



The Impact of Substance Use on the Developing Adolescent Brain

Produced in Partnership:



Network Coordinating Office

ATTC

Addiction Technology Transfer Center Network
Funded by Substance Abuse and Mental Health Services Administration



Interdisciplinary Leaders in
Substance Use Education,
Research, Care and Policy



by



at the
University of
Chicago



Webinar Moderator

Tracy McPherson, PhD

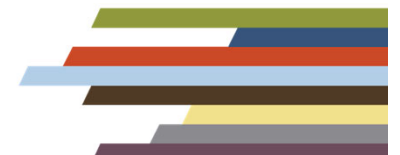
Senior Research Scientist

Public Health Department

NORC at the University of Chicago

4350 East West Highway 8th Floor,
Bethesda, MD 20814

McPherson-Tracy@norc.org



Produced in
Partnership...



Network Coordinating Office

ATTC Addiction Technology Transfer Center Network
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attcnetwork.org



Interdisciplinary Leaders in
Substance Use Education,
Research, Care and Policy

amersa.org

ADOLESCENT

S B I R T

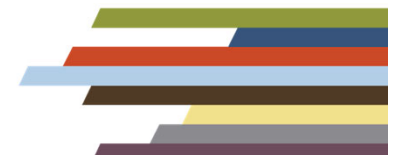
Screening, Brief Intervention & Referral to Treatment

by

NORC

at the
University of
Chicago

sbirt.webs.com





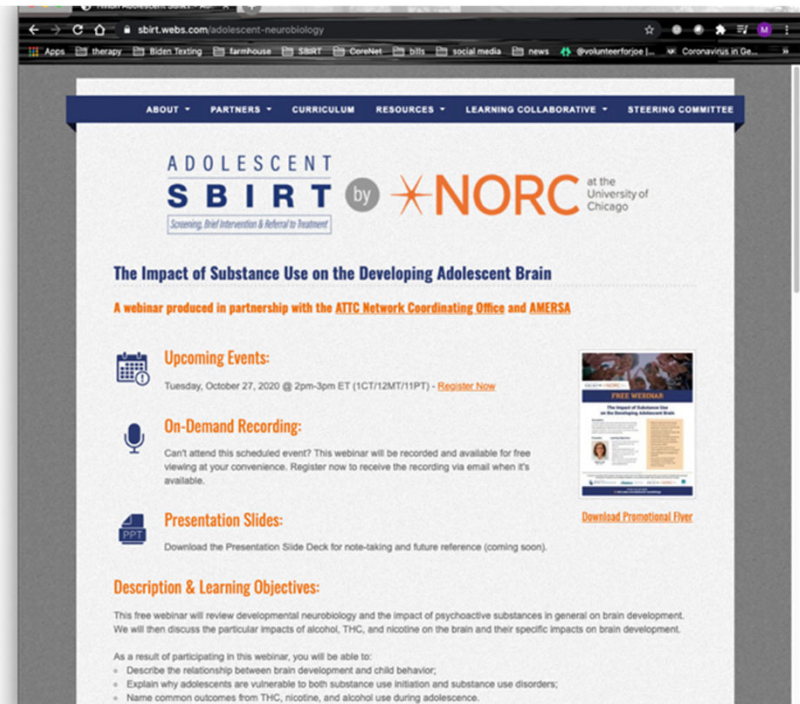
- 1) The Impact of Substance Use on the Developing Adolescent Brain
- 2) Who's Doing What?: The Epidemiology of Adolescent Substance Use
- 3) Substance Use Interventions for Adolescents and Transitional Age Youth
- 4) Integrating Stigmatized Loss and Disenfranchised Grief into the SBIRT Model

attcnetwork.org/centers/global-attc/tay-webinar-series

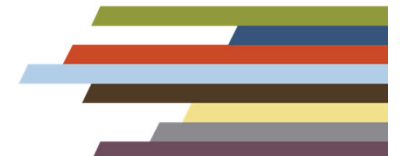
Access Materials

- Bookmark the website
- Follow-up email
- On-demand access 24/7
- Brief survey
- Certificate of Completion brief application (1 NAADAC CE)

sbirt.webs.com/adolescent-neurobiology



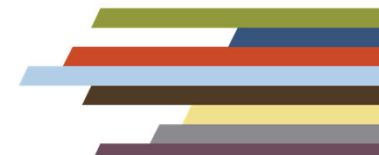
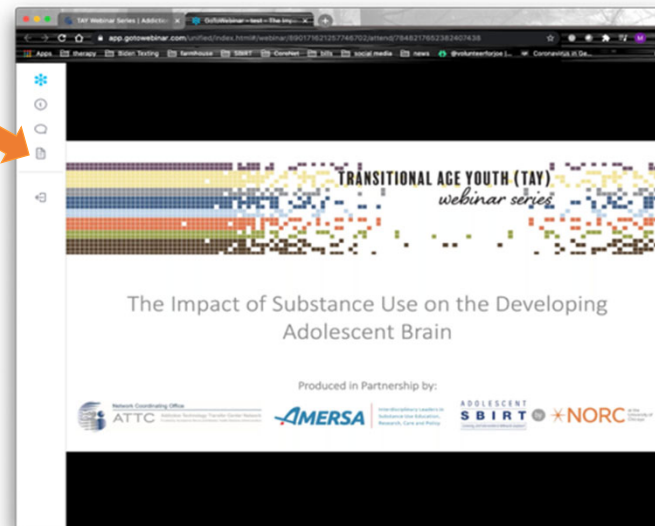
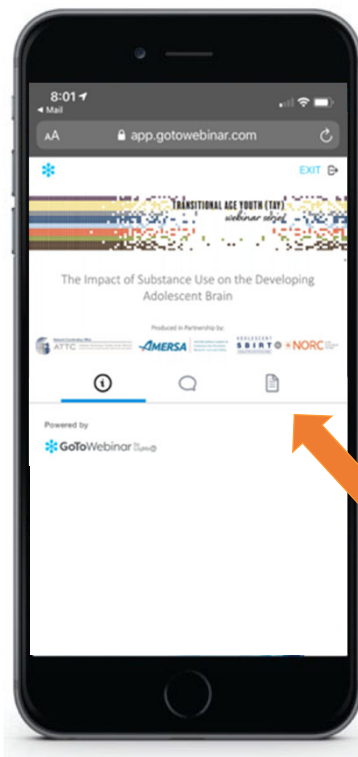
The screenshot displays the website for 'Adolescent SBIRT by NORC' at the University of Chicago. The page is titled 'The Impact of Substance Use on the Developing Adolescent Brain' and is a webinar produced in partnership with the ATTC Network Coordinating Office and AMERSA. It lists an upcoming event on Tuesday, October 27, 2020, at 2pm-3pm ET, with a 'Register Now' link. It also offers an 'On-Demand Recording' for those who cannot attend, and 'Presentation Slides' for download. The 'Description & Learning Objectives' section states that the webinar will review developmental neurobiology and the impact of psychoactive substances on brain development, and lists three learning objectives: describing the relationship between brain development and child behavior, explaining why adolescents are vulnerable to substance use, and naming common outcomes from THC, nicotine, and alcohol use.



Access PowerPoint Slides

Access the PowerPoint slides through the “Handouts” pane of your GoToWebinar Control Panel on your computer or mobile device.

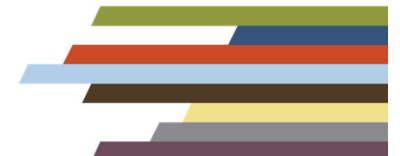
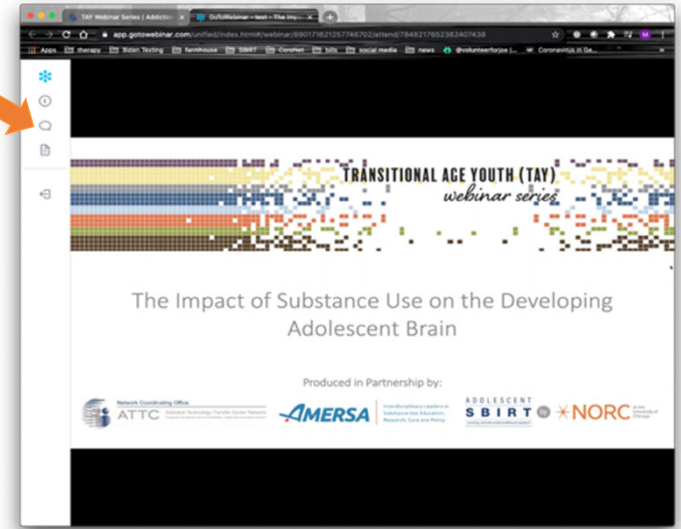
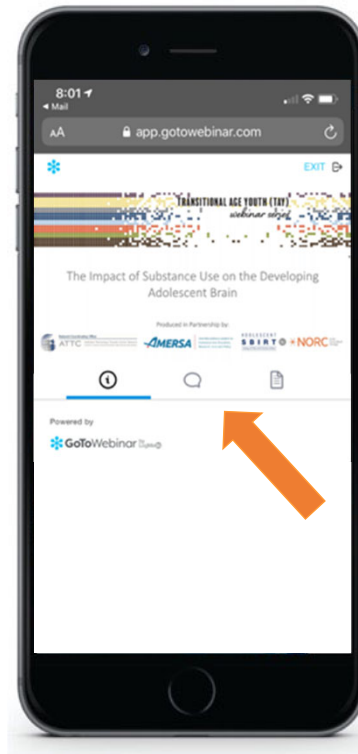
Or, download them from the website.



Ask Questions

Ask questions at any point through the “Chat” pane of your GoToWebinar Control Panel on your computer or mobile device.

Answers will be posted on the website.





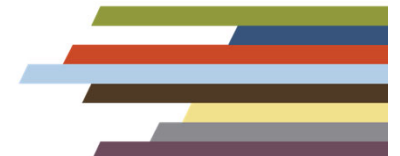
Webinar Presenter

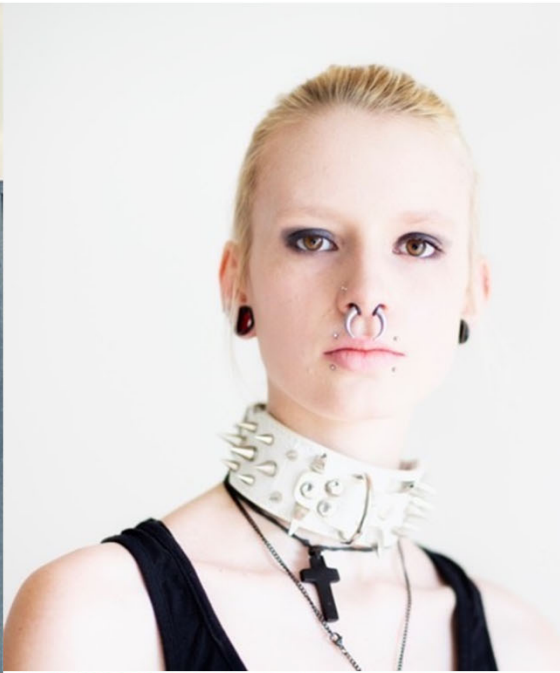
Sharon Levy, MD, MPH

Director, Adolescent Substance
Use and Addiction Program
(ASAP)

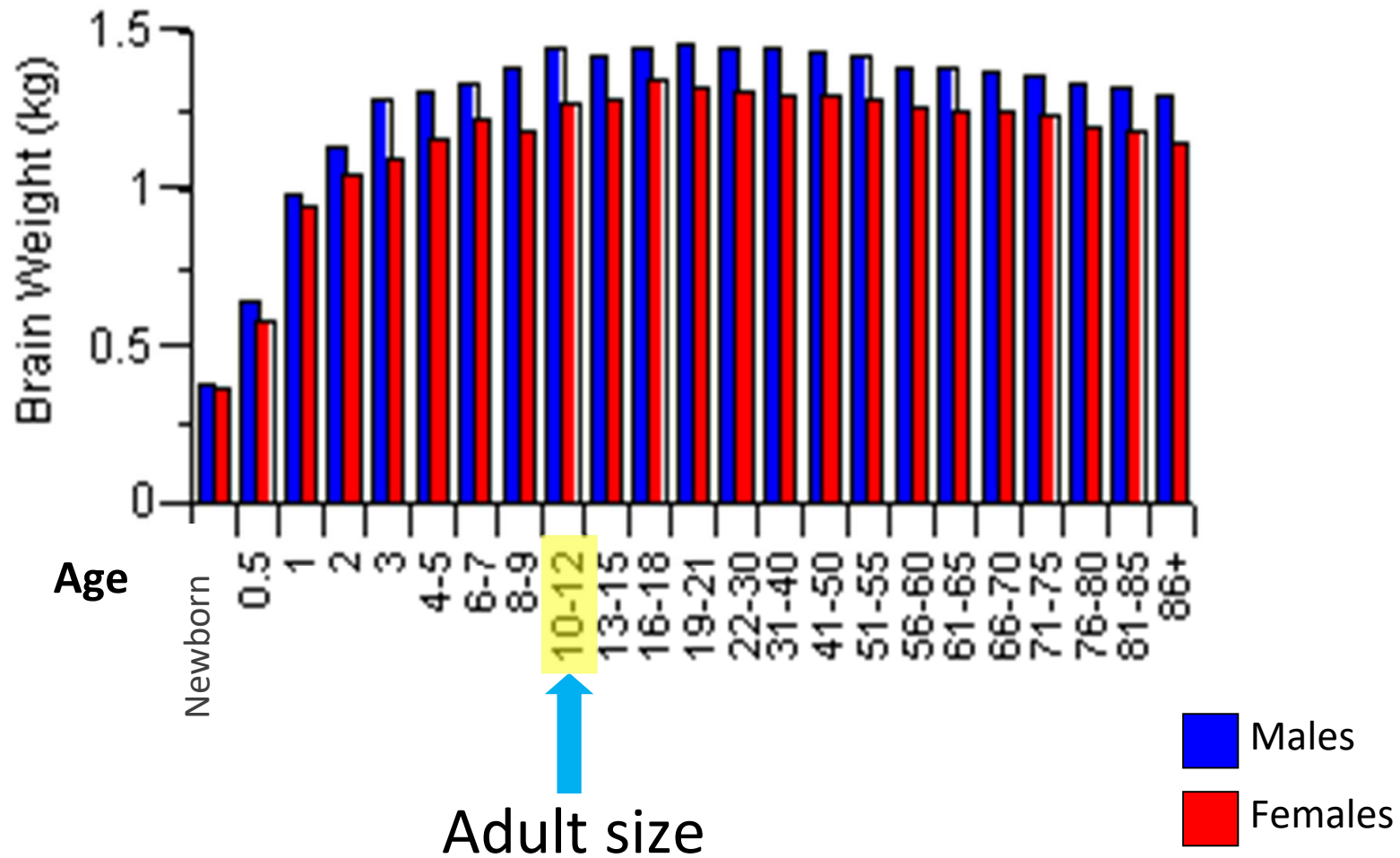
Boston Children's Hospital

Associate Professor of Pediatrics
Harvard Medical School





Brain weight by age



Source: Dekaban, A.S. and Sadowsky, D. (1978). *Annals of Neurology*, 4:345-356.

Neuron growth in brain development

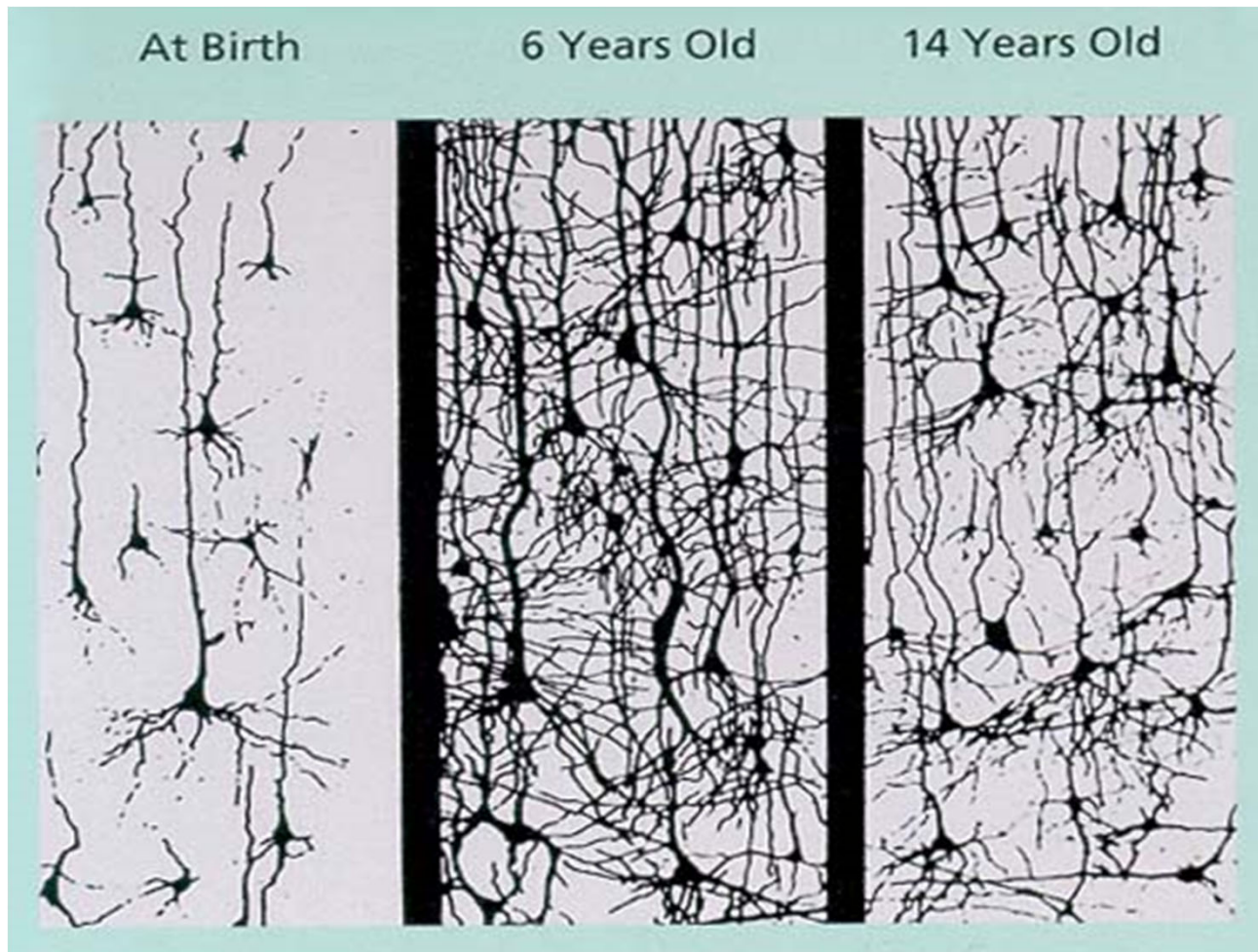
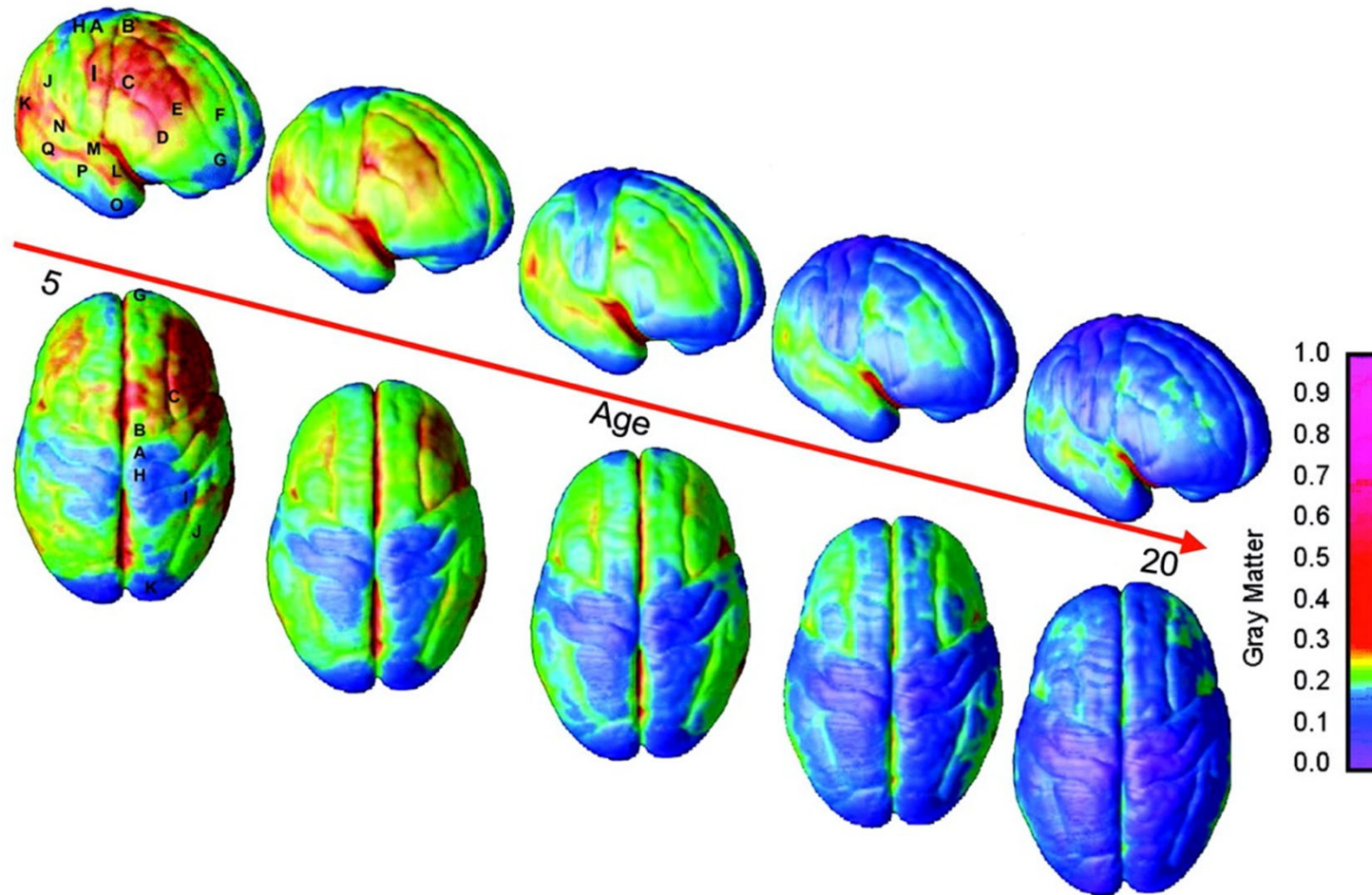


Image retrieved from: http://etec.cltl.ubc.ca/510wiki/Brain-based_Learning

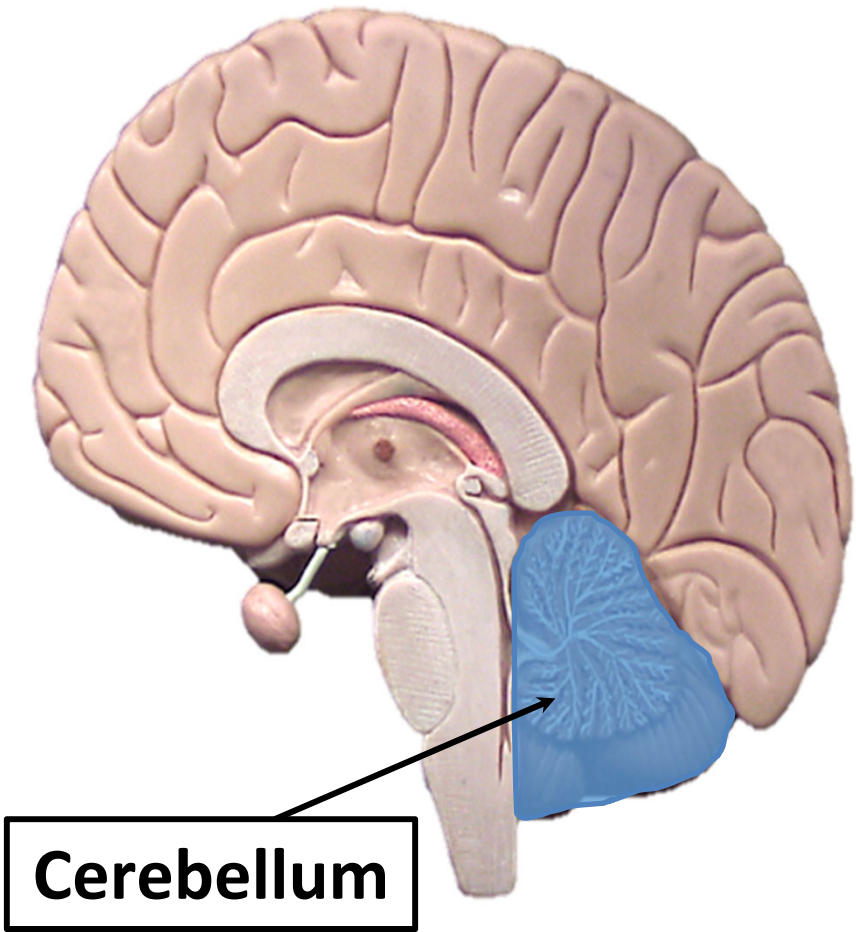
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Brain maturation

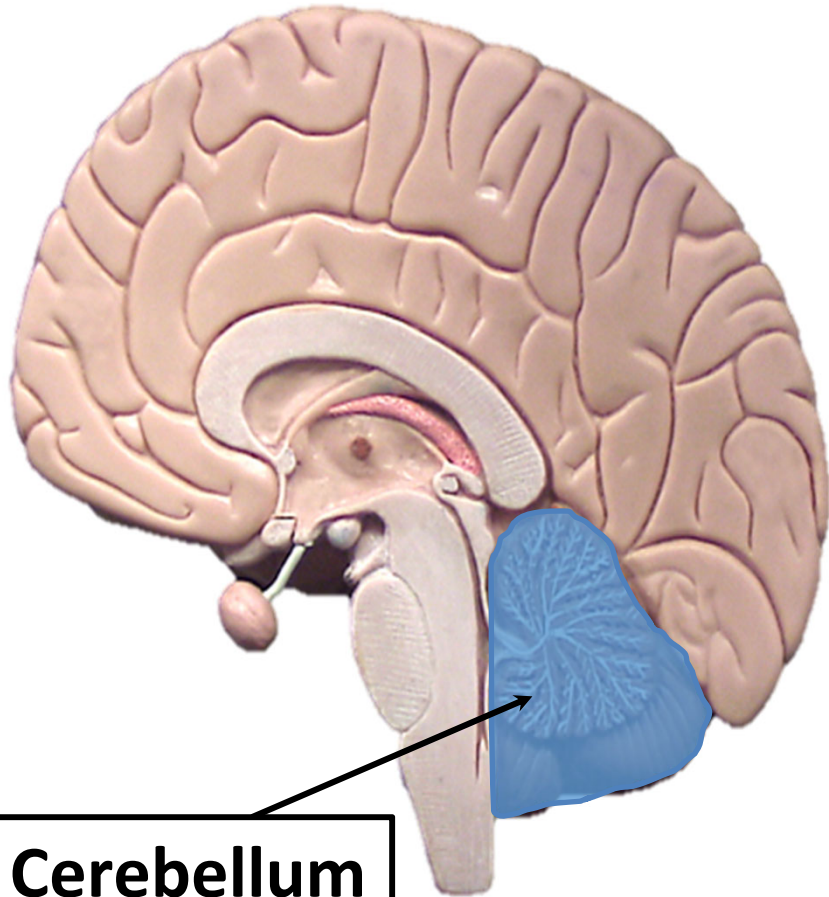


Source: Copyright (2004) National Academy of Sciences, USA. Gogtay et al. *PNAS* 2004;101(21):8174-8179. Retrieved on February 17, 2015. Permission received from PNAS.

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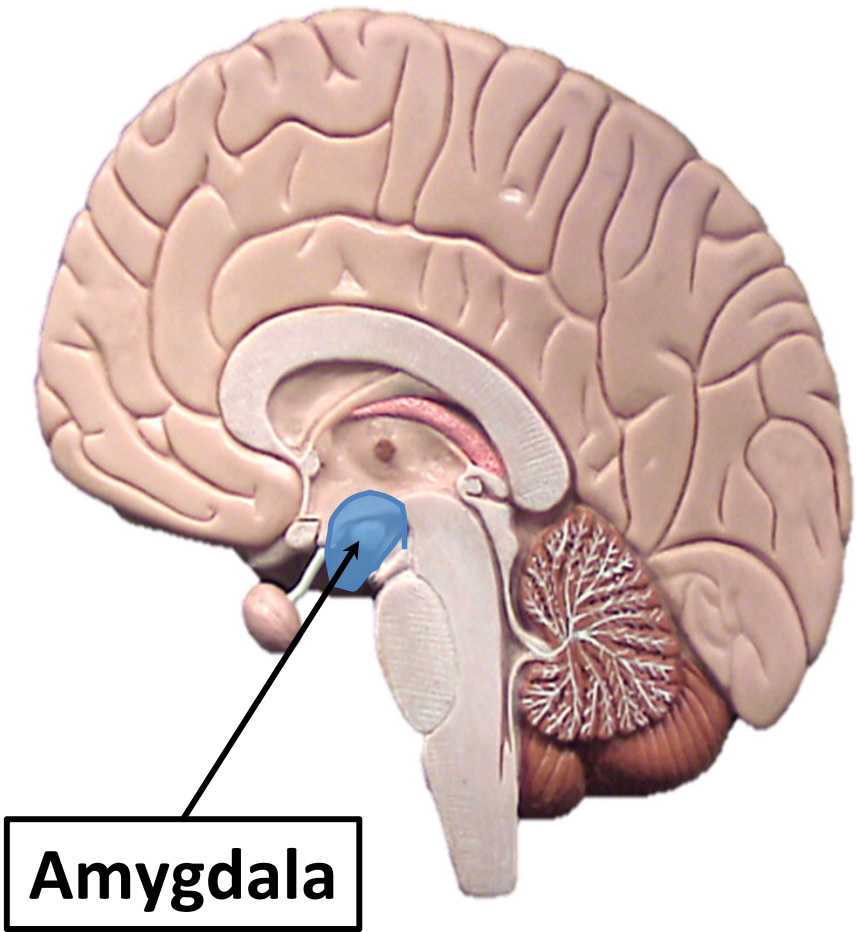


Cerebellum

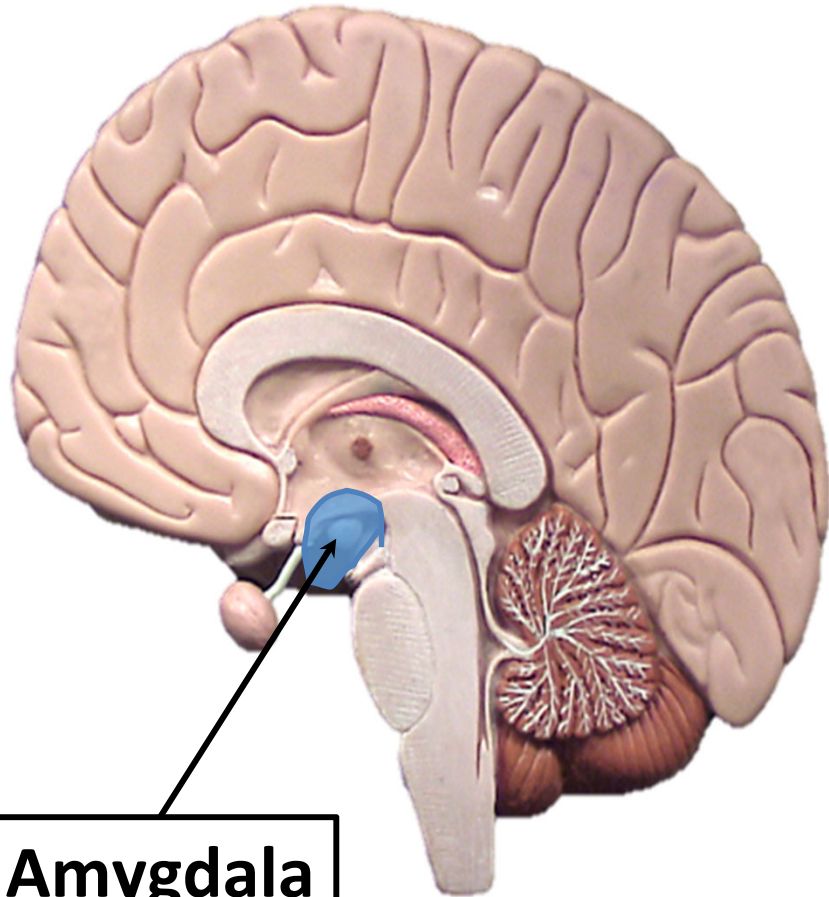


Cerebellum



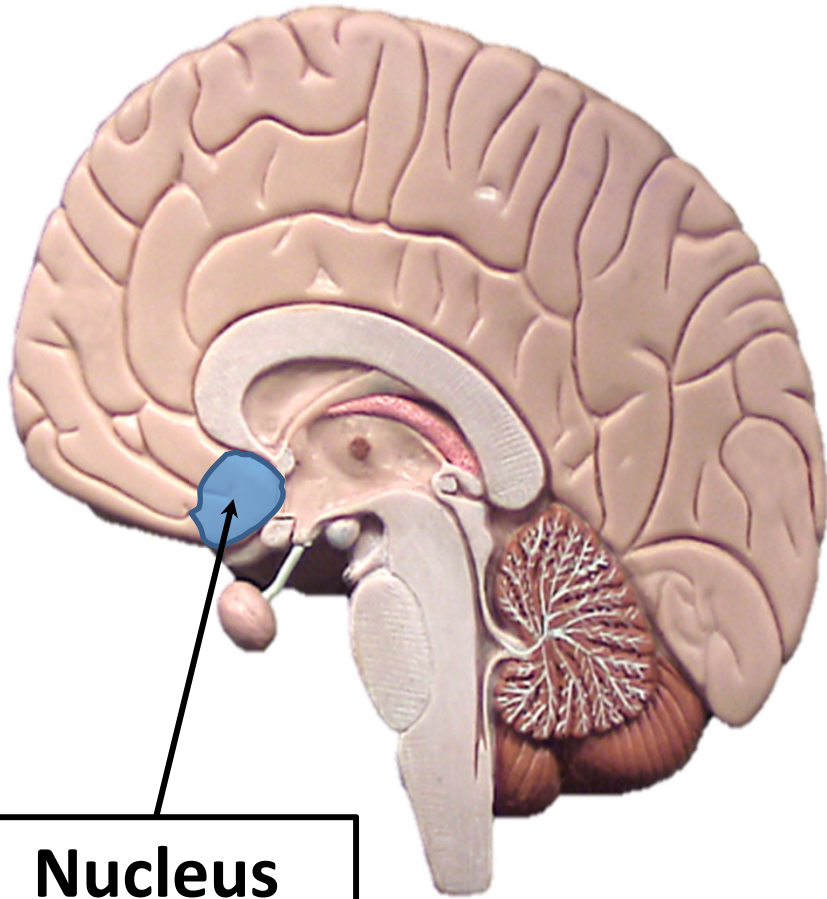


Amygdala

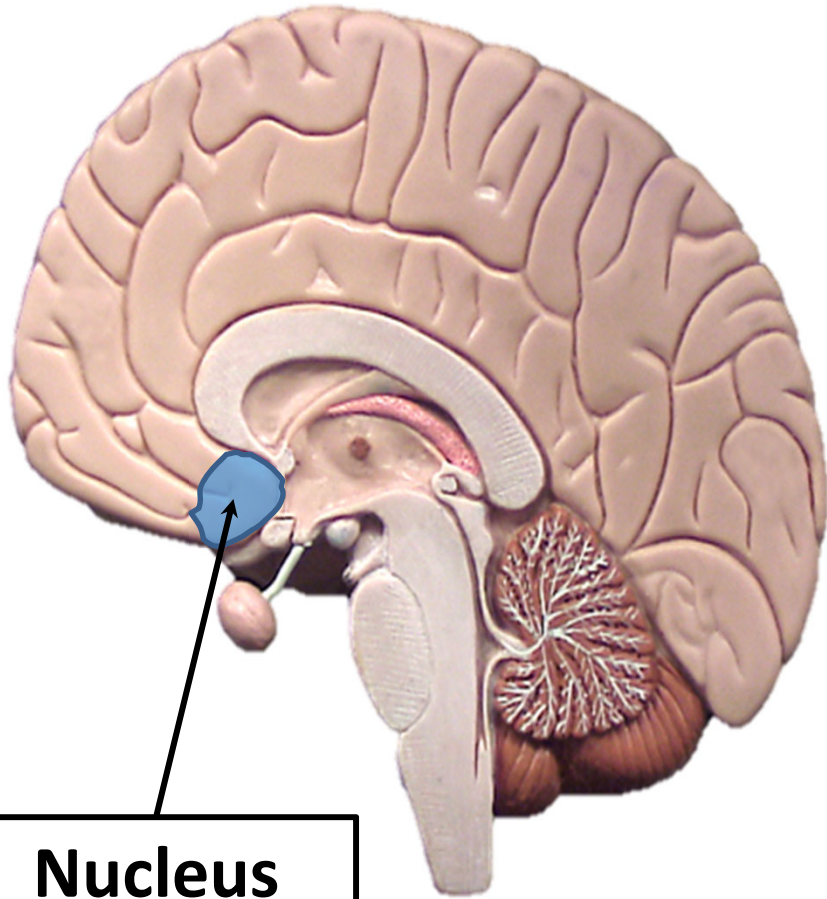


Amygdala



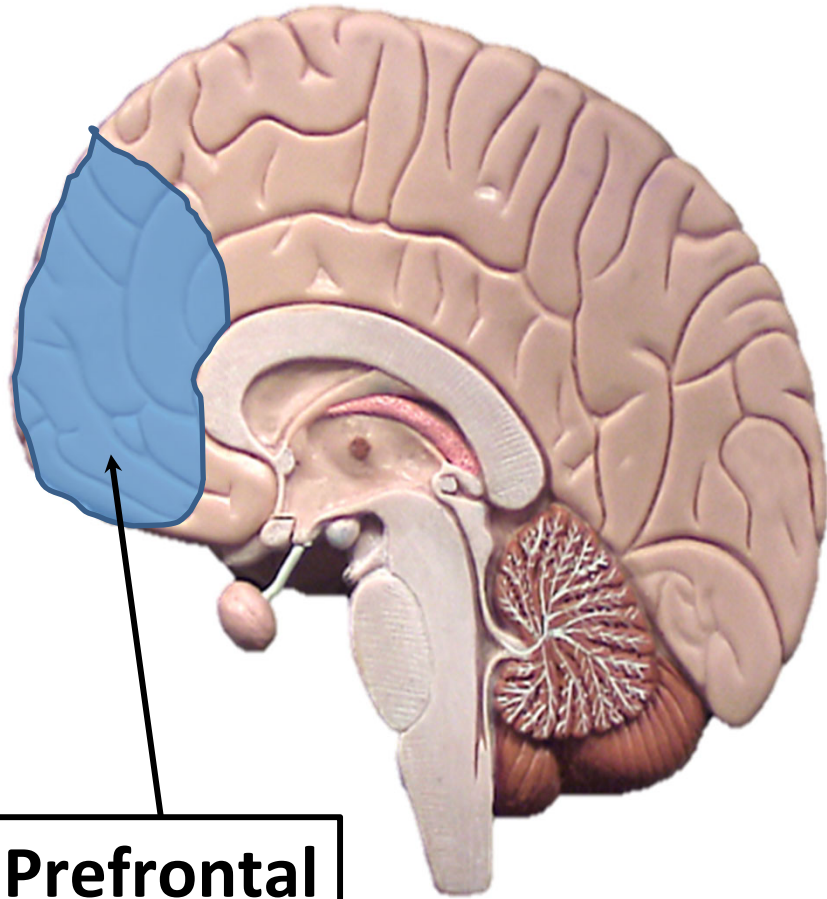


**Nucleus
accumbens**

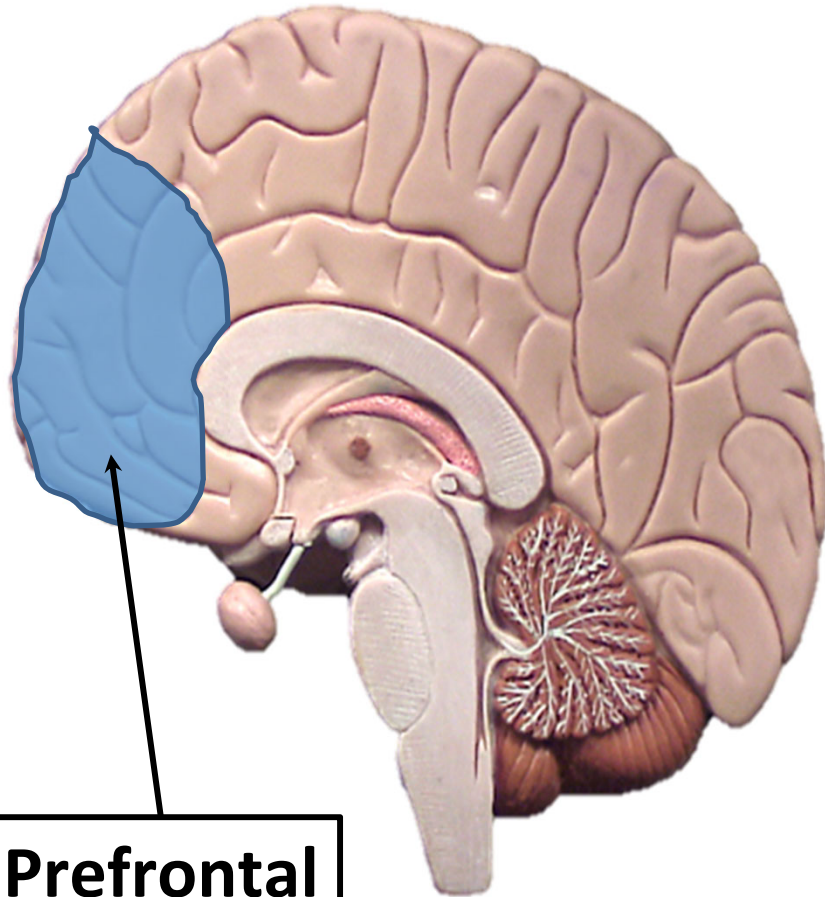


Nucleus accumbens



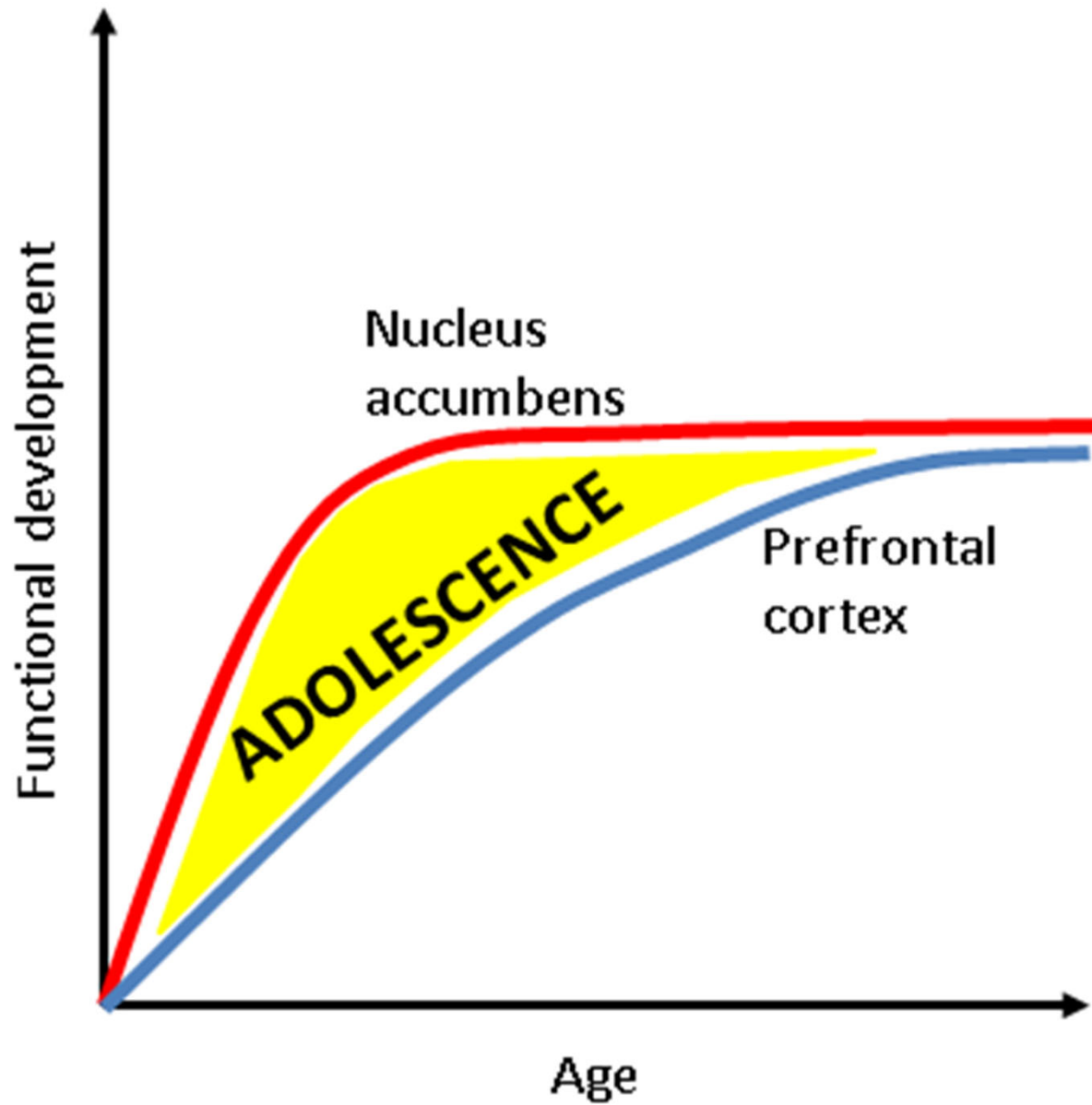


**Prefrontal
cortex**



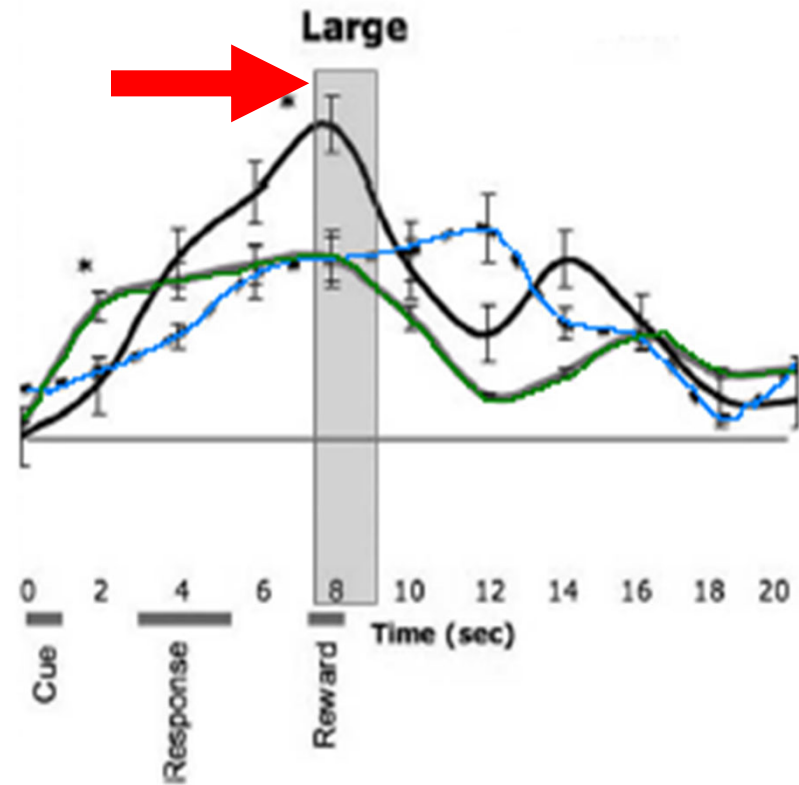
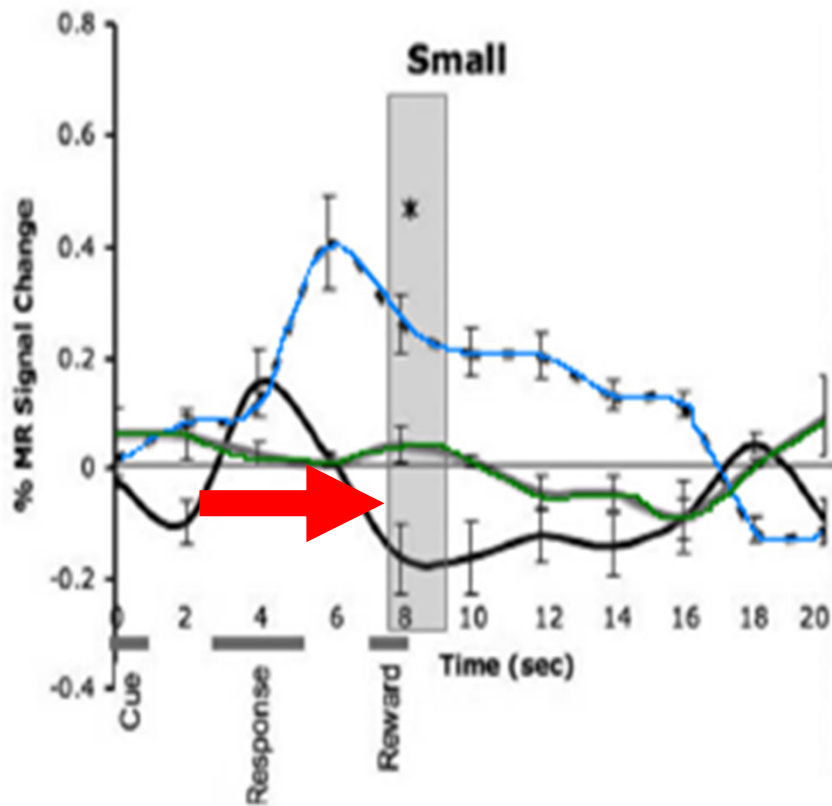
**Prefrontal
cortex**





Source: Casey BJ, et al., Development Reviews. 2008; 28: 62-77.

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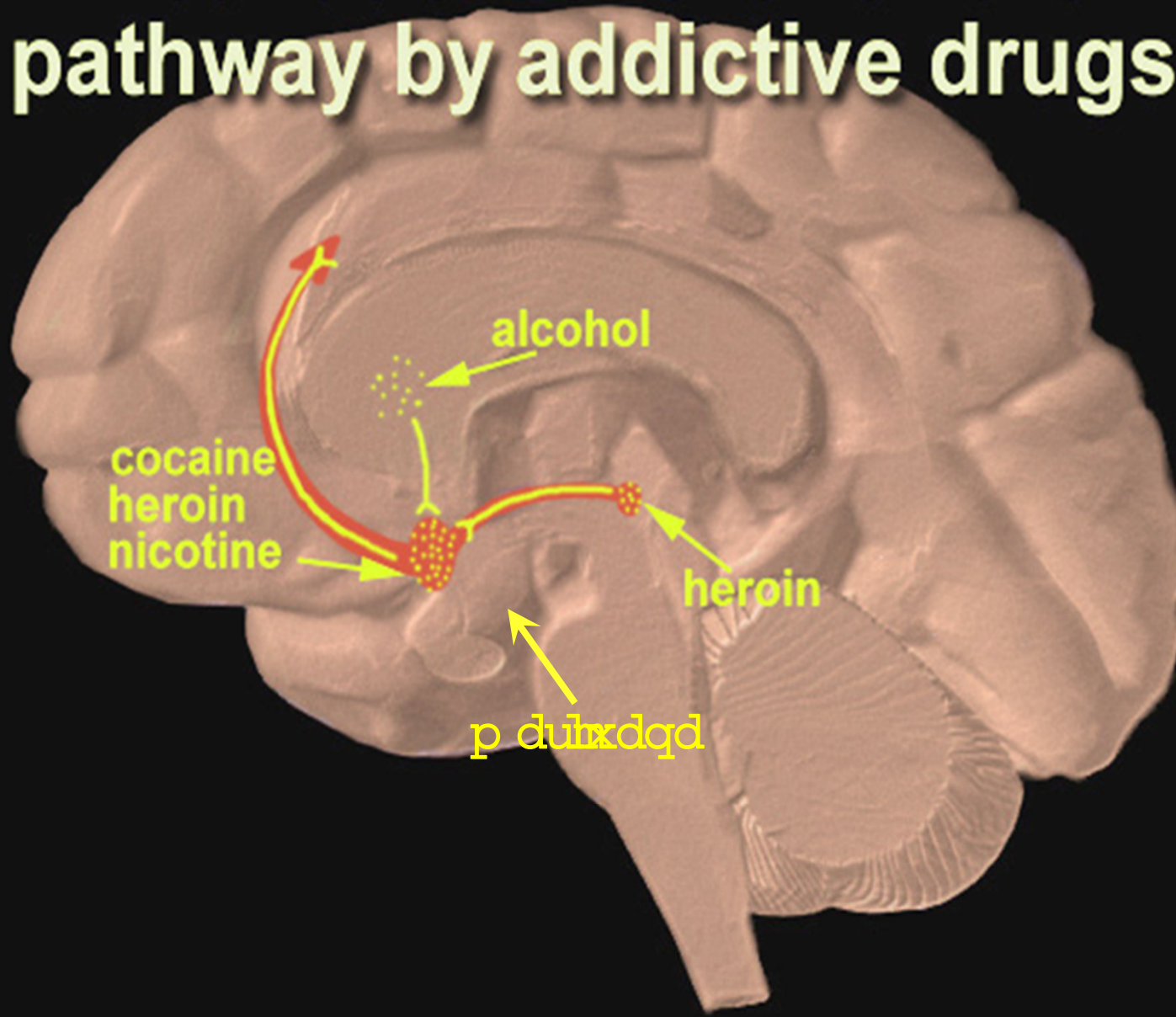


■ Children, ages 7-11

■ Teens, ages 13-17

■ Adults, ages 23-29

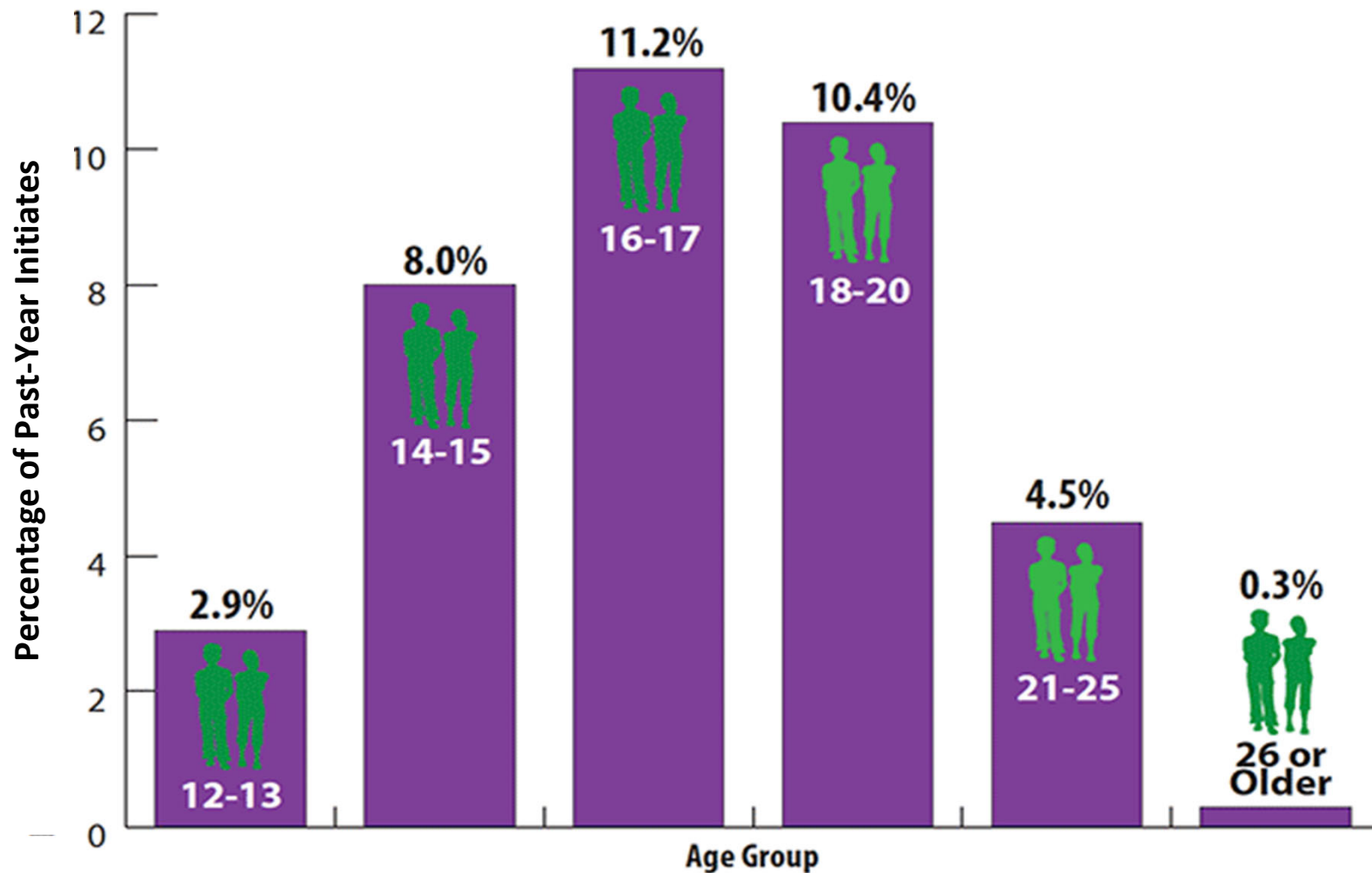
Activation of the reward pathway by addictive drugs



Adolescents are **developmentally primed** to use drugs



Most drug use starts in adolescence



Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2011 and 2012.

Adolescents are **developmentally vulnerable** to develop substance use disorders

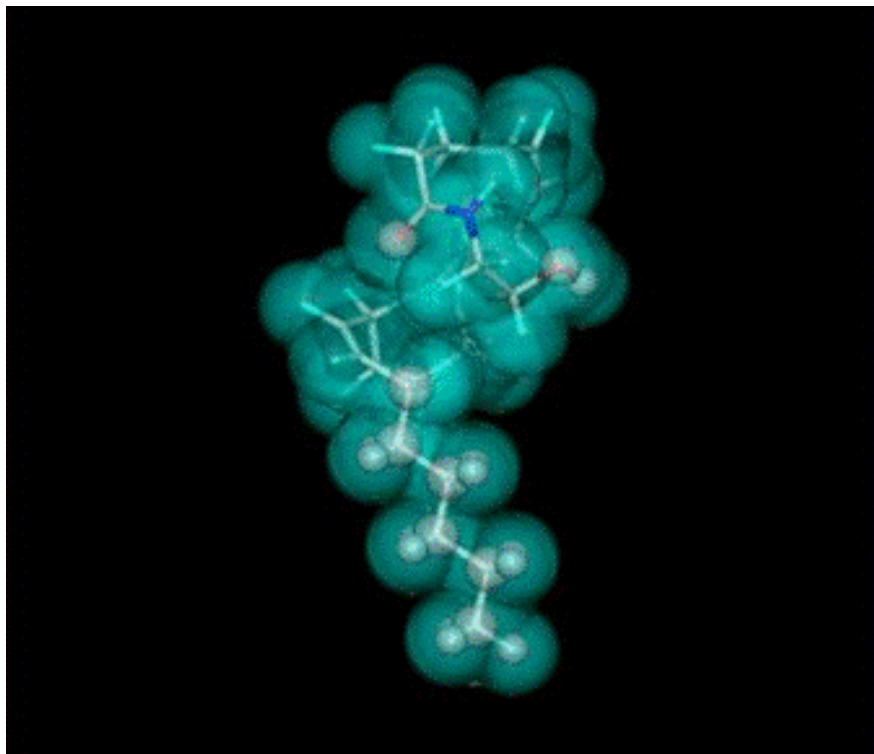




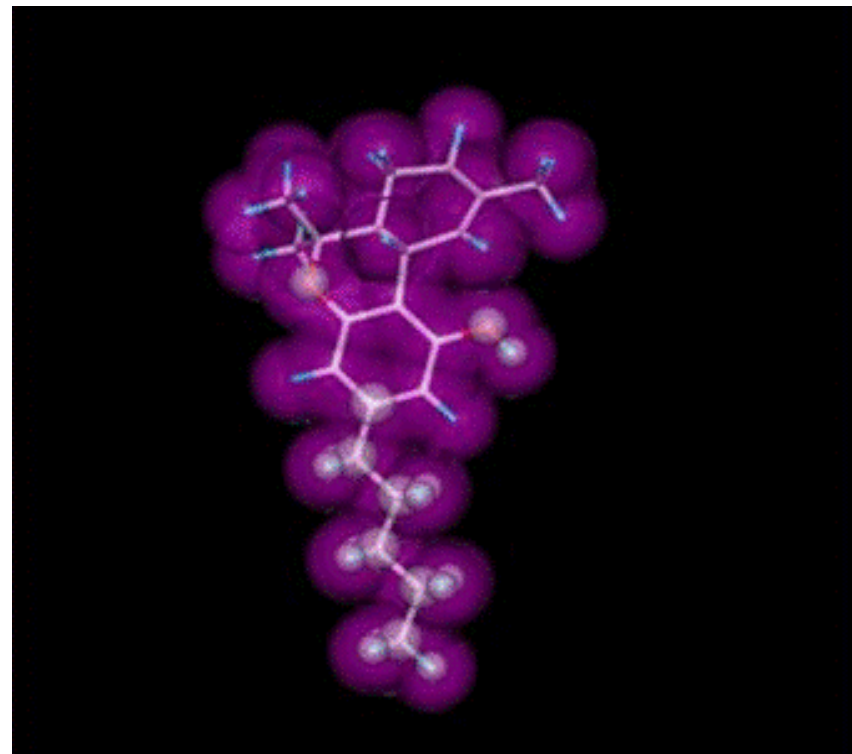
THC



Anandamide

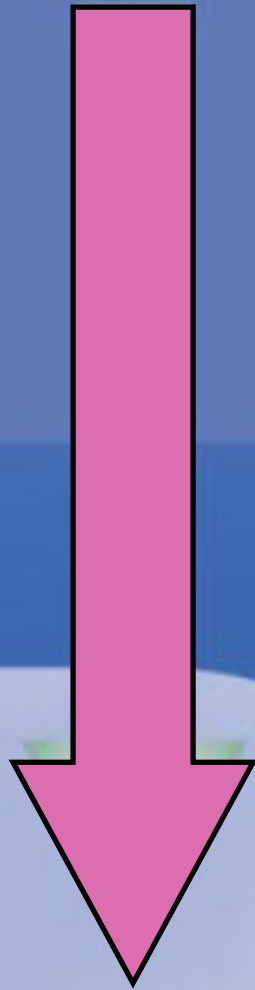


THC

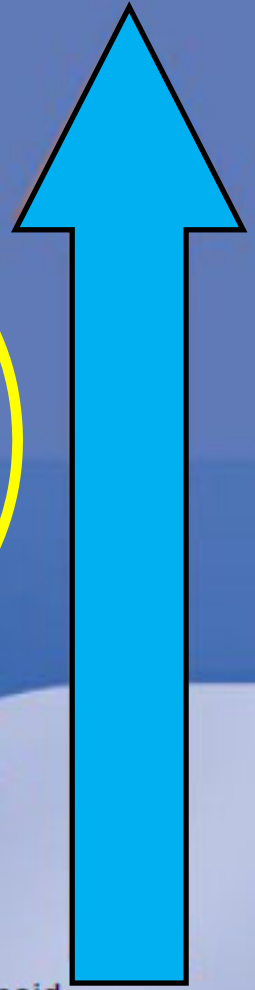


The neuron's "volume control" dials down neuron activity when too strong

Signal direction for neurotransmitters



Signal direction for endocannabinoids

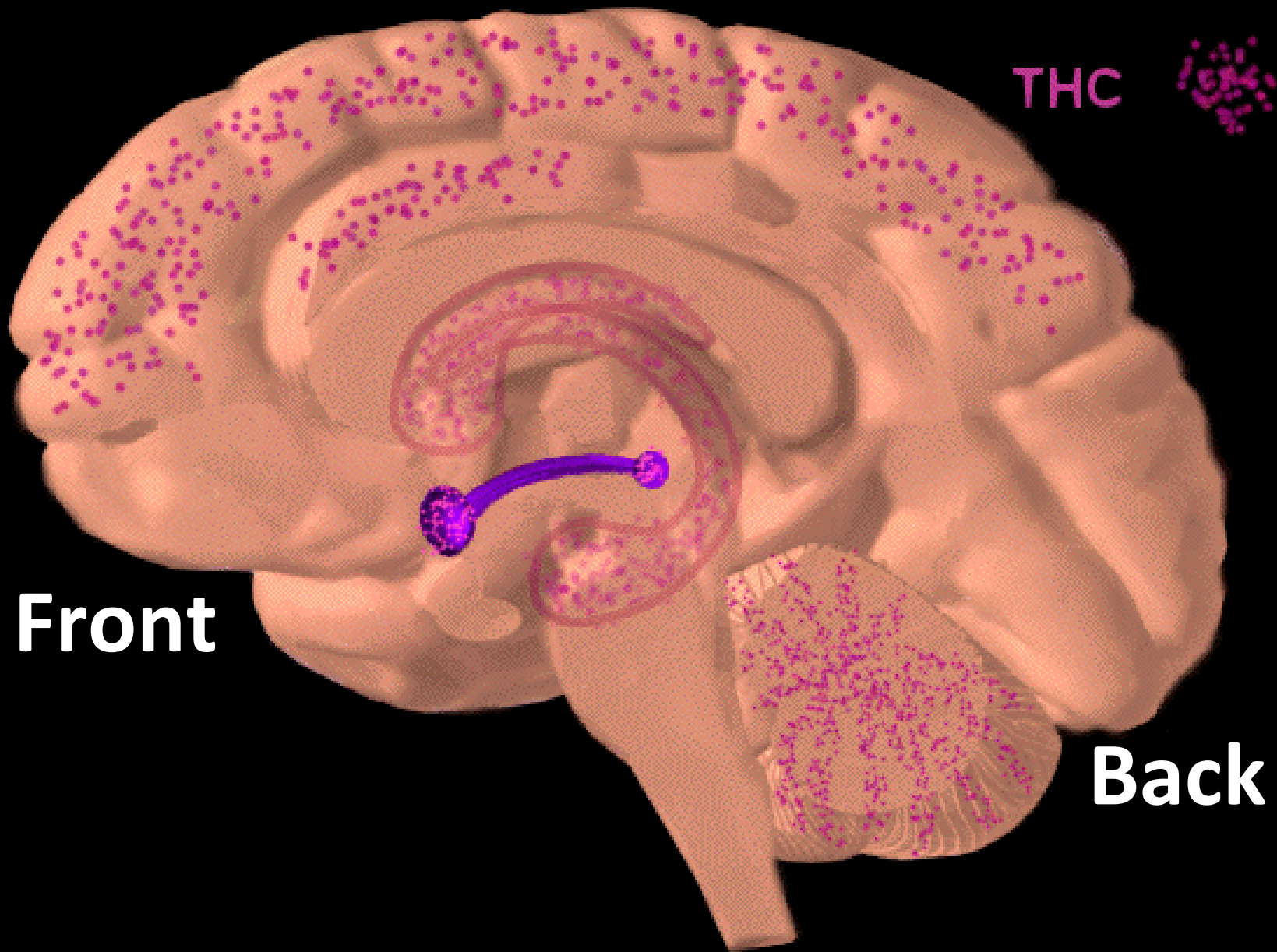


Presynaptic neuron

CB1 receptor

Postsynaptic neuron

Endocannabinoid



Receptor binding in brain tissue

Compound	Potency relative to THC
(-)-Delta9-THC	1
Anandamide	.47*

*The affinity of anandamide for cannabinoid receptors ranges from about one-fourth to one-half that of THC. The differences depend on the cells or tissue that are tested and on the experimental conditions, such as the binding assay used.

Source: Joy J, Watson SJ, Benson JJ, eds. Cannabinoids and animal physiology. In: *Marijuana and Medicine: Assessing the Science Base*. Washington, DC: Division of Neuroscience and Behavioral Health - Institute of Medicine. National Academies Press; 1999:288

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THC vs. Anandamide



Source: Joy J, Watson SJ, Benson JJ, eds. (1999). Cannabinoids and animal physiology. In: *Marijuana and Medicine: Assessing the Science Base*. Washington, DC: Division of Neuroscience and Behavioral Health -Institute of Medicine. National Academies Press.

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Memory impairment



Source: Iversen L. How cannabis works in the brain. In *Marijuana and Madness*. Ed. Castle & Murray, 2004. Oxford University Press.

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Persistent cannabis users show neuropsychological decline from childhood to midlife

Madeline H. Meier^{a,b,1}, Avshalom Caspi^{a,b,c,d,e}, Antony Ambler^{e,f}, HonaLee Harrington^{b,c,d}, Renate Houts^{b,c,d}, Richard S. E. Keefe^d, Kay McDonald^f, Aimee Ward^f, Richie Poulton^f, and Terrie E. Moffitt^{a,b,c,d,e}

^aDuke Transdisciplinary Prevention Research Center, Center for Child and Family Policy, ^bDepartment of Psychology and Neuroscience, and ^cInstitute for Genome Sciences and Policy, Duke University, Durham, NC 27708; ^dDepartment of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, NC 27710; ^eSocial, Genetic, and Developmental Psychiatry Centre, Institute of Psychiatry, King's College London, London SE5 8AF, United Kingdom; and ^fDunedin Multidisciplinary Health and Development Research Unit, Department of Preventive and Social Medicine, School of Medicine, University of Otago, Dunedin 9054, New Zealand

The Dunedin Study

N = 1,037



13 yrs
(Pre-initiation)

18 yrs

21 yrs

32 yrs

38 yrs



Assessment ages

The Dunedin Study

N = 1,037



13 yrs
(Pre-initiation)



18 yrs

21 yrs



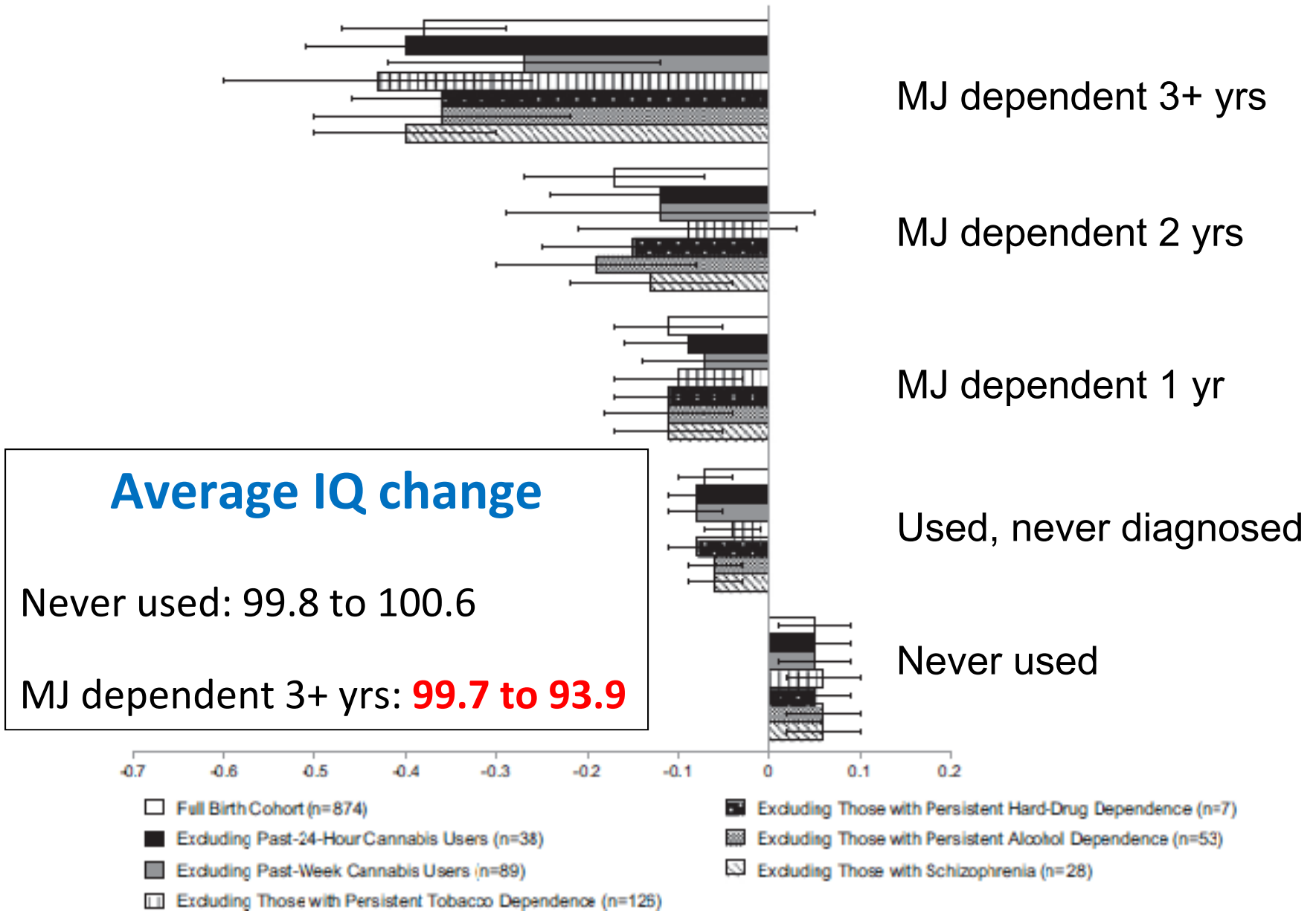
32 yrs



38 yrs



Assessment ages



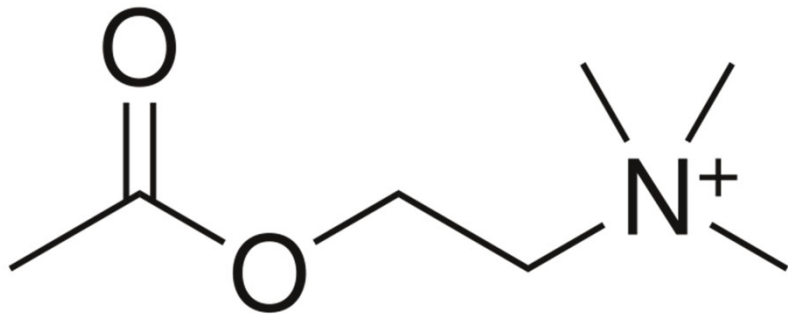
Source: Meier et al. (2012). Persistent cannabis users show neuropsychological decline from childhood to midlife. *P Nat Acad Sci* 109(40):E2657–E2664.

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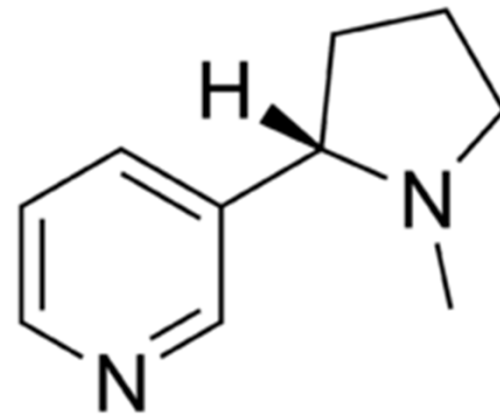
Nicotine



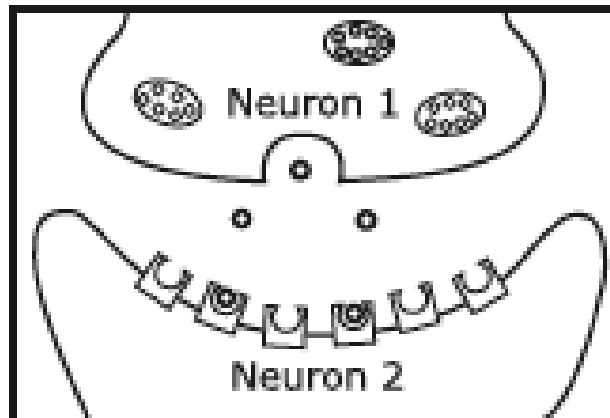
Acetylcholine



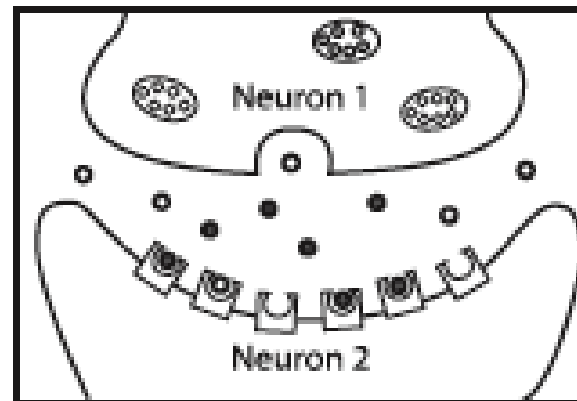
Nicotine



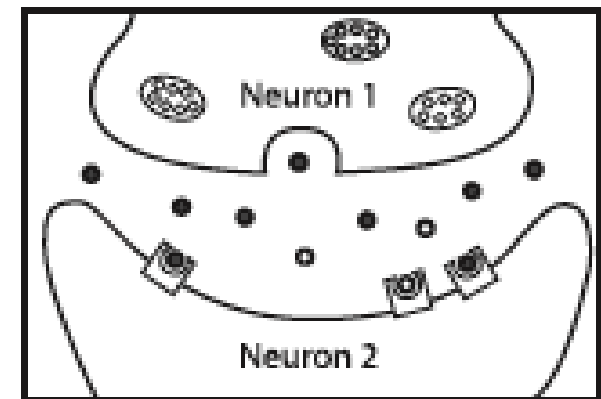
Nicotine Receptors in the CNS



Nonsmoker

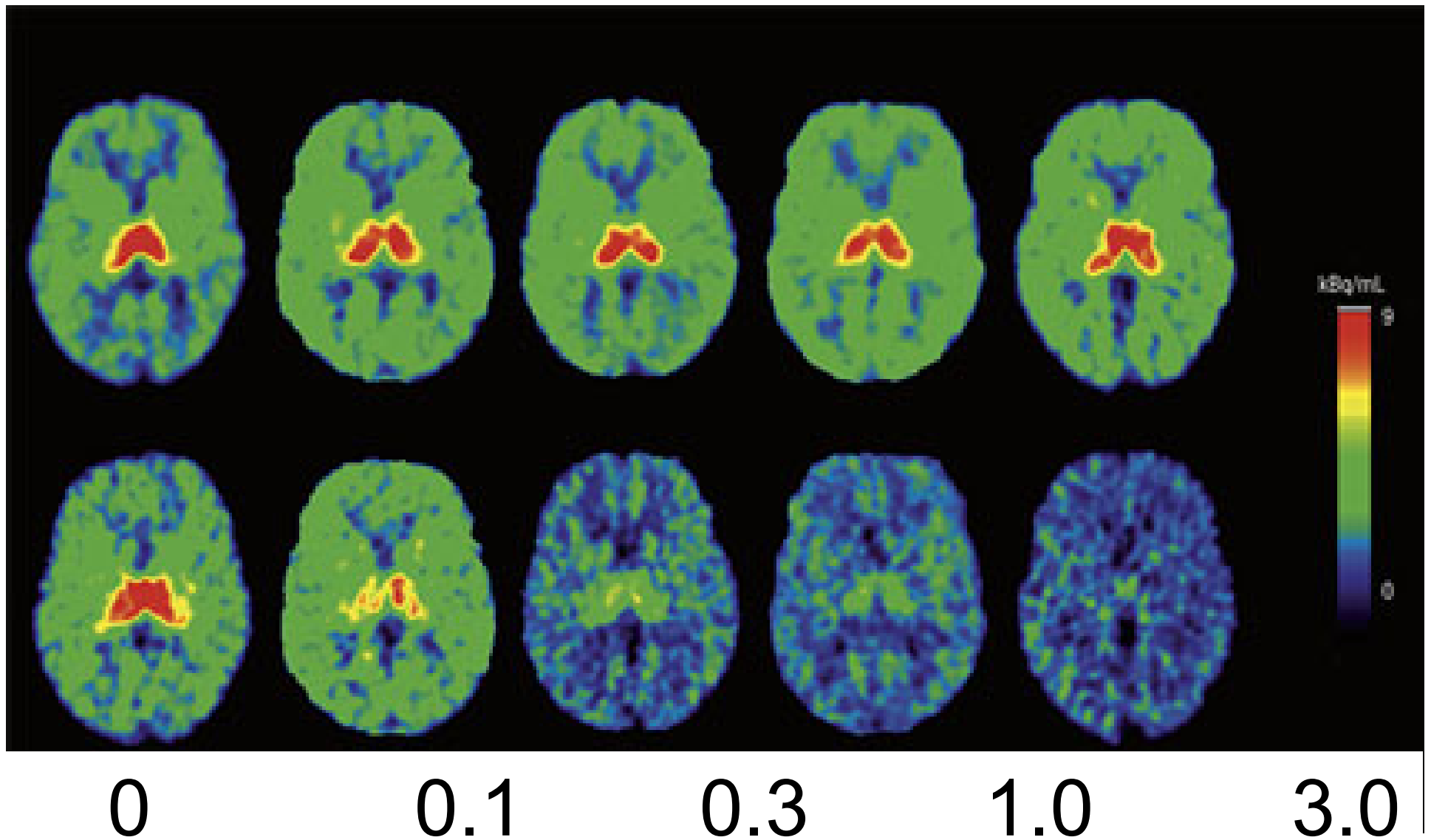


New Smoker

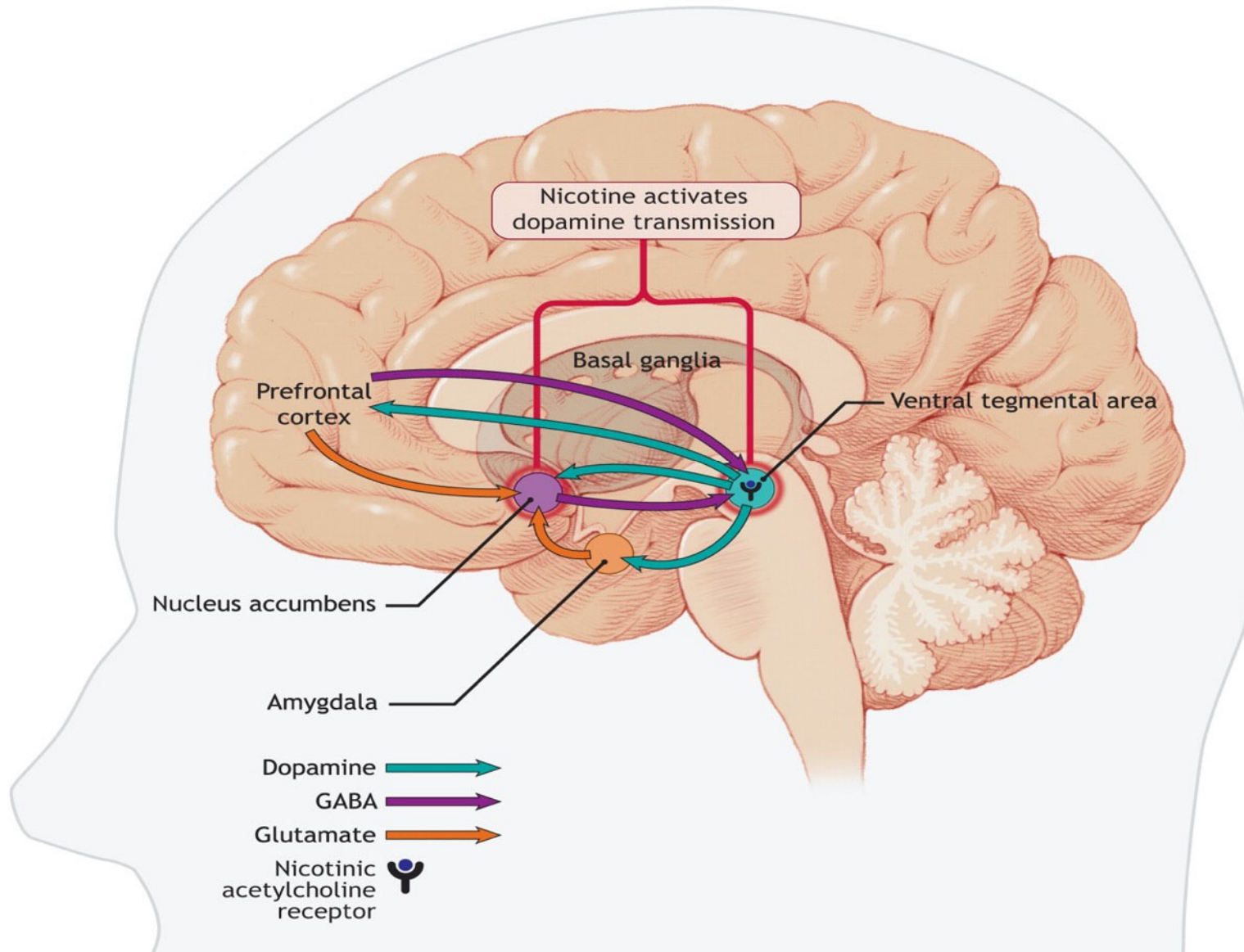


Addicted Smoker

Source: <https://www.drugabuse.gov/publications/brain-power/grades-6-9/legal-doesn't-mean-harmless-module-2/background>



Brody AL, et al. Cigarette Smoking Saturates Brain $\alpha 4\beta 2$ Nicotinic Acetylcholine Receptors. *Arch Gen Psychiatry*. 2006;63(8):907–914. doi:10.1001/archpsyc.63.8.907



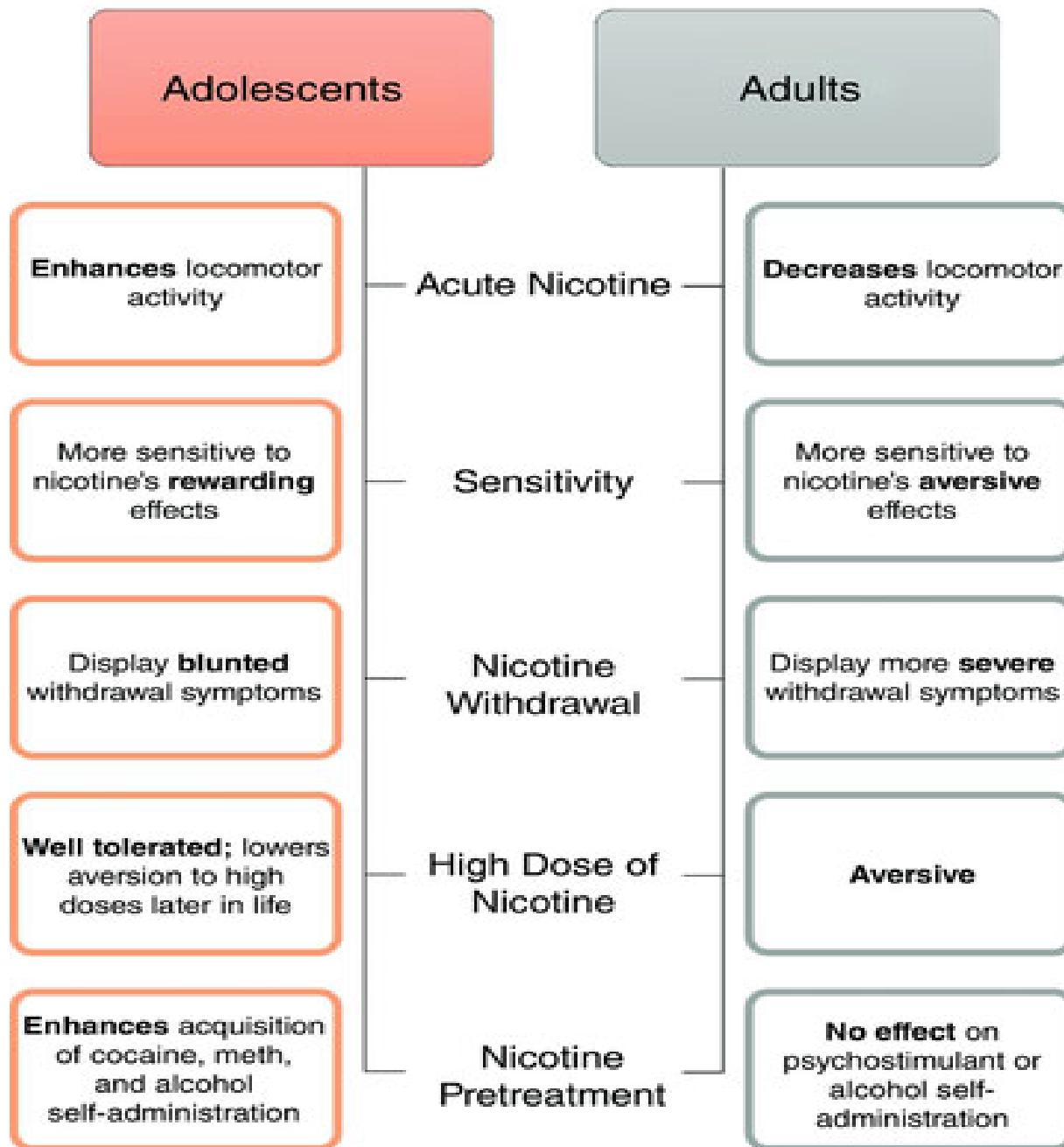
FP DM Qryhp ehuf 53/533: 4:: #44,46:6046;3>GR L#kwsv-2yr lruj 243148362fp dnt3:395:

Slide 43

LS16

Current data indicate that nicotine disrupts normative limbic development and primes behavioral susceptibility to drugs of abuse (McQuown et al. 2009; Dao et al. 2011).

Levy, Sharon, 10/13/2020

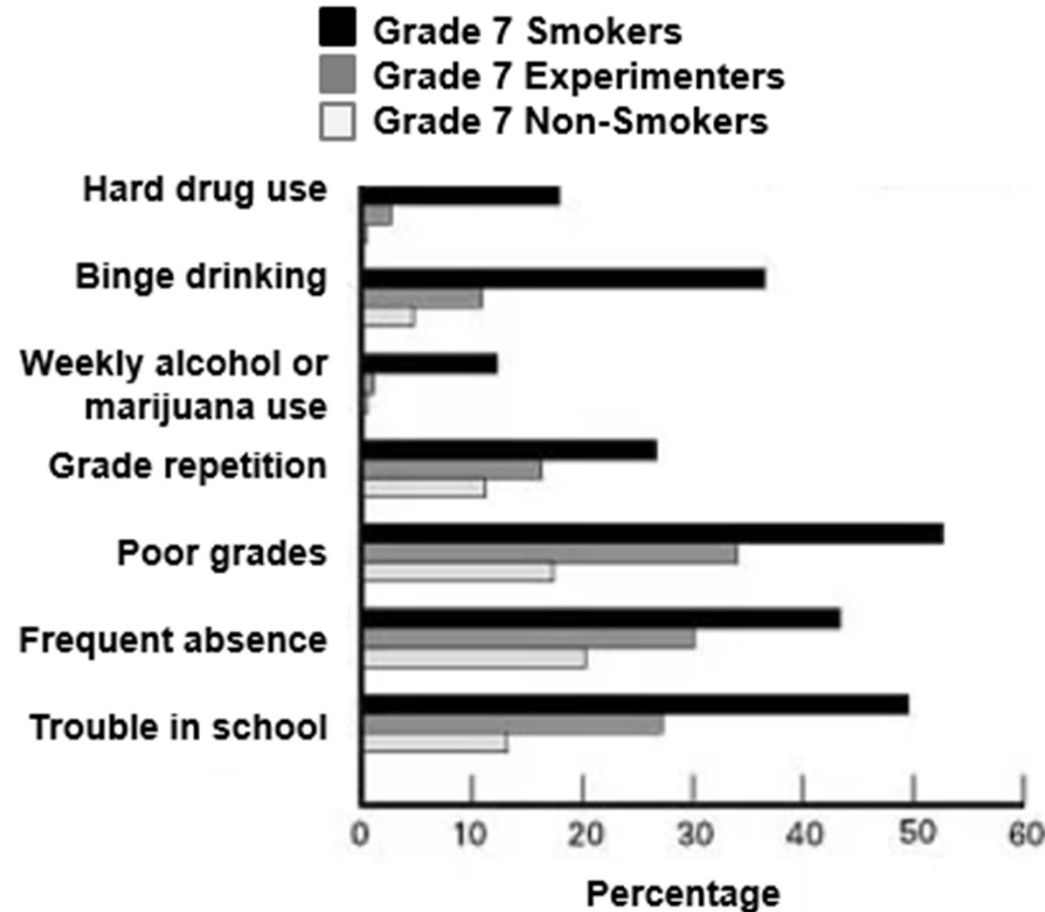


Source: <https://physoc.onlinelibrary.wiley.com/doi/full/10.1113/JP270492>

Does Early Smoking Signal Later Problems?

by Phyllis L. Ellickson, Robert M. Bell, Khanh Van T. Bui, David J. Klein, Joan S. Tucker, Kimberly A. McGuigan

Concurrent Problems of Grade 7 Nonsmokers, Experimenters, and Smokers



“Smokers were those who had smoked three or more times in the past year; experimenters had smoked, but fewer than three days in the preceding year and not in the past month; and nonsmokers were those who had never smoked.”

Ellickson, Phyllis L., Robert M. Bell, Khanh Van T. Bui, David J. Klein, Joan S. Tucker, and Kimberly A. McGuigan, Does Early Smoking Signal Later Problems?. Santa Monica, CA: RAND Corporation, 2002. https://www.rand.org/pubs/research_briefs/RB4547.html.

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Vaping



Self-Reported Use of Tobacco, E-cigarettes, and Marijuana Versus Urinary Biomarkers

Rachel Boykan, Catherine R. Messina, Gabriela Chateau, Allison Eliscu, Jonathan Tolentino and Maciej L. Goniewicz

Pediatrics May 2019, 143 (5) e20183531; DOI: <https://doi.org/10.1542/peds.2018-3531>

Comparison of Urinary Cotinine (ng/mL) Concentrations Among Adolescents and Young Adults (n = 517), Ages 12–21, Who Reported Past-Week Use of Nicotine-Containing Products

	Mean	SD	Median
Only tobacco (n = 6)	330.30	517.84	99.97
Only e-cigarette (n = 51)	189.72	472.49	3.56
Dual users (tobacco and e-cigarette) (n = 9)	524.77	708.45	267.55
Pod users (n = 19)	598.68	739.58	259.03
Tobacco alone and marijuana (n = 3)	638.77	619.59	442.92
E-cigarette alone and marijuana (n = 24)	329.67	651.69	7.6
Dual users and marijuana (n = 6)	448.73	592.75	297.61

Boykan, R., et al. (2019). "Self-Reported Use of Tobacco, E-cigarettes, and Marijuana Versus Urinary Biomarkers." *Pediatrics* **143(5)**: e20183531.

Vaping Dictionary

- Nicked
- French inhale
- Ghosting
- Stacking
- Blinking
- Nic sick



Nicotine Toxicity



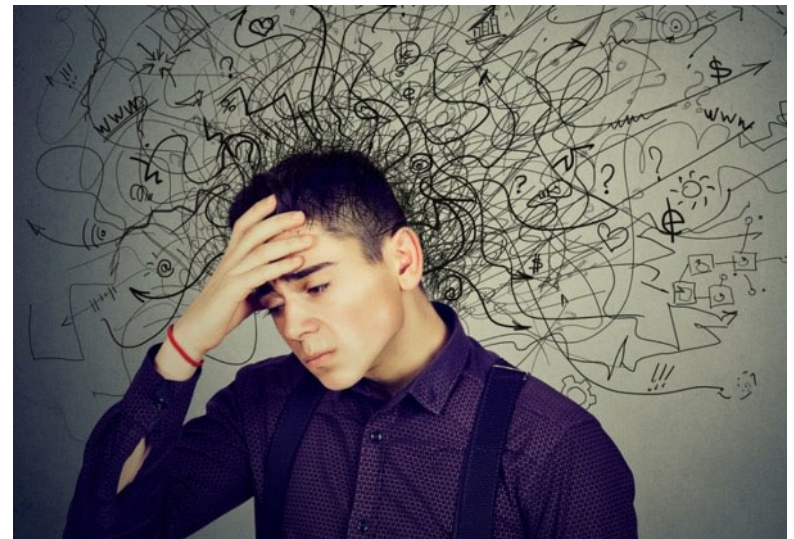
Stomach pain



Dizziness



Headaches



Decreased Concentration

“When I first used I would get a buzz and my entire body would feel tingly. My eyes would water up. I would feel as if I had been spinning around and just stopped.

14 year old boy describing nicotine effects

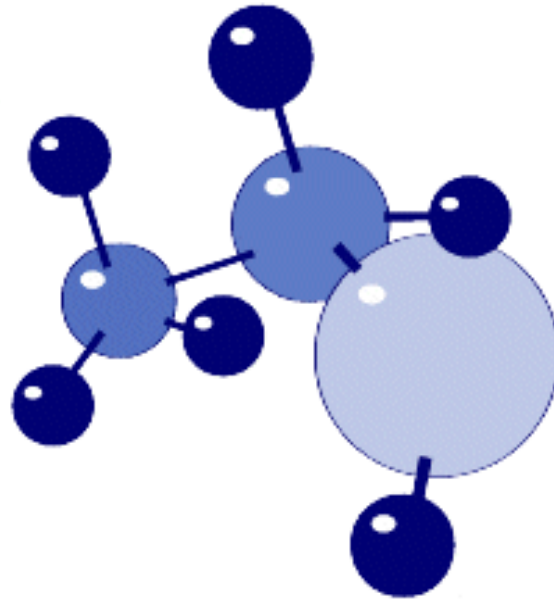
“When I first used I would get a buzz and my entire body would feel tingly. My eyes would water up. I would feel as if I had been spinning around and just stopped. **It felt great.**”

14 year old boy describing nicotine effects

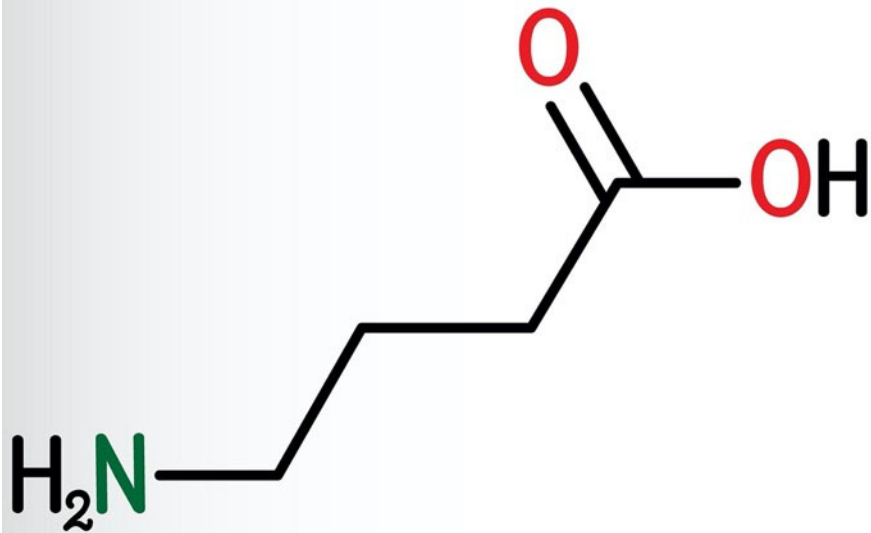
“When I first used I would get a buzz and my entire body would feel tingly. My eyes would water up. I would feel as if I had been spinning around and just stopped. It felt great. **I don't feel those things anymore.**”

14 year old boy describing nicotine effects

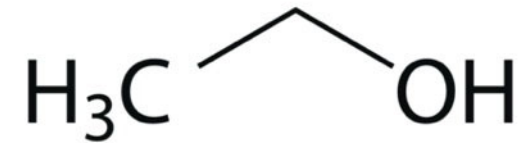
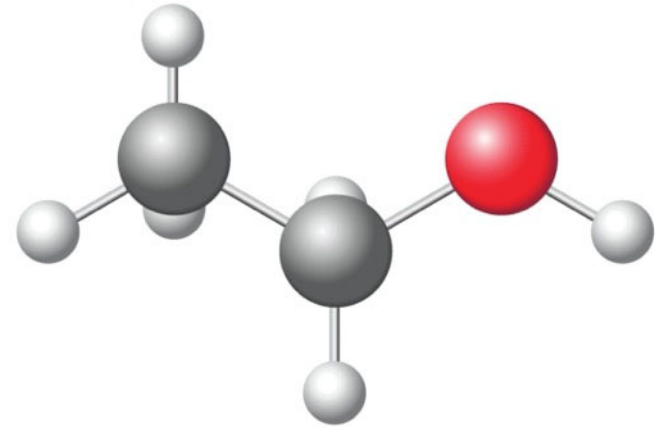
Ethyl Alcohol

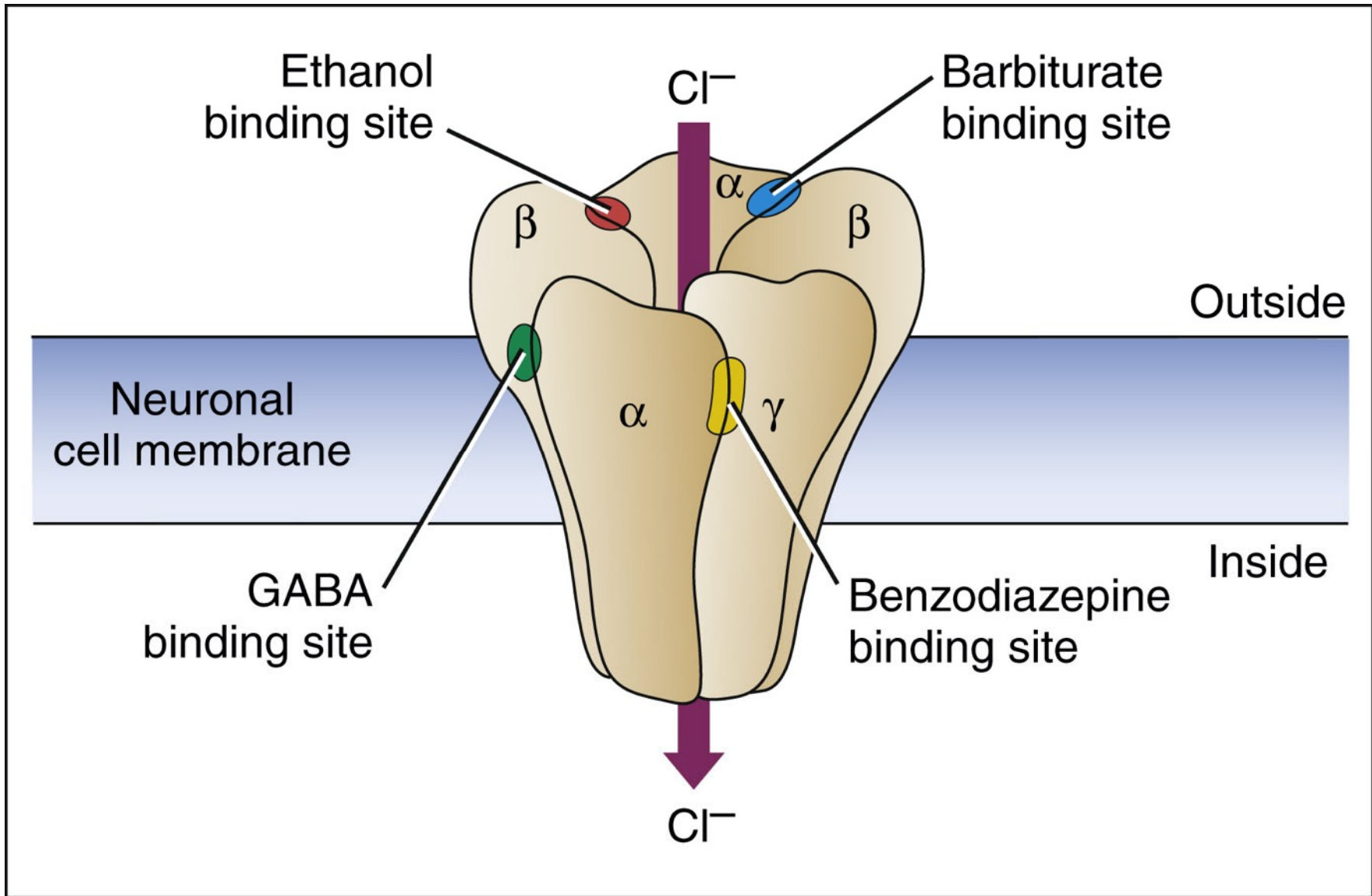


GABA

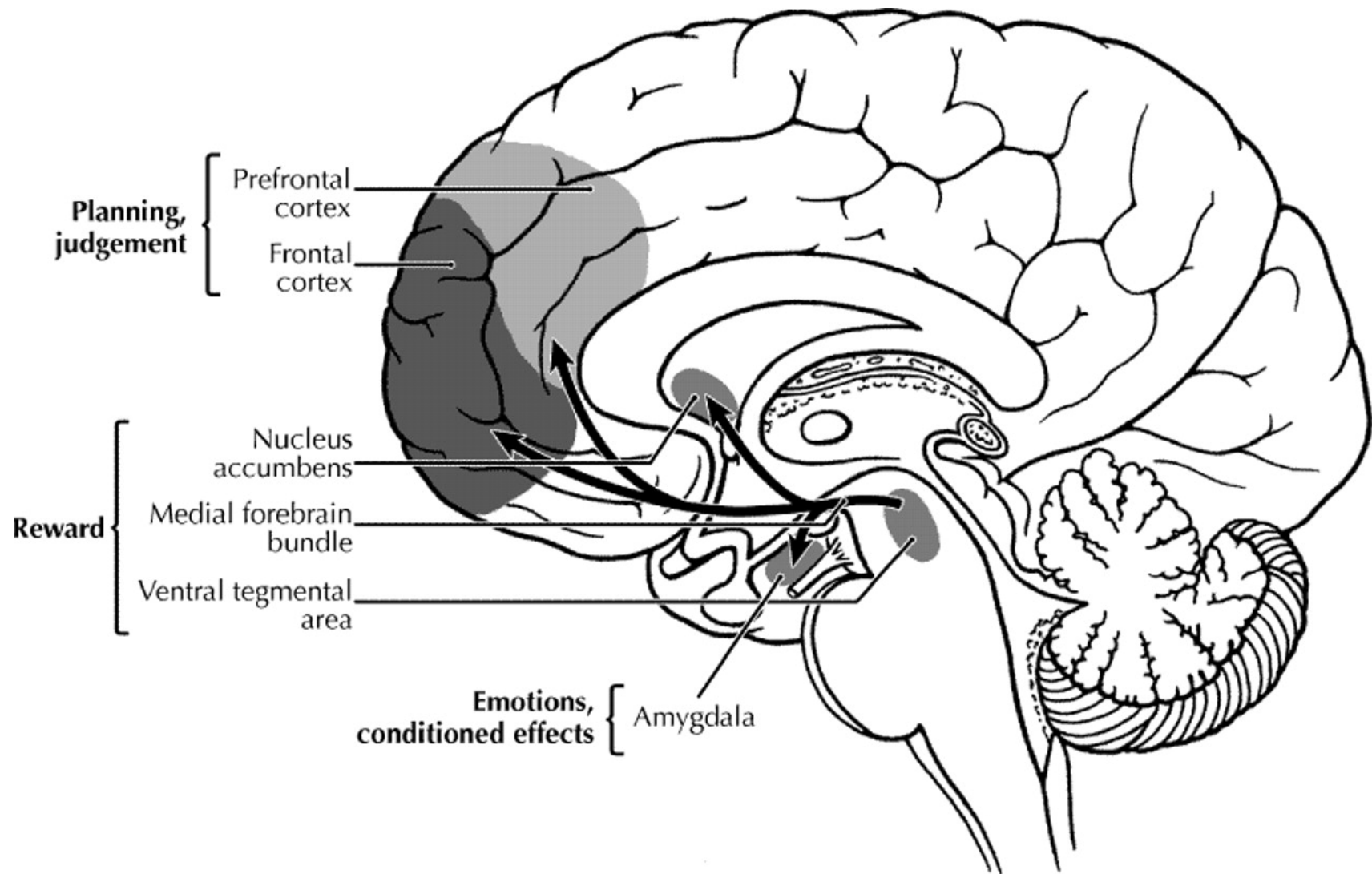


Alcohol





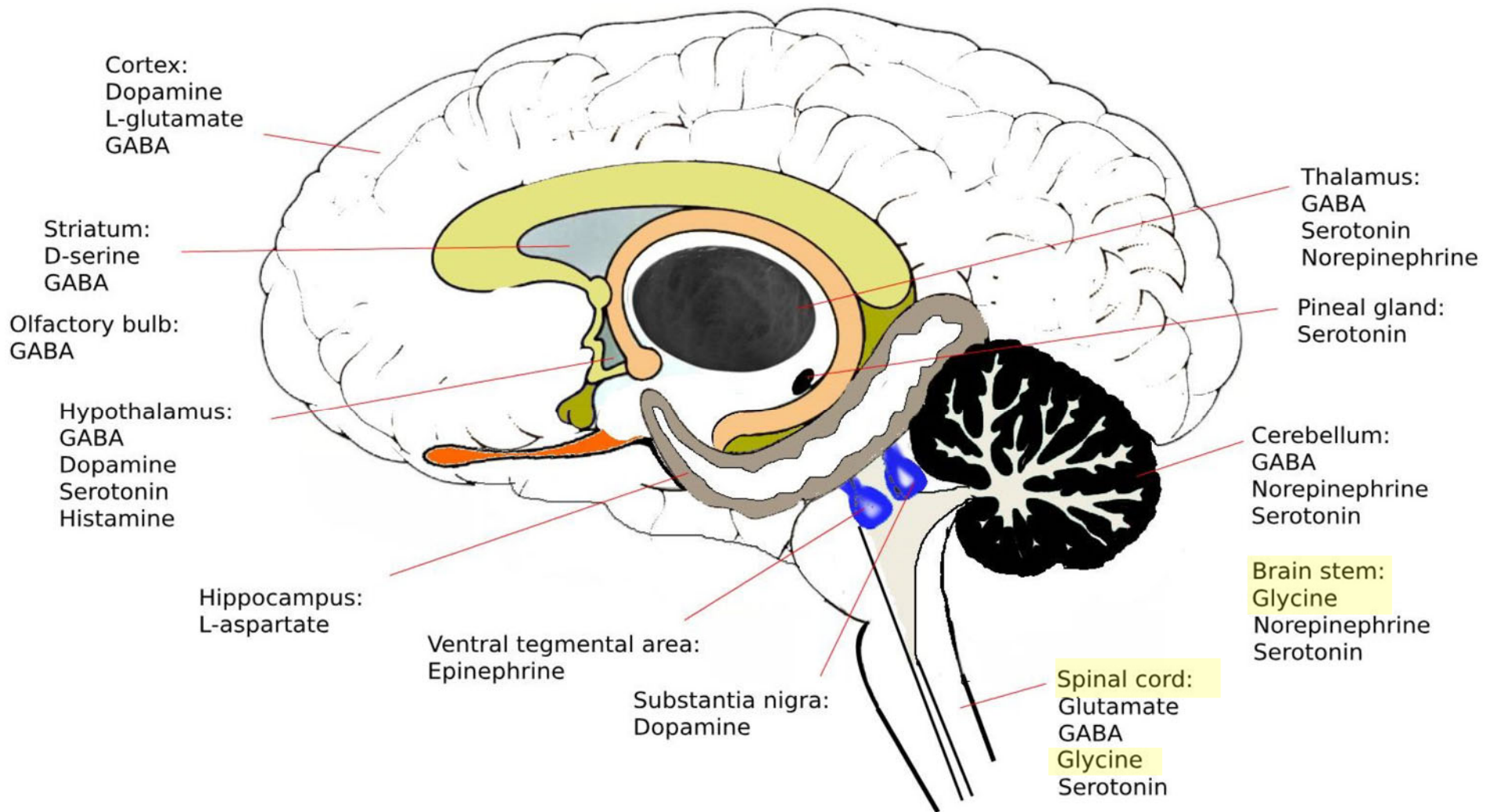
Source: <https://pubs.niaaa.nih.gov/publications/arh21-2/144.pdf>



Source: <https://youthneuro.org/media/pdf/journal/releases/0108.pdf>

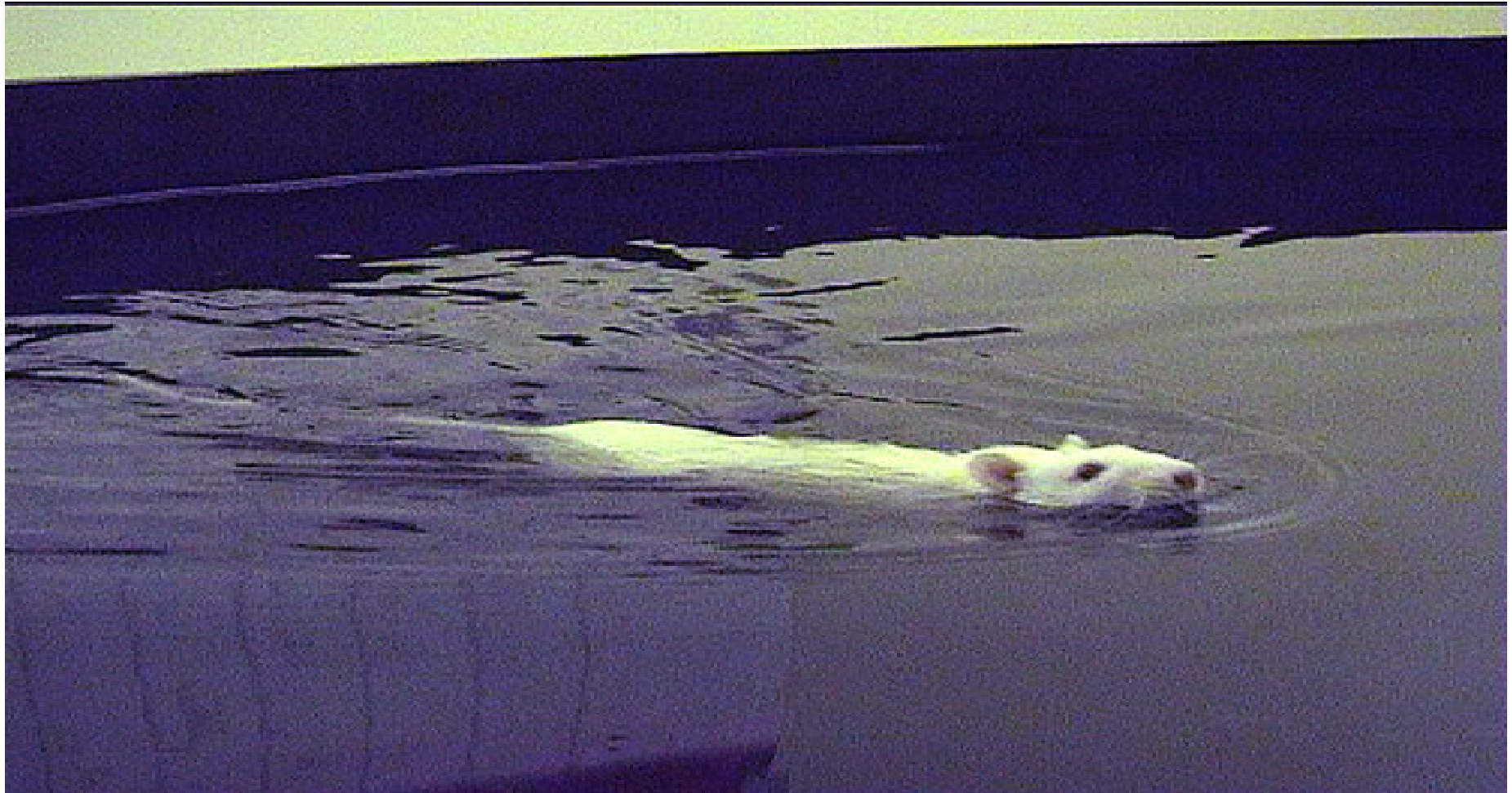
90% of all alcohol consumed by underage drinkers occurs in the context of a binge.

Source: <https://www.niaaa.nih.gov/publications/brochures-and-fact-sheets/underage-drinking>


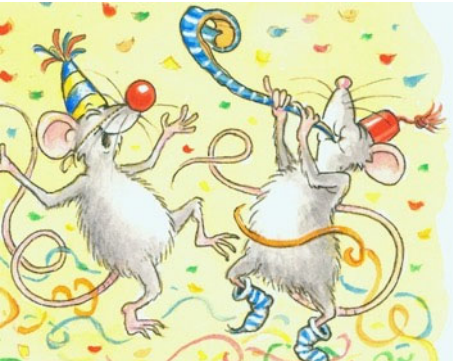


<https://www.mdpi.com/2076-3417/9/21/4719/htm>

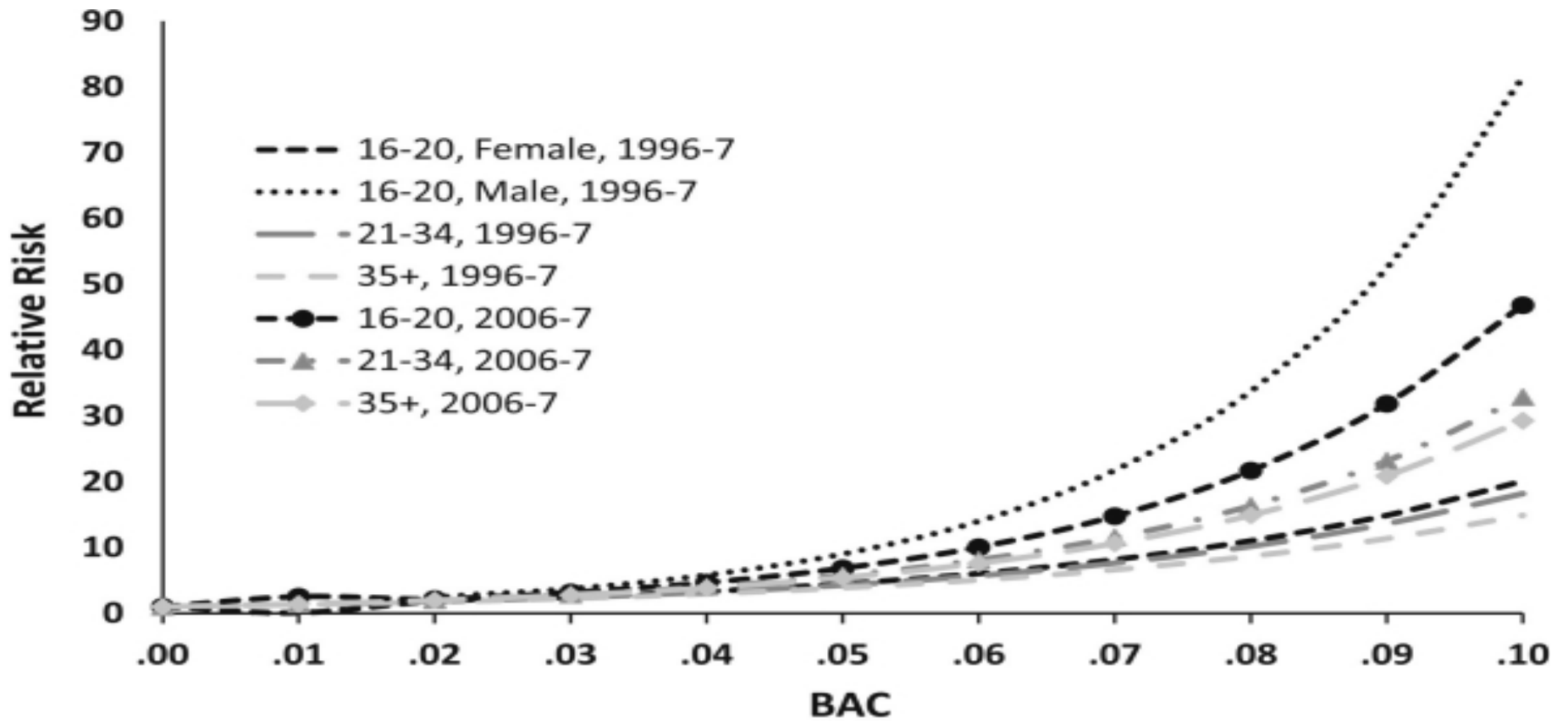
The Water Maze Test



Sircar R, Sircar D. Adolescent Rats Exposed to Repeated Ethanol Treatment Show Lingering Behavioral Impairments. *Alcohol. Clin. Exp. Res.* 2005;29(8):1402–1410. Available at: <http://doi.wiley.com/10.1097/01.alc.0000175012.77756.d9>

Intoxicated Adult Rat	Swimming Speed	Time to Platform
	<p>Decreased</p>	<p>Increased</p>
Intoxicated Adolescent Rat	Swimming Speed	Time to Platform
	<p>Unchanged</p>	<p>Increased</p>

Sircar R, Sircar D. Adolescent Rats Exposed to Repeated Ethanol Treatment Show Lingering Behavioral Impairments. *Alcohol. Clin. Exp. Res.* 2005;29(8):1402–1410. Available at: <http://doi.wiley.com/10.1097/01.alc.0000175012.77756.d9>



Voas RB, Torres P, Romano E, Lacey JH. Alcohol-related risk of driver fatalities: an update using 2007 data. J Stud Alcohol Drugs. 2012 May;73(3):341-50

Summary

- Adolescent development primes teens for substance use.
- All psychoactive substance use triggers dopamine release. Without the protection of the frontal cortices, adolescents are at greater risk for neurological changes associated with addiction.
- Substances each have unique impacts on other areas of the brain leading to the unique clinical picture resulting from long term use.



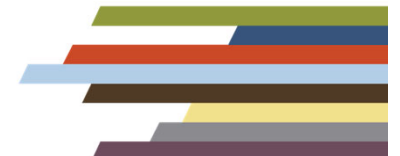
Thank You!

Sharon Levy, MD, MPH

Director, Adolescent Substance
Use and Addiction Program
(ASAP)

Boston Children's Hospital

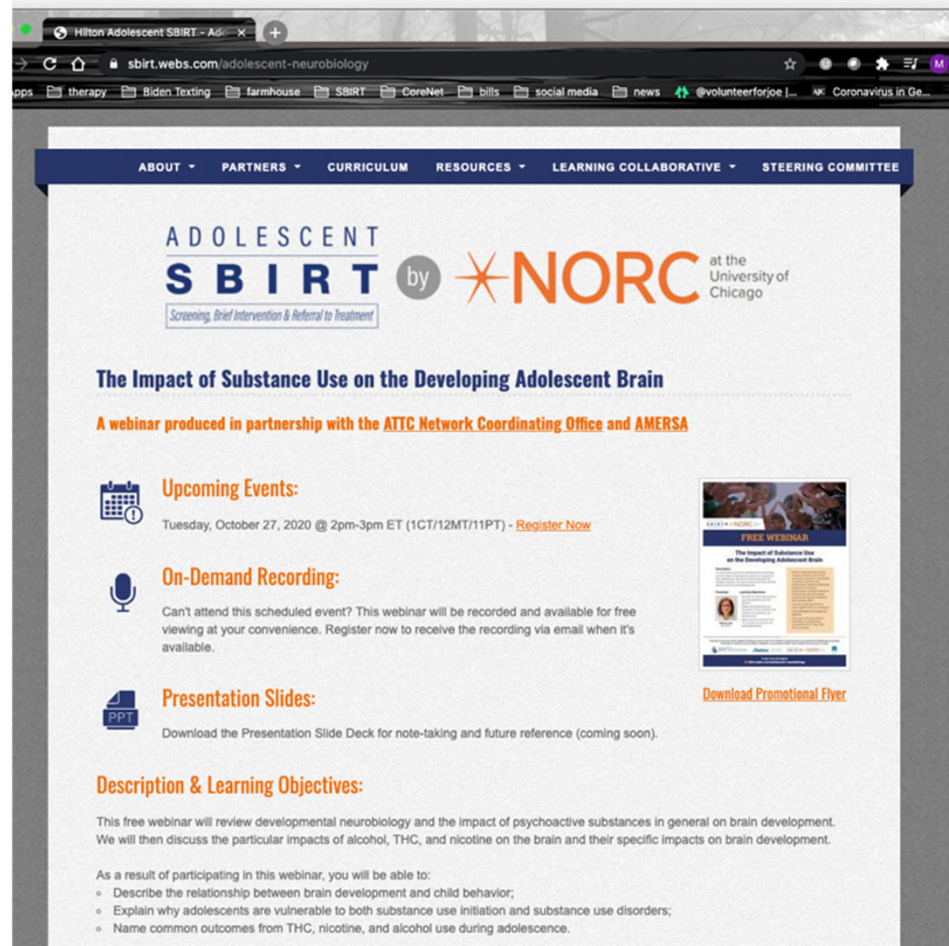
Associate Professor of Pediatrics
Harvard Medical School



In Our Last Few Moments...

- Follow-up email
- PowerPoint slides
- On-demand access 24/7
- Brief survey
- Certificate of Completion brief application (1 NAADAC CE)

sbirt.webs.com/adolescent-neurobiology



The screenshot shows a web browser window displaying the website sbirt.webs.com/adolescent-neurobiology. The page features a navigation menu with links for ABOUT, PARTNERS, CURRICULUM, RESOURCES, LEARNING COLLABORATIVE, and STEERING COMMITTEE. The main content area is titled "ADOLESCENT SBIRT by NORC at the University of Chicago". Below this, the text reads "The Impact of Substance Use on the Developing Adolescent Brain" and "A webinar produced in partnership with the ATTC Network Coordinating Office and AMERSA".

Upcoming Events:
Tuesday, October 27, 2020 @ 2pm-3pm ET (1CT/12MT/11PT) - [Register Now](#)

On-Demand Recording:
Can't attend this scheduled event? This webinar will be recorded and available for free viewing at your convenience. Register now to receive the recording via email when it's available.

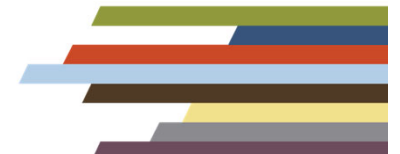
Presentation Slides:
Download the Presentation Slide Deck for note-taking and future reference (coming soon).

Description & Learning Objectives:
This free webinar will review developmental neurobiology and the impact of psychoactive substances in general on brain development. We will then discuss the particular impacts of alcohol, THC, and nicotine on the brain and their specific impacts on brain development.

As a result of participating in this webinar, you will be able to:

- Describe the relationship between brain development and child behavior;
- Explain why adolescents are vulnerable to both substance use initiation and substance use disorders;
- Name common outcomes from THC, nicotine, and alcohol use during adolescence.

Additional elements include a "Download Promotional Flyer" link and a thumbnail image of the webinar flyer.





Related Products & Resources from the ATTC Network

- [CLAS Standards in Behavioral Health: Working with Youth and Adolescents](#) (Recorded webinar)
- [Understanding Latino Youth Recovery: Issues, Assets and Creating Resiliency](#) (Recorded webinar)
- Adolescent Brain Maturation and Health: Intersections on the Developmental Highway
 - [Recorded presentation](#)
 - [Handouts](#)
- [Effects on Marijuana Use on Developing Adolescents](#) (Recorded webinar)
- [Vaping Overview and CATCH My Breath Program](#) (Recorded webinar)
- [Vaping 2: Education vs Punishment Using Deferred Citation](#) (Recorded webinar)
- [Understanding Suicide Part 2 Adolescents and the Changing Brain](#) (Recorded webinar)

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- ATTC Network Office publishes the Messenger monthly
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the **Messenger**
October 2020

October is Domestic Violence Awareness Month

In Honor of Domestic Violence Awareness Month:

Responding to Substance Use Coercion in Treatment and Recovery Services

By Carole Warshaw, MD, and Gabriela Zapata-Alma, LCSW, CADC,

Intimate Partner Violence (IPV) Can Have Profound

include deliberately introducing a partner to substances, forcing or coercing a partner to use, interfering with treatment, controlling medication; sabotaging recovery efforts; threatening a partner with withdrawal, and leveraging the stigma associated with substance use to discredit a partner with potential sources of safety and support.

attcnetwork.org/centers/global-attc/tay-webinar-series



Related Products & Resources from the PTTC Network

- [Underage Alcohol Use: An Overview of Data and Strategies](#) (Recorded webinar)
- [Youth Opioid Addiction: What Preventionists Need to Know](#) (Recorded webinar)
- [Selecting and Implementing Evidence-Based Practices to Address Substance Misuse Among Young Adults: Webinar on SAMHSA's Resource Guide](#)
- [Preventing Youth Vaping \(Webinar Series\) Part 1 of 2: The Extent and Risk Factors for Youth Vaping](#) (Recorded webinar)
- [Preventing Youth Vaping Part 2 of 2: Policy Recommendations and Promising Practices for Addressing Youth Vaping](#) (Recorded webinar)
- [The Benefits of Engaging Youth in Communities: Insights and Evidence from Developmental Science](#) (Recorded webinar)
- [Vaping and LGBTQ Youth](#) (Recorded webinar)
- [Informing Prevention 6-Part Webinar Series on Adolescents: Mountain Plains PTTC](#)
- [Adolescent SBIRT Pocket Card](#)

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- PTTC Network Office publishes the *PTTC POST* monthly
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The Impact of Substance Use on the Developing Adolescent Brain

Produced in Partnership:



Network Coordinating Office

ATTC

Addiction Technology Transfer Center Network
Funded by Substance Abuse and Mental Health Services Administration



Interdisciplinary Leaders in
Substance Use Education,
Research, Care and Policy



by



at the
University of
Chicago

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