

The Developing Brain: Understanding Childhood and Adolescence Through a Neuroscience Lens

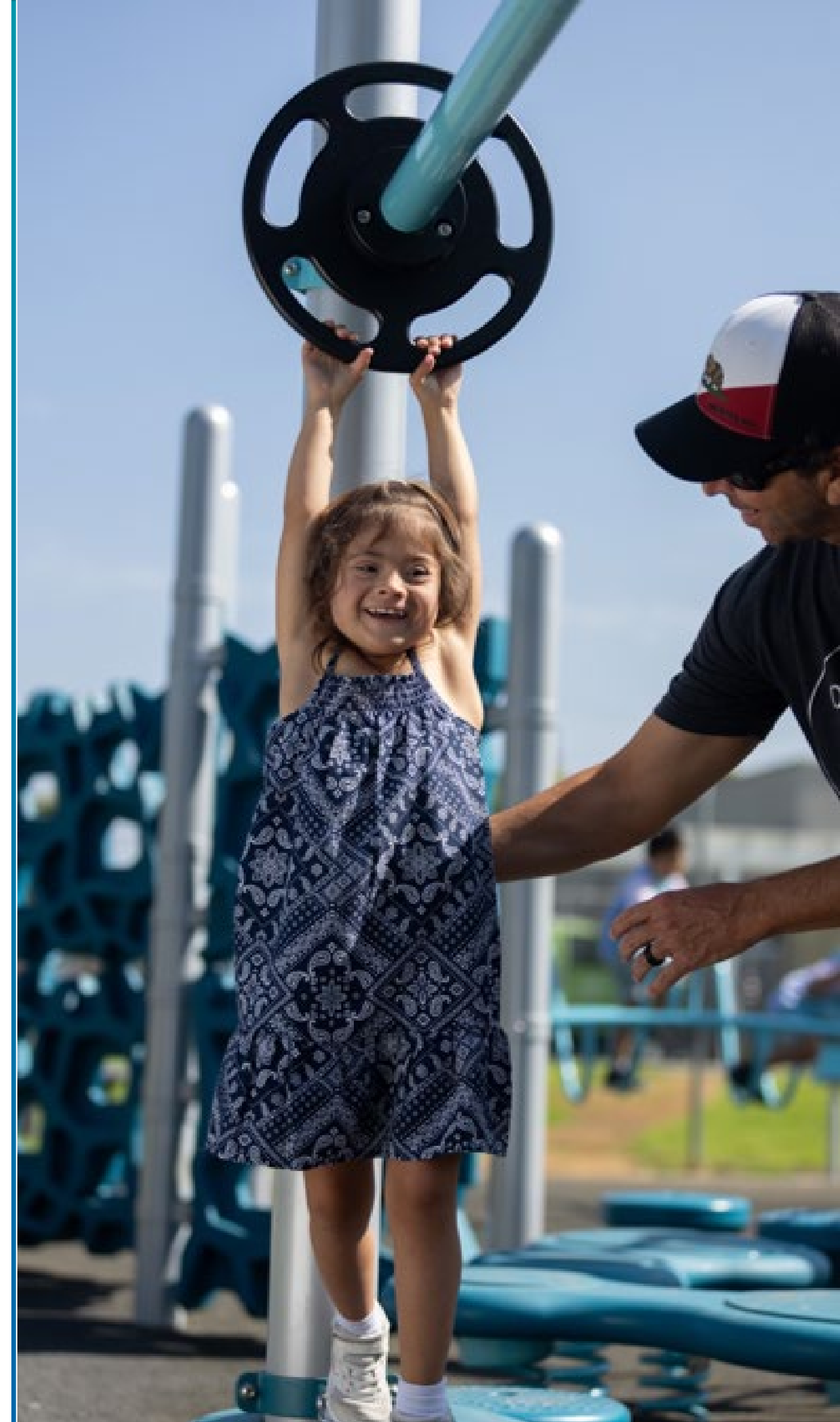
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Disclosures

- None



Neurons

- ~86 billion neurons in the brain
- Make over 100 trillion connections
- Communicate via electrical and chemical signals
- Source of all our thoughts and emotions

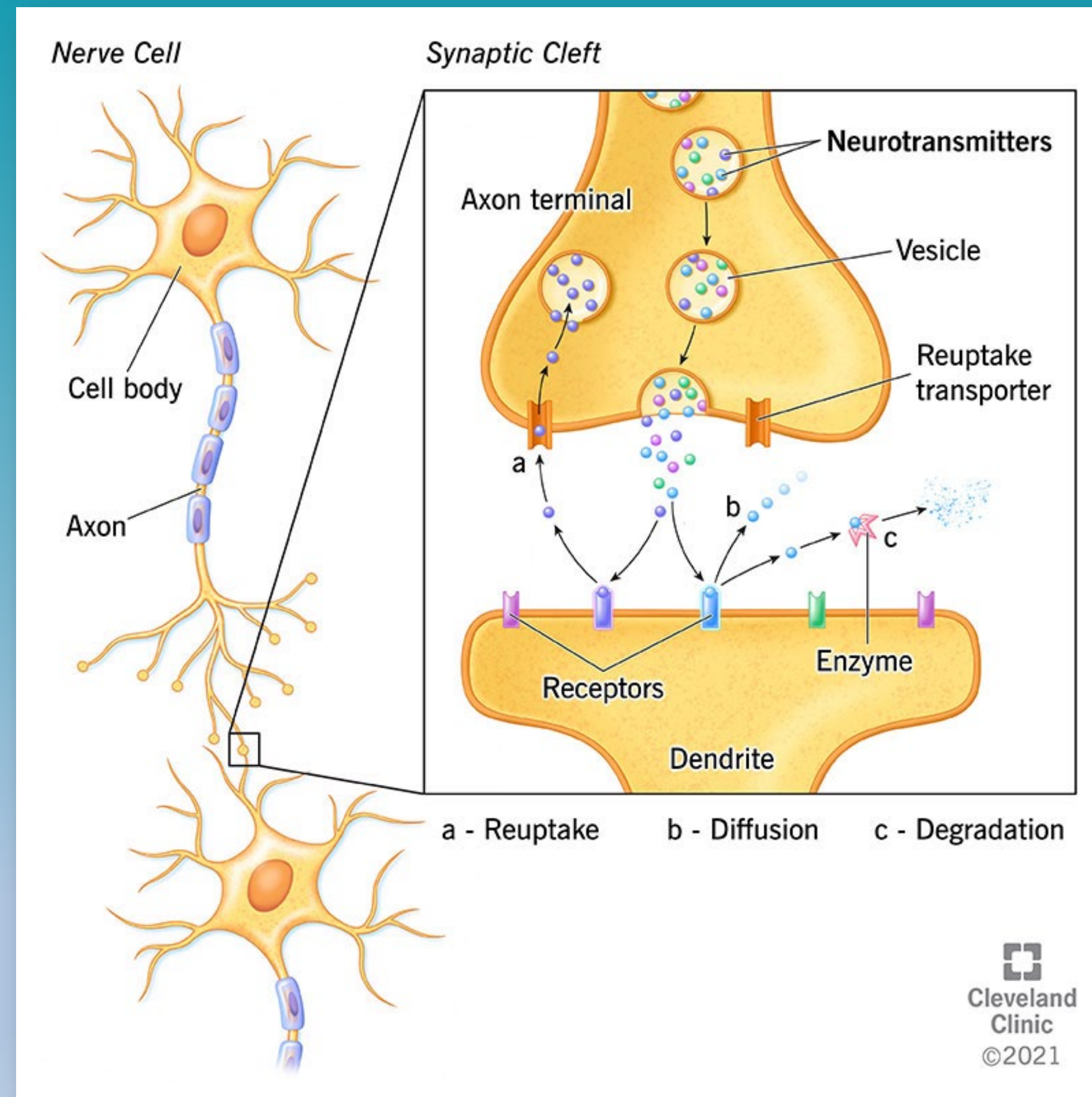


Fig 1

Parts of the Brain

- Brain stem
- Cerebellum
- Cerebrum
 - Outer layer has 4 lobes
 - Frontal – Personality, Judgment, Planning, Problem solving, Concentration, Motor Movement, Speech Production
 - Temporal - Understanding Language, Hearing, Memory, Emotions
 - Parietal - Sensory Processing, Sensory Integration, Spatial Awareness
 - Occipital - Vision

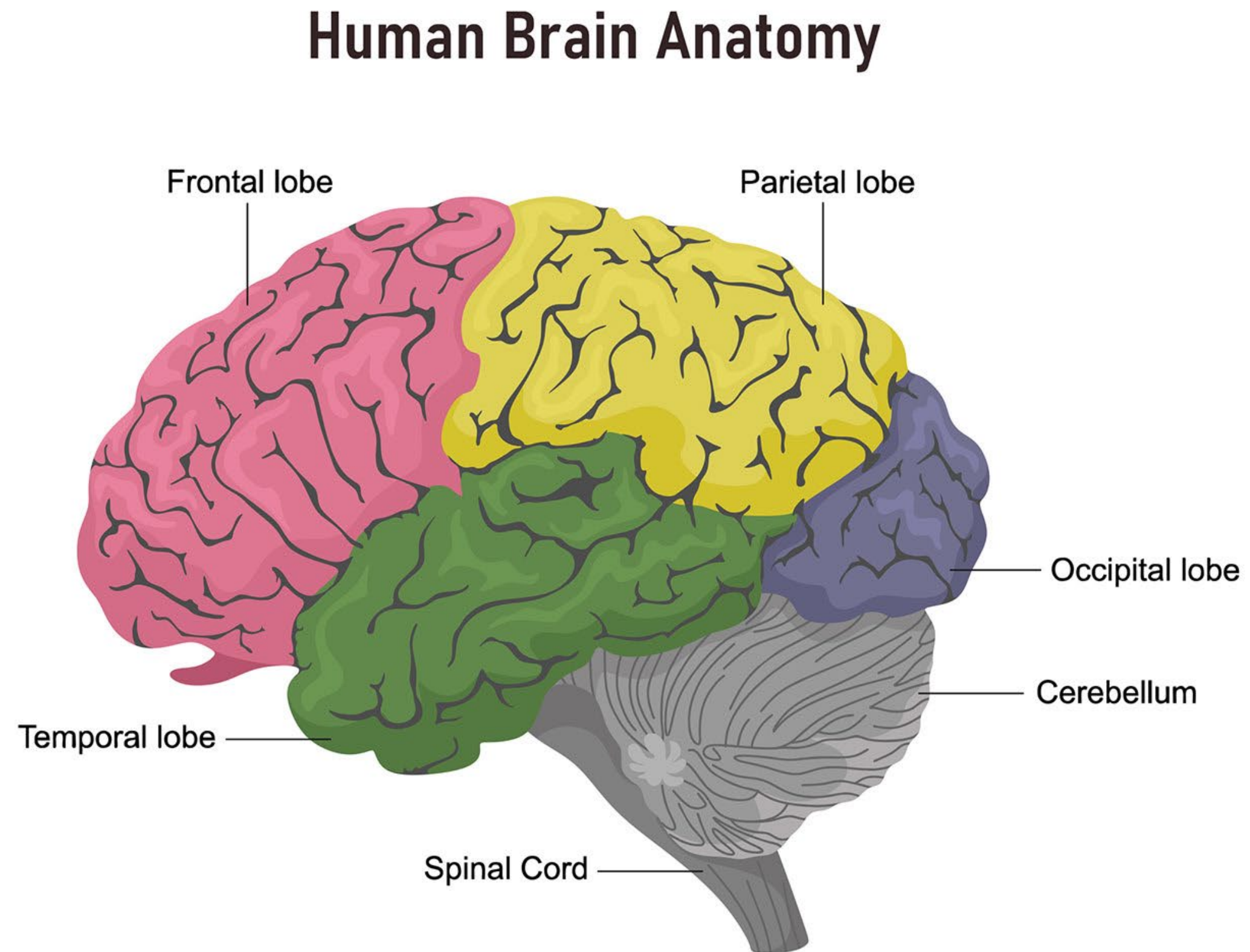


Fig 2

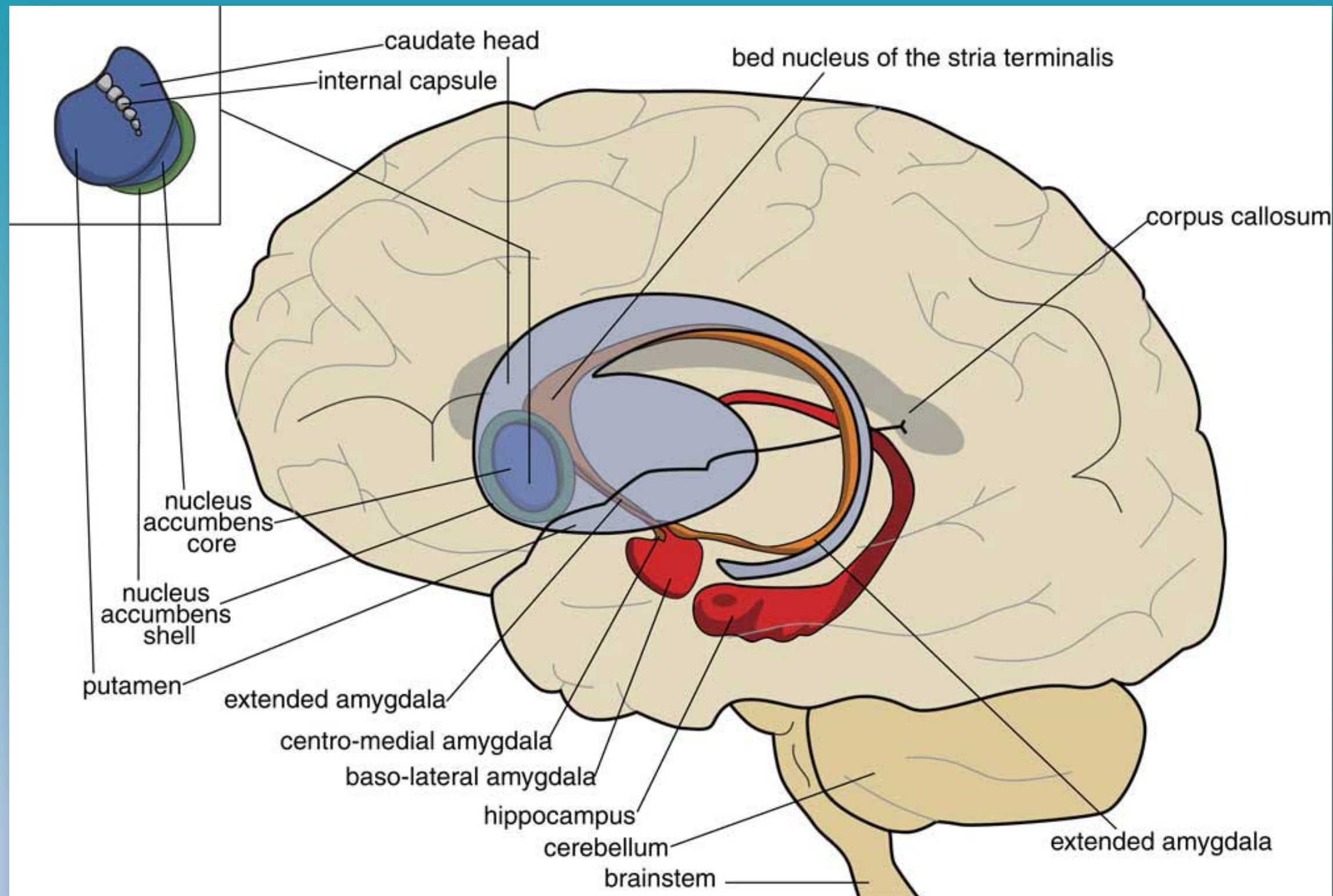


Fig 3

Simplistic View of the Brain

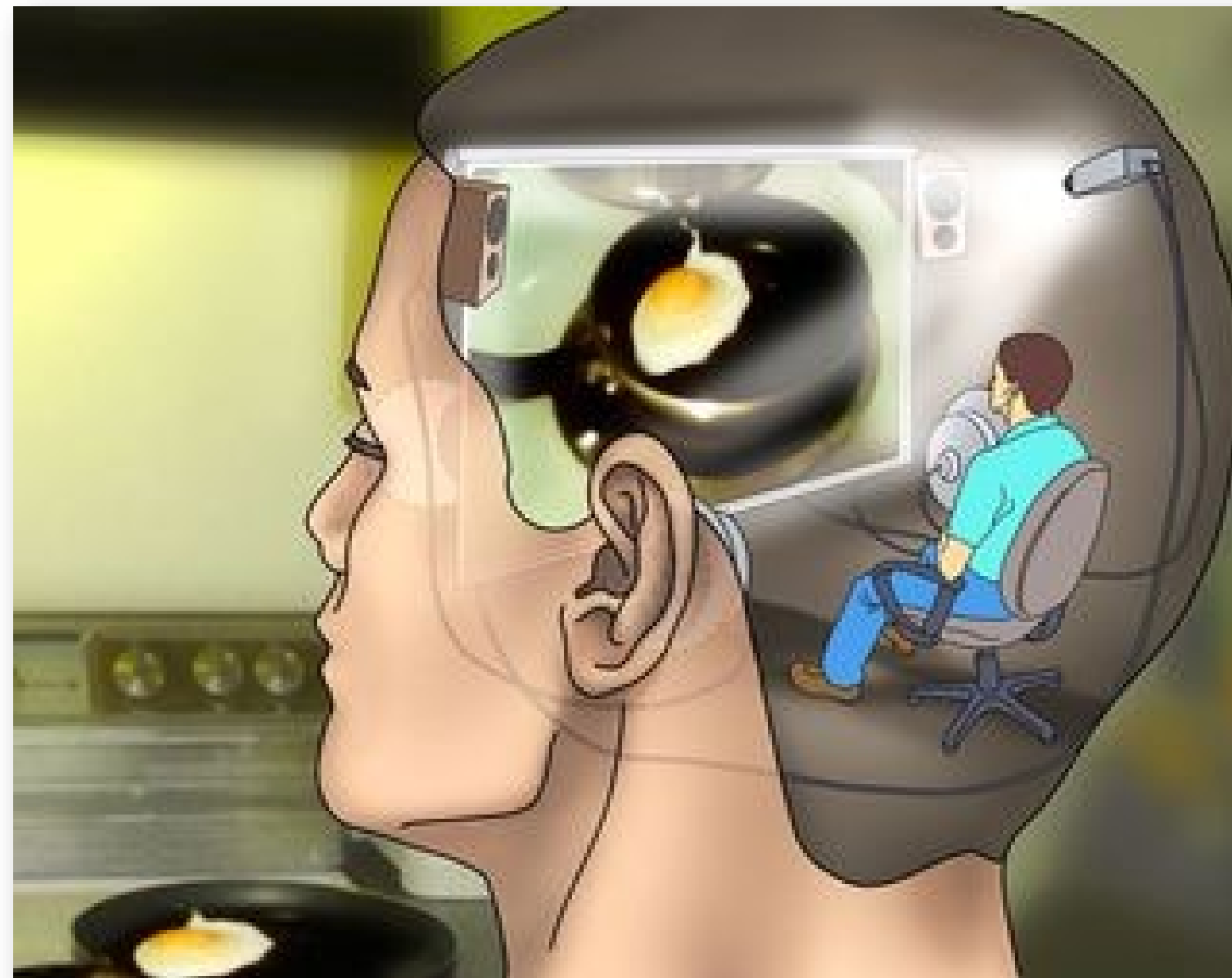


Fig 4

Neural Networks

- More realistic representation of brain function

Neural Networks

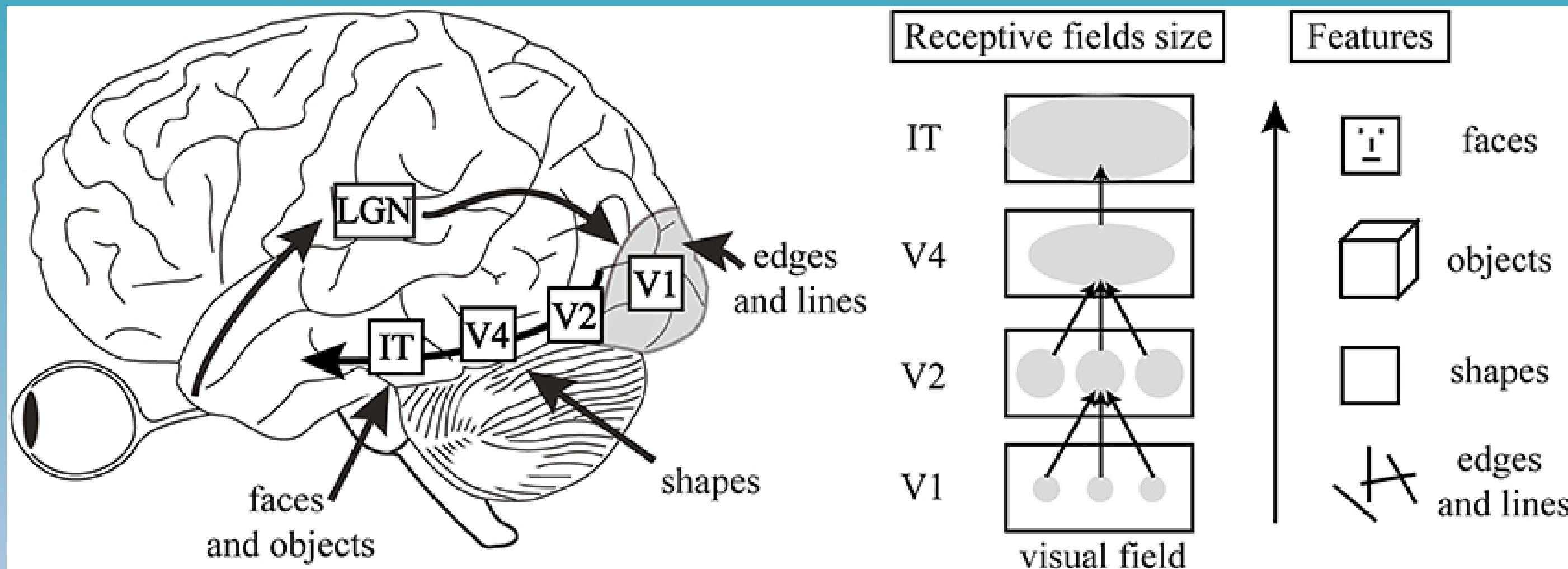


Fig 5

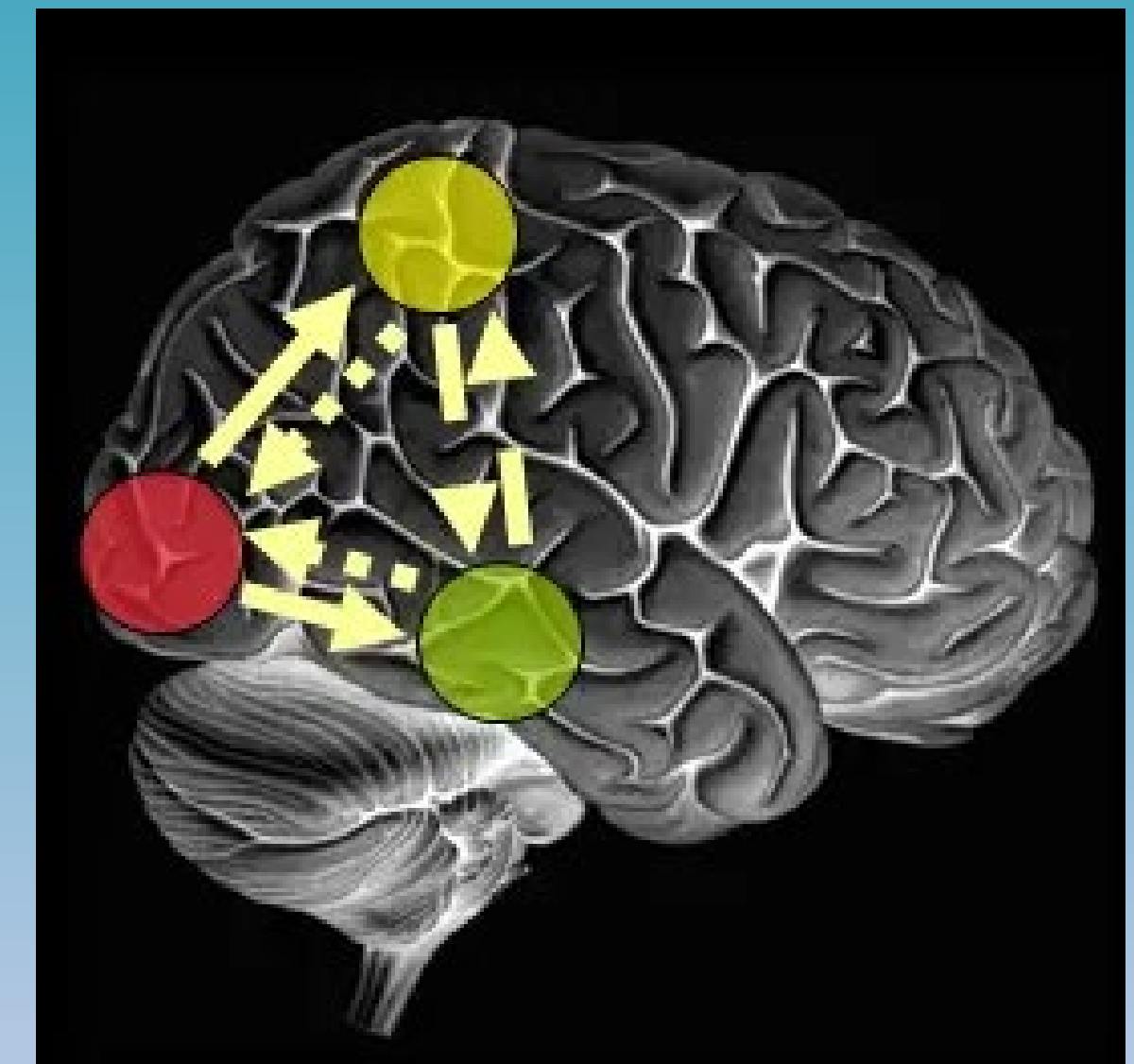


Fig 6

Neural Networks

- More realistic representation of brain function
- Complex interconnection of various parts of the brain that underlie how we function
- May be a way to help with understanding and diagnosis of behavioral health conditions

Neural Networks

- Currently, we can't reliably diagnose behavioral health conditions with imaging
- Part of the issue is the inaccuracy of symptom-based diagnosis (ex. MDD – 227 combinations)
- We are getting closer – Stanford study showing 6 neural patterns of different types of depression

Brain Development

- **Infancy & Toddlerhood (0-2 Years):**
 - Brain Changes: neurons make a lot of connections and myelination increases (makes electrical transmission faster). Brain doubles in size.
- **Early Childhood (2-7 Years):**
 - Brain Changes: Pruning of unused connections, increasing efficiency.
- **Middle Childhood (7-11 Years):**
 - Brain Changes: Brain has reached about it's full size; networks start to stabilize.
- **Adolescence (11+ Years):**
 - Brain Changes: Significant remodeling, including increased white matter (myelination) for faster communication, and getting rid of unneeded connections in the prefrontal cortex.

Brain Development

- **Early Childhood (2-7 Years) Behavioral Issues:**
 - Egocentrism: Inability to see perspectives other than their own, leading to selfishness or assuming everyone knows what they know.
 - Emotional Outbursts & Whining: Frustration due to limited communication skills and inability to understand cause-and-effect.
 - Rigid Routines: Needing items in specific places or order.
- **Management Strategies:**
 - Foster Perspective-Taking: "How do you think Jack feels when you take their toy?", "How would you feel if someone took your toy...How do you think Jack feels after you take his toy"
 - Use Role-Playing/Pretend Play: Use imaginative play to act out social scenarios, emotions, and rules.
 - Encourage Sharing Through Play: Use cooperative games that require taking turns.
 - Provide Consistent Structure: Maintain regular, predictable routines.
 - Simplify Instructions: Give clear, short, one-step commands rather than complex explanations.
 - Validate Feelings While Setting Limits: Acknowledge their emotion ("I know you are sad") but firmly enforce rules ("but we do not hit").

Brain Development

- **Middle Childhood (7-11 Years) Behavioral Issues:**
 - Rigid Thinking and Rules: Children may become inflexible, insisting there is only one right way to do things.
 - Struggle with Hypotheticals: Difficulty understanding "what if" scenarios.
 - Perfectionism and Anxiety: They may fear failure or obsess over the quality of their work or get upset if they lose a game.
 - Argumentative/Black-and-White: Trouble understanding nuances, leading to rigid, argumentative, or "right-vs-wrong" behaviors.
 - Social Comparison & Insecurity: Increased focus on peer group acceptance can cause anxiety about body image, competence, and appearance.
- **Management Strategies:**
 - Utilize Concrete Examples: Use tangible objects (blocks, physical, real-world examples) to explain concepts rather than abstract explanations.
 - Provide Structure and Consistency: Since they appreciate rules and order, establish clear, consistent routines to reduce anxiety.
 - Promote Social Learning: Foster group projects and peer interaction to help them navigate perspective-taking.
 - Focus on Effort over Achievement: Combat perfectionism by praising their hard work and problem-solving process, not just the final result.

Brain Development

- **Adolescence (11+ Years) Behavioral Issues:**

- Questioning Authority: Adolescents move from accepting rules as absolute to viewing them as relative, leading to questioning of parents and teachers.
- Idealism and Criticism: Their ability to imagine how the world "should be" can make them highly critical of adults and societal standards.
- Argumentativeness: Enhanced logical and deductive reasoning skills are often tested through constant debate and challenging of established views.
- Egocentrism/Self-Consciousness: A belief that others are just as focused on them as they are on themselves (imaginary audience), leading to social anxiety.
- Risk-Taking: The ability to think about possibilities can lead to exploring scenarios without fully appreciating real-world consequences.

- **Management Strategies:**

- Encourage Rational Debate: Engage them in discussions that allow them to use their logical skills to explore complex topics, rather than shutting down arguments.
- Promote Autonomy with Boundaries: Allow for increased decision-making, but maintain clear, consistent, and logical, rather than absolute, rules.
- Encourage Perspective-Taking: Help them move past their own idealistic, self-focused view by encouraging empathy and considering other viewpoints.
- Active Engagement: Encourage them to channel their idealism into tangible, productive projects or social causes.
- Foster Responsibility: Allow them to experience natural consequences to help bridge the gap between hypothetical logic and reality.

Learning

- Observational
 - Vicarious punishment – learning what not to do by seeing another have an adverse consequence.
 - Modeling – learning new behaviors through observing others.
 - Requires attention to the model, retention of the information, reproduction of the behavior, and motivation to perform it.



Fig 7



Fig 8

Learning

- Hebbian theory – neurons that fire together, wire together
- Classical (Pavlovian) conditioning
 - Pairing of neutral stimuli with stimuli that elicit a biological reaction (fear, salivation, etc.) will lead to the neutral stimuli also eliciting the biological response.

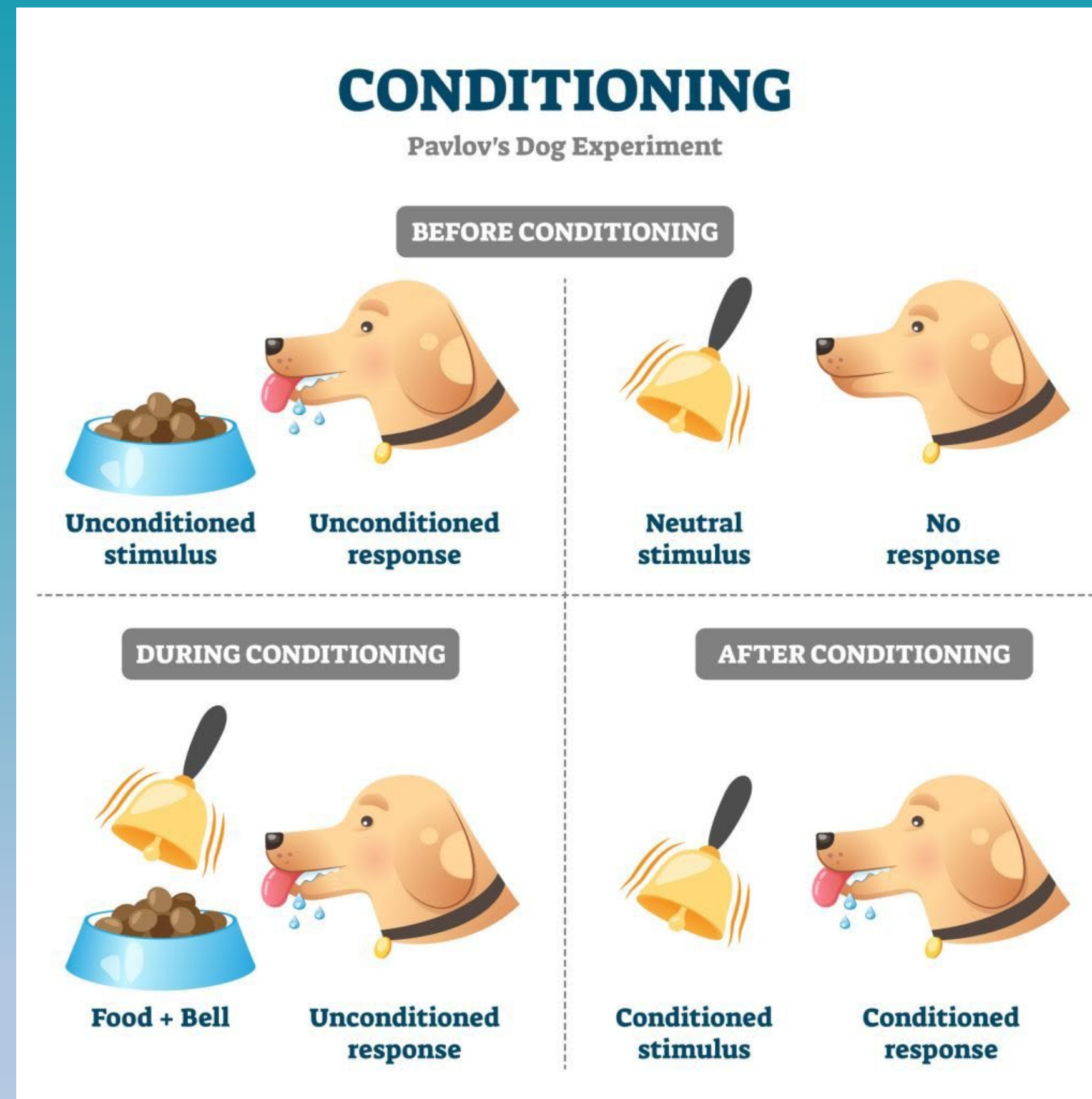


Fig 9

Learning

- Instrumental (Operant) conditioning – Central to maintaining behavior (good and bad) and a core component of many of our therapies
 - The consequence of a person's behavior leads to either an increase or decrease of that behavior
 - Consequences of behavior are either reinforcing (increase the behavior) or punishing (decrease the behavior)
 - Reinforcers and punishers can be either positive or negative

	Positive (get something)	Negative (something removed)
Reinforcement (target behavior increased)	Child does their chore when asked, is given a dollar – more likely to do their chore next time asked -Best to reward right away -Reward should be only available for doing desired behavior -Can use secondary reinforcers (tokens, points)	Something aversive is taken away when child does a behavior – more likely to do that behavior again to remove the bad feeling -Cutting -Drug withdrawal
Punishment (target behavior decreased)	Corporal punishment when a child does a negative behavior – the behavior will likely decrease -May increase anxiety -May worsen relationship with caregiver -Correlates with increased overall aggression and other behavioral issues - Natural consequences/Overcorrection are acceptable	Removing a positive experience from the child in response to a behavior – reduces the likelihood of that behavior -Time outs -Taking away enjoyable items -Don't remove things too long-can lead to resentment and hopelessness

- When teaching a new task best to start with continuous reinforcement (1 target behavior = reward) then start requiring more target behaviors for reward (VR)
- Make sure the reward is what child actually wants
- Limit access to the rewards to only when the desired behaviors occur
- Immediate rewards are better than delayed, especially for younger children
- Use of “lower” value rewards and secondary reinforcers
- As the behavior gets established start reducing rewards to enhance intrinsic motivation
- Don't try to do it all at once, pick just 1-3 targets
- Why do rewards lead to such strong learning?
 - Trigger release of dopamine in the nucleus accumbens – makes us feel good and activates parts of the brain associated with learning (amygdala, striatum and frontal lobe)

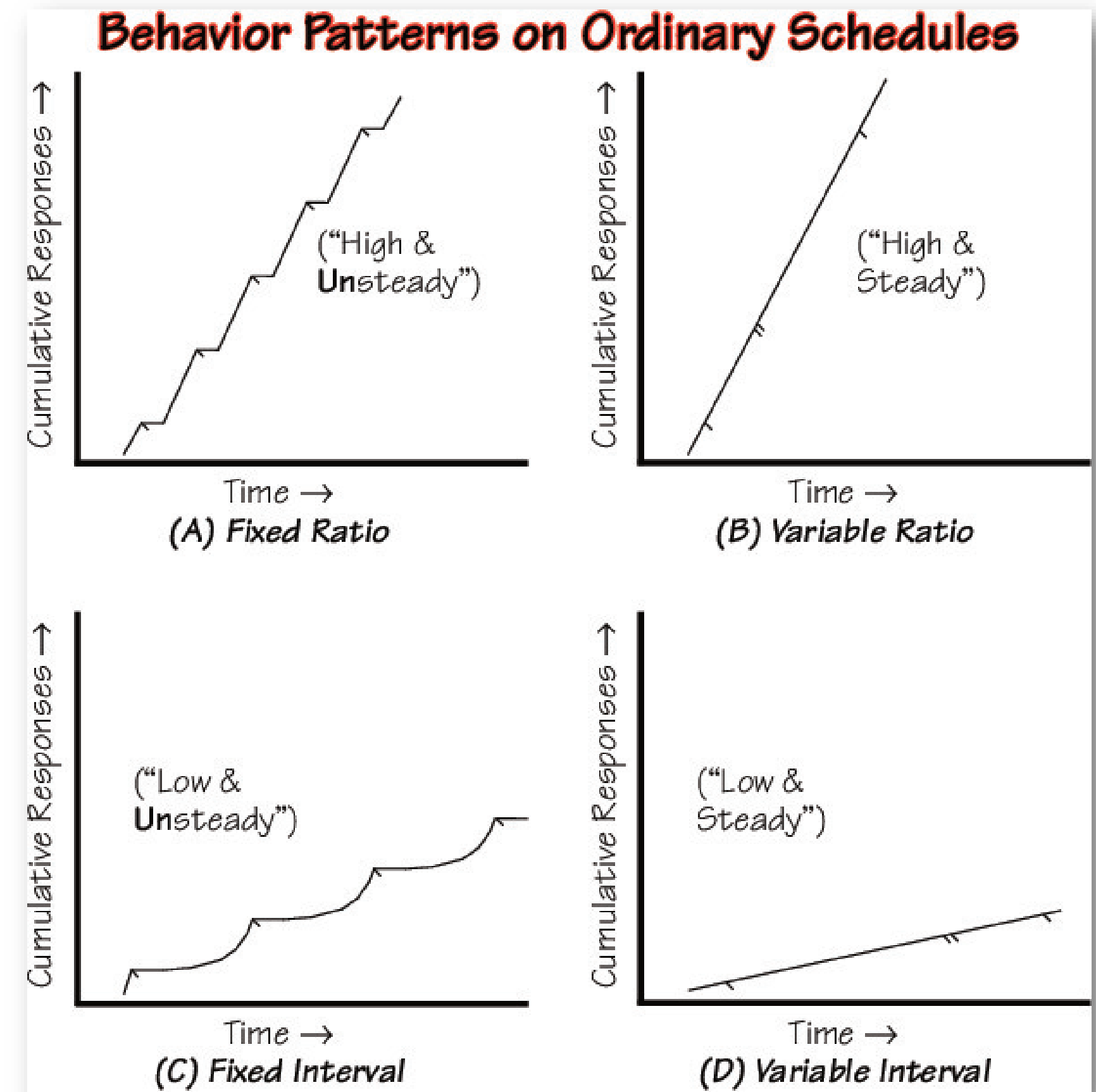


Fig 10

Reinforcement, Punishment, Both?

- Generally, we learn better from positive reinforcement
 - Efficacy can be dependent on various factors, some of which we may not be aware of
 - Is the reward worth the effort to the child
 - If trying to replace an undesirable behavior, you need to understand the drive behind that behavior
- Punishment may stop a behavior but doesn't teach an alternative acceptable behavior and it leaves the need the behavior was fulfilling unmet
 - Results in return of the behavior once punishment is inconsistent or a different undesirable behavior develops to meet the need

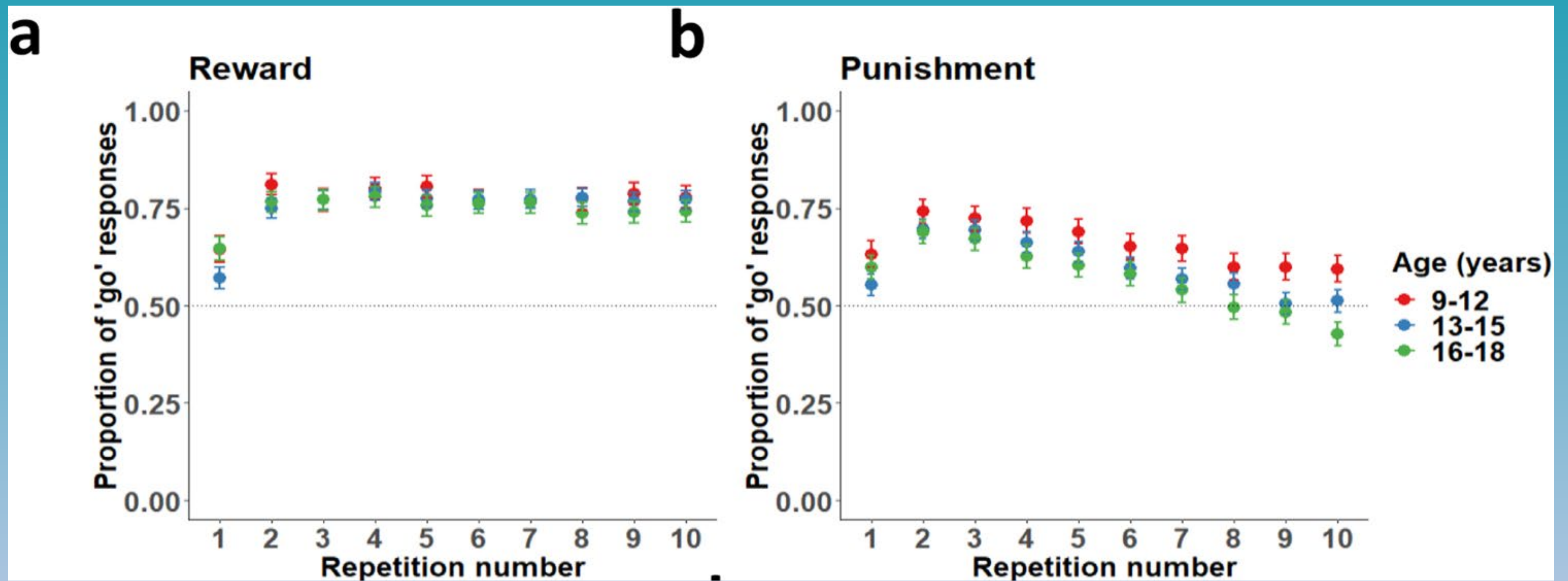


Fig 11

Reinforcement, Punishment, Both?

- In some cases, the answer may be both
 - Negative punishment (taking something reinforcing away) can be used to stop an unwanted behavior quickly
 - Then working to use positive reinforcement for doing an alternative acceptable behavior
 - Be sure to try and understand what need the unwanted behavior was fulfilling
 - If a child could do well, they would do well

Conduct Disorder

- Some children have altered brain functions that make learning contingencies more difficult
- Particularly understanding why they are being punished or not getting the expected reward
 - Appear to have reduced activity in the frontal cortex and caudate
 - Leads to difficulties learning from mistakes
 - Can learn the associations but may take more time and consistency with a focus more on reward than punishment

Executive Functions

- Regulate thoughts, emotions, and actions to achieve goals
- Frontal lobes play a large part (continue developing through young adulthood)
- Composed of:
 - Working Memory: Holding and manipulating information in the mind over short periods
 - Inhibitory Control (Self-Control): Managing impulses, distractions, and emotions to maintain focus on goals
 - Cognitive Flexibility (Flexible Thinking): Adjusting behavior or thoughts when faced with new information, unexpected changes, or challenging situations

Executive Functions

- What you may see when there's a problem:
 - Trouble with emotion regulation
 - Toddlers-early school age – lots of intense, long tantrums (usually >15min)
 - Late school age – Teens – More yelling over little things, can be aggressive both to others and self
 - Poor organization/planning
 - Losing things, forgetting, needing constant reminders, always late, can't prioritize
 - Struggle to build routines
 - Loses focus easily

Executive Functions

- Conditions in which we see deficits in executive functions:
 - ADHD
 - Depression
 - Schizophrenia
 - Mania
 - Stress

Executive Functions

- Ways to help:
 - Keep things simple – 1-2 step commands
 - Maintain structure and routines (schedules)
 - Use timers
 - Help with organization (check lists, planners, calendars)
 - Create a clutter free work area
 - Check to make sure they heard/understood directions
 - Positive reinforcement
 - Be patient

Stress and Brain Function

- When calm or under manageable stress the brain is able to carry out its functions of taking information from our senses, analyzing it, storing things in memory, making rational choices, etc.

- Top-down control
 - Slower, methodical, rational (Stop-Think-Respond)

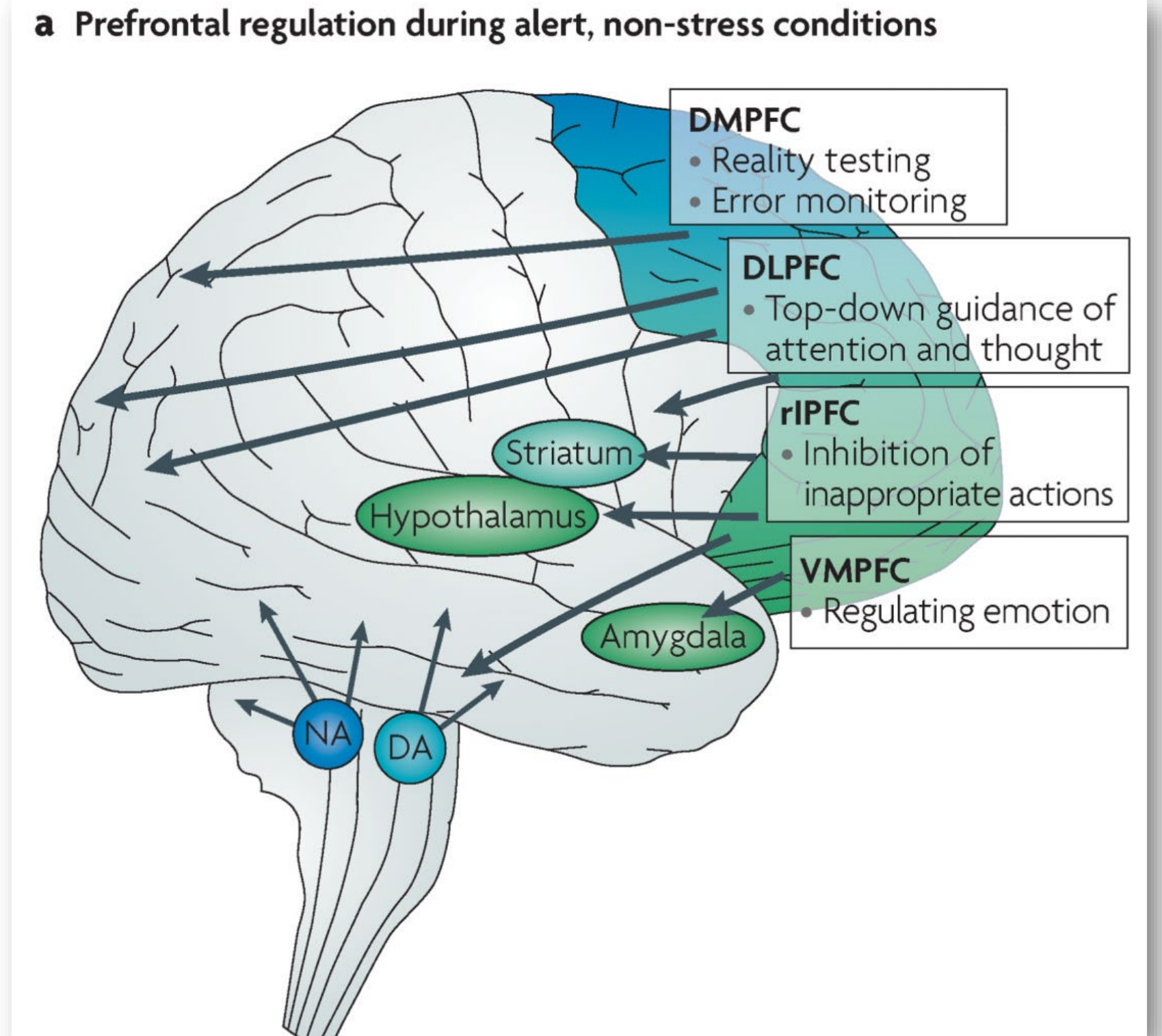


Fig 12a

Stress and Brain Function

- When calm or under manageable stress the brain is able to carry out its functions of taking information from our senses, analyzing it, storing things in memory, making rational choices, etc.
- When stress overwhelms the system – we flip our lid
 - Go from calm and rational to hot and impulsive
 - No longer learning - just reacting

- Bottom-up control
 - The more emotional and reactive parts of the brain take over (Amygdala)
 - Mediated by increases in NE and DA which further activates the amygdala and weakens activity in the frontal lobe

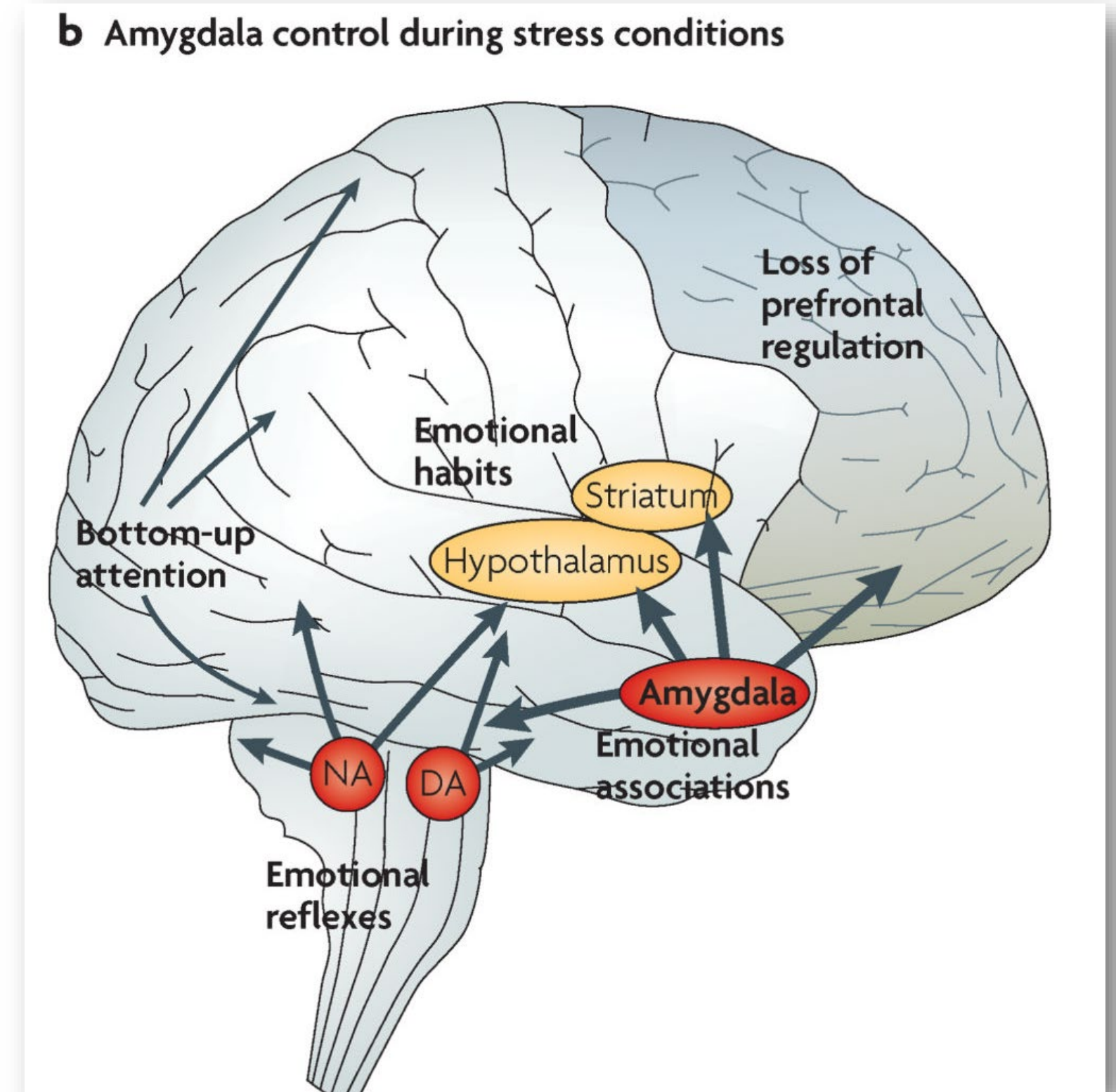


Fig 12b

Stress and Brain Function

- What it can look like:
 - Young children (<6):
 - Screaming, kicking, biting, scratching, throwing, rolling on the ground, running away, hiding
 - Elementary school children:
 - Defiance, verbal arguments, yelling, breaking things, running away
 - Teens:
 - Aggressive arguing (getting in your face), verbal abuse, actual aggression towards self or others, breaking things, running away, substance use, isolating, excessive screen time

Stress and Brain Function

- What to do when a lid is flipped
 - Stay calm
 - Don't try to reason or rationalize with them
 - Validate, let them know you're there if they need you
 - Distract – offer acceptable alternatives to help them calm (offer a snack, listen to music, go for a walk, avoid highly stimulating activities like gaming)
 - Disengage (have them go to another room)
 - Safety

Stress and Brain Function

- What to do when a lid is flipped
 - Be mindful of them learning maladaptive strategies
 - With less frontal control and increased NE and DA in the system other brain circuits related to learning are more active
 - Behaviors that they try that reduce their sense of danger may become learned habits (being aggressive to make you give in/self harm/drugs)
 - Wait until you see a shift in their emotional/physical state to try and reengage
 - Can see slower breathing, less pacing/movements, lower volume to voice
 - May go from angry to sad – if they are open to it you can try to comfort/hold them (be mindful some children with ASD, PTSD, some teens may find this aversive)
 - Once calm you can try to talk about what happened. If they start to escalate again, back off



Q & A



- Figure:
- 1 – <https://my.clevelandclinic.org/health/articles/22513-neurotransmitters>
- 2 – <https://www.hopkinsmedicine.org/health/conditions-and-diseases/anatomy-of-the-brain>
- 3 – Loonen, Anton & Ivanova, S.. (2017). Circuits regulating pleasure and happiness: evolution and role in mental disorders. Acta neuropsychiatrica. 30. 1-14.
- 4 - <https://www.psychologytoday.com/us/blog/the-imprinted-brain/201407/come-back-homunculus-all-is-forgiven>
- 5 - <https://gracewlindsay.com/2018/05/17/deep-convolutional-neural-networks-as-models-of-the-visual-system-qa/>
- 6 - <https://www.cbs.mpg.de/methods-and-development-groups/brain-networks>

- 7 - <https://news.mit.edu/2018/brain-circuit-observational-learning-0503>
- 8 - <http://oscareducation.blogspot.com/2013/01/observational-learning-or-learning-by.html>
- 9 - <https://www.simplypsychology.org/classical-conditioning.html>
- 10 - <https://behaviorinfo.com/reinforcement-schedules-mysteries-of-living-43-of-72/>
- 11 - Pauli, R., Brazil, I.A., Kohls, G. et al. (2023). Action initiation and punishment learning differ from childhood to adolescence while reward learning remains stable. *Nat Commun* 14, 5689.
- 12 - Arnsten A. F. (2009). Stress signalling pathways that impair prefrontal cortex structure and function. *Nature reviews. Neuroscience*, 10(6), 410–422.

- **National Suicide Prevention Lifeline.** Call: **988 or 1-800-273-TALK**; Spanish line: **888-628-9454**; TTY: **800-799-4TTY** (4889) (8255). You'll be connected to a skilled, trained counselor at a crisis center in your area, anytime 24/7.
- **ParentGuidance.Org**
<https://parentguidance.org/>
Welcome - parentguidance.org
We offer education and therapeutic support to empower and give you hope as you support your child's mental health.
- **National Parent Helpline**
<https://www.nationalparenthelpline.org/>
We provide vital information, support, and referrals through calls, texts, and chats to diverse parents, children, and youth seeking help nationwide. The National Parent & Youth Helpline™ is operated by Parents Anonymous® and available 24 hours a day/7 days a week.
- **Mental Health America**
<https://mhanational.org/mental-health-resources-parents>
Find resources on caregiving as a parent - whether caring for children or your own parents.
- **San Diego County Office of Education**
<https://www.sdcoe.net/students/health-well-being/mental-health-supports>
Prioritizing mental health is important for students to be able to learn effectively; it's also a key component that helps staff teach and support learners every day. The San Diego County Office of Education (SDCOE) has compiled resources and information for students, families, and schools that keep mental health supports top of mind.
- **Soluna App**
<https://solunaapp.com/>
Confidential support for 13- to 25-year-olds in California. No cost. No pressure. Chat 1:1 with a professional coach, use interactive tools to destress, or explore quizzes, videos, forums, and more.

San Diego County Resources

- **National Suicide Prevention Lifeline.** Call: **988** or **1-800-273-TALK**; Spanish line: **888-628-9454**; TTY: **800-799-4TTY** (4889) (8255). You'll be connected to a skilled, trained counselor at a crisis center in your area, anytime 24/7.
- **San Diego County Access and Crisis Line.** Call: **888-724-7240**. Crisis counseling or referrals, 24 hours a day/7 days a week.
- **Rady Children's Behavioral Health Urgent Care (BHUC) Walk-in Clinic.** Call: **858-966-5484**. 1 p.m.-5:15 p.m., Mon- Fri. 4305 University Avenue, Suite 150, San Diego, CA 92105. Serves youth ages 5-21 struggling with concerns that pose an imminent risk to their safety, the safety of others, or significantly impair their daily lives.
- **Rady Children's Hospital Emergency Room.** Call: **858-966-8005**. 3020 Children's Way, 1st Floor, San Diego, CA 92123.
- **San Diego County Emergency Screening Unit.** Call: **619-876-4502**. 4309 3rd Avenue, San Diego, CA 92103. Available to children and adolescents for emergency psychiatric assistance.
- **Center for Community Solutions.** Call: **888-385-4657**
- **Crisis Action and Connection.** Call: **619-591-5740**
- **North County Crisis Intervention and Response Team.** Mon-Fri from 12:00 p.m. to 8:00 p.m. Weekends from 12:00 p.m. to 5:00 p.m. Escondido, call: **760-233-0133** | Vista, call: **760-305-8225**.
- **2-1-1 San Diego:** Dial **2-1-1** from a mobile or **858-300-211** from any phone

California & National Resources

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- **California Coalition for Youth Crisis Line.** Call/text: **1-800-843-5200**. Available 24 hours/7 days a week. Languages other than English are available. Anonymous and confidential for youth and TAY struggling with behavioral issues. Provides local community resources for you and your family. Text and live chat available from 4:30pm-8:30pm daily via website **www.calyouth.org** or phone.
- **California Peer-Run Warm Line:** Call: **855-845-7415**. 24/7 non-emergency emotional support and referrals.
- **Crisis Text Line.** National crisis text line. Text the word "HOME" to **741-741 24/7**.
- **National Sexual Assault Hotline.** Call: **800-656-HOPE** (4673).
- **Teen Line.** Call: **800-852-8336**. 6:00 p.m. to 10:00 p.m. PST or text TEEN to **839863**.
- **Trevor Project Lifeline.** Call: **866-488-7386**. Text: Text the word "Trevor" to **202-304-1200**. 24-hour hotline that provides crisis intervention and suicide prevention services to lesbian, gay, bisexual, transgender and questioning young people (LGBTQ) ages 13-24. **www.thetrevorproject.org**.
- **Soluna App**
<https://solunaapp.com/>
Confidential support for 13- to 25-year-olds in California. No cost. No pressure. Chat 1:1 with a professional coach, use interactive tools to destress, or explore quizzes, videos, forums, and more.