The Neuroscience within Trauma and Addiction

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An Addiction Hits Close to Home

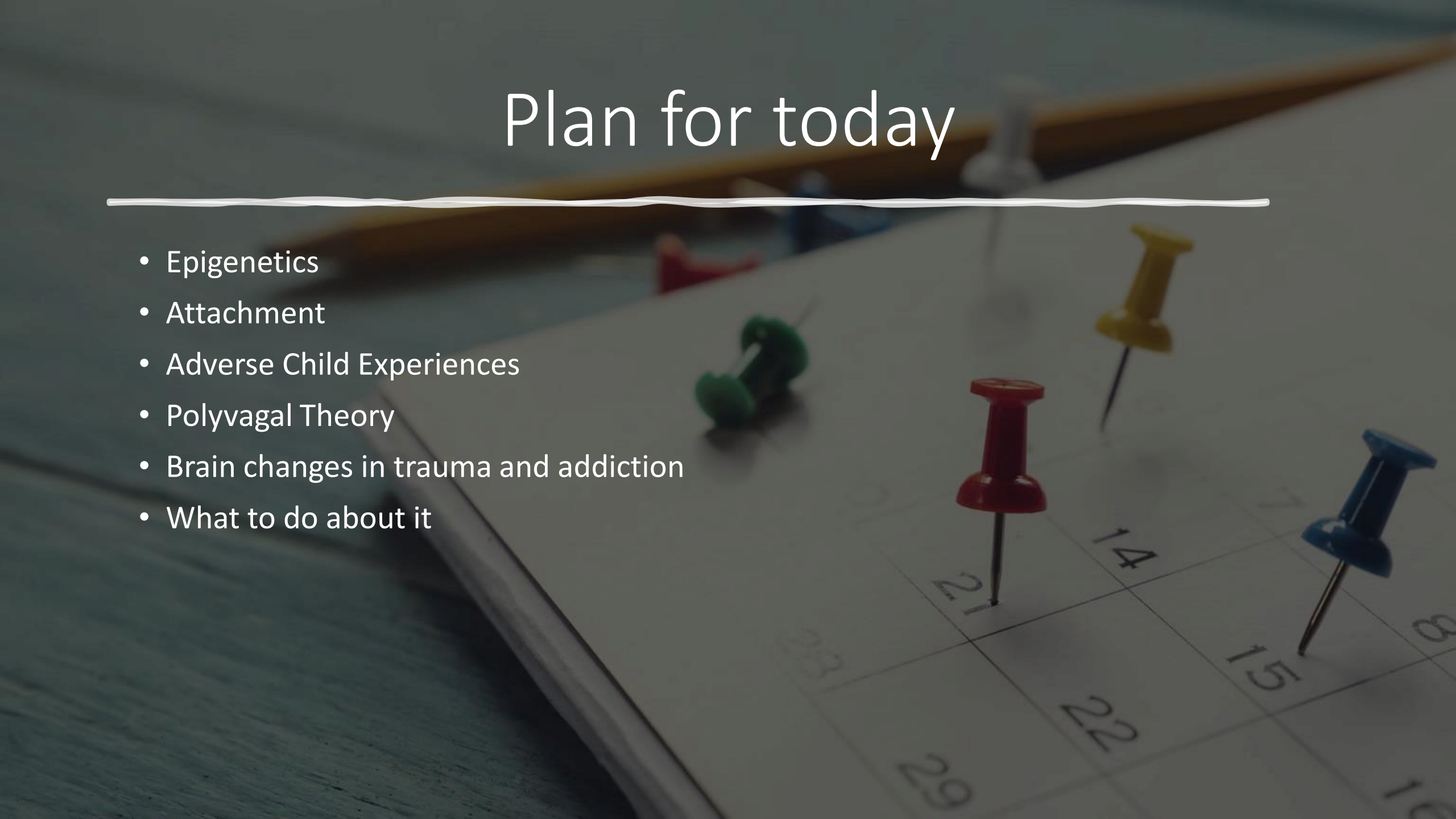
https://www.youtube.com/watch?v=r26Gvb8RpkU&ab_channel=WafflesXP

We initially love the addiction more than anything else

And although we love the addiction initially, we become enslaved to it.

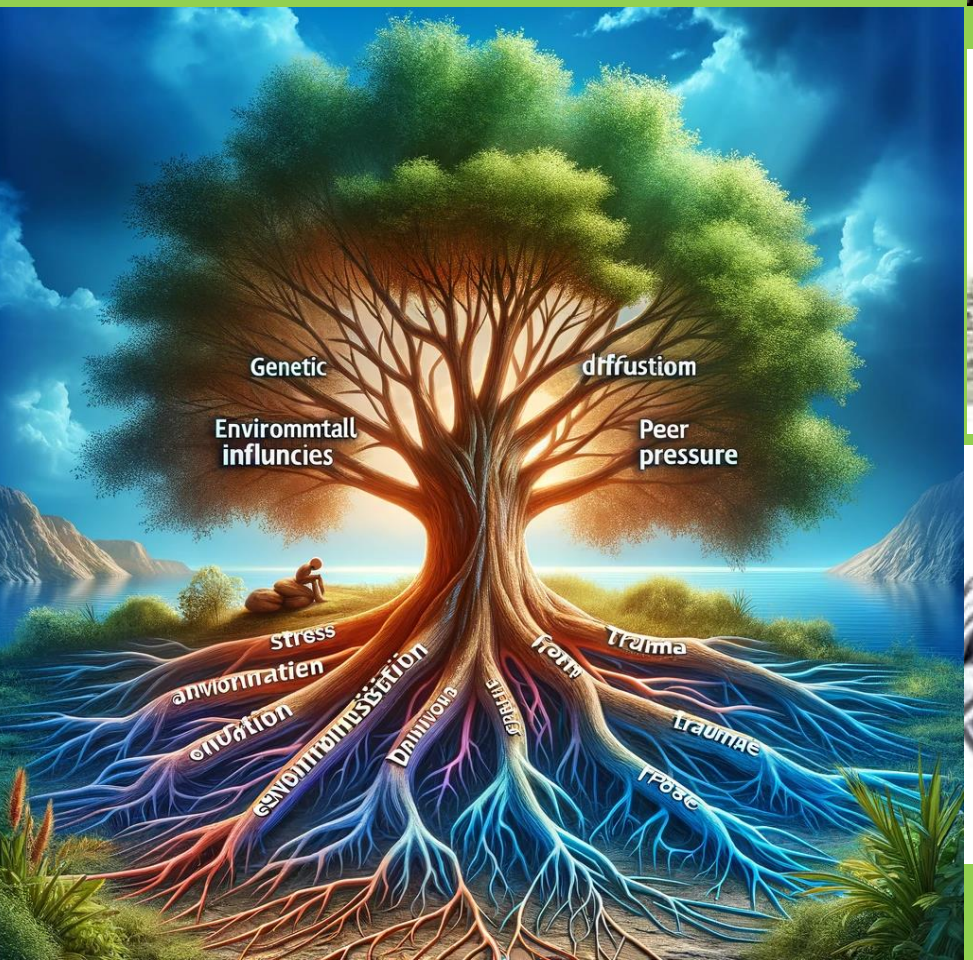
Plan for today

- Epigenetics
- Attachment
- Adverse Child Experiences
- Polyvagal Theory
- Brain changes in trauma and addiction
- What to do about it



Roots of the word ADDICTION

Adam Slater (2018)
Irresistible



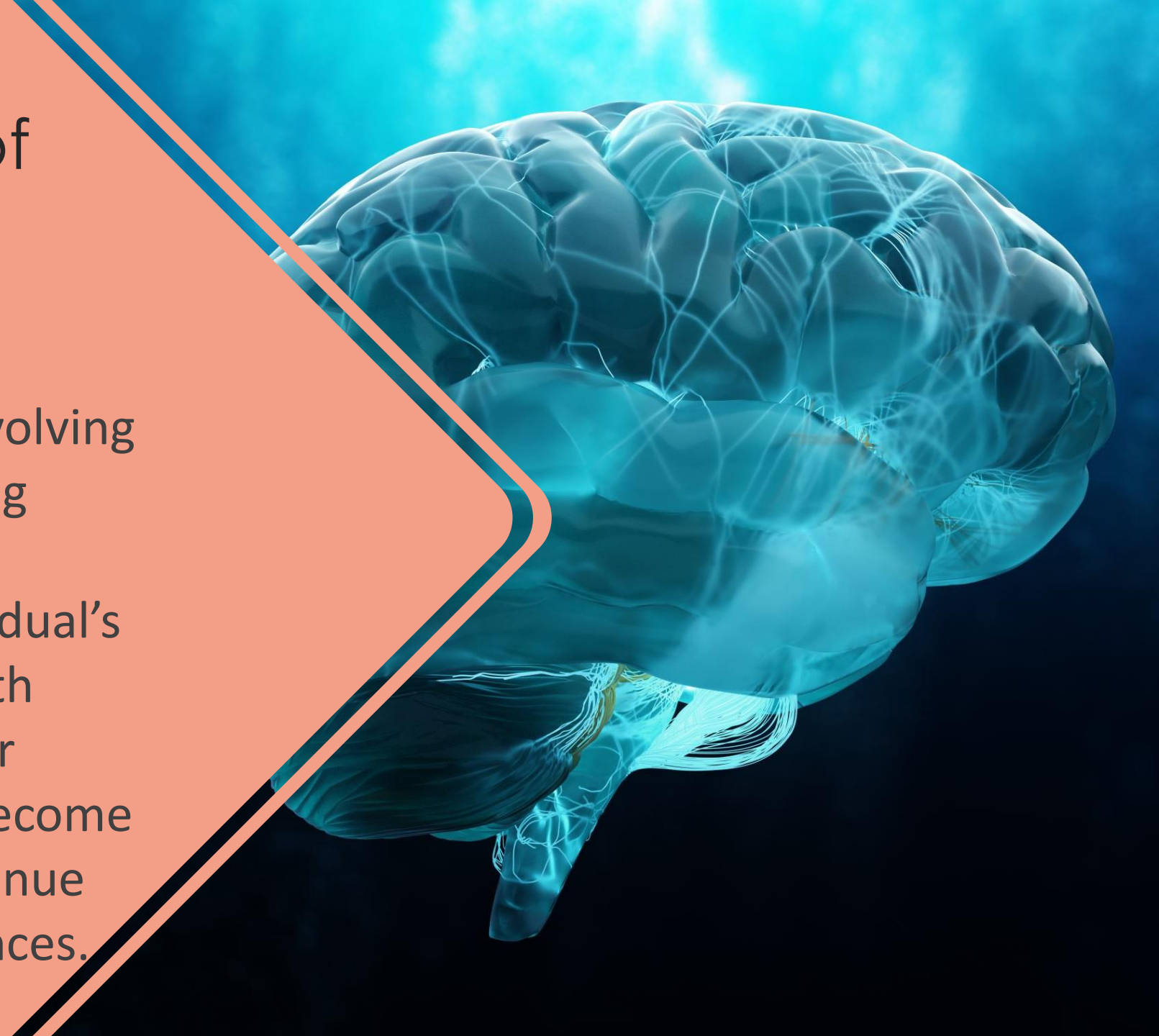
In Rome being **“addicted”** meant that you had just been sentenced to slavery.

If you owed someone money and couldn’t repay, a judge would sentence you to work as a slave until you could repay the debt.

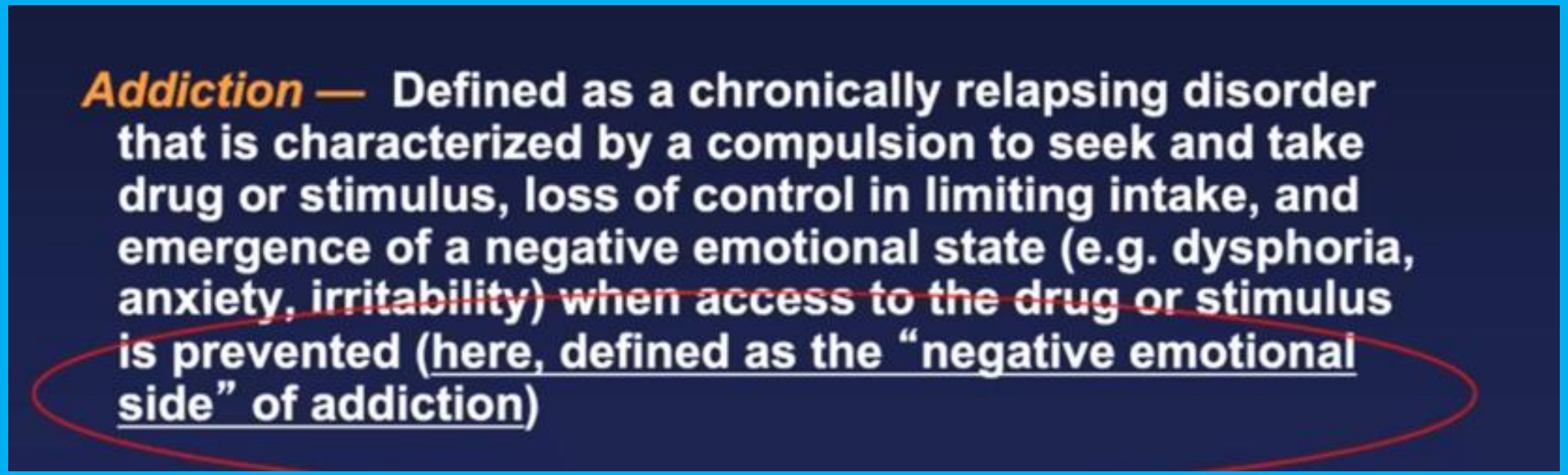
Addiction later evolved to describe any bond that was difficult to break.

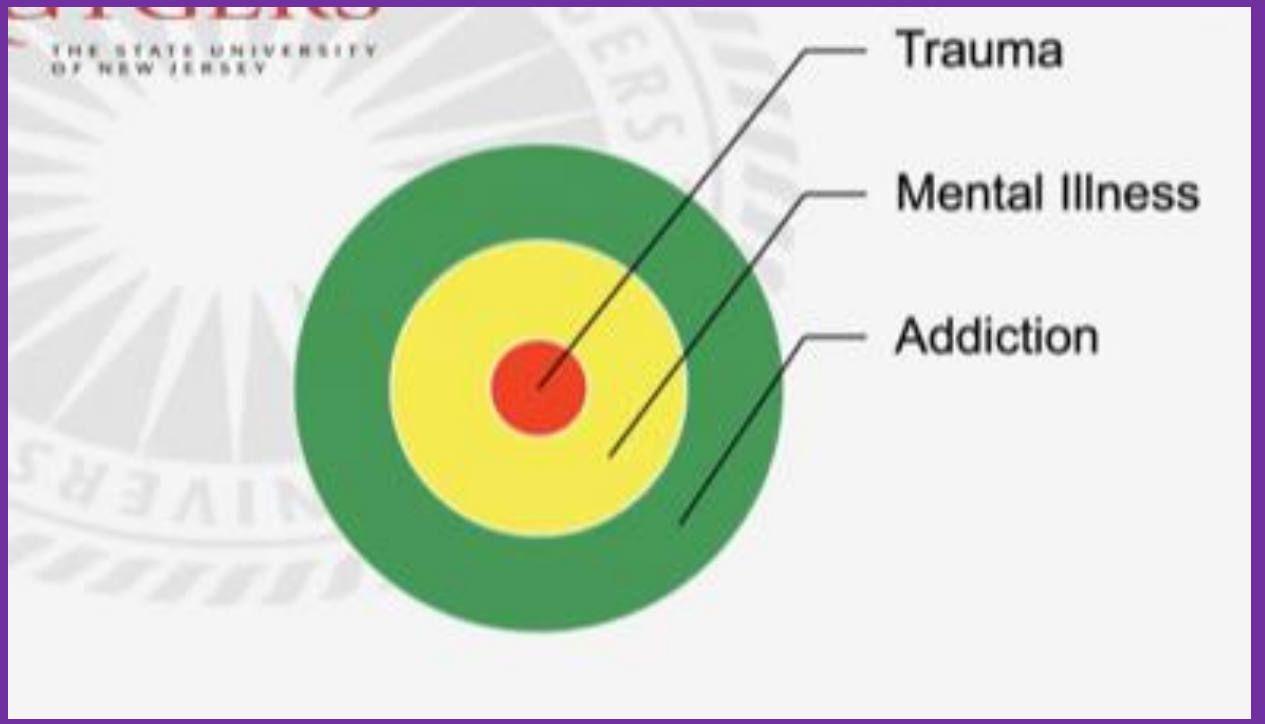
ASAM Definition of Addiction (2011)

- Addiction is a treatable, chronic medical disease involving complex interactions among brain circuits, genetics, the environment, and an individual's life experiences. People with addiction use substances or engage in behaviors that become compulsive and often continue despite harmful consequences.



A better definition of addiction per the National Institute of Alcohol Abuse and Alcoholism (NIAAA)





Trauma is almost always at the core of serious addiction which leads way to mental illness and then addiction to mask it.

The Four Cs of Addiction

- Wilson (2014) notes that all addictions, regardless of their differences, result in an established set of **"core brain changes"** which, in turn, present as recognized signs, symptoms, and behaviors such as those listed in the **Four C's:**

1. ***Craving and Preoccupation*** with obtaining, engaging in or recovering from the use of the substance or behaviors in question.

2. ***Loss of Control*** in using the substance or of engaging in the behavior and noted by increasing frequency or duration, larger amounts or intensity, and/or increasing the risk and behavior in an effort to obtain the desired effect.

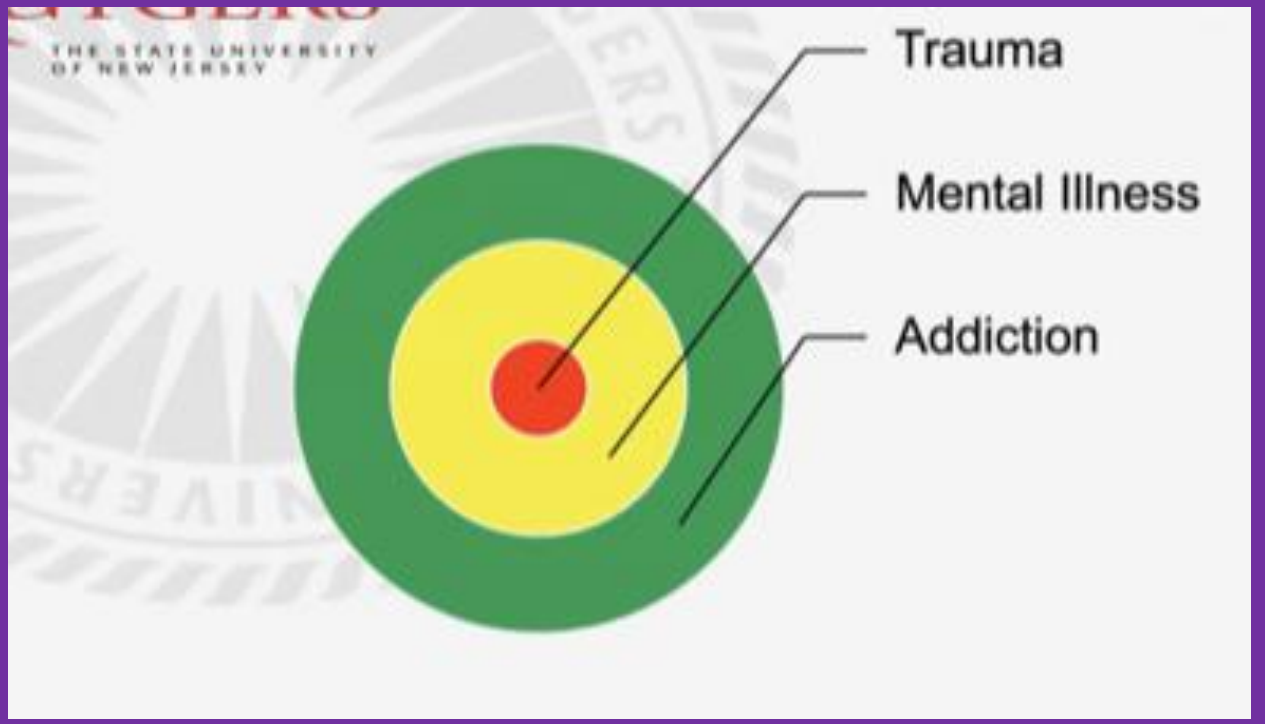
3. ***Negative Consequences*** in physical, social, occupational, financial, or psychological areas.

4. ***Compulsive*** *in nature*

Similarities between Chemical/Substance Addictions and Behavioral Addictions

- Cause chemical reactions in the brain
- Are a tool to escape or avoid pain
- Produce a tolerance
- Have psychological withdrawal symptoms
- Can have devastating biopsychosocial consequences

Trauma, Mental Illness, and Addiction. Which comes first?



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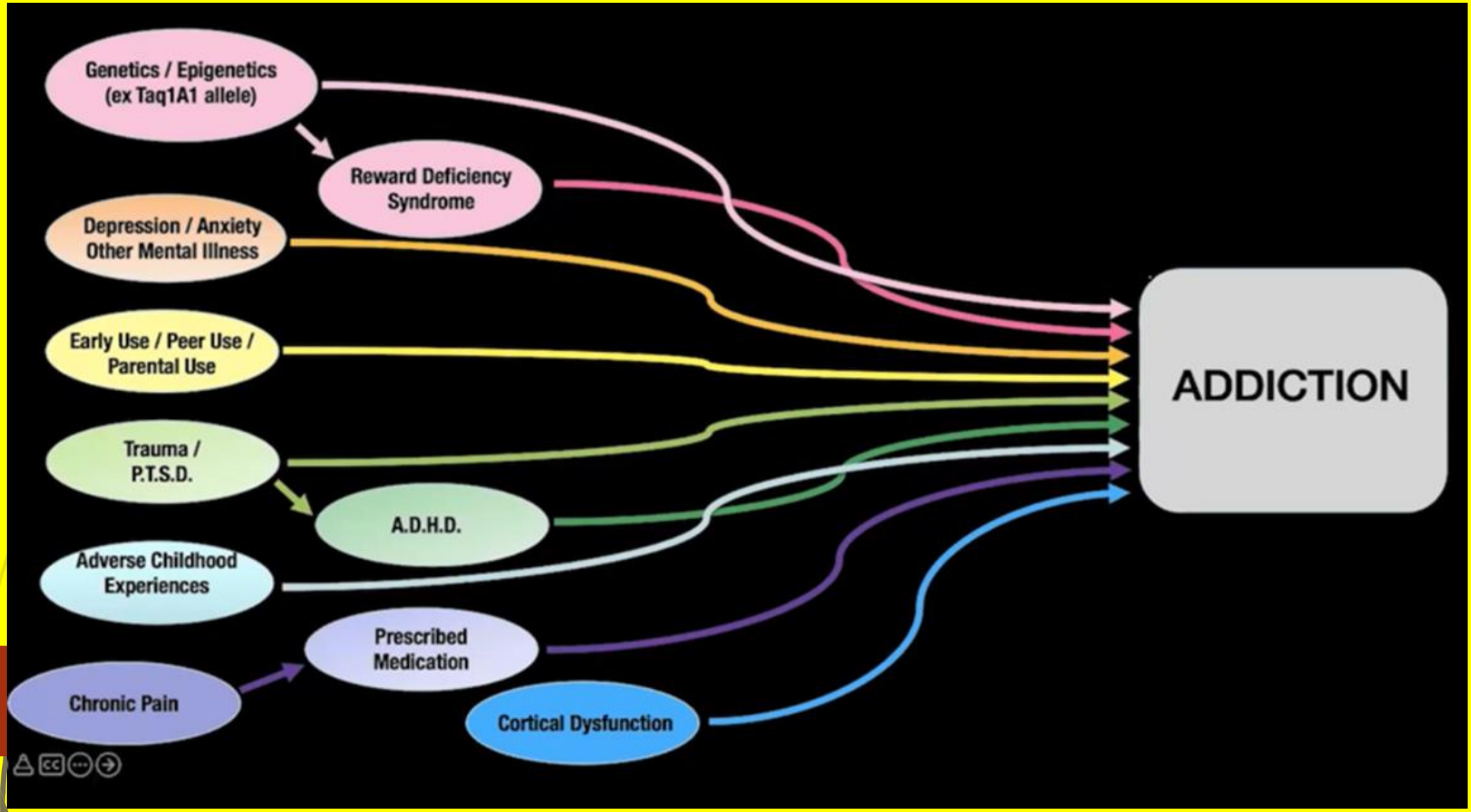
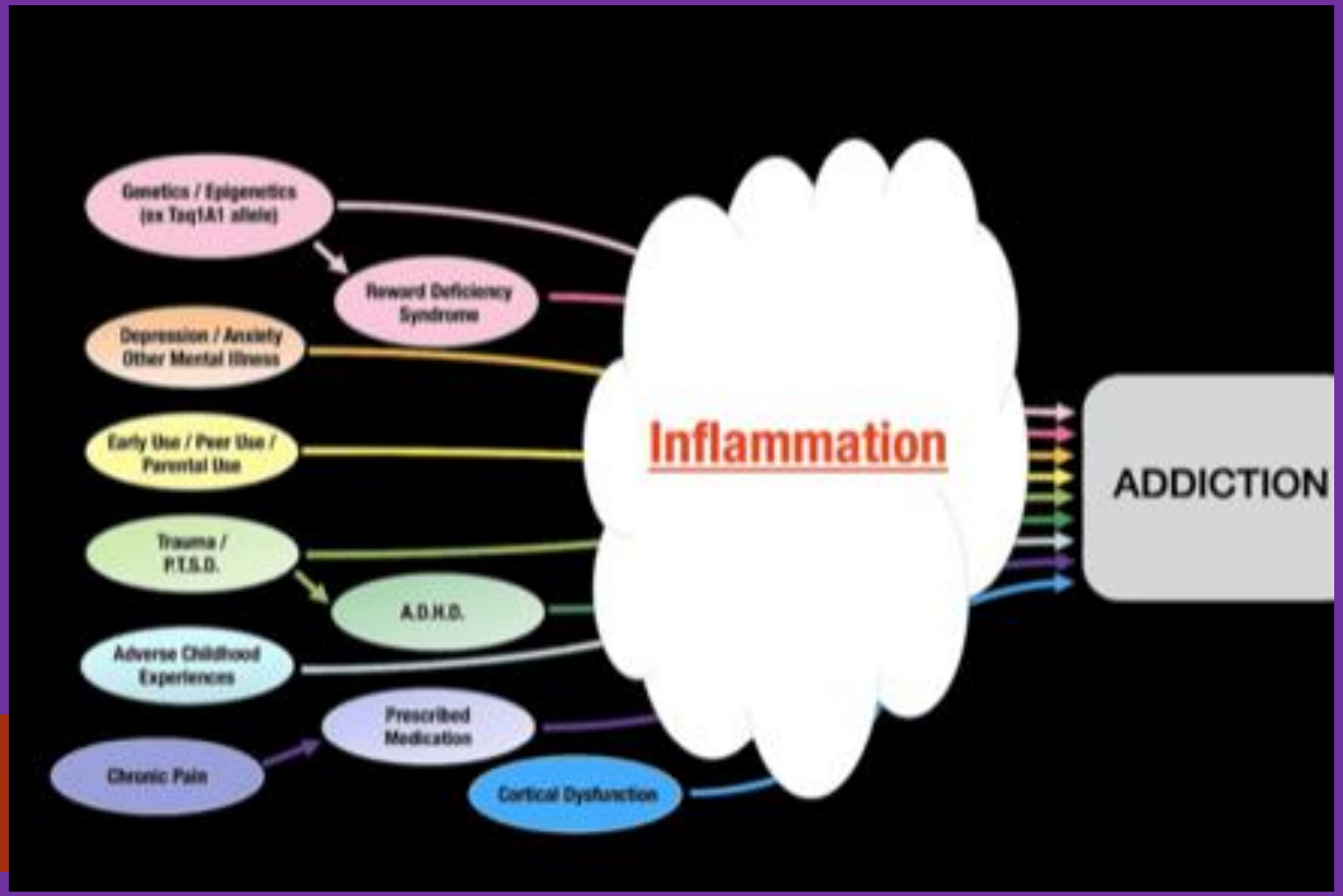


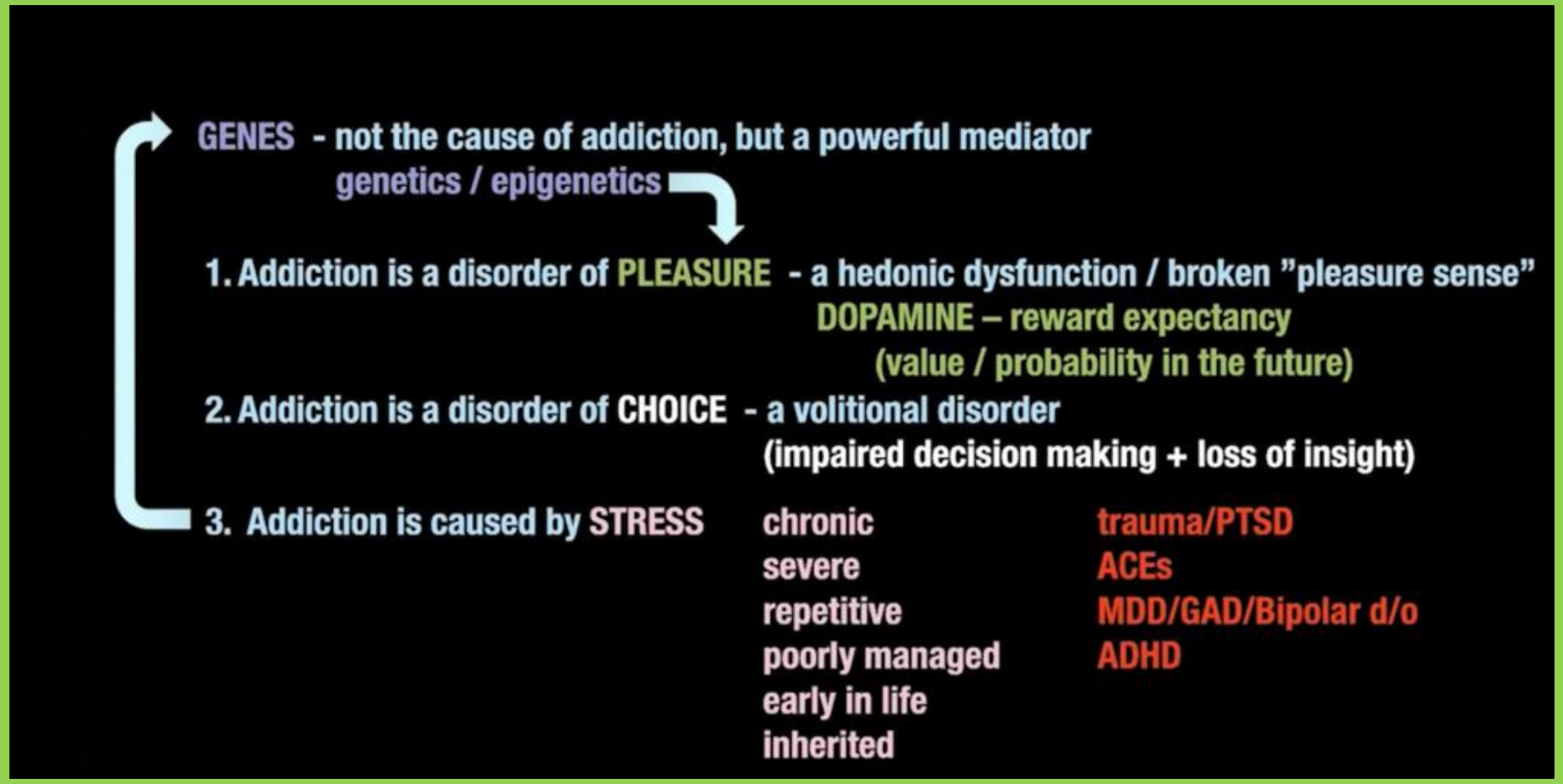
Dr. McCauley's model encompasses several pathways that can lead to addiction:

All addiction pathways lead to inflammation in the brain and body



Dr. McCauley's Integrative Model of Addiction

Disorder of pleasure/hedonic system
Disorder of choice
Caused by stress



Epigenetics

- These are exciting times.
- New science is enabling us to better understand what external and internal factors alter us.
- Our physical health, our emotional well-being, and our longevity are not only impacted by the hard-wired genetic code we inherit, but our genome is impacted by environmental influences to include as well as the way we live.

Epi (greek): in addition to, on

- The study of heritable changes in gene expression without a change in DNA sequence.

easingly highlighted in the public

Definition please:

- Epigenetics literally means **"above" or "on top of"** genetics. It refers to external modifications to DNA that turn genes "on" or "off."
- These modifications **do not change the DNA sequence,** but instead, they affect how cells **"read" genes.** A very exciting trend in epigenetic research involves investigating the process by which our genetic tendencies are altered or influenced in their expression by outside exposure or stimuli.
- These epigenetic changes can last through **multiple cell divisions for the duration of the cell's life** but what is particularly compelling is that these changes may persist for **multiple generations** within our family line (Kain & Terrell, 2018).

Trauma's Impact on Epigenetics

- Early trauma, for example, is one of the factors that can cause epigenetic changes and these changes can be passed on to the next generation and beyond.
- Researchers have come to appreciate that the horrors of the **Holocaust** did not only impact those who suffered the terror of the concentration camps.
- As one would expect, the survivors of the Holocaust often suffered from PTSD, but this did not stop there.
- Their children were more likely themselves to develop PTSD and other mood and anxiety disorders, whether or not they were exposed to traumatic events in their own lives (Yehunda et al. 1998).

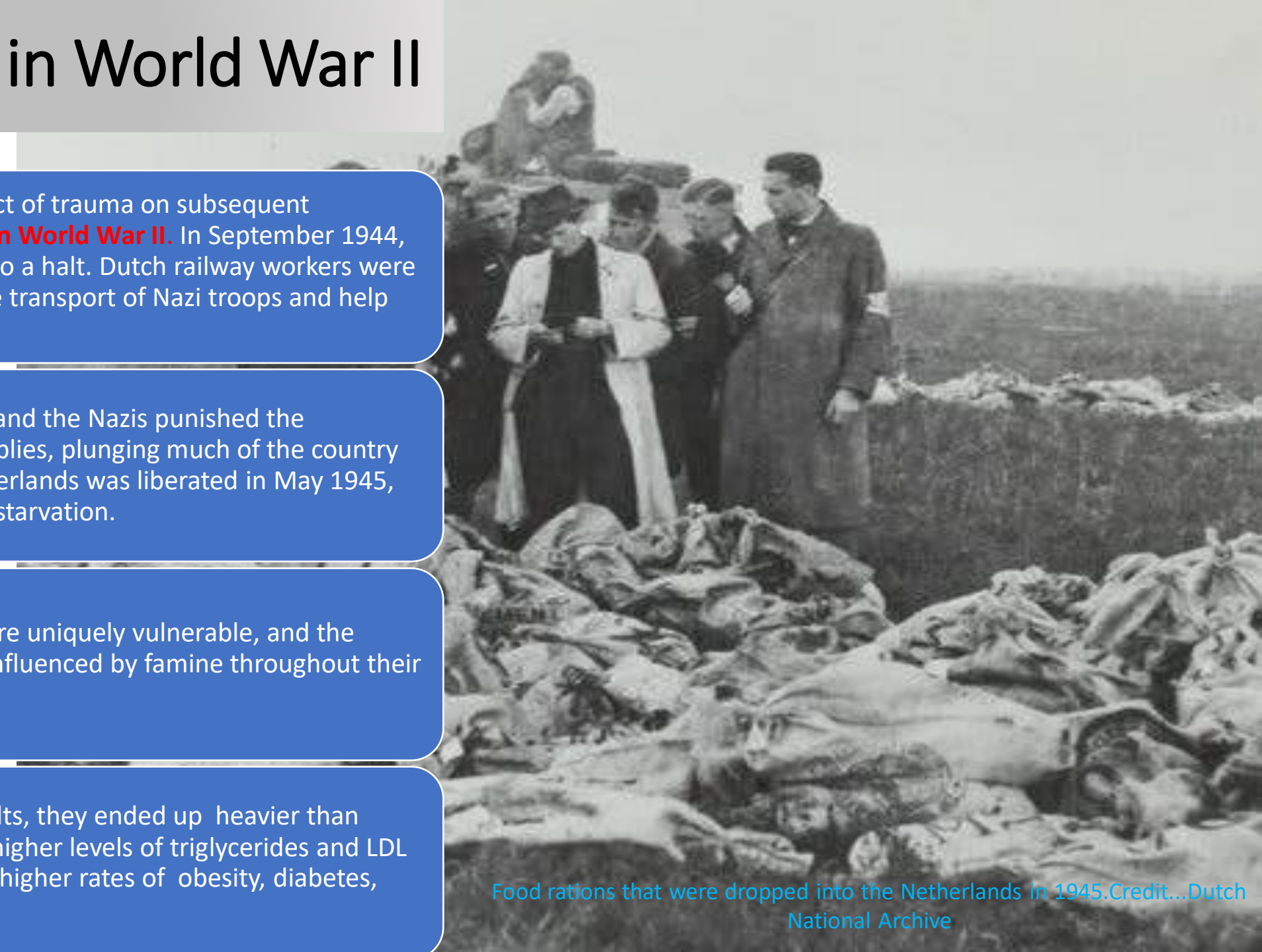
Dutch Famine in World War II

Another sad example of the impact of trauma on subsequent generations is the **Dutch Famine in World War II**. In September 1944, trains in the Netherlands ground to a halt. Dutch railway workers were hoping that a strike could stop the transport of Nazi troops and help the advancing Allied forces.

Sadly, the Allied campaign failed, and the Nazis punished the Netherlands by blocking food supplies, plunging much of the country into famine. By the time the Netherlands was liberated in May 1945, more than 20,000 people died of starvation.

Pregnant women, it turns out, were uniquely vulnerable, and the children they gave birth to were influenced by famine throughout their lives.

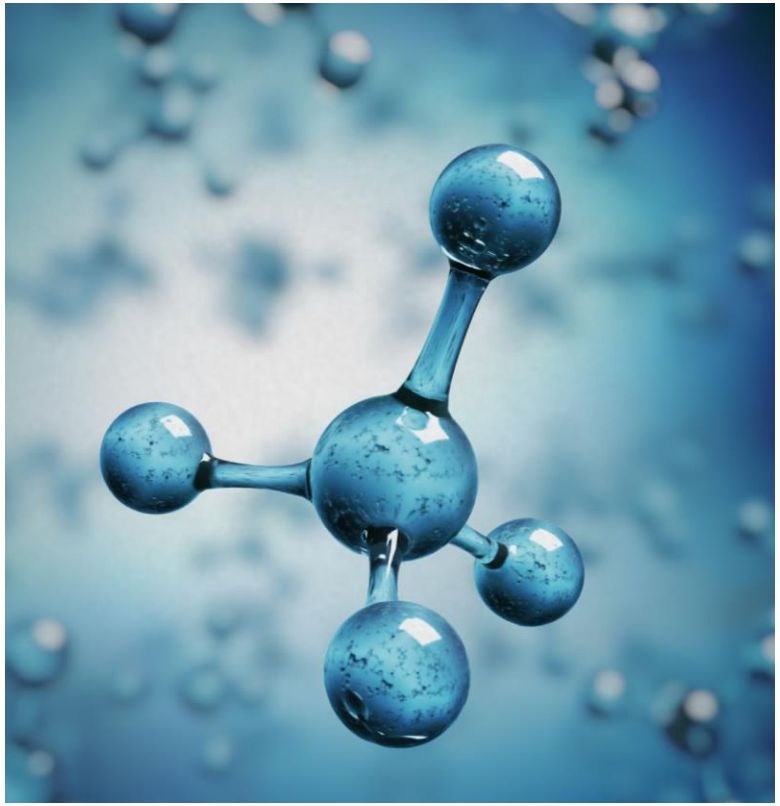
When these children became adults, they ended up heavier than average. In middle age, they had higher levels of triglycerides and LDL cholesterol and they experienced higher rates of obesity, diabetes, and schizophrenia.



Food rations that were dropped into the Netherlands in 1945.Credit...Dutch National Archive

For the science nerds among us:

- There are three primary mechanisms through which epigenetic changes in gene expression occur. But first a **biology refresher:**
- DNA from humans is made up of approximately 3 billion nucleotide bases.
- There are four fundamental types of these bases that comprise DNA: Adenine, Cytosine, Guanine, and Thymine, commonly abbreviated as A, C, G, and T, respectively.
- The sequence, or the order, of the bases is what determines our life instructions.
- There are about 20,000 genes in total. Genes are specific sequences of bases (parts of DNA) that provide unique and tailored instructions on how to make important proteins
- Proteins are large and very complex molecules that play many critical roles in the body and do most of the work in cells. Proteins are required for the structure, function, and regulation of the body's tissues and organs and are made up of hundreds and thousands of smaller units called amino acids.
- The sequence of amino acids is what determines each protein's unique 3-dimensional structure and its specific function. Proteins can be described according to their very large range of functions in the body to include antibody, enzyme, messenger, and structural component.



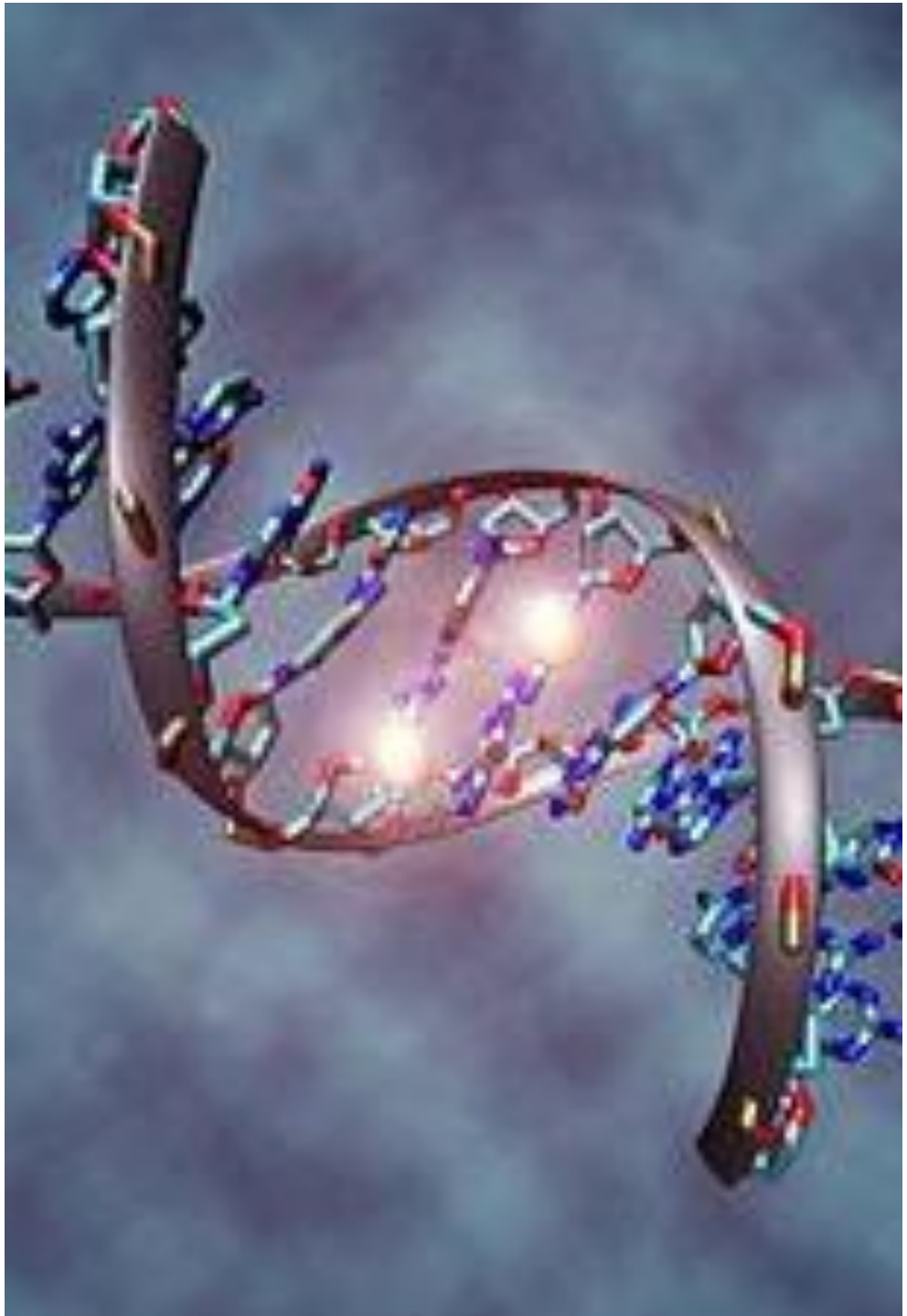
Epigenetic Changes – The Big Three

With that brief biology refresher out of the way, we can explore the three most well-known and best understood of several mechanisms through which epigenetic changes in gene expression occur.

As noted earlier, although a person's complement of genes or sequence of genes remains essentially the same from birth onward, except for the occurrence of mutations that can change the function of genes.

Different environmental exposures during development, diet, stress, emotional problems, etc., throughout a person's life chemically modify DNA and the proteins bound to it. In addition, individual's **histones**, or the proteins around which DNA winds when it is compacted into chromosomes, carry different chemical **tags** which are also influenced by environmental events.

These **tags** are thought to alter the extent to which DNA is wrapped around the histones, thereby affecting the availability of genes for activation. (Suitable my Nature, 2014; Fraga et al., 2005).



Epigenetic Changes – The Big Three

DNA methylation:

- The first type of epigenetic modification occurs on the DNA strand itself.
- This reaction, called DNA methylation, is a biological process by which methyl groups are added to the DNA molecule and thereby changes the activity of a DNA segment without changing the sequence.
- When located in a gene promoter, DNA methylation typically acts to repress or block gene transcription, effectively turning that gene off (University of Leicester, 2020),

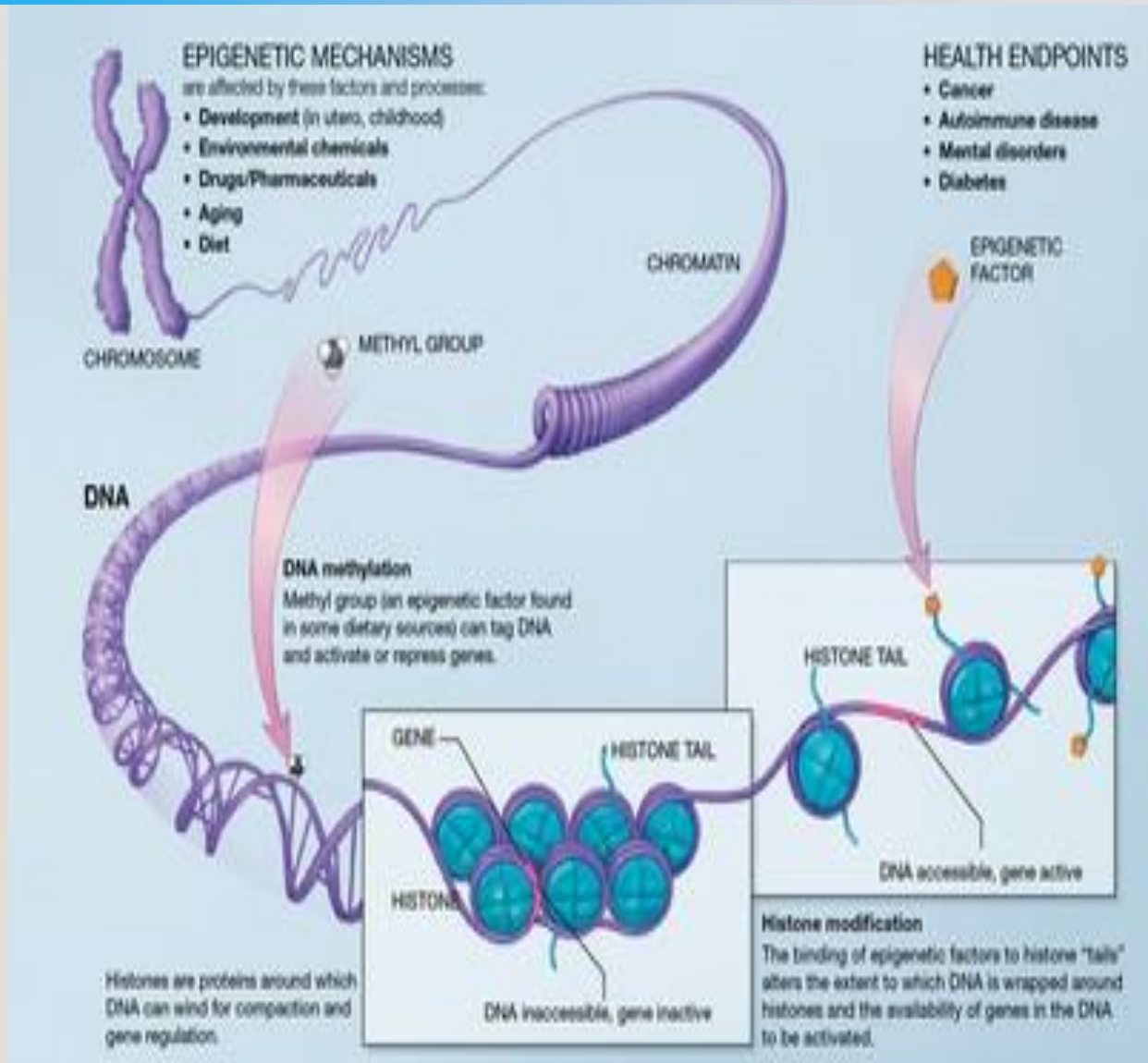
Epigenetic Changes – The Big Three

Histone modifications:

The second two types of modifications involve histones. Histones are the proteins that hold chromosome together. In histone modification, genes are actually wrapped up tightly so the genes cannot be accessed (essentially turned off) or unwrapped so they can be accessed or activated (essentially turned on). There are multiple types of histone modifications which are catalyzed by a number of enzyme families; the most well characterized modifications include acetylation and methylation:

Histone Acetylation is performed by *histone acetyltransferases (HATs)* which add an acetyl group to lysine amino acids (which are positively charged) in the histone tail which acts to mask the positive charge. This causes loosening of chromatin to promote gene activation (Strahl and Allis, 2000).

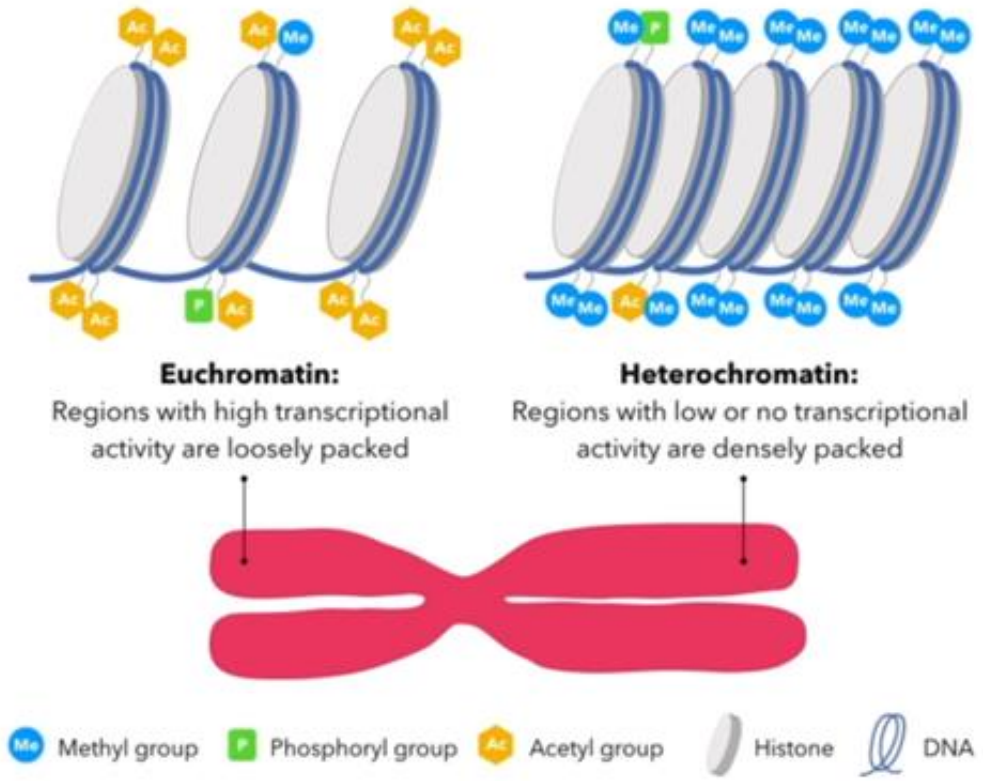
Histone Methylation can occur on lysine or arginine amine acids and can occur in mono-, di- or tri-methylation events by *histone methyltransferases*. This mark does not substantially alter the charge of amino acids and can be associated with both gene activation and inactivation (Laura,2008).



Three methods of chromatin Packing

Modification	Modification*	Charge	Effect
Methylation	R-CH3	Neutral	Increases packing
Acetylation	R-COCH3	Negative	Decreases packing
Phosphorylation	R-PO4	Negative	Decreases packing

*R = chemical functional group



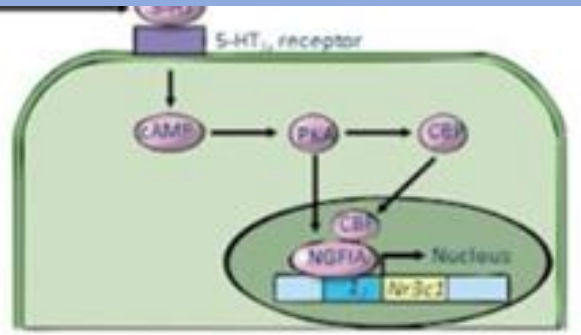
Epigenetics and Early Environment – possible Transgenerational inheritance

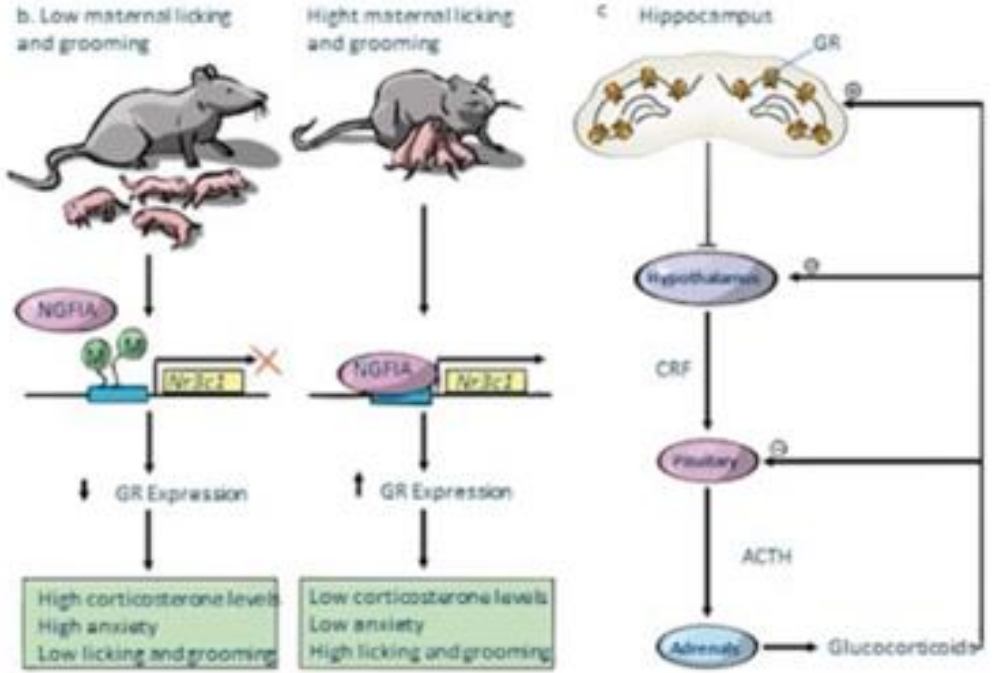
Early environment can lead to lasting epigenetic changes that influence

- Gene transcription
- Endocrine regulation
- Behaviour

Mechanism for lasting effects of early adversity

Possible transgenerational inheritance of environmental information via epigenetic mechanisms
some evidence in *C.elegans* and mouse, limited evidence in humans





Epigenetics Takeaway

- Knowing about epigenetics is both scary and amazing at the same time.
- Terrifying in that we know that if we live poorly, paying little attention to how we live, i.e., the impact of poor diet, lack of exercise, living in stress, exposing ourselves to environmental toxins, overreliance on medications, etc., our genome will be altered, resulting in poor physical and/or emotional health and that this effect can be passed on to our progeny for generations to come.
- On the other hand, good choices bless us and our future generations. Bearing this in mind, we can appreciate more fully how discussions in the pages ahead about attachment, adverse childhood experiences, Polyvagal Theory, and disconnected living impact us in mind, body, soul, and genome.

Early Attachment

- Attachment is a really big deal and has lifelong implications for all of us. Safe and secure attachment are absolutely necessary for developing healthy and secure development, emotional health, and the ability to regulate our emotions.
- Two early pioneers in this field, **Dr. John Bowlby** (1969) and **Dr. Mary Ainsworth** (1973) carved the way to our understanding of attachment and child development theory.
- They **defined attachment** as a deep and enduring emotional bond that leads to connections between us across time and space.
- This attachment is not always mutual and can travel in only one direction. For example, a child can attach to a parent, but the parent does not always attach to the child or vice versa (Kain & Terrell, 2018).

Attachment – Dr. John Bowlby

- In an interview with Dr. Milton Stenn in 1977, Dr. John Bowlby shared that his career started off in the medical direction. He noted that he was following in his surgeon father's footsteps. His father was a well-known surgeon in London and John explained that his father encouraged him to study medicine at Cambridge.
- Bowlby ended up following his father's suggestion but was not terribly interested in anatomy and natural sciences. However, during his time at Trinity College, he became particularly interested in developmental psychology which led him to give up medicine by his third year. When John left medicine, he accepted a teaching opportunity at a school called Priory Gates for six months where he worked with maladjusted children.
- Bowlby stated that the experience at Priory Gates was extremely important to his career in research as he learned that the problems of today should be understood and dealt with at a developmental level (Kanter, 2007).

Attachment – Dr. Mary Ainsworth

- Bowlby was not the only act in town as he collaborated extensively with Dr. Mary Ainsworth.
- Mary was born in **Glendale Ohio.** When she was 15, she read William McDougall's book, ***Character and the Conduct of Life*****,** which inspired her to pursue psychology.
- While she was teaching at **John Hopkins,** Mary began working on creating a means to measure attachments between mothers and their children.
- It was this that led her to develop her famous **"Strange Situation"** assessment, in which a researcher observes a child's reactions after a mother briefly leaves her child alone in an unfamiliar room.
- The child's reaction after the separation and upon the mother's return, revealed important information about attachment. Based on her observations and research,
- Mary determined that there were **three main styles of attachment:** secure, anxious-avoidant, and anxious-resistant. Since these initial findings, her work has spawned numerous studies into the nature of attachment and the different attachment styles that exist between children and their caregivers (VeryWellMind, 2019)

Four Phases of Attachment

- Rudolph Schaffer and Peggy Emerson (1964) analyzed the number of attachment relationships that infants form in a longitudinal study with 60 infants.
- In their study, infants were observed every four weeks during the first year of life, and then once again at 18 months.
- Schaffer and Emerson determined that four distinct phases of attachment emerged:

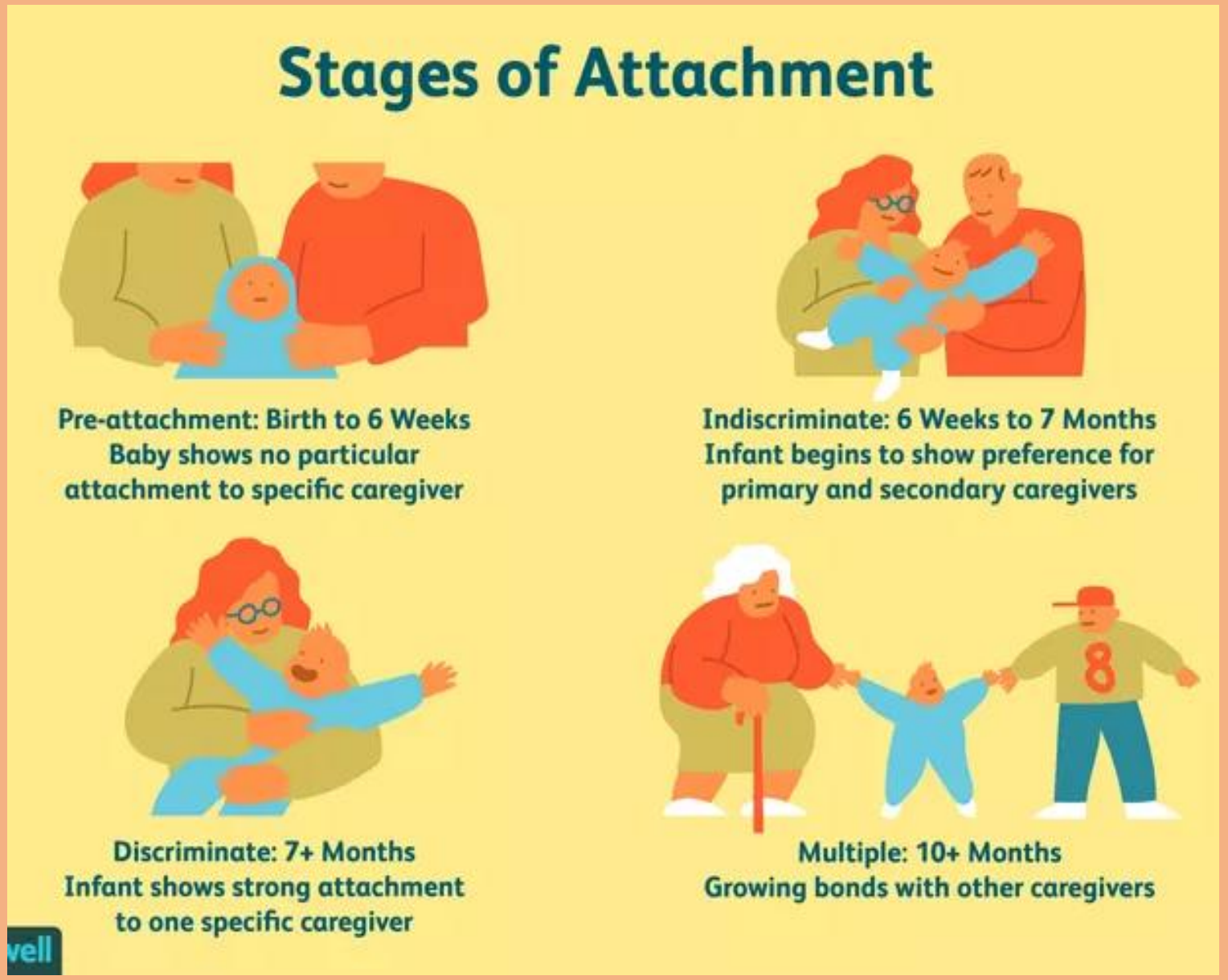


Illustration by JR Bee (VeryWellMind, 2019

Four Phases of Attachment

Rudolph Schaffer and Peggy Emerson (1964)

- **Pre-attachment stage:** From birth to three months, infants do not show any particular attachment to a specific caregiver. The infant's signals, such as crying and fussing, naturally attract the attention of the caregiver and the baby's positive responses encourage the caregiver to remain close" (Schaffer & Emerson, 1964).
- **Indiscriminate attachment:** From around six weeks of age to seven months, infants begin to show preferences for primary and secondary caregivers. During this phase, infants begin to develop a feeling of trust that the caregiver will respond to their needs. While they will still accept care from other people, they become better at distinguishing between familiar and unfamiliar people as they approach seven months of age. They also respond more positively to the primary caregiver" (Schaffer & Emerson, 1964).
- **Discriminate attachment:** At this point, from about seven to eleven months of age, infants show a strong attachment and preference for one specific individual. They will protest when separated from the primary attachment figure (separation anxiety) and begin to display anxiety around strangers (stranger anxiety)" (Schaffer & Emerson, 1964).
- **Multiple attachments:** After approximately nine months of age, children begin to form strong emotional bonds with other caregivers beyond the primary attachment figure. This often includes the father, older siblings, and grandparents" (Schaffer & Emerson, 1964).

Attachment Styles

As nicely summarized by Lyons-Ruth (1996), the basic the attachment styles culminating from John Bowlby's and Mary Ainsworth's research and the fourth by Drs. Mary Main's and Judith Solomon's (Main & Solomon, 1986) work include:

- Secure
- Avoidant
- Ambivalent
- Disordered

Attachment Styles Explained

- **Secure attachment:** Secure attachment is marked by distress when separated from caregivers and joy when the caregiver returns. Remember, these children feel secure and are able to depend on their adult caregivers. When the adult leaves, the child may be upset but he or she feels assured that the parent or caregiver will return. When frightened, securely attached children will seek comfort from caregivers. These children know their parent or caregiver will provide comfort and reassurance, so they are comfortable seeking them out in times of need" (Lyons-Ruth, 1996).
- **Ambivalent attachment:** Ambivalently attached children usually don't appear too distressed by the separation, and, upon reunion, actively avoid seeking contact with their parent, sometimes turning their attention to play objects on the laboratory floor. This attachment style is considered relatively uncommon, affecting an estimated 7 percent to 15 percent of U.S. children. Ambivalent attachment maybe a result of poor parental availability. These children cannot depend on their mother (or caregiver) to be there when the child is in need" (Lyons-Ruth, 1996).
- **Avoidant attachment:** Children with an avoidant attachment tend to avoid parents or caregivers. When offered a choice, these children will show no preference between a caregiver and a complete stranger. Research has suggested that this attachment style might be a result of abusive or neglectful caregivers. Children who are punished for relying on a caregiver will learn to avoid seeking help in the future" (Lyons-Ruth, 1996).
- **Disorganized attachment:** Children with a disorganized attachment often display a confusing mix of behavior and may seem disoriented, dazed, or confused. Children may both avoid or resist the parent. Some researchers believe that the lack of a clear attachment pattern is likely linked to inconsistent behavior from caregivers. In such cases, parents may serve as both a source of comfort and a source of fear, leading to disorganized behavior" (Lyons-Ruth, 1996).

Attachment Style Percentages

Mary Ainsworth and her colleagues reported in 1978 that studies on the three initial attachment classifications revealed:

- 70 percent of American infants have been classified as secure
- 20 percent as avoidant-insecure
- 10 percent as resistant-insecure (Ainsworth et al., 1978).

Kain and Terrell (2018) warn that there are worrying declines in secure attachment and that in more recent research populations, the percentages of secure attachment have declined by **10 percent** (Andreassen et al., 2007).

Attachment Takeaways

- Studies reveal that Interactions during the first three years of life can affect cognitive development and will impact physical, emotional, and mental health of children as they age and develop (Colmer et al., 2011).
- Typically, a parent's emotional response will serve as a template for helping their child learn about emotion. As parents model appropriate emotion regulation through conversations or actions, children learn to control/regulate their emotions.
- On the other hand, insecurely attached children may learn to mask their emotional distress or exaggerate them in order to gain the parent's attention; therefore, making up for a parent who is not consistently responsive (Laible, 2010).
- This type of maladaptive behavior has devastating and potentially consequences resulting in poor social skills, emotional dysregulation, depression, anxiety, peer exclusion, social rejection, and/or low self-esteem (Lewis et al, 2015; Newman, 2017).
- So, it behooves any of us who are young parents to ensure that we are spending lots and lots of time with our infants and children in healthy, safe, and connected ways, particularly early in life to develop secure attachment so they will be able to have joy, fulfilling relationships, and emotional stability.

Trauma and Adverse Childhood Experiences

Trauma exposure, particularly child maltreatment (e.g., neglect, emotional, physical and sexual abuse), has been established as one of the main determinants of emotional dysregulation and is also a known risk factor for psychiatric disorders, especially depression and PTSD (McLaughlin et al.,2012; McLaughlin et al., 2013).

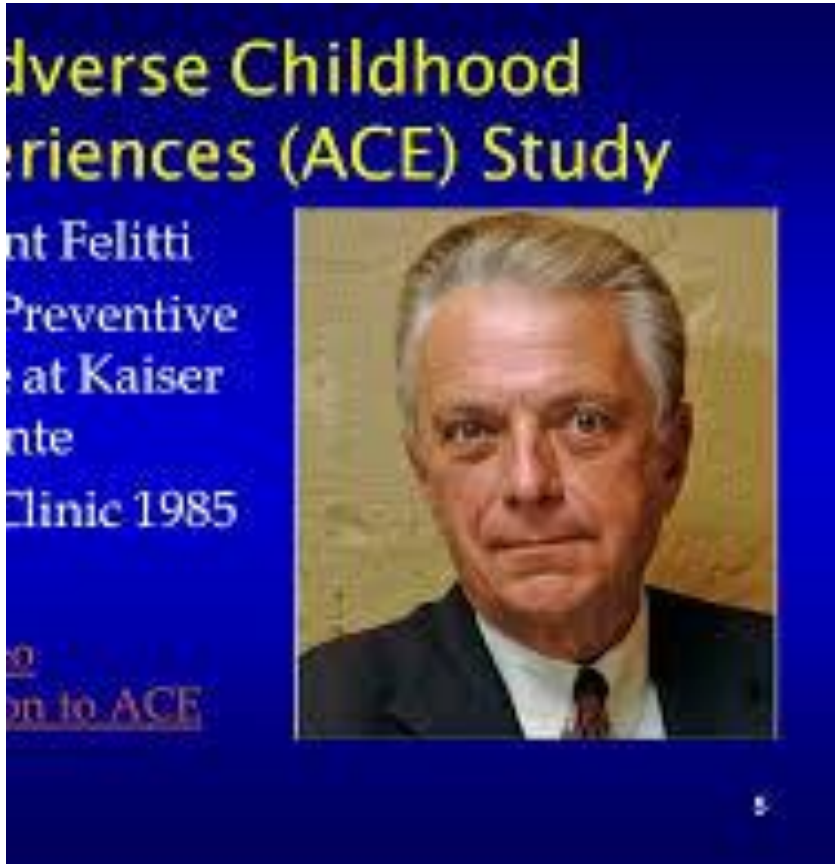
Moreover, several prior studies have shown that trauma exposure is clearly associated with profound deficits in emotional regulation across the entire lifespan, including during preschool (Langevin, Hebert, Allard-Dansereau; Bernard-Bonnin, 2016), adolescence (Shields & Cicchetti, 1997; Vettese, Dyer, Li, & Wekerle, 2011) and even adulthood (Briere & Rickards, 2007; Thompson, Hannan, & Miron, 2014; Dunn et al., 2018).

Trauma occurs when we are faced with an experience that overwhelms our ability to process incoming information both at the time of that experience and in future situations (Barta, 2018).

Dr. Michael Barta suffered from trauma himself as a child which led him to addictions that ultimately landed him in jail and almost destroyed his life. In is book, *TINSA*, he wrote that trauma occurs when our natural defenses are unable to keep us safe from physical, emotional, or mental threats or harm (Barta, 2018).

Trauma - Adverse Childhood Experiences

- In the mid-1980's, Dr. Vincent Felitti noticed a puzzling and paradoxical trend in the obesity clinic he was heading.
- Specifically, many of his participants who were having the most success in losing weight were dropping out only to gain the weight back. He interviewed the nearly 300 participants and discovered a surprising pattern: almost all of the dropouts had suffered some form of childhood trauma (Kain & Terrell, 2018).
- This initial study grew into a major public health study with Dr. Felitti teaming up with Dr. Anda at the Centers for Disease Control (CDC) that continues to this day, involving more than 17,000 individuals.
- This research came to be known as the Adverse Childhood Experiences (ACE) Study (Felitti et al., 2014). In this study, people were asked about ten different types of traumatic events that happened to them when they were children to include physical and sexual abuse, family problems, and neglect.



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3. ***Negative Consequences*** in physical, social, occupational, financial, or psychological areas.

4. ***Compulsive*** *in nature*

Trauma - Adverse Childhood Experiences (ACE)

The ten reference categories experienced during childhood or adolescence are as below, with their prevalence in parentheses (Felitti and Anda, 2009):

Abuse

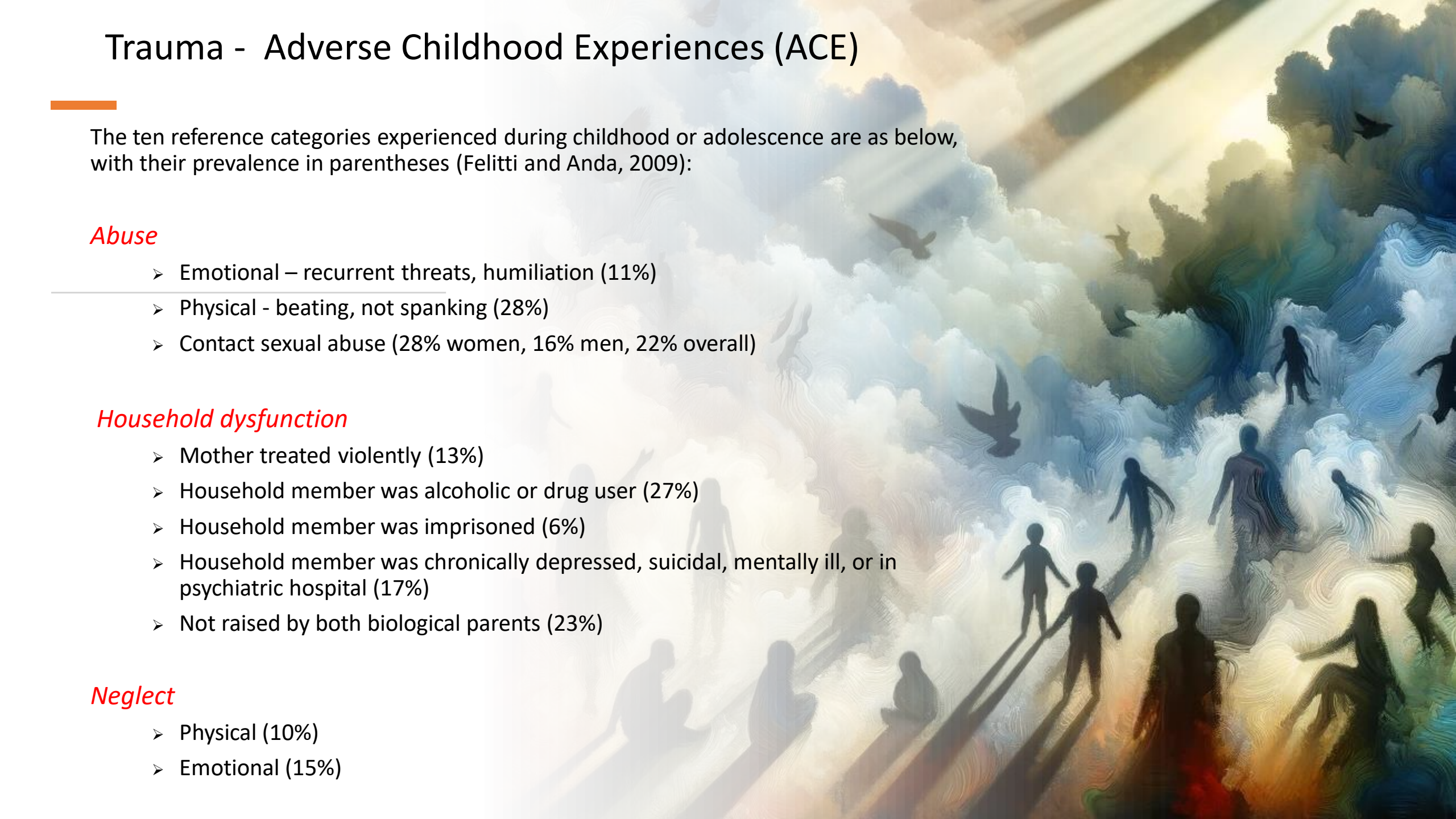
- Emotional – recurrent threats, humiliation (11%)
- Physical - beating, not spanking (28%)
- Contact sexual abuse (28% women, 16% men, 22% overall)

Household dysfunction

- Mother treated violently (13%)
- Household member was alcoholic or drug user (27%)
- Household member was imprisoned (6%)
- Household member was chronically depressed, suicidal, mentally ill, or in psychiatric hospital (17%)
- Not raised by both biological parents (23%)

Neglect

- Physical (10%)
- Emotional (15%)



Trauma - Adverse Childhood Experiences

- Somewhat surprising in the Felitti studies was that emotional abuse was more likely to cause depression than any other kind of trauma – even sexual abuse.

- This suggests that the kind of treatment children receive from parents is a tremendously powerful predictor of positive outcome and when that trust is broken, devastation surely ensues.

Dr. Michael Barta's Adverse Childhood Experiences

Barta (2018) in his book, *TINSA,* defines ACEs a little differently as summarized below:

- Sexual assault or abuse
- Physical assault or abuse
- Psychological or emotional trauma
- Serious accidents, medical procedures, or illnesses
- Manmade or natural disasters
- Witnessing violence to include domestic abuse
- School violence to include bullying
- Traumatic grief or unwanted separation
- Terrorism or war
- Betrayal by others to include relational trauma

Big T Trauma and Little t Trauma

The experts in the field divide trauma into two categories:

- Big T trauma: Traumas that are associated with horrific single events such as natural disasters, terrorism, and war.
- Little t trauma: Trauma that are smaller in nature such as bullying, neglect, and betrayal.

Big T Trauma and Little t Trauma

- In my personal experience as a pediatric psychologist, far more of my patients have been subjected to "little t" traumas and I agree with Barta that these experiences have a tremendous impact on how children view themselves, their relationships, and their place in the world.
- Moreover, the long-term consequences of these traumas are tremendous and often lead to a total inability or impaired ability to access appropriate responses to threatening events and can lead to chronic hyperarousal, intense anxiety, panic, mood instability, poor emotional/behavioral regulation, feelings of powerlessness, helplessness, shame, and even immobility.
- Of all traumas, relational (or loss of connection) trauma is particularly devastating.
- The implications here are enormous. Specifically, in order to promote safe and healthy emotional regulation, we must be able to pinpoint where in the lifespan people hurt us physically, emotionally, mentally, or spiritually, whether intentionally or accidentally.
- If we can resolve our developmental wounds, we can move on and experience a more fulfilling life.

ACE Scores and Outcomes

As Dr. Felitti in a 2009 lecture points out, studies reveal many shocking long-term horrible outcomes when we are exposed to ACEs and this raises exponentially according to how many of them, we have been exposed to.

The results indicate that for every category of traumatic experience we have had as a child, we are dramatically more likely to be depressed as an adult.

If we have ACE scores of 4 we are:

- 260% more likely to have chronic obstructive pulmonary disease than someone with a score of 0
- 240% more likely to contract hepatitis, 460% more likely to experience depression
- 1,220% more likely to attempt suicide

If we have ACE scores of 6 we are:

- Five times more likely to become depressed as an adult and if we have had

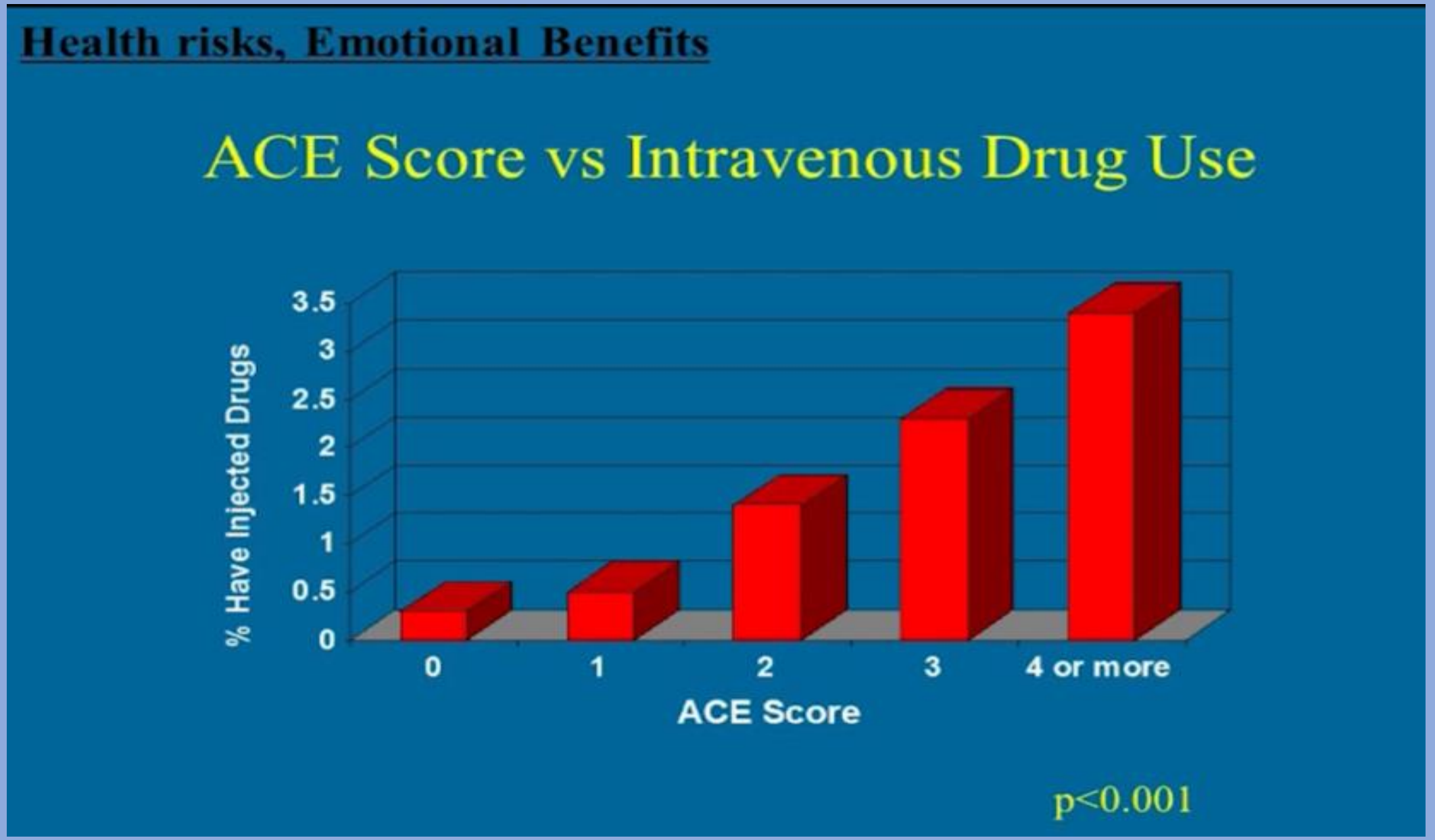
If we have ACE scores of 7 we are:

- 3,100 percent more likely to attempt suicide as an adult (Felitti et al., 2014; Felitti 2004; Felitti and Anda, 2009; Felitti et al., 1998).

Dr. Felitti offered the following graphs which nicely detail the dramatic impact that ACEs have on our society:

Dr Vincent Felitti (2009) https://www.youtube.com/watch?v=KEFfThbAYnQ (Accessed February 17, 2020)

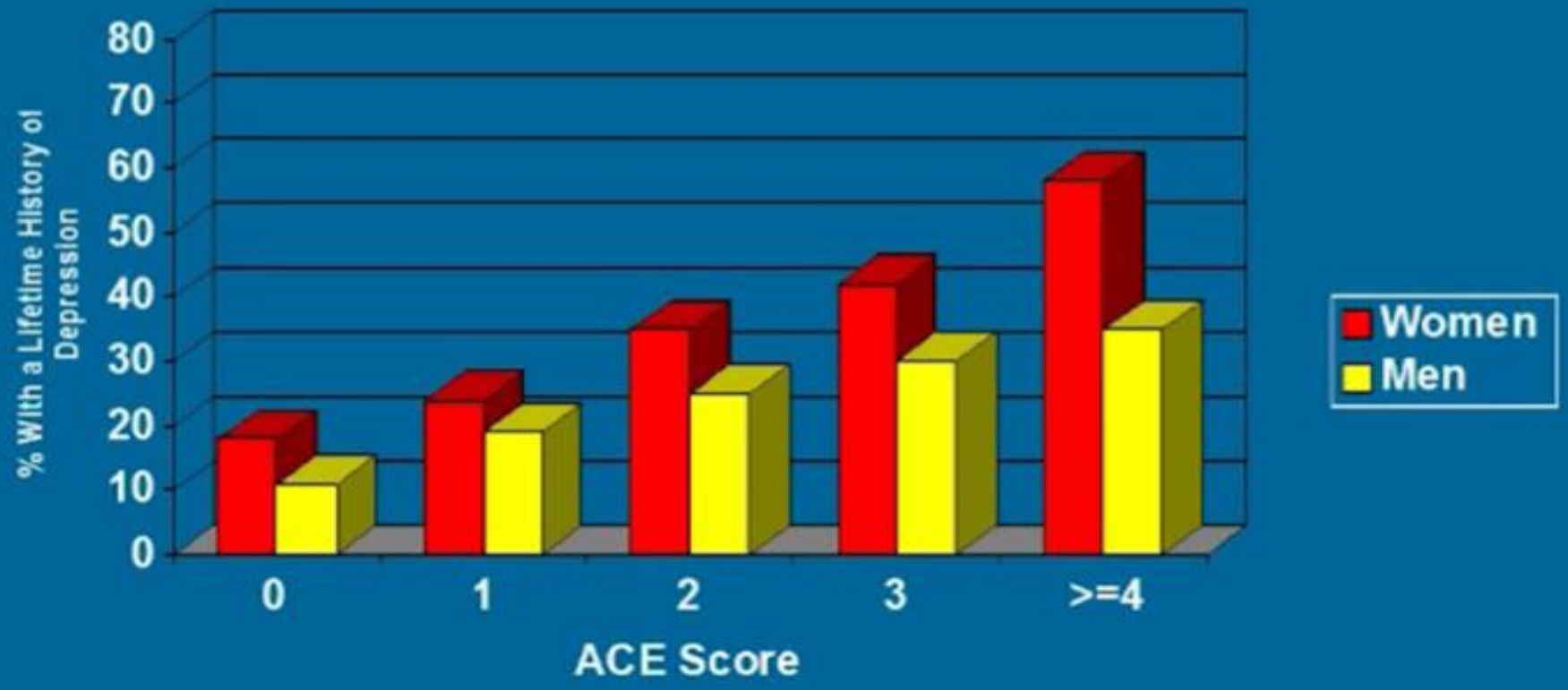
Health risks, Emotional Benefits



Dr Vincent Felitti (2009) https://www.youtube.com/watch?v=KEFfThbAYnQ (Accessed February 17, 2020)

Damaged well-being

Childhood Experiences Underlie Chronic Depression



Dr Vincent Felitti (2009) https://www.youtube.com/watch?v=KEFfThbAYnQ (Accessed February 17, 2020)

Dr Vincent Felitti (2009) https://www.youtube.com/watch?v=KEFfThbAYnQ (Accessed February 17, 2020)

ACEs Increase the Likelihood of Heart Disease*

• Emotional abuse	1.7x
• Physical abuse	1.5x
• Sexual abuse	1.4x
• Domestic violence	1.4x
• Mental illness	1.4x
• Substance abuse	1.3x
• Household criminal	1.7x
• Emotional neglect	1.3x
• Physical neglect	1.4x

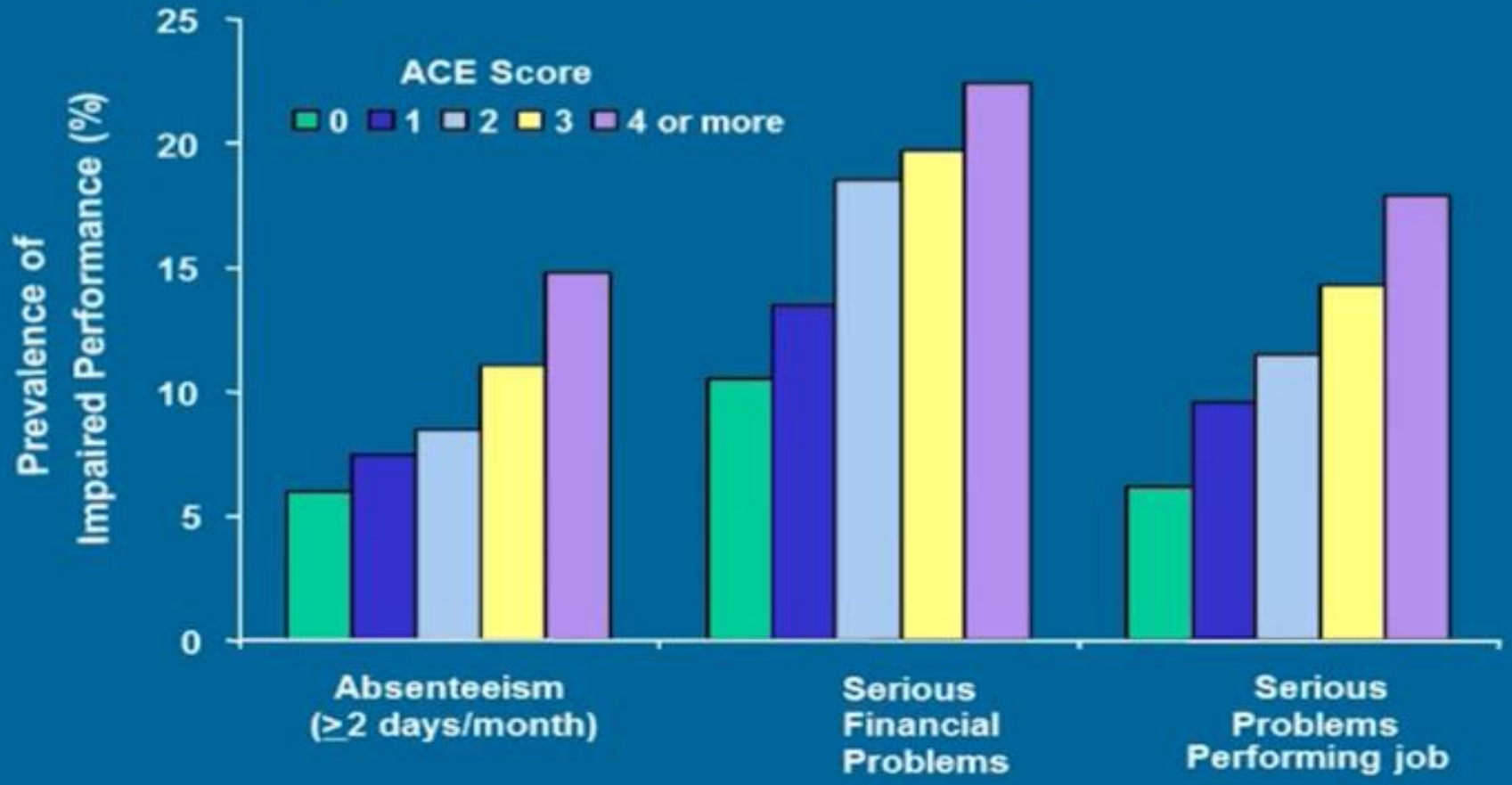
*After correction for age, race, education, and conventional risk factors like smoking & diabetes.

Circulation, Sept. 2004

Dr Vincent Felitti (2009) https://www.youtube.com/watch?v=KEFfThbAYnQ (Accessed February 17, 2020)

Social malfunction:

ACE Score and Indicators of Impaired Worker Performance



Dr Vincent Felitti (2009) https://www.youtube.com/watch?v=KEFfThbAYnQ (Accessed February 17, 2020)

A Few Trauma Takeaways to Think About

- Most of us will have a least one ACEs in our developmental years, and, if not extreme, this will not necessarily harm us. However, if any one ACE is extreme or if there are too many, we can be marked for problems in life.
- It is essential that we do not sweep our traumas under the rug but, rather, deal with them before they deal with us. I admit that I minimized my ACEs and naively prided myself in my ability to manage them. In hindsight, I would now have chosen to seek good therapy earlier in my life by a trauma-informed therapist. This would have improved my capacity to deal with the stressors that eventually unhinged me.
- I respectfully and lovingly urge any of us who are raising children to be ever so mindful of the impact of excessive adversity on our children. We parents should not assume that, even though our children appear to be doing well, that they are necessarily internally well if they have been exposed to excessive ACEs.
- We do our children right by getting the help to heal the dysfunction in our lives, in our marriages, and/or in our family dynamics and, in so doing, freeing our children from having to pay the price in their own lives and in their progeny for possibly generations to come.

Trauma's Impact on Social Engagement

- My own clinical experience suggests that the most common forms of trauma are due to a lack of attunement or connection with parental or adult figures while growing up.
- As Barta (2015) writes, "These deficiencies are not about bad parenting but about a parent's inability or diminished ability to respond to the child's emotional needs. Most parents are doing the best they can with the tools they have, but whether deliberately or inadvertently, the traumas of our childhood can have tremendous impact on our lives (Barta, 2018, p. 17)
- As trauma expert, Dr. Peter Levine notes in his book, *Healing Trauma*, "Trauma is much about loss of connection – to ourselves, to our bodies, to our families, to others, and to the world around us. This loss of connection is often hard to recognize because it doesn't happen all at once. It can happen slowly over time, and we adapt to these subtle changes sometimes without even noticing them.
- These are the hidden effects of trauma, the ones most of us keep to ourselves...Our choices become limited as we avoid certain, feelings, people, and situations. The result of a gradual constriction of freedom is the loss of vitality and potential for the fulfilment of our dreams" (Levine, 2008, p. 9).

How does the brain become addicted to substances or behaviors?

Special appreciation to Dr. Kevin McCauley and Dr. Georg Koob whose brilliant work inspired important content for this presentation

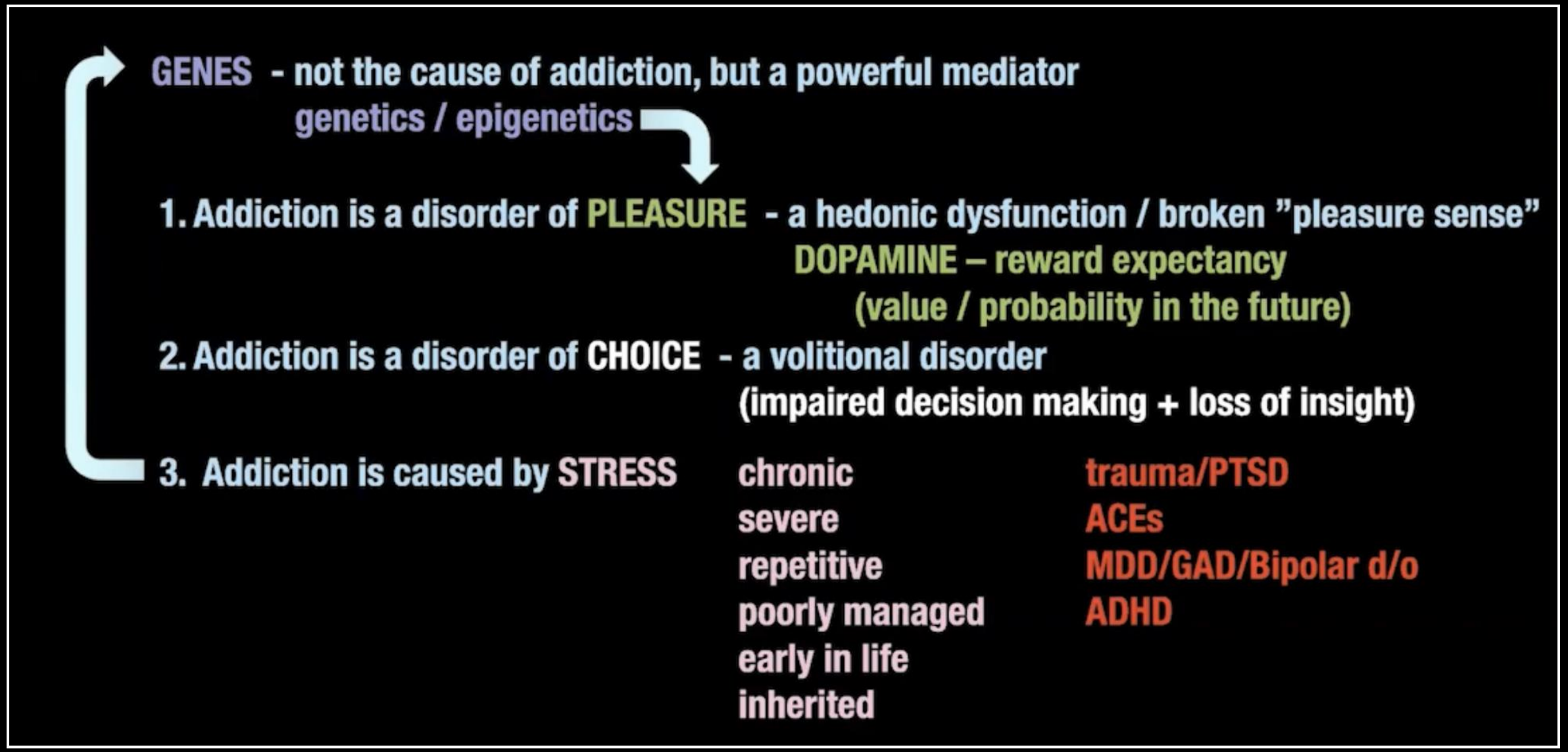
Please click the links below to access their brilliant lectures:

Dr. Kevin McCauley

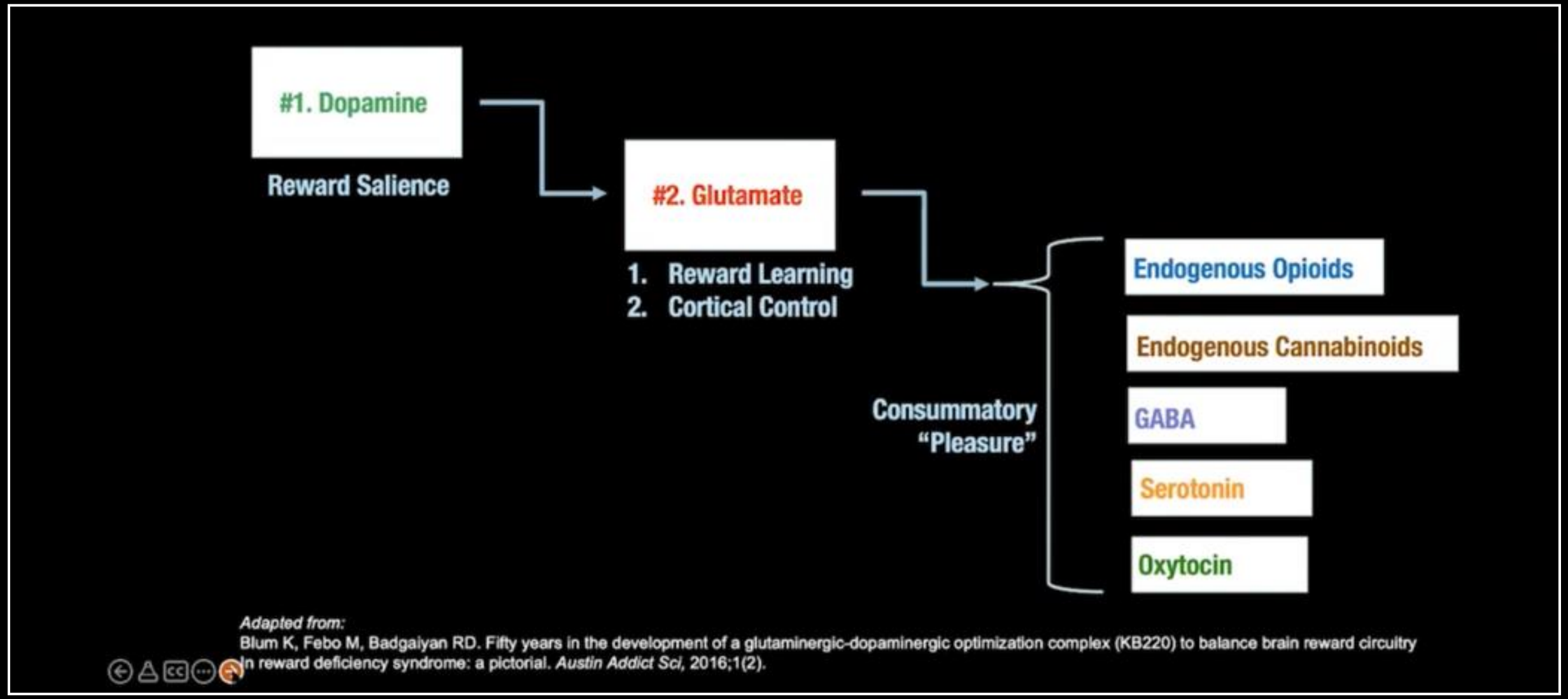
https://www.youtube.com/watch?v=zYphZvRHm6Y&list=PLvpkbo8ssyriex9eUKI6JGaR1UX2NGdtn&ab_channel=KTOO360TV

Dr. Georg Koob:

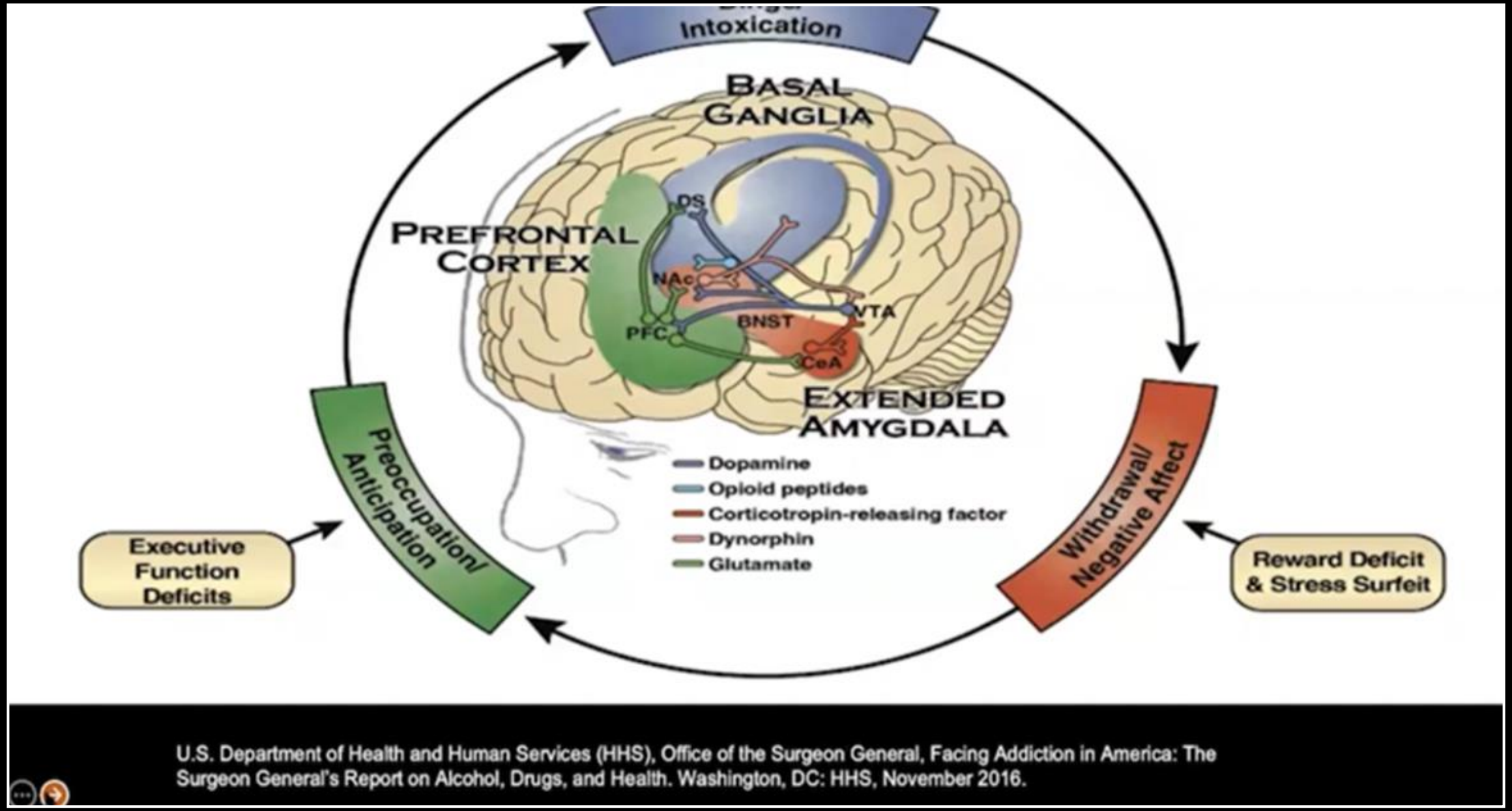
https://www.youtube.com/watch?v=mGqBN72sSz4&ab_channel=AddictionPolicyForum



Dr. McCauley's model is brilliantly integrative



The "Brain Reward Cascade" (Blum)



U.S. Department of Health and Human Services (HHS), Office of the Surgeon General, Facing Addiction in America: The Surgeon General's Report on Alcohol, Drugs, and Health. Washington, DC: HHS, November 2016.

There are three entry points for the addiction process, each involving different regions of the brain.

The Neuroscience of Addiction

- The Role of **Dopamine**
  - Sensitization
  - Desensitization

  - **Hypofrontality** – Not a good thing

- The Marriage of **Triune Brain therapy** and

  Polyvagal Theory

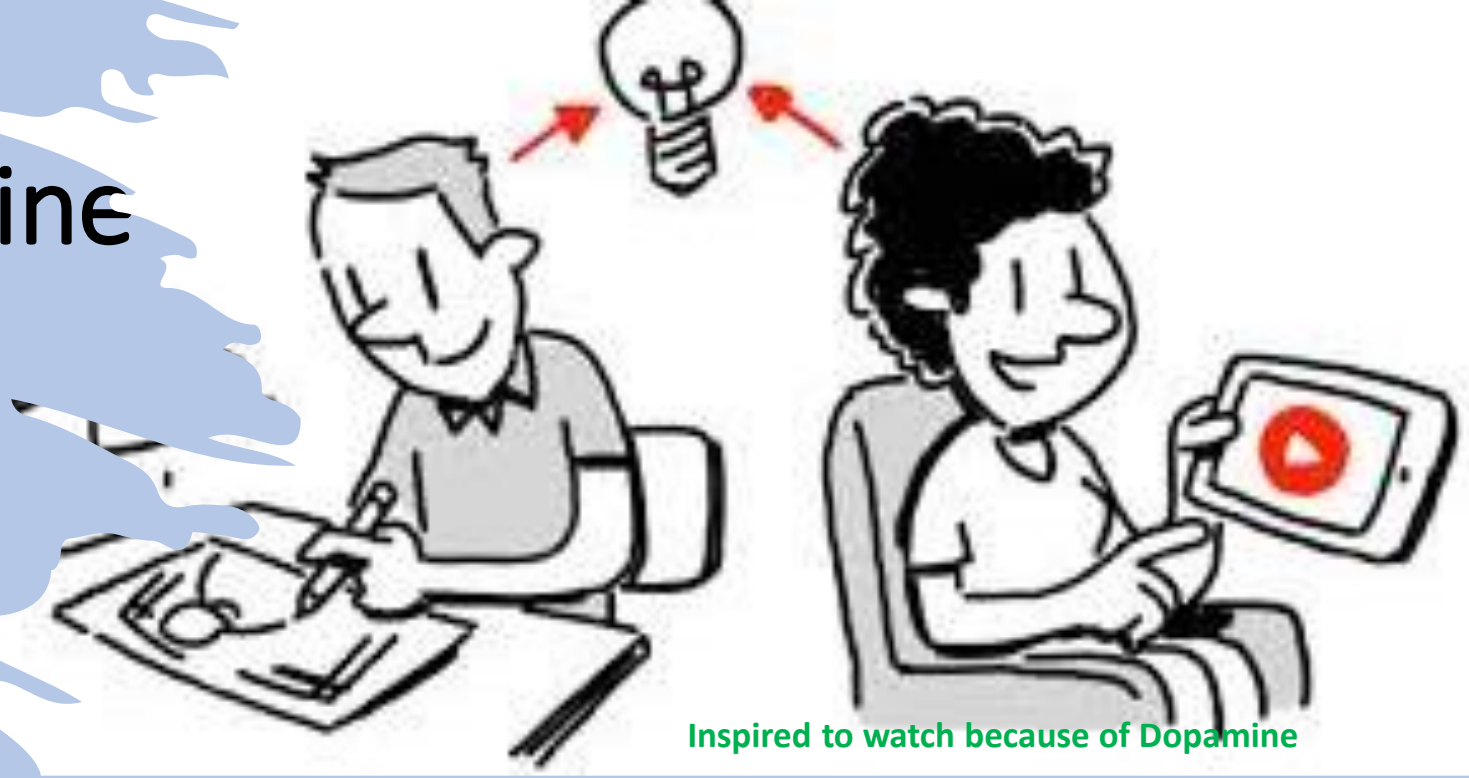
How the Brain Gets Hooked on Substances and Behaviors

- As Kardaras(2016) stated in his book, *Glow Kids*, in order to fully understand addiction, we need to understand the brain's reward system and the impact of dopamine on that reward pathway.
- Specifically, how much dopamine is activated by a substance or behavior is correlated directly with the addictive potential of that substance or behavior.
- Dopamine, as many of us know, is the "feel-good" neurotransmitter that is the most critical and important part of the addiction process. Dopamine was discovered in 1958 by Arvid Carlsson and Niles-Ake Hillarp at the National Heart Institute of Sweden.

Functions of Dopamine

Dr. Susan Weinschenk (2009) noted that **dopamine** is created in various parts of the brain and is critical in several brain functions to include:

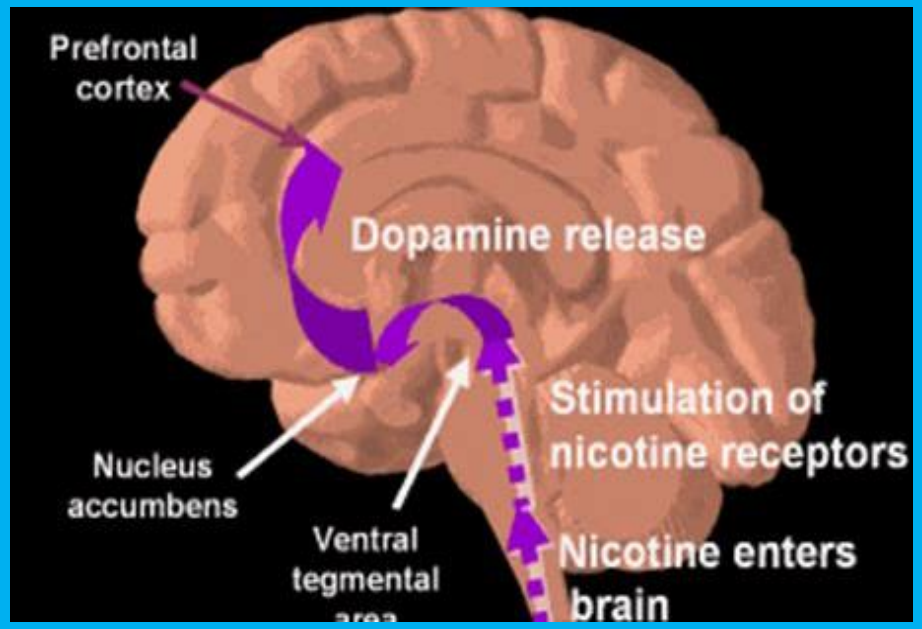
- Thinking
- Moving
- Sleeping
- Mood
- Attention
- Motivation
- Seeking and reward



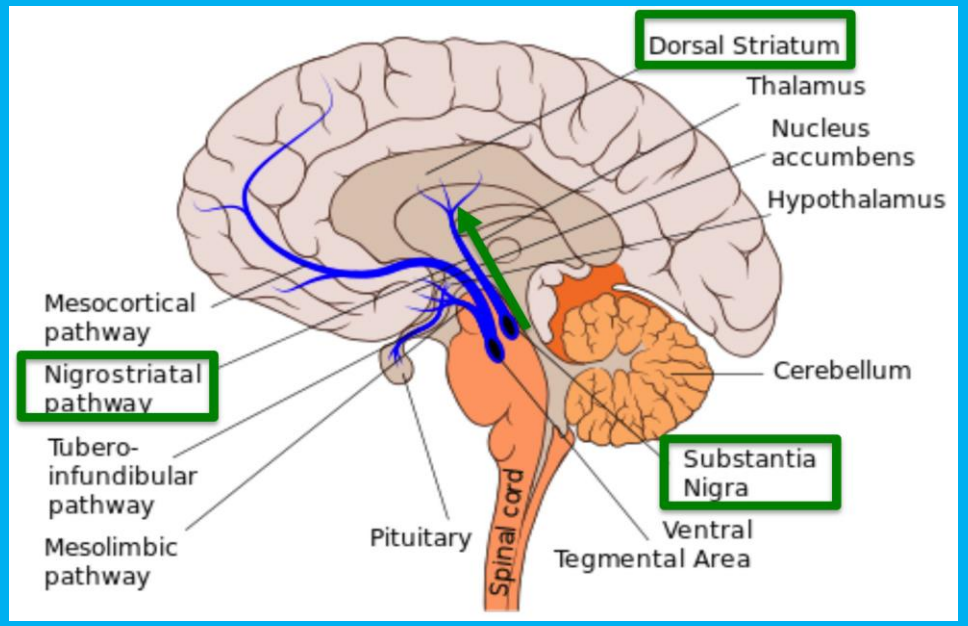
Inspired to watch because of Dopamine

Two Main Dopamine Reward Pathways

Mesocorticolimbic for motivation and reward Nigrostriatal for movement



The Mesocorticolimbic Pathway transports dopamine from the VTA to the nucleus accumbens, amygdala, and prefrontal cortex. The nucleus accumbens is found in the ventral medial portion of the striatum and is believed to play a role in reward, motivation, desire, and even the placebo effect.



The Nigrostriatal Pathway travels from the substantia nigra to the striatum. The nigrostriatal pathway is important for facilitating movement.

Dopamine is both a neuromodulator and a neurotransmitter

- According to Stanford neuroscientist Dr. Andrew Huberman, dopamine is both a neuromodulator and a neurotransmitter. The main difference between neurotransmitter and neuromodulator is that a neurotransmitter is a chemical messenger released by a neuron to affect either one or two post-synaptic neurons or another specific effector organ whereas a neuromodulator is a chemical messenger released by a neuron to affect a group of neurons or effector organs with a specific receptor.

- Furthermore, a neurotransmitter directly affects the postsynaptic partner to produce a quick, rapid effect while a neuromodulator indirectly affects the post-synaptic partner, especially through a second messenger to produce a slow but long-lasting effect. Dopamine can be released locally or volumetrically (a large dump). When it is released volumetrically, it affects many neurons. Very concerning, dopamine can ultimately affect gene expression according to Dr. Lieberman.

- Click here to listen to Dr. Hubererman's excellent lecture on dopamine: https://www.youtube.com/watch?v=QmOF0crdyRU&t=2s&ab_channel=AndrewHuberman

More on Dopamine

- When an individual performs an action that is satisfying to a need or fulfills a desire, dopamine is released into the nucleus accumbens, a cluster of nerve cells beneath the cerebral hemispheres that are specifically associated with reward and pleasure. This is also known as the brain's "pleasure center."

- Natural dopaminergic activities, such as eating and sex, usually come after effort and delay and serve a survival function.

- These are called the "natural rewards" as contrasted with addictive chemicals/behaviors (which can highjack the same circuity).

- Addictive drugs and behaviors, such as gambling and video gaming, actually offer a short-circuit to this process which only ends up flooding the nucleus accumbens with dopamine and does not serve any biological function.

Dopamine vs Endogenous Opioids

- Although **dopamine** has been referred to as the **"pleasure molecule,"** it is more about seeking and searching for pleasure, rather than pleasure itself. Dopamine is more involved in drive and motivation to seek.

- The "final reward" or what we experience as feelings of pleasure, Wilson (2014) writes, involve the release of **endogenous opioids**.

- You can think of dopamine as **"wanting"** and opioids as **"liking."**

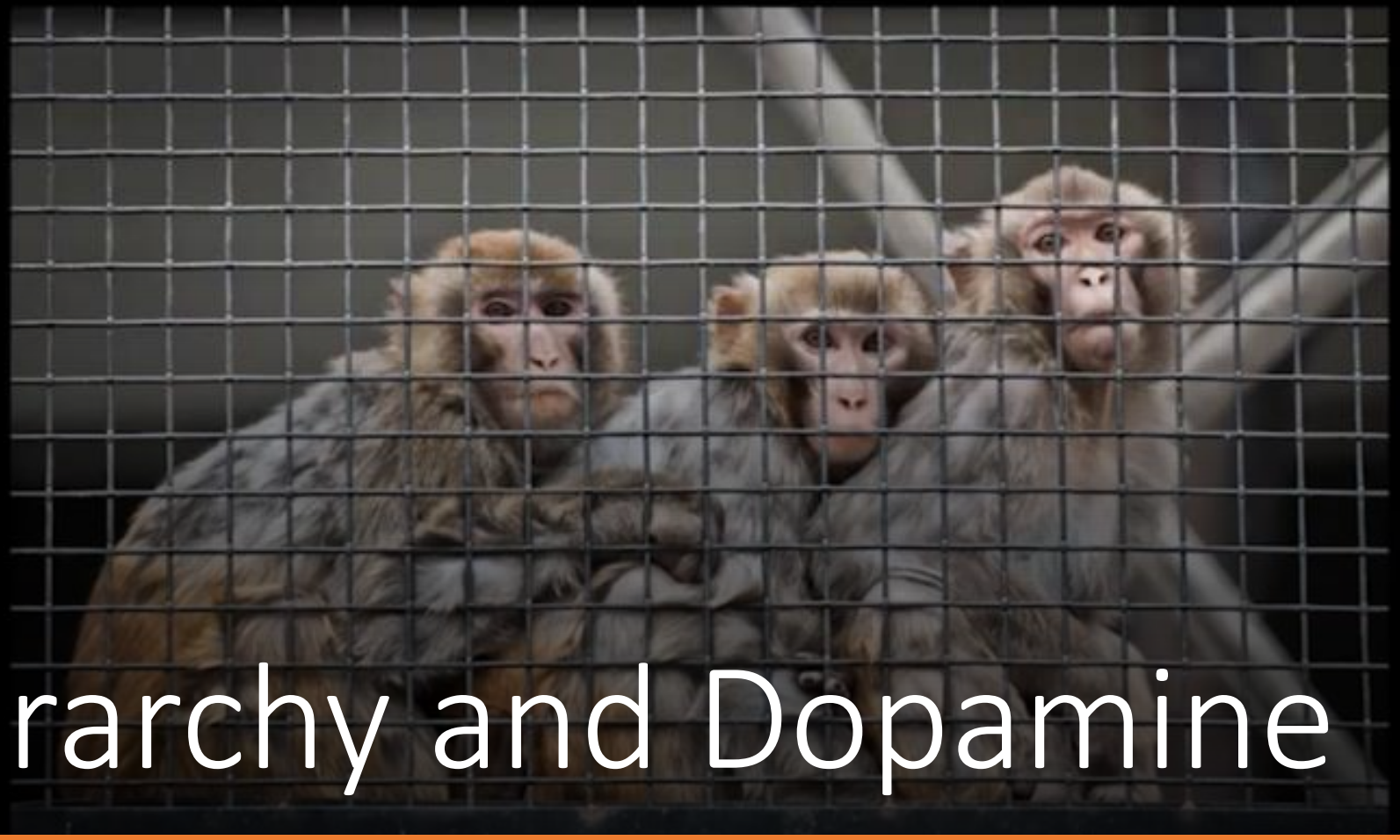
- As psychologist Dr. Weinschenk explains, "Dopamine causes us to want, desire, seek out and, search; however, the dopamine system is stronger than the opioid system and we hence seek more than we are as satisfied…" (Weinschenk, 2009).

- "Addicts want it more but gradually like it less. Addiction might be thought of as *"wanting gone amok."* (Wilson, 2014).

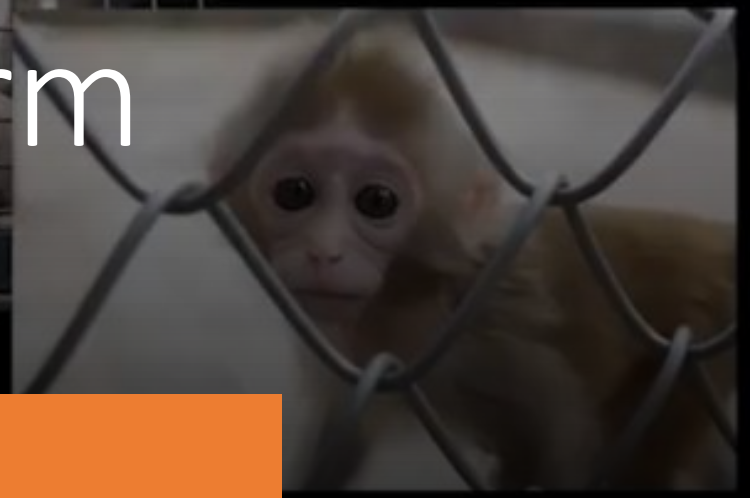
Click here to listen to Gary Wilson's outstanding lecture:

https://www.youtube.com/watch?v=ZLtSoWrEplM&ab_channel=Reach10

The Morgan Study: Social Dominance Damages the Brain's Dopamine System



Hierarchy and Dopamine

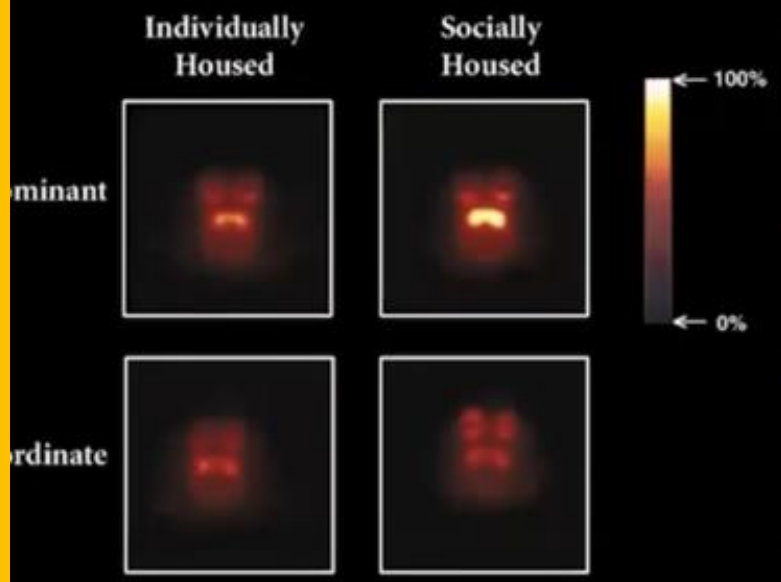


Like humans, monkeys form social hierarchies.

When given access to cocaine, low status monkeys consumed cocaine excessively to the point of addiction whereas high status monkeys barely touched it…

Low status monkeys have fewer D2 dopamine receptors.

Social Context and Dopamine Function



- **Morgan study:** PET scans of brain dopamine system comparing monkeys housed individually and socially
- Individual susceptibility to cocaine reward depended on social context
- **Socially-housed and dominant monkeys:** more DAD2 receptors and cocaine was not a reinforcer (resistant to cocaine's effects)
- Subordinate Monkeys: fewer DAD2 receptors regardless of housing status, and cocaine was a reinforcer

Morgan D, Grant KA, Gage HD, et al. Social dominance in monkeys: dopamine D2 receptors and cocaine self-administration. *Nature Neuroscience*. 2002;5(2):169-174. doi:10.1038/nn798.

Dopamine also is involved in bad and neutral things.

- Kutlu et al (2021): KCS Model – DA handles prediction error, association formation, attention, temporal dynamics
- Reward Prediction Error seen in specific reward learning contexts but not seen in aversive learning contexts
- Dopamine seen in neutral learning contexts, especially ones that are new (novel)
- Dopamine codes for a valence-independent perceived saliency (scaled physical intensity of a stimulus)

Kutlu MG, Zachry JE, Melugin PR, et al. Dopamine release in the nucleus accumbens core signals perceived saliency [published online ahead of print, 2021 Sep 8]. Curr Biol. 2021;S0960-9822(21)01188-X. doi:10.1016/j.cub.2021.08.052

Dopamine is not required for reward

- DA Knockout mice cannot make dopamine
- They have serious sensory and motor deficits
- Without replacement DA they will starve unless food is placed in their mouths
- But they still find sugar sweet and return to it
- Dopamine is critical for goal-directed behaviors but not for reward

Cannon CM, Palmiter RD. Reward without dopamine. J Neurosci. 2003;23(34):10827-10831. doi:10.1523/JNEUROSCI.23-34-10827.2003

Dr. McCauley's "Ns" of Domaine

Dopamine encodes for things that are:	meaning	example
Novel	first exposure	magnification of learning of new & relevant experiences
Noxious	aversive stimuli	re-experiencing of traumatic events
Neutral	valence-independent stimuli	association with otherwise unrelated sensory & emotional cues, cunning/baffling/powerful nature of cue-induced relapse
Nearby	proximal, imminent	near in space and/or time; fantasy and fictive imagining; failure of delay discounting; craving
Numerated	number, amplitude, counts	social media "likes," hoarding (collection/accumulation addiction)
"N-Joyable"	rewarding stimuli	the core component of a hedonic (pleasurable) experience
Near-misses	reward prediction error	illusion of "better than expected" value, mis-remebering past intoxication episodes, chasing losses
"N-centive"	incentive, motivational drive	wanting > liking

Bought the BMW but still wanting the Ducati Diavel

Wanting versus Liking

Dopamine and DeltaFosB “Keep doing it!”

Highly salient activities, in this case addiction, lead to the accumulation of DeltaFosB, a protein that activates the genes involved with addiction. The molecular changes it potentiates are almost identical for both sexual conditioning and chronic drug use. Specifically, DeltaFosB rewires the brain to crave IT whatever IT is.

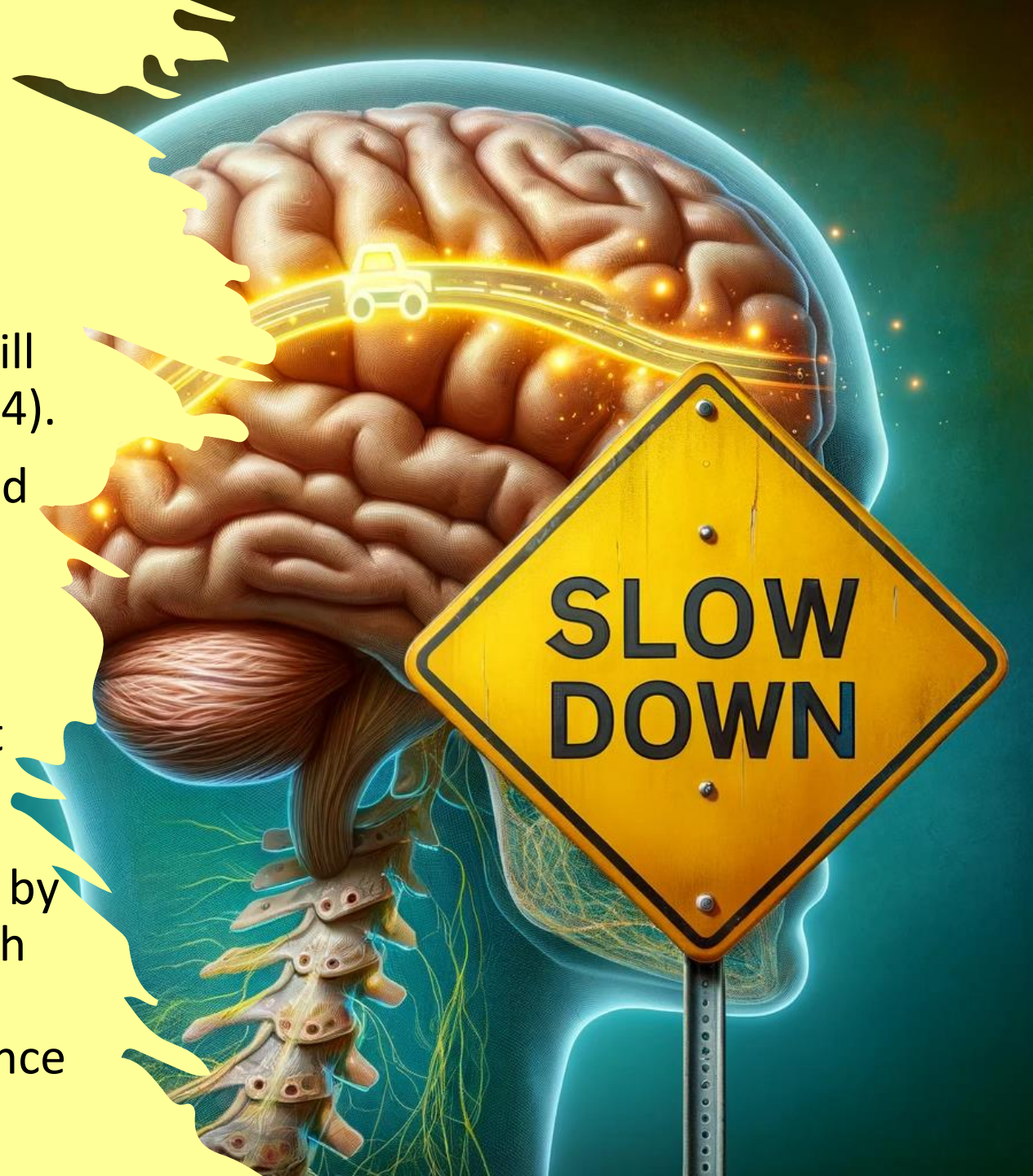
In a sense, dopamine is like the foreman on a construction site barking orders and DeltaFosB is the worker on the site. Dopamine is yelling, “This activity is really important, and you should do it again and again.”

DeltaFosB is responsible for ensuring that you remember and repeat the activity.

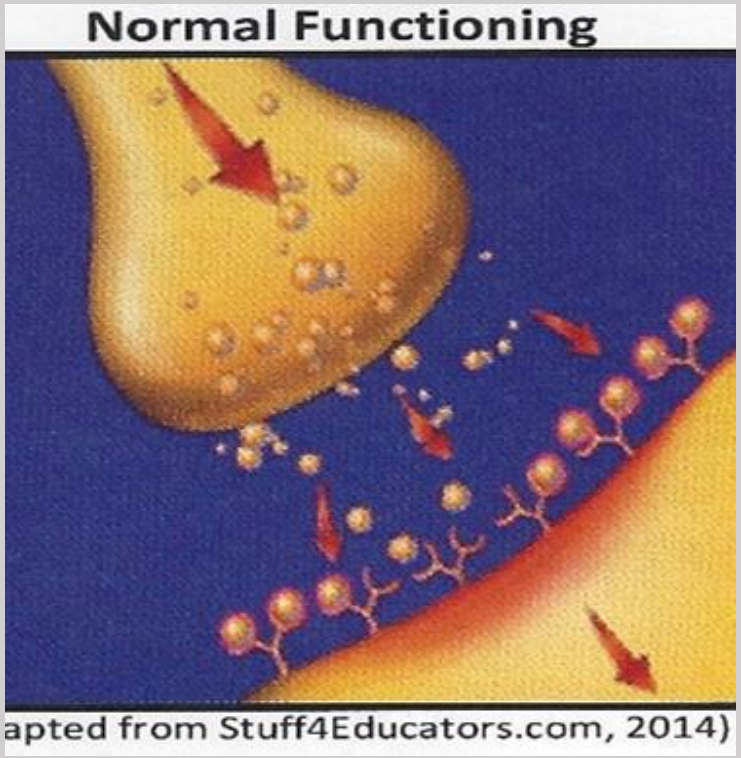
This repeated process produces what is called sensitization which is based on the principle, “Nerve cells that fire together wire together” as noted by Canadian researcher Donald Hebb in 1949. Repeated activity strengthens cell connections.

Dopamine and CREB
“Slow it Down, Silver!”

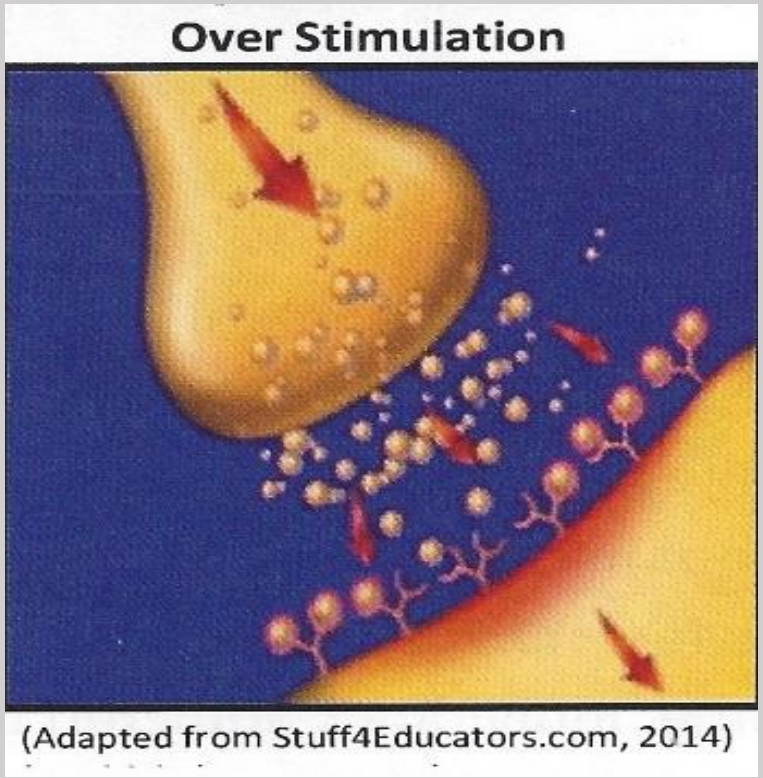
- As the brain recognizes that it needs a rest, it will kick out **CREB** to slow things down (Wilson, 2014).
- In essence, **DeltaFosB** acts like the gas pedal and **CREB** functions as the brakes.
- CREB specifically inhibits dopamine and endogenous opioids to take the joy out of the binging/addictive behavior or substance so that you can give it a rest.
- This numbed pleasure response that is induced by CREB is often identified as **desensitization** which leads to **tolerance** - the need of increasingly higher doses to achieve the same effect. Tolerance is a key factor in addiction.



Dopaminergic Downregulation at the Synaptic Level



apted from Stuff4Educators.com, 2014)



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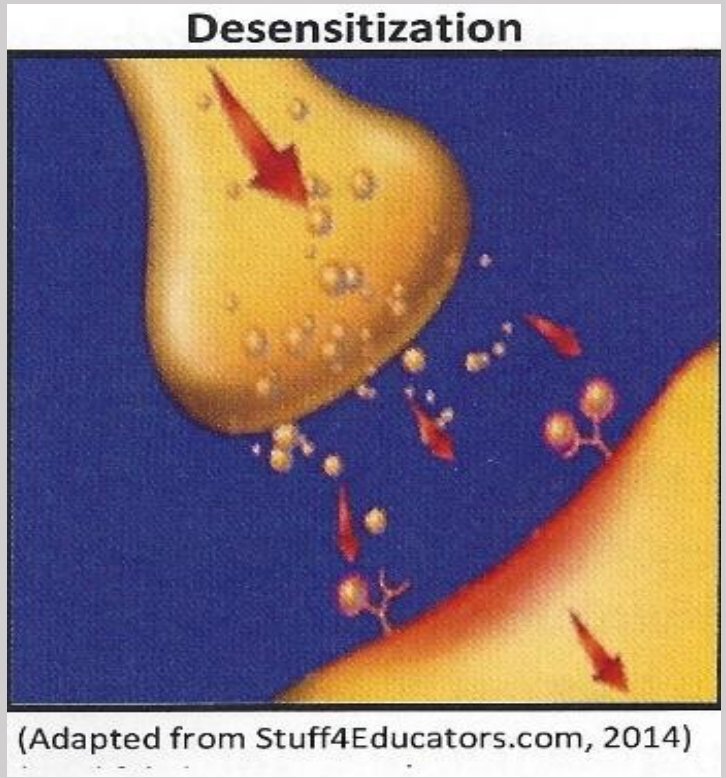


(Adapted from Stuff4Educators.com, 2014)

So, we see that chronic overstimulation can lead to two opposite effects:

01

Increased dopamine activity (wanting/seeking it more) –

sensitization via **DeltaFosB**

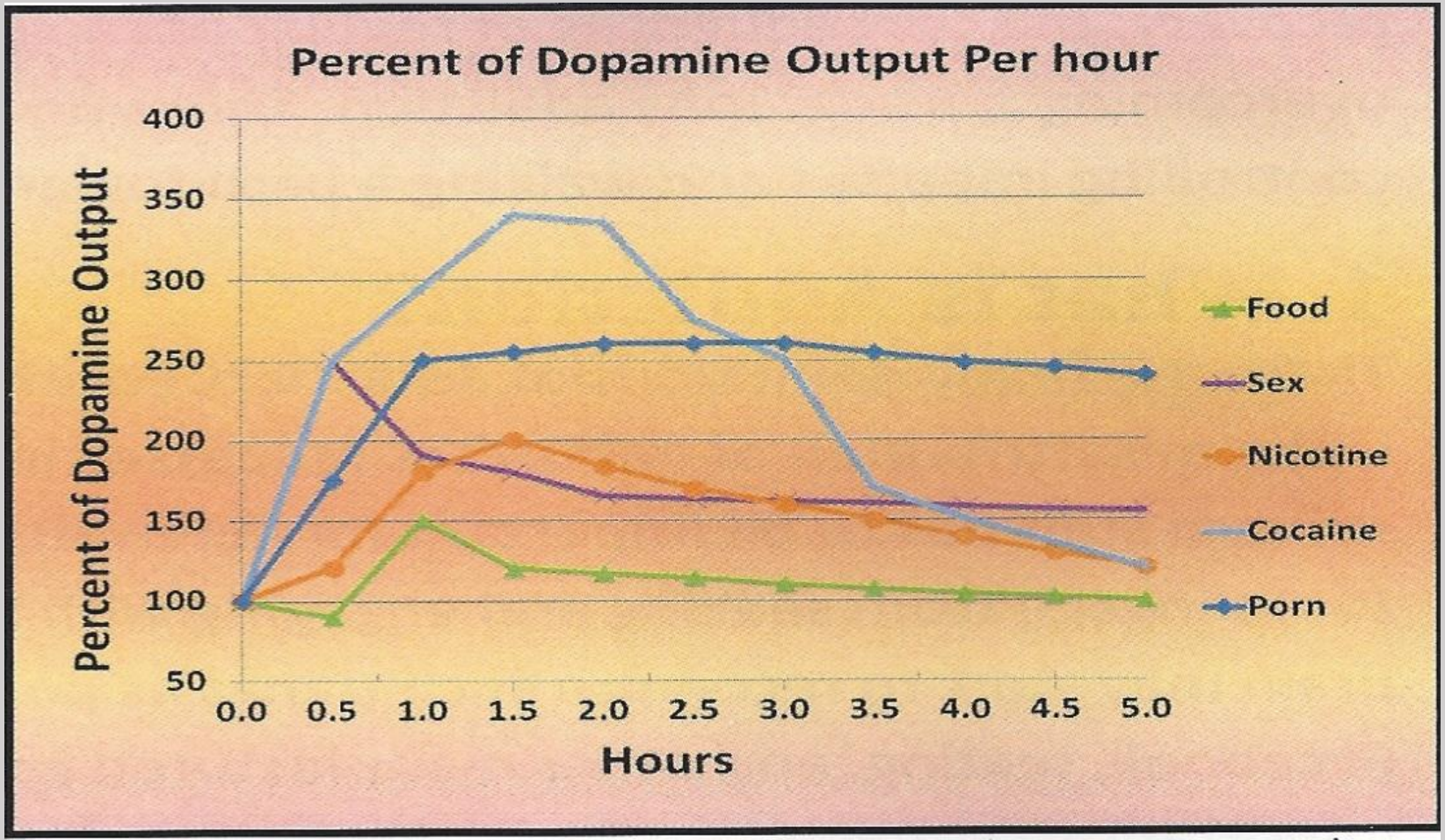
02

Decreased dopamine and opioid activity (liking it/enjoying it less) – **desensitization** via **CREB**

What Cranks Us Up?

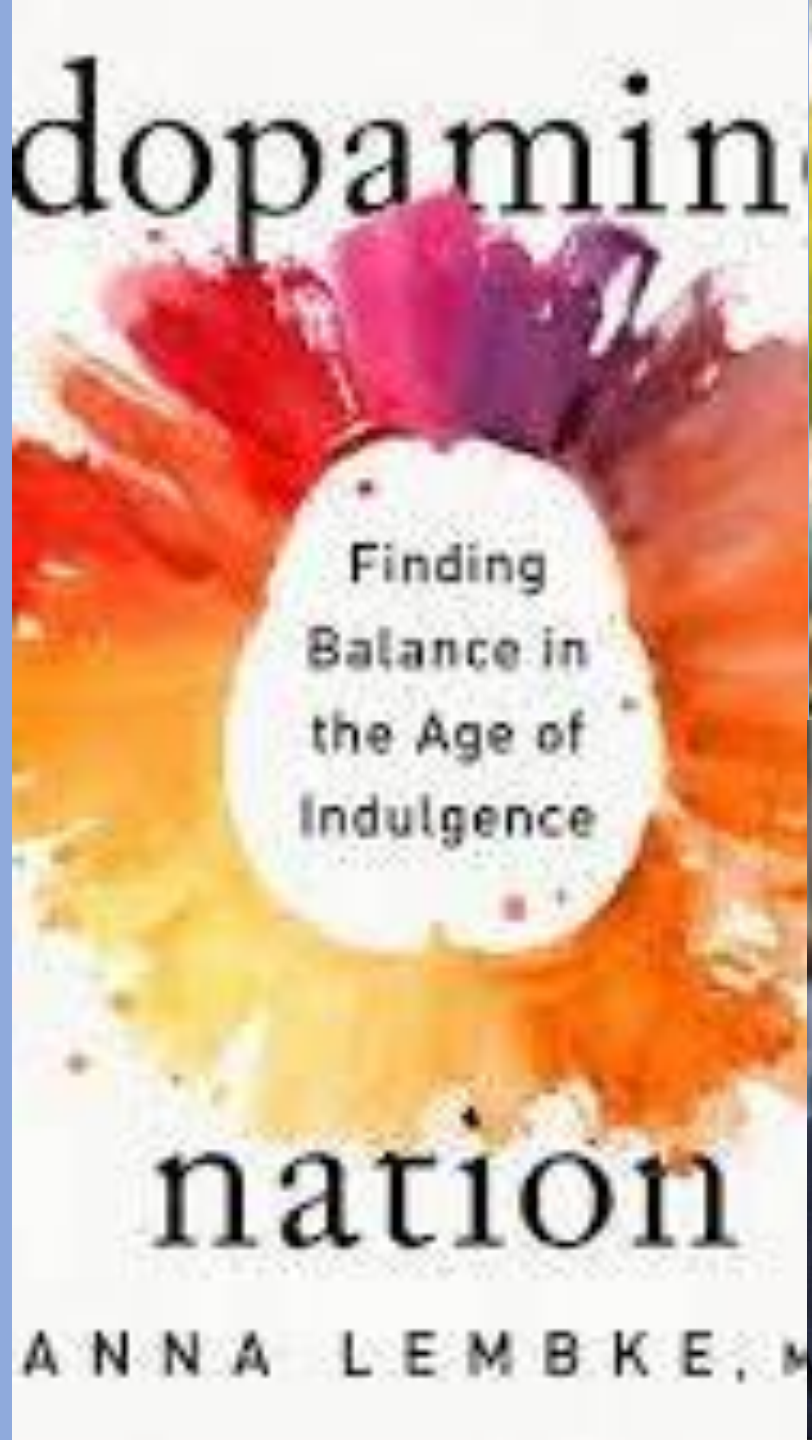
Summary of dopamine increases:

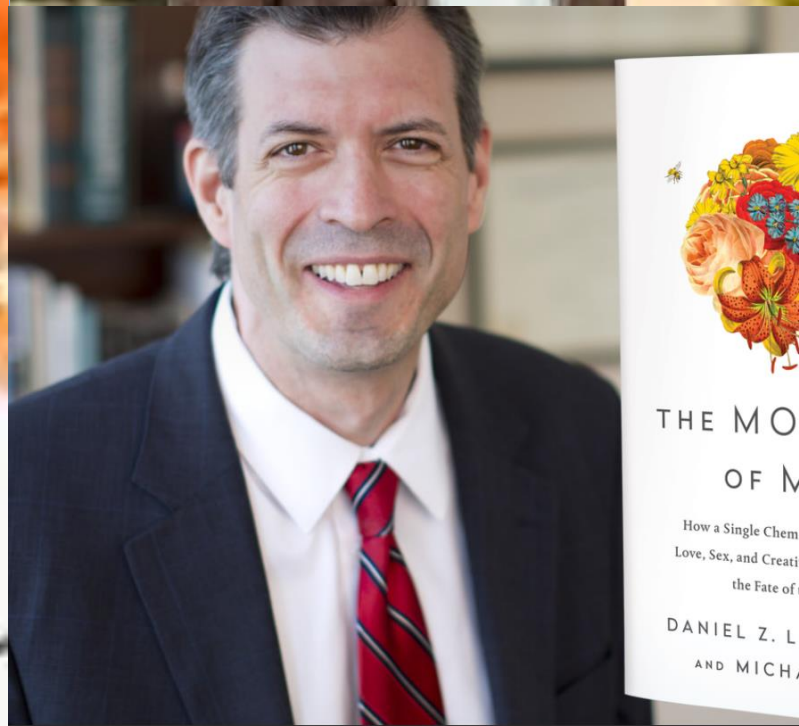
- Food – 150% increase
- Nicotine – 200% increase
- Snorting cocaine – 350% increase
- Sexual intimacy – 250% increase
- Pornography – 250% increases and stays elevated for longer – even when compared to cocaine



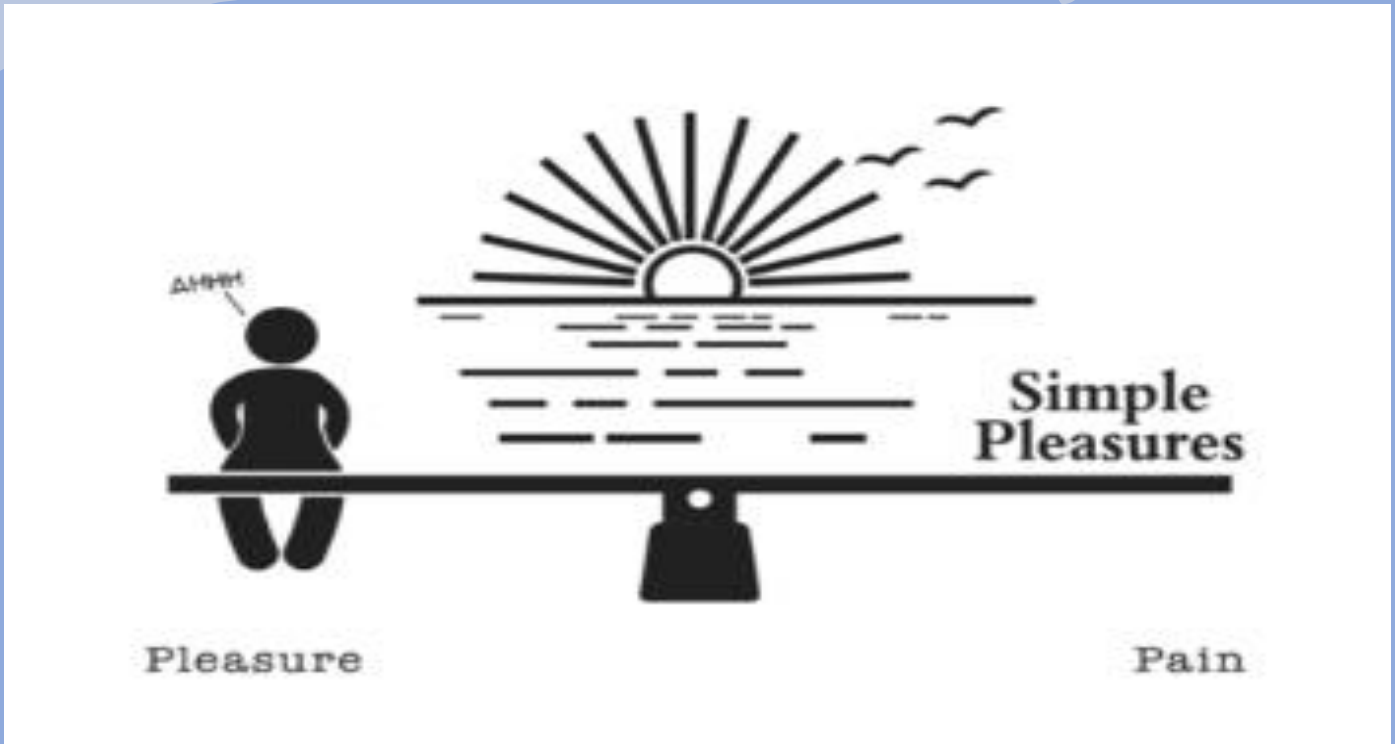
(Di Chiara & Imperato, 1988; newlifehabits.com, 2010)

The next few slides are from groundbreaking work of Dr. Anna Lembke and Dr. Daniel Lieberman and give us additional insights into how dopamine impacts the addiction process.



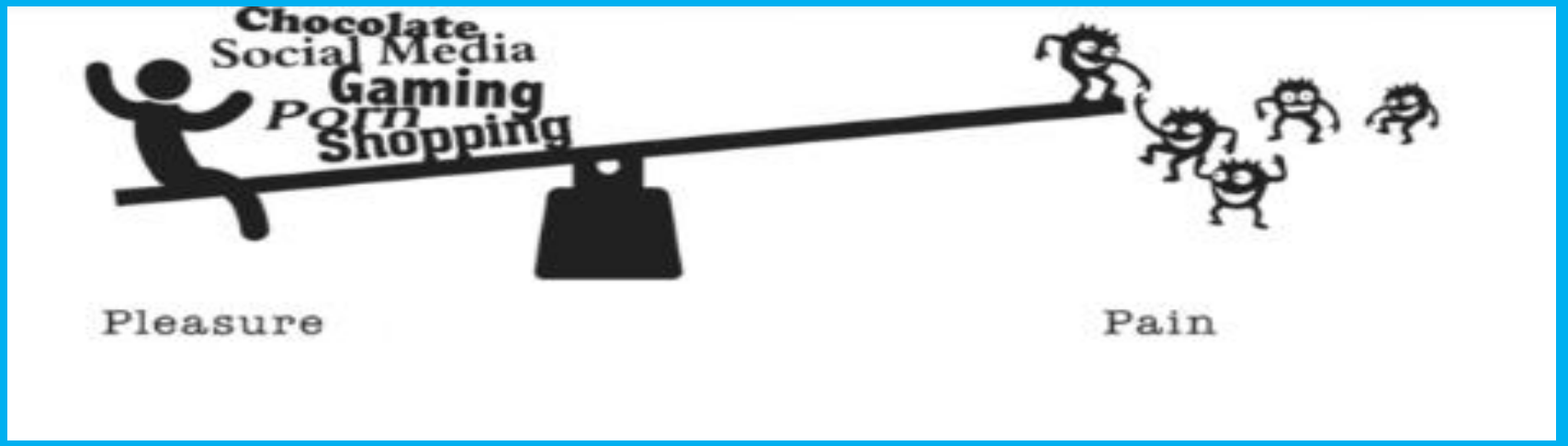


Pleasure and Pain Nicely in Balance



➡According to Stanford Psychiatrist, Dr. Anna Lembke, dopamine which acts on **pleasure** neurocircuits, and **pain** are related and help create a homeostatic balance in the brain and body.

The following slides are based on Anna Lembke(2021) *Dopamine Nation* book.
Click here to watch her excellent YouTube video:
https://www.youtube.com/watch?v=5Pu82wZRZwo&ab_channel=AndreaSamadi

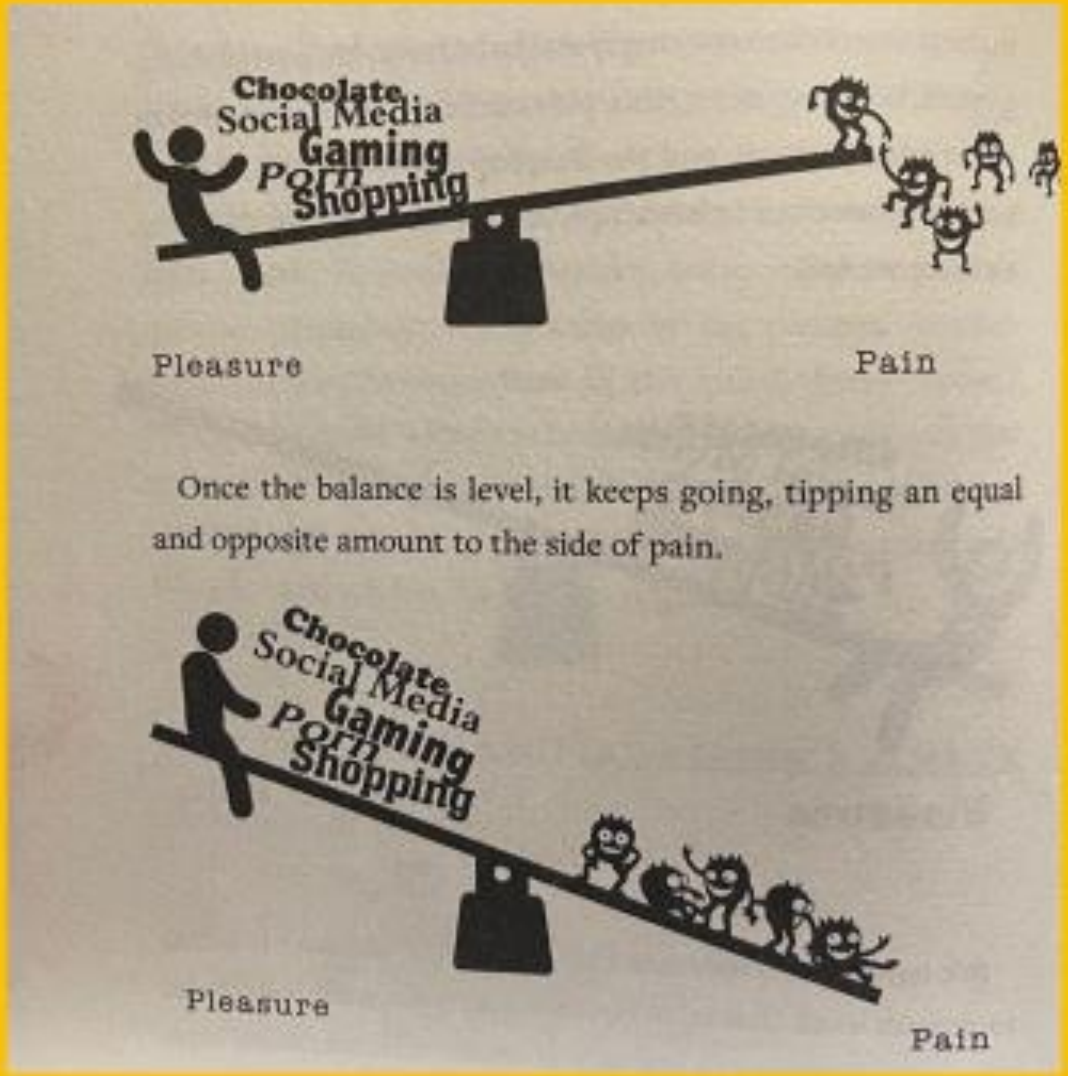


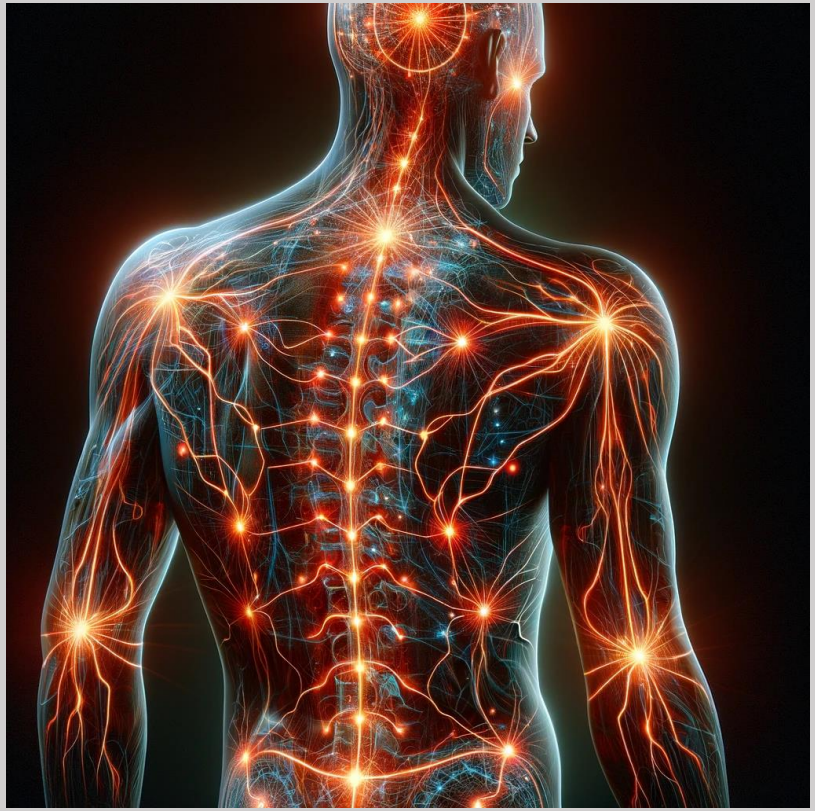
Our brain down-regulates our dopamine to bring us back to homeostasis (gremlins jumping on the lever).

As we actively seek pleasure, pain gremlins begin to jump on the teeter totter to try to restore homeostasis balance.

Anna Lembke (2021) https://www.youtube.com/watch?v=5Pu82wZRZwo&ab_channel=AndreaSamadi

Pleasure – Pain Shift





Pain circuits activate in order to move toward homeostasis or balance

Then the balance is more on the "pain" side which is where we want more to feel "normal" again.

Anna Lembke, 2021, https://www.youtube.com/watch?v=5Pu82wZRZwo&ab_channel=AndreaSamadi

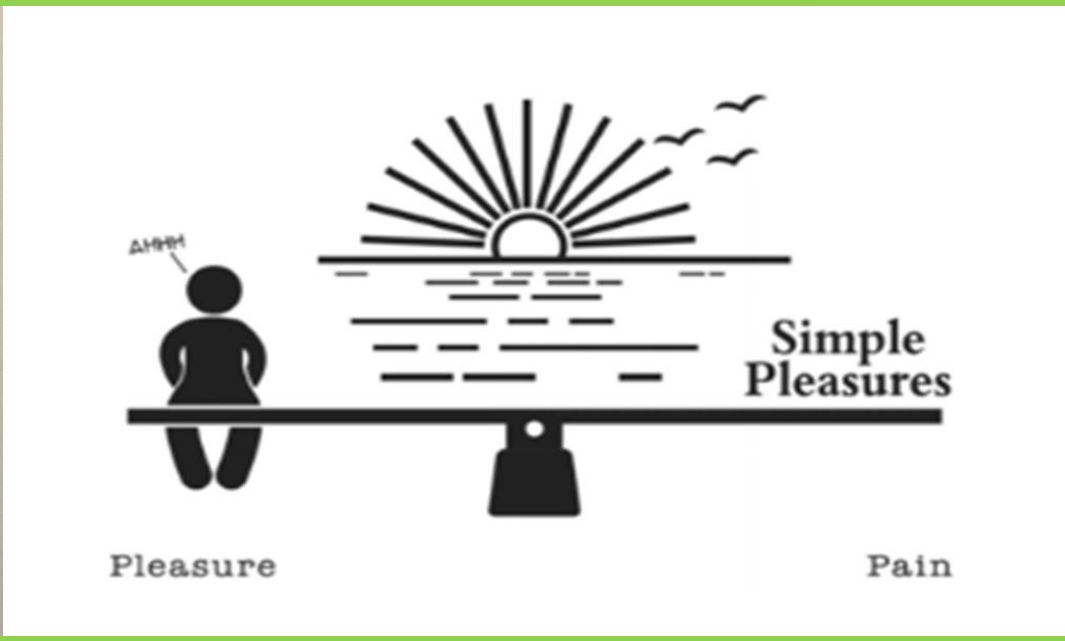
Pleasure and pain out of balance

This is a dopamine-deficit state, where we are walking around unhappy.

Dopamine Nation "It's harder for us to experience pleasure and more likely we will experience pain."

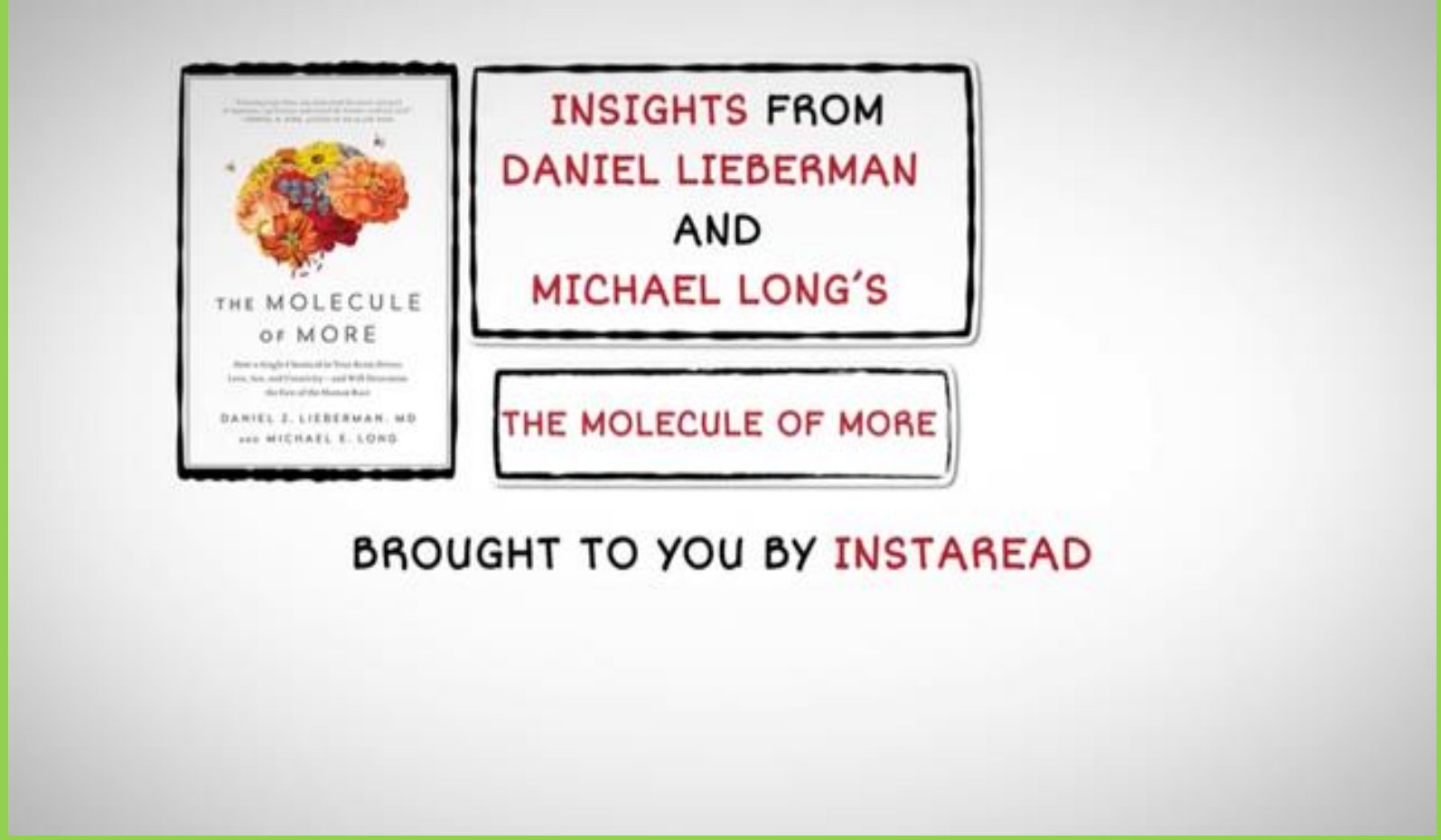
Anna Lembke (2021)
https://www.youtube.com/watch?v=5Pu82wZRZwo&ab_channel=AndreaSamadi

Dr. Lembke recommends a 30-day dopamine fast in order to rebalance the dopaminergic circuits in the brain.



Anna Lembke (2021)

The following slides are taken largely from Dr. Lieberman's excellent book, *The Molecule of More*

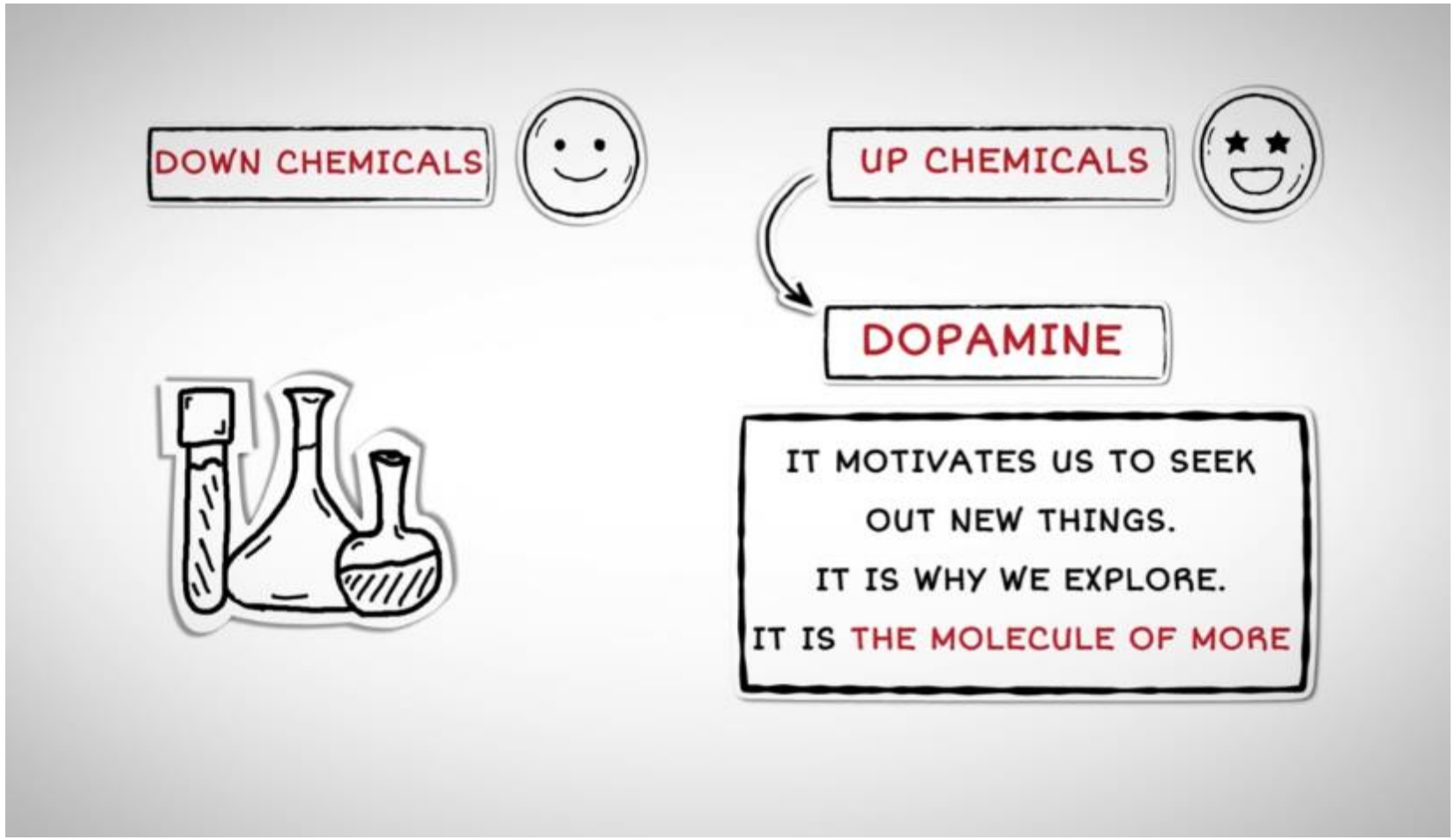


The Molecule of More

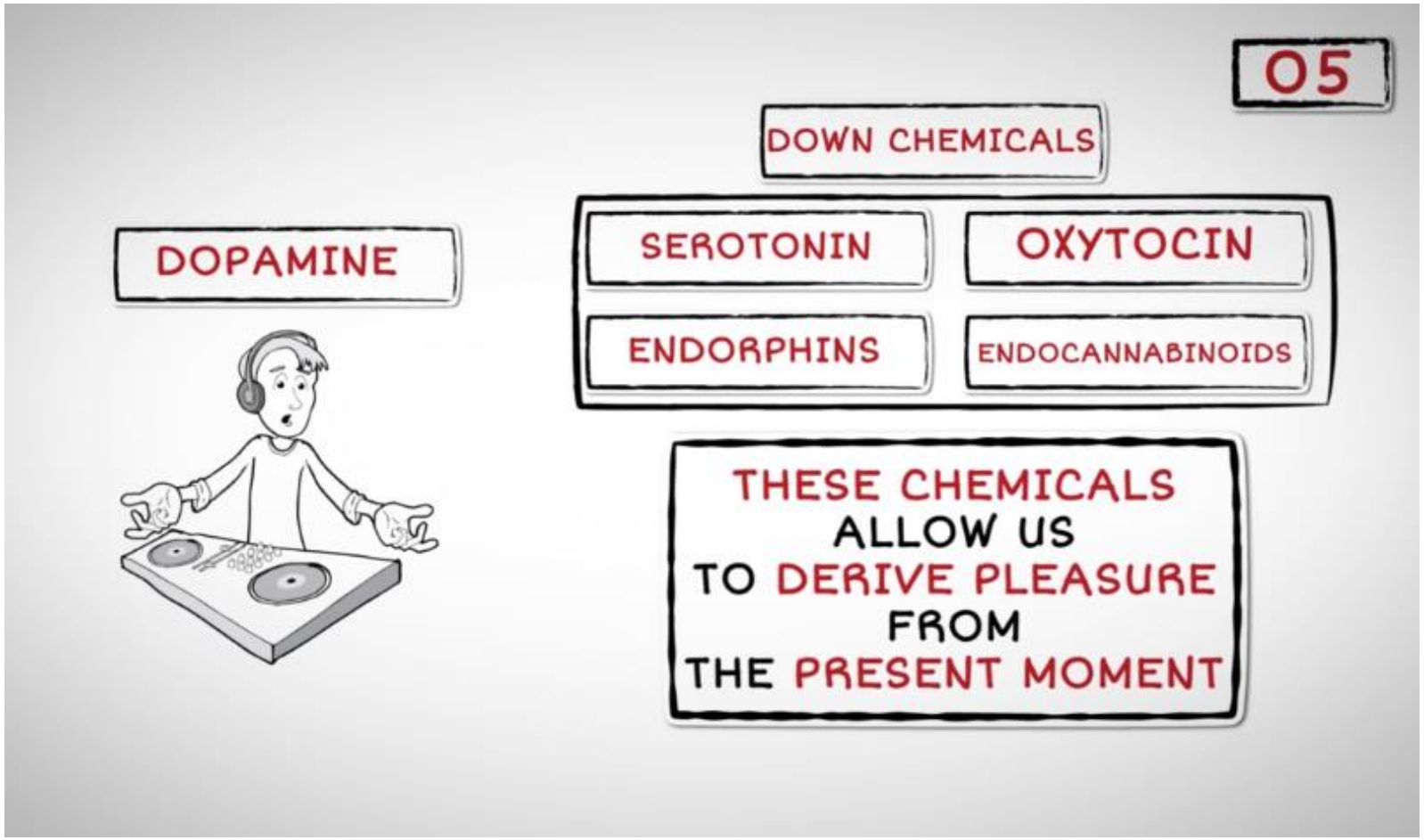
Click here to listen to Dr. Lieberman:
https://www.youtube.com/watch?v=TjKCzYYkKN4&ab_channel=Valuetainment

Click here to listen to animated video on Molecule of More:
https://www.youtube.com/watch?v=sPpY_nePtV8&ab_channel=Instaread

The brain has up chemicals and down chemicals
The up-chemical dopamine drives us to seek new things

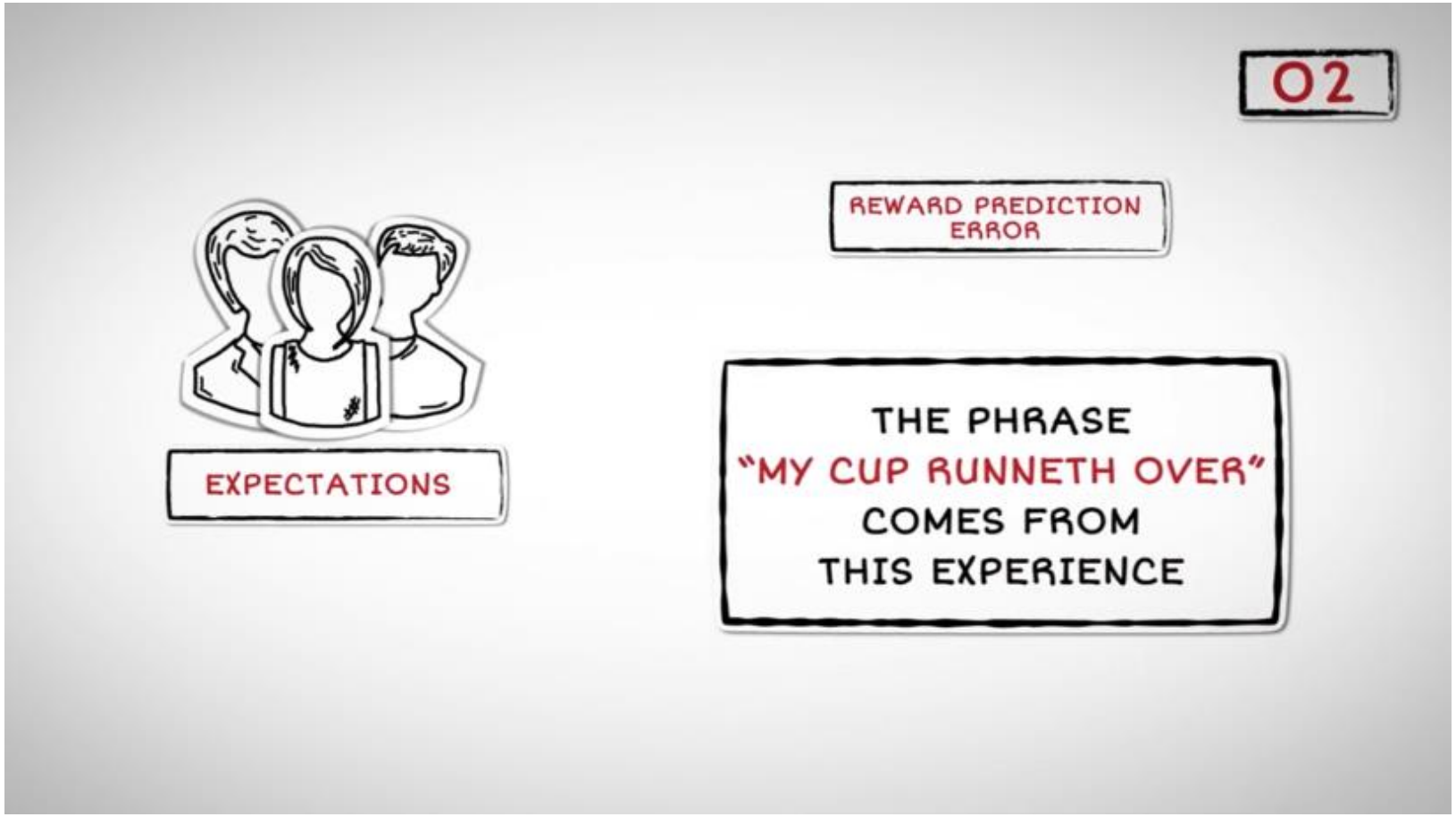


The Down Chemicals – designed for the here and now



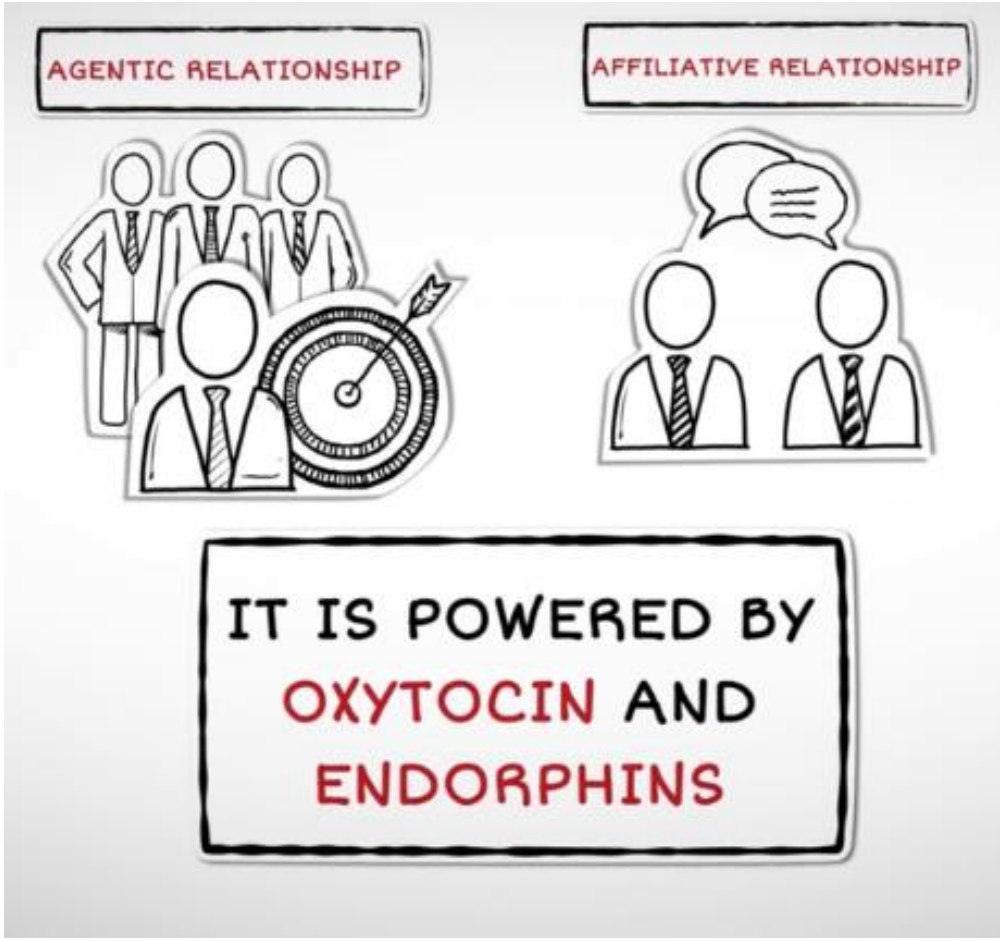
Reward Prediction Error

When the expected becomes unexpected which increases dopamine dramatically and compels us to continue seeking the new thing. This can become addicting.



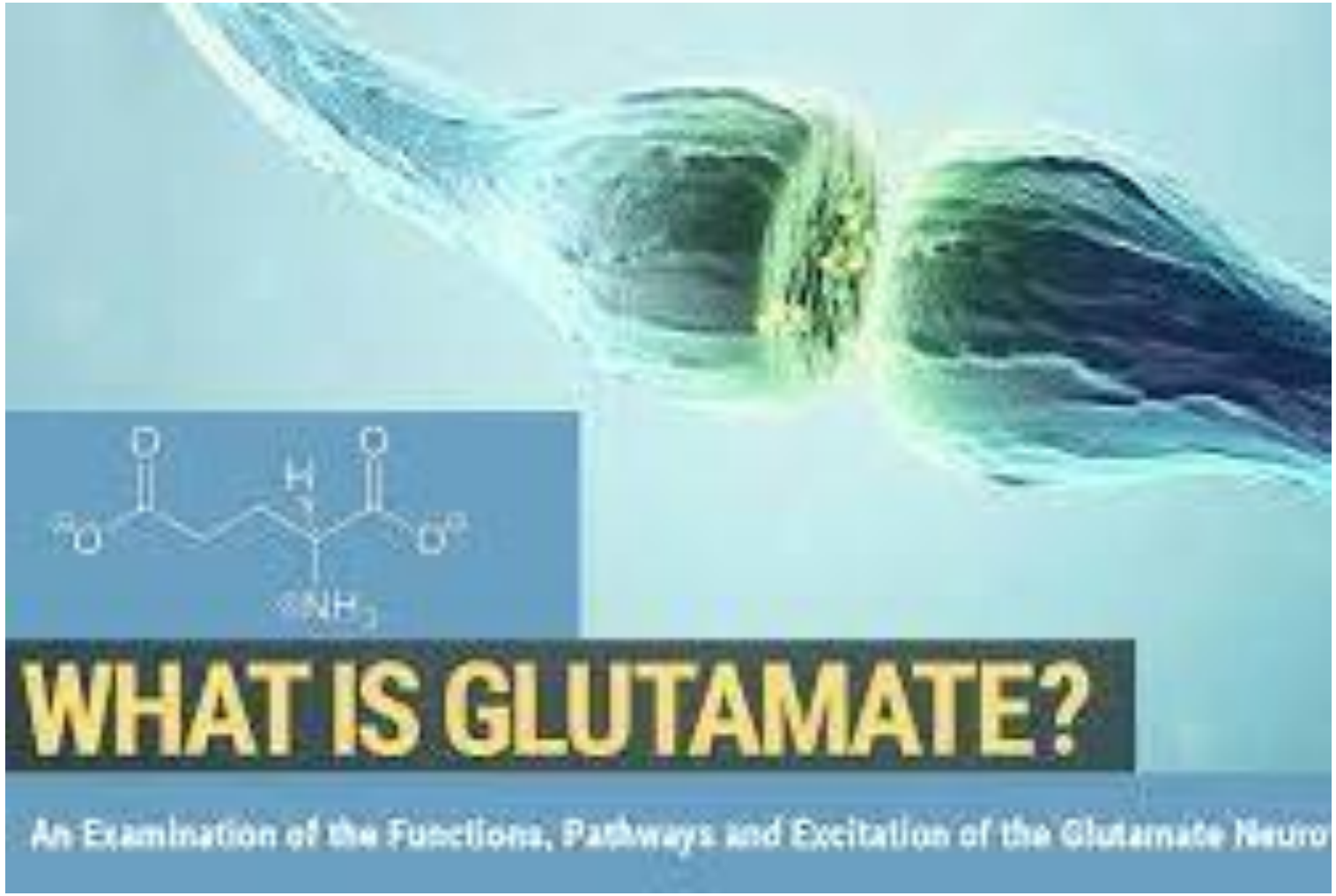
Here & Now Circuits

Allow us to back off the future pursuit and enjoy the present and all that it offers – relationships, peace, connection



Addiction neurochemical #2: Glutamate

Glutamate is an excitatory neurotransmitter with several types of receptors found throughout the central nervous system, and its metabolism is important to maintaining optimal levels within the extracellular space. As such, it is important to memory, cognition, and mood regulation.

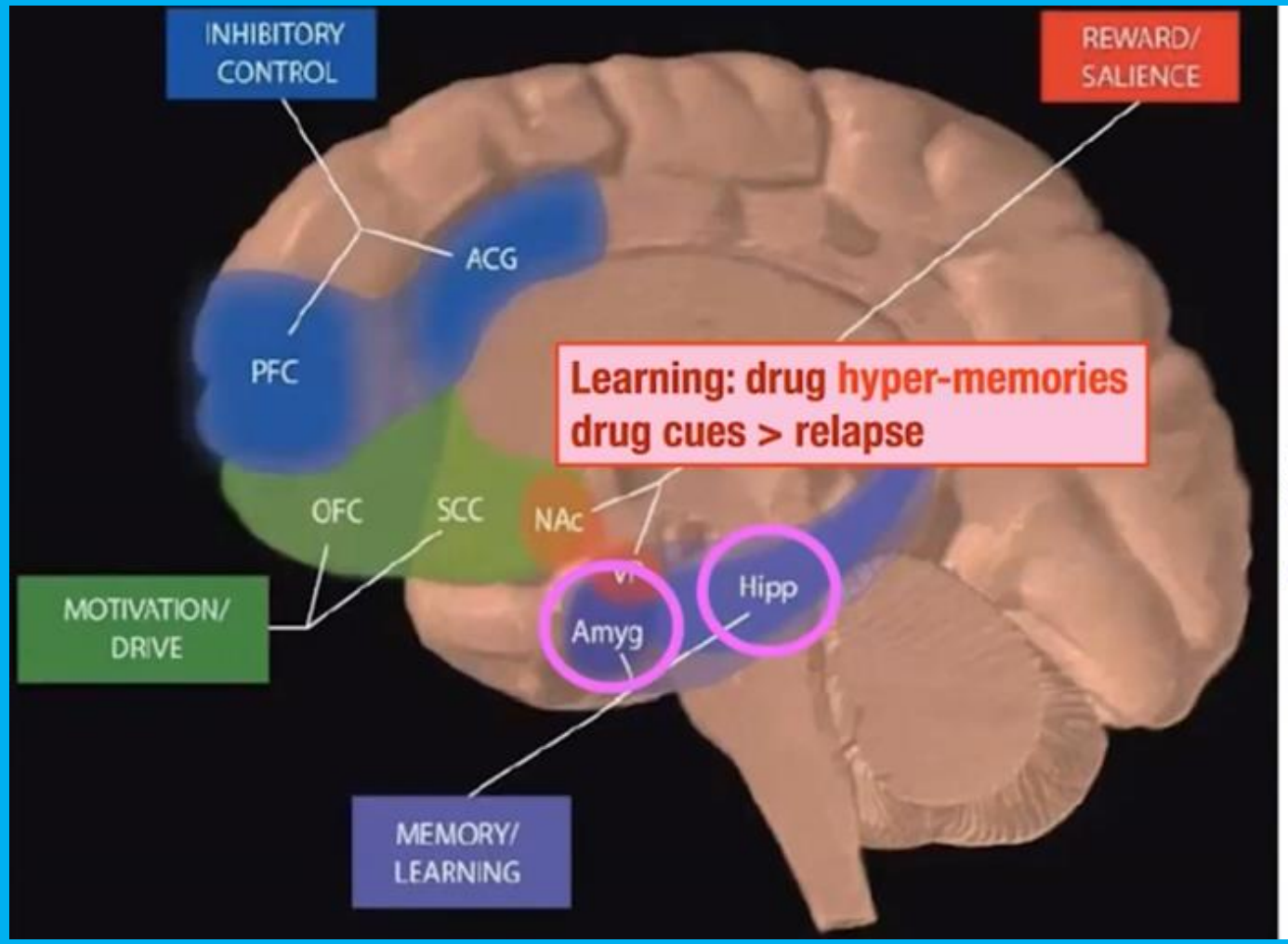


Addiction neurochemical #2 Glutamate

- The most abundant neurochemical in the brain
- Critical in memory formation & consolidation
- All drugs of abuse and many addicting behaviors effect Glutamate which preserves drug memories

  and creates drug cues
- And … glutamate is the neurochemical of "motivation" (it initiates drug seeking)

Glutamate leads to hyper-memorization of drug cues and leads to relapse.



2. Hyper- Memorized

Memory/Learning Areas:

Hipp: **Hippocampus**
- memory formation

Amyg: **Amygdala**
- fear conditioning
- early emotion

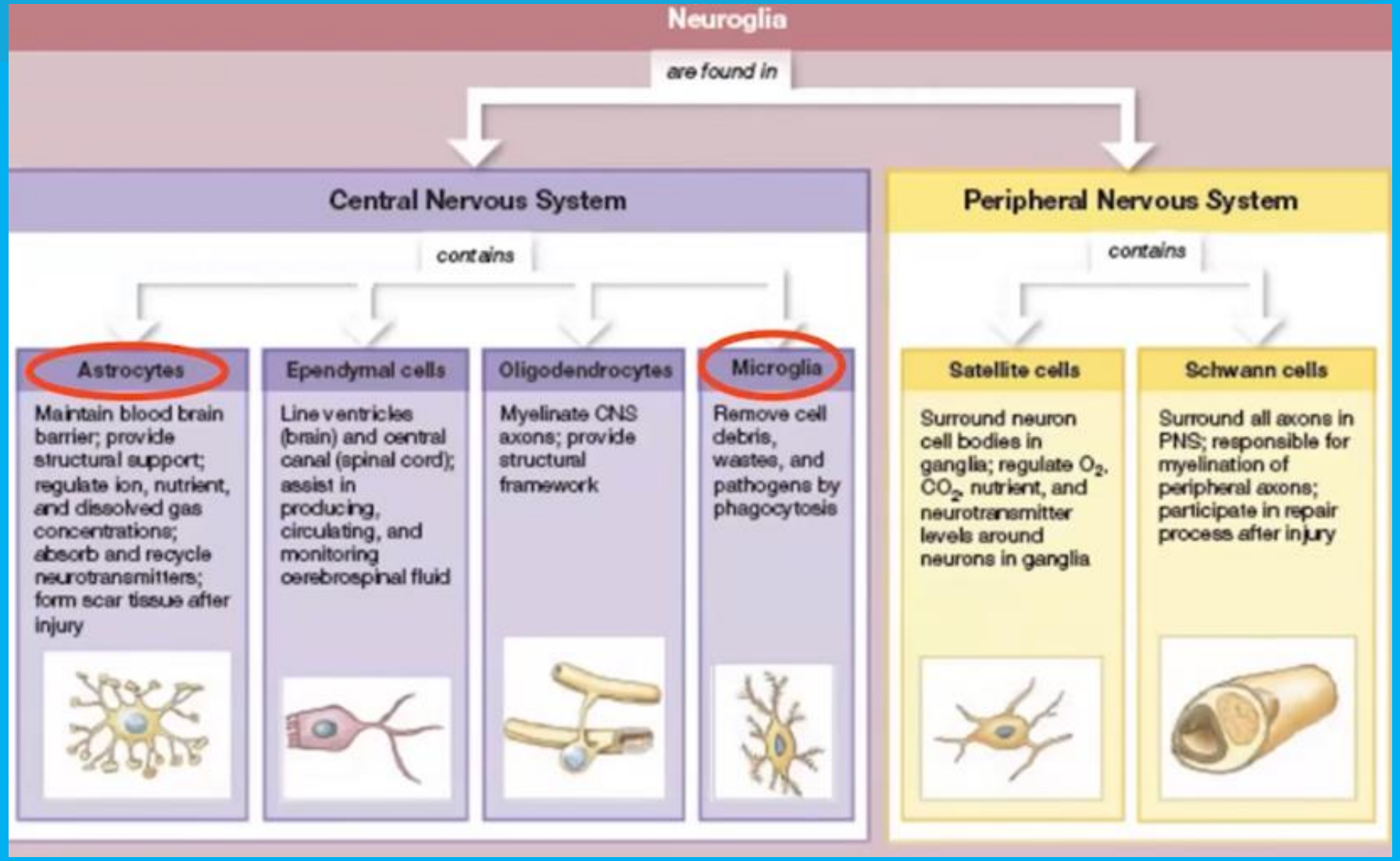
Glutamate spillover and overlearning

- Enduring vulnerability to relapse due to recruitment of “corticofugal” GLU projections to striatum
- Excess GLU “spills” out of the synapse to bind to extra-synaptic GLU receptors
- Changes in synaptic plasticity leads to pathologic learning and memory
- Result: impairment of inhibition of drug seeking

Peter W. Kalivas, PhD
Department of Neurosciences
Medical University of South Carolina

Glial Cells

Glial cells comprise about 33 – 66% of the brain and once thought to be of minor significance are hugely important to brain health and specifically, to the health of neurons.

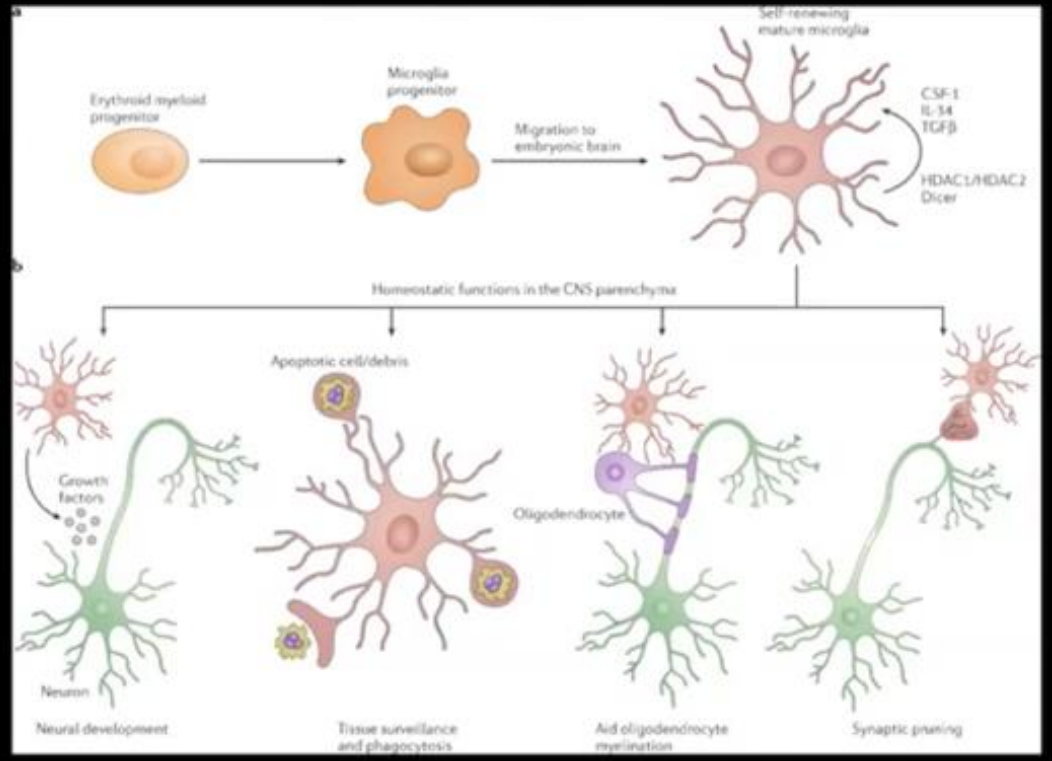


Astrocyte Glial Cells

- Traditionally seen as support cells for neurons
- Connect synapses to blood vessels and make contact with hundreds of synapses and across different populations of neurons
- Integrate signals from many synapses at once
- Critical for glutamate regulation (express glutamate transporters)
- Also express cytokines for inflammatory signaling

Microglia

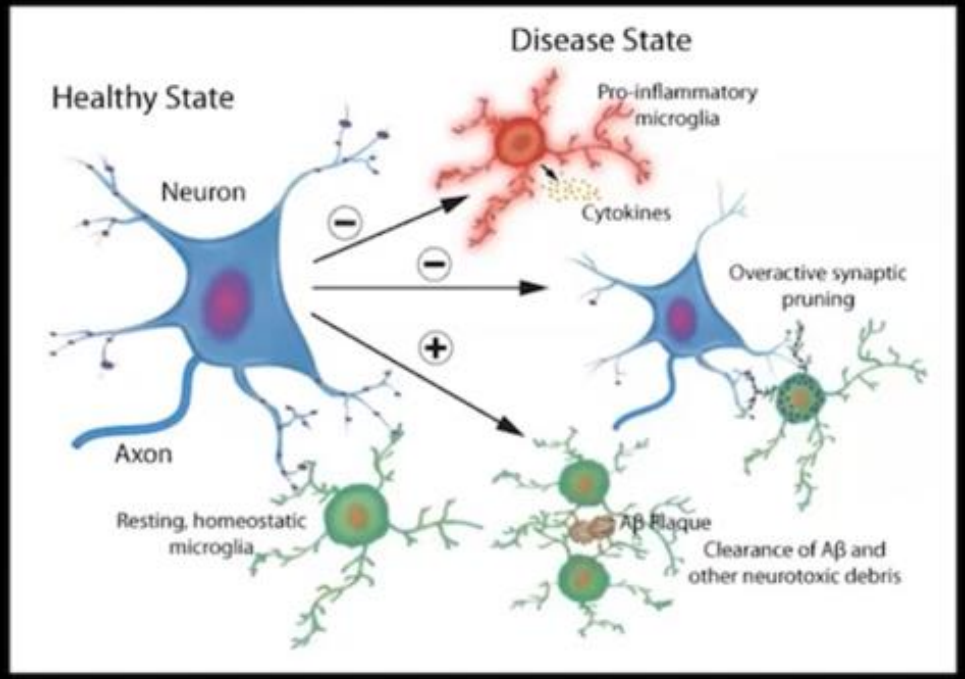
Microglia



- The resident immune cells of the CNS (the macrophages of the brain)
- Actively survey a specific brain tissue microenvironment for Pathogen Associated Molecular Patters (PAMPs) given off by pathogens, toxins and drugs
- Also detect Danger-Associated Molecular Patterns (DAMPs) released from damaged or dying brain cells
- Receive cytokine signals from other microglia
- Assist neuronal synapse remodeling (plasticity, pruning) critical for normal development and beyond

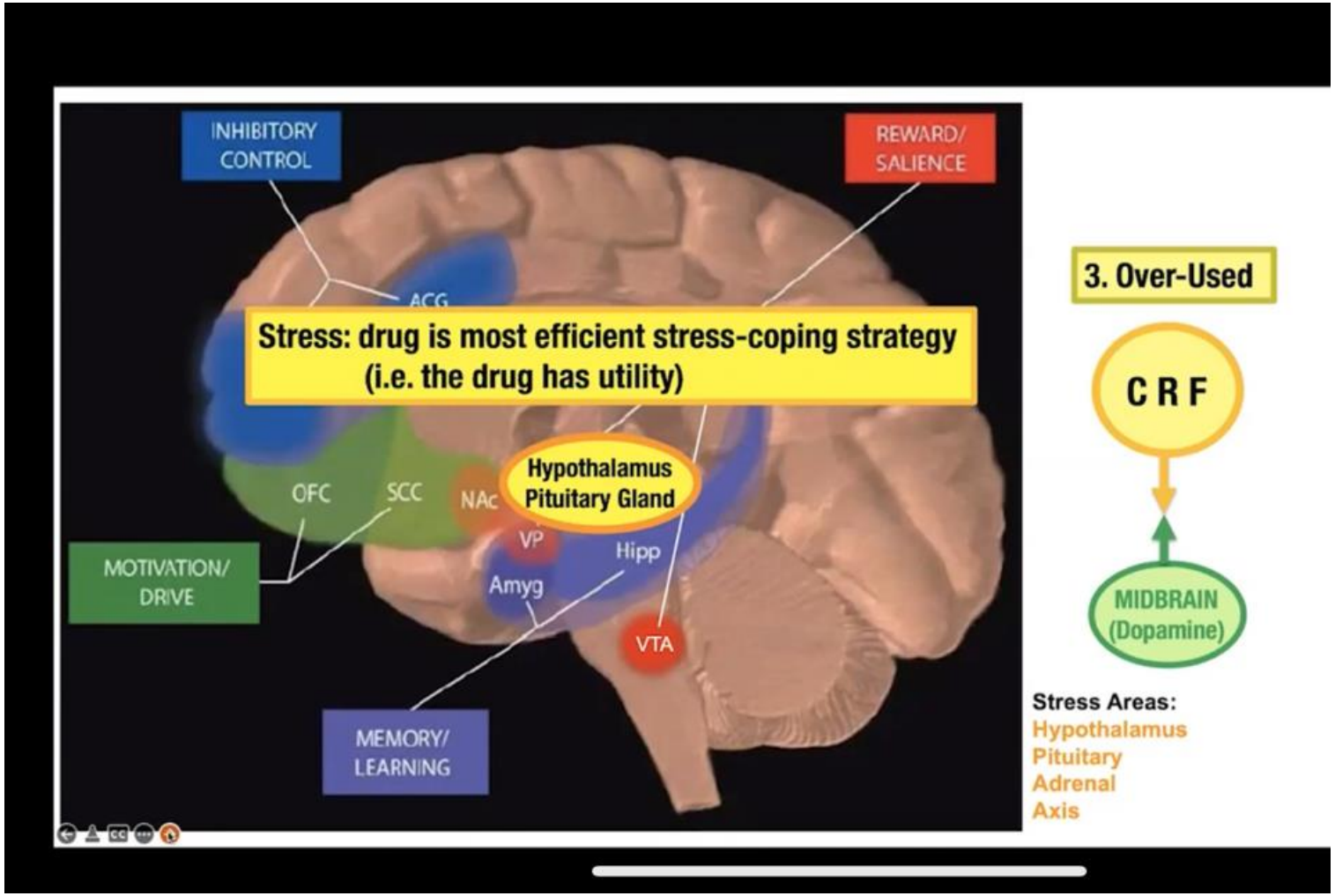
Microglia are damaged by excessive glutamate.

Reactive Microgliosis: response to pathogen/injury



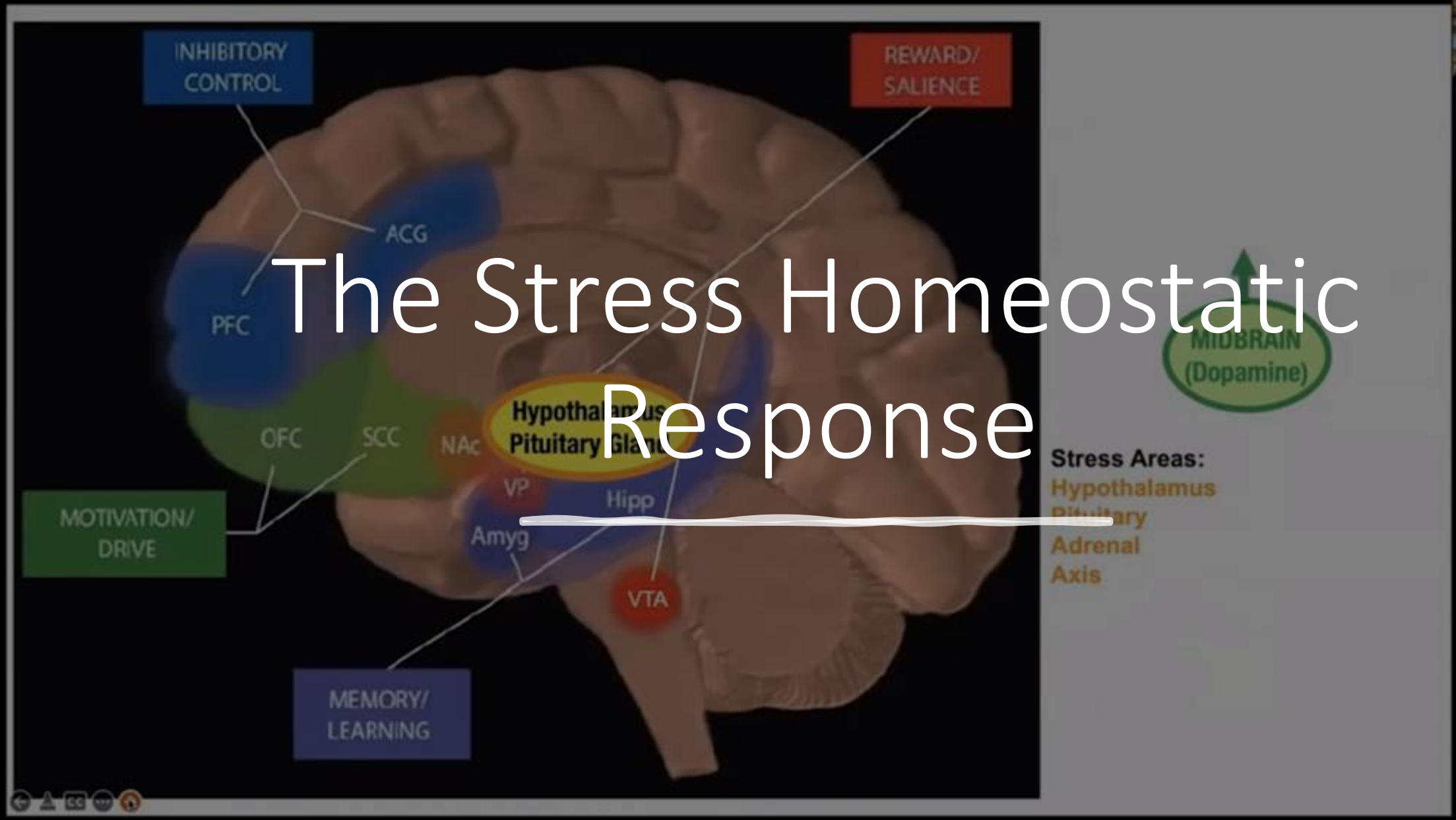
- Resting microglia: injury to brain > Reactive Microgliosis
- Microglia respond rapidly to stress and trauma
- Shift from ramified (resting) state to ameoboid (activated) state
- Microglia are very fast-moving cells (fastest in the brain: entire brain parenchyma scanned by microglia every few hours)
- Become macrophages > phagocytize pathogens and debris
- Antigen-presenting cell to T lymphocytes

Addiction Chemical #3: Cortisol



The activation of CRF_1 receptors by CRF in the hypothalamus initiates the hypothalamic–pituitary–adrenal (HPA) axis, ultimately resulting in the release of glucocorticoids (cortisol in primates and corticosterone in rodents) from the adrenal cortex.

The Stress Homeostatic Response



Hedonic Allostasis Theory (Koob & LeMoal)

George Koob, PhD
Chair, Neurobiology of Addictive Disorders
Scripps Neurosciences Institute

- With continued drug use and withdrawal, the "anti-reward" system is recruited to counter-balance excess Dopamine using the stress hormone CRF
- Brain is unable to maintain normal "homeostasis"
- So the brain reverts to "allostasis" - change of the hedonic "set point" under stress in an attempt to maintain stability
- The result is anhedonia – an inability to find pleasure in normally pleasurable activities

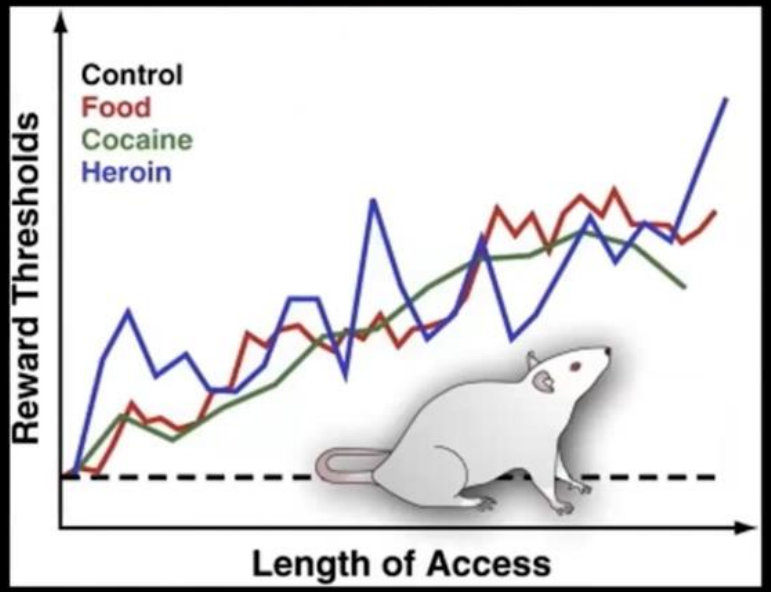
LeMoal M, Koob GF. Drug addiction: pathways to the disease and pathophysiological perspectives. European Neuropsychopharmacology (2007) 17: 377-93.

Allostasis

Stress hormone, cortisol is released to counter excessive dopamine in in effort to attain homeostasis. But a new set point is made which results in an inability to find pleasure.

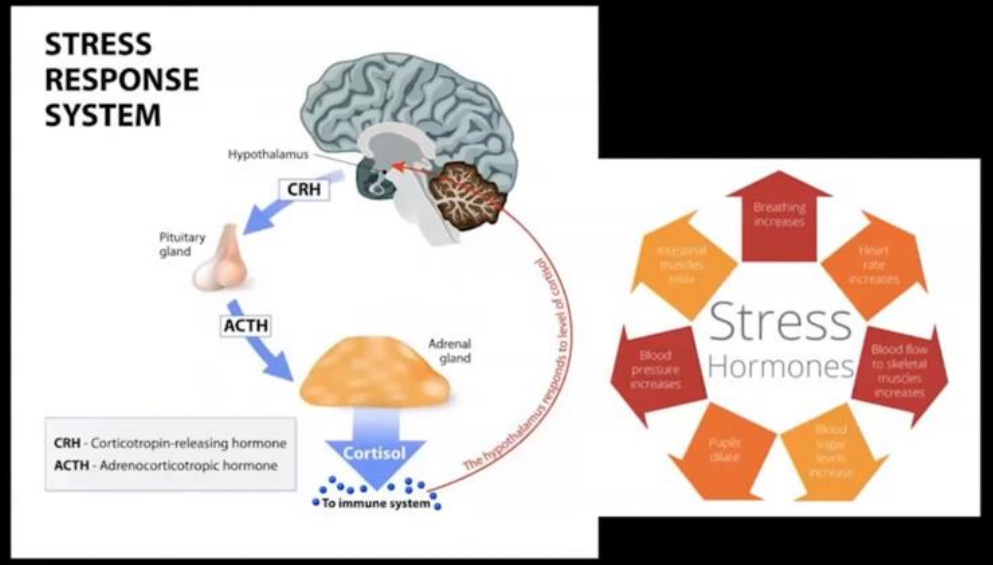
A-process:

Drugs activate brain circuits that elicit pleasurable emotional states (reward) …

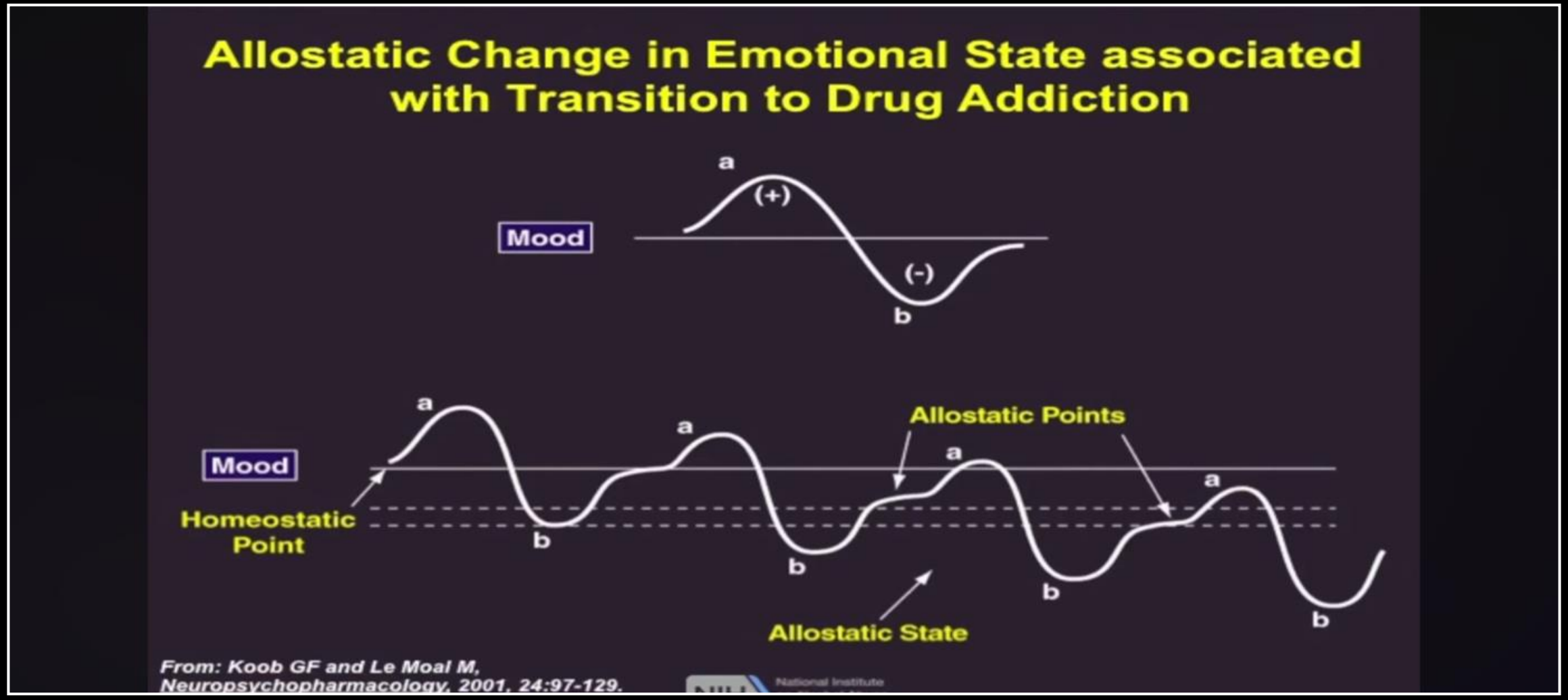


B-process:

… triggering counter-regulatory stress hormones to restore affective/emotional homeostasis



The initial response of pleasure (A-process) leads to a homeostatic process of stress or pain (B-process) in keeping with Lemke's earlier comments on dopamine but in this instance, cortisol.



This slide depicts how the allostatic response creates new set points for pleasure and pain.

The Marriage of Triune Brain Theory and Polyvagal Theory

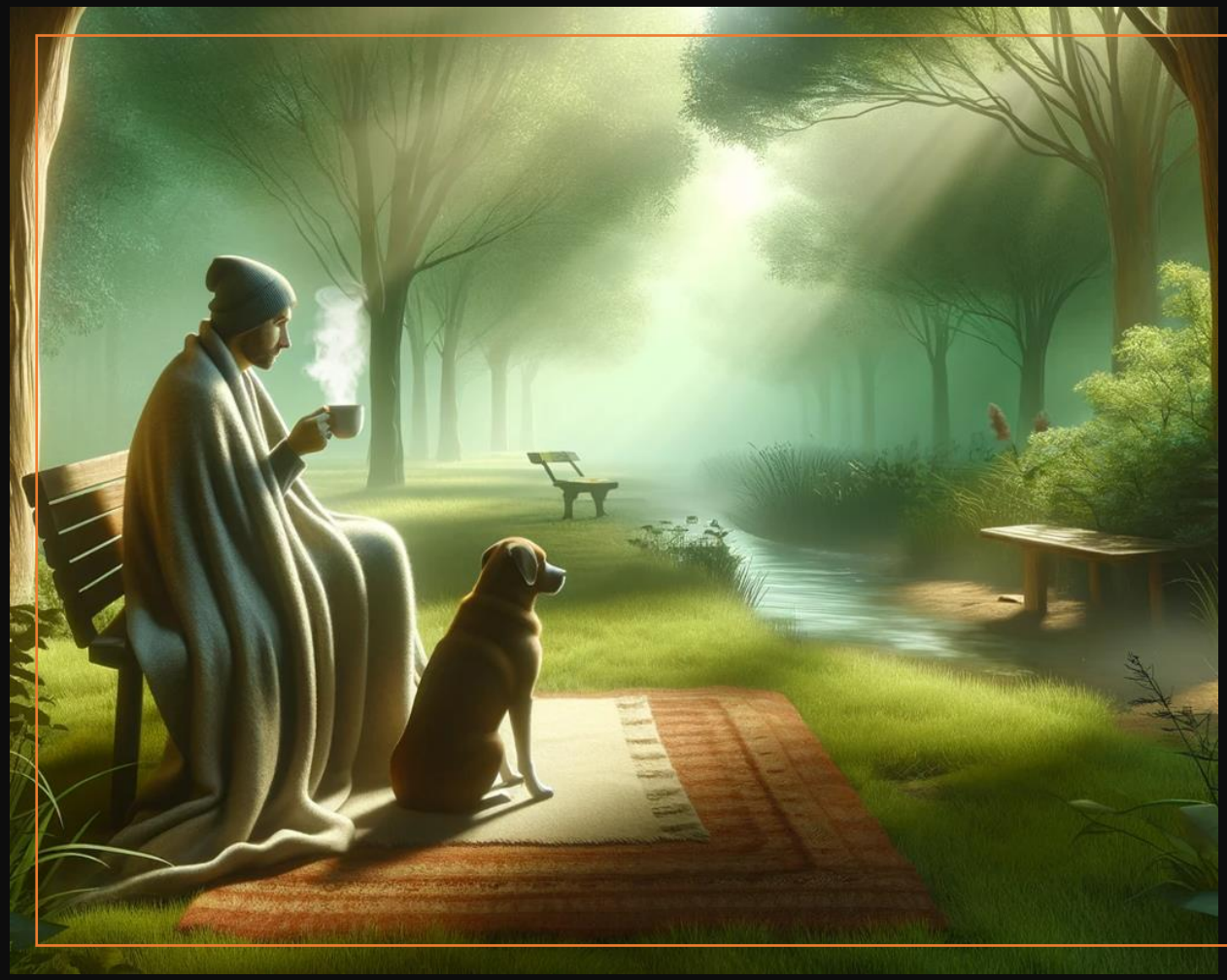
The greatest thing then, in all education, is to make our nervous system our ally as opposed to our enemy

– William James

Polyvagal Theory, Trauma, and Addiction

Dysregulation of the Nervous System:

- Individuals with addiction often have a history of trauma or chronic stress, leading to a dysregulated nervous system.
- Polyvagal theory suggests that substance use can be a way to self-medicate, seeking to alleviate feelings of distress or emotional pain by shifting the state of the nervous system.



Polyvagal Theory, Trauma, and Addiction

Seeking Safety and Comfort: The theory posits that when the body's social engagement system is not functioning optimally (due to trauma, stress, etc.), individuals may turn to substances as a substitute for social connection and comfort. This is particularly relevant in understanding why some individuals with addiction report feeling more 'at ease' or 'connected' when under the influence.

Polyvagal Theory, Trauma, and Addiction

Impact on Social Relationships: Polyvagal theory emphasizes the importance of safe and supportive social relationships for emotional regulation. Addiction can disrupt these relationships, further exacerbating feelings of isolation or disconnection, which can in turn perpetuate the cycle of substance use.

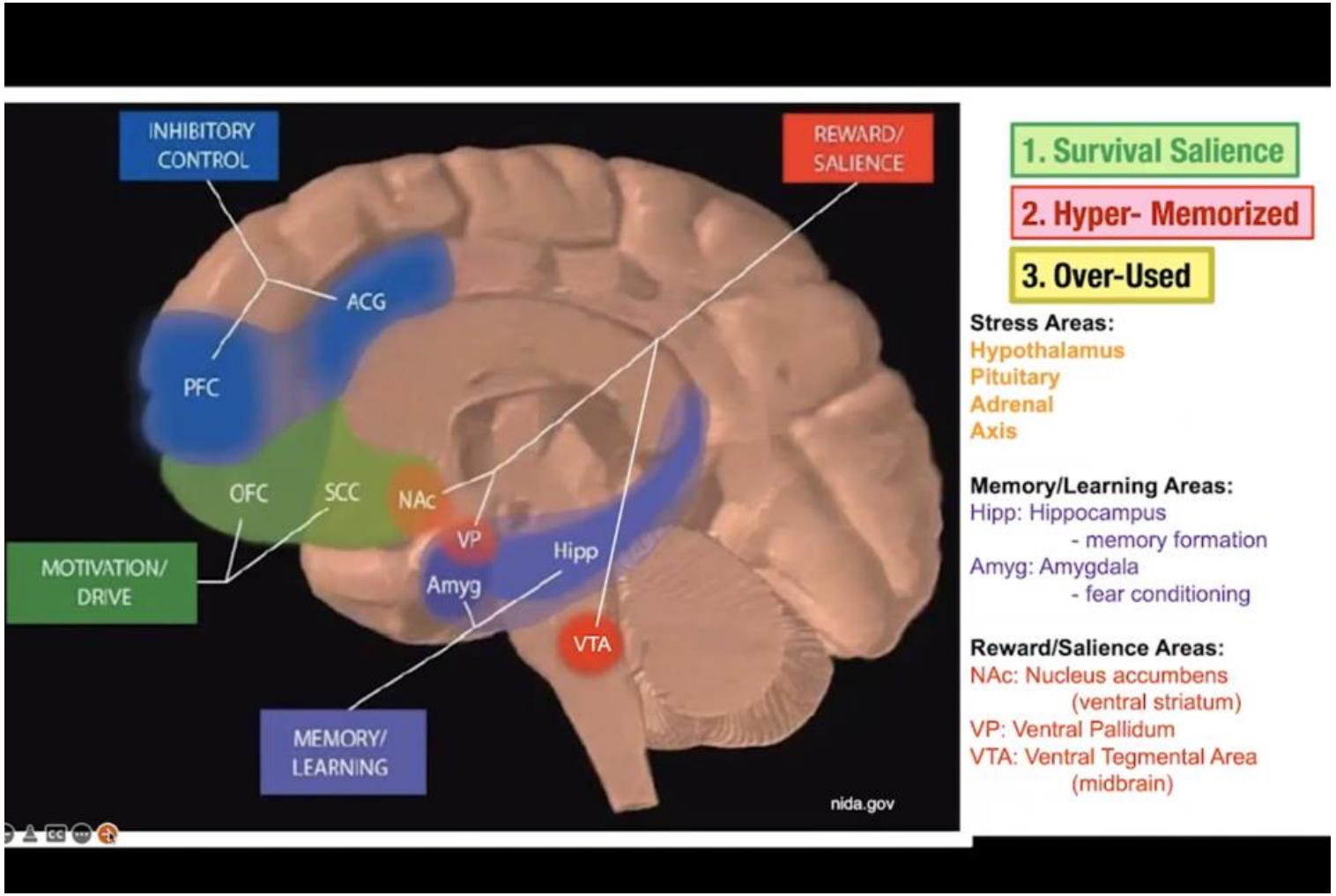
Polyvagal Theory, Trauma, and Addiction

Treatment Approaches: Understanding the role of the autonomic nervous system in addiction can inform treatment approaches. Therapies that focus on body-based regulation, like mindfulness, yoga, and other forms of physical activity, can be effective. Additionally, fostering safe and supportive social environments is crucial in recovery, aligning with the polyvagal emphasis on the importance of social connection and engagement.

Polyvagal Theory, Trauma, and Addiction

Relapse and Recovery: Polyvagal theory can also provide insights into the challenges of relapse and recovery.

The theory suggests that during times of stress or triggered trauma responses, the nervous system might revert to more primitive survival states (fight, flight, freeze), which can increase the risk of relapse.



To summarize: The process of addiction involves

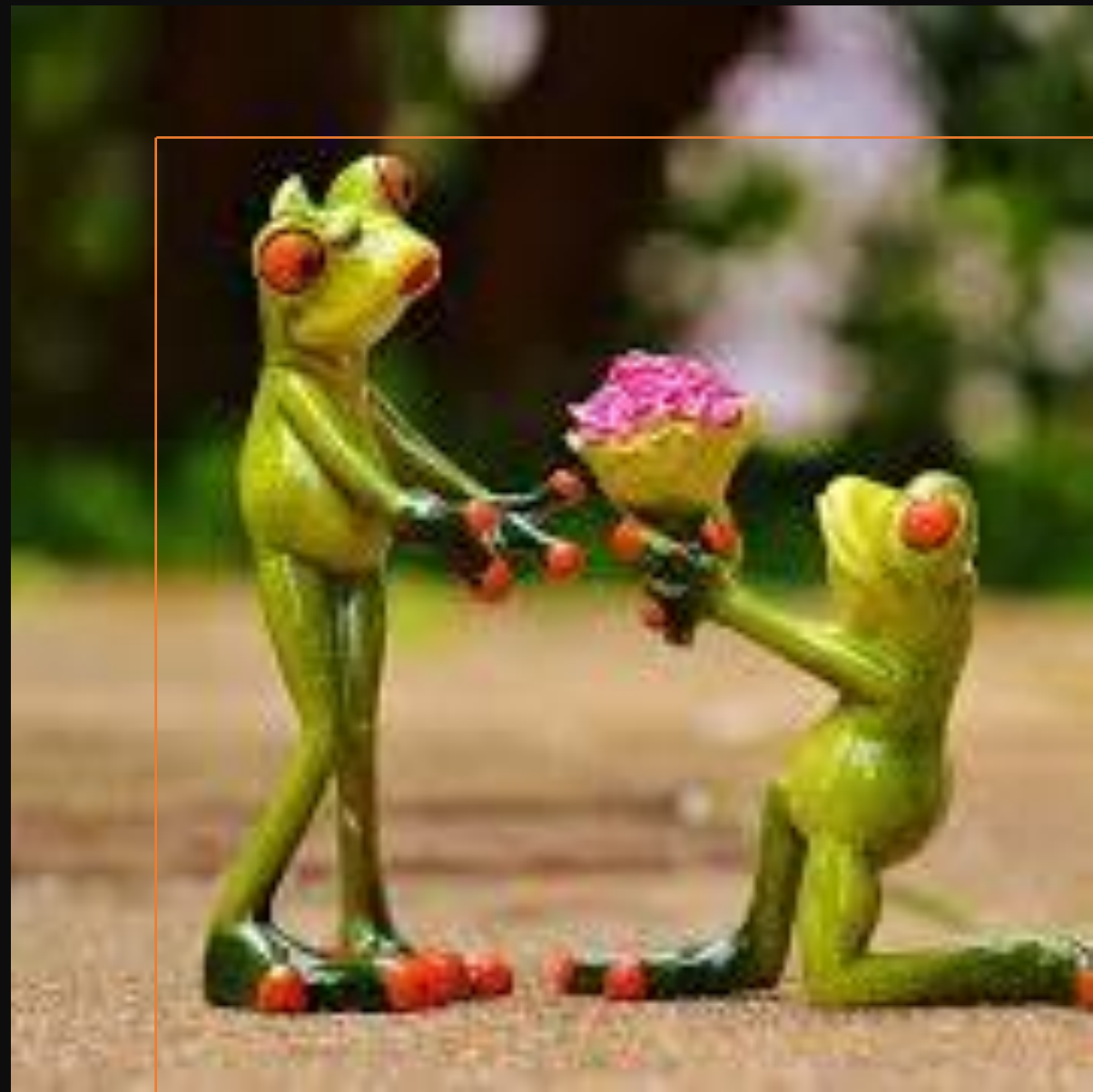
1. Excessive and errant survival salience via dopamine.

2. Hyper-memorization of the addictive substance or behavior.

3. Over-use which creates stress via cortisol (HPA activation).

The Marriage of Triune Brain Theory and Polyvagal Theory

- In the last 10 years new and exciting neuroscience has emerged that helps us map out our physical, emotional, and cognitive responses to the world around us and provides us a way through the ensuing tempest within ourselves.
- Dr. Barta (2018) proposes a model that demonstrates how the brain and the nervous system work together to fuel emotional dysregulation. In his model which he calls TINSA (Trauma Induced Sexual Addiction), he pairs some of the greatest minds in neurology and psychology to include:
  - Dr. Stephen Porges' **Polyvagal Theory**
  - Dr. Paul Maclean's **Triune Brain Theory**.



Triune Brain Theory

- MacLean (2009) proposed that there are three distinct formations in our brain which are used in different situations for everyday survival purposes.
- These specific structures developed sequentially on top of each other at different times during the evolution of the brain for the purposes of giving the organism the ability to survive during that period of time.
- Even though the brain became more advanced and adaptive, the older more primitive structures of the brain still play an especially important role in thought, process, and behavior.

(For my Christian friends who might worry about this model contradicting sensitivities about creationism – not to worry. As explained by Dr. Andy Doan, M.D. Ph.D., ophthalmology surgeon and neuroscience researcher, and paraphrased by me, "God is very efficient, and He included in our more developed brain substructures that He already designed for lower life forms/animals. No need to re-do what was already perfect and efficient").

Triune Brain Theory

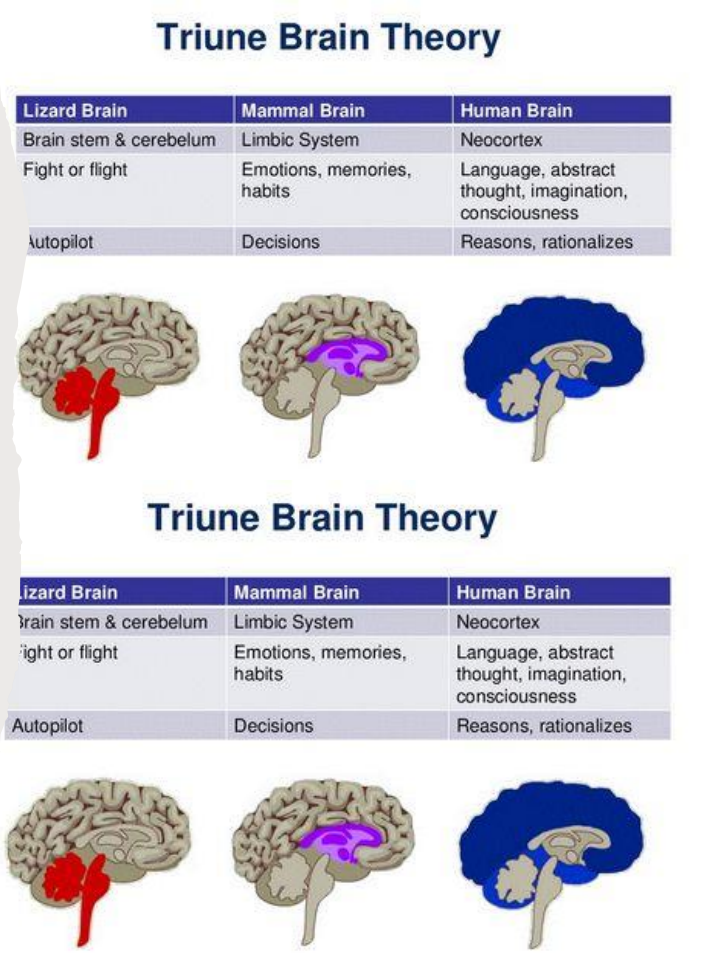
Lizard Brain	Mammal Brain	Human Brain
Brain stem & cerebelum	Limbic System	Neocortex
Fight or flight	Emotions, memories, habits	Language, abstract thought, imagination, consciousness
Autopilot	Decisions	Reasons, rationalizes

The Triune Brain in Evolution, Paul MacLean, 1960

Triune Brain Theory

<u>The Reptilian Brain (or Reptilian Complex)</u>:

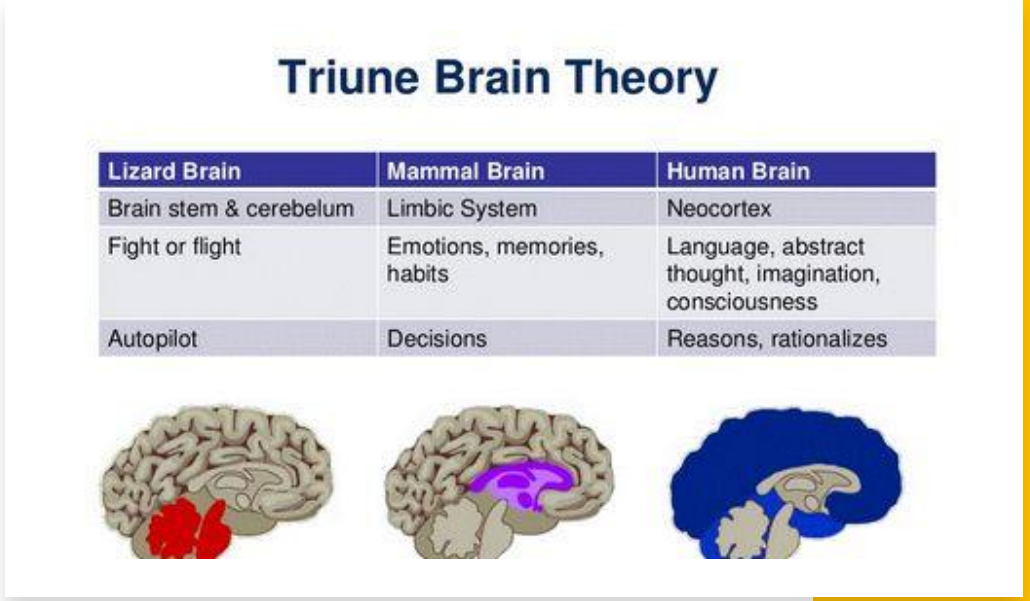
- As the name suggests, this is the most primitive brain and it developed about 500 million years ago in fish and later reptiles.
- Its roles include sensation, instinctual reaction, breathing, temperature regulation. TINSA hypothesizes that the reptilian complex promotes certain survival functions as well, most specifically, immobilization or freeze.
- We often see lizards, for example, freeze in the face of danger such as a lunch-starved predator in an instinctive reaction that can be life-saving (sadly for the lizard, it doesn't always work, and he sometimes ends up being a snack anyway).



Triune Brain Theory

The Mammalian Brain (or Limbic System):

- Later, about 150 million years ago, the limbic system first appeared in small animals.
- This system developed as critters were able to move more freely about as they were now equipped with extremities.
- As such, it often became necessary to either fight off or flee from would-be predators. In addition, the capacity to have memory and emotions developed.
- This enabled the animal to control the body's response to danger and to remember that danger as well as the ability to be vigilant and scan the surrounding environment for potential dangers. Like critters, we often revert to this neurological system when we act instinctively.



Triune Brain Theory

The Frontal Lobe (or Neocortex):

- According to Maclean (1990), the frontal lobes came on board only about 2 or 3 million years ago.
- As in the reptilian brain and the limbic system, the purpose of this brain formation is to react to and protect us from danger.
- Unlike our more primitive neighbors, this system reacts **consciously**. Very importantly, there was a need to develop a system that made possible more “civilized” responses to threats and at the same time one that offered the possibility to *connect* to others for safety.
- Therefore, the frontal lobe allows us to access a new way of surviving based on **socialization**. This makes it possible for us to use analysis, logic and decision-making, and this is what specifically separates us from other lower-ordered animals that rely on instincts alone for survival

Triune Brain Theory – To Bring it Home

- To bring it home, on topside we have the cortical brain consisting of the frontal lobe which is the most recently developed portion of the brain, i.e., **the conscious, thinking brain**.
- At the bottom, we have our subcortical, unconscious brain, which is made up of the **reptilian and limbic complexes** and is directed largely by raw instinct and emotions which often results in immediate knee-jerk reactions that happen in a split second.
- Barta (2018) informs us that, in the best of worlds, we try to lead with our **frontal lobe** and remain socially engaged if something threatening confronts us and in order think our way out of it, smile, and/or stay calm.
- But in times of intense stress or in situations that remind us of past trauma, this survival mechanism is quickly overrun by earlier, more primitive survival strategies of our mammalian/limbic brain and our reptilian brain structures.
- As such, when our neocortex fails us, the limbic system takes command and we are then rapidly sent into our fight-or-flight response and if this does not work and we cannot run away or fight our way out of it, the most primitive line of defense is deployed and we simply freeze, become immobilized, or completely collapse. This hijacking process can occur whether the threat is real or merely perceived (Barta, 2018).

Polyvagal Theory

Made simple

Autonomic Nervous System

Sympathetic

Activated, anxiety, fear, terror, anger

Parasympathetic

Ventral Vagal

Connected, calm, safety

Dorsal Vagal

Shut-down, depressed

Polyvagal Theory

The Autonomic Nervous System

The autonomic nervous system is our **personal surveillance system**.

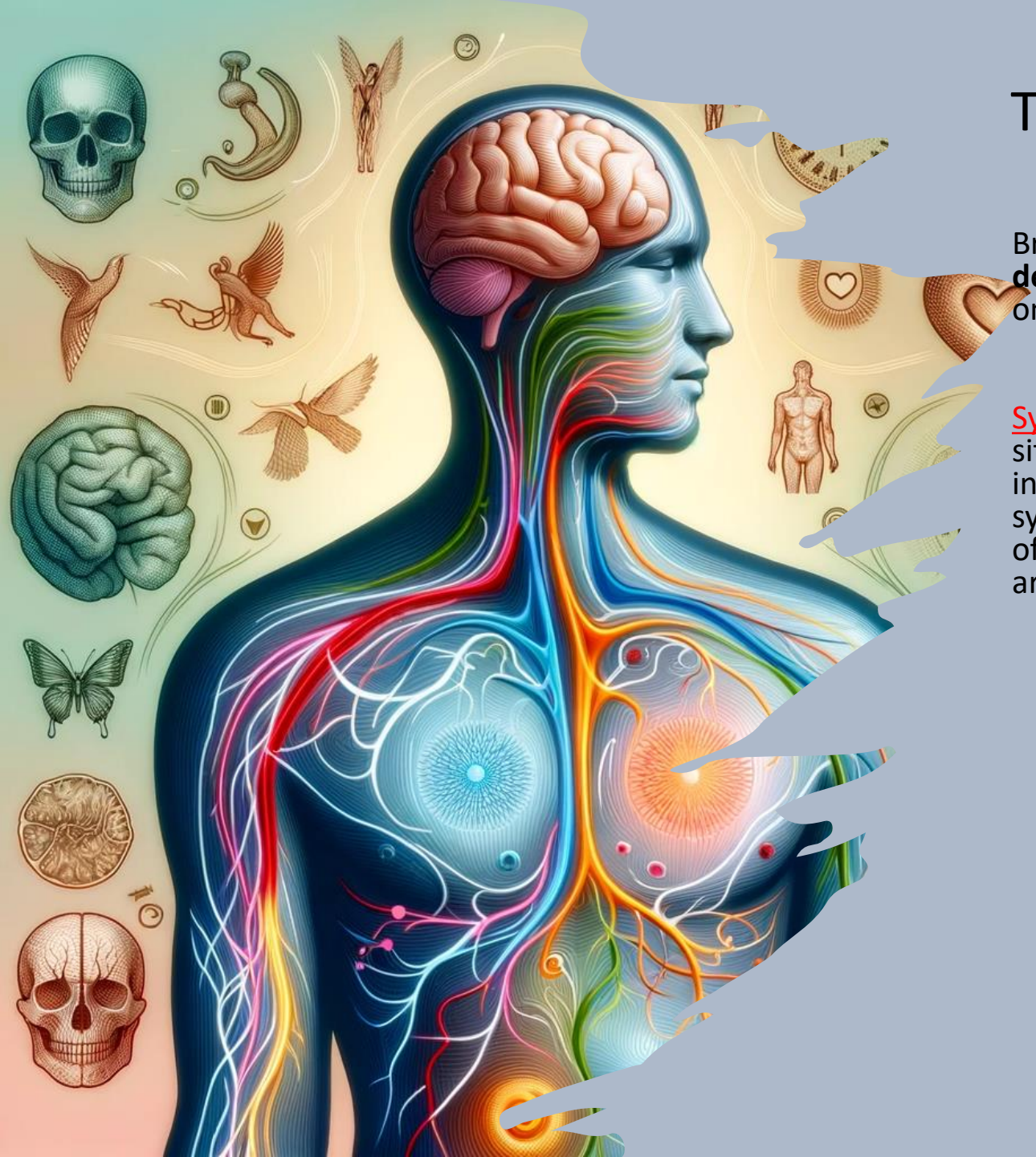
In an effort to keep us out of danger, it is always on guard; asking the question, “Is this safe?” Its dedicated goal is to protect us by sensing safety and risk.

It achieves this by listening moment by moment to what is happening in and around our bodies and in the connections, we have to others (Dana, 2018).

This listening happens far below awareness and far away from our conscious control.

Dr. Porges, understanding that this is not awareness that comes with perception which is conscious, coined the term **neuroception** to describe the way our autonomic nervous system scans for cues of safety, danger, and life threat, without involving the thinking parts of our brain or the unconscious parts of the brain (Porges, 2017).

Dr. Steve Porges



Polyvagal Theory
The Autonomic Nervous System

Briefly stated, our response to threat will move us toward one of **three defensive responses**. Two of which keep us in perpetual defense and one of which moves us toward health and restoration.

Sympathetic Division: Prepares the body for stressful or emergency situations – fight or flight. The sympathetic nervous system originates in spinal nerves (nerves that arise from the spinal cord) and is our system of mobilization. The sympathetic nerves are found in the middle of our backs in the thoracic and lumbar regions of the spinal cord. There are two mobilization systems in our sympathetic nervous system.

- Sympathetic Adrenal Medullary (SAM): The SAM system is activated very quickly, within 100 milliseconds and brings up a burst adrenaline for a fast response to a stressor. SAM activation triggers a short-term and rapid response to a stressor which is followed by a return to regulation (Dana, 2018).
- Hypothalamic-Pituitary-Adrenal (HPA) Axis: The HPA axis takes over when the quick, adrenaline surge of energy of the SAM does not resolve the distress. The HPA releases cortisol (AKA stress hormone). This release takes longer and is much slower in taking effect, requiring minutes to take effect rather than seconds (Dana, 2018).

Polyvagal Theory
Sympathetic Division

- The sympathetic division increases heart rate and the force of heart contractions and widens (dilates) the airways to make breathing easier.
- It causes the body to release stored energy.
- Muscular strength is increased. This division also causes palms to sweat, pupils to dilate, and hair to stand on end.
- It slows body processes that are less important in emergencies, such as digestion and urination (Merck Manual).
- When we are in this physical state, we can feel emotions such as fear and/or rage and, if extremely activated, absolute terror (Rothschild, 2017).

Parasympathetic Division

- The parasympathetic division conserves and restores calm/homeostasis. It slows the heart rate and decreases blood pressure. It stimulates the digestive tract to process food and eliminate wastes. Energy from food is processed and used to restore and build tissues (Merck Manual).
- Dr. Porges discovered that the parasympathetic division of the Autonomic Nervous System consists of two branches which lead to two different responses.
- The main nerve in the parasympathetic nervous system is the 10th cranial nerve, aka vagus nerve, which is the largest of the 12 cranial nerves and has huge implications for our well-being and health.
- The name vagus comes from the Latin word *vagary* which means *wanderer,* and this nerve is definitely a vagabond.
- The vagus travels downward from the brainstem to the heart and stomach and then back upward to the face and its connection with other cranial nerves.
- This amazing wandering nerve is a mixed nerve which communicates bidirectionally between the body and the brain. 80% percent of its fibers are sensory (afferent) sending information from the body to the brain, and 20% are motor (efferent), sending action information from the brain to the body (Dana, 2018).

The vagus nerve has two very distinct branches: **Dorsal vagal nerve** and **ventral vagal nerve**.

Dorsal Vagal Nerve: Barta (2018) notes that the most primitive form of defense occurs when the dorsal vagal nerve is activated.

- It is not sophisticated in that it is unmyelinated and slow. When activated, the dorsal vagal nerve promotes. shutdown, freeze, and collapse
- An example of this shutdown is when a gazelle, for example, is being stalked by a lion and when trapped with no possible way to flee, drops down and appears to be deader than a doornail.
- This is not a conscious process but is, rather, a very primitive and unconscious one. When we are in this physical state, we can feel emotions such as sadness, depression, grief, shame and/or disgust (Rothschild, 2017).

Ventral Vagal Nerve: Barta (2018) writes that the second response of our parasympathetic nervous system (the first being freeze and collapse as noted above) is responsible for our ability to engage socially and to handle social relationships.

- According to Barta, the social engagement system is controlled by our ventral vagus nerve which is a very smart myelinated nerve with a rapid response time. As such, it allows us to "know" if we are safe enough so we can calm our defenses through a process of **"neuroception"** which, as noted earlier, is translated as the brain's ability to sense safety.
- This serves not only bonding needs but allows us to shift out of sympathetic arousal and move into parasympathetic calm or to downshift from activation to calm. When we are in this emotional state, we can feel emotions such as calm, pleasure, love, sexual arousal, and "good" grief (Rothschild, 2017).

Marriage of MacLean's Triune Brain Theory with Porges' Polyvagal Theory

Through the marriage of MacLean's Triune Brain Theory with Porges' Polyvagal Theory, we can explain how each part of the triune brain is correlated with the three responses of the autonomic nervous system (Barta, 2018).

Sympathetic

Limbic System (Mammalian Brain)

Developed 150 million years ago

Fight or Flight

Unconscious

Social Engagement (Parasympathetic – Ventral Vagal)

Frontal Lobe (Neocortex)

Developed 2 to 3 million years ago

Ventral Vagal

Present/Safe/Aware

Conscious

Parasympathetic (Dorsal Vagal)

Reptilian Brain (Reptilian Complex)

Developed 500 million years ago

Freeze

Unconscious

Polyvagal Theory – Autopilot or the Choice of Connection?

So, our neurosystem, left on autopilot will, when we are faced with stress and threat, move us to either:

(a) **Sympathetic fight or flight** which equates to extreme anxiety, anger, rage, and or terror or to

(b) **Dorsal vagal shutdown** which leads to slowing down, withdrawal, and possibly even depression. If these modes of coping become excessive, we are at risk for potentially using maladaptive strategies such as addictions to quell the pain of negative physical symptoms, associated negative emotions, and/or complete withdrawal and possibly self-destructive behavior.

The best response, of course, is to activate our **social engagement system of the ventral vagal pathway** of the parasympathetic branch. In this state, our heart rate is regulated, our breath is full, we take in the faces of friends, and we can tune in to conversations and tune out distracting noises.

Polyvagal Theory – The Stream

When we enter into an autonomic state, the information about that state travels up the automatic pathways up to the brain where a **story is drafted** to make sense of the embodied experience/sensations.

In other words, the physiological state produced by the autonomic nervous system creates a **psychological story.**

Dana (2020) describes this as a metaphor of a **stream** where we can imagine the flow of experience. At the river's source is neuroception and at the river's mouth is the story. In between **lie perception, autonomic state, feelings, and behavior.** We are accustomed to entering in the river downstream with feeling and behavior, or story being at the fore.

However, **neuroception** takes place at the furthest point upstream. We need to make our way back to the starting point, leaving behind the story, behavior, and feelings in order to identify the state and **bring perception or awareness** to neuroception (Dana, 2020).

This has implications for treatment which we will discussed "downstream" in this paper.

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Sympathetic

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Present/Safe/Aware

Conscious

Parasympathetic (Dorsal Vagal)

Reptilian Brain (Reptilian Complex)

Developed 500 million years ago

Freeze

Unconscious

Polyvagal Theory and Treatment

Now that we have a new understanding of how our autonomic nervous system works, we can use this knowledge to restore to emotional, psychological, and physical health. Never before has a breakthrough in neuroscience offered such a paradigmatic shift of hope.

Neuroception Perception State Feelings Behavior Story

Polyvagal Theory and Treatment

- So, the first step in healing is to move our neuroception - what our autonomic nervous system is automatically sensing regarding safety and danger without our awareness to perception to awareness or perception.

- We can then appreciate what our physiological state is causing us to feel emotionally and subsequently change the behaviors that we then engage in.

- The ensuing story or narrative we give to this process to make sense of what we are sensing and feeling, if positive and healthy, helps us correct our autonomic state.

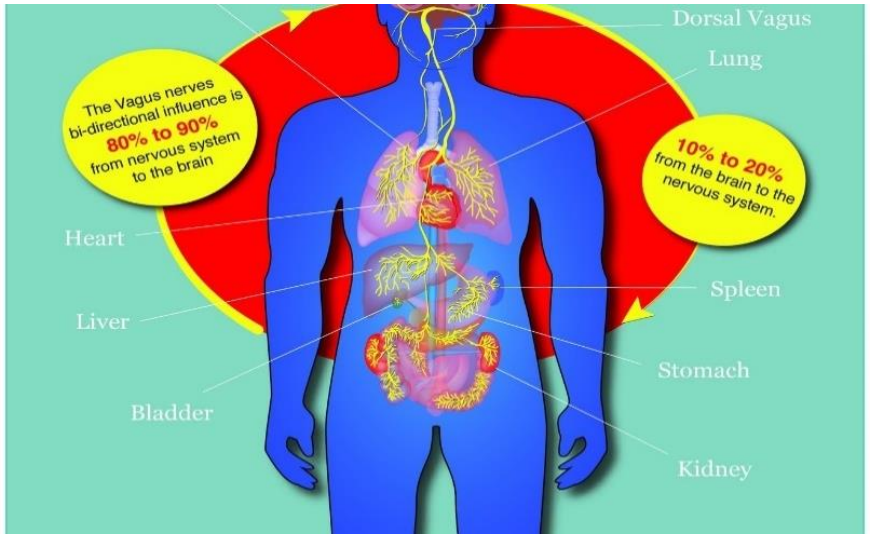
- On the other hand, if our narrative is false, as it often is (e.g., we often shame and blame ourselves or we catastrophize the situation), then our autonomic state becomes even more activated or shut down and our subsequent emotions become more anxious or depressed, respectively, and we enter into a negative feedback loop, a process that leads to emotional problems/illness and/or physical problems.

Polyvagal Theory and Treatment

There are two basic approaches to healing: Bottom up and Top Down:

Bottom-up entails working with the body more directly. It is important to appreciate that, as previously noted, 80 percent of the fibers in the vagus nerve are sensory in that they go from the organs to the brain and 20 present are motor in that they travel from the brain to various body organs. (Porges, 2017). This suggests that what our bodies tell us is indeed very important and we must make every effort to listen and heal on that level.

Top-down strategies which involve our thinking and hopefully more rational brain require a certain level of cognitive development and maturity so very young children may not be able to benefit from this approach (e.g., Cognitive Behavioral Therapy aka CBT).



Polyvagal Theory and Treatment

As previously noted by Deb Dana, it is in a ventral vagal state and a neuroception of safety that brings the possibility for connection, curiosity, and change. She nicely presents a polyvagal approach which she calls the four R's (the first three are bottom up and the last is bottom down (Dana, 2018):

The Four R's

- Recognize the autonomic state
- Respect the adaptive survival response
- Regulate or co-regulate in a ventral vagal state
- Re-story

Polyvagal Theory and Treatment
#1 Recognize the Autonomic State

- I recommend that we make the **Autonomic Nervous System Precision Regulation Chart** (next slide) our companion as we use it to recognize where we, our children, and/or others are on that continuum. In so doing, we become able to make what is **implicit** (under the table and outside of our awareness) **explicit** (on the table and in our awareness).

- We can use the color codes to describe for ourselves and for others where we and others are with just one neutral and non-judgmental word.

- This is particularly helpful for children as well as this helps to give them a physical and emotional language that connect the mind with the body.

The chart below adapted by Dr. Rothschild nicely demonstrates the shifting in body sensations, physiological symptoms, and emotions as we move between autonomic states (Rothschild, 2017) (please consider buying).

AUTONOMIC NERVOUS SYSTEM: PRECISION REGULATION
** WHAT TO LOOK FOR **

"Normal" Life → Threat to Life

		LETHARGIC Parasympathetic I (PNS I)	CALM Parasympathetic II (PNS II) *Ventral Vagus*	ACTIVE/ALERT Sympathetic I (SNS I)	FLIGHT/FIGHT Sympathetic II (SNS II)	HYPER FREEZE Sympathetic III (SNS III)	HYPO FREEZE Parasympathetic III (PNS III) *Dorsal Vagus* Collapse
PRIMARY STATE		**Apathy, Depression**	**Safe, Clear Thinking, Social Engagement**	**Alert, Ready to Act**	**React to Danger**	**Await Opportunity to Escape**	**Prepare for Death**
AROUSAL		**Too Low**	**Low**	**Moderate**	**High**	**Extreme Overload**	**Excessive Overwhelm Induces Hypoarousal**
MUSCLES		Slack	Relaxed/toned	Toned	Tense	Rigid (deer in the headlights)	Flaccid
RESPIRATION		Shallow	Easy, often into belly	Increasing rate	Fast, often in upper chest	Hyperventilation	Hypo-ventilation
HEART RATE		Slow	Resting	Quicker or more forceful	Quick and/or forceful	Tachycardia (very fast)	Bradycardia (*very* slow)
BLOOD PRESSURE		Likely low	Normal	On the rise	Elevated	Significantly high	Significantly low
PUPILS, EYES, EYE LIDS		Pupils smaller, lids may be heavy	Pupils smaller, eyes moist, eye lids relaxed	Pupils widening, eyes less moist, eye lids toned	Pupils very dilated, eyes dry, eye lids tensed/raised	Pupils very small or dilated, eyes very dry, lids very tense	Lids drooping, eyes closed or open and fixed
SKIN TONE		Variable	Rosy hue, despite skin color (blood flows to skin)	Less rosy hue, despite skin color (blood flows to skin)	Pale hue, despite skin color (blood flow to muscles)	May be pale and/or flushed	Noticeably pale
HUMIDITY	Skin	Dry	Dry	Increased sweat	Increased sweat, may be cold	Cold sweat	Cold sweat
	Mouth	Variable	Moist	Less moist	Dry	Dry	Dry
HANDS & FEET (TEMPERATURE)		May be warm or cool	Warm	Cool	Cold	Extremes of cold & hot	Cold
DIGESTION		Variable	Increase	Decrease	Stops	Evacuate bowel & bladder	Stopped
EMOTIONS (LIKELY)		Grief, sadness, shame, disgust	Calm, pleasure, love, sexual arousal, "good" grief	Anger, shame, disgust, anxiety, excitement, sexual climax	Rage, fear	Terror, may be dissociation	May be too dissociated to feel anything
CONTACT WITH SELF & OTHERS		Withdrawn	Probable	Possible	Limited	Not likely	Impossible
FRONTAL CORTEX		May or may not be accessible	Should be accessible	Should be accessible	May or may not be accessible	Likely inaccessible	Inaccessible
INTEGRATION		Not likely	Likely	Likely	Not likely	Impossible	Impossible
RECOMMENDED INTERVENTION		**Activate, Gently Increase Energy**	**Continue Therapy Direction**	**Continue Therapy Direction**	**Put on Brakes**	***Slam on Brakes***	***Medical Emergency CALL PARAMEDICS***

The Autonomic Nervous System Precision Regulation Chart is Available for purchase on Amazon for $8.99 (a very high recommend):
Babette Rothschild (2017) https://www.amazon.com/Autonomic-Nervous-System-Table-Laminated/dp/039371280X/ref=sr_1_15?dchild=1&keywords=deb+dana&qid=1590326813&s=books&sr=1-15

Polyvagal Theory and Treatment
#1 Recognize the Autonomic State

If we find ourselves in the **Orange Zone** to **Red Zone,** we are overly activated and are prone to experience:

- Rapid heartrate
- Hyperventilation
- Panic attacks
- Inability to focus or follow through
- Distress in relationships
- Emotions of fear, terror, rage, anger
- Possible health consequences to include heart disease, high cholesterol, high blood pressure, weight gain, memory impairment, headaches, chronic neck shoulder and back tension, stomach problems, and increased vulnerability to illness (lower immune response) (Dana, 2018).

Polyvagal Theory and Treatment

#1 Recognize the Autonomic State

If we find ourselves in the **Yellow Zone,** we are under-activated or shutdown and are prone to experience:

- Slow heartrate
- Shallow breathing
- Withdrawal from others
- Emotions of sadness, depression, shame, disgust
- Possible health consequences to include chronic fatigue, fibromyalgia, stomach problems, low blood pressure, type 2 diabetes, and weight gain (Dana, 2018)

Polyvagal Theory and Treatment

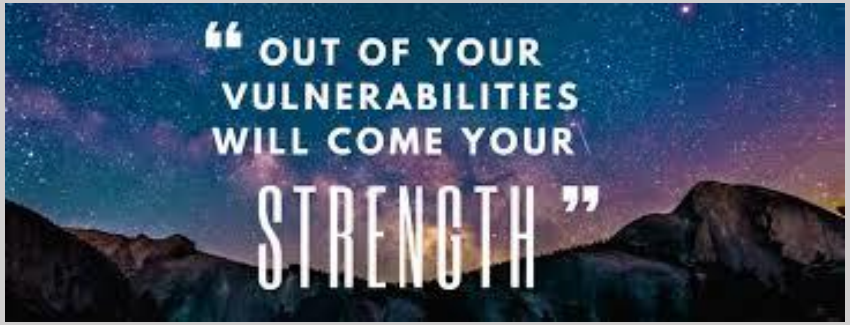
#1 Recognize the Autonomic State

If we find ourselves in the **Green Zone,** we experience safety and connection and we are prone to experience:

- Regulated heart rate (vagal brake lowers heartrate by 20 beats per minute)
- Breath is full
- Feeling regulated
- We take in the faces of others
- We can “tune in” to conversations and “tune out” distractions
- We can see the “big picture”
- We can connect with the world and the people in it
- Able to reach out to others
- Able to play and take time to enjoy life and others
- Able to be productive in work
- Able to organize and follow-through
- Able to heal emotionally and physically
- Emotions of happiness, joy, love, peace, calm
- Possible health consequences include a healthy heart, regulated blood pressure, a healthy immune system, decreased vulnerability to illness, good digestion, quality sleep, and an overall sense of well-being (Dana, 2018)

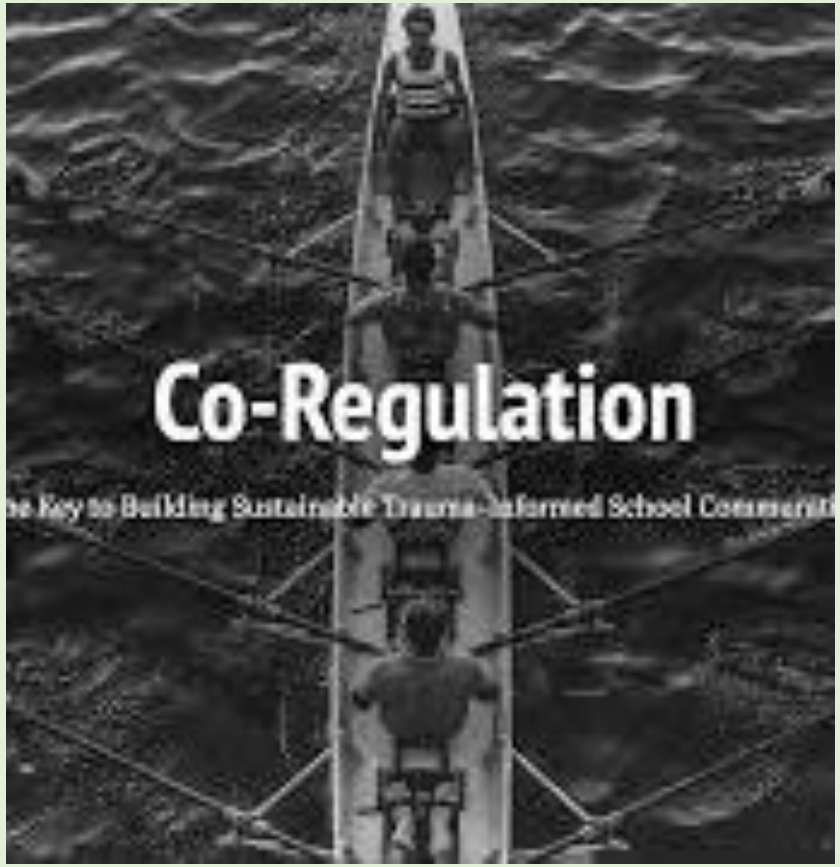
Polyvagal Theory and Treatment
#2 Respect the Adaptive Survival Response

- One of the beautiful aspects of Polyvagal Theory is that it removes **shame** from the equation.
- Dr. Porges kindly states in reference to clients, “I was going to say that depending on the age of my client, but actually, regardless of age, the first thing to convey to the client that they did not do anything wrong… If we want individuals to feel safe, we don’t accuse them of doing something wrong or bad. We explain to them how their body responded, how their responses are adaptive, how we need to appreciate this adaptive feature and how the client needs to understand that this adaptive feature is flexible and can change in different contexts.”(Porges, 2017, p. 121 - 122).
- So, rather than shaming a woman for shutting down in **dorsal vagal freeze** when being molested or raped which will only fuel her shame, guilt, and emotional pain, we must compassionately inform her that her autonomic nervous system was brilliant and that, in reading the cues, immobilized her in a situation where fighting or fleeing could have possibly cost her her life.
- Many a judge have literally ruined survivors of abuse by blaming them for not running or fighting and invalidated their trauma and thus failed to honor their day in court.



Polyvagal Theory and Treatment
#3 Regulate or Co-regulate in a Ventral Vagal State

1. Once we recognize that we are dysregulated and we have pinpointed which defensive physiological state we are in and where we are on the emotional regulation continuum (see emotional regulation chart above) i.e., activation or slowing/shutting down, we can take action by using bottom-up self-regulation strategies and co-regulation strategies
2. As Herman Melville once wrote, "*We cannot live for ourselves, a thousand fibers connect us.*" Connection is a biological imperative according to Porges (2015).
3. Our autonomic nervous system longs for connection and it is through our biology that we are wired to connect. It is by means of co-regulation that we connect with others and create a shared sense of safety (Dana, 2020).
4. As specifically defined by Dr Porges, co-regulation is the mutual regulation of physiological states between individuals. In life, it occurs first between mother and infant but later extends to friends, partners, co-workers, and groups such as families to name a few (Porges, 2017).



Polyvagal Theory and Treatment

#3 Regulate or Co-regulate in a Ventral Vagal State

We humans are social creatures and “our nature is to recognize, interact, and form relationships” with others (Cacioppo & Cacioppo, 2014, p. 1).

As we know, babies need to connect for survival and positive co-regulation in low birthweight babies, in particular, leads to heart rate, temperature, and breathing stabilization, more organized sleep, rapid improvement in state regulation, and reduced mortality, severe illness, and infection (Jefferies, 2012).

Connection is a wired-in biological necessity and isolation or even the perception of social isolation can lead to a compromised ability to regulate our autonomic state which diminishes our physical and emotional well-being (Porges & Furman, 2011).

We can all appreciate that when we feel alone, we suffer. In a Ted Talk presentation, Cacioppo (2013) reported a rather shocking meta-analysis study of over 100,000 participants which found increased risks of dying early due to the following:

1. Air pollution: 5% increased risk of dying early
2. Obesity: 20% risk of dying early
3. Alcoholism: 30% risk of dying early
4. Loneliness: 45% risk of dying early

Polyvagal Theory and Treatment

#3 Regulate or Co-regulate in a Ventral Vagal State

- So, when we recognize that we are suffering and dysregulated it is very helpful and sometimes lifesaving to seek safe others.
- Conversely, when we are emotionally regulated ourselves, we can offer our safe regulation to others, be they adults or children. This is a particularly important and essential component to good parenting.
- We can gift our safe regulation to ourselves and to others by choosing the following strategies below. Remember, through the process of neuroception, others read our cues of safety just as we read theirs.
- Quid pro quo, we receive back what he give and vice versa. We would do well to practice these strategies, so they become automatic whenever we move out of the **green zone** and want to return.

Polyvagal Theory and Treatment

#3 Regulate or Co-regulate in a Ventral Vagal State

Kind eyes: As they say, they eyes are the window of the soul.

Melodious voice: Speak with a more melodious voice, full of prosody and life.

Polyvagal Theory and Treatment

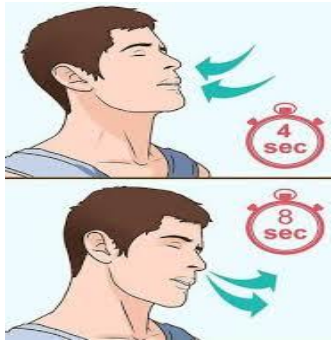
#3 Regulate or Co-regulate in a Ventral Vagal State

Smiling mouth and eyes: Smile not only with your mouth but with your eyes. Whether or not we are aware, our neuroception scans for congruence between the smiling mouth and smiling eyes. Crow's feet wrinkles are testament to someone who lives a more joyful life. So maybe reconsider that Botox.

Avoid leaning in: Leaning in can be perceived as very threatening. Most of us don't like it when others enter into 0ur personal space, particularly in western cultures, and the end result is typically defensive activation moving us toward fight or flight or less typically, occasional freeze responses.

Polyvagal Theory and Treatment

#3 Regulate or Co-regulate in a Ventral Vagal State



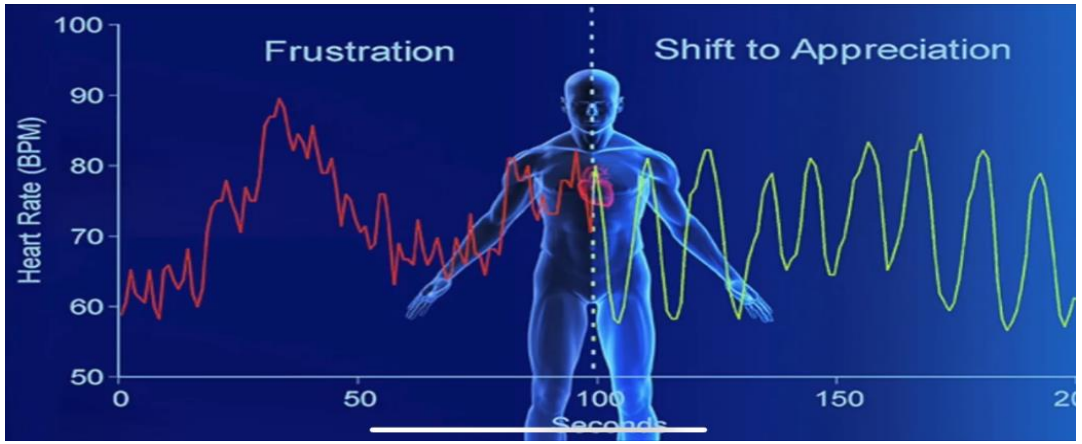
Slow and low Breathing: Our lungs are the only internal body organ that we can directly control, and proper breathing has a huge impact our health. Breathe slowly with exhalations longer than inhalations – breathing out slowly accentuates relaxation and actually can slow our heart rate by 20 beats per minutes (vagal brake).

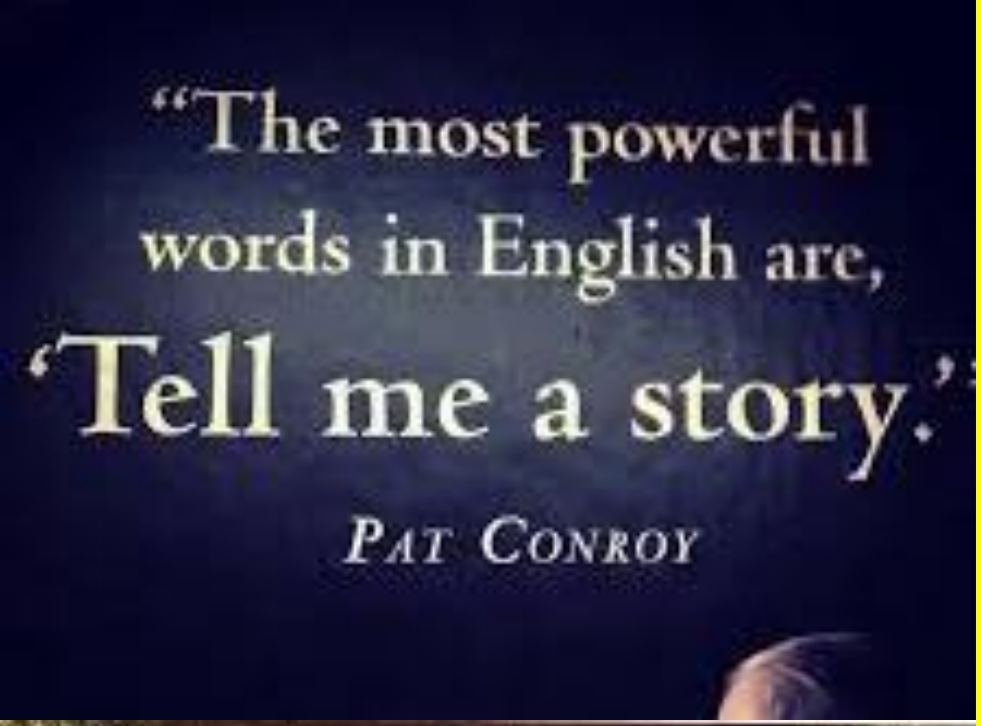
Heartfelt positive emotions: As we breathe, we should try to bring positive emotions such as gratitude, joy, and love, or any positive experience or memory into our heart. The importance of positive emotions in the heart is now supported by the latest neuroscience. The electromagnetic field of the heart can now be measured and extends outward to a distance of about three to five feet as compared to that of the brain which extends only 2 to 4 inches.

Polyvagal Theory and Treatment

#3 Regulate or Co-regulate in a Ventral Vagal State

Heartfelt positive emotions: When we focus on positive emotions, our heart radiates a nicely coherent wave as compared to a dysregulated wave when our emotions are negative. This has impact on not only our emotional and physical health but the health of others (HeartMath Institute, 2020). Moreover, the heart has over 40,000 cells called sensory neurites which are very similar to the cells in the brain and there is evidence that the heart has a certain capacity for some types of memory as well as a gut level wisdom that guides us (Dispenza & Braden, 2019).





Polyvagal Theory and Treatment

#4 Re-story

- Now that we or ourselves and our loved ones are in a more regulated state by use of the bottom-up strategies discussed above, we should be more settled and thus, more able to use top-down strategies and correct the narrative or re-story the situation, be it a current event or something in our distant past (Dana, 2018, 2020; Kain, 2018). We humans by nature are meaning-making machines, autonomically pulled to the story (Dana, 2020).
- Sadly, our narrative is often negative as there is a bias toward the negative (Hanson & Mendius, 2009). Although this tendency to see the negative in our circumstances and in ourselves might have a survival advantage in that we will be vigilant for the tiger, expecting him to eat us when we are in the wild, it works against us when there is no threat.
- Additionally, victims of shock or acute trauma are particularly vulnerable to creating false narratives about themselves and the world around them (Porges, 2017; Dana, 2018, Kain & Terrell, 2018). In a more regulated state, we are safe to possibly do a Ctrl-Alt-Del or reset on the old story and rewrite a new or revised version that better reflects our past or current autonomic adventure, one that allows us to accept and appreciate the heroic nature of our autonomic nervous system that enabled us to survive through the pain and/or trauma of the past and embrace the beauty and joy of what we now have and the bright future that lies ahead.

Polyvagal Theory and Treatment

#4 Re-story

- As Drs. Kain and Terrell eloquently write, “As our capacity increases, our narratives are likely to change, to include the sense of success at meeting challenges, of developing curiosity, or of a willingness to explore. Eventually, our narratives may also include access to a sense of safety and connection. Rather than I am constantly afraid and unhappy, a client will begin to tell himself a different story: I am stronger than I thought and able to meet challenges with greater balance and success” (Kain & Terrell, 2018, pgs. 101-192).
- They add, “At the same time, our somatic narratives will begin to change. We may literally experience changes in our symptoms – decreased inflammation, less pain, fewer migraines. Our illness narratives my alter to include the possibility of being free of pain, free of symptoms that have beleaguered us for most of our lives” Kain & Terrell, 2018, p 192).

In Summary

Merely the understanding of the neuroscience of trauma and addiction help to destigmatize them and makes them less terrifying.

Neuroscience helps us heal from trauma and addiction as it gives solid grounding on which to base good and effective treatments.

Polyvagal Theory provides us with one science-based treatment for trauma and addiction. To be fair, there are others.

No healing occurs without connection (Hari, 2018 and Gabor Mate, 2021).

Trauma breaks love but love heals trauma (Anderson, 2023).