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Neurobiology of Addiction:

Implications for Occupational Therapy Intervention

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Learning Outcomes

- As a result of this course, participants will be able to name 3 aspects of brain function which differs in the person with Substance Use Disorder vs. 'typical' brain .
- As a result of this course, participants will be able to describe the neuroadaptation cascade.
- As a result of this course, participants will be able to list 5 treatment options to lower dopamine spikes.

Why is this important?

- Scientific explanation for irrational behavior in otherwise rational person
- Helps in developing new strategies for behavioral and pharmacological treatments
- Answers the big question: What is addiction?
- Helps reduce stigma, shame, guilt, & anger experienced by client and family

Reluctance to Accept Disease Model of Addiction

➤ *Appears to involve behaviors of choice*

Other behavior disorders with irrational compulsive behaviors:

- OCD
- Tourette's
- Eating Disorders

➤ *Similar areas of the brain are disrupted*

Substance Use Disorder (SUD)

- ASAM defines SUD as a primary chronic brain disorder with genetic, psychosocial, and environmental factors influencing its course
- Chronic relapsing disease characterized by impaired control, preoccupation with use, use despite adverse consequences, and distorted thinking, most notably denial

Definition:

"Addiction is a primary, chronic disease of brain reward, motivation, memory and related circuitry. Dysfunction in these circuits leads to characteristic biological, psychological, social and spiritual manifestations. This is reflected in an individual pathologically pursuing reward and/or relief by substance use and other behaviors.

Addiction is characterized by inability to consistently abstain, impairment in behavioral control, craving, diminished recognition of significant problems with one's behaviors and interpersonal relationships, and a dysfunctional emotional response. Like other chronic diseases, addiction often involves cycles of relapse and remission. Without treatment or engagement in recovery activities, addiction is progressive and can result in disability or premature death."

American Society of Addiction Medicine

Primary Neurologic Disorder

- Parkinson's Disease
- Both addiction (SUD) and Parkinson's Disease are diseases of Dopamine Deficiency

Addiction is a PRIMARY Neurologic disease

➤ Neurologic = Brain & Spinal Cord

PRIMARY = not due to something else (anxiety, depression, trauma, ADD/ADHD, Bipolar Disorder)

Sometimes it is difficult to differentiate between Primary vs. Substance induced (secondary) Psychiatric disorder

How Common is SUD?

- 85% to 90% of adult US population uses alcohol or other mood altering substance at one time or another
- 10% to 12% have SUD
 - What makes them different?
 - Why me?

Genetics

- *Family Studies*
 - Children of Alcoholics are 3 to 4 times more likely to be alcoholic than the general population
- *Adaption Studies*
 - Biological children of alcoholics have a much higher risk of alcoholism REGARDLESS of WHO PARENTS THEM
 - Studies involving monozygotic twins separated at birth had the same results by age 30

What was learned from twin studies?

- You can't parent alcoholism out of a genetic alcoholic
- Bad parenting does not cause alcoholism/addiction and good/great parenting can't fix it

Genetic Predisposition

- Accounts for 50-60% of vulnerability for addiction
- Higher vulnerability from other family related illnesses
 - DMII
 - Hypertension
 - Breast cancer

Biopsychosocial Model

- Biological/neurological – genetics
- Psychological – psychiatric disorders, self medication, learned behaviors
- Social – family, relationships, environment

Alcoholics have pre-existing abnormalities

- EEG studies
 - EEG shows P300 decreased in alcohol-naïve sons of alcoholics
 - Decrease in theta waves prior to first drink

➤ *The Alcoholic is different **BEFORE** the first drink*

Pre-morbid differences

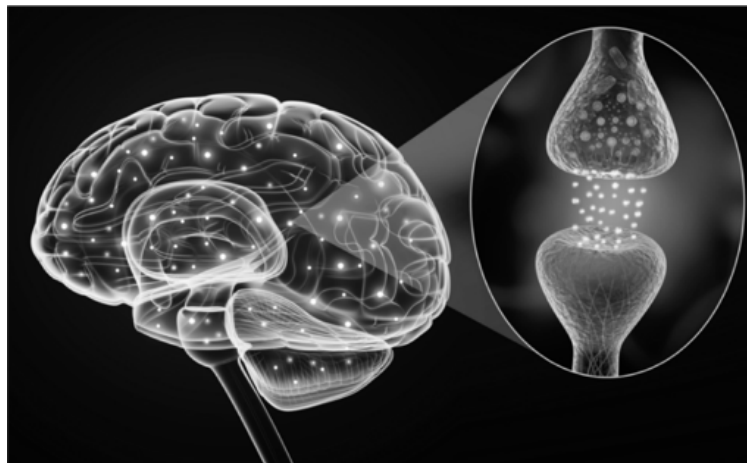
- Euphoria – first time drinkers report of intensity of euphoria
- FHP (family history positive) report MUCH greater euphoria with alcohol exposure than FHN (family history negative)
- First time drinkers report of negative side effects of acute alcohol exposure

Pre-morbid differences

- FHP report less negative effects than FHN
 - Less body sway
 - Less nausea
 - Less disorientation
 - Better cognitive abilities and physical performance on driving tests
 - WEAKER WARNING SYSTEM

Pre-morbid differences

- PET Scans demonstrate compromised dopamine D2 receptor activity
- Lack of dopamine activity increases risk
- PET Scan reveal D2 receptors in obese patients – inverse relation to BMI (the lower the dopamine-the higher the BMI)



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Addiction=Reward Deficiency Syndrome

- A decrease in endogenous neurotransmitters leads to a sense of incompleteness, decreased pain tolerance, uneasiness and anxiety.
- Since 85–90% of the US population is exposed to alcohol or drugs during their lifetime, the person genetically pre-disposed to addiction is very likely to find what replaces or 'fixes' their 'reward deficiency'.

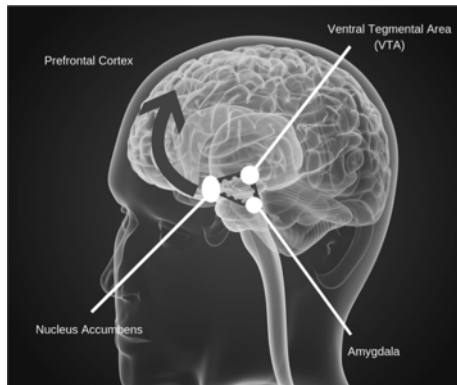
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New Brain / Old (primitive) Brain



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Relapse and conditioning



- Repeated substance use has caused conditioning to occur in related circuits
- Now 'cues' associated with substance use can activate the reward and withdrawal circuits
- This can evoke anticipation of substance or feelings similar to withdrawal that can precipitate relapse in an abstinent person

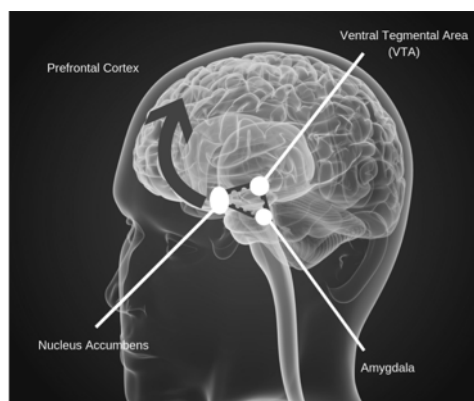
Reward Circuits

- *Limbic region rewards life sustaining behaviors with a spike in Dopamine*
 - Food
 - Liquid
 - Procreation
 - Shelter
- *The brain registers these activities so we will repeat them*

Limbic Region

- Pleasurable life sustaining activities increase Dopamine in the limbic region
- Alcohol and drugs increase Dopamine 3-5 times that of normal rewarding behaviors

Why do we use drugs?

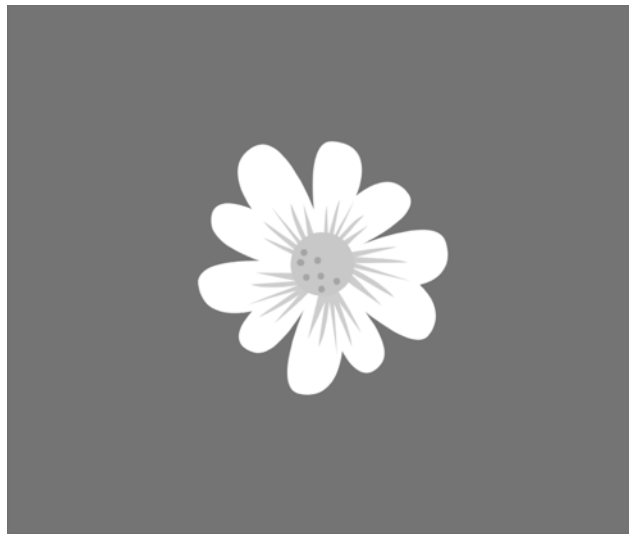


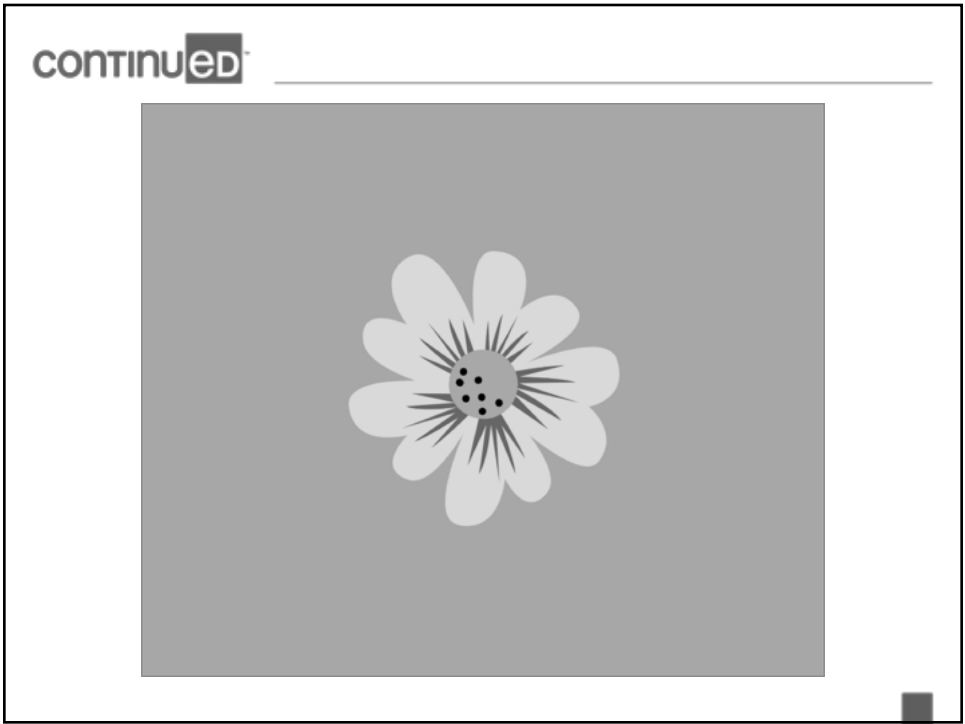
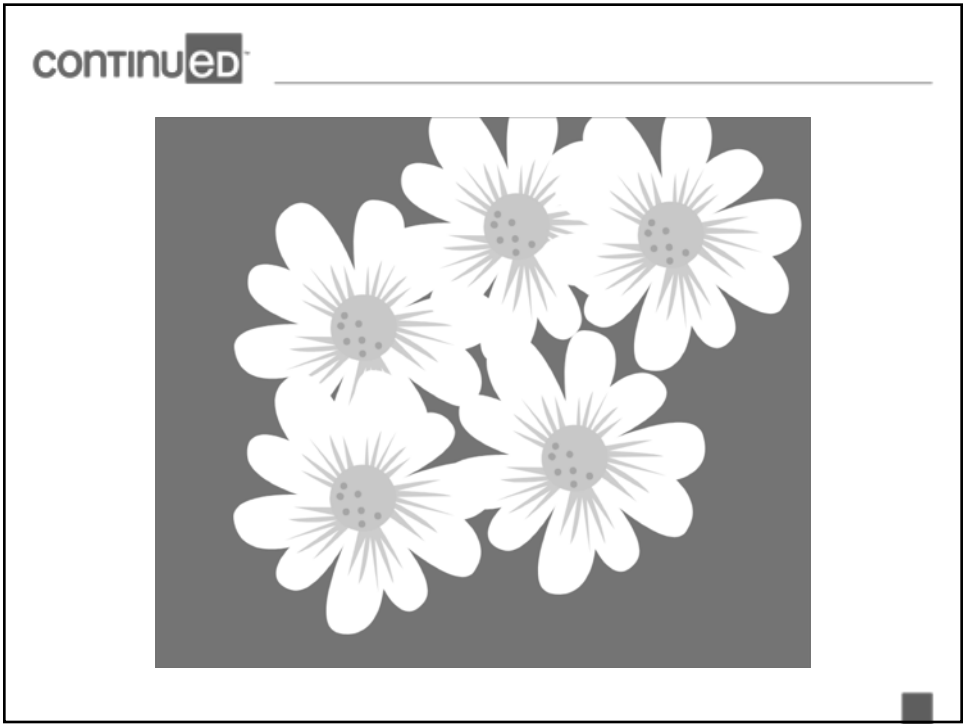
BRAIN REWARD PATHWAYS

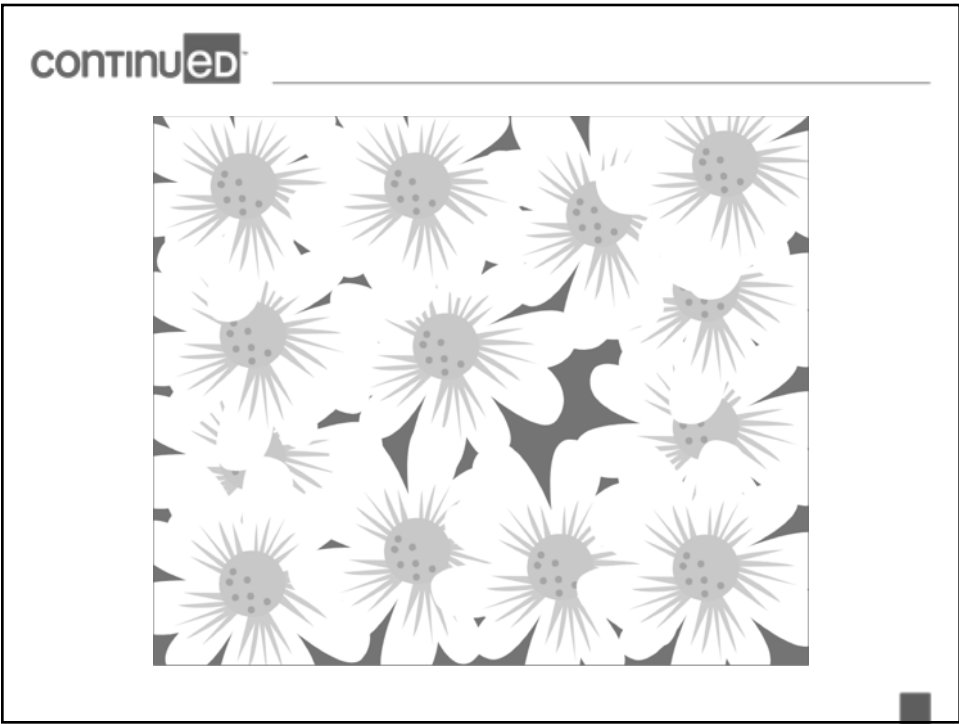
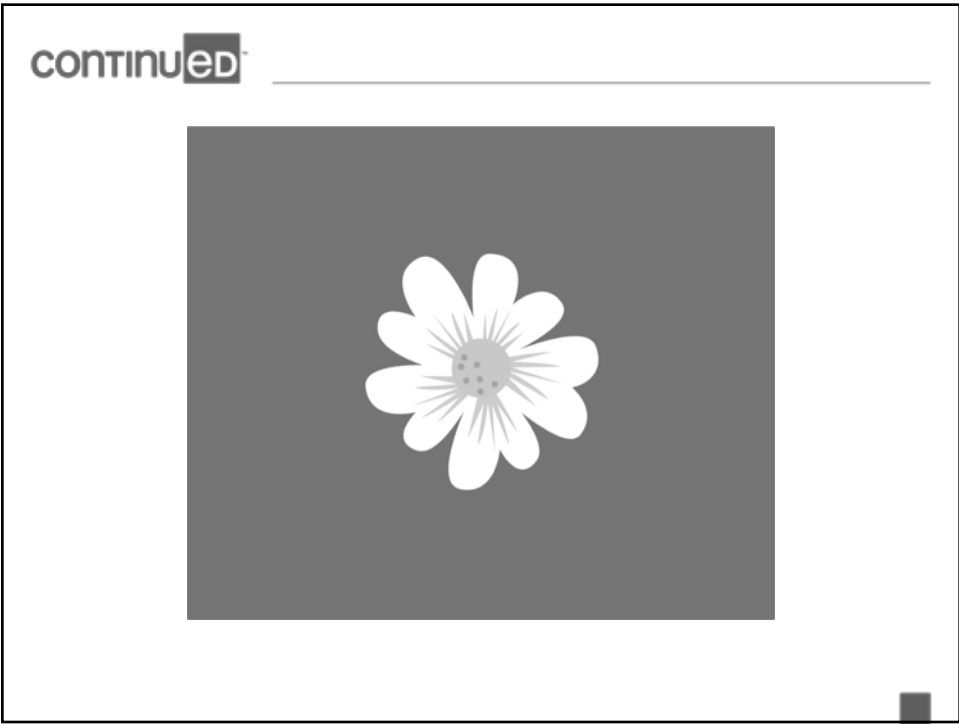
- Food
- Water
- Sex
- Child rearing
- Drug of Choice

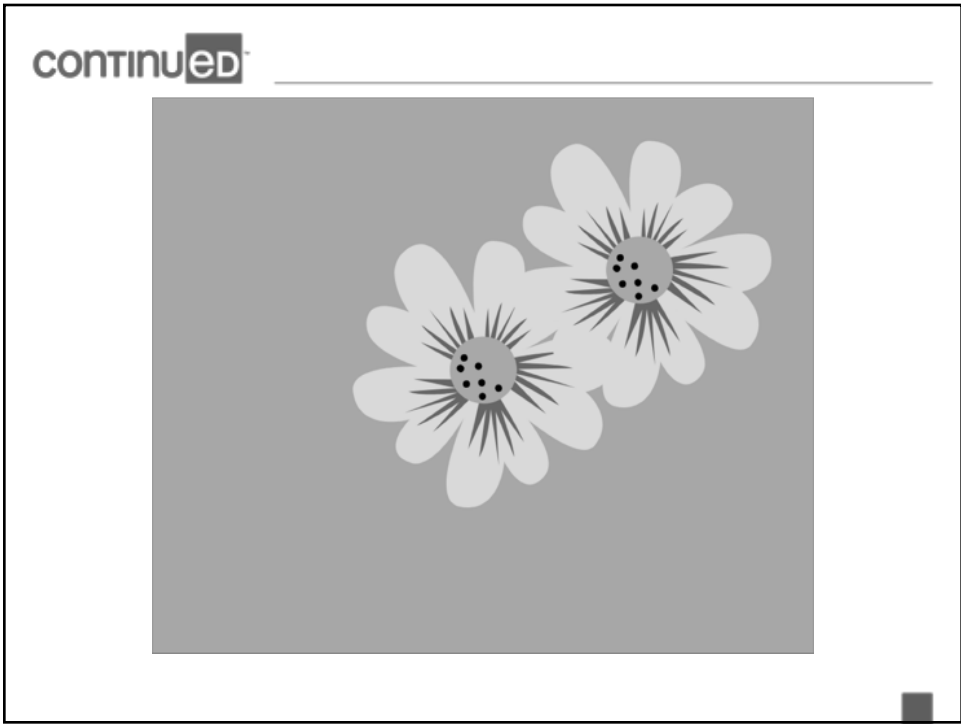
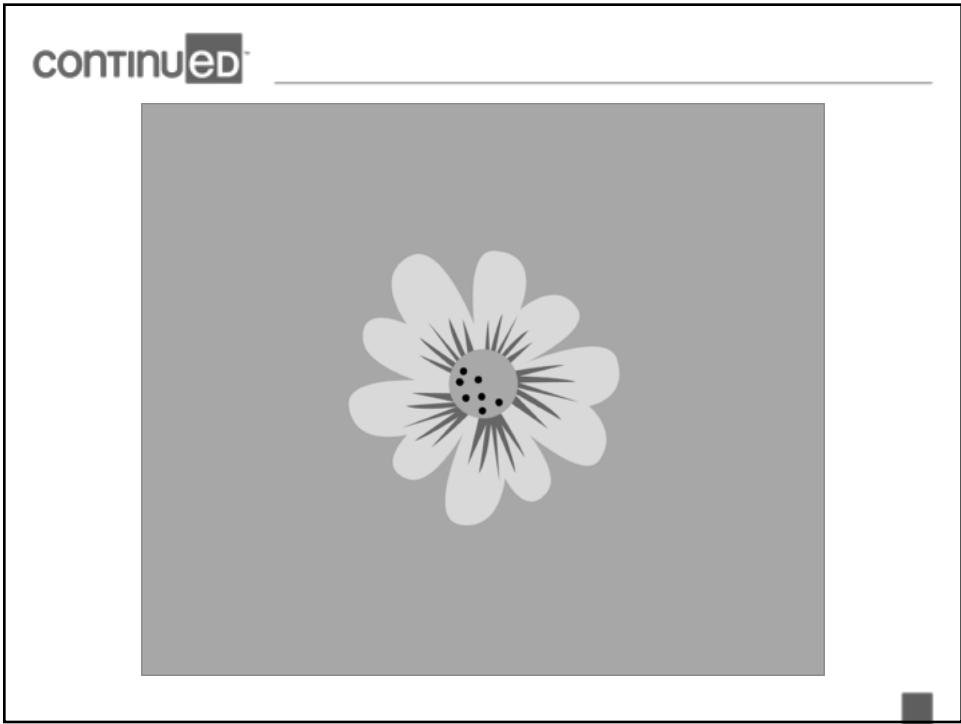
Neuroadaptation Cascade

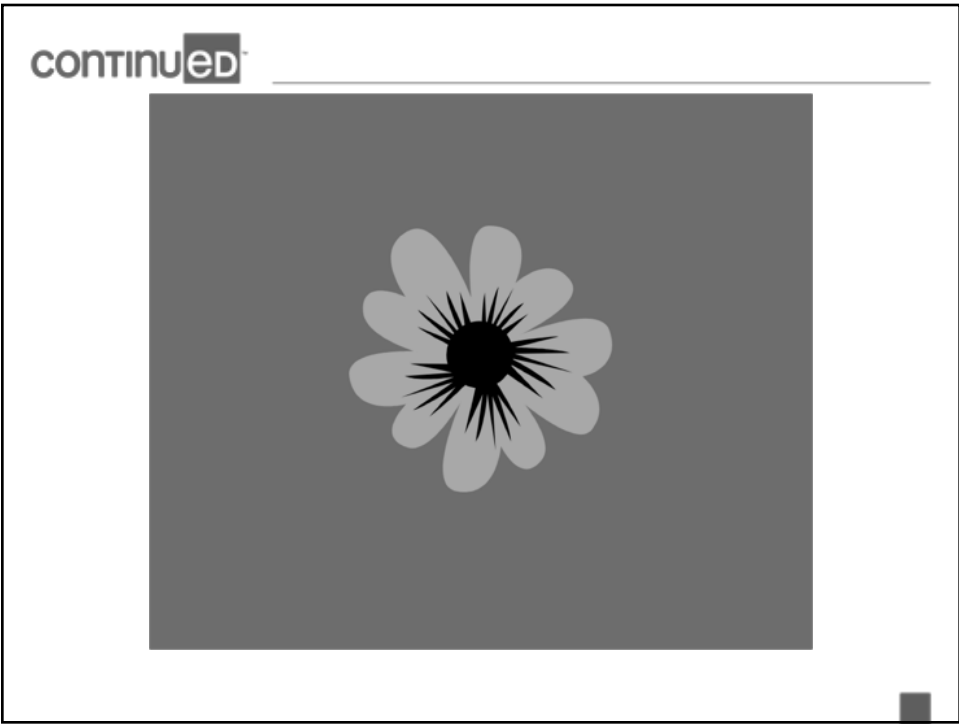
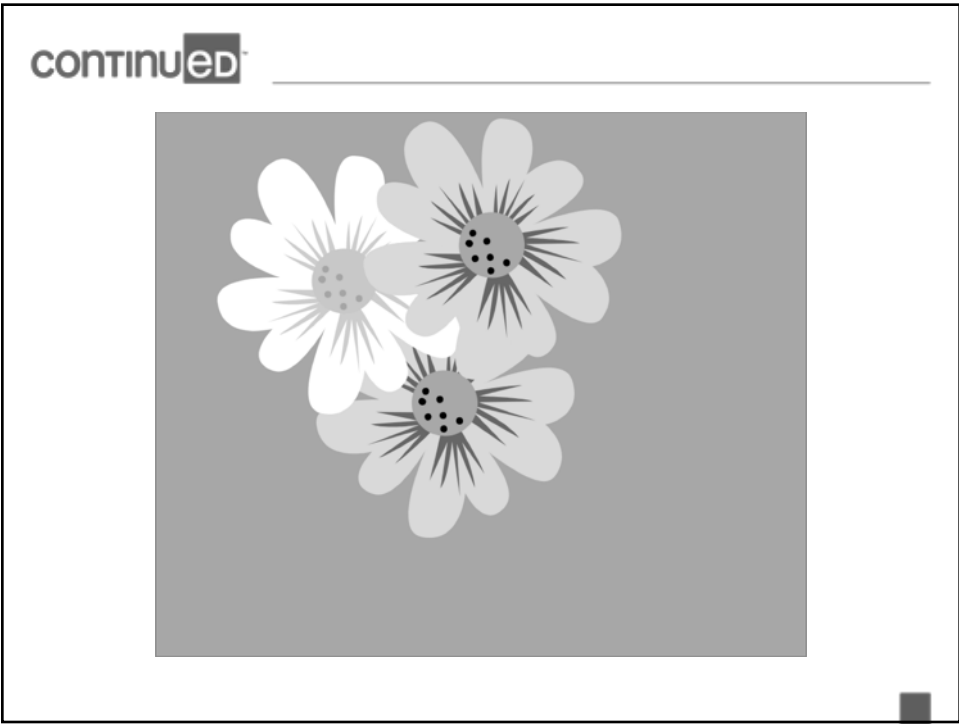
- Repeated exposure causes a blunted response to everyday experiences.
- Normal pleasure (food, sex, relationships) cannot compete, they lose relative value.
- Normal drives hierarchy is disrupted and replaced with new priorities concerned with obtaining and using substances.











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➤ *Dopamine deprivation produces chronic unpleasant feelings, depression, and a loss of motivation, which leads to the urge/need to take drugs to feel better.*

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Memory and Control Circuits

- As the reward circuits become blunted the addict also loses the ability to curb the need to seek and use drugs
- The memory of the drug becomes more powerful than the drug itself
- Frontal brain regions required to exert inhibitory control over desires and emotions are impaired



Conditioned learning

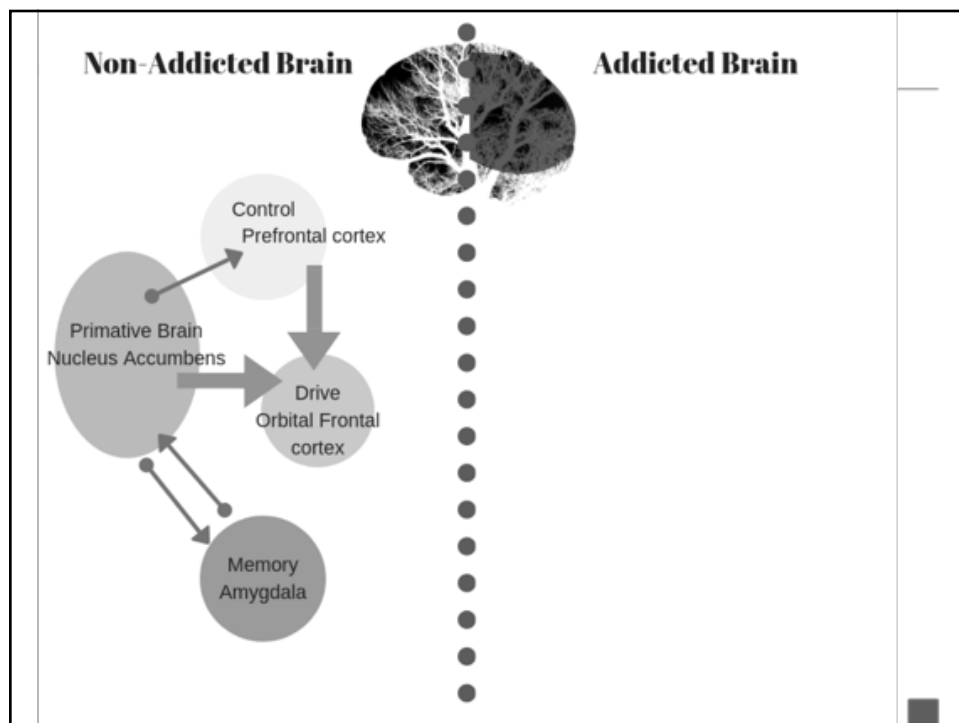
- Pavlov's Dogs
- Experiences a learned or conditioned response to the substance and starts to anchor the drug with the associated activity/environment
- These triggers or cues increase dopamine and glutamate and increase cravings and withdrawal symptoms.
- These memories and responses become hardwired or implanted into the brain.
 - Long term potentiation, emotional memory formation, Synaptic plasticity

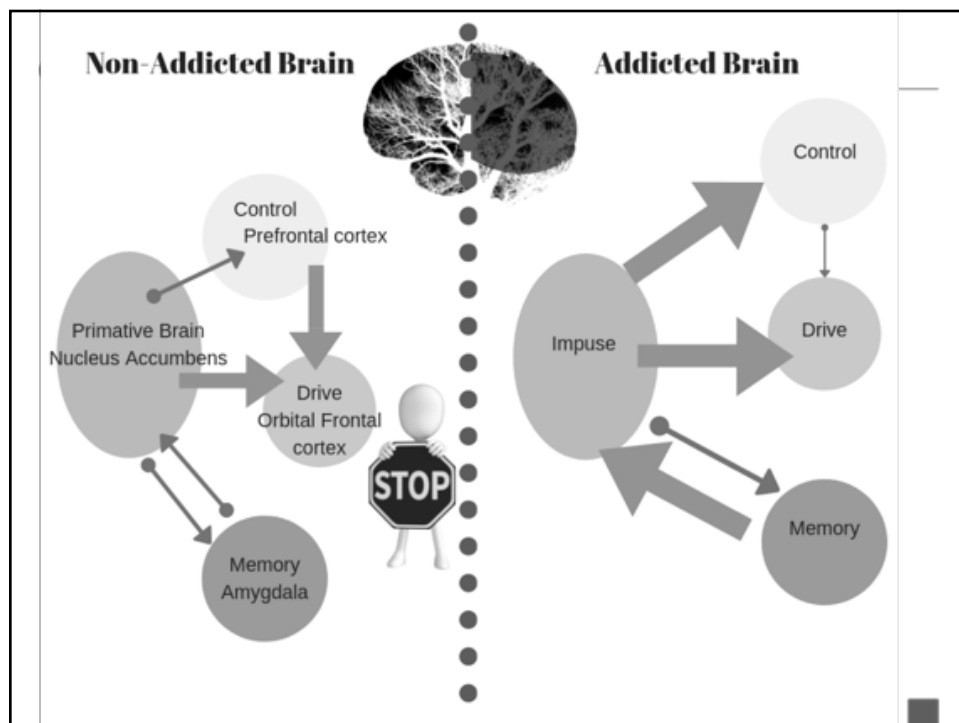
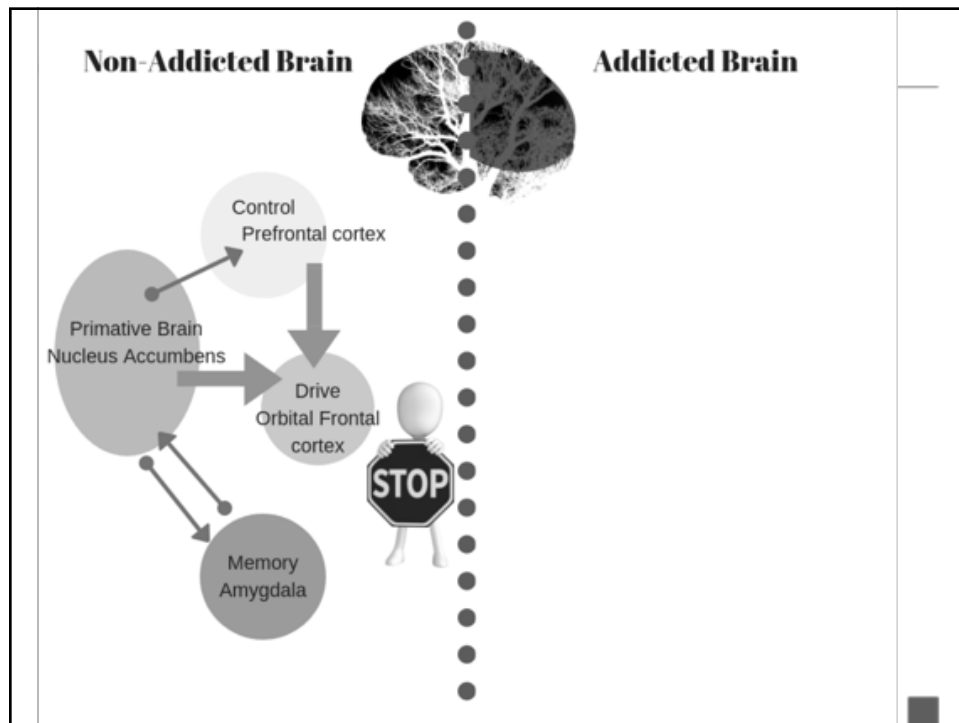
Synaptic Plasticity

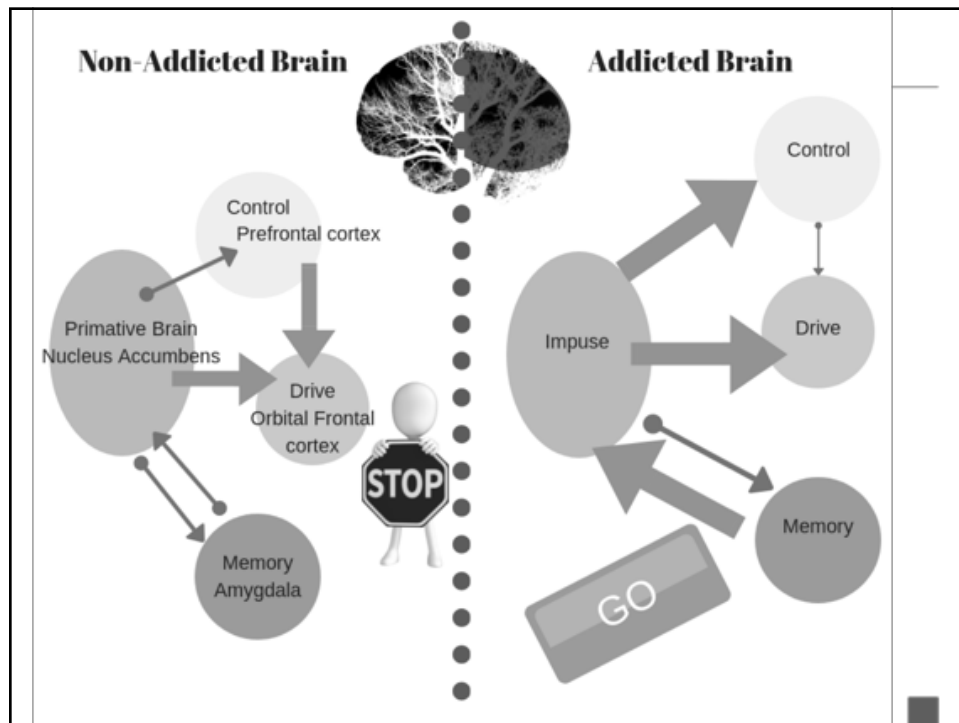
- Drugs produce alterations in signals carried by glutamate from the pre frontal cortex to the Nac (region involved with judgement and control). Glutamate is also involved with OCD.
- Drugs can reshape neuropathways which may account for the formation and persistence of drug stimulus associations.
- Drugs also impair the ability to learn new behaviors required for sobriety.

Orbital-Frontal Cortex

- Addiction also involves disruption of circuits involving compulsive behaviors and drives.
- Intermittent dopamine release results in OFC dysfunction via the striato-thalamo-orbitofrontal circuit.
- Hyperactivity in the OFC associated with craving
- Pathology in the OFC has been observed in patients with OCD, Tourette's Syndrome, impulsivity – Glutamate is also involved in these conditions







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Brain Development

- Adolescents and young adults brains are still developing in areas associated with judgement, risk taking, and immediate gratification.
- Just when they are more likely to be exposed to drugs is when their brains are most susceptible.

Epigenetic Changes

- Stress and drug exposure can cause lasting changes to genes and their function which can result in long-term changes in brain circuits.
- Genes may increase vulnerability or mitigate the effect of the environment.

Stress: the anti-reward system

- Stress increases Corticotrophin Releasing Factor (CRF)
- CRF causes increase in dopamine and glutamate in the addict's limbic region.
- Elevated CRF increases cravings and relapse
- CRF interaction with dopamine resets hedonic set point
- CRF is activated for several months after withdrawal
- Early childhood trauma causes changes the brain's response to stress and increases vulnerability to addiction in later life.

Addiction: Effects of learning

- The brain circuits involved in declarative memory
 - 'Knowing what' are distinctive from those involved in non-declarative or procedural 'knowing how' memory
- Procedural Learning is rigid, life long, and partially unconscious.
- Addiction stereotypes important procurement skills through Procedural Learning

Backward Bicycle

- Smarter Everyday
<https://www.youtube.com/watch?v=MFzDaBzBIL0>
- **Knowledge Does Not Equal Understanding**
- "Self knowledge avails us nothing" Alcoholics Anonymous

Denial

- Denial reengineers the conscious interpretation of reality to ensure addiction runs in stealth mode
- Insight deficient
- VTA & Nac, prefrontal cortex, & hippocampus
- The brain is hardwired for denial – addiction hijacks the denial system
- Interferes with seeking treatment and leads to relapse

Treatment

- Denial
 - Clients and family members
- Motivational Enhancement Therapy, Motivational Interview
- Al-anon
- Allow clients to experience consequences

Avoid spikes in Dopamine

- Avoid situations that cause spikes in DA
- Relapse Prevention Therapy – avoid triggers and cues (people, places, things)
- External cues – cash, cigarettes, sugar, drinking buddy
- Internal cues – loneliness, celebration, anger
- Smoking cessation

Stress

- Learn new ways to handle and manage stress
- CBT (Cognitive Behavioral Therapy)
- Relaxation therapy
- Yoga
- Massage
- Meditation
- Coping strategies
- Exercise

Time takes Time

➤ *Allow time for the brain to heal*

- Time without dopamine spikes allows the brain to heal.
- Hypofrontality resolves – regains control over choices and behaviors.
- Hedonic set point returns to baseline – normal pleasure becomes pleasurable again.
- Mood, energy, and sleep improve.

12 Step Programs

- Denial – powerlessness, surrender
- Avoidance of dopamine spikes – environment, character defects, making amends, daily inventory, daily meditation and prayer.
- Spiritual Awakening – life of serenity and peace, much happier than before onset of addiction
- SERVICE

H.R.6 - implications for OT

- Reduction of opioid dependence through: best practices in acute care setting on how to treat pain and reduce dependence on opioids, also in the ER.
- Promote access to treatment by having CMS complete a report on how to change payment for services to stop incentivizing opioid treatment and increase incentives for non-pharmacological services.
- Promoting access to services under Medicaid, how to use current services to expand use of non-pharmacological services.
- Increases pain research specifically to non-pharmacological.

Summary

- Addiction is a primary chronic brain disorder
- Addiction impairs the brain's reward circuitry
- Addiction affects brain circuits involving judgement, memory, and impulse control resulting in a nonsensical pursuit of rewards.
- Addiction is NOT a choice!!
- Addiction must be treated as a chronic disease much the same as HTN, diabetes, asthma, cancer

Online Resources:

- [AOTA summary of the bill and its provisions related to OT.](#)
[Section-by-section analysis of the bill from Congress.](#)
[AOTA Fact Sheet on OT and Pain Rehabilitation](#)
- Smarter Everyday <https://www.youtube.com/watch?v=MFzDaBzBIL0>
- <https://www.drugabuse.gov>
- <https://www.samhsa.gov>
- <https://www.asam.org/resources/definition-of-addiction>
- <https://www.drugabuse.gov/publications/teaching-packets/brain-actions-cocaine-opiates-marijuana/section-iii-introduction-to-drugs-abuse-cocaine-opia-11>
- Graphic arts CANVA.com

Resources:

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Questions

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