent brain.
Notes: The nucleus accumbens and amygdala are the two most prominent parts of the central nervous system involved in riskier behavior and increased sex drive among teenage adolescents. The nucleus accumbens is highly sensitized to accomplish desirable goals. A decrease in dopamine in the nucleus accumbens is involved in increased vulnerability to drug addiction and risky decisions. Sex hormones (estrogen and testosterone) bind with their receptors to induce increased sex drive and emotional volatility and impulsivity. Due to an immature prefrontal cortex, adolescents also have an increased sex drive and problems in self-regulation as illustrated in this flow diagram.[19,23,26,27,54]

nerve fibers connecting the right and left hemispheres of the brain, which allows for efficient communication between the hemispheres and enables an individual to access a full array of analytical and creative strategies to respond to complex dilemmas that may arise in adolescent life. Hence, the role of experience is critical in developing the neurocircuitry that allows for increased cognitive control of the emotions and impulses of adolescence. Adolescents, who tend to engage in risky behaviors in relatively safe environments, utilize this circuitry and develop the skills to tackle more dangerous situations; however, with an immature prefrontal cortex, even if adolescents understand that something is dangerous, they may still engage in such risky behavior.[21]

Risk-taking behavior

The exact biological basis of risk-taking behavior in adolescents remains enigmatic. Adolescents are at their peak of physical strength, resilience, and immune function, yet mortality rates among 15–24 year olds are more than triple the mortality rates of middle school children. The Centers for Disease Control and Prevention has identified the leading causes of death and illness among adolescents,[22,23,59] as illustrated in Figure 5. It is generally held that adolescents take risks to test and define themselves, as risk-taking can be both beneficial and harmful. It can lead to situations where new skills are learned and new experiences can prepare them for future challenges in their lives. Risk-taking serves as a means of discovery about oneself, others, and the world at large. The proclivity for risk-taking behavior plays a significant role in adolescent development, rendering this a period of time for both accomplishing their full potential and vulnerability. Hence, acquiring knowledge regarding adolescent brain maturation can help understand why teens take risks, while keeping in mind that risk-taking behavior is a normal and necessary component of adolescence. This knowledge may help in developing physiologically and pharmacologically effective interventions that focus on reducing the negative consequences associated with risk-taking behavior among the adolescent population.[22]

Risk perception

It has been established that, around the age of 12 years, adolescents decrease their reliance on concrete thinking and begin to show the capacity for abstract thinking, visualization of potential outcomes, and a logical understanding of cause and effect.[23] Teens begin looking at situations and deciding whether they are safe, risky, or dangerous. These aspects of

RECEIVED by MSC 9/27/2024 8:39:40 PM

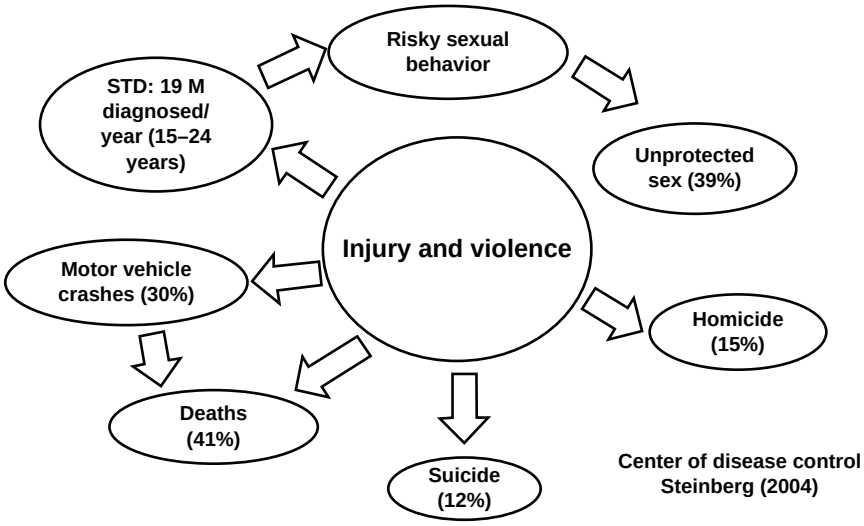


Figure 5 Leading cause of death among adolescents (10–24 years).
Notes: Injury and violence are the two most common leading causes of death during adolescence. Out of 19 million adolescents (15–24 years) in the US that were diagnosed with HIV/AIDs, 39% admitted that they had unprotected sex. In addition to risky sex behavior, 30% of adolescents had been involved in motor vehicle accidents, with 41% of these linked to deaths; 12% committed suicide; and 15% were victims of homicide as illustrated in this figure (Steinberg 2004, Centers for Disease Control and Prevention).[18]
Abbreviations: AIDS, acquired immune deficiency syndrome; HIV, human immunodeficiency virus; M, million; STD, sexually transmitted disease.

development correlate with the maturation of the frontal lobe, and is marked by a shift from the development of additional neural connections to synaptic pruning, as well as by an increase in the release of hormones, all of which drive an adolescent's mood and impulsive behavior.

By the age of 15 years, there is little difference in adolescents' and adults' decision-making patterns pertaining to hypothetical situations. Teens were found to be capable of reasoning about the possible harm or benefits of different courses of action; however, in the real world, teens still engaged in dangerous behaviors, despite understanding the risks involved.[22,23,59] Hence, both the role of emotions and the connection between feeling and thinking need to be considered while studying the way teens make decisions.

Investigators have differentiated between "hot" cognition and "cold" cognition.[24] Hot cognition is described as thinking under conditions of high arousal and intense emotion. Under these conditions, teens tend to make poorer decisions. The opposite of hot cognition is cold cognition, which is critical and over-analyzing.[25] In cold cognition, circumstances are less intense and teens tend to make better decisions. Then, with the addition of complex feelings – such as fear of rejection, wanting to look cool, the excitement of risk, or anxiety of being caught – it is more difficult for teens to think through potential outcomes, understand the consequences of their decisions, or even use common sense.[26] The apparent immaturity of the connections between the limbic system, prefrontal cortex, and the amygdala provides further support for this concept.

Sensation seeking

The nucleus accumbens, a part of the brain's reward system located within the limbic system, is the area that processes information related to motivation and reward. Brain imaging has shown that the nucleus accumbens is highly sensitive in adolescents, sending out impulses to act when faced with the opportunity to obtain something desirable.[27] For instance, adolescents are more vulnerable to nicotine, alcohol, and other drug addictions because the limbic brain regions that govern impulse and motivation are not yet fully developed.[28] During puberty, the increases in estrogen and testosterone bind receptors in the limbic system, which not only stimulates sex drive, but also increases adolescents' emotional volatility and impulsivity. Changes in the brain's reward sensitivity that occur during puberty have also been explored. These changes are related to decreases in DA, a neurotransmitter that produces feelings of pleasure.[29] Due to these changes, adolescents may require higher levels of DAergic stimulation to achieve the same levels of pleasure/reward, driving them to make riskier decisions.

Self-regulation

Self-regulation has been broadly classified as the management of emotions and motivation.[30] It also involves directing and controlling behavior in order to meet the challenges of

RECEIVED by MSC 9/27/2024 8:39:40 PM

the environment and to work toward a conscious purpose. Self-regulation also entails controlling the expression of intense emotions, impulse control, and delayed gratification. As adolescents progress toward adulthood with a body that is almost mature, the self-regulatory parts of their brains are still maturing. An earlier onset of puberty increases the window of vulnerability for teens, making them more susceptible to taking risks that affect their health and development over a prolonged period.[31]

Behavioral control requires a great involvement of cognitive and executive functions. These functions are localized in the prefrontal cortex, which matures independent of puberty and continues to evolve up until 24 years of age. It has been suggested that, during this period, adolescents should not be overprotected, but be allowed to make mistakes, learn from their own experiences, and practice self-regulation. Parents and teachers can help adolescents through this period by listening and offering support and guidance.

Recently, Steinberg studied risk-taking behavior in teens and how this was influenced by their peers.[32] He used a driving simulation game in which he studied teens deciding on whether or not to run a yellow light, and found that when teens were playing alone they made safer decisions, but in the presence of friends they made riskier decisions. When teens find themselves in emotionally arousing situations, with their immature prefrontal cortices, hot cognitive thinking comes into play, and these adolescents are more likely to take riskier actions and make impulsive decisions.

Societal influences

Mass media, community, and adult role models can also influence adolescent risk-taking behaviors. Teens are constantly exposed to emotionally arousing stimuli through multimedia, which encourages unprotected sex, substance abuse, alcohol abuse, and life-threatening activities.[32,33] Even neighborhoods, friends, and communities provide teens with opportunities to engage in risky behaviors, although local law enforcement authorities regulate the purchase of cigarettes, access to and acceptability of guns, and the ability to drive cars. Even adults can have trouble resisting engaging in some of these risky behaviors; however, the temptation must be much harder for teens, whose judgment and decision-making skills are still developing.[34]

Recent functional MRI studies have demonstrated the extent of development during adolescence in the white matter and grey matter regions within the social brain. Activity in some of these regions showed changes between adolescence and adulthood during social cognition tasks. These studies have provided evidence that the concept of mind usage remains developing late in adolescence.[1,21,33]

Substance abuse

The mechanisms underlying the long-term effects of prenatal substance abuse and its consequent elevated impulsivity during adolescence are poorly understood. Liu and Lester[34] have reported on developmentally-programmed neural maturation and highlighted adolescence as a critical period of brain maturation. These investigators have studied impairments in the DAergic system, the hypothalamic–pituitary–adrenal axis, and the pathological interactions between these two systems that originate from previous fetal programming in order to explain insufficient behavioral inhibition in affected adolescents. In addition, Burke[35] has examined the development of brain functions and the cognitive capabilities of teenagers. Specifically, these two sets of investigators have explored the effect of alcohol abuse on brain development, and the fundamental cognitive differences between adolescents and adults, and have suggested that the adultification of youth is harsh for those whose brains have not fully matured.

Cannabis

Cannabis is the most commonly consumed drug among adolescents, and its chronic use may affect maturational refinement by disrupting the regulatory role of the endocannabinoid system.[36] Adolescence represents a critical period for brain development and the endocannabinoid system plays a critical role in the regulation of neuronal refinement during this period. In animals, adolescent cannabinoid exposure caused long-term impairment in specific components of learning and memory, and differentially affected emotional reactivity with milder effects on anxiety behavior and more pronounced effects on depressive behavior.[37] Epidemiological studies have suggested that adolescent cannabis abuse may increase their risk of developing cognitive abnormalities, psychotic illness, mood disorders, and other illicit substance abuse later in life.[36,38–40] Cannabis abuse in adolescence could increase the risk of developing psychiatric disorders, especially in people who are vulnerable to developing psychiatric syndromes. So far, only a few studies have investigated the neurobiological substrates of this vulnerability;[56] hence, further investigation is required to clarify the molecular mechanisms underlying the effect of cannabis on the adolescent brain.

RECEIVED by MSC 9/27/2024 8:39:40 PM

Nicotine

Recent studies have provided a neural framework to explain the developmental differences that occur within the mesolimbic pathway based on the established role of DA in addiction.[41,42] During adolescence, excitatory glutamatergic systems that facilitate DAergic neurotransmisson are overdeveloped, whereas inhibitory GABAergic systems remain underdeveloped. DAergic pathways originate in the ventral tegmental area and terminate in the nucleus accumbens, where dopamine is increased by nicotine, but decreased during withdrawal. Thus, it has been hypothesized that adolescents display enhanced nicotine reward and reduced withdrawal via enhanced excitation and reduced inhibition of ventral tegmental area cell bodies that release DA in the nucleus accumbens.[44,45] Although this framework focuses on both adolescents and adults, it may also apply to the enhanced vulnerability to nicotine in adults that were previously exposed to nicotine during adolescence, suggesting that the diagnostic criteria developed for nicotine dependence in adults (based primarily on withdrawal) may be inappropriate during adolescence, when nicotine withdrawal does not appear to play a major role in nicotine use.[39] Furthermore, treatment strategies involving nicotine replacement may be harmful for adolescents because it may cause enhanced vulnerability to nicotine dependence later in adulthood. Adolescents that initiate tobacco abuse are more vulnerable to long-term nicotine dependence. A unifying hypothesis has been proposed based on animal studies, and it suggests that adolescents (as compared to adults) experience enhanced short-term positive effects and reduced adverse effects toward nicotine, and they also experience fewer negative effects during nicotine withdrawal.[39] Thus, during adolescence, the strong positive effects associated with nicotine are inadequately balanced by the negative effects that contribute to nicotine dependence in adults.

Alcohol

Recently, the development of brain functions, the cognitive capabilities of adolescents, and the effect of alcohol abuse on brain maturation have been examined.[49,50] Cognitive differences between adolescents and adults suggest that the adultification of youths is deleterious for youths whose brains have not fully matured. Adolescence is the time during which most individuals first experience alcohol exposure, and binge drinking is very common during this period.[29,50,43] There is increasing evidence for long-lasting neurophysiological changes that may occur following exposure to ethanol during adolescence in animal models.[50] If alcohol exposure is neurotoxic to the developing brain during adolescence, then understanding how ethanol affects the developing adolescent brain becomes a major public health issue. Adolescence is a critical time period when cognitive, emotional, and social maturation occurs and it is likely that ethanol exposure may affect these complex processes. During a period that corresponds to adolescence in rats, the relatively brief exposure to high levels of alcohol via ethanol vapors caused long-lasting changes in functional brain activity.[51] The following observations were recorded: disturbances in waking electroencephalography; a reduction in the P3 wave (P3a and P3b) component of event-related potential measurements; reductions in the mean duration of slow-wave sleep; and the total amount of time spent in slow-wave sleep – findings that are consistent with the premature sleep patterns observed during aging.[50]

Sex differences

Sex differences in many behaviors, including drug abuse, have been attributed to social and cultural factors.[43,46] A narrowing gap in drug abuse between adolescent boys and girls supports this hypothesis;[52] however, some sex differences in addiction vulnerability reflect biologic differences in the neurocircuits involved in addiction. A male predominance in overall drug abuse appears by the end of adolescence, while girls develop a rapid progression from the time of the first abuse to dependence, and this represents female-based vulnerability. Recent studies have emphasized the contribution of sex differences in the function of the ascending DAergic systems, which are critical in reinforcement.[3,43] These studies highlight the behavioral, neurochemical, and anatomical changes that occur in the DAergic functions that are related to the addictions that occur during adolescence. In addition, these studies have presented novel findings about the emergence of sex differences in DAergic function during adolescence.[43,46–48] Sex differences in drinking patterns and the rates of alcohol abuse and dependence begin to emerge during the transition from late puberty to young adulthood. Increases in pubertal hormones, including gonadal and stress hormones, are a prominent developmental feature of adolescence and could contribute to the progression of sex differences in alcohol drinking behavior during puberty. Witt[46] reviewed experimental and correlational studies of gonadal and stress-related hormone changes, as well as their effects on alcohol consumption and the associated neurobehavioral actions of alcohol on the mesolimbic dopaminergic system. Mechanisms have been suggested by which reproductive and stress-related hormones may modulate neural circuits within the brain reward system, and these hormones may produce sex differences in terms of

RECEIVED by MSC 9/27/2024 8:39:40 PM

alcohol consumption patterns and adolescents' vulnerability to alcohol abuse and dependence, which become apparent during the late pubertal period.

Chemotherapy

Recently, Vázquez et al[53] emphasized the need for the early and accurate diagnosis of CNS complications during and after pediatric cancer treatment because of the improvement in overall survival rates related to innovative and aggressive oncologic therapies. A major concern in this issue is recognizing the radiologic features of these CNS complications. Radiologists are supposed to be familiar with the early and late effects of cancer therapy in the pediatric CNS (toxic effects, infection, endocrine or sensory dysfunction, neuropsychological impairment, and secondary malignancies) in order to provide an accurate diagnosis and to minimize morbidity. The acquisition of further knowledge about these complications will enable the development of more appropriate therapeutic decisions, effective patient surveillance, and an improved quality of life by decreasing the long-term consequences in survivors. Certain chemotherapeutic compounds and environmental agents, such as anesthetics, antiepileptics, sleep-inducing and anxiolytic compounds, nicotine, alcohol, and stress, as well as agents of infection have also been investigated quite extensively and have been shown to contribute to the etiopathogenesis of serious neuropsychiatric disorders.[54] All of these agents have a deleterious influence on developmental processes during the time when the brain experiences major changes in early childhood and during adulthood. Several of these agents have contributed to the structural and functional brain abnormalities that have been observed in the biomarker profiles of schizophrenia and fetal alcohol syndrome. The effects of these agents are generally permanent and irreversible.[54]

Nutrition

The rapid expansion of knowledge in this field, from basic science to clinical and community-based research, is expected to lead to urgently needed research in support of effective, evidence-based medicine and treatment strategies for undernutrition, overnutrition, and eating disorders in early childhood. Eating is necessary for survival and provides a sense of pleasure, but may be perturbed, leading to undernutrition, overnutrition, and eating disorders. The development of feeding in humans relies on the complex interplay between homeostatic mechanisms; neural reward systems; and adolescents' motor, sensory, and emotional capabilities. Furthermore, parenting, social factors, and food influence the development of eating behavior.

Recently, the neural development of eating behavior in children has been investigated.[55] Furthermore, developmentally programmed neural maturation has been discussed in order to highlight adolescence as the second most critical period of brain maturation.[56] These studies used impairments of the DAergic system, the hypothalamic–pituitary–adrenal axis, and pathological interactions between these two systems originating from fetal programming in a dual-system model to explain insufficient behavioral inhibition in affected adolescents.

The range of exogenous agents, such as alcohol and cocaine, which are generally likely to detrimentally affect the development of the brain and CNS defies estimation, although the accumulated evidence is substantial.[57–60] Pubertal age affects the fundamental property of nervous tissue excitability; excessive excitatory drive is seen in early puberty and a deficiency is seen in late puberty. It has been postulated that, with adequate fish oils and fatty acids, the risk of psychopathology can be minimized, whereas a deficiency could lead to subcortical dysfunction in early puberty, and a breakdown of cortical circuitry and cognitive dysfunctions in late puberty.[61] Thus, postpubertal psychoses, schizophrenia, and manic–depressive psychosis during the pubertal age, along with excitability, may be the result of continuous dietary deficiency, which may inhibit the expression of the oligodendrocyte-related genes responsible for myelinogenesis. The beneficial effect of fish oils and fatty acids in schizophrenia, fetal alcohol syndrome, developmental dyslexia, attention deficit hyperactivity disorder, and in other CNS disorders supports the hypothesis that the typical diet might be persistently deficient in the affected individuals, as illustrated in Figure 6. However, the amount of fish oils and fatty acids needed to secure normal brain development and function is not known. It seems conjectural to postulate that a dietary deficiency in fish oils and fatty acids is causing brain dysfunction and death; however, all of these observations tend to suggest that a diet focusing on mainly protein is deficient, and the deficiency is most pronounced in maternal nutrition and in infancy, which might have a deleterious impact on the maturation of the adolescent brain.

Conclusion

Neuromorphological, neurochemical, neurophysiological, neurobehavioral, and neuropharmacological evidence suggests that the brain remains in its active state of maturation during adolescence.[1,7,19,21] Such evidence supports the hypothesis that the adolescent brain is structurally and functionally vulnerable to environmental stress, risky behavior, drug

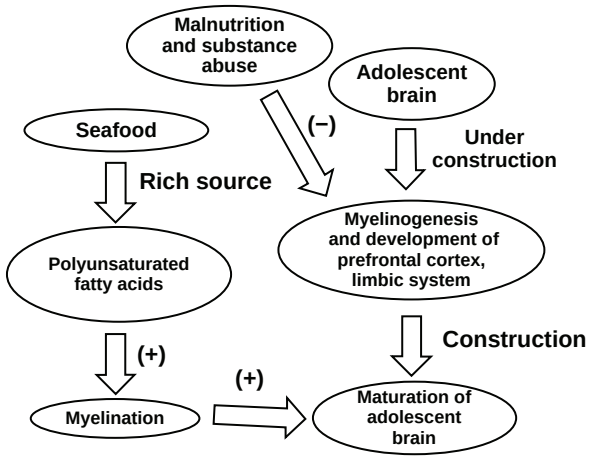


Figure 6 Effect of seafood on the maturation of the adolescent brain.
Notes: MRI studies have provided evidence that in addition to the prefrontal cortex and limbic system, myelinogenesis and neurocircuitry remains under construction during adolescence.[1,7,19,21] Myelinogenesis requires precursors such as polyunsaturated fatty acids, of which many seafoods are a rich source. Hence, consuming seafood may accelerate brain maturation in adolescents. However, malnutrition and substance abuse may inhibit maturation of the adolescent brain. (+) induction; (–) inhibition.

addiction, impaired driving, and unprotected sex. Computed tomography and MRI studies also provide evidence in support of this hypothesis.[19]

Brain maturation occurs during adolescence due to a surge in the synthesis of sex hormones implicated in puberty including estrogen, progesterone, and testosterone. These sex hormones augment myelinogenesis and the development of the neurocircuitry involved in efficient neurocybernetics. Although tubulinogenesis, axonogenesis, and synaptogenesis can occur during the prenatal and early postnatal periods, myelinogenesis involved in the insulation of axons remains under construction in adolescence. Sex hormones also significantly influence food intake and sleep requirements during puberty. In addition to dramatic changes in secondary sex characteristics, sex hormones may also influence the learning, intelligence, memory, and behavior of adolescents.

Furthermore, it can be observed that the development of excitatory glutamatergic neurotransmission occurs earlier in the developing brain as compared to GABAergic neurotransmission, which makes the pediatric population susceptible to seizures.

The development and maturation of the prefrontal cortex occurs primarily during adolescence and is fully accomplished at the age of 25 years. The development of the prefrontal cortex is very important for complex behavioral performance, as this region of the brain helps accomplish executive brain functions.

A detailed study is required in order to determine the exact biomarkers involved, as well as the intricate influence of diet, drugs, sex, and sleep on the maturation of the adolescent brain as discussed briefly in this report.

Acknowledgments

The moral support and encouragement of President Kallol Guha is gratefully acknowledged.

Disclosure

The authors report no conflicts of interest in this report.

References

1. Giedd JN, Blumenthal J, Jeffries NO, et al. Brain development during childhood and adolescence: a longitudinal MRI study. *Nat Neurosci*. 1999;2(10):861–863.
2. Li K, Xu E. The role and the mechanism of gamma-aminobutyric acid during central nervous system development. *Neurosci Bull*. 2008;24(3):195–200.
3. Wahlstrom D, Collins P, White T, Luciana M. Developmental changes in dopamine neurotransmission in adolescence: behavioral implications and issues in assessment. *Brain Cogn*. 2010;72(1):146–159.
4. Kaplan PS. *Adolescence*. Boston, MA: Houghton Mifflin Company; 2004.
5. Gavin L, MacKay AP, Brown K, et al; Centers for Disease Control and Prevention (CDC). Sexual and reproductive health of persons aged 10–24 years – United States, 2002–2007. *MMWR Surveill Summ*. 2009;58(6):1–58.
6. Sylwester R. *The Adolescent Brain: Reaching for Autonomy*. Newbury Park (CA): Corwin Press; 2007.
7. Baird AA, Gruber SA, Fein DA, et al. Functional magnetic resonance imaging of facial affect recognition in children and adolescents. *J Am Acad Child Adolesc Psychiatry*. 1999;38(2):195–199.
8. Frontline: Inside the Teenage Brain [webpage on the Internet]. Arlington (TX): Public Broadcasting Service; 2002. Available from: http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/. Accessed August 6, 2009.
9. Dahl RE. Beyond raging hormones: the tinderbox in the teenage brain. *Cerebrum*. 2003;5(3):7–22.
10. Blakemore SJ. Development of the social brain in adolescence. *J R Soc Med*. 2012;105(3):111–116.
11. Sisk CL, Foster DL. The neural basis of puberty and adolescence. *Nat Neurosci*. 2004;7(10):1040–1047.
12. Peper JS, van den Heuvel MP, Mandl RC, Hulshoff Pol HE, van Honk J. Sex steroids and connectivity in the human brain: a review of neuroimaging studies. *Psychoneuroendocrinology*. 2011;36(8):1101–1113.
13. Choudhury S, Blakemore SJ, and Charman T. Social cognitive development during adolescence. *Soc Cogn Affect Neurosci*. 2006;1(3):165–174.
14. den Bos (2011) W.V *The neurocognitive development of social decision making*. Doctoral Research Thesis. (P 1–189) Amsterdam.
15. Somerville LH, Fani N, and Erin B. McClure-Tone E.B. Behavioral and neural representation of emotional facial expressions across the lifespan. *Dev Neuropsychol*. 2011;36(4):408–428.
16. Sales JM and Irvin CE. Theories of adolescent risk taking (2009) The biopsychological model. *In Adolescent Health*. Diclemente R.J, Santelli, J.S, Crosby RA (Eds) (pp 31–50) San Fransisco: John Wiley and Sons.
17. Frontline: Interview Deborah Yurgelun-Todd [webpage on the Internet]. Arlington: Public Broadcasting Service; 2002. Available form: http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/interviews/todd.html. Accessed February 14, 2013.
18. Guyer AE, McClure-Tone EB, Shiffrin ND, Pine DS, Nelson EE. Probing the neural correlates of anticipated peer evaluation in adolescence. *Child Dev*. 2009;80(4):1000–1015.

RECEIVED by MSC 9/27/2024 8:39:40 PM

19. Casey BJ, Jones RM, Hare TA. The adolescent brain. *Ann N Y Acad Sci*. 2008;1124:111–126.
20. Walsh D, Bennett N. *Why Do They Act That Way? A Survival Guide to the Adolescent Brain for You and Your Teen*. New York: Simon and Schuster; 2004.
21. Giedd JN. Structural magnetic resonance imaging of the adolescent brain. *Ann N Y Acad Sci*. 2004;1021:77–85.
22. Steinberg L. Risk taking in adolescence: what changes and why? *Ann N Y Acad Sci*. 2004;1021:51–58.
23. Steinberg L. Cognitive and affective development in adolescence. *Trends Cogn Sci*. 2005;9(2):69–76.
24. Abelson, R. P. (1963). Computer simulation of "hot cognition", in S. S. Tomkins and S. Messick (Eds.), *Computer simulation of personality* (pp. 277–302). New York: Wiley.
25. Ziva K (1990). "The case for motivated reasoning". *Psychological Bulletin* 108(3): 480–498.
26. Benes FM. The development of the human frontal cortex: The maturation of neurotransmitter system and their interactions. In: Nelson CA, Luciana M, editors. *Handbook of Developmental Cognitive Neuroscience*. Cambridge, MA: MIT Press; 2001:79–92.
27. Gardner M, Steinberg L. Peer Influence on risk taking, risk preference and risky decision-making in adolescence and adulthood. *Dev Psychol*. 2005;41(4):625–635.
28. http://www.hhs.gov [homepage on the Internet]. New Research on Adolescent Brain Development. Center for Substance Abuse Prevention;2004. http://www.hhs.gov/opa/familylife/tech_assistance/etraining/adolescent_brain/risk_taking/changes/sensation_seeking/index.html#fn3. Accessed March 14, 2013.
29. Lopez B, Schwartz SJ, Prado G, Campo AE, Pantin H. Adolescent neurological development and implications for adolescent substance abuse prevention. *J Prim Prev*. 2008;29(1):5–35.
30. Steinberg L, Belsky J. An evolutionary perspective on psychopathology in adolescence. In: Cicchetti D, Toth SL, editors. *Adolescence: Opportunities and Challenges: Volume 7 of Rochester Symposium on Developmental Psychology Series*. Rochester, NY: University of Rochester Press; 1996:93–124.
31. Simpson RA. Raising Teens: A Synthesis of Research and a Foundation for Action. Center for Health Communication, Harvard School of Public Health. 2001. Available from: http://www.hsph.harvard.edu/chc/parenting/report.pdf.
32. Steinberg L. A social neuroscience perspective on adolescent risk-taking. *Dev Rev*. 2008;28(1):78–106.
33. Blakemore SJ. Development of the social brain in adolescence. *J R Soc Med*. 2012;105(3):111–116.
34. Liu J, Lester BM. Reconceptualizing in a dual-system model the effects of prenatal cocaine exposure on adolescent development: a short review. *Int J Dev Neurosci*. 2011;29(8):803–809.
35. Burke AS. Under construction: brain formation, culpability, and the criminal justice system. *Int J Law Psychiatry*. 2011;34(6):381–385.
36. Palmer RH, Young SE, Hopfer CJ, et al. Developmental epidemiology of drug use and abuse in adolescence and young adulthood: evidence of generalized risk. *Drug Alcohol Depend*. 2009;102(1–3):78–87.
37. Bossong NG, Niesink RJ. Adolescent brain maturation, the endogenous cannabinoid system and the neurobiology of cannabis-induced schizophrenia. *Prog Neurobiol*. 2010 Nov;92(3):370–385.
38. Vik P, Brown SA. Life events and substance abuse during adolescence. In: Miller TW, editor. *Children of Trauma*. Madison, CT: International Universities Press; 1998:179–204.
39. Rubino T, Zamberletti E, Parolaro D. Adolescent exposure to cannabis as a risk factor for psychiatric disorders. *J Psychopharmacol*. 2012;26(1):177–188.
40. Gonzalez R, Swanson JM. Long-term effects of adolescent-onset and persistent use of cannabis. *Proc Natl Acad Sci U S A*. 2012;109(40):15970–15971.
41. O'Dell LE. A psychobiological framework of the substrates that mediate nicotine use during adolescence. *Neuropharmacology*. 2009;56 Suppl 1:263–278.
42. Philpot R, Kirstein C. Developmental Differences in the Accumbal Dopaminergic Response to Repeated Ethanol Exposure. Ann. *N Y. Acad. Sci*. 2004;1021:422–426.
43. Kuhn C, Johnson M, Thomae A, et al. The emergence of gonadal hormone influences on dopaminergic function during puberty. *Horm Behav*. 2010;58(1):122–137.
44. Burke AS. Under construction: brain formation, culpability, and the criminal justice system. *Int J Law Psychiatry*. 2011;34(6):381–385.
45. Spear LP. Adolescent period: biological basis of vulnerability to develop alcoholism and other ethanol–mediated behaviors. In: Noronha A, Eckardt M, Warren K, editors. *Review of NiAAA's Neuroscience and Behavioral Research Portfolio*. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2000:315–333.
46. Witt ED. Puberty, hormones, and sex differences in alcohol abuse and dependence. *Neurotoxicol Teratol*. 2007;29(1):81–95.
47. Nolen-Hoeksema S, Girgus JS. The emergence of gender differences in depression during adolescence. *Psychological Bulletin*. 1994;115(3):424–443.
48. Lenroot RK, Giedd JN. Sex differences in the adolescent brain. *Brain Cogn*. 2010;72(1):1–19.
49. Spear LP. The adolescent brain and age–related behavioral manifestations. *Neurosci Biobehav Rev*. 2000;24(4):417–463.
50. Ehlers CL, Criado JR. Adolescent ethanol exposure: does it produce long-lasting electrophysiological effects? *Alcohol*. 2010;44(1):27–37.
51. Allen CD, Lee S, Koob GF Rivier C . Immediate and prolonged effects of alcohol exposure on the activity of the hypothalamic-pituitary-adrenal axis in adult and adolescent rats. *Brain Behav Immun*. 2011 June;25(Suppl 1):S50–S60.
52. Schulte MT, Ramo D, and Brown SA. Gender Differences in Factors Influencing Alcohol Use and Drinking Progression Among Adolescents. *Clin Psychol Rev*. 2009 August;29(6):535–547.
53. Vázquez E, Delgado I, Sánchez-Montañez A, Barber I, Sánchez-Toledo J, Enríquez G. Side effects of oncologic therapies in the pediatric central nervous system: update on neuroimaging findings. *Radiographics*. 2011;31(4):1123–1139.
54. Archer T. Effects of exogenous agents on brain development: stress, abuse and therapeutic compounds. *CNS Neurosci Ther*. 2011;17(5):470–489.
55. Gahagan S. Development of eating behavior: biology and context. *J Dev Behav Pediatr*. 2012;33(3):261–271.
56. Sisk CL and Foster DL. The neural basis of puberty and adolescence. *Nature Neuroscience* 2004;7:1040–1047.
57. Liu J, Lester BM. Reconceptualizing in a dual-system model the effects of prenatal cocaine exposure on adolescent development: a short review. *Int J Dev Neurosci*. 2011;29(8):803–809.
58. Saugstad LF. From superior adaptation and function to brain dysfunction – the neglect of epigenetic factors. *Nutr Health*. 2004;18(1):3–27.
59. Steinberg L. Risk taking in adolescence: new perspectives from brain and behavioral science. *Curr Dir Psychol Sci*. 2007;16(2):55–59.
60. Brown SA, Tapert SF, Granholm E, Delis DC. Neurocognitive functioning of adolescents: effects of protracted alcohol use. *Alcohol Clin Exp Res*. 2000;24(2):164–171.
61. Rayyan M, Devlieger H, Jochum F, Allegaert K. Short-Term Use of Parenteral Nutrition With a Lipid Emulsion Containing a Mixture of Soybean Oil, Olive Oil, Medium-Chain Triglycerides, and Fish Oil. A Randomized Double-Blind Study in Preterm Infants. *JPEN J Parenter Enteral Nutr*. 2012 January;36(1 suppl):81S–94S.

RECEIVED by MSC 9/27/2024 8:39:40 PM

RECEIVED by MSC 9/27/2024 8:39:40 PM

Neuropsychiatric Disease and Treatment

Dovepress

Publish your work in this journal

Neuropsychiatric Disease and Treatment is an international, peer-reviewed journal of clinical therapeutics and pharmacology focusing on concise rapid reporting of clinical or pre-clinical studies on a range of neuropsychiatric and neurological disorders. This journal is indexed on PubMed Central, the 'PsycINFO' database and CAS. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit http://www.dovepress.com/testimonials.php to read real quotes from published authors.

Submit your manuscript here: http://www.dovepress.com/neuropsychiatric-disease-and-treatment-journal

RECEIVED by MSC 9/27/2024 8:39:40 PM

Appendix I
National Academies of Sciences, Engineering, and Medicine, *The Promise of Adolescence: Realizing Opportunity for All Youth* (Washington, DC: The National Academies Press, 2019)

NATIONAL ACADEMIES Sciences Engineering Medicine

NATIONAL ACADEMIES PRESS Washington, DC

This PDF is available at http://nap.nationalacademies.org/25388



The Promise of Adolescence: Realizing Opportunity for All Youth (2019)

DETAILS

492 pages | 6 x 9 | PAPERBACK

ISBN 978-0-309-49008-5 | DOI 10.17226/25388

CONTRIBUTORS

Richard J. Bonnie and Emily P. Backes, Editors; Committee on the Neurobiological and Socio-behavioral Science of Adolescent Development and Its Applications; Board on Children, Youth, and Families; Division of Behavioral and Social Sciences and Education; Health and Medicine Division; National Academies of Sciences, Engineering, and Medicine

BUY THIS BOOK

FIND RELATED TITLES

SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine. 2019. *The Promise of Adolescence: Realizing Opportunity for All Youth*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25388.

Visit the National Academies Press at nap.edu and login or register to get:

- Access to free PDF downloads of thousands of publications
- 10% off the price of print publications
- Email or social media notifications of new titles related to your interests
- Special offers and discounts

All downloadable National Academies titles are free to be used for personal and/or non-commercial academic use. Users may also freely post links to our titles on this website; non-commercial academic users are encouraged to link to the version on this website rather than distribute a downloaded PDF to ensure that all users are accessing the latest authoritative version of the work. All other uses require written permission. (Request Permission)

This PDF is protected by copyright and owned by the National Academy of Sciences; unless otherwise indicated, the National Academy of Sciences retains copyright to all materials in this PDF with all rights reserved.

RECEIVED by MSC 9/27/2024 8:39:40 PM

THE PROMISE OF ADOLESCENCE
Realizing Opportunity for All Youth

Committee on the Neurobiological and Socio-behavioral Science of Adolescent Development and Its Applications

Richard J. Bonnie and Emily P. Backes, *Editors*

Board on Children, Youth, and Families

Division of Behavioral and Social Sciences and Education

Health and Medicine Division

A Consensus Study Report of

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

Copyright National Academy of Sciences. All rights reserved.

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

This activity was supported by contracts between the National Academy of Sciences and the Bezos Family Foundation (unnumbered), the National Public Education Support Fund (unnumbered), the Robert Wood Johnson Foundation (#75005), and the Seattle Foundation (unnumbered), which was supported by the Annie E. Casey Foundation, the Chan Zuckerberg Initiative, the Conrad N. Hilton Foundation, the Ford Foundation, and the Raikes Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

International Standard Book Number-13: 978-0-309-49008-5
International Standard Book Number-10: 0-309-49008-1
Library of Congress Control Number: 2019945550
Digital Object Identifier: https://doi.org/10.17226/25388

Additional copies of this publication are available for sale from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

Copyright 2019 by the National Academy of Sciences. All rights reserved.

Printed in the United States of America

Suggested citation: National Academies of Sciences, Engineering, and Medicine. (2019). *The Promise of Adolescence: Realizing Opportunity for All Youth*. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/25388.

Copyright National Academy of Sciences. All rights reserved.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. C. D. Mote, Jr., is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the **National Academies of Sciences, Engineering, and Medicine** to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the **National Academies of Sciences, Engineering, and Medicine** at **www.nationalacademies.org**.

Copyright National Academy of Sciences. All rights reserved.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

Consensus Study Reports published by the National Academies of Sciences, Engineering, and Medicine document the evidence-based consensus on the study's statement of task by an authoring committee of experts. Reports typically include findings, conclusions, and recommendations based on information gathered by the committee and the committee's deliberations. Each report has been subjected to a rigorous and independent peer-review process and it represents the position of the National Academies on the statement of task.

Proceedings published by the National Academies of Sciences, Engineering, and Medicine chronicle the presentations and discussions at a workshop, symposium, or other event convened by the National Academies. The statements and opinions contained in proceedings are those of the participants and are not endorsed by other participants, the planning committee, or the National Academies.

For information about other products and activities of the National Academies, please visit www.nationalacademies.org/about/whatwedo.

Copyright National Academy of Sciences. All rights reserved.

COMMITTEE ON THE NEUROBIOLOGICAL AND SOCIO-BEHAVIORAL SCIENCE OF ADOLESCENT DEVELOPMENT AND ITS APPLICATIONS

RICHARD J. BONNIE, (*Chair*), University of Virginia
ANNA AIZER, Brown University
MARGARITA ALEGRÍA, Harvard Medical School and Massachusetts General Hospital, Boston
CLAIRE D. BRINDIS, University of California, San Francisco
ELIZABETH CAUFFMAN, University of California, Irvine
MESMIN DESTIN, Northwestern University
ANGELA DIAZ, Icahn School of Medicine at Mount Sinai
NANCY E. HILL, Harvard University
MICHELLE JACKSON, Stanford University
ARLENE F. LEE, Maryland Governor's Office for Children *(formerly)*
LESLIE LEVE, University of Oregon
JENS LUDWIG, University of Chicago
SUSAN VIVIAN MANGOLD, Juvenile Law Center
BRUCE S. MCEWEN, The Rockefeller University
STEPHEN T. RUSSELL, The University of Texas at Austin
JOANNA LEE WILLIAMS, University of Virginia

EMILY P. BACKES, *Study Director*
ELIZABETH TOWNSEND, *Associate Program Officer*
DARA SHEFSKA, *Research Associate*
MARY GHITELMAN, *Senior Program Assistant*
TAMMY CHANG, *James C. Puffer, M.D./American Board of Family Medicine Fellow*
STEPHANIE OH, *Christine Mirzayan Science and Technology Policy Graduate Fellow* (*January through May 2018)*

Copyright National Academy of Sciences. All rights reserved.

BOARD ON CHILDREN, YOUTH, AND FAMILIES

ANGELA DIAZ, (*Chair*), Icahn School of Medicine at Mount Sinai
HAROLYN BELCHER, Kennedy Krieger Institute and Johns Hopkins University School of Medicine
W. THOMAS BOYCE, University of British Columbia
DAVID V. B. BRITT, Sesame Workshop *(retired CEO)*
RICHARD F. CATALANO, University of Washington
DIMITRI CHRISTAKIS, University of Washington
JEFFREY W. HUTCHINSON, Uniformed Services University of the Health Sciences
JACQUELINE JONES, Foundation for Child Development
STEPHANIE J. MONROE, The Wrenwood Group, LLC
JAMES M. PERRIN, Harvard Medical School and Massachusetts General Hospital, Boston
NISHA SACHDEV, Bainum Family Foundation
DONALD F. SCHWARZ, Robert Wood Johnson Foundation
MARTÍN J. SEPÚLVEDA, IBM Corporation *(retired)*
MARTIN H. TEICHER, McLean Hospital and Harvard Medical School
JONATHAN TODRES, Georgia State University College of Law

NATACHA BLAIN, *Director*

Copyright National Academy of Sciences. All rights reserved.

Title: Only Skin Deep

Artist: Angela Casarez (Fort Worth, TX)

Artist age: 19

Artist statement:

This collage of different facial features and anatomy illustrates the many dimensions of global health disparities that include race, ethnicity, socioeconomic status, and geography. It is critically important for both policy makers and health care providers to identify the many facets of disparities so that solutions address health security for a variety of different circumstances and lifestyles. Efforts to eliminate disparities and increase equity must be part of a broader effort to transform health care and improve the quality and breadth of care delivered to individual patients—no matter what piece of this collage they may identify with. The strongest and most evident point this piece illustrates is simply that we are all human. Yet ironically, although beneath our skin and our socioeconomic positions, we all share the same anatomy, modern medicine is not practiced with such certainty and consistency. With that, I and my piece put forth that a world in which everyone has an equal chance to be healthy, safe, and happy, is one in which health care is as undeniable as the fact that any and every human possesses a zygomaticus major to smile.

This artwork was submitted as a part of the National Academy of Medicine's Young Leaders Visualize Health Equity nationwide call for art. This call for art encouraged young people between the ages of 5 and 26 to use art to explore how the social determinants of health play a role in shaping their lives and their communities, and what it might look and feel like to one day live in a world where everyone has the same chance to be healthy, safe, and happy. More information on this project can be found at nam.edu/youngleaders.

Copyright National Academy of Sciences. All rights reserved.



Copyright National Academy of Sciences. All rights reserved.

Preface

Our nation's youth hold the key to our future well-being. Investing generously in them will create a "more perfect union." That is the central message of this consensus report on the "promise of adolescence" sponsored by the Funders for Adolescent Science Translation, a consortium of foundations that came together with the aim of using science to produce more equitable and positive life outcomes for youth. This report takes its place in a sequence of National Academies of Sciences, Engineering, and Medicine reports exploring the science of child and adolescent development that began with *From Neurons to Neighborhoods*, the path-breaking Institute of Medicine study on the science of early childhood development published in 2000.

The science of adolescent development explores the neurobiological and socio-behavioral processes that underlie the unique and fascinating process of maturation. The 21st century has featured extraordinary advances in knowledge about the unique developmental processes—and challenges—of adolescence as well as the important role of this developmental period in shaping the trajectory of the life course. Our committee's assignment was to synthesize these exciting advances in the science of adolescent development and draw out their implications for the social systems charged with helping all adolescents flourish.

This committee's study is a companion to a parallel study funded by the Robert Wood Johnson Foundation exploring the neurobiological and socio-behavioral sciences' findings concerning childhood development from the prenatal period through early childhood. Together, these two reports consolidate the extraordinary advances in the science of human development

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

in order to inform child- and youth-serving institutions and policy makers. In this respect, they also complement a 2014 Health Resources and Services Administration-funded study focused on improving the safety and well-being of young adults.

Studying adolescents provides a rich opportunity for exploring the developing mind. For one thing, the fascinating process of evolving self-awareness—indeed, a preoccupation with self—is heightened during adolescence and our individual memories of that experience tend to be especially vivid. In addition, our sense of identity—of who we are and who we want to be—is taking shape during adolescence. We all tend to remember these experiences many years later.

As the report explains, the adolescent brain undergoes a remarkable transformation between puberty and the mid-20s that underpins amazing advances in learning and creativity. The plasticity of the adolescent brain also provides the potential for resilient responses to childhood trauma and distress. Personal experience teaches us, of course, that the excitement and emotional preoccupations of adolescence can yield both opportunity and risk. As a society, we bear a collective obligation to unleash the creativity of the adolescent brain while cushioning adolescents from experiences that could endanger their future well-being.

Another central theme of this report, signified by its subtitle, is that our nation must ensure that the "promise of adolescence" is realized for *all* adolescents. As the report shows, millions of adolescents are being left behind because they have lacked equal opportunity to succeed. Disparities in developmental outcomes for disadvantaged youth are attributable to lack of adequate resources and supports in their families and in the neighborhoods where they live, as well as the effects of bias and discrimination. The committee has concluded that we have the knowledge needed to reduce these disparities and close the opportunity gap. The committee has also expressed its collective view that these remedial measures *should* be taken because it is unjust (and contrary to the nation's collective self-interest) to allow these disparities to continue. We did so because this value judgment is implicit in our charge.

On behalf of the National Academies and its Board on Children, Youth and Families, I want to thank the member foundations of Funders for Adolescent Science Translation for sponsoring this important study. I am deeply grateful to Emily Backes and the National Academies staff for their extraordinary skill and diligence, and most of all, to my fellow members of the committee. It has been a pleasure to work with such talented colleagues on this interesting and important project. I look forward to working with them, as well as our sponsors, to disseminate the committee's findings and implement its recommendations for developmentally informed youth-serving systems.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

I want to close with a personal observation. The Virginia Bar Association, to which I belong, devoted the plenary session of its annual meeting in 2019 to a panel discussion lamenting the incivility of discourse in our fractious society. As we discussed what our organization can and should do about it, I observed that our current state of polarization has emerged and deepened over several decades and that remedial efforts should focus on our young people, beginning in adolescence when they are learning how people differ from one another and as they are discovering (and shaping) their own identities. As parents and teachers, our obligation is to help them develop the desire, and the skill, to listen to each other and to respect differences in their beliefs and values. We need to invest in our youngsters to repair our weakened (and imperfect) union.

Richard J. Bonnie, *Chair*
Committee on the Neurobiolgoical and
Socio-behavioral Science of Adolescent
Development and Its Applications

Copyright National Academy of Sciences. All rights reserved.

Acknowledgments

This report would not have been possible without the contributions of many people. First, we thank the sponsors of this study: the Funders for Adolescent Science Translation, including the Annie E. Casey Foundation, the Bezos Family Foundation, the Chan Zuckerberg Initiative, the Ford Foundation, the Conrad N. Hilton Foundation, the Raikes Foundation, the Robert Wood Johnson Foundation, and the National Public Education Support Fund.

Special thanks go to the members of the study committee, who dedicated extensive time, thought, and energy to the project. Thanks are also due to Tammy Chang (University of Michigan, Ann Arbor) who contributed her time and expertise throughout the report process, as well as Natalie Slopen (University of Maryland, College Park), who served as a liaison between our study committee and the Committee on Applying Neurobiological and Socio-behavioral Sciences from Prenatal through Early Childhood Development: A Health Equity Approach. We also extend our gratitude to Nat Kendall-Taylor, Marisa Gerstein Pineau, and Daniel Busso from the Frameworks Institute for their insights on communicating about adolescence.

In addition to its own research and deliberations, the committee received input from several outside sources, whose willingness to share their perspectives and experiences was essential to the committee's work. We thank Linda Burton (Duke University), Tammy Fields (Palm Beach County Youth Services Department), Andrew J. Fuligni (University of California, Los Angeles), Seema Gajwani (Office of the Attorney General for the District of Columbia), Roberto G. Gonzales (Harvard School of Education), Phil Hammack (University of California, Santa Cruz), Cheri Hoffman

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

(U.S. Department of Health and Human Services), Diane Hughes (New York University), Allyson Mackey (University of Pennsylvania), Gloria Mark (University of California, Irvine), Steve Michael (Iowa Collaboration for Youth Development), Jacqueline Nesi (Brown University), Candice Odgers (Duke University), Uma Rao (University of California, Irvine), Russell Romeo (Barnard College), Robert Sainz (Economic and Workforce Development Department, City of Los Angeles), Kaveri Subrahmanyam (California State, Los Angeles), and Roderick J. Watts (University of New York).The committee also gathered information through two commissioned analyses. We thank Monica Kirkpatrick Johnson (Washington State University) for "Contemporary Adolescents: Understanding the Demographic, Social, and Economic Changes Shaping Adolescent Life" and the University of Michigan MyVoice team for "Contemporary Adolescents: Understanding the Lived Experiences of Today's Youth."

The committee was also able to elicit input from adolescents throughout the report process. We extend our gratitude to the thoughtful young people who graciously gave their time to inform our work: Zachary Caplan, Darius Craig, Tanya Gumbs, Shyara Hill, Marcus Jarvis, Carolin Larkin, Nyla Mpofu, Jocelyn Nolasco, and Ayanna Tucker. We were truly awed by their ability to speak their truth and their impassioned commitment to bettering society. Their insights were incredibly valuable.

This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report: Sarah M. Bagley, CATALYST Clinic, Boston University School of Medicine/Boston Medical Center; Robert Wm. Blum, Department of Population, Family and Reproductive Health, Urban Health Institute, Johns Hopkins University; Catherine Bradshaw, Curry School of Education and Human Development, University of Virginia; Jeanne Brooks-Gunn, Teachers College and College of Physicians and Surgeons, Columbia University; Cleopatra Cabuz, Technology and Partnerships (retired), Honeywell Safety and Productivity Solutions; Ron E. Dahl, Institute of Human Development, University of California, Berkeley; Amy Dworksy, Chapin Hall, The University of Chicago; Adriana Galván, Department of Psychology Brain Research Institute, University of California, Los Angeles; Jonathan Guryan, Institute for Policy Research, Northwestern University; Cheri Hoffman, Division of Children and Youth Policy, Office of the Assistant Secretary for Planning and Evaluation, U.S.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Department of Health and Human Services; Velma McBride Murry, Department of Human and Organizational Development, Vanderbilt University; Anne C. Peterson, Ford School, University of Michigan; Alex R. Piquero, School of Economic, Political and Policy Sciences, The University of Texas at Dallas; Ricki Price-Baugh, Director of Academic Achievement, Council of the Great City Schools.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations of this report nor did they see the final draft before its release. The review of this report was overseen by Rosemary Chalk, independent consultant, Bethesda, Maryland, and Antonia M. Villarruel, School of Nursing, University of Pennsylvania. They were responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

The committee also wishes to extend its gratitude to the staff of the National Academies of Sciences, Engineering, and Medicine, in particular to Liz Townsend and Dara Shefska, who contributed research and writing assistance to the committee's work and played an important role in editing portions of the report. Mary Ghitelman provided key administrative and logistical support and made sure that committee meetings and report production ran efficiently and smoothly. Thanks are also due to fellows Stephanie Oh, who provided valuable research assistance in the report's early stages, and Katrina Ferrara, who made important contributions during the editing process. Throughout the project, Natacha Blain, director of the Board on Children, Youth, and Families, provided helpful oversight. The committee is also grateful to Anthony Bryant and Pamella Atayi for their financial and administrative assistance on the project. From the Division of Behavioral and Social Sciences and Education Office of Reports and Communication, we thank Kirsten Sampson Snyder, Yvonne Wise, and Douglas Sprunger, who shepherded the report through the review and production process and assisted with its communication and dissemination. We also thank Marc DeFrancis for his skillful editing.

We are grateful to our colleagues and collaborators in the Health and Medicine Division (HMD) and the National Academy of Medicine's Culture of Health Program. In particular, we would like to extend our thanks to HMD's Rose Marie Martinez, Amy Geller, Yami Negussie, and Sophie Yang for their wonderful collegiality and thoughtful input throughout the endeavor. Thanks are also due to National Academy of Medicine staff Charlee Alexander, Kyra Cappelucci, Ivory Clarke, and the entire Culture of Health Program team.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Finally, the committee wishes to thank our chair, Richard Bonnie, for his time, intellectual leadership, and devotion to this study. It was an honor to work with Richard, and this report is truly better for his commitment.

Emily P. Backes, *Study Director*
Committee on the Neurobiolgoical and
Socio-behavioral Science of Adolescent
Development and Its Applications

Copyright National Academy of Sciences. All rights reserved.

Contents

Summary 1

PART I: ADOLESCENCE AS A PERIOD OF OPPORTUNITY

1 Introduction 17
Study Charge and Approach, 19
History of Adolescence, 24
Contemporary Adolescents, 26
The Promise of Adolescence, 32
The Political Challenge, 32
Study Methods, 33
Organization of the Report, 34

2 Adolescent Development 37
Puberty, 38
Neurobiological Development, 46
Psychosocial Development in Adolescence, 59
Conclusion, 75

3 How Environment "Gets Under the Skin": The Continuous Interplay Between Biology and Environment 77
Understanding Epigenetics, 78
Reciprocal Interactions Between Brain, Body, and Environment, 84
Ameliorating Early Life Adversities in Adolescence, 91
Conclusion, 93

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

4 **Inequity and Adolescence** 95
Disparities in Adolescent Outcomes, 97
Sources of Disparities: Inequality of Opportunity, 116
Achieving Equity for Adolescents, 137
Conclusion, 144

PART II: USING DEVELOPMENTAL KNOWLEDGE TO ASSURE OPPORTUNITY FOR ALL YOUTH

5 **Introduction** 149
Growing System Complexity, 150
Parents and Caregivers, 152
Faith-based Institutions, 155
Envisioning Developmentally Informed Youth-Serving Systems, 157

6 **Education** 159
Societal Changes, 162
Improved Understanding of Adolescence, 166
Creating the Education Sector of the Future, 171
Recommendations, 197

7 **Health System** 209
The Vision: Seamless Access to Adolescent-Friendly Health Services, 210
Sexual and Reproductive Health Care, 216
Behavioral Health Care, 221
Confidentiality and Parental Consent Requirements, 231
Adolescent Health Care Workforce, 236
Meeting Adolescents Where They Are: Services in Nonclinical Settings, 237
Recommendations, 242

8 **Child Welfare System** 257
Child Maltreatment and the Adolescent Brain, 259
Introduction to the Child Welfare System, 261
Aligning the Child Welfare System with the Needs of Adolescents, 266
Developmental Research on Adolescents in the Child Welfare System: Challenges and Promising Solutions, 274
Flourishing for Child Welfare-Involved Adolescents, 285
Recommendations, 286

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

9 Justice System **295**
Developmentally Informed Juvenile Justice: Progress Report, 297
Reducing Racial Disparities, 307
Opportunities for Continued Juvenile Justice Reforms, 313
A Developmentally Informed Criminal Justice System, 330
Opportunities for Cross-System Collaboration, 336
Recommendations, 340

10 The Scientific Opportunity **347**
Data Limitations, 348
Recommendations for Future Research, 350
Investments in Research on Adolescence, 354
Conclusion, 355

References **357**

APPENDIXES

A Assessing the Evidence 445
B Youth Engagement 449
C Biosketches of Committee Members and Staff 459

Copyright National Academy of Sciences. All rights reserved.

Summary

Adolescence—beginning with the onset of puberty and ending in the mid-20s—is a critical period of development during which key areas of the brain develop and mature. These changes in brain structure, function, and connectivity mark adolescence as a period of opportunity to discover new vistas, to form relationships with peers and adults, and to explore one's developing identity. It is also a period of resilience that can ameliorate childhood setbacks and set the stage for a thriving trajectory over the life course.

Because adolescents comprise nearly one-fourth of the entire U.S. population, the nation needs policies and practices that will better leverage these developmental opportunities to harness the promise of adolescence—rather than focusing myopically on containing its risks. The National Academies of Sciences, Engineering, and Medicine were asked to convene a committee of experts to examine the neurobiological and socio-behavioral science of adolescent development and to outline how this knowledge can be applied, both to promote adolescent well-being, resilience, and development and to rectify structural barriers and inequalities in opportunity, enabling all adolescents to flourish. The challenge for a caring society is to take maximum advantage of the developmental opportunities afforded by adolescence to forge positive trajectories into adulthood for all adolescents.

ADOLESCENT DEVELOPMENT

Puberty occurs over an extended period of a young person's life during which developmental changes result in the maturation of primary and

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

secondary sex characteristics and the acquisition of reproductive maturity. Pubertal development varies greatly from one individual to the next, and the age at which an adolescent matures depends on a combination of genetic and environmental influences, including early life experiences. Socially, pubertal maturation and its accompanying physical changes also affect how adolescents perceive themselves and how they are treated by others, and in this regard early pubertal timing has been shown to have challenging social consequences. Structural changes that disrupt the systemic factors that increase risk for early puberty (e.g., resource deprivation) as well as supportive relationships can mitigate the risks associated with early puberty and foster resilient outcomes.

Neurobiologically, throughout adolescence the connections within and between brain regions become stronger and more efficient, and unused connections are pruned away. Such developmental plasticity means adolescents' brains are adaptive; they become more specialized in response to environmental demands. The timing and location of these dynamic changes are also important. The onset of puberty brings about changes in the limbic region of the brain, resulting in greater sensitivity to rewards, threats, novelty, and peers. In contrast, it takes longer for the cortical region, which is implicated in cognitive control and self-regulation, to develop.

Consequently, adolescent brains are not simply "advanced" child brains or "immature" adult brains, but have evolved to meet the needs of this stage of life. Indeed, the temporal discrepancy in the specialization of and connections between brain regions makes adolescence unique. The developmental changes heighten sensitivity to rewards, willingness to take risks, and the salience of social status, propensities that are necessary for exploring new environments and building nonfamilial relationships. Adolescents must explore and take risks to build the cognitive, social, and emotional skills necessary for productivity in adulthood.

The increased cognitive abilities gained throughout adolescence also provide the capacity for other aspects of psychosocial development, such as developing identity and capacity for self-direction. An adolescent's identity is an emerging reflection of his or her values, beliefs, and aspirations, and it can be constructed and reconstructed over time and experience. Multiple factors, including family, culture, peers, and media, shape identity development, but young people are also active agents in the process. Ultimately, how adolescents' multifaceted identities are manifested—neurobiologically, behaviorally, or otherwise—and what role identity plays in their overall well-being greatly depends on their experiences in particular social contexts.

Adolescence is also marked by a growing capacity for self-direction. Over the course of adolescence, youth gain the cognitive skills needed to reflect on complex questions about their role in the world. This enables them to question the legitimacy and fairness of everyday experiences and of

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

social institutions. Indeed, the social systems they must navigate—schools, employment, health care, justice—are complex, and navigating them often requires independent decision making. Such skills are important not only to support the transition to adulthood but also to make adolescence itself a period that fosters a propensity to contribute to others.

In summary, although adolescence is often thought of as a time of turmoil and risk for young people, it is more accurately viewed as a developmental period rich with opportunity for youth to learn and grow. Adolescence thus forms a critical bridge between childhood and adulthood and is a window of opportunity for positive, life-shaping development.

HOW ENVIRONMENT "GETS UNDER THE SKIN": THE CONTINUOUS INTERPLAY BETWEEN BIOLOGY AND ENVIRONMENT

While the malleable brains of adolescents are adaptable to learning and innovation, they are also vulnerable to toxic exposures. The emerging science of epigenetics[1] focuses our attention on the ongoing plasticity of the brain and the reciprocal influences of the brain, body, and environment. Contrary to the common understanding that the effects of heredity are immutable and direct, contemporary studies of gene-environment interaction and epigenetics show that the way heredity is expressed in behavior depends significantly on environmental influences. The epigenetic approach also embraces a "trajectory" model of the life course: the trajectory of an individual's life may be changed, negatively or positively, at each life stage. Protective environmental factors support positive or flourishing trajectories, while adverse experiences may lead to at-risk or poor trajectories. The future condition of the brain and body will be affected by events that have changed the trajectory in the past, and interventions undertaken in the present have the potential to remediate past developmental challenges.

Adolescents' heightened sensitivity and responsiveness to environmental influences also implies "resilience," meaning adolescents have the opportunity to develop neurobiological adaptations and behaviors that leave them better equipped to handle adversities that emerge throughout the life course. Thus, investments in programs and interventions that capitalize on brain plasticity during adolescence can promote beneficial changes in developmental trajectories for youth who may have faced adverse experiences earlier in life or are facing them now and prevent future challenges and risks.

[1] Epigenetics studies the seamless and ongoing interaction between genes and the environment, with particular interest in cataloging the numerous environmental mechanisms comprising the nongenetic influences of gene expression.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

INEQUITY AND ADOLESCENCE

The promise of adolescence can be severely curtailed by economic, social, and structural disadvantage and, in all too many cases, by racism, bias, and discrimination. These potent societal determinants shape adolescents' life-course trajectories in multiple ways, not only by reducing access to the opportunities, services, and supports enjoyed by more privileged youth but also by exposing less privileged youth to excess risks, stresses, and demands. These excess pressures "get under the skin" and adversely affect the brain and body during this critical developmental period.

Striking differences in opportunity are associated with striking differences in outcomes—in health, safety, well-being, and educational and occupational attainment—and in trajectories over the life course. Educational achievement, as measured by reading and math proficiency, high school graduation rates, and college completion, varies by race and ethnicity, socioeconomic status, and gender, with White and higher-income youth consistently experiencing better outcomes than other groups. Disparities also exist in the occurrence and impact of chronic health conditions (by socioeconomic status) and mortality (by race and ethnicity, socioeconomic status, and gender), due in part to exposure to violence. Moreover, there is consistent evidence that at all ages, LGBT youth are at higher risk of poor mental health and suicide than their heterosexual and cis-gender peers. Among adolescents, poor and Black youth are dramatically overrepresented in foster care. And in the juvenile justice system, Black youth are detained at a rate six times higher than White youth and three times higher than Latinx youth. (See Chapter 4.)

These disparities are often compounded for the youth experiencing them because they cut across the multiple systems with which they interact, and deficiencies in one area negatively affect outcomes in others. For example, poor health reduces educational attainment, while involvement in child protective services negatively affects juvenile justice outcomes. Together, these disparities grow as youth age and result in large disparities in their adult outcomes, such as poorer rates of employment and earnings, increased likelihood of criminal justice involvement, and poorer health and well-being.

However, disparities in adolescent outcomes are not immutable: they are responsive to changes in underlying conditions, and adolescents themselves show resilience and demonstrate strengths and assets that may be utilized to overcome inequities. Recent trends show that, in fact, adolescent well-being has improved over time, as illustrated by the steady decline in teen childbearing rates since 1990, which have been accompanied by significant declines in disparities by race and ethnicity.

Because a full understanding of the sources of these outcome disparities is necessary to formulate effective strategies for reducing them, we cat-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

egorize the possible sources of these disparities as follows: (1) differences in family wealth and income, combined with living in neighborhoods segregated by income and race, (2) differences in institutional responses to adolescents by schools, the health system, the justice system, or the welfare system, and (3) prejudicial or discriminatory attitudes or behavior on the part of the adults or peers who interact with adolescents on a regular basis. Of course, other possible sources of outcome disparities exist, but here we point to some of the specific, quantifiable sources that have been captured empirically.

More than 9 million children and youth (ages 0 to 18) in the United States live in households with incomes below the poverty level, and rates of child poverty are highest for Black, Latinx, and American Indian and Alaska Native youth. For adolescents, growing up in poverty is associated with worse physical and mental health, as well as higher prevalence of risky behaviors and delinquency. The stagnation of wages for those in the bottom half of the income distribution over the past 50 years has reduced the resources available to lower-income families for investment in their children. Like income, wealth accumulation affects the resources families have available for investing in the next generation, especially for investments in higher education. Racial differences in wealth are three times greater than racial differences or gaps in income, with the average White household in 2010 having nearly six times the wealth of the average Black household (see Chapter 4).

In addition, because of the relatively high rates of residential segregation in the United States, adolescents from poor or minority families are much more likely than others to live in poor and segregated neighborhoods. Low-income neighborhoods, in turn, are more likely than other neighborhoods to be lacking in access to health care, youth-oriented organizations, and learning centers, and they are also more likely to be located near polluting factors, to have high levels of violence and low levels of safety, and to have low-quality housing. Moreover, poor families and minority families experience considerably more stress than others. As a result, not only are poor families less able to invest financially in their children, but also their nonfinancial investments, such as the amount and quality of their caregiving, are also affected by family disadvantage.

This disparity in family resources is often compounded by the institutions and systems with which youth interact. Segregation of schools by family income is the single most predictive factor of academic achievement gaps by race and income. The increasing income segregation of U.S. schools, compounded by rising income inequality, has most likely prevented society from achieving the full benefit of the significant, recent gains in financial parity across schools, suggesting that children from disadvantaged households likely need *more* resources (not equal resources) if society is to reduce

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

disparities in educational outcomes. School segregation is driven largely by neighborhood segregation and, as such, the policy or institutional response to the increasing segregation of U.S. schools largely lies in housing policy, but tightness in the housing market and housing discrimination reduce the likelihood that low-income families can move to low-poverty neighborhoods. Moreover, lack of health care access and low health care quality, as well as laws and policies that drive crossover from involvement with the child welfare system into involvement in the juvenile justice system, compound disadvantage and contribute to disparities in opportunity.

A third source of disparities in adolescent outcomes derives from the explicit and implicit (or unconscious) prejudice and bias that individuals hold against groups defined by race, ethnicity, gender, LGBTQ identity, ability status, and so on. The experience of being targeted by such bias can include both singular significant interactions as well as a series of less obvious but frequent events, referred to as micro-aggressions. At a time when adolescents are especially sensitive to the attitudes and behaviors of adult members of the community, evidence suggests that educators, health professionals, child welfare system actors, and justice system actors exhibit behaviors that lead to disparate treatment of youth by race, gender, LGBTQ identity, and ability status. When aggregated in an institutional context, these biases can result in disparate outcomes for the affected groups.

An effective strategy, or set of strategies, to reduce inequities needs to address the main sources of these disparities. The committee recognizes some promising policies and programs that attempt to tackle these disparities in opportunity, including (1) policies and programs to reduce disparities in income, wealth, and neighborhood resources, such as the Supplemental Nutrition Assistance Program and the Earned Income Tax Credit; (2) trauma-informed approaches preparing adults serving youth to address differential exposure to violence and trauma among youth; and (3) emerging tools, such as predictive analytics, to erase or counteract bias in decision making by system-level actors.

With any strategy, greater coordination is needed across the multiple systems responsible for adolescents: the school system, health care system, and juvenile justice and child protection systems. Parity in public system funding is a first step, but it will not be sufficient to significantly reduce disparities. To significantly reduce or eliminate disparities, disadvantaged youth will likely require disproportionate funding.

Although progress may not be immediate, there is substantial reason for optimism. Progress has already been made in reducing disparities in adolescent outcomes, especially in the areas of education, health, and teen pregnancy. With the notable exception of the juvenile justice system, the evidence suggests that as overall adolescent health and well-being improve, disparities fall. These trends underscore the hope that with additional effort

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

and a comprehensive approach, further reductions in outcome disparities among adolescents are indeed attainable.

USING DEVELOPMENTAL KNOWLEDGE TO ASSURE OPPORTUNITY FOR ALL YOUTH

The committee's charge requested recommendations regarding ways by which youth-serving systems—education, health, child welfare, and justice—can apply accelerating knowledge about adolescent development (and particularly knowledge from the neurobiological and socio-behavioral sciences) to their own work. Of course, investing in youth also requires investing in the adult caregivers who support them, as supportive familial, caregiver, and adult relationships play a significant role in fostering positive outcomes for adolescents. Such investments need to be multilevel and multisectoral; interventions to change parenting behavior may be futile if the systems themselves are not attuned to the pressing economic needs of parents.

The following sections briefly identify the major domains of the committee's recommendations for each of the four youth-serving systems designated in the committee's charge: education, health, child welfare, and justice. Detailed recommendations for specific actors and actions can be found in Chapters 6 through 9.

Recommendations for the Education System

Our enriched understanding of adolescence, together with major changes in the labor market, require rethinking and modernizing a public school system that was largely designed for early 20th century life. As the economy has changed over the past several decades, the skills and dispositions required to succeed in the current and future job market are increasingly interpersonal and socio-emotional. Relatedly, today's increasingly knowledge-based economy requires a mindset of learning, malleability, and expectation for growth and improvement.

When young people reach adolescence, they vary widely in their academic skills and needs and in their future career aspirations. The secondary school system of the future must meet teens "where they are" and offer differentiated and responsive academic opportunities, including individualized instruction, tutoring, tracking, and credentialing. Growing recognition of the importance of skills other than reading, writing, and arithmetic for both personal fulfillment and success in modern life requires schools to broaden their mission to incorporate the teaching of nonacademic skills such as decision making, practical knowledge, and adaptability. The growing diversity of U.S. adolescents also requires schools to better recognize

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

adolescents' integrated needs, become more culturally sensitive, and become adept at assisting youth with issues related to identity and social competence. Moreover, recognizing the importance of caregivers in adolescents' lives, the education system will need to provide additional supports for adolescents and their families to assist them in navigating an increasingly complex education sector.

In short, secondary schools should be modernized to reflect the preparation, knowledge, and skills that youth need for the 21st century and rectify longstanding and persistent disparities in resources across the demographic backgrounds of their students. This committee's recommendations for transforming secondary education for the 21st century highlight six key areas to implement such change:

RECOMMENDATION 6-1: Rectify disparities in resources for least-advantaged schools and students.

RECOMMENDATION 6-2: Design purposeful but flexible pathways through education.

RECOMMENDATION 6-3: Teach practical knowledge and non-academic skills, such as decision making, adaptability, and socio-emotional competence.

RECOMMENDATION 6-4: Protect the overall health and well-being of each student.

RECOMMENDATION 6-5: Foster culturally sensitive learning environments.

RECOMMENDATION 6-6: Help adolescents and families navigate the education sector.

Recommendations for the Health System

Access to appropriate health care services is important to ensure adolescents' well-being both today and for a lifetime. Access is particularly important while they are developing habits that will affect their long-term health, such as diet, exercise, and substance use. Yet adolescents face a variety of barriers to accessing health care, which contributes to longstanding disparities in their use of such care that are measurable by race and ethnicity, LGBTQ status, ability status, and socioeconomic status. While limited access to health care has been most frequently associated with financial barriers, adolescents face the additional challenge that they are

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

generally inexperienced in navigating the health care system independently, concerned that their health needs and services remain confidential, and more likely than adults to engage in risk-taking behaviors that could have both short- and long-term effects on their health.

Developmentally appropriate changes to provider practices and innovative care delivery systems can help adolescents become more engaged with their care and achieve better outcomes. To ensure the health and well-being of all adolescents, health systems should offer integrated, comprehensive health services that prepare youth for the distinct physical, cognitive, and social changes that take place during adolescence, prepare them to navigate the health system independently, and provide services that are culturally informed and attentive to the needs of all youth.

A systemic approach to prioritizing the health and well-being of adolescents is needed on a national level, including clear goals and priorities to help mobilize both the public and private sectors to improve adolescent health. The committee's recommendations draw on neurobiological and socio-behavioral research to identify more effective health policy, programs, and practices with five key aims:

RECOMMENDATION 7-1: Strengthen the financing of health care services for adolescents, including insurance coverage for uninsured or under-insured populations.

RECOMMENDATION 7-2: Improve access to comprehensive, integrated, coordinated health services for adolescents.

RECOMMENDATION 7-3: Increase access to behavioral health care and treatment services.

RECOMMENDATION 7-4: Improve the training and distribution and increase the number of adolescent health care providers.

RECOMMENDATION 7-5: Improve federal and state data collection on adolescent health and well-being, and conduct adolescent-specific health services research and disseminate the findings.

Recommendations for the Child Welfare System

The purpose of the child welfare system is to protect children at risk of abuse or neglect by their parents or guardians (or whomever the state defines as a perpetrator). Historically and up to the present day, two defining aspects of the child welfare system have been its focus on young children and its attention to preventing serious physical abuse. These foci are

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

coupled with a funding scheme that prioritizes funding for out-of-home placement. As a result, the system is under-resourced in providing support services to *prevent* out-of-home placement and in providing support to families, particularly families with adolescents. This approach is ill-suited to helping adolescents in the child welfare system flourish, given their more advanced decision-making skills, their need for a balance of autonomy and healthy relationships, and their ability to use technology to seek solutions, relative to younger children. In addition, courts with jurisdiction over adolescents as a result of acting-out behaviors for status offenses have insufficient resources to address the underlying and presenting problems of these youth and their families.

Also of great concern are disparities within the child welfare system: poor children and children of color are disproportionately referred to the child welfare system. In general, both disproportionate need and differential treatment by community members and the child welfare system play important roles in explaining these disparities. Community reporters are more likely to report children of color to child welfare authorities, which suggests discriminatory reporting and increased surveillance for maltreatment in communities of color. A second important source of systemic disparity in treatment is that families of color are offered fewer in-home services that might prevent the placement of a child or adolescent in foster care. As a result, children of color are both more likely to be removed from a home and more likely to remain in foster placements longer without a permanent resolution.

Over the past two decades, Congress has gradually enacted statutory changes that better align the child welfare system with the developmental assets and challenges that adolescents face, including focusing attention on family reunification, prioritizing placement with relatives over strangers, and providing services for those adolescents aging out of foster care. These federal statutory changes are significant advances, but additional efforts are needed to ensure that all adolescents involved with the child welfare system have the opportunity to flourish. The committee's recommendations center on providing services and supports for adolescents that differ from those provided to their younger counterparts within the child welfare system, focusing on adolescents' need to be involved as partners in decisions affecting their housing, health and mental health, and education. The committee's six key areas of recommendation are

RECOMMENDATION 8-1: Reduce racial/ethnic disparities in child welfare system involvement.

RECOMMENDATION 8-2: Promote broad uptake by the states of federal programs that promote resilience and positive outcomes for adolescents involved in the child welfare system.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

RECOMMENDATION 8-3: Provide services to adolescents and their families in the child welfare system that are developmentally informed at the individual, program, and system levels.

RECOMMENDATION 8-4: Conduct research that reflects all types and ages of adolescents in the child welfare system.

RECOMMENDATION 8-5: Foster greater collaboration between the child welfare, juvenile justice, education, and health systems.

RECOMMENDATION 8-6: Provide developmentally appropriate services for adolescents who engage in noncriminal misconduct without justice-system involvement.

Recommendations for the Justice System

Over the past 15 years, advances in the science of adolescent development have had a substantial impact on juvenile justice reform and have also focused attention on the potential value of developmentally appropriate practices for older adolescents involved in the criminal justice system. Findings regarding adolescent brain development have highlighted the diminished culpability of adolescent offenders and their potential responsiveness to preventive interventions based on evidence-based risk- and needs-assessments.

While it is clear that a developmental approach to the juvenile justice system has been widely embraced by reformers and is having a discernible impact on law and practice in many states, progress across the country is uneven, and sustained effort and attention are needed to accelerate advances and to prevent an erosion of gains. Priority areas for reform within the juvenile justice system include the need for increased family engagement and greater attention to procedural fairness, including fairness in interactions with the police, legal representation for youth, and reduced use of juvenile fines and fees. Another reform priority is reducing the unwarranted harm to juveniles' future well-being caused by justice-system involvement, including public disclosure of justice-system records, listing on sex offender registries, and solitary confinement.

Similar reform efforts recognizing the developmental needs of older adolescents and young adults are emerging within the criminal justice system, including reducing automatic transfers of juveniles to criminal courts based only on the charged offense, and creating developmentally informed correctional programs for young offenders. These efforts should be guided by the science of adolescent development and the core principles of a developmental approach.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Despite decades of attention under federal law, racial/ethnic disparities in police, prosecutorial, and judicial decision making in the juvenile justice and criminal justice systems persist, and in some contexts they are actually increasing. While the literature reflects continuing uncertainty about the relative contribution of differential offending, differential enforcement, and differential judicial processing, it is clear that the lack of progress in reducing disparities within the justice system has led to harmful outcomes for minority and other affected youth.

Previous National Academies' reports on juvenile justice outlined recommendations for needed reforms to ensure that the juvenile justice system accounts for and attends to the developmental needs of youth. This committee reaffirms those recommendations, and offers several additional recommendations in five key areas:

RECOMMENDATION 9-1: Reduce disparities based on race, ethnicity, gender, ability status, and sexual orientation or gender identity and expression among adolescents involved in the justice system.

RECOMMENDATION 9-2: Ensure that youth maintain supportive relationships while involved in the justice system and receive appropriate guidance and counsel from legal professionals and caregivers.

RECOMMENDATION 9-3: Implement policies that aim to reduce harm to justice-involved youth in accordance with knowledge from developmental science.

RECOMMENDATION 9-4: Implement developmentally appropriate and fair policies and practices for adolescents involved in the criminal justice system.

RECOMMENDATION 9-5: For those youth in the custody of the justice system, ensure that policies and practices are implemented to prioritize the health and educational needs of adolescents and avoid causing harm.

CONCLUSION

Adolescence, spanning the years from the onset of puberty to adulthood, is a formative period when changes in cognition, affect, and interpersonal behavior occur alongside the most extensive neurobiological transitions since infancy, especially with respect to pubertal and brain development. These changes make it clear that adolescent brains are not best understood as simply "advanced" child brains or "immature" adult brains. Instead they

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

have evolved to meet the developmental needs of humans at this stage of life. Collectively, the pubertal, neurobiological, cognitive, and psychosocial changes occurring during adolescence mark this as a period of great opportunity for adolescents to flourish and thrive.

However, in the United States today many families lack adequate resources and neighborhood supports, leaving many adolescents at significant disadvantage during this critical period of development. To fail to address the sources of these disparities is to waste human capital: lower worker productivity, lost wages and employment, worse health and mental health, increased criminal justice involvement, and a drain on public support. These outcomes would reduce economic growth and exacerbate rising income inequality. Creating positive impact by improving opportunities for adolescents not only improves trajectories relevant to multiple outcomes, but also, by making use of high-impact, cost-effective interventions, it can counteract the effects of childhood stresses and deprivations and prevent negative outcomes in adulthood.

These realities also highlight a compelling scientific challenge. To understand how we can help all adolescents flourish, we need to connect two bodies of research: the deepened understanding of developmental processes needs to also encompass a richer understanding of the impact of the social environment. Achieving this will require a major commitment by our research establishment. Future research investments in adolescence should support efforts that (1) deepen our knowledge of the processes of adolescent development, (2) examine the socio-environmental contexts that offer opportunities for flourishing, and (3) understand and combat inequities that curtail the promise of adolescence for all youth.

Our society has a collective responsibility to build systems that support and promote positive adolescent development. These systems should reflect a rich understanding of the developmental needs of adolescents and a specific recognition of adolescence as a time of great opportunity to promote learning and discovery and to remediate past developmental challenges. Until society embraces this responsibility, the promise of adolescence will remain unfulfilled for millions of youth.

Copyright National Academy of Sciences. All rights reserved.

Part I: Adolescence as a Period of Opportunity

Copyright National Academy of Sciences. All rights reserved.

1

Introduction

Although often thought of as an age span, such as the second decade of life or "the teenage years," adolescence is the distinct period of bio-developmental change in a person's life that bridges childhood and adulthood. It denotes a set of developmental transitions beginning with the onset of puberty[1] and ending during the mid-20s, characterized by maturation of the body, intensification of capacity for learning, and emergence of personal identity. From a social vantage point, the developmental tasks of adolescence include taking responsibility for oneself and forming relationships with others. This period of developmental maturation is underpinned by unique changes in brain structure and function.

All these transitions mark adolescence as a period of both opportunity and risk (see Chapter 2). Parents (or parent surrogates)[2] typically bear primary responsibility as caretakers of their children, but the whole society

[1] The average child in the United States experiences the onset of puberty between the age of 8 and 10 years. The onset of puberty may be defined by two biological components, adrenarche and gonadarche. Adrenarche, which refers to the maturation of the hypothalamic-pituitary-adrenal (HPA) axis typically begins in late childhood, but levels of adrenarchal hormones continue to rise throughout adolescence (Blakemore et al., 2010). Gonadarche typically begins in early adolescence, at approximately ages 9 to 11, and involves the reactivation of the hypothalamic-pituitary-gonadal (HPG) axis. See Chapter 2 for a full discussion of adolescent development and puberty.

[2] In this report, the committee uses the term "parents" to broadly encompass those adults in adolescents' lives who are their primary caretaker. For some young people, the primary caretaker is a grandparent, aunt or uncle, step-parent, or foster parent, among others.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

shares the obligation to help adolescents achieve their full potential in adulthood (Casey et al., 2010; Galván, 2014; Spear, 2010).

In the past, it was thought that the brain was entirely developed before a person entered adolescence and that cognitive functions were fully mature by then. But it is now widely understood that key areas of the brain and its circuitry continue maturing from the onset of puberty and well into an individual's mid-20s (Giedd et al., 1999; Lenroot and Giedd, 2006). This demarcates adolescence as a sensitive period of neurodevelopment that is especially affected by the environment, including physical factors such as nutrition, trauma, and toxic exposures, as well as social factors such as the influence of parents and caregivers, peers, and teachers (Fuhrmann et al., 2015).

For these reasons, it is important to understand the potentially profound impact that an uneven social distribution of risks and resources can have on youth, privileging some while leaving disadvantaged populations behind (Steinberg, 2014; see also Chapter 4). The challenge for a caring society is to take maximum advantage of the developmental opportunities afforded by adolescence. The remarkable adaptability, plasticity, and heterogeneity of adolescent brains (Ismail et al., 2017) creates accompanying opportunities—and obligations—for individuals and agencies responsible for protecting and serving youth to help all adolescents flourish.

Over the past two decades, advances in neurobiology and neuroimaging have demonstrated the dramatic extent of brain maturation during adolescence. However, as a recent *Lancet* commission on adolescence has noted, this exciting advance in knowledge has not penetrated the everyday understanding of informed citizens and policy makers, including many who serve young people (Patton et al., 2016). While some youth-serving policies and programs have embraced developmentally informed changes, the wide-scale changes needed to support and bolster adolescents' development have not yet materialized.

The challenge of educating the public is compounded by a deeply ingrained tendency to view adolescence as mainly a time of vulnerability and risk—a viewpoint that may have been reinforced in recent years by oversimplified headlines about a "mismatch" in the adolescent brain between intensifying desires and emotions (akin to "stepping on the gas") and a more slowly developing capacity for self-regulation ("stepping on the brakes)." This preoccupation with risk leads to a tendency to attribute risk and vulnerability to developing young people, while overlooking society's responsibility to protect and support them in their growth. To continue the metaphor, it draws attention to "risky drivers" rather than the conditions of the roads, the presence of guardrails, and the availability of driver education. A preoccupation with risk also leads to a selective valuing of policies and practices that aim to shield adolescents from harm and relative disregard for those that create incentives for discovery and innovation.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

A key theme of this report is that recent advances in neuroscientific understanding have been fundamentally misunderstood by large segments of the public. The defining characteristics of the adolescent brain are malleability and plasticity. These attributes may sometimes be worrisome but they also generate unique opportunities for learning, exploration, and growth. Our society needs policies and practices that will help us better leverage these developmental opportunities to harness the promise of adolescence—rather than focusing myopically on containing its risks.

A second important theme of the report—and a major challenge for the nation—is that the promise of adolescence is now unrealized for many of our nation's adolescents due to deeply rooted structural inequalities that underpin well-documented disparities in developmental outcomes. These structural inequalities include substantial differences in family resources, in the safety and support of neighborhoods, and the occurrence of racial/ethnic bias. (See Chapter 4.) Counteracting and erasing these disparities will require sustained, multipronged, multilevel interventions. Developmental science can tell us what to do, but only a sustained political commitment can enable us to do it.

STUDY CHARGE AND APPROACH

The National Academies of Sciences, Engineering, and Medicine appointed the Committee on the Neurobiological and Socio-behavioral Science of Adolescent Development and Its Applications ("the committee") to prepare a report examining the neurobiological and socio-behavioral science of adolescent development and outlining how this knowledge can be applied to institutions and systems (1) to promote adolescent well-being, resilience, and development and (2) to rectify structural barriers and inequalities in opportunity. (See the committee's full Statement of Task in Box 1-1.) Sixteen prominent scholars and practitioners were included on the committee, representing a broad array of disciplines including neuroscience, developmental and social psychology, economics, sociology, adolescent health and medicine, law, and education and learning. They met and deliberated over a 15-month period to reach the findings presented in this report.

The study builds on the foundation laid by the first study in the National Academy of Medicine's Culture of Health study series, *Communities in Action: Pathways to Health Equity.* The Funders for Adolescent Science Translation (FAST) provided funding for this committee's study and report. FAST members include the Annie E. Casey Foundation, the Bezos Family Foundation, the Chan Zuckerberg Initiative, the Conrad N. Hilton Foundation, the Ford Foundation, the National Public Education Support Fund, the Raikes Foundation, and the Robert Wood Johnson Foundation.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

BOX 1-1
Statement of Task

An ad hoc committee will examine the neurobiological and socio-behavioral science of adolescent development, health, well-being, resilience, and agency including the science of positive youth development. The committee will also focus on how this knowledge can be applied to institutions and systems so that adolescent well-being, resilience, and development are promoted and that systems address structural barriers and inequalities in opportunity and access. The study will aim to build off the first study in the National Academy of Medicine's Culture of Health study series and outline the implications of developmental interactions with the social distribution of risks and resources identified in the first study, *Communities in Action: Pathways to Health Equity.*

As appropriate to their review, the study committee will make evidence-driven recommendations to key stakeholders serving adolescents and their families including government agencies and community institutions; federal, state, and local policy makers who guide allocation of resources; and the research community. The committee will highlight promising models, opportunities for translations, and potential policy areas to better support adolescents, and will identify three to five research gaps. The committee will also work with a communications consultant throughout the process to identify and communicate key messages.

The committee will explore

1. What are the unique neurobiological and socio-behavioral characteristics in adolescence that make this a period of unique opportunity for positive developmental trajectories? Adolescence has largely been seen as a time of heightened risk and poor decision making; however, emerging research suggests that adolescence, especially the adaptive flexibility of adolescents, is also a period of opportunity for learning and skill acquisition. How can these opportunities be maximized and harmful risks mitigated?
2. Recognizing that development begins early in life; how do early life conditions, including supports and adversity, shape adolescent development? What is the role of adolescent agency? What does science tell us about our ability, during the adolescent period, to mediate past developmental challenges?
3. As outlined in the report, *Communities in Action: Pathways to Health Equity,* areas of potential structural inequities (p. 7), include intrapersonal, interpersonal, institutional, and systemic mechanisms that guide allocation of resources along the lines of race, gender, class, sexual orientation, gender expression, and other dimensions of individual and group identity. Of these, which ones are particularly important in supporting or threatening positive adolescent development? What role does historical trauma play in health and development?
4. What does the science suggest about how systems (e.g., health, justice, education/higher education, child welfare) could be changed to improve the process and outcomes of adolescent development? How can systems recognize and support resilience, and promote adolescent agency and the development of positive youth assets to improve their services?

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

The central charge for the committee was to draw upon research from neurobiological and socio-behavioral science to highlight promising models, opportunities for translations, and policies to better support adolescents (see Chapters 2 through 4); identify research gaps (see Chapter 10); and develop evidence-based recommendations to key stakeholders serving adolescents and their families (see Chapters 6 through 9). Targets for these recommendations include government agencies and community institutions; federal, state, and local policy makers who guide the allocation of resources; and the research community. Taken together, these recommendations are intended to outline a vision in support of positive development for all adolescents.

Successful Development

In undertaking this task, the committee gave much thought to what successful maturation during adolescence entails or requires. How can we best ensure that all adolescents will flourish? A flourishing adolescent experiences high levels of emotional, psychological, and social well-being.[3] The psychological and philosophical literature identifies a range of possible indicators of flourishing, including happiness, satisfaction, behavioral flexibility, growth, and resilience in the aftermath of adversity (Fredrickson and Losada, 2005). Many of the current academic discussions of flourishing focus on how best to achieve it. The central challenge is to identify a core set of conditions or capabilities that need to be supported, such as bodily health, bodily integrity, and material control over one's environment (Nussbaum, 2003, 2011; Sen, 1993, 1999).[4]

The committee considered a range of capabilities that appear to be central to a flourishing adolescence and determined that the necessary conditions are good health, education, positive socialization, and the fostering of stable, supportive familial and caretaker relationships. Ultimately, the committee regards supporting and promoting flourishing during adolescence as essential for youth to transition into successful adulthood. This report therefore focuses on the youth-serving systems specifically tasked with supporting these capabilities—the health, education, child welfare, and justice systems—and discusses the role of families and neighborhoods in shaping experiences within those systems (see Chapters 6 through 9). While a number of other systems and system-level actors, ranging from religious institutions to law enforcement, also touch the lives of adolescents,

[3] Flourishing is a concept that originated in Aristotle's discussions of what it means to "do and live well," and it is embraced as an ideal by political philosophers and psychologists alike. See, for example, Keyes (2002, p. 210).

[4] For a useful summary, see https://plato.stanford.edu/entries/capability-approach/.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

the systems outlined in the committee's charge shape many of adolescents' experiences as they develop and transition into adulthood. Each of them has a profound obligation to implement evidence-informed policies and practices to enable all adolescents to flourish.

The Age Span of Adolescence

In order to interpret the scope of its charge, the committee, inevitably, needed to define the age span of "adolescence." At the lower boundary, it is generally accepted that the onset of puberty—at approximately ages 10 to 12—signals the beginning of the developmental processes of adolescence. The more consequential question for the committee's work concerns the upper bound of adolescence. On the one hand, the unique period of brain development and heightened brain plasticity at the heart of the committee's charge continues into the mid-20s. On the other hand, the socio-emotional changes associated with adolescence (e.g., forming relationships with peers and adults and developing personal identity) occur largely during the teenage years and, in everyday life, graduation from high school and leaving the family home, mark a fairly distinct social transition to "young adulthood," typically signified by the 18th birthday (the legal "age of majority"). However, as explained in a recent National Academies report, most 18–25 year-olds experience a prolonged period of transition to *independent* adulthood, a worldwide trend that blurs the boundary between adolescence and "young adulthood," developmentally speaking.

With these considerations in mind, the committee interprets its charge to encompass youth ages 10 to 25. While there is a growing recognition that young adulthood is a critical life stage in itself, especially in educational and occupational terms, for the purposes of this report, the committee encompasses young adulthood within a broad conception of adolescence. While older adolescents (or young adults) differ greatly in their social roles and tasks from younger adolescents, it would be developmentally arbitrary in developmental terms to draw a cut-off line at age 18.

Although the committee has interpreted its charge as one including young adults (ages 18 to 25), it focuses most of its attention on the needs of adolescents ages 10 to 18), typically those living with their families and attending secondary schools. Thus, some chapters (Chapters 6, 8, and 9) clearly center on a subset of the population, typically because of legal definitions. In Chapters 6 and 9, for example, we focus on secondary schools and the juvenile justice system instead of higher education and the criminal justice system—although both chapters discuss the latter systems to a lesser degree. Because higher education (including technical education) and the criminal justice system are designed to serve individuals of all ages and to effectuate much more complex social purposes than specifically serving ado-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

lescents, the committee does not focus the majority of its recommendations on these systems. Moreover, this committee was not constituted to take on the challenges of reforming criminal justice and higher education, notwithstanding the observation that young adults ages 18 to 25 may sensibly be characterized as adolescents from a developmental point of view. (For further understanding of the need to invest in the health and well-being of young adults, see *Investing in the Health and Well-being of Young Adults* (Institute of Medicine and National Research Council, 2014).)

Even within the period of adolescence, much of the literature uses different terms for different phases or stages. In this report, the committee refers to adolescence as encompassing four periods—early adolescence (ages 10 to 12), middle adolescence (ages 13 to 15), late adolescence (ages 16 to 18), and young adulthood (ages 19 to 25). Figure 1-1 visually depicts these periods as shading into one another around these ages, recognizing that they are fluid and based, in part, on socially constructed transition points (e.g., from elementary to secondary school and so on).

The Life-Course Perspective

The well-being of adolescents is shaped by experiences during the prenatal and early childhood years. Fortunately, the prenatal and early childhood periods are already widely recognized to be sensitive times for development. Over the past several decades large-scale investments in supports for young children—such as Early Head Start, Head Start, and home visiting programs—have contributed to broader public awareness of the importance of prenatal and early childhood development in achieving positive outcomes for all young children. Of course, more can be done, as far too many young children enter adolescence bearing the scars of childhood adversity, including toxic stress, exposure to environmental toxins, child maltreatment, food insecurity, and limited access to high-quality early care and education.

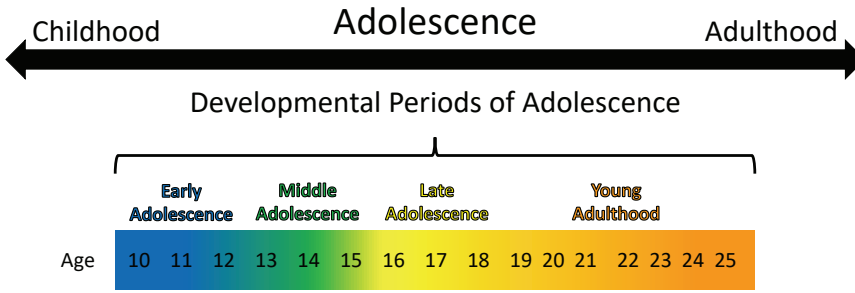


FIGURE 1-1 Developmental periods of adolescence.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

A companion National Academies' study on applying the neurobiological and socio-behavioral science concerning prenatal through early childhood development was under way to address these issues during the time of this committee's investigations.[5] The resulting report discusses programs and policies designed to mitigate adverse prenatal and early childhood conditions during a child's earliest years. In accordance with our charge, this committee discusses how early life conditions, including supports and adversity, can affect adolescent development and how past developmental challenges may be mediated in adolescence (see Chapter 3). Taken together, the two reports take a life-course perspective, arguing that a strong infrastructure for young children should be extended throughout adolescence to nurture positive development for all children from birth to adulthood.

HISTORY OF ADOLESCENCE

Popular understanding of adolescence as a distinct period of neurobiological and socio-emotional development and of the duration of that period has evolved over time, shaped by social and cultural change. The first use of the word "adolescence" appears to have occurred in the 15th century, the word being derived from the Latin *adolescere*, meaning "to grow up or to grow into maturity." However, the word and the concept only gained widespread popular use at the turn of the 20th century, first in the United States and later in other Western countries. Psychologist G. Stanley Hall characterized adolescence as a "new" developmental phase resulting from social changes brought about by the industrial revolution and the introduction of public schooling occurring during the Progressive era, when reformers were advocating for compulsory education and legal restrictions on child labor (Arnett and Cravens, 2006; Hall, 1904). Yet nearly 90 years after Hall's observations, anthropologists Alice Schlegel and Herbert Barry documented evidence that the vast majority of pre-industrial societies throughout human history appear to have recognized a period that corresponds to adolescence, that is, a period when a person is no longer a child but is not yet an adult (Schlegel and Barry, 1991). More recently, anthropologists Carol Worthman and Kathy Trang have documented the biological-social mismatch that has been associated with increasingly younger ages of physical maturation accompanied by older ages of social maturation around the world, pointing to an increasingly globalized cultural construction of adolescence (Worthman and Trang, 2018).

[5] For more information on the Committee on Applying Neurobiological and Socio-behavioral Sciences from Prenatal through Early Childhood Development: A Health Equity Approach, see www.nationalacademies.org/earlydevelopment.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

While a period of adolescence may have been recognized across time and culture, and a global understanding may now be emerging (Worthman and Trang, 2018), Hall's observations a century ago about the impact of the industrial revolution in the United States are still salient. Taking young people out of the workplace and placing them in schools erased the expectation that young teens would become "bread earners" and, instead, prolonged their dependence on their parents and families. Moreover, this change gave them an opportunity to form their own peer groups. A side effect of this change was the opportunity for adolescents to experience a period of social development and freedom without the responsibilities of adulthood.

Spurred by post-World War II economic expansion, as of mid-century a discernible youth culture had emerged in the United States, defined by distinct youth styles, behaviors, and interests. The latter half of the 20th century saw the rise of youth engagement in and creation of social and political movements, including student-led civil rights protests, anti-Vietnam War protests, and divestment and anti-apartheid initiatives, through which adolescents exerted agency and actively sought to change the contexts in which they lived.

Beginning in the late 20th century and into the early 21st century, society began to recognize the emergence of "young adulthood," sometimes thought of as an extension of adolescence. In *Investing in Young Adults* (2014), a committee of the National Academies suggested that young adulthood should be viewed as a distinct developmental period, reflecting the social and economic developments that have prolonged the transition to independent adulthood. For the purposes of this report, however, our committee encompasses young adulthood within a prolonged period of adolescence.

The 21st-century blurring of the age of adulthood reflects a larger point: that conceptions of when and how adolescence begins and ends are, in part, socially constructed and vary across time and place. Currently, we understand adolescence as beginning with the onset of puberty and ending when young people take on various socially defined tasks signifying adulthood. Due to trends toward earlier onset of puberty and changing societal dynamics around the commencement of adulthood, adolescence, which once lasted only a matter of years, is now conceived as a much longer period—lengthened at the beginning by the earlier onset of puberty and at the end by the increasingly protracted transition of young people into careers, marriages, and financial independence (Steinberg, 2014).

Ideas about the upper boundary of adolescence are also socially determined. They are connected to familial, social, legal, and cultural expectations regarding what it means to be an adult, and the point in time when youth "become adults" may be, and historically has been, defined in a

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

variety of ways.[6] Today, included among the tasks signifying a successful transition to adulthood are completing postsecondary education, gaining financial independence, starting a career, and getting married. It is therefore of real consequence that these milestones are continually shifting. For example, Americans were delaying marriage, on average, until the age of 29 as of 2011; delaying child bearing, with the median age of first birth for females being 26.7, in 2015; and looking to their parents for continued financial support, with over half of 18–24-year-olds living with their parents in 2015.

With the onset of puberty happening earlier and earlier and marriage occurring later and later, adolescence in the United States now lasts roughly 15 years. While this lengthening has increased for all Americans, there is great variation in how the period has elongated. Puberty is most often beginning earlier among the nation's poorest children, while the transition to adulthood is increasingly delayed for more affluent adolescents, who are more likely to pursue higher education and delay marriage and parenthood (Steinberg, 2014). This pattern is extremely important, because early life experiences, including social risks and disadvantages, have been shown to lower the age of pubertal timing, whereas delayed adulthood elongates the period of novel experiences and learning. As a result, longer adolescence benefits the privileged far more than the underprivileged (Steinberg, 2014, p. 177).

CONTEMPORARY ADOLESCENTS

Today's adolescents are growing up in remarkable times. At least since the industrial revolution of the 18th and 19th centuries, each new generation has faced a progressively modernizing world with changing expectations and opportunities for young people (e.g., see Modell, 1991). This appears to be accelerating, as adolescents in the 21st century are experiencing sometimes dramatic shifts in the social, cultural, economic, and technological environments. As they navigate their adolescent years and emerge into adulthood, demographic shifts are altering community and family life in fundamental ways. For example, today's youth population in the United States is more culturally and ethnically diverse than ever before, while at the same time

[6] For example, legal rights associated with adulthood vary in age both across and within societies. In the United States, society imposes different legal ages for driving (ranging from ages 14 to 17 among some U.S. states, with a range of restrictions on driving and age to receive full license across states), military service (age 18, or 17 with parental consent), marriage (typically age 18, with some states allowing marriage at younger ages with parental or judicial consent), voting (typically age 18, or in recent years, 16 in some countries and U.S. localities), and drinking alcohol (age 21 in the United States. but younger in many other countries). Each of these has been in some way and in certain times a marker of adulthood.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

inequalities in income and opportunity among youth continues to increase. Perhaps no societal development will have a greater impact on the lives and well-being of adolescents in the 21st century than the digital revolution. Finally, although it is still too early to predict the precise effects, the polarization and intensity of political discourse in the United States and what appears to many young people as a battle for national identity are bound to have a long-term impact on current and future cohorts of adolescents.

Demographic Trends

Adolescents currently represent nearly one-fourth of the entire U.S. population. According to the Census Bureau, there were approximately 73.5 million adolescents ages 10 to 25 in 2017, representing 22.6 percent of the U.S. population (U.S. Census Bureau, 2018b).[7] While in raw numbers the size of the adolescent population has grown recently, it is now declining slightly as a proportion of the population (U.S. Census Bureau, 2018b). Based on a projected continued decline in fertility as well as the continued aging of the population, this trend is likely to continue for several more decades (Colby and Ortman, 2014). According to U.S. Census projections, youth (10 to 24 years old) are expected to comprise about 18 percent of the population in 2040.[8] Immigration is projected to slow a little as well, although the percentage of the population that is foreign-born is expected to rise, albeit more slowly than it has been rising in recent years (Colby and Ortman, 2014).

The composition of the U.S. population overall, as well as among adolescents, has also become more racially and ethnically diverse; the U.S. population as a whole is expected to become minority majority, that is, with more than half belonging to a category other than non-Latinx White alone, by 2044 (Colby and Ortman, 2014). Because this is expected to occur more quickly among children under 18, the crossover from minority

[7] Although females outnumber males at older ages, males in this age range constitute a very slight majority (51%) (U.S. Census Bureau, 2018b). In the 2010 Census, 56 percent of 10–24-year-olds were non-Latinx White, 21 percent were Latinx (of any race), 14.5 percent were Black or African American, 4.6 percent were Asian, 2.6 percent reported two or more races, and less than 1 percent each were American Indian/Alaskan Native and Native Hawaiian/Pacific Islander (U.S. Census Bureau, 2018a). Just over 90 percent of adolescents are native-born; the remainder are a mix of naturalized citizens and both documented and undocumented immigrant non-citizens (U.S. Census Bureau, 2012). More than one-quarter of children in the United States had at least one foreign-born parent in 2014; 22 percent were second generation, that is, native-born but with at least one foreign-born parent (Child Trends, 2014).

[8] In 2040, it is estimated that there will be 66.1 million adolescents (10–24-year-olds) in the United States, or roughly 18 percent of the population. (See Table 3, National Population Projects Tables, U.S. Census, 2017, https://www.census.gov/data/tables/2017/demo/popproj/2017-summary-tables.html).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

to majority of the population for adolescents ages 10 to 25 should occur much sooner, by 2020.

These broad trends intersect with several other key aspects of adolescents' lives that are changing due to demographic trends in the overall population: the socioeconomic status of their families, and thus their own status; how and where they live, including not only migration but also the family and institutional structures they live in; and the shifting landscape of their education as well as their employment and work experiences (adolescents' education and employment are discussed in detail in Chapter 6).

For most adolescents, socioeconomic status is linked to the status of their families. Poverty rates for families have been dropping in recent years following the Great Recession, falling from 13.2 percent in 2010 to 10.3 percent in 2017 (Fontenot et al., 2018). Poverty rates vary substantially across racial/ethnic groups, with 6.3 percent of non-Latinx White families, 7.7 percent of Asian families, 16.9 percent of Latinx families, and 19.0 percent of Black families living below the poverty line in 2017. Single-mother families have especially high rates of poverty, at almost 28 percent; one-third of Black and Latinx single-mother families were in poverty in 2017.

Youth today are also more likely to live in urban areas than in the past, a trend that has been observable for adolescents over the past 35 years. Data from the Monitoring the Future (MTF) surveys,[9] which ask adolescents where they mostly grew up, shows a decline in the percentage of those reporting that they grew up on a farm or in the country, from 24.7 percent in 1976 to 16.5 percent in 2012 (Bachman et al., 1980, 2014). More adolescents have reported over time that they were living in cities or in suburbs of medium-sized cities (fewer than 100,000 people). White adolescents are much more likely to report living or having grown up on farms or in the country than are Black adolescents, and also more likely to report living in small cities or suburbs; Black adolescents report living in medium, large, or very large cities more often.

Technology and the Digital Revolution

These demographic and social changes are happening alongside and often intertwined with an extraordinarily fast-paced changing world of technology, all in the context of shifting political and economic change. Through the Internet and social media, youth have broad access to information and ideas in ways that were never before possible, giving rise to new forms of digital community among youth, as well as new forms of social

[9]The Monitoring the Future surveys are funded by the National Institute on Drug Abuse. MTF is an ongoing study of the behaviors, attitudes, and values of American secondary schools students, college students, and young adults.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

action and interaction. An example of the latter is the leading role youth have taken in social movements in response to gun violence. Taken together, these broad trends have global as well as local impacts and make up the broader context for the typical developmental changes that characterize the period of adolescence for all youth.

For adolescents, the technological and digital revolution have become a key context of their development, permeating nearly every aspect of their lives. In a recent survey conducted by the Pew Research Center, researchers found that approximately 76 percent of adolescents surveyed use social media, with 45 percent indicating that they are almost always online, whether by phone or computer. When these numbers are broken down by gender and race and ethnicity, they show that girls were more likely than boys (50% vs. 39%) to identify as being "almost constantly" online, as were Latinx youth when compared to Whites (54% vs. 4%) (Anderson and Jiang, 2018).

Given adolescents' near-constant interaction with digital technology, it is important to understand the ways in which this engagement may present opportunities for positive development, as well as potential risks. For example, engagement online and with digital media may help adolescents achieve a healthy level of autonomy by providing opportunities to associate with peers and cultures they might not otherwise encounter in their daily lives, opening the door to new interests (e.g., music, writing, coding, sports), which could benefit them as they move into adulthood (Boyd, 2014; Ito et al., 2008). This type of engagement can also provide a new way for youth to build social networks. LGBTQ youth, for example, are able to connect with each other and build supportive and empowering communities in ways that were unavailable to previous generations (Hammack, 2018). Further, in addition to forming new relationships, research suggests that online contact among young people's existing social networks reinforces the bonds that are made offline, making them feel more connected and supported by their peers and families (Uhls et al., 2017).[10]

Notwithstanding the many worries that have been expressed about the possible detrimental effects of social media consumption on overall adolescent well-being, strong evidence documenting such effects has not yet emerged (Orben and Przybylski, 2019). Some specific reasons for concern are generally acknowledged, however. In recent years, bullying has been

[10] While much of popular reporting today suggests that adolescents' use of digital and social media may be creating tension between parents and youth, research is mixed about the impact of technology on family relationships. While some research has found that technology may create a barrier and limit communication with parents, there is also evidence that the use of social media, texting, and other communication technologies may offer new ways for parents and children to relate and communicate (Lee, 2009; Schwartz et al., 2014; Subrahmanyam and Greenfield, 2008).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

increasingly moving from the schoolyard to the Internet. While previous generations could usually find refuge once at home, the public nature of cyberbullying makes it difficult for youth to escape, which in turn can increase the risk of mental health issues such as depression and anxiety (National Academies of Sciences, Engineering, and Medicine, 2016). According to a recent study on adolescent well-being and social media, an adolescent's ability to cope with bullying plays a significant role in social media's overall impact on well-being (Schwartz et al., 2014; Subrahmanyam and Greenfield, 2008; Weinstein, 2018).

Adolescents are also at risk of negative consequences when sharing information online. Whereas in previous generations, such actions were often easily forgotten in time, for today's youth online personal histories become part of that person's digital footprint, which often remains connected to their name long after an initial posting (Madden et al., 2007). Laws such as the Privacy Rights for California Minors in the Digital World help by giving adolescents under age 18 the right to remove posted material, but not all states provide such protection (Costello et al., 2016). The federal Children's Online Privacy Protection Act (COPPA) of 1998 also provides some protection, but only for youth under age 13.

The rapidly changing nature of communications technology and the influx of digital media will continue to shape young people's development, and this context for development presents both opportunities and potential risks, making understanding the role of technology in adolescents' lives a critical area of future research; see Chapter 10. Moreover, technology presents another context with the potential to increase inequities as not all youth have access to the benefits of digital technologies, such as youth from low-income or rural households who may be unable to access high-speed Internet at home (Anderson and Perrin, 2018).

Civic Engagement

Another potentially significant trend among 21st-century adolescents in the United States is a burst of civic engagement, somewhat reminiscent of the period of dissent during the Vietnam conflict and the Civil Rights Movement in the 1960s and 1970s. Youth today are engaging in multiple forms of "participatory politics" to amplify their voices on issues of public concern, and increasingly they are doing so through digital media (Cohen, et al., 2012). Indeed, young people are exercising agency and capitalizing on technology as a new forum for political engagement (Finlay et al., 2010; Smith, 2013). In a recent Pew Research Center survey, two-thirds of all 18–24-year-olds reported participating in some sort of political activity in social networking spaces during the past 12 months (Smith, 2013). Young people have been major contributors to the Occupy movement and other

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

attempts to raise awareness about inequality and promote policies that support greater equity. Through movements such as Black Lives Matter, which encompasses intersecting axes of racial and economic oppression, young people are at the forefront of advancing an intersectional approach to combatting systemic inequity and discrimination. Political organizing for school safety and reducing gun violence is another recent example.

Volunteering to serve others is another measurable indicator of civic engagement. Among 8th, 10th, and 12th graders in the MTF surveys, 27.1 percent, 34.4 percent, and 38.8 percent (respectively) reported volunteering at least once per month in 2015 (Child Trends, 2015). However, rates of volunteering and other forms of civic behavior tend to drop when young people enter their early twenties and are no longer enrolled in high schools or colleges (Finlay et al., 2010). Similarly, 18–24-year-olds' voting rates are consistently lower than those of older age groups, although early analyses of returns from the 2018 election show increased rates (File, 2014; Langer and Siu, 2018).

Much like the patterns observed among adults, for whom civic engagement is positively correlated with educational attainment, adolescents who plan to complete 4-year college degrees are more civically involved than those with plans for 2-year degrees or no higher education, as are those whose parents have higher levels of education (Syvertsen et al., 2011). Notably, this gap has been growing since the early 1990s (Syvertsen et al., 2011). Wray-Lake and Hart (2012) report a growing gap specifically in voting behavior by education level across cohorts, but not in other conventional political activities (such as attending meetings, donating money, working for a campaign, or wearing a button for a candidate). Females and minorities of all ages are less likely to engage in political activities (other than voting), although holding socioeconomic status and other demographic characteristics constant, Blacks have higher levels of political participation than do Whites (Fisher, 2012). Despite patterns of lower levels of political engagement among members of historically marginalized groups, in the United States there has been a recent uptick in the number of women, openly LGBTQ+ people, and (importantly for this report) young people elected to political positions (Caron, 2018; DeSilver, 2018).

In summary, the explosion of new communication technologies and the positive as well as compromising possibilities they offer, together with the shifting access to and demands for civic engagement that are now emerging, not only comprise key contexts shaping adolescents' lives today but also suggest the agency of young people. In each context, adolescents are themselves actively influencing change in their lives and communities, while at the same time shaping the experiences and environments of their development.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

THE PROMISE OF ADOLESCENCE

Having reviewed the background and context for the report as well as the characteristics of 21st-century adolescents and the world they inhabit, we return now to the committee's basic assignment and the core themes of the report.

Adolescence is a developmental stage in which heightened neurosensitivity and normative changes in neural and hormonal development intersect with changes in young people's social, technological, and cultural environments, opening a critically important gateway to adulthood. Brain development is complex and ongoing throughout childhood and adolescence, with different parts of the brain experiencing major changes at different times. The nature of these changes—in brain structures, functions, and connectivity—and the developmental plasticity unique to this period of life—present remarkable opportunities for learning and growth as well as amelioration of the harmful effects of childhood exposures.

While humans retain a baseline level of neuroplasticity required for experience-based learning throughout their lives, adolescent brain circuitry is exceedingly adaptable and "experience-dependent," which means that adolescents are specially primed to learn from their particular circumstances and environments during this period (Fuhrmann et al., 2015). (See Chapter 2 for a full discussion of the developing adolescent brain.) In addition to being a period of profound cognitive transformation, adolescence is also a time of numerous biological, psychosocial, and emotional changes (see Chapter 2). The changes in the body, the brain, and behavior occurring during adolescence are interrelated and interact with one another and with the environment to shape the adolescents' pathways to adulthood.

Because pubertal, neurological, cognitive, and psychosocial changes are occurring, adolescence is a critical period of opportunity to shape developmental trajectories. With this growth and learning, each new experience is an opportunity for the adolescent to discover new interests, develop new skills, and otherwise flourish. This heightened sensitivity and responsiveness to environmental influences also suggests that adolescence is a period during which interventions—at both the individual and societal levels—may be used to redirect and remediate maladaptation in brain structure and behavior from earlier developmental periods, that is, to achieve resilience (see Chapter 3). Adolescence therefore holds great promise to realize positive trajectories for all youth.

THE POLITICAL CHALLENGE

Here, then, lies the political challenge. How does a caring society take advantage of this critical developmental opportunity in a world character-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

ized by substantial—and worsening—disparities in resources, safety, social supports, and other necessary conditions of well-being for children and adolescents? Widening income and wealth inequality in the United States has placed individuals and families that are at the lower end of the socioeconomic distribution at a historically great distance from those at the top end of the distribution (Chetty et al., 2017; Piketty and Saez, 2014). Economic inequality poses unique challenges to young people across the socioeconomic distribution and is also strongly associated with other measures of inequality.

It is well documented that economic inequality strongly influences the opportunities available to adolescents from lower socioeconomic backgrounds. Greater inequality often accompanies more severe residential segregation, such that young people from families with lower incomes and less wealth, and often families from nondominant racial groups, live in communities that are increasingly isolated and separated from economic and educational opportunities (Ananat, 2011; Oliver and Shapiro, 2006; Owens, 2016; Quillian, 2014; Reardon and Bischoff, 2011). In addition to this unequal and reduced access to resources, inequality contributes to the way young people perceive themselves, their place in the world, and the possibilities for their futures.

It is now understood that these inequalities shape individuals' developmental trajectories by "getting under the skin." For example, adolescents living in poverty often experience heightened levels of stress, which can lead not only to short-term changes in observable behavior but also to long-lasting changes in brain structure and function and in connectivity within the brain (see Chapter 3). While some of these changes may help an adolescent adapt to their particular social and physical environment, they may also make it more difficult to function in another environment should conditions change. In this way, key experiences interact with fundamental neurobiological processes to shape developmental trajectories.

The salience of environmental influences in shaping development during adolescence, together with the critical developmental importance of adolescence, make a powerful case for remedial action. The nation should ensure that all adolescents have a genuine opportunity to flourish, not only as an expression of a collective sense of justice but also as an investment in the nation's future.

STUDY METHODS

To understand the science of adolescent development and its applications, the committee reviewed the existing research literature in disciplines such as neuroscience, developmental and social psychology, adolescent health and medicine, and education and learning. To understand the roles,

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

structures, policies, practices, and effects of social systems, we also reviewed pertinent research in social and behavioral sciences, law, and public policy. The committee held four in-person meetings and conducted additional deliberations by teleconference and electronic communications during the course of the study. The first and second in-person meetings were information-gathering meetings during which the committee heard from a variety of stakeholders, including the study's sponsors, youth, researchers and scholars, and policy makers from the federal, state, and local levels. The third and fourth meetings were closed to the public to enable the committee to deliberate and to formulate its conclusions and recommendations.

Recognizing that the lived experience of young people represents an important form of evidence itself, the committee sought to hear the voices of young people in a variety of ways. First, the committee invited six adolescents from a range of backgrounds to speak at a public session in June 2017. These young people described their experiences in the foster care and juvenile justice systems as well as the health and education systems, commented on the impact on their lives of ever-changing access to technology and social media, and reflected on their hopes for the future. Second, the committee commissioned an analysis from the University of Michigan's My Voice program to understand adolescents' own perceptions of this period of life as well as their perspectives on inequality in their communities.[11] Finally, the committee invited the Maryland Youth Advisory Council to assemble a "youth reflection panel" to comment on possible committee recommendations. In the course of all of these activities, the committee heard from youth about their priorities for the future and the greatest challenges they currently face. The insights the committee garnered from these activities are included throughout the report in text boxes highlighting "Youth Perspectives" as well as in Appendix B.

ORGANIZATION OF THE REPORT

The committee's report is organized into two parts and 10 chapters. Part I conveys the scientific findings that serve as a foundation for the report. Following this introduction, Chapter 2 summarizes the scientific literature on adolescent development, including biological, neurological, and socio-behavioral changes that show why we characterize adolescence as a period of opportunity. Chapter 3 describes the emerging science of epigenetics and the ways in which the brain, body, and environment interact to shape life-course trajectories. Chapter 4 concludes Part I by summarizing the evidence bearing on the extent to which different groups of ado-

[11] MyVoice is a text-message based survey of 1,480 young people (ages 14 to 24) across the United States. The program's methodology is described in DeJonckheere et al. (2017).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

lescents are—and are not—achieving important developmental outcomes and highlights variations in achievement among different subpopulations of youth, posing the fundamental challenge we were asked to address—how can deploying knowledge of adolescent development help us rectify these disparities?

Part II begins with Chapter 5, which introduces the concept of using developmental knowledge to assure opportunity for all youth. Chapters 6, 7, 8, and 9 then focus on four key youth-serving systems—education, health, child welfare, and justice—in order to answer the question that lies at the heart of our charge: How can these systems be changed to help all adolescents flourish? Each of these chapters also discusses the ways in which families, neighborhoods, and communities can most successfully interact with each system to improve the process and outcomes of adolescent development.[12] Finally, Part II concludes with Chapter 10, in which the committee outlines several priorities for research on adolescent development.

[12] Appendix A explains the committee's approach to assessing the evidence. Appendix B summarizes the committee's activities to hear from adolescents themselves and to learn from their lived experiences. Appendix C provides biographical sketches of the committee's members and staff.

Copyright National Academy of Sciences. All rights reserved.

2

Adolescent Development

Adolescence is a period of significant development that begins with the onset of puberty[1] and ends in the mid-20s. Consider how different a person is at the age of 12 from the person he or she is at age 24. The trajectory between those two ages involves a profound amount of change in all domains of development—biological, cognitive, psychosocial, and emotional. Personal relationships and settings also change during this period, as peers and romantic partners become more central and as the adolescent moves into and then beyond secondary school or gains employment.

Importantly, although the developmental plasticity that characterizes the period makes adolescents malleable, malleability is not synonymous with passivity. Indeed, adolescents are increasingly active agents in their own developmental process. Yet, as they explore, experiment, and learn, they still require scaffolding and support, including environments that bolster opportunities to thrive. A toxic environment makes healthy adolescent development challenging. Ultimately, the transformations in body, brain, and behavior that occur during adolescence interact with each other and with the environment to shape pathways to adulthood.

Each stage of life depends on what has come before it, and young people certainly do not enter adolescence with a "blank slate." Rather, adolescent development is partly a consequence of earlier life experiences. However, these early life experiences are not determinative, and the adaptive plasticity of adolescence marks it as a window of opportunity for change

[1]The average child in the United States experiences the onset of puberty between the age of 8 and 10 years.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

through which mechanisms of resilience, recovery, and development are possible. (Chapter 3 discusses this life-course perspective on development in detail.) This chapter explores three key domains of adolescent development: puberty, neurobiological development, and psychosocial development. Within each domain, we highlight processes that reflect the capacity for adaptive plasticity during adolescence and beyond, marking adolescence as a period of unique opportunity for positive developmental trajectories.

PUBERTY

Puberty, a normative developmental transition that all youth experience, is shaped by both social and biological processes. Although often misconstrued as an abrupt, discrete event, puberty is actually a gradual process occurring between childhood and adolescence and one that takes many years to complete (Dorn and Biro, 2011). Biologically, puberty involves a series of complex alterations at both the neural and endocrine levels over an extended period that result in changes in body shape (morphology), including the maturation of primary and secondary sex characteristics during late childhood and early adolescence and, ultimately, the acquisition of reproductive maturity (Dorn and Biro, 2011; Natsuaki et al., 2014).

Two biological components of puberty, *adrenarche* and *gonadarche*, are relevant in understanding the link between puberty and adolescent well-being. Adrenarche, which typically begins between ages 6 and 9, refers to the maturation of the hypothalamic-pituitary-adrenal (HPA) axis, during which the levels of adrenal androgens (e.g., dehydroepiandrosterone and its sulfate) begin to increase. While adrenarche begins in late childhood, levels of adrenarchal hormones continue to rise throughout adolescence, peaking in the early 20's (Blakemore et al., 2010). Adrenal androgens contribute to the growth of pubic and axillary hair. Gonadarche typically begins in early adolescence, at approximately ages 9 to 11, and involves the reactivation of the hypothalamic-pituitary-gonadal (HPG) axis (for a review, see Sisk and Foster, 2004).[2] The rise of gonadal steroid hormones to adult levels occurs as a result of HPG reactivation and is primarily responsible for breast and genital development in girls.

[2]HPG hormones can bind within cell nuclei and change the transcription and expression of genes to regulate further hormone production, brain function, and behavior (Melmed et al., 2012; Sisk and Foster, 2004). The process begins in the brain when a gonadotropin-releasing hormone (GnRH) is secreted from the hypothalamus. The activation of GnRH is not unique to the pubertal transition; GnRH is also active during pre- and perinatal periods of development but undergoes a quiescent period during the first year of postnatal life until it reawakens during the pubertal transition. GnRH stimulates the pituitary gland to secrete luteinizing hormone (LH) and follicle-stimulating hormones (FSH), which then stimulate the ovary and testes to secrete estradiol and testosterone.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

The consequence of these complex changes in HPA and HPG axes at the neuroendocrine level is a coordinated series of visible, signature changes in body parts. These include a growth spurt, changes in skin (e.g., acne) and in body odor, the accumulation of body fat (in girls), the appearance of breast budding (in girls) and enlargement of testes and increased penis size (in boys), the growth of pubic and axillary hair, the growth of facial hair (in boys), and the arrival of the first period (i.e., menarche, in girls). Key pubertal events are highlighted in Figure 2-1; however, as discussed next, there is a great deal of variation in the timing and tempo of these events.

It is useful to distinguish three distinct yet interrelated ways to conceptualize individual differences in pubertal maturation. *Pubertal status* refers to how far along adolescents are in the continuum of pubertal maturation at any given moment. For instance, if an 11-year-old girl has just experienced menarche, she is considered to have advanced pubertal status because menarche is the last event that occurs in the process of the female pubertal transition. Pubertal status is inherently confounded with age, because older adolescents are more likely to have attained advanced pubertal status.

Pubertal timing, on the other hand, refers to how mature an adolescent is when compared to his or her same-sex peers who are of the same age. In other words, pubertal timing always includes a reference group of one's peers. For example, a girl who experiences menarche at age 10 may be an earlier maturer in the United States, because her menarcheal timing is earlier than the national average age for menarche nationwide, which was found to be 12.4 years in a cohort of girls born between 1980 and 1984 (McDowell et al., 2007). Only 10 percent of girls in the United States

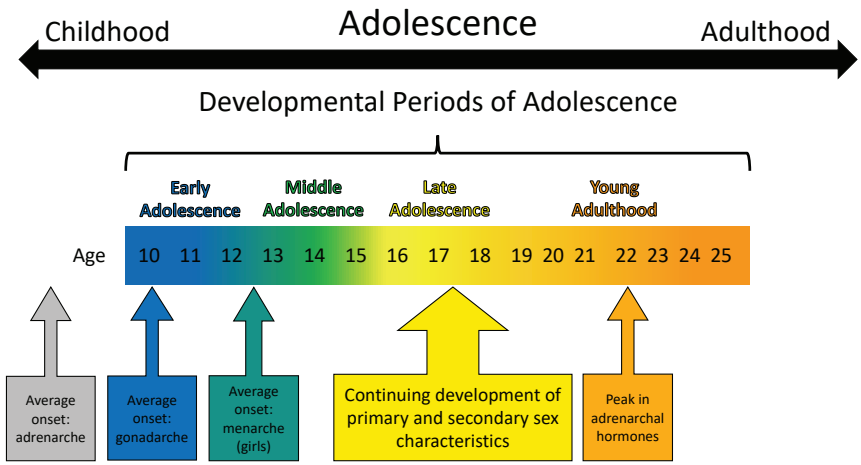


FIGURE 2-1 Key pubertal events across adolescence.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

are estimated to have experienced menarche before 11.11 years of age (Chumlea et al., 2003), suggesting that the girl in this example would be considered to have early pubertal timing. Unlike pubertal status, pubertal timing is not confounded by age because, by definition, pubertal timing is inherently standardized within same-sex, same-age peers typically residing in the same country.

Pubertal tempo is a within-the-individual metric that refers to how quickly a person completes these sets of pubertal changes. For example, some boys may experience a deepening of their voice and the development of facial, axillary, and pubic hair all within a matter of months, whereas other boys may have a gap of several years between voice-deepening and the development of facial hair. Pubertal tempo has gained more attention recently with the rise of sophisticated longitudinal methodology and the resulting availability of longitudinal data on pubertal maturation (e.g., Ge et al., 2003; Marceau et al., 2011; Mendle et al., 2010).

Regardless of the metric used, most of the research on adolescent pubertal development has focused on girls. We know comparatively little about the processes, correlates, and outcomes of pubertal maturation in boys, except for the well-replicated findings that girls typically begin and complete puberty before boys. Evidence is now emerging that the relationship between puberty and structural brain development in the amygdala and hippocampus region may differ by sex (Satterthwaite et al., 2014; Vijayakumar et al., 2018). These sex differences in associations between brain development and puberty are relevant for understanding psychiatric disorders characterized by both hippocampal dysfunction and prominent gender disparities during adolescence.

It is also important to consider the pubertal development of transgender and gender-nonconforming youth. Transgender and gender-nonconforming individuals usually identify as a gender other than the one they were assigned at birth (Sylvia Rivera Law Project, 2012). Individuals who are gender-nonconforming may identify as transgender, genderqueer, genderfluid, gender-expansive, or nonbinary. Puberty is a time that can be enormously stressful, and the fear of developing—or the actual development of—secondary sexual characteristics that do not match a child's gender identity can be intense and even destabilizing (de Vries et al., 2011). Some transgender and gender-nonconforming youth might take medications that block puberty. Although puberty blockers have the potential to ease the process of transitioning, the long-term health effects of these drugs are not yet known (Boskey, 2014; Kreukels and Cohen-Kettenis, 2011).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

The Role of Early Experiences on Pubertal Timing and Tempo

As noted earlier, the timing and rate of pubertal development vary greatly. The age at which someone matures is due to a combination of genetic and environmental influences (e.g., Mustanski et al., 2004). Early life experiences, including social risks and disadvantages, have been shown to accelerate pubertal tempo and lower the age of pubertal timing (Marshall and Tanner, 1969). Specifically, accelerated pubertal tempo and early pubertal timing have been associated with stressors, including childhood sexual abuse and physical abuse, obesity, prematurity, light exposure, father absence, and exposure to endocrine disruptors (such as chemicals in plastics, pesticides, hair-care products, and many meat and dairy items) (see e.g., Steinberg, 2014, pp. 54–55). This section reviews the literature on associations between these early experiences and normative variations in pubertal timing and tempo. We close this section with a brief discussion of these associations as a marker of adaptive plasticity.

Maltreatment

One of the most widely studied early experiences related to pubertal development is child maltreatment, and in particular, sexual abuse. A series of studies shows that the age of menarche tends to be lower for girls who experienced child sexual abuse as compared to girls who have not experienced this (Bergevin et al., 2003; Natsuaki et al., 2011; Romans et al., 2003; Turner et al., 1999; Wise et al., 2009). Trickett and Putnam (1993) suggested that the trauma of child sexual abuse introduces physiological as well as psychological consequences for children, including accelerated maturation by premature activation of the HPA and HPG axes. In addition, some studies have observed a relationship between childhood physical abuse and early maturation, though less robustly and less consistently than for sexual abuse (Bergevin et al., 2003; Wise et al., 2009), and these studies do not always control for the possibility of concurrent sexual abuse (e.g., Romans et al., 2003).

In one of the few studies to examine pubertal development longitudinally in adolescents with maltreatment histories, Mendle and colleagues (2011) followed a sample of 100 girls in foster care at four points in time over 2 years, beginning in the spring of their final year of elementary school. The previously established association between sexual abuse and earlier onset of maturation and earlier age at menarche was replicated, and in addition, physical abuse was found to be related to a more rapid tempo of pubertal development. A recent longitudinal study of 84 sexually abused girls and matched-comparison girls replicated the association between sexual abuse and earlier pubertal onset (including breast development and pubic

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

hair; Noll et al., 2017). Further, using this same sample, childhood sexual abuse predicted earlier pubertal development which, in turn, was associated with higher levels of internalizing symptoms such as depression and anxiety concurrently and 2 years later (Mendle et al., 2014). A third study with this sample found that earlier-maturing girls were more anxious in the pre- and peri-menarche periods than their later-maturing peers; however, their anxiety declined after menarche, suggesting a time-limited effect on mental health and the potential for recovery upon completion of pubertal maturation, as girls enter later adolescence (Natsuaki et al., 2011).

The association between sexual abuse and earlier pubertal development was recently replicated using a large population-based sample of adolescents, the National Longitudinal Study of Adolescent Health[3] (N = 6,273 girls). In that study, child sexual abuse predicted earlier menarche and development of secondary sexual characteristics, whereas other types of maltreatment did not (Mendle et al., 2016). The distinctive role for early pubertal timing suggests that the heightened sexual circumstances of puberty may be especially challenging for girls whose lives have already been disrupted by adverse early experiences, yet also suggests a potential opportunity for intervention and resilience, particularly in later adolescence, once pubertal development is complete. However, the vast majority of research in this area has focused solely on girls, and we know very little about whether maltreatment is also associated with earlier pubertal timing in boys.

Other Family and Health Factors

Other family factors that may be stress-inducing yet much less extreme than maltreatment have also been associated with pubertal timing and tempo. For example, Quinlan (2003) found that the number of caretaking transitions a child experiences was associated with earlier menarche. Sung and colleagues (2016) found that exposure to greater parental harshness (but not unpredictability) during the first 5 years of life predicted earlier menarche; and a recent meta-analysis found that father absence was significantly related to earlier menarche (Webster et al., 2014), although genetic confounding may play a role in this association (Barbaro et al., 2017).

Health factors that may affect the metabolic system are also predictive of pubertal timing. For example, in girls, low birth weight (Belsky et al., 2007) and obesity/higher body mass index (BMI) (Wagner et al., 2015) have both been associated with earlier pubertal maturation. For boys, overweight (BMI ≥ 85th and < 95th percentile) has been associated with earlier pubertal maturation, whereas obesity (BMI ≥ 95th percentile) was associ-

[3]For more information on the National Longitudinal Study of Adolescent Health, see https://www.cpc.unc.edu/projects/addhealth.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

ated with later pubertal maturation (Lee et al., 2016), suggesting a complex association between aspects of the metabolic system and puberty in boys.

Environmental Exposures

Recently, researchers have examined whether a child's exposure to chemicals is related to pubertal maturation by serving as an endocrine disruptor (see e.g., Lomniczi et al., 2013; Simonneaux et al., 2013; Steingraber, 2007). In the first longitudinal study of age of pubertal timing and exposure to persistent organic pollutants—chemicals used in flame retardants—researchers found that the age at pubertal transition was consistently older in participants who were found to have higher chemical concentrations in collected blood samples (Windham et al., 2015). The effects of neuroendocrine disruptors on girls' pubertal timing may begin during the prenatal period, as there is evidence that female reproductive development is affected by phthalate or bisphenol A exposure during specific critical periods of development in the mother's uterus (Watkins et al., 2017).

Accelerated Maturation and Adaptive Plasticity

It is clear that early experiences can factor into accelerated pubertal timing and tempo, and theorists suggest that this may be adaptive. According to Mendle and colleagues (2011, p. 8), "age at certain stressful life transitions represents a dose-response relationship with maturation, with earlier ages at these events associated with earlier development (e.g., Ellis and Garber, 2000)." Belsky et al. (1991) posited that children who are raised in harsh, stressful environments may have accelerated pubertal development to compensate for a mistrust of commitment and of investment in social relationships. According to Belsky and colleagues, early pubertal timing may serve the evolutionary biological purpose of elongating the window for reproductivity and fertility, to permit more conceptions in a lifetime. Thus, the well-documented association between adverse early life experiences and early pubertal development may itself be an adaptive response, one that reflects the plasticity in neurobiological systems during adolescence to adapt to the specific socio-cultural context.

The Social Context of Pubertal Maturation

Despite the role that stressful early life events play in accelerating pubertal timing, it is important to note that adolescence is also a period of potential for recovery. Even when an adolescent has experienced early adversity and this has precipitated earlier pubertal maturation, the social context in which that adolescent is developing can ultimately change the trajectory

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

of their outcomes—for better or worse. For example, closer and less conflict-laden parent-child relationships can reduce associations between pubertal maturation and behavior problems, while more conflict-laden and less close relationships exacerbate them (Booth et al., 2003; Dorn et al., 2009; Fang et al., 2009). Parental knowledge of an adolescent child's whereabouts and activities also plays a role, as the influence of pubertal timing on problematic outcomes is weakened when such parental knowledge of adolescent whereabouts and activities is high, and it is amplified when knowledge is low (Marceau et al., 2015; Westling et al., 2008). During early childhood, a secure infant-mother attachment can buffer girls from the later effects of harsh environments on earlier pubertal maturation (Sung et al., 2016).

The Context of Biological Sex and Gender Norms

The biological changes of puberty take place in social and cultural contexts, and these dynamic person-context interactions have implications for adolescent development. For instance, the physical changes associated with pubertal maturation affect an adolescent's self-image as much as the way he or she is treated and responded to by others (Graber et al., 2010), and culturally grounded gender norms may make these associations more salient for girls than boys. Indeed, in the United States, although menstruation is acknowledged as a normal biological event, it is nevertheless often accompanied by feelings of shame and the need to conceal it from others, particularly males (Stubbs, 2008). As a result, the arrival of a girl's first menstrual cycle is often accompanied by embarrassment and ambivalence (Brooks-Gunn et al., 1994; Moore, 1995; Tang et al., 2003), as well as by negative feelings (Rembeck et al., 2006), including anxiety, surprise, dismay, panic, and confusion (Brooks-Gunn and Ruble, 1982; Ruble and Brooks-Gunn, 1982).

The arrival of puberty has other social consequences, such as changing dynamics and maturing relationships with parents, siblings, and peers, as well as the emergence of peer relationships with adults. Pubertal maturation is associated with a higher incidence of sexual harassment, both by peers of the same gender and across genders (McMasters et al., 2002; Petersen and Hyde, 2009; Stattin and Magnusson, 1990). Social consequences may be exacerbated among youth experiencing early pubertal timing.

The increase in pubertal hormones (e.g., estradiol, progesterone, testosterone, dehydroepiandrosterone) and the changes they drive, such as the emergence of secondary sex characteristics, is also associated with the development of substance use (Auchus and Rainey, 2004; Grumbach, 2002; Grumbach and Styne, 2003; Havelock et al., 2004; Matchock et al., 2007; Oberfield et al., 1990; Terasawa and Fernandez, 2001; Young and Altemus, 2004). At the same time, the causal direction of these findings is somewhat

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

mixed (Castellanos-Ryan et al., 2013; Dawes et al., 1999; Marceau et al., 2015), with variation by sex. In girls, relatively early pubertal timing and faster pubertal tempo often mark an increased risk for adolescent substance use (Cance et al., 2013; Castellanos-Ryan et al., 2013; Costello et al., 2007; Lee et al., 2014). By contrast, in boys later pubertal timing and/or slower pubertal tempo mark an increased risk for substance use (Davis et al., 2015; Marceau et al., 2015; Mendle and Ferrero, 2012). This striking gender difference in associations between pubertal maturation and substance use highlights how the same biological event (pubertal maturation) can lead to very different outcomes as a function of one's biological sex.

Puberty and Stress Sensitivity

Puberty-related hormones influence the way adolescents adjust to their environment, for example by experiencing symptoms of depression and anxiety. One mechanism through which this might occur is in pubertal hormones' ability to alter sensitivity to stress, making adolescent girls particularly sensitive to exogenous stressors. Recent studies using salivary cortisol as an index of stress regulation have documented heightened stress reactivity and delayed post-stress recovery in pubescent adolescents (Gunnar, et al., 2009; Stroud et al., 2004; Walker et al., 2004). Cortisol is a steroid hormone released by the HPA axis, and disruption to this axis has been implicated in the development of symptoms of depression and anxiety (e.g., Gold and Chrousos, 2002; Guerry and Hastings, 2011; Sapolsky, 2000).

In fact, cortisol secretion is closely intertwined with age, puberty, and sex, which together appear to contribute to adolescent girls' vulnerability to external stressors (Walker et al., 2004; Young and Altemus, 2004). As will be discussed in Chapter 3, cortisol, along with neuroendocrine, autonomic, immune, and metabolic mediators, usually promotes positive adaptation in the body and the brain, such as efficient operation of the stress response system. However, when cortisol is over- or under-produced it can, along with the other mediators, produce negative effects on the body and brain, such as forming insulin resistance and remodeling the brain circuits that alter mood and behavior. At the same time, as will be shown in Chapter 3, interventions during adolescence have the potential to mediate the harmful effects of stress.

Summary

In summary, puberty is shaped by both biological and social processes. Biologically, puberty occurs over an extended period during which neuroendocrine alterations result in the maturation of primary and secondary sex characteristics and the acquisition of reproductive maturity. The timing and tempo of pubertal development varies greatly, and the age at which an ado-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

lescent matures depends upon a combination of genetic and environmental influences, including early life experiences. Socially, pubertal maturation and its accompanying physical changes affect how adolescents perceive themselves and how they are treated by others, and early pubertal timing especially has been shown to have social consequences. While we know a great deal about the biological processes of puberty, much of the research, particularly on the role of adverse early experiences, is based on studies of girls rather than boys and excludes transgender and gender-nonconforming youth. Thus, it is important to monitor whether or not conclusions drawn from the extant research are relevant for both girls and boys, and to consider how further study of puberty in boys, transgender youth, and gender-nonconforming youth may deepen our understanding of these dynamic processes.

Despite this limitation, research on associations between stress exposure and pubertal timing and tempo makes clear the importance of early experiences and highlights the role of social determinants of health. Stressful living conditions are related to earlier pubertal timing and accelerated pubertal tempo. While early puberty may be an evolutionarily adaptive response to context that reflects neurobiological plasticity, there are important consequences that suggest it may not be adaptive in terms of supporting a long-term path to health and well-being for youth living in the 21st century. Structural changes that disrupt the systemic factors that increase risk for early puberty (e.g., resource deprivation) as well as supportive relationships can mitigate the risks associated with early puberty, can foster positive outcomes, and may promote adolescents' capability for resilience.

NEUROBIOLOGICAL DEVELOPMENT

Adolescence is a particularly dynamic period of brain development, second only to infancy in the extent and significance of the neural changes that occur. The nature of these changes—in brain structures, functions, and connectivity—allows for a remarkable amount of developmental plasticity unique to this period of life, making adolescents amenable to change.[4] These normative developments are required to prepare the brain so it can respond to the demands and challenges of adolescence and adulthood, but they may also increase vulnerability for risk behavior and psychopathology (Paus et al., 2008; Rudolph et al., 2017). To understand how to take advantage of this versatile adolescent period, it is first important to recognize how and where the dynamic changes in the brain are taking place; Figure 2-2 shows structures and regions of the brain that have been the focus of adolescent developmental neuroscience.

[4] See Chapter 3 for a discussion of the adaptive plasticity of adolescence and the potential of interventions during adolescence to mediate deficiencies from earlier life periods.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

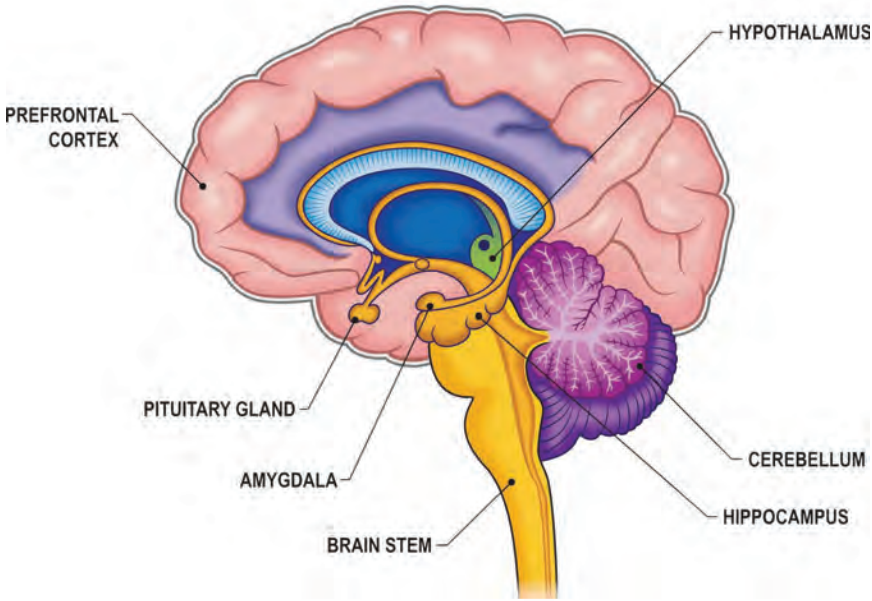


FIGURE 2-2 Brain areas important to adolescent development.
SOURCE: iStock.com/James Kopp.

In the following sections, we summarize current research on structural and functional brain changes taking place over the course of adolescence. Our summary begins with a focus on morphological changes in gray and white matter, followed by a discussion of structural changes in regions of the brain that have particular relevance for adolescent cognitive and social functioning. We then discuss current theoretical perspectives that attempt to account for the associations between neurobiological, psychological, and behavioral development in adolescence.

Notably, the field of adolescent neuroscience has grown quickly over the past several decades. Advances in technology continue to provide new insights into neurobiological development; however, there is still a lack of agreed-upon best practices, and different approaches (e.g., in equipment, in statistical modeling) can result in different findings (Vijayakumar et al., 2018). Our summary relies on the most recent evidence available and, per the committee's charge, we focus on neurobiological changes that make adolescence a period of unique opportunity for positive development. This is not intended to be an exhaustive review of the literature; moreover, studies tend to use "typically" developing adolescents, which limits our ability to comment on whether or how these processes may change for young people with developmental delays or across a broader spectrum of neurodiversity.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

High Plasticity Marks the Window of Opportunity

Studies of adolescent brain development have traditionally focused on two important processes: changes in gray matter and changes in myelin. Gray matter is comprised of neural cell bodies (i.e., the location of each nerve cell's nucleus), dendrites, and all the synapses, which are the connections between neurons. Thus, increases or decreases in gray matter reflect changes in these elements, representing, for instance, the formation or disappearance of synapsis (also known as "synaptogenesis" and "synaptic pruning"). New learning and memories are stored in dynamic synaptic networks that depend equally on synapse elimination and synapse formation. That is, unused connections and cells must be pruned away as the brain matures, specializes, and tailors itself to its environment (Ismail et al., 2017).

White matter, on the other hand, is comprised of myelin. Myelin is the fatty sheath around the long projections, or axons, that neurons use to communicate with other neurons. The fatty myelin insulates the axonal "wire" so that the signal that travels down it can travel up to 100 times faster than it can on unmyelinated axons (Giedd, 2015). With myelination, neurons are also able to recover quickly from firing each signal and are thereby able to increase the frequency of information transmission (Giedd, 2015). Not only that, myelinated neurons can more efficiently integrate information from other input neurons and better coordinate their signaling, firing an outgoing signal only when information from all other incoming neurons is timed correctly (Giedd, 2015). Thus, the increase in white matter is representative of the increase in quality and speed of neuron-to-neuron communication throughout adolescence. This is comparable to upgrading from driving alone on a single-lane dirt road to driving on an eight-lane paved expressway within an organized transportation/transit authority system, since it increases not only the amount of information trafficked throughout the brain but also the brain's computational power by creating more efficient connections.

Recent advances in neuroimaging methods have greatly enhanced our understanding of adolescent brain development over the past three decades. In the mid-2000s developmental neuroscientists described differential changes in gray matter (i.e., neurons) and white matter (i.e., myelin) over the course of adolescence. Specifically, gray-matter volume was believed to follow an inverted-U shape, peaking in different regions at different ages and declining over the course of late adolescence and adulthood (Lenroot and Giedd, 2006). In contrast, cortical white matter, which reflects myelin growth, was shown to increase steadily throughout adolescence and into early adulthood, reflecting increased connectivity among brain regions (Lenroot and Giedd, 2006). The proliferation of neuroimaging studies, particularly longitudinal studies following children over the course of ado-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

lescence, has enabled researchers to examine these processes in more detail and across a larger number of participants (Vijayakumar et al., 2018).

Analyses of about 850 brain scans from four samples of participants ranging in age from 7 to 29 years (average = 15.2 years) confirm some previous trends, disconfirm others, and highlight the complexity in patterns of change over time. Researchers found that gray-matter volume was highest in childhood, decreased across early and middle adolescence, and began to stabilize in the early twenties; this pattern held even after accounting for intracranial and whole brain volume (Mills et al., 2016). Additional studies of cortical volume have also documented the highest levels occurring in childhood with decreases from late childhood throughout adolescence; the decrease appears to be due to the thinning of the cortex (Tamnes et al., 2017). Importantly, this finding contrasts with the "inverted-U shape" description of changes in gray-matter volume and disconfirms previous findings of a peak during the onset of puberty (Mills et al., 2016).

For white-matter volume, on the other hand, researchers found that across samples, increases in white-matter volume occurred from childhood through mid-adolescence and showed some stabilizing in late adolescence (Mills et al., 2016). This finding generally confirms patterns observed in other recent studies, with the exception that some researchers have found continued increases in white-matter volume into early adulthood (versus stabilizing in late adolescence; e.g., Aubert-Broche et al., 2013). Figure 2-3 shows these recent findings related to gray and white matter.

The widely held belief about a peak in cortical gray matter around puberty followed by declines throughout adolescence was based on the best available evidence at the time. New studies show steady declines in cortical volume beginning in late childhood and continuing through middle adolescence. While the decrease in volume is largely due to cortical thinning rather than changes in surface area, there appear to be complex, regionally specific associations between cortical thickness and surface area that change over the course of adolescence (Tamnes et al., 2017). Discrepant findings can be attributed to a number of factors including head motion during brain imaging procedures (more common among younger participants), different brain imaging equipment, and different approaches to statistical modeling (Tamnes et al., 2017; Vijayakumar et al., 2018). There do appear to be converging findings regarding overall directions of change; however, inconsistencies in descriptions of trajectories, peaks, and regional changes will likely continue to emerge as researchers work toward agreed-upon best practices (Vijayakumar et al., 2018). Importantly, though, as Mills and colleagues (2016, p. 279) point out, it is critical to acknowledge that "it is not possible to directly relate developmental changes in morphometric MRI measures to changes in cellular or synaptic anatomy" (also see Mills and Tamnes, 2014). In other words, patterns of change in overall gray- or

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

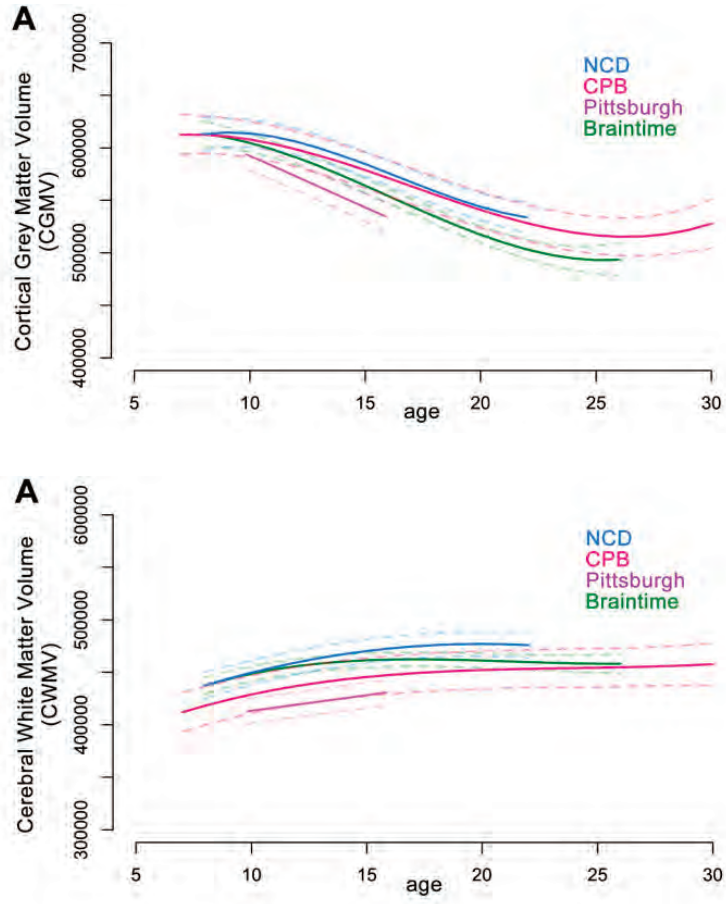


FIGURE 2-3 Cortical gray- and white-matter volume, ages 5 to 30.
NOTES: Age in years is measured along the x-axis and brain measure along the y-axis (raw values (mm^3). Best fitting models are represented by the solid lines. Dashed lines represent 95-percent confidence intervals. Four longitudinal datasets from: CPB = NIH Child Psychiatry Branch (National Institute of Mental Health); NCD = Neurocognitive Development (University of Oslo); Pittsburgh = University of Pittsburgh; and Braintime = Leiden University.
SOURCE: Mills et al. (2016, pp. 277–278).

white-matter volume do not provide insight into the specific ways in which neural connections (e.g., synapses, neural networks) may change within the adolescent brain.

In fact, some neural circuity, consisting of networks of synaptic connections, is extremely malleable during adolescence, as connections form and

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

reform in response to a variety of novel experiences and stressors (Ismail et al., 2017; Selemon, 2013). Gray-matter reduction in the cortex is associated with white-matter organization, indicating that cortical thinning seen in adulthood may be a result of both increased connectivity of necessary circuitry and pruning of unnecessary synapses (Vandekar et al., 2015). Thus, adolescent brains can modulate the strength and quality of neuronal connections rapidly to allow for flexibility in reasoning and for leaps in cognition (Giedd, 2015).

Structural Changes in the Adolescent Brain

Two key neurodevelopmental processes are most reliably observed during adolescence. First, there is evidence of significant change and maturation in regions of the prefrontal cortex (PFC) involved in executive functioning and cognitive and impulse control capabilities (Crone and Steinbeis, 2017; Steinberg, 2005). In other words, areas of the brain that support planning and decision-making develop significantly during the second decade of life. Second, there is evidence of improved connectivity[5] within and between the cortical (i.e., outer) and subcortical (i.e., inner) regions of the brain. Moreover, in both the cortical and subcortical regions, there are age-related and hormone-related changes in neural activity and structure, such as increased volume and connectivity (Gogtay et al., 2004; Østby et al., 2009; Peper and Dahl, 2013; Wierenga et al., 2014).

Over the course of adolescence, regions of the PFC undergo protracted development and significant remodeling. Cortical circuits, especially those that inhibit behavior, continue to develop, enhancing adolescents' capacity for self-regulation (Caballero and Tseng, 2016). Compared to adults, adolescents have a significantly less mature cortical system and tend to utilize these regions less efficiently, and this impacts their top-down cognitive abilities including planning, working memory, impulsivity control, and decision-making (Casey and Caudle, 2013). Ongoing development of structures and connections within the cortical regions corresponds to more efficient balancing of inputs and outputs as adolescents interact with the world.

Changes within subcortical brain regions are also reflected in adolescent capabilities. For instance, increased volume in certain subregions of the hippocampus may predict greater capacity for memory recall and retention in adolescents (Tamnes et al., 2014). Adolescents also display heightened activity in the hippocampus, compared with adults, and differential reward processing in the striatum, which is part of the basal ganglia and plays an important role in motivation and perception of reward. This neural activ-

[5] "Connectivity" refers to the formation of synapses, or connections between neurons; groups of interconnected neurons form circuit-like neural networks.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

ity may explain their increased sensitivity to rewards and contribute to their greater capacity for learning and habit formation, particularly when incentivized by positive outcomes (Davidow et al., 2016; Sturman and Moghaddam, 2012).

Another subcortical structure, the amygdala, undergoes significant development during puberty and gains new connections to other parts of the brain, such as the striatum and hippocampus (Scherf et al., 2013). The amygdala modulates and integrates emotional responses based on their relevance and impact in context. In conjunction with the amygdala's substantial development, adolescents show higher amygdala activity in response to threat cues[6] than do children or adults (Fuhrmann et al., 2015; Hare et al., 2008; Pattwell et al., 2012). Consequently, they are prone to impulsive action in response to potential threats[7] (Dreyfuss et al., 2014). Changes in the hippocampus and amygdala may be responsible for suppressing fear responses in certain contexts (Pattwell et al., 2011). Such fearlessness can be adaptive for adolescents as they explore new environments and make important transitions—such as entering college or starting a new job away from home. Children and adults do not tend to show the same kind of fear suppression as adolescents, suggesting that this is unique to this stage of development (Pattwell et al., 2011).

A Neurodevelopmental Perspective on Risk-Taking

In recent years, researchers have worked to reconcile contemporary neuroscience findings with decades of behavioral research on adolescents. There has been a particular emphasis on understanding "risky" behavior through the lens of developmental neuroscience. Risk-taking can be driven by a tendency for sensation-seeking, in which individuals exhibit an increased attraction toward novel and intense sensations and experiences despite their possible risks (Steinberg, 2008; Zuckerman and Kuhlman, 2000). This characteristic is heightened during adolescence and is strongly associated with reward sensitivity and drive (Cservenka et al., 2013) as well as the rise in dopamine pathways from the subcortical striatum to the PFC (Wahlstrom et al., 2010). Ironically, as executive function improves, risk-taking based on sensation-seeking also rises, likely due to these strengthened dopamine pathways from the striatum to the PFC regions (Murty et al., 2016; Wahlstrom et al., 2010). Despite these stronger sensation-seeking

[6] The threat cues used in the research cited here were pictures of "fearful faces," which serve as a social cue of impending danger.

[7] Impulsive action in response to potential threat was assessed using a "go/no-go" task. Simply put, this is a task in which participants are presented with two types out of three facial emotions ("happy" or "calm" or "fearful") that are randomly assigned as "go" (stimulate action = press a button) or "no-go" (inhibit action = do not press button).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

tendencies, however, by mid-adolescence most youth are able to perform cognitive-control tasks at the same level as adults, signaling their capacity for executive self-control (Crone and Dahl, 2012).

Risk-taking can also be driven by impulsivity, which includes the tendency to act without thinking about consequences (impulsive action) or to choose small, immediate rewards over larger, delayed rewards (impulsive choice) (Romer et al., 2017). Impulsive action, which is based on insensitivity to risk, is a form of risk-taking that peaks during early adolescence and is inversely related to working memory ability (Romer et al., 2011). It may also be a consequence of asynchronous limbic-PFC maturation, which is described below. Notably, impulsive actions are seen most frequently in a subgroup of adolescents with pre-existing impairment in self-control and executive function (Bjork and Pardini, 2015). In contrast, impulsive choice behaviors, which are made under conditions of known risks and rewards, do not peak in adolescence. Instead, impulsive choice declines from childhood to adulthood, reflecting the trend of increasing, prefrontal-regulated executive functions throughout adolescence (van den Bos et al., 2015). Interestingly, when given the choice between two risky options with ambiguous reward guarantees, adolescents are more inclined to explore the riskier option than are adults (Levin and Hart, 2003), showing a greater tolerance for ambiguities in reward and stronger exploratory drive (Tymula et al., 2012).

Theoretical models have emerged to explain how neurobiological changes map onto normative "risk" behaviors in adolescence. While some argue that these models and accompanying metaphors may be overly simplistic (e.g., Pfeifer and Allen, 2012), the models are nevertheless utilized frequently to guide and interpret research (e.g., Steinberg et al., 2018). We briefly discuss two of them here: the "dual systems" model and the "imbalance" model.

The "dual systems" model (Shulman et al., 2016; Steinberg, 2008) represents "the product of a developmental asynchrony between an easily aroused reward system, which inclines adolescents toward sensation seeking, and still maturing self-regulatory regions, which limit the young person's ability to resist these inclinations" (Steinberg et al., 2018). The "reward system" references subcortical structures, while the "self-regulatory regions" refer to areas like the PFC. Proponents of the dual-systems model point to recent findings on sensation seeking and self-regulation from a study of more than 5,000 young people spanning ages 10 to 30 across 11 countries. A similar pattern emerged across these settings. In 7 of 11 countries there was a peak in sensation seeking in mid-to-late adolescence (around age 19) followed by a decline. Additionally, there was a steady rise in self-regulation during adolescence; self-regulation peaked in the mid-20s in four countries and continued to rise in five others. The researchers note that there were more similarities than differences across countries and sug-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

gest that the findings provide strong support for a dual-systems account of sensation seeking and self-regulation in adolescence.

A second model, the "imbalance" model, shifts the focus away from an orthogonal, dual systems account and instead emphasizes patterns of change in neural circuitry across adolescence. This fine-tuning of circuits is hypothesized to occur in a cascading fashion, beginning within subcortical regions (such as those within the limbic system), then strengthening across regions, and finally occurring within outer areas of the brain like the PFC (Casey et al., 2016). This model corresponds with observed behavioral and emotional regulation—over time, most adolescents become more goal-oriented and purposeful, and less impulsive (Casey, 2015). Proponents of the imbalance model argue that it emphasizes the "dynamic and hierarchical development of brain circuitry to explain changes in behavior throughout adolescence" (Casey et al., 2016, p. 129). Moreover, they note that research stemming from this model focuses less on studying specific regions of the brain and more on how information flows within and between neural circuits, as well as how this flow of information shifts over the course of development (e.g., "temporal changes in functional connectivity within and between brain circuits," p. 129).

Rethinking the "Mismatch" Between the Emotional and Rational Brain Systems

Regardless of whether one of these two models more accurately represents connections between adolescent neurobiological development and behavior, both perspectives converge on the same point: fundamental areas of the brain undergo asynchronous development throughout adolescence. Moreover, adolescent behavior, especially concerning increased risk-taking and still-developing self-control, has been notably attributed to asynchronous development within and between subcortical and cortical regions of the brain. The former drives emotion, and the latter acts as the control center for long-term planning, consideration of outcomes, and level-headed regulation of behavior (Galván et al., 2006; Galván, 2010; Mueller et al., 2017; Steinbeis and Crone, 2016). Thus, if connections within the limbic system develop faster than those within and between the PFC region,[8] the imbalance may favor a tendency toward heightened sensitivity to peer influence, impulsivity, risk-taking behaviors, and emotional volatility (Casey and Caudle, 2013; Giedd, 2015; Mills et al., 2014).

[8] While there may be asynchronous development of circuits within specific regions of the brain during adolescence, this does not mean that these regions are "fixed" by the end of adolescence; instead, people retain the ability for neural plasticity and change throughout the life course (see Chapter 3).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Indeed, adolescents are more impulsive in response to positive incentives than children or adults, although they can suppress these impulses when large rewards are at stake. Adolescents are also more sensitive than children or adults to the presence of peers and to other environmental cues, and show a heightened limbic response to threats (Casey, 2015). As the cortical regions continue to develop and activity within and across brain regions becomes more synchronized, adolescents gain the capacity to make rational, goal-directed decisions across contexts and conditions.

The idea of asynchrony or "mismatch" between the pace of subcortical development and cortical development implies that these developmental capacities are nonoptimal. Yet, even though they are associated with impulsivity and risk-taking, we should not jump to the conclusion that the gap in maturation between the emotion and control centers of the brain is without developmental benefit. As Casey (2015, p. 310) notes, "At first glance, suggesting that a propensity toward motivational or emotional cues during adolescence is adaptive may seem untenable. However, a heightened activation into action by environmental cues and decreased apparent fear of novel environments during this time may facilitate evolutionarily appropriate exploratory behavior." While an adolescent's "heart over mind" mentality may compromise judgment and facilitate unhealthy behaviors, it can also spawn creativity and exploration. Novelty seeking can be a boon to adolescents, spurring them to pursue exciting, new directions in life (Spear, 2013).

If properly monitored and cushioned by parents and the community, adolescents can learn from missteps and take advantage of what can be viewed as developmental *opportunities*. Indeed, because adolescents are more sensitive to rewards and their decision-making ability may skew more toward seeking the positive benefits of a choice and less toward avoiding potential risks, this tendency can enhance learning and drive curiosity (Davidow et al., 2016). To avoid stereotyping all adolescents as "underdeveloped" or "imbalanced," it is important to recognize the nuances in the different types of risk-taking behavior and to counterbalance a focus on negative outcomes by observing the connections between risk-taking and exploration, curiosity, and other attributes of healthy development (Romer et al., 2017).

The "mismatch" model provides one way of understanding adolescents' capacity for self-control and involvement in risky behavior. A better model of adolescent neurobiological development, some argue, is a "lifespan wisdom model," prioritizing the significance of experience on brain maturation that can only be gained through exploration (Romer et al., 2017). Indeed, growing evidence shows that adolescents have a distinctive ability for social and emotional processing that allows them to adapt readily to the capricious social contexts of adolescence, and equips them

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

with flexibility in adjusting their motivations and prioritizing new goals (Crone and Dahl, 2012; Nigg and Nagel, 2016).

Despite differences between neurobiological models, there is agreement that distinctions between adolescent and adult behaviors necessitate policies and opportunities intended to address adolescent-specific issues. With their heightened neurocognitive capacity for change, adolescents are in a place of both great opportunity and vulnerability. Key interventions during this period may be able to ameliorate the impact of negative experiences earlier in life, providing many adolescents with a pivotal second chance to achieve their full potential and lead meaningful, healthy, and successful lives (Guyer et al., 2016; see also Chapter 3).

Cognitive Correlates of Adolescent Brain Development

Reflective of the ongoing changes in the brain described above, most teens become more efficient at processing information, learning, and reasoning over the course of adolescence (Byrnes, 2003; Kuhn, 2006, 2009). The integration of brain regions also facilitates what is called "cognitive control," the ability to think and plan rather than acting impulsively (Casey, 2015; Casey et al., 2016; Steinberg, 2014).

Changes in components of cognitive control, such as response selection/inhibition and goal selection/maintenance, along with closely associated constructs such as working memory, increase an individual's capacity for self-regulation of affect and behavior (Ochsner and Gross, 2005). Importantly, each of these aspects of cognitive control appears to have distinct developmental trajectories, and each may be most prominently associated with distinct underlying regions of the cortex (Crone and Steinbeis, 2017). For example, although the greatest developmental improvements in response inhibition and interference control may be observed prior to adolescence, improvements in flexibility, error monitoring, and working memory are more likely to occur throughout the second decade of life (Crone and Steinbeis, 2017). This suggests different developmental trajectories, whereby more basic, stimulus-driven cognitive control processes develop earlier than do more complex cognitive control processes, which rely on internal and abstract representation (Crone and Steinbeis, 2017; Dumontheil et al., 2008).

Those functions that do continue to show significant developmental change during adolescence seem to especially rely on the capacity for abstract representation, which is a capacity that has been found to undergo a distinctive increase during adolescence (Dumontheil, 2014). The capacity for abstract representation can relate to both temporal and relational processes, that is, to both long-term goals and to past or future events (temporal) and to representing higher-order relationships between represen-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

tations (relational) as distinct from simple stimulus features (Dumontheil, 2014). From early through late adolescence (into adulthood), this increase in abstract thinking ability makes teens better at using evidence to draw conclusions, although they still have a tendency to generalize based on personal experience—something even adults do. Adolescents also develop greater capacity for strategic problem-solving, deductive reasoning, and information processing, due in part to their ability to reason about ideas that may be abstract or untrue; however, these skills require scaffolding and opportunities for practice (Kuhn, 2009).

Recent research on cognitive development during adolescence has focused on both cognitive and emotional (or "affective") processing, particularly to understand how these processes interact with and influence each other in the context of adolescent decision making. First, the capacity for abstract representation and for affective engagement with such representations (Davey et al., 2008) increases the capacity for self-regulation of emotions in order to achieve a goal (Ochsner and Gross, 2005). Indeed, the capacity to regulate a potent, stimulus-driven, short-term response may rely on the ability to mentally represent and affectively engage with a longer-term goal. Furthermore, such stimulus-driven, affective influences on cognitive processing, including on decision making, risk-taking, and judgment, change significantly over the course of adolescence (Hartley and Somerville, 2015; Steinberg, 2005).

Beyond individual capacities for cognitive regulation, the social and emotional context for cognitive processing matters a great deal. The presence of peers and the value of performing a task influence how motivating certain contexts may be and the extent to which cognitive processing is recruited (Johnson et al., 2009). Moreover, there is increasing evidence that some of these changes in cognitive and affective processing are linked to the onset of puberty (Crone and Dahl, 2012). Researchers have found that adolescents do better than young adults on learning and memory tasks when the reward systems of the brain are engaged (Davidow et al., 2016).

These changes in cognitive functioning may have adaptive qualities as part of normative adolescent development, even though they also make some individuals more vulnerable to psychopathology, such as depression and anxiety disorders. Notably, the flexibility of the frontal cortical network may be greater in adolescence than in adulthood (Jolles and Crone, 2012). Such flexibility may result in an improved ability to learn to navigate the increasingly complex social challenges that are part of adolescents' social worlds, and as adolescents encounter increasing opportunities for autonomy it may prove to be adaptive. In addition, the ability to shift focus in a highly motivated way could allow more learning, problem solving, and use of creativity (Kleibeuker et al., 2016). Of particular relevance, such emerging abilities may also determine the degree to which an indi-

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

vidual can take advantage of new learning opportunities, including mental health–promoting interventions. With the right supports, this capacity for flexibility and adaptability can foster deep learning, complex problem-solving skills, and creativity (Crone and Dahl, 2012; Hauser et al., 2015; Kleibeuker et al., 2012).

Summary

The extensive neurobiological changes in adolescence enable us to reimagine this period as one of remarkable opportunity for growth. Connections within and between brain regions become stronger and more efficient, and unused connections are pruned away. Such developmental plasticity means adolescents' brains are adaptive; they become more specialized in response to environmental demands. The timing and location of the dynamic changes are also important to understand. The onset of puberty, often between ages 10 and 12, brings about changes in the limbic system region resulting in increased sensitivity to both rewards and threats, to novelty, and to peers. In contrast, it takes longer for the cortical regions, implicated in cognitive control and self-regulation, to develop (Steinberg et al., 2018).

Adolescent brains are neither simply "advanced" child brains, nor are they "immature" adult brains—they are specially tailored to meet the needs of this stage of life (Giedd, 2015). Indeed, the temporal discrepancy in the specialization of and connections between cortical and subcortical brain regions makes adolescence unique. The developmental changes heighten sensitivity to reward, willingness to take risks, and the salience of social status, propensities that are necessary for exploring new environments and building nonfamilial relationships. Adolescents must explore and take risks to build the cognitive, social, and emotional skills they will need to be productive adults. Moreover, the unique and dynamic patterns of brain development in adolescence foster flexible problem-solving and learning (Crone and Dahl, 2012). Indeed, adolescence is a seminal period for social and motivational learning (Fuligni, 2018), and this flexibility confers opportunity for adaptability and innovation.

While developmental plasticity in adolescence bears many advantages, as with all aspects of development the environment matters a great deal. The malleable brains of adolescents are not only adaptable to innovation and learning but also vulnerable to toxic experiences, such as resource deprivation, harsh, coercive or antisocial relationships, and exposure to drugs or violence. All of these can "get under the skin" as adolescents develop, or more precisely interact with the brain and body to influence development (see Chapter 3).

What is more, the majority of mental illnesses—including psychotic and substance use disorders—begin by age 24 (Casey, 2015; Giedd, 2015).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

This means that we have a collective responsibility to ask, "How can we create the kinds of settings and supports needed to optimize development during this period of life?" This goes well beyond simply keeping youth out of harm's way, and instead signals an urgent need to consider how we design the systems with which adolescents engage most frequently to meet their developmental needs. Notably, scholars studying adolescent developmental neuroscience suggest the next generation of research should consider questions that shift from understanding risk to understanding thriving, and context-specific opportunities to promote it. Such questions for the field include, "How does brain development create unique opportunities for learning and problem solving?," "Is the adolescent brain more sensitive to some features of the social environment than others?," and "Are trajectories of change [in cognitive control and emotional processing] steeper or quicker during some periods than others, potentially providing key windows for input and intervention?" (Fuligni et al., 2018, p. 151).

PSYCHOSOCIAL DEVELOPMENT IN ADOLESCENCE

As described above, young people develop increased cognitive abilities throughout adolescence. These cognitive abilities provide the capacity for other aspects of psychosocial development that occur during the period. This section describes the psychosocial developmental tasks—including developing identity and a capacity for self-direction—that adolescents complete during their transition to adulthood. Understanding one's self, understanding one's place in the world, and understanding one's capacity to affect the world (i.e., agency) are all processes that begin to take shape during adolescence in tandem with the physiological, neurobiological, and cognitive changes discussed above.

The trajectory of social and emotional development in adolescence may perhaps be best characterized as a time of increasing complexity and integration. As is true of their neurobiological development during the period, adolescents' capacity for understanding and engaging with self, others, and societal institutions requires both integration and deepening. It requires adolescents to integrate multiple perspectives and experiences across contexts, and also to deepen their ability to make sense of complex and abstract phenomena.

This section begins with a summary of developmental trends in adolescent self- and identity development at a broad level, followed by a brief discussion of how these trends reflect recent findings from developmental neuroscience. From there, we discuss group-specific social identities. While there are many critical dimensions of social identity (e.g., gender, social class, religion, immigration status, disability, and others), we use race and sexuality as exemplars given the recent, monumental shifts in racial/ethnic

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

demographics and in the social and political climate around sexual minority status in the United States. The focus on race and sexuality is not intended to minimize other dimensions of identity; indeed, identity development is a salient process for all adolescents regardless of social group memberships. Moreover, as we discuss below, developmental scientists are increasingly calling for research that examines the *intersectional* nature of identities, both at the individual level as well as in ways that reflect membership in multiple groups that have historically experienced marginalization (Santos and Toomey, 2018).

Identity

Finding an answer to the question, "Who am I?" is often viewed as a central task of adolescence. Decades ago, Erik Erikson (1968) argued that during adolescence, youth take on the challenge of developing a coherent, integrated, and stable sense of themselves, and that failing to do so may make the transition to adult roles and responsibilities more difficult. Erikson's concept of identity development assumes opportunities for exploration and choice and may or may not generalize across global contexts (Arnett, 2015; Syed, 2017). However, it has utility in the United States, where societal structures and dominant values such as independence and individuality encourage identity exploration.

Closely related to the question, "Who am I?" is the question, "*How* do I see myself?" (Harter, 2012). McAdams (2013) describes the developmental trajectory of "self" using a set of sequential metaphors: the "social actor" in childhood (because children engage in action) grows to become a "motivated agent" in adolescence (because teens are more purposeful and agent-driven, guided by values, motives, and hopes), and finally an "autobiographical author" in emerging adulthood, a time when young people work on building a coherent self-narrative. Studies of youth across the span of adolescence show that, for many young people, the sense of self and identity become more integrated, coherent, and stable over time (Harter, 2012; Klimstra et al., 2010; Meeus et al., 2010). Importantly, theory suggests and empirical evidence supports the idea that having a more "achieved" identity and integrated sense of self relates to positive well-being in adulthood and even throughout the life course (e.g., Kroger and Marcia, 2011; Meca et al., 2015; Schwartz et al., 2011).

While there is great variability across youth, there are also some distinct developmental trends in the emergence of self and identity. In early adolescence, young teens' self-definitions are increasingly differentiated relative to childhood. They see themselves in multiple ways across various social and relational contexts, for example one way when with their family and another way when with close friends in the classroom. Although a young

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

adolescent may carry a great number of "abstractions" about his or her self, these labels tend to be fragmented and sometimes even contradictory (Harter, 2012). For instance, a 13-year-old may view herself as shy and quiet in the classroom, as loud and bubbly with close friends, and as bossy and controlling with her younger siblings. Longitudinal studies suggest that some perceptions of self (e.g., academic self-concept) decline in early adolescence as youth transition to middle school; however, there is a great deal of individual variability, variability across domains (e.g., academic vs. behavioral self-concept), and variability by gender (higher athletic self-concept among males vs. females; Cole et al., 2001; Gentile et al., 2009).

In middle adolescence, teens may still hold onto multiple and disjointed abstractions of themselves; however, their growing cognitive abilities allow for more frequent comparisons among the inconsistencies, and heightened awareness of these contradictions can create some stress (Brummelman and Thomaes, 2017; Harter, 2012). In this period, youth may also be more aware that their conflicting self-characterizations tend to occur most often across different relationship contexts. As in early adolescence, discrepancies between real and ideal selves can create stress for some youth, but as teens develop deeper meta-cognitive and self-reflection skills, they are better able to manage the discrepancies. To continue with the same hypothetical teen introduced above at age 13, at age 16 she might view being shy and quiet in the classroom and loud and bubbly with friends as parts of a more holistic, less fragmented sense of self.

Older adolescents have greater abilities to make sense of their multiple abstractions about self. They can reconcile what seem like contradictory behaviors by understanding them in context (Harter, 2012). For instance, older teens are more likely to view their different patterns of behavior across settings as reflecting a positive trait like "flexibility," or they may characterize themselves as "moody" if they vacillate between positive and negative emotions in different situations. While peers are still important in late adolescence, youth may rely on them less when making self-evaluations; they also have greater capacity for perspective-taking and attunement to others, especially in the context of supportive relationships.

Emerging adulthood provides additional opportunities for experimenting with vocational options, forming new friendships and romantic relationships, and exercising more independent decision-making (Arnett, 2015; Harter, 2012; Schwartz et al., 2005). Many young adults shift from "grand" visions of possible selves to visions that are narrower and directly related to immediate opportunities. New experiences across contexts—like attending college or transitioning into the workforce—can shape whether emerging adults develop an authentic and integrated sense of self.

With the normative development of heightened sensitivity to social information, some youth may rely heavily on peer feedback in self-evaluation;

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

however, parents still play an important role in supporting a positive sense of self, especially when they are attuned to youths' needs and couple their high expectations with support (Harter, 2012). Indeed, secure and supportive relationships with parents can help early and middle adolescents develop a clear sense of self (Becht et al., 2017) and can buffer youth who are socially anxious against harsh self-criticism (Peter and Gazelle, 2017).

Identity and Self: A Neurobiological Perspective

Recent advances in developmental neuroscience appear to complement decades of behavioral research on youth. For instance, the integrated-circuitry model of adolescent brain development discussed in the previous section (Casey et al., 2016), along with other models emphasizing the growing integration within and between emotionally sensitive brain regions (e.g., the limbic system) and those involved in planning and decision making (e.g., the cortical regions), correspond with the observation that adolescents develop a more coherent sense of self over time and experience. Likewise, changes observed in social and affective regions of the brain during adolescence align with behavioral tendencies toward exploration and trying new things (Crone and Dahl, 2012; Flannery et al., 2018). Although the evidence base is still growing, recent studies document how self-evaluation and relational identity processes are linked with regions of the brain like the ventromedial PFC (vmPFC) (which plays a role in the inhibition of emotional responses, in decision making, and in self-control) and the rostral/perigenual anterior cingulate cortex (which plays a role in error and conflict detection processes). In particular, activity in these regions increases from childhood through adolescence in a manner consistent with changes in identity development (Pfeifer and Berkman, 2018).

Recent theoretical models of value-based decision making suggest specific ways in which identity development and neural development are linked in adolescence (Berkman et al., 2017; Pfeifer and Berkman, 2018). An important premise is that while adolescents may be more sensitive to social stimuli such as peer norms and to rewarding outcomes such as tangible gains, their sense of self is still a critical factor influencing their behavior. In other words, while social norms and tangible gains and costs represent some of the "value inputs," their construal of self and identity are also factors in their decision making. Moreover, neural evidence, like the activation observed in the vmPFC during self- and relational identity tasks, suggests that identity and self-related processes may play a greater role in value-based decision making during adolescence than they do in childhood (Pfeifer and Berkman, 2018).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Social Identities in Adolescence

As many youth work toward building a cohesive, integrated answer to the question, "Who am I?," the answer itself is shaped by membership across multiple social identity groups: race, ethnicity, nationality, sexuality, gender, religion, political affiliation, ability status, and more. Indeed, in the context of increasingly complex cognitive abilities and social demands, youth may be more likely to contest, negotiate, elaborate upon, and internalize the meaning of membership in racial/ethnic, gender, sexual, and other social identity groups (e.g., Umaña-Taylor et al., 2014). From a developmental perspective, these tasks are paramount in a pluralistic, multiethnic and multicultural society like the United States, which, as discussed in Chapter 1, is more diverse now than in previous generations.

Ethnic-Racial Identity. Currently, our nation's population of adolescents is continuing to increase in diversity, with no single racial or ethnic group in the majority. A burgeoning area of study over the past two decades concerns ethnic-racial identity (ERI), and research in this field has found that for most youth, particularly adolescents of color, ERI exploration, centrality, and group pride are positively related to psychosocial, academic, and even health outcomes (Rivas-Drake et al., 2014). ERI is multidimensional—it includes youths' beliefs about their group and how their race or ethnicity relate to their self-definition—both of which may change over time (Umaña-Taylor et al., 2014). For immigrant youth, developing their own ERI may involve an internal negotiation between their culture of origin and that of their new host country, and most immigrant youth show a great deal of flexibility in redefining their new identity (Fuligni and Tsai, 2015). Regardless of country of origin, making sense of one's ERI is a normative developmental process that often begins in adolescence (Williams et al., 2012). Indeed, given that research has consistently found ERI to be associated with adaptive outcomes, dimensions of ERI can be understood as components of positive youth development (Williams et al., 2014).

Sexual Orientation and Gender Identity. One of the distinctive aspects of adolescence is the emergence and awareness of sexuality, and a related aspect is the emerging salience of gender roles and expression. Adolescence is also a time when identities or sense of self related to gender and sexuality are developed and solidified (Tolman, 2011), and this occurs in a period during which sexuality and gender norms are learned and regulated by peers (Galambos et al., 1990). In this developmental context, LGBTQ youth begin to understand their sexual and gender identities.

The growing societal acceptance and legal recognition of LGBTQ youth is implicated in the recent observed drop in the age at which most of these

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

young people "come out," that is, disclose their same-sex sexual identities. Less than a generation ago, LGBTQ people in the United States typically came out as young adults in their 20s; today the average age at coming out appears to be around 14, according to several independent studies (Russell and Fish, 2017).

In the context of such changes and growing acceptance and support for LGBTQ youth developing their sexual identity, it might be expected that the longstanding health and behavior disparities between these adolescents and heterosexual and cis-gender adolescents would be lessening. Yet multiple recent studies challenge that conclusion. Things do not appear to be getting "better" for LGBTQ youth: rather than diminishing, health disparities across multiple domains appear to be stable if not widening (Russell and Fish, 2017). This pattern may be explained by several factors, including greater visibility and associated stigma and victimization for LGBTQ youth, just at the developmental period during which youth engage in more peer regulation and bullying in general, especially regarding sexuality and gender (Poteat and Russell, 2013). In fact, a meta-analysis of studies of homophobic bullying in schools showed higher levels of homophobic bullying in more recent studies (Toomey and Russell, 2016). These patterns point to the importance of policies and programs that help schools, communities, and families understand and support LGBTQ (and all) youth (see Chapter 7).

Identity Complexity. Beyond race, gender, or sexuality alone, having a strong connection to *some* dimension of social identity—which could also be cultural, religious, or national—appears to be important for psychological well-being in adolescence (Kiang et al., 2008). Recent research also suggests that young adolescents benefit from having a more complex, multifaceted identity that goes beyond stereotypical expectations of social-group norms, especially when it comes to inclusive beliefs (Knifsend and Juvonen, 2013). For instance, a youth who identifies as a Black, 13-year-old, transgender female who plays volleyball and loves gaming is apt to have more positive attitudes toward other racial/ethnic groups than she would if she viewed racial/ethnic identity and other social identities as necessarily convergent (such as the notion that "playing volleyball and being a gamer are activities restricted to youth from specific racial/ethnic groups"; Knifsend and Juvonen, 2014).

However, context is still important, and the association between identity complexity and inclusive beliefs in early adolescence tends to be stronger for youth who have a diverse group of friends (Knifsend and Juvonen, 2014). Among college-age students there is also variation by race and ethnicity. For instance, the positive association between having a complex social identity and holding more inclusive attitudes toward others

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

has been found most consistently among students who are members of the racial/ethnic majority; for members of racial/ethnic minority groups, convergence between racial/ethnic identity and other in-group identities is not related to attitudes toward other racial/ethnic groups (Brewer et al., 2013). Beyond outgroup attitudes, there is evidence that social identity complexity has implications for youths' own perceptions of belonging; for instance, Muslim immigrant adolescents (ages 15 to 18) with greater identity complexity reported a stronger sense of identification with their host country (Verkuyten and Martinovic, 2012).

Social Identity and Neurobiology

Cultural neuroscience provides some insight into how social identity development may manifest at the neurobiological level, although there is still much work to be done to understand the deep associations between biology and culture (Mrazek et al., 2015). In adolescence, evidence suggests, areas of the brain attuned to social information may be undergoing shifts that heighten youths' social sensitivity (Blakemore and Mills, 2014), and of course, adolescents' "social brains" develop in a cultural context. For instance, we know the amygdala responds to stimuli with heightened emotional significance; in the United States, where negative stereotypes about Blacks contribute to implicit biases and fears about them, amygdala sensitivity to Black faces has been documented in adult samples (Cunningham et al., 2004; Lieberman et al., 2005; Phelps et al., 2000).

In a study of children and adolescents (ages 4 to 16) in the United States, Telzer and colleagues (2013) found that amygdala activation in response to racial stimuli, such as images of Black faces, was greater in adolescence than during childhood. They suggest that identity processes reflecting heightened sensitivity to race, along with biological changes (e.g., those stemming from puberty) related to a "social reorientation" of the amygdala, may be among the mechanisms that explain these race-sensitive patterns of activation in adolescence (Telzer et al., 2013). Importantly, neural activation appears to vary based on the context of social experiences. Specifically, the amygdala activation observed in response to Black faces was attenuated for youth who had more friends and schoolmates of a race differing from their own (i.e., cross-race friends).

The foregoing findings converge with psychobehavioral studies that demonstrate the importance of school and friendship diversity. Attending diverse middle schools and having more cross-race friends is associated with more positive attitudes toward outsider groups, less social vulnerability, greater social and academic competence, and better mental health (Graham, 2018; Williams and Hamm, 2017). Adolescence is a period of transformation in social cognition (Blakemore and Mills, 2014; Giedd, 2015), so in

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

light of the findings from psychobehavioral and cultural neuroscience research on the benefits of diversity, important questions may be asked about whether adolescence is a critical period for providing exposure to difference. For instance, should we expect the benefits of exposure to diversity to be maximized if such exposure occurs during adolescence, or are benefits most likely with cumulative exposure that begins well before this period?[9]

Identity Development in Context

Identity development takes place in specific socio-cultural, political, and historical contexts. As an example, consider recent cultural and political shifts regarding same-sex relationships in the United States: in the period of one generation there has been dramatic social change regarding understanding and awareness of LGBTQ lives and issues. For context, consider that less than 20 years ago, marriage between same-sex couples was just beginning to be recognized anywhere in the world (the first country to do so was the Netherlands in 2001); less than 20 years later, 25 countries have legalized same-sex marriage, and recent surveys show that most young people in the United States approve of same-sex marriages (Pew Research Center, 2015). Moreover, the identity language and labels used among youth who are often placed under the umbrella of LGBTQ have continued to rapidly evolve. A growing number of LGBTQ youth say they have a nonbinary gender identity (i.e., neither male nor female) or sexual identity (e.g., pansexual, bisexual, queer) (Hammack, 2018). Indeed, young people appear to be leading a movement toward challenging existing categories and constructing new identities.

Meanwhile, in the past decade there has been a dramatic change in public awareness and understanding of transgender identities. Popular attention to the gender changes of a number of celebrities coincided with growing emergence and awareness of transgender children.[10] Thus, a subject that was literally unknown by most people in the United States has within a decade become the subject of public discussion and political debate. School systems are grappling with gender change and accommodations for transgender students, and the typical developmental challenges of adolescence are being navigated by a growing number of openly transgender, gender-nonbinary, or gender-nonconforming adolescents (Wilson et al, 2017).

[9] For instance, rodent models suggest that empathy is shaped by social context (e.g., rats usually assist members of their own genetic strain, but will extend their prosocial behavior to unrelated peers if they are raised together; Bartal et al., 2011; Meyza et al., 2017).

[10] See, for example, "Beyond 'He' or 'She': The Changing Meaning of Gender and Sexuality," TIME Magazine, March 16, 2017.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Developmental scientists have recently called for a deeper investigation of the ways in which intersecting axes of oppression shape youth development, often referred to as "intersectionality" (Crenshaw, 1990; Santos and Toomey, 2018; Velez and Spencer, 2018). Indeed, against a backdrop of social stratification and oppression, relationships between identity, experience, and behavior may not operate the same way for all youth (Spencer, 1995). For example, the way in which knowledge is socially constructed contributes to maintaining systems and structures that control and exclude marginalized populations such as people with disabilities (Peña et al., 2016). Smart and Smart (2007) argue that society has historically viewed people with disabilities from a medical perspective, in which individuals were labeled as ill, dysfunctional, and in need of medical treatment. This approach perpetuates an ableist worldview that suggests people with disabilities should strive toward an able-bodied norm, reflecting society's perceptions that certain abilities are essential to fully function in the world (Hutcheon and Wolbring, 2012). This example highlights why an intersectional perspective is important for understanding adolescent psychosocial development in context, both for considering systemic factors that shape opportunities and for broadening the range of questions, values, samples, and experiences that have been defined and studied from a dominant-group perspective (Syed et al., 2018). Ultimately, intersectional approaches and related integrative models are needed to understand how youth development in context can lead to further marginalization for some youth (Causadias and Umaña-Taylor, 2018) or to adaptability and resilience for others (Gaylord-Harden et al., 2018; Suárez-Orozco et al., 2018).

Summary

We have long considered identity exploration as a hallmark of adolescence. An adolescent's identity is an emerging reflection of his or her values, beliefs, and aspirations, and it can be constructed and reconstructed over time and experience. Multiple factors—family, culture, peers, media—shape identity development, but young people are also active agents in the process. Movement toward stability and coherence is normative, yet there remain dynamic elements that shape the relationship between identity and behavior; teens often select activities that feel identity-congruent, and may interpret and respond to a given situation based on aspects of identity that are salient in the moment (Oyserman, 2015; Oyserman and Destin, 2010). This has implications for adolescents' experiences in important contexts such as school. Identity processes are connected to a larger set of self-development characteristics, including self-regulation, self-efficacy, and a sense of agency, all of which youth need to help develop and commit to meaningful goals. Ensuring that adolescents understand how all identities can be consistent

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

with their current academic choices and future educational and vocational aspirations is an important consideration for the education system and is discussed further in Chapter 6.

Recent neuroscientific findings suggest that changes in social and affective regions of the brain correspond to developmental changes in identity development. Moreover, identity and self-related processes may play a greater role in decision making during adolescence than they do in childhood. Youth may also experience identity congruence, affirmation, or marginalization through their interpersonal interactions with policies, sociopolitical events, and historical factors. Ultimately, how adolescents' multifaceted identities are manifested—neurobiologically, behaviorally, and otherwise—and the role identity plays in their overall well-being depend a great deal on experiences in context. This requires us to reflect on the nature of the contexts in which adolescents are developing their identities.

Consider, for example, that a youth's likelihood of involvement in extremist organizations may be heightened as they search for meaningful ingroups, if they accept group beliefs without questioning them (i.e., identity foreclosure), and/or if they feel their personal or group identities are under threat (Dean, 2017; Schwartz et al., 2009). As Schwartz and colleagues note, "providing mainstream paths for young people, within the cultural constraints of their society, can help to alleviate the anger, frustration, and hopelessness leading many young people [towards extremism]" (Schwartz et al., 2009, p. 553). While the overwhelming majority of adolescents do not become involved in extremist groups, acknowledging this possibility underscores how the significant opportunities afforded by identity exploration in adolescence can be thwarted by conditions that increase the likelihood of marginalization.

Adolescent Capacity for Self-Direction

As adolescents ask, "Who am I?" their growing cognitive capacities also permit reflection on themselves in relation to a broader collective: "What is my role in my school? my community? my society?" As adolescents grow older, they have more opportunities to make their own choices in domains that matter for future outcomes, and their capacity to make such choices also increases; Box 2-1 describes youths' perspectives on this emerging autonomy, agency, and independence.

In the following section, we discuss developmental changes in autonomy, purpose, and agency in adolescence. One might think of these three things not only as competencies that develop within adolescents, but also as resources or opportunities they need to thrive as they transition into adult roles. Framing them as *both* capacities of the individual youth *and* as characteristics

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

BOX 2-1
Youth Perspectives: Sense of Agency, Purpose, and Autonomy

During adolescence, young people begin to develop autonomy, agency, and independence. When adolescent respondents age 16 to 24 were asked in a recent MyVoice poll about their perceptions of adolescence, respondents overwhelmingly spoke about this time as a period of opportunity and excitement, but with associated stressors and anxieties related to growing responsibilities and independence. (See Appendix B for a description of MyVoice and its methodology.)

> "It's been exciting learning about all the things I can do with myself and preparing my life being fully independent. I can start to see my future shaping up which is cool."—21-year-old, Asian, female

> "I feel that I have been able to start thinking about what I'm really passionate about and start cultivating skills that benefit those passions. It's exciting to start finding myself and see what may be the future." —17-year-old, White, female

> "I have fully come to terms with what I want to do in my life and with my sexuality."—16-year-old, Black, female

> "Building a stronger bond with my family and friends and learning that you have to keep pushing forward even through the hard times." —18-year-old, Hispanic, male

Many of the adolescents polled acknowledged feeling fearful about their new autonomy and independence. Lack of support, lack of knowledge of how to become an "adult," and stressors related to developing identity, relationships, increased responsibilities, and financial concerns were prominent themes.

> "Stressful. You can never be quite sure what decisions to make, and if they're even the right choice." —17-year-old, White, female

> "It's been rough. Becoming financially responsible was tough to learn and it took me years to finally spend and save money responsibly." —23-year-old, Hispanic, female

> "Stressful because you just get thrown off the deep end." —17-year-old, Asian, male

> "Very STRESSFUL. I am learning how to become an adult and it is hard, college is two years away from me and I am not ready. I am too scared to be on my own." —16-year-old, Hispanic, male

> "Increasingly difficult. I have social anxiety which has made it especially hard for me to get a job and even get my driver's license. I've yet to do either thing."—19-year-old, White, male

SOURCE: Information from MyVoice, 2019.

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

afforded by supportive settings reminds us that developmental pathways that lead to thriving in adulthood are not forged by adolescents alone, but instead require alignment between youths' strengths and the resources available in their environments.

Striving for Autonomy While Remaining Connected

For most adolescents, establishing a level of independence and self-sufficiency is normative. This typically involves individuating from one's family. However, gaining a sense of autonomy does not mean that adolescents strive to become detached from their family. Indeed, the developmental task for most teens is about establishing a balance between autonomy and connection (McElhaney et al., 2009). While many adolescents would like more autonomy for making decisions, this varies by age and domain (Daddis, 2011; Smetana, 2011). Most youth report having enough autonomy when it comes to making moral decisions, but younger adolescents tend to desire more autonomy for personal matters (e.g., hairstyle and clothing choices) and conventional matters (e.g., cursing/swearing) than older teens. This increase in desired autonomy among younger teens maps onto findings that older teens report having more autonomy across multiple domains than their younger peers.

Not only do young adolescents have less autonomy than older youth, they also tend to overestimate how much autonomy their peers have; in other words, younger adolescents tend to think their friends are allowed to have more control over their choices and behaviors than they actually do. Adolescents who think they have low levels of autonomy over decisions also tend to believe their friends have more autonomy, whereas adolescents who feel they have enough autonomy are less influenced by perceptions of their peers (Daddis, 2011).

Autonomy and Culture

The concept of "autonomy" implies independence, which generally is accepted as a core value among cultures oriented toward individualism. In contrast, one might expect youth from cultures oriented toward collectivism and interdependence to be more inclined toward harmonious, less conflictual relationships with parents and a lower desire for individuation. However, evidence suggests that teens in many cultures, both those labeled "individualist" and those labeled "collectivist," strive to develop autonomy, and levels of parent-teen conflict are similar in immigrant and nonimmigrant families (Fuligni and Tsai, 2015; Tsai et al., 2012). Studies of youth from multiple ethnic backgrounds in the United States, including those who are U.S.-born and those from immigrant families, show that most

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

adolescents express a desire to have control over personal choices (Phinney et al., 2005). Importantly, while youth across cultural backgrounds identify autonomy as important, there can be culturally relevant variations in how autonomy is defined. For example, some adolescents from Asian American heritage groups describe autonomy through the lens of "interdependence" (Russell et al., 2010).

Examining Autonomy and Culture "Under the Skin"

While all teens may desire autonomy from their parents and seek identities and self-definitions that go beyond their role in the family, adolescents in immigrant families in the United States may have a stronger sense of family obligation relative to youth in nonimmigrant families. Recent findings from the field of cultural neuroscience demonstrate the integration between biology and sociocultural context (Telzer et al., 2010; Fuligni and Telzer, 2013). In one study, White and Latinx older adolescents participated in laboratory-based tasks in which they were asked to allot cash rewards to themselves or to their families; during the task their patterns of brain activity were observed using functional magnetic resonance imaging (fMRI). While youth from both groups allotted cash rewards to family at the same rate, among Latinx youth the "reward centers" of the brain were more activated when they contributed to family, whereas White youth showed more brain activity in the reward centers when allotting cash to themselves. Across both groups, those who felt a stronger sense of family identification and who felt fulfilled by contributing to family had more activation in the reward centers of the brain when allotting cash to their family. Thus, the cultural meaning that youth and families make around issues of autonomy, connection, and obligation are connected to neurobiological responses in the context of family contribution.

Some studies show linkages between broad cultural orientations, such as being more individually or more collectively oriented, and patterns of neural response (Mrazek et al., 2015). Moreover, cultural neuroscientists posit that developmental growth and transitions in neural activity shape the transmission of cultural values, like preference for social hierarchy (Mrazek et al., 2015). In addition to the vmPFC and the anterior cingulate cortex regions of the brain implicated in personal identity development, researchers speculate that the temporoparietal junction may be implicated in culturally embedded identities that orient youth toward independence or interdependence (Cheon et al., 2011; Mrazek et al., 2015; Saxe et al., 2009).

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

Finding Meaning and Taking Action: Purpose and Agency

Purpose

Purpose has been defined as "a stable and generalized intention to accomplish something that is at once meaningful to the self and of consequence to the world beyond the self" (Damon et al., 2003, p. 121) and also as "a central, self-organizing life aim that organizes and stimulates goals, manages behaviors, and provides a sense of meaning" (McKnight and Kashdan, 2009, p. 242). Thus, one's sense of purpose can be oriented toward life aims that are self-focused or toward aims that transcend the self (Sumner et al., 2018; Yeager et al., 2012). Higher scores on measures of purpose are generally associated with more positive psychological well-being, a more consolidated identity, a deeper sense of meaning, and fewer health-compromising behaviors; a sense of purpose is also positively correlated with religiosity and spirituality (Burrow and Hill, 2011; Sumner et al., 2018). Moreover, there is evidence that purpose helps explain associations between identity commitment and positive youth adjustment (Burrow and Hill, 2011).

For all adolescents, developing a sense of purpose requires some support, particularly while their sense of orientation toward the future is still under development (Steinberg et al., 2009). For adolescents who experience marginalization—by virtue of membership in one or more groups that experience systemic oppression (García Coll et al., 1996; Causadias and Umaña-Taylor, 2018)—developing a sense of purpose may be compromised if structural discrimination makes links between present action and future outcomes unpredictable (e.g., for adolescents with an undocumented immigration status) (Gonzales, 2016; Sumner et al., 2018). Adolescents experiencing marginalization may internalize such messages as they become more aware of their own external realities; the messages may also be reinforced through family socialization practices. For example, researchers studying low-income White adolescents suggest that parents' messages of "isolation and threat, helplessness and hopelessness, and live fast, die young," which may be adaptive in the short-term and in the immediate settings where the families live, can compromise youth's sense of purpose, hope, and agency (Jones et al., 2018).

Agency to Take Action

Adolescents' growing competencies in flexible problem-solving, their awareness of and concern with others, and their openness to exploration and novelty (Crone and Dahl, 2012) make adolescence a particularly opportune time to allow for agency and leadership (Flanagan and Christens,

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

2011). Indeed, young people have been at the helm of social movements for centuries. For some youth, active civic engagement may be an adaptive means for coping with systemic injustice, particularly for those in historically marginalized communities (Diemer and Rapa, 2016; Ginwright et al., 2006; Hope and Spencer, 2017). In a recent multi-methods study of middle and late adolescents in seven community organizations (four in the United States, two in Ireland, and one in South Africa), many of which served low-income or working class communities, researchers documented multiple benefits of civic engagement. Findings suggest the context of youth organizing promoted the skills of critical thinking and analysis, social and emotional learning, and involvement in community leadership and action (Watts, 2018; Watts et al., 2011).

In relation to research on community leadership and action, recent work has examined the construct of "critical consciousness" among adolescents (Watts et al., 2011). Contemporary definitions of critical consciousness, grounded in the work of Brazilian educator Paolo Freire (1970), include the elements of critical reflection, motivation, and action (Diemer et al., 2015). These core concepts have informed the development of new measures of critical consciousness for middle and late adolescents (e.g., Diemer et al., 2017; McWhirter and McWhirter, 2016; Thomas et al., 2014). Youth with higher levels of critical consciousness are more likely to recognize injustice and may feel a greater sense of agency or efficacy in responding to it (Diemer and Rapa, 2016; Shedd, 2015). Critical consciousness is also positively associated with vocational and educational attainment (Diemer et al., 2010; Luginbuhl et al., 2016; McWhirter and McWhirter, 2016).

Capacity for Self-Direction as a Developmental Opportunity

While there is general agreement about the benefits of purpose and agency in adolescence, ongoing work is needed to better understand the circumstances under which they are best fostered and the way they relate to other processes (e.g., critical consciousness) and to behavior (e.g., volunteering, social activism). For instance, do opportunities for critical reflection contribute to an adolescent's sense of purpose? Are community service or civic action necessary for building an adolescents' belief in their own agency to create change?

Additional research might determine whether a sense of purpose that transcends the self has greater positive impact on an adolescent than one that is more self-focused. Current work in this area suggests that a self-transcendent sense of purpose better predicts academic regulation, performance, and persistence among high school students (Yeager et al., 2014); however, whether this extends beyond the school context is unclear. As research methods and methods in studies of critical consciousness continue

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

to advance (e.g., Diemer et al., 2015), we may have a better understanding of how this particular kind of agency develops across adolescence, and for whom and under what conditions greater critical consciousness is most beneficial. Finally, an emerging body of work on adolescents' contribution mindset (i.e., giving to others; Fuligni and Telzer, 2013) and value-based decision making (Pfeifer and Berkman, 2018) may provide some insight into the neurobiological correlates underlying the cognitive and social skills needed for developing purpose.

Summary

Over the course of adolescence, youth gain the cognitive skills needed to reflect on complex questions about their aims in life and their role in the world. They can question the legitimacy and fairness of everyday experiences and of social institutions. Indeed, the social systems they must navigate—schools, employment, health care, justice—are quite complex and often require them to engage in independent decision making. Two important questions stemming from this reality are, "What experiences are needed to support adolescents' agency as they transition into adult roles?" and "What might our society look like if all adolescents felt a sense of commitment to something personally meaningful and goal-directed that extends beyond the self?" (Bronk, 2014).

Supporting opportunities for autonomy and agency and fostering a sense of purpose may help adolescents explore meaningful questions about who they are, and about their place in the world and their capacity to shape it. Continuing shifts in the social, cultural, economic, and technological contexts in which today's adolescents are developing require thoughtful consideration as to how, when, and where adolescents can find and act upon ideas and issues they find meaningful. For example, religion has traditionally been a context where youth have found purpose and meaning, and religious involvement is associated with civic engagement (Furrow et al., 2004; Pew Research Center, 2019; Sumner et al., 2018). Religion can also be protective against stressors like discrimination and against negative mental health outcomes (Hope et al., 2017). However, adolescents and young adults today are less likely to be religiously engaged than those in earlier generations (Pew Research Center, 2018). If faith-based institutions are playing a less central role in the lives of greater numbers of today's adolescents, this brings to the fore questions about the alternative settings and experiences to which youth are turning and whether these settings play a comparable role in fostering involvement and purpose.

Although there is great variation in how the skills of autonomy, purpose, and agency manifest and how they are defined and valued, adolescents should be afforded opportunities—in families, schools, or out-of-school

Copyright National Academy of Sciences. All rights reserved.

The Promise of Adolescence: Realizing Opportunity for All Youth

settings—to develop them. Such skills not only are important to support the transition to adulthood, but also make adolescence itself a period that fosters a propensity to choose their own paths in life and to shape the roles they want to play in their communities (Fuligni, 2018).

CONCLUSION

Adolescence, spanning the period from the onset of puberty to adulthood, is a formative period where changes in cognition, affect, and interpersonal behavior occur alongside the most extensive biological transitions since infancy, especially with respect to pubertal and brain development. Collectively, the pubertal, neurobiological, cognitive, and psychosocial changes occurring during adolescence mark this as a period of great opportunity for adolescents to flourish and thrive.

While often thought of as a time of turmoil and risk for young people, adolescence is more accurately viewed as a developmental period rich with opportunity for youth to learn and grow. If provided with the proper supports and protection, normal processes of growth and maturation can lead youth to form healthy relationships with their peers and families, develop a sense of identity and self, and experience enriching and memorable engagements with the world. Adolescence thus forms a critical bridge between childhood and adulthood and is a critical window of opportunity for positive, life-altering development. As a positive window of opportunity, adolescence marks a period of optimism, where the assets of youth and their development may be capitalized for the betterment of society.

Important questions emerge from these findings. What are the "windows of opportunity" for promoting a positive developmental trajectory and adaptive plasticity? What are the mechanisms that shape developmental trajectories, for better or worse, during adolescence and over the life course? To begin to answer these, in the next chapter we consider the emerging science of epigenetics as it reveals the ongoing plasticity of the brain and the reciprocal influences of brain on body and vice versa.

Copyright National Academy of Sciences. All rights reserved.