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Basic Neuroscience Of Addiction & Recovery

With

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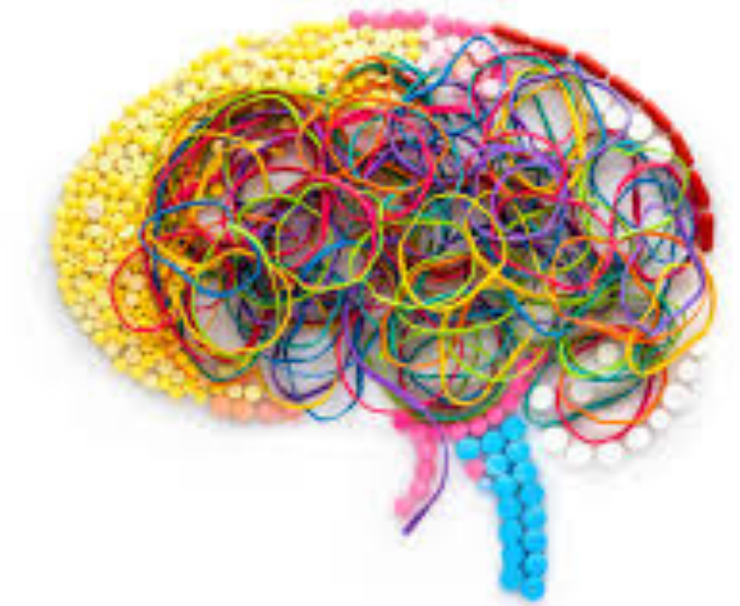
www.mindbodybreakthrough.net

Course Outline

- Basic Understanding: Addiction, Attachment, & Trauma



- The Three Brain Systems Implicated In Addiction

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Session 1

Basic Understanding: Addiction, Attachment & Trauma

"The Opposite Of Addiction Is Not Sobriety; The Opposite Of Addiction Is Connection." —Johann Hari

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What Is Addiction?

Addiction, also known as substance dependence, is a chronically relapsing biochemical condition characterised by; (a) compulsion to seek and engage the substance/behaviour of abuse, (b) loss of control in limiting intake, and (c) emergence of a strong negative emotional state (e.g., dysphoria, anxiety, irritability, etc) when access to the substance/behaviour of abuse is prevented. (DSM V, 2013)

Types of Addictions (Substance & Behavioural)

Substance: alcohol; caffeine; cannabis; hallucinogens (such as LSD); inhalants; opioids; sedatives, hypnotics, and anxiolytics (such as benzodiazepines); stimulants (such as cocaine); and tobacco

Behavioural: gambling disorder, compulsive sexual disorder, compulsive buying, compulsive/problematic internet use, pathological stealing (kleptomania), Internet gaming disorder, binge-eating disorder, pyromania (obsessive desire to set fire to things)

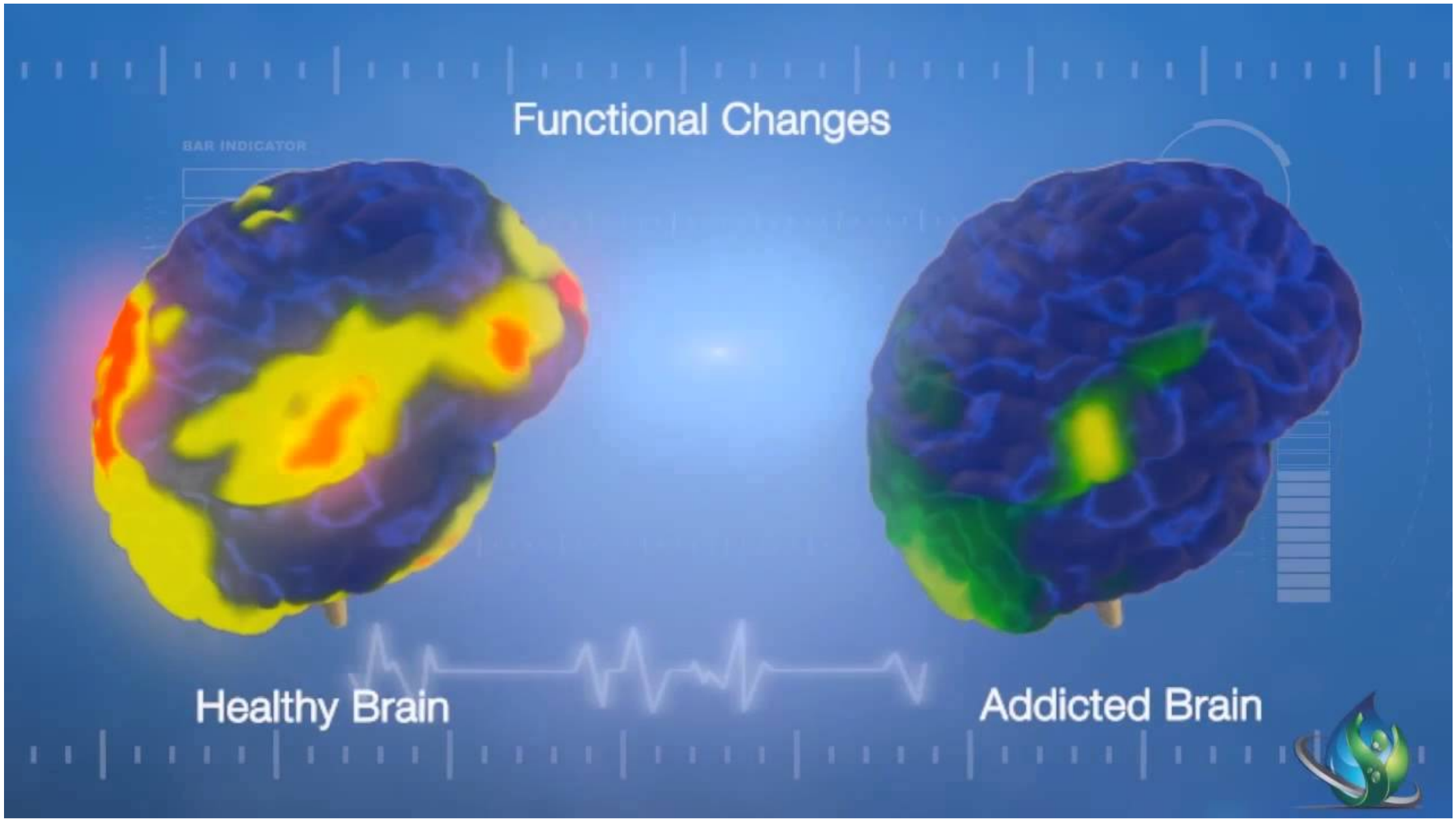
Substance Misuse

In England and Wales, the rate of death relating to substance misuse in 2019 was 76.7 deaths per million people (increasing from 46.6 deaths per million people in 2012). Males accounted for two-thirds of drug poisoning deaths and almost half of all substance misuse related deaths involved opiates such as heroin and morphine. However, cocaine deaths rose for the eighth consecutive year to their highest level (The ONS).

A 'substance' is defined as any psychoactive compound with the potential to cause unhealthy dependency, leading to health and social problems. These substances may be legal (e.g., alcohol and tobacco), illegal (e.g., heroin and cocaine); or controlled for medical purposes (e.g., oxycodone, benzodiazepine)

These substances are classified into seven groups based on their pharmacological and behavioural effects:

- Nicotine — cigarettes, vapor-cigarettes, cigars, chewing tobacco, and snuff
- Alcohol — including all forms of beer, wine, and distilled liquors
- Cannabinoids — Marijuana, hashish, hash oil, and edible cannabinoids
- Opioids — Heroin, methadone, buprenorphine, oxycodone, vicodin (hydrocodone), etc.
- Depressants — Benzodiazepines (e.g., valium, librium, and xanax) and barbiturates (e.g., seconal)
- Stimulants — Cocaine, amphetamine, methamphetamine, methylphenidate (e.g. ritalin), and atomoxetine (e.g. stratera)
- Hallucinogens — LSD, mescaline, and MDMA (e.g., ecstasy)


Functional Changes
BAR INDICATOR
Healthy Brain
Addicted Brain

DSM 5 Criteria for Diagnosing Substance Use Disorders

1. Taking the substance in larger amounts or for longer than you're meant to.
2. Wanting to cut down or stop using the substance but not managing to
3. Spending a lot of time getting, using, or recovering from use of the substance.
4. Cravings and urges to use the substance.
5. Not managing to do what you should at work, home, or school because of substance use.
6. Continuing to use, even when it causes problems in relationships.
7. Giving up important social, occupational, or recreational activities because of substance use.
8. Using substances again and again, even when it puts you in danger.
9. Continuing to use, even when you know you have a physical or psychological problem that could have been caused or made worse by the substance.
10. Needing more of the substance to get the effect you want (tolerance).
11. Development of withdrawal symptoms, which can be relieved by taking more of the substance.

Fewer than 2 symptoms = no disorder; 2-3 = mild disorder; 4-5 = moderate disorder; 6 or more = severe disorder.

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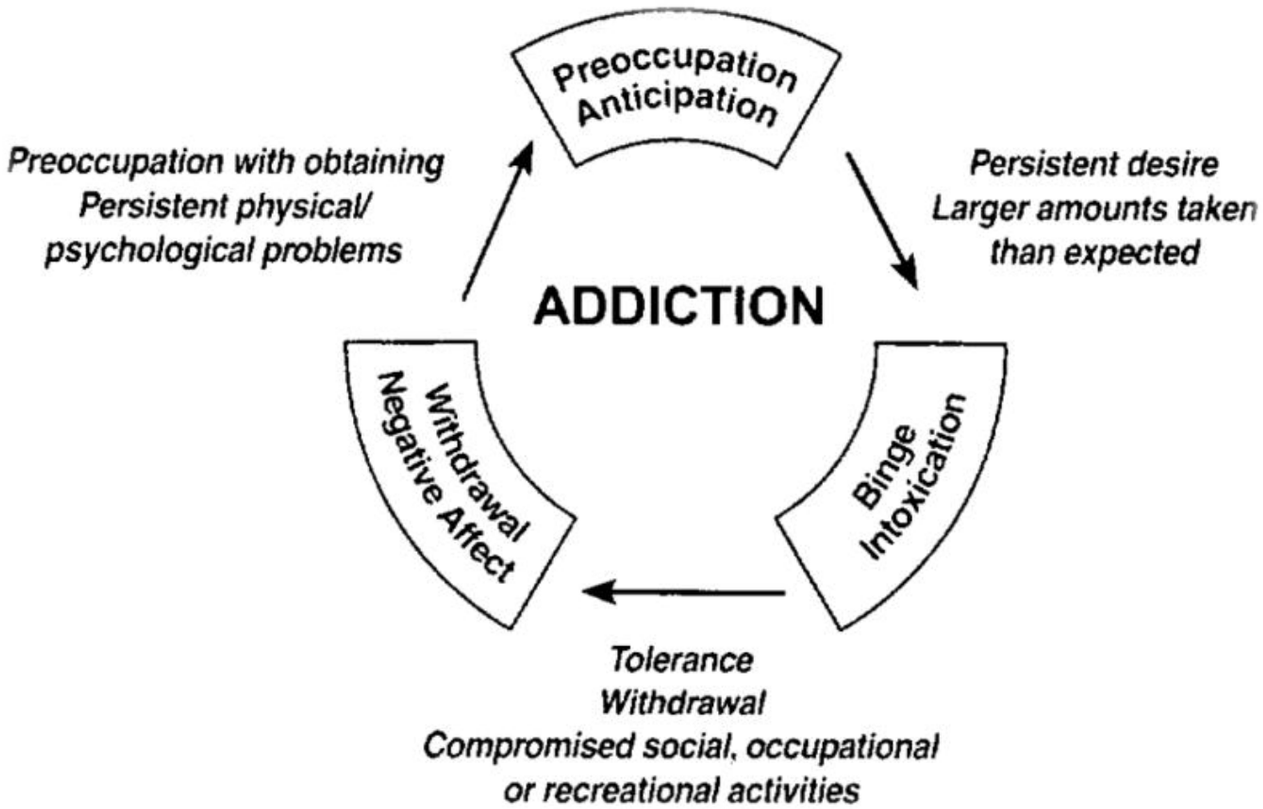
The Addiction Cycle

Addiction can be conceptualised as a three-stage, recurring cycle;

- binge/intoxication
- withdrawal/negative affect
- preoccupation/anticipation (craving)



(Koob, 2004)

Neurotransmitters Implicated In the Addiction Cycle

Koob, F.B. & Simon E.J., 2009

Binge/Intoxication	Response
Dopamine	Increase
Serotonin	Increase
GABA	Increase
Acetylcholine	Increase
Opioid Peptides	Increase

Preoccupation/ Anticipation	Response
Dopamine	Increase
Serotonin	Increase
Gutamate	Increase
Hypocretin (orexin)	Increase
CRF	Increase

Withdrawal/ Negative Affects	Response
Dopamine	Decrease
Serotonin	Decrease
Dynorphine	Increase
CRF	Increase
Substance P	Increase
Neuropeptide Y	Decrease
Nociceptin	Decrease
Oxytocin	Decrease
Endocannabinoids	Decrease

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Causes of Addiction

Adverse childhood experiences (ACE) is the number one risk factor for addiction in adolescent-hood and adulthood. (Dube, S.R. et al., 2003; Kara, R. Et al., 2011)

Several studies in addiction have repeatedly found extraordinarily high percentages of childhood trauma of various sorts, including physical, sexual and emotional abuse; neglect; household dysfunction; domestic violence; parental separation/divorce; loss of parents through death, incarceration, deportation, etc. (Gordon, H.W., 2002)

According to the renowned ACE (Adverse Childhood Experiences) studies, for each adverse childhood experience (ACE), the risk for addiction (substance or behavioural) increased between two and fourfold. Individuals with five or more ACEs had seven to ten times greater risk for substance abuse than those with none. (Dube, S.R. et al., 2006)

Nearly two-third of injection drug use can be attributed to abusive and traumatic childhood events. (Dube, S.R. et al., 2003)

The rate of ACEs among women substance abusers ranges from 50% to nearly 100% (National Institute on Drug Abuse in 2002)

For each emotionally traumatic childhood circumstance, there is a two-to-threefold increase in the likelihood of early alcohol abuse and other illicit substances (Dube, S.R. et al., 2003)

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Trauma, Attachment, Addiction and Brain Activity

- Imaging studies on individuals with severe childhood trauma show shrunk brain volumes in multiple regions (e,g. the PFC and corpus callosum are 7-8% smaller, the hippocampus is 15% smaller). These shrinkages of brain tissues have been associated with increased risk factors for substance addiction. (Anderson, C.M. et al., 2002)
- A traumatised developing brain shows reduced blood flow in the vermis, a part of the cerebellum at the back of the brain thought to play a key role in addictions because of its influences on the dopamine system in the midbrain. (De Bellis, M.D. et al., 1999)
- In one study of the EEGs of adults who had suffered sexual abuse, the vast majority had abnormal brainwaves, and over a third showed seizure activity. (Teicher, M.H. 2000)

- Early abuse also dysregulates the serotonin system, the feel good neurotransmitter, leading to depression, aggression and higher susceptibility to addictions. Similar effects are seen in the norepinephrine system involved in mood and behaviour regulation, resulting in hypersensitivity to life stressors and hyperactivity. Such maladaptations increase the risk of addiction. (Higley, J.D & Linnoila, M., 1997; Clarke, A.S. et al., 1996)
- Early maternal deprivation/neglect dysregulates the oxytocin system. Oxytocin regulates social bonding, attachment, mood, anxiety and aggression. The interaction between oxytocin ad dopamine has been linked to drug-seeking behaviours (Heim, C. et al., 2009; Teicher, M.H., 2000; McGregor, I.S., 2008)
- Rats whose mothers had given them more licking, grooming and other types of nurturing contact during their infancy had, as adults, more efficient brain systems for reducing anxiety. They also had more receptors for benzodiazepines, natural tranquillising chemicals found in the brain. (Caldji, C. et al., 1998)

Session 2

Three Brain Systems Implicated In Addiction

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Three Brain Systems Implicated in Addiction

- The opioid and dopamine system (mediates the binge/intoxication stage)

- The stress system (mediates the withdrawal/negative affect stage)

- The self-regulation system (mediates the preoccupation/anticipation (craving) stage)

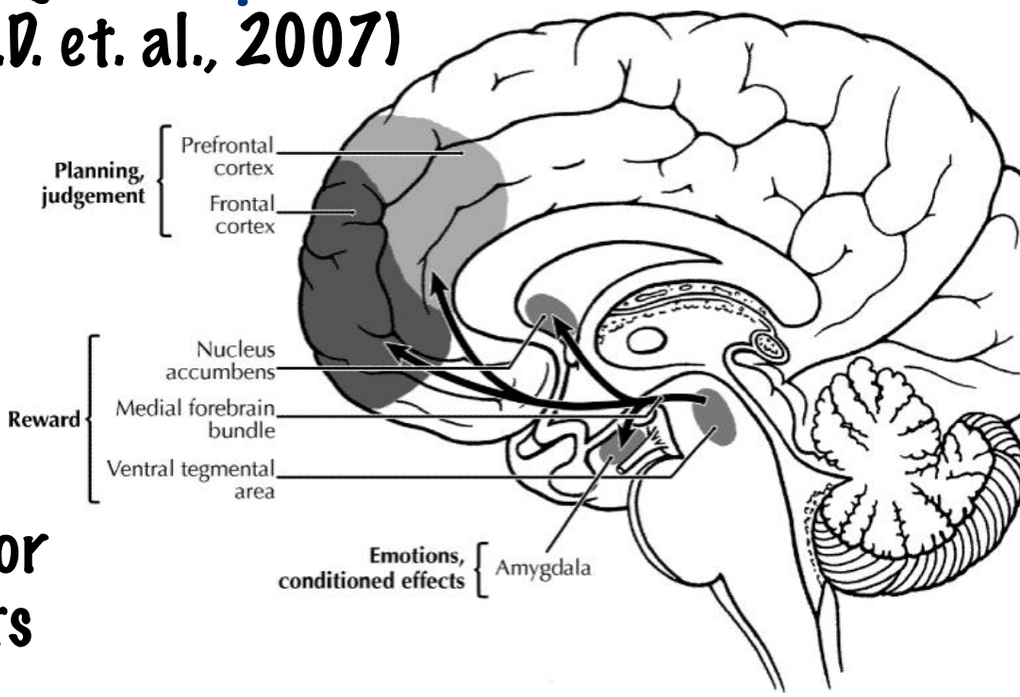
The Opioid & Dopamine System

Mediating the binge/intoxication stage

- In humans, positron emission tomography studies have shown that intoxicating doses of alcohol and drugs release dopamine and opioid peptides (e.g. endorphins) into the emotional brain. (Mitchell, J.M. et. al., 2012; Volkow, N.D. et. al., 2007)

- The fast and steep release of dopamine is associated with the subjective sensation of the so-called high/ euphoria. (Volkow, N.D. et. al., 2003)

- This is because fast and steep increases in dopamine activate low-affinity dopamine D_1 receptors, which are necessary for the rewarding effects of addictions and for triggering substance dependency and drug-seeking habits linked to the binge/intoxication stage. (Caine, S.B et. al., 2007)



- D_2 receptors help inhibit addictions. Dopamine stimulation of high affinity D_2 receptors is not sufficient to generate enough reward in addiction but vital in leading a normal life. D_2 receptors eventually get suppressed and worn out as addiction takes root. (Caine, S.B et. al., 2002; Norman, A.B., et. al., 2011)

- Excess dopamine exposure promotes habit formation and exaggerated incentive salience that fosters excessive seeking, via increases in dopamine, GABA, and glutamate neurotransmissions. (Norman, A.B., et. al., 2011)

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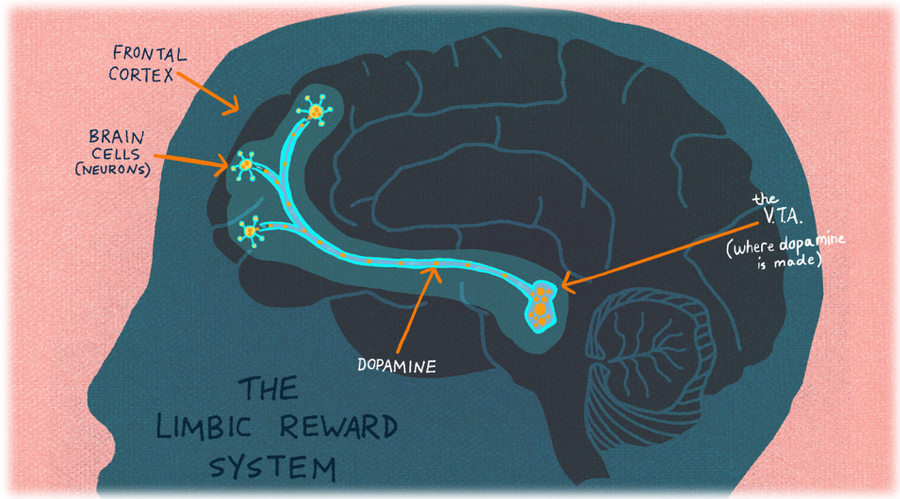
The Opioid & Dopamine System & ACE

- Childhood attachment relationship influences the child's opioid and dopamine systems. Happy, safe and attuned emotional interactions with parents stimulate a release of natural opioids in an infant's brain. (Schore, A.N. 1994; Machin and Dunbar 2011)

- This opioid release promotes the mother-infant attachments and the proper development of the child's opioid and dopamine systems involved in mediating love, connection, pain relief, pleasure, incentive and motivation. (Nummenmaa, L. et al.,2015)

- Childhood trauma reduces the number of both endogenous opioid release and dopamine receptors, leading to insecure attachment styles in human adults and high risk factors for substitute relationships such as addiction. (Nummenmaa, L. et al.,2015)

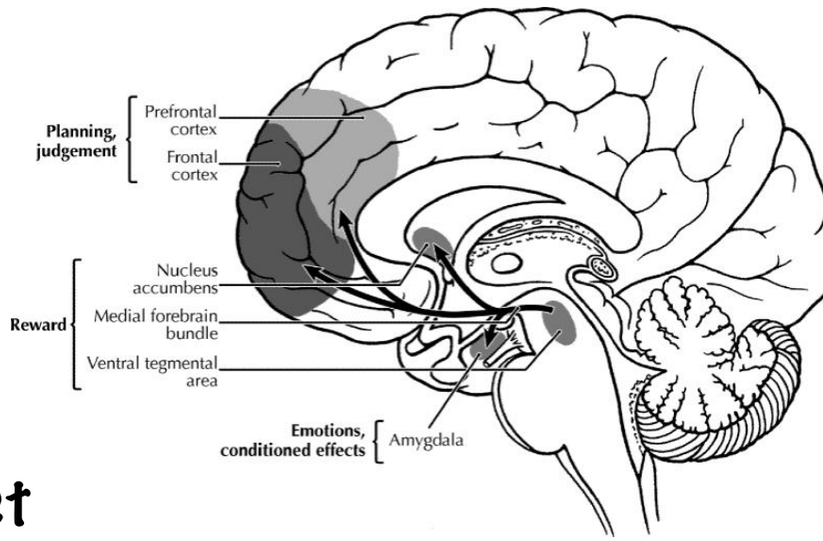


- Studies have shown that healthy social-emotional stimulation in childhood is necessary for the growth of the nerve endings that release opioids and dopamine and for the growth of receptors to which opioids & dopamine need to bind in order to do their work (Lehmann, K. et al., 2009)

The Stress System

Mediating the withdrawal/negative affect stage of addiction

- The binge/intoxication stage eventually triggers the opponent-process responses (tolerance) that diminish the reward effects and increase the activity of the stress system, through the engagement of stress hormone (corticotropin-releasing factor (CRF)) and dynorphin (dysphoria opioid). (Norman, A.B., et. al., 2011)
- Addiction dysregulates both the hypothalamic-pituitary-adrenal (HPA) axis and the brain stress system mediated by corticotropin-releasing factor (CRF) (Heinrichs & Koob, 2004).
- The brain's stress and reward systems are intricately connected. Moderate forms of stress, such as skydiving, activate the reward system. Excessive activation of the reward system, however (as in addictions), excessively engages the brain's stress system (Funk, C.K. et al., 2007).



- During withdrawal from abused substances that include alcohol, cocaine, cannabinoids, opioids, and nicotine, the peptide CRF is excessively activated in the amygdala, triggering exaggerated fight/flight responses (George, O. et al., 2007). Symptoms may include; chronic irritability, emotional pain, restlessness, dysphoria, alexithymia (inability to recognise or describe one own's emotional feelings), stress, and loss of motivation for natural life's day-to-day rewards.
- These stress-driven negative emotional states create an additional source of motivation for compulsive craving/seeking of substance of abuse, leading to negative reinforcement (Nealey, K.A., et al., 2011).
- Endogenous anti-stress systems, such as neuropeptide Y, nociceptin, and endocannabinoid, that oppose the stress system are under-active in addictions, contributing to the severe negative emotional states during withdrawal that often drive chronic relapse. (Hirvonen J. et al., 2012).

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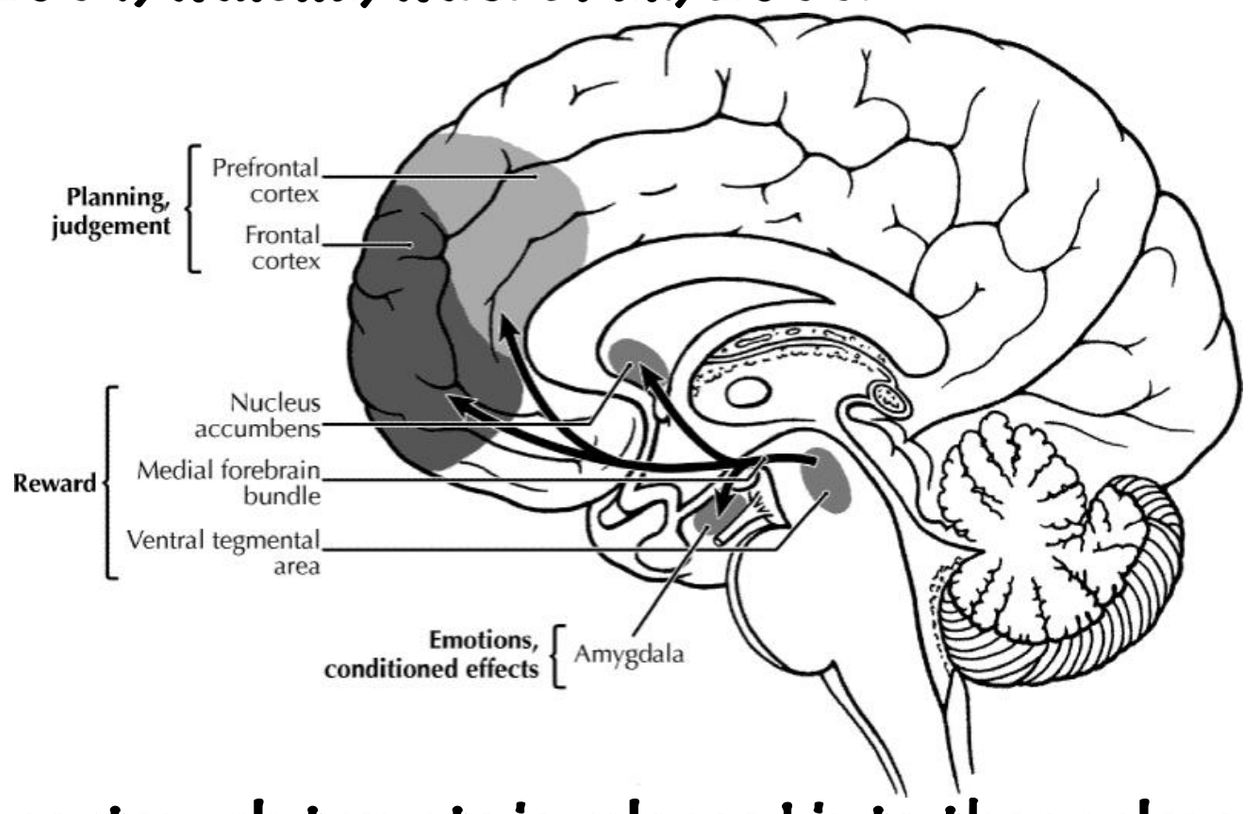
The Self-Regulation System

Mediating the preoccupation/anticipation (craving) stage

Regarding craving, there are two opposing systems: The GO system and the STOP system; The Go system drives craving and engages habit-seeking via the emotional brain, while the STOP system suppresses craving and increases self-regulatory capacity (impulse control) via the thinking brain. (Jasinska, A.J. et al., 2014; Milella, M.S. et al., 2016)

When an individual with addiction encounters an external cue or stimulus associated with their addiction, cells in the nucleus accumbens are excessively activated, blunting the effects of the self-regulation system (The STOP system)(Gipson, C.D. et al., 2013)



Normally, when a cue comes to the prefrontal cortex, glutamate is released into the nucleus accumbens, triggering a memory trace or engram (craving). Excess glutamate is then removed from the synaptic cleft by glial cells (serving as glutamate transporters). In addiction, however, there are fewer glial cells, causing glutamate to accumulate in the synaptic cleft and overpower the PFC's self-regulatory (impulse control) pathway (The STOP craving system) (Scofield, M.D. et al., 2016)

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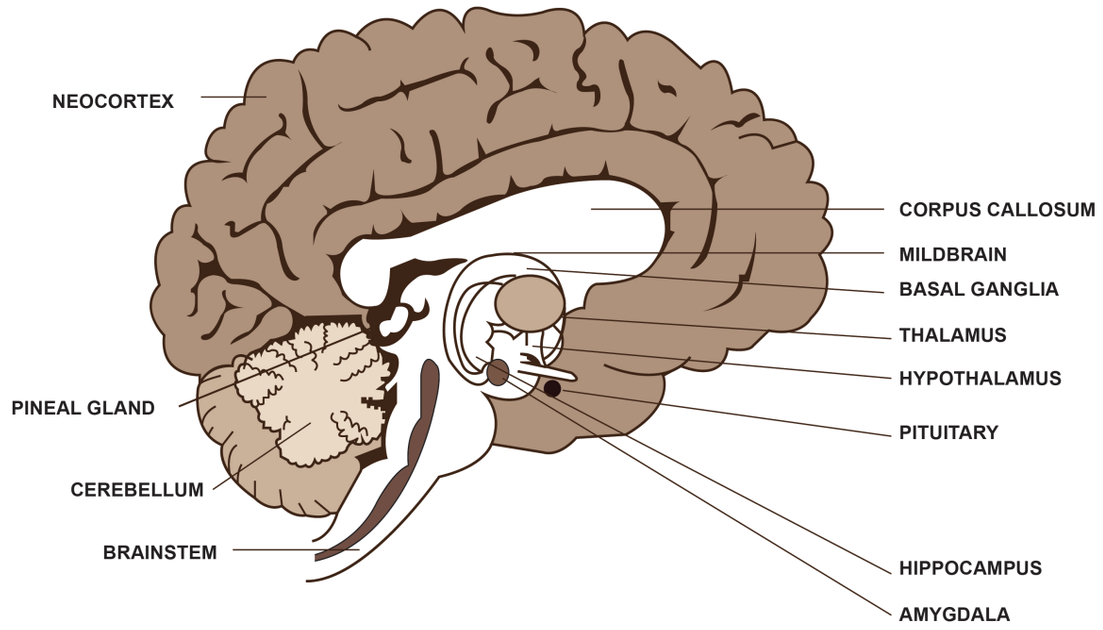
The Self-Regulation System

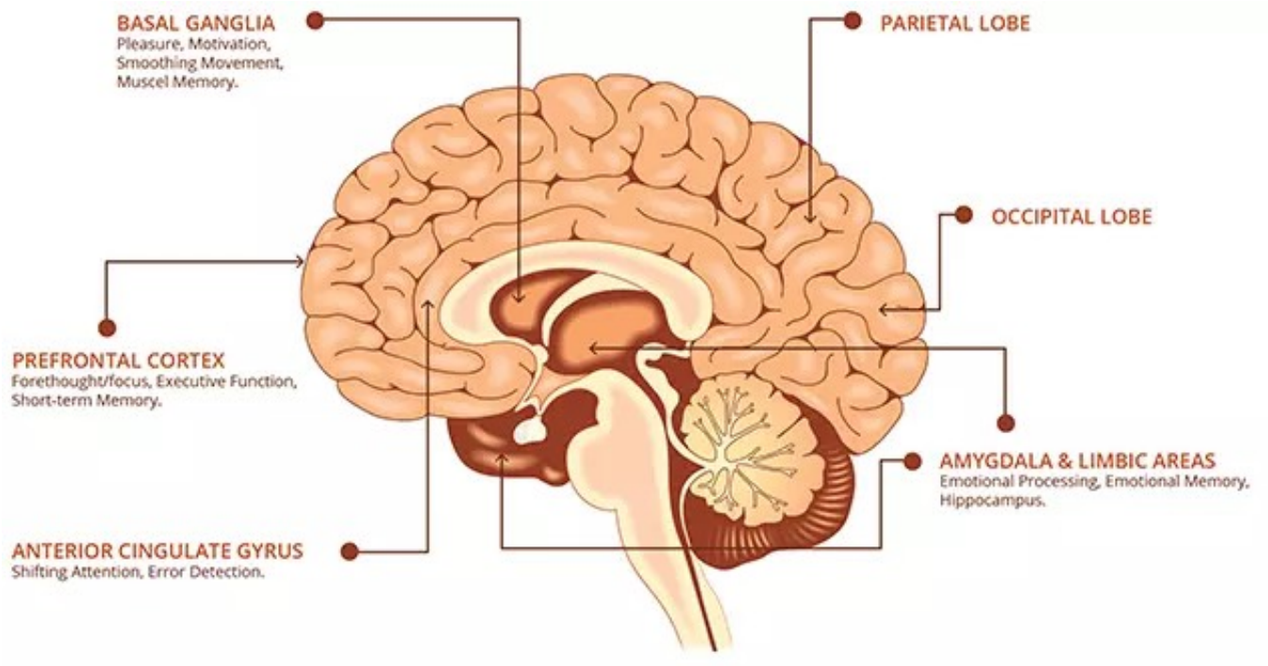
Mediating the preoccupation/anticipation (craving) stage

To stimulate craving, the GO system involves a number of powerful regions in the brain; including the anterior cingulate cortex (the OCD box), amygdala (the security guard), insula (the feeler) & basal ganglia (the emergency responder) (Rando, K. et al., 2011; Contreras-Rodríguez, O, et al., 2015)

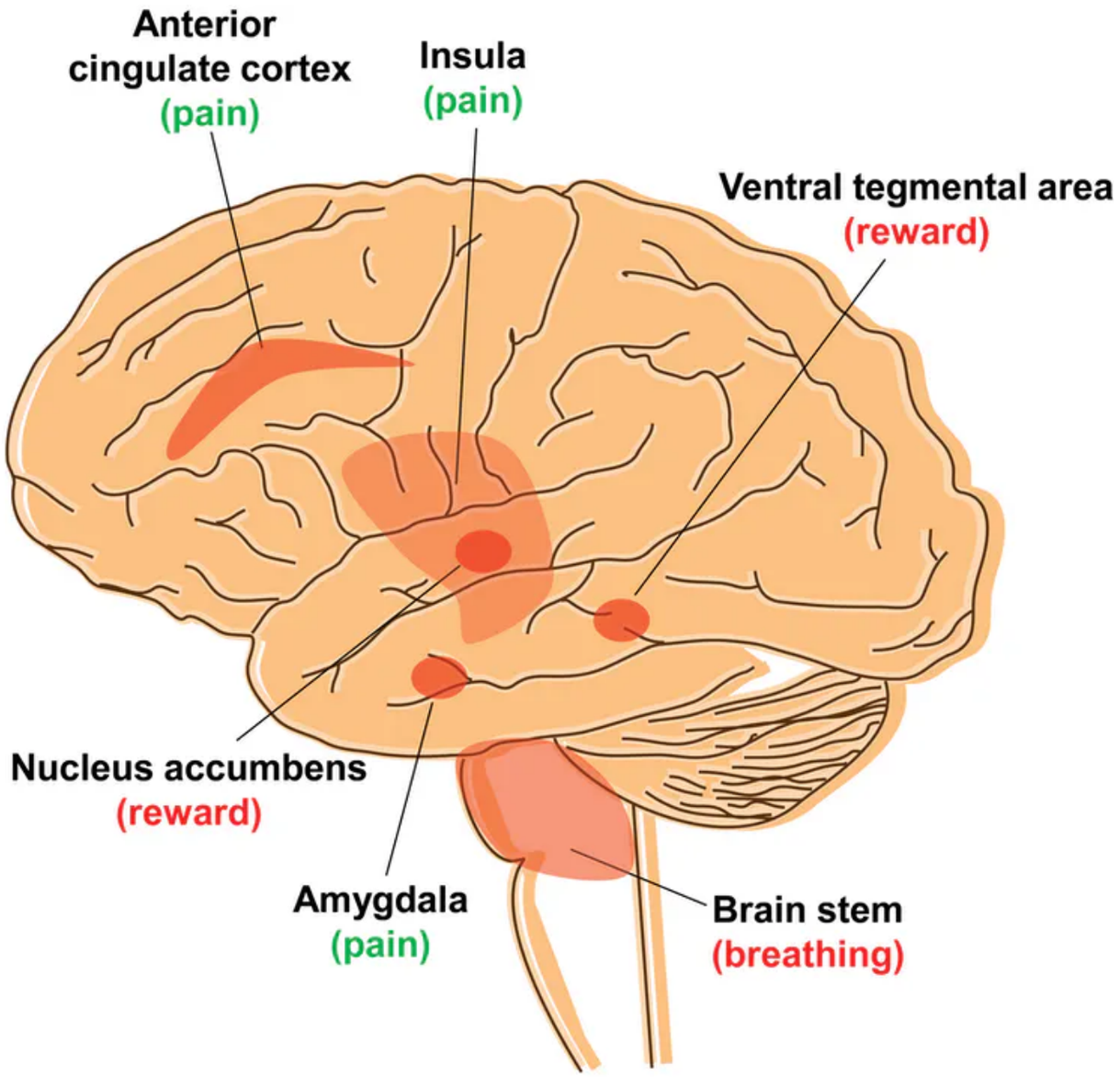


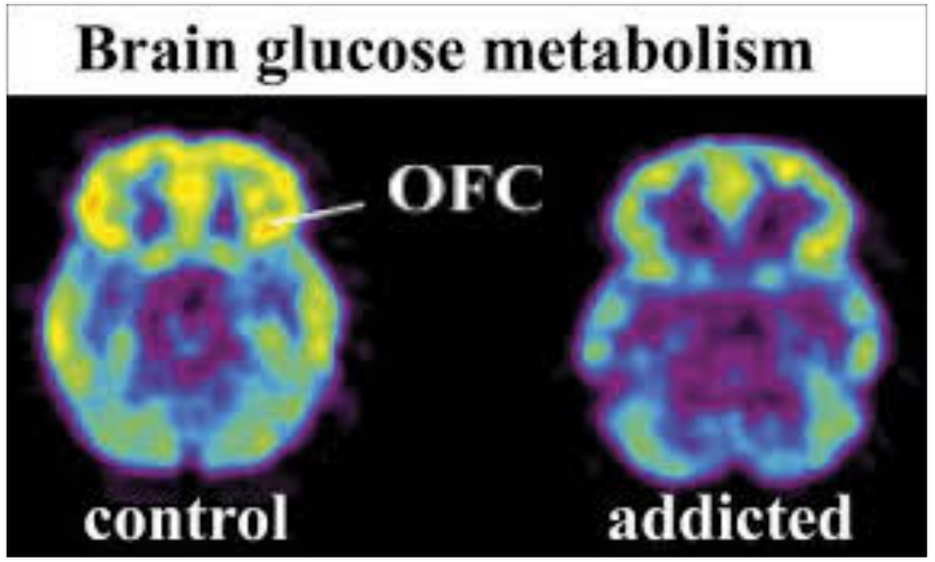
The hyperactivity of the GO system eventually overpowers the STOP craving system that is meant to suppress craving. (Contreras-Rodríguez, O, et al., 2015)

Human imaging studies have reported deficits in executive function that are reflected by decreases in the pre-frontal cortex activity, interfering with decision making, self-regulation, inhibitory control, and working memory. (Volkow, N.D. et al., 2011)

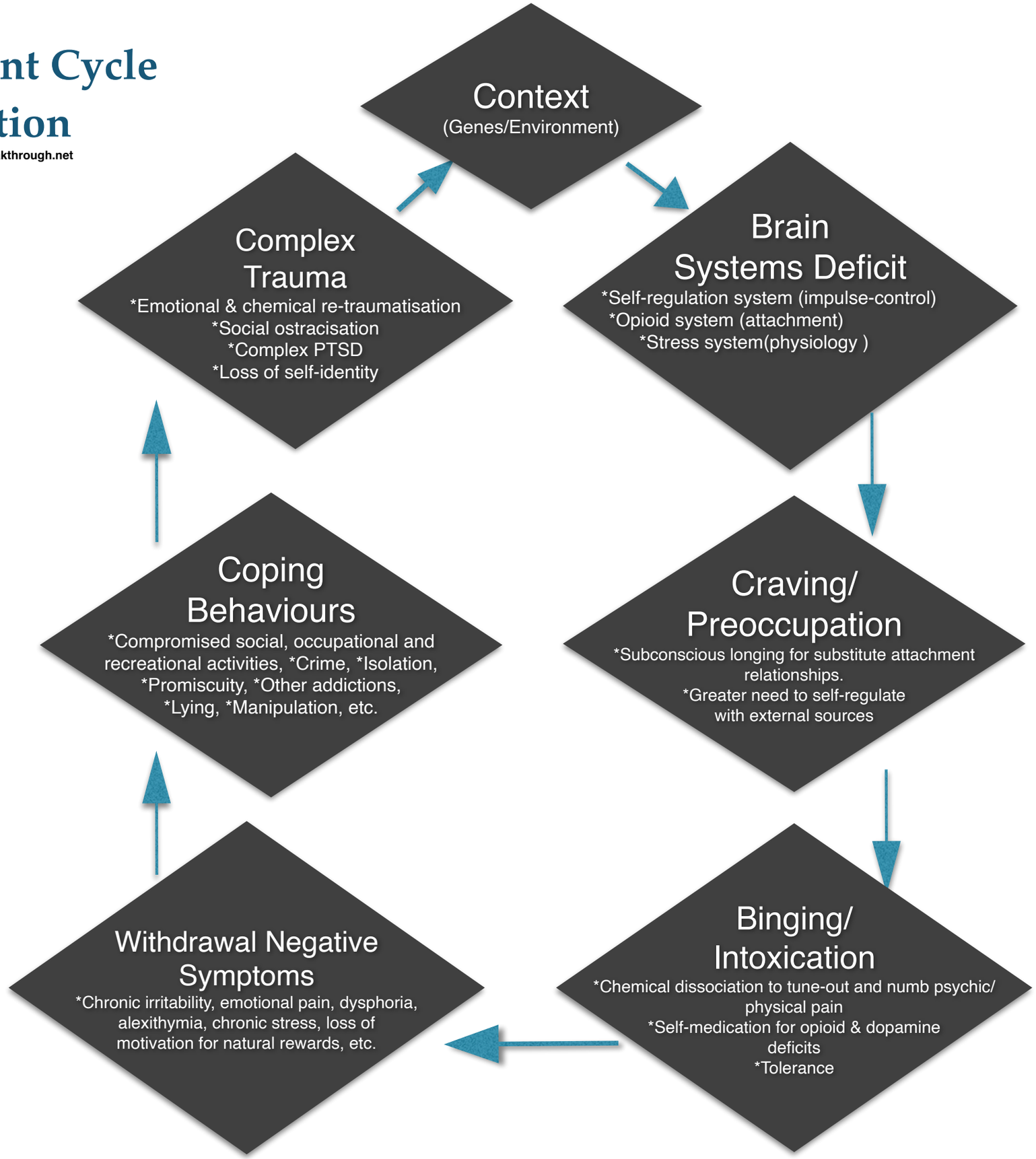


The Go System Vs The Stop System Of Addiction





The Attachment Cycle Of Addiction



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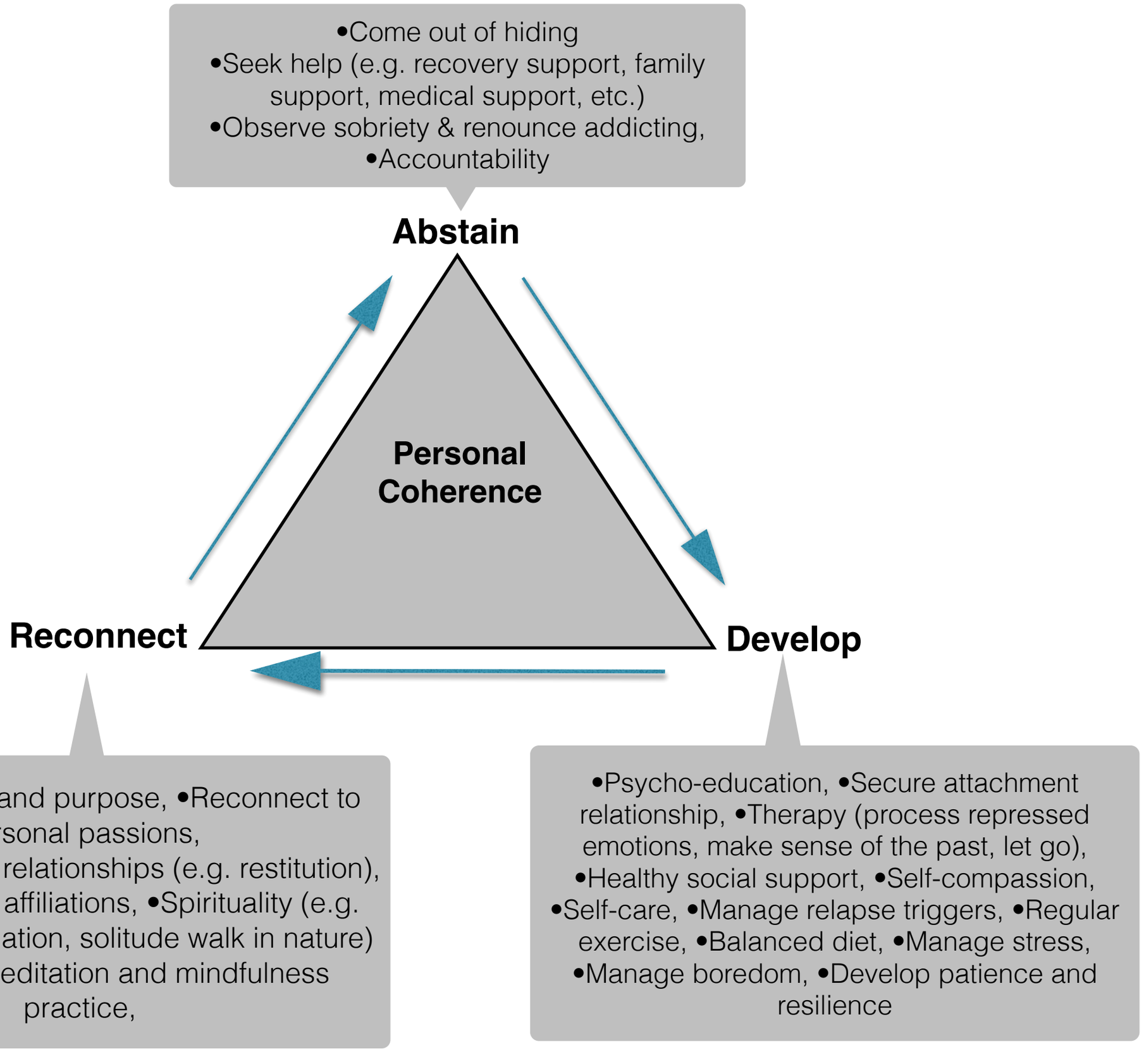
The A.D.R. Model Of Addiction Recovery



List of Helpful Recovery Organisations

- 12 Steps Meetings (https://www.alcoholics-anonymous.org.uk)
- Refuge Recovery (www.refugerecovery.org)
- Narcotics Anonymous (https://ukna.org)
- Rehab Online (https://rehab-online.org.uk)
- Drinkline (0300 123 1110)
- Celebrate Recovery (www.celebraterecovery.com)
- Women for Sobriety (www.womenforsobriety.org)
- SMART Recovery (www.smartrecovery.org)
- Drugsand.me (https://drugsand.me)
- LifeRing (www.lifering.org
- In The Rooms (www.intherooms.org)
- Al-Anon (https://www.al-anonuk.org.uk)
- Co-Dependants Anonymous (https://codauk.org)
- Re-Solv (https://www.re-solv.org)
- Visit Adfam for more helpful organisations: https://adfam.org.uk/help-for-families/useful-organisations

Q&A Session

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"There are no constraints on the human mind, no walls around the human spirit, no barriers to our progress except those we ourselves erect."

—Ronald Reagan, 40th U.S President

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