Neuroplasticity: The Yin and Yang of Addiction and Recovery

HEALTHY CONTROL

PATIENT WITH METHAMPHETAMINE USE DISORDER

1 MONTH OF ABSTINENCE

14 MONTHS OF ABSTINENCE

Neuroplasticity: the yin and yang of addiction and recovery

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Neuroplasticity; the yin and yang of addiction recovery

The brain: Overview
Localization versus Plasticity
Neuroplasticity and addiction
Neuroplasticity and recovery
Implications for SUD and Mental Health Professionals

We see with ...
1. our eyes
2. our feet/hands
3. a cane
4. our Brains
“We see with our brains, not with our eyes”
Norman Doidge, 2007

“The eyes look, but the brain sees”
Jesper Clement, 2018

“Our eyes merely sense changes in light energy; it is our brains that perceive and hence see... our sense receptors translate different kinds of energy from the external world, no matter what the source, into electrical patterns that are sent down our nerves.

Doidge, N. 2007
These electrical patterns are the universal language “spoken” inside the brain – there are no visual images, sounds, smells, or feelings moving inside our neurons.”

Doidge, N. 2007

“I’ve lost everything, but I still can’t I stop!”

“How did this happen to me?”

“How could she choose drugs over me?”
Neuroplasticity: the yin and yang of addiction recovery

The brain: Overview
The Brain: An Overview

1. Three-pound organ.
2. Is the most complex part and the crown jewel of the human body.
3. The seat of intelligence, interpreter of the senses, initiator of body movement, and controller of behavior.

NIH, 2020

The Brain: An Overview

1. The most complex structure in the known universe.
2. Is its own universe or “Neuroverse™” – Phillipe Douyou, 2019
3. A committee of experts. All the parts of the brain work together, but each part has its own special properties.
4. The brain is essentially looking out for its survival – vis-à-vis the body’s survival - RJ

NIH, 2020
How does communication happen in the brain?

1. The brain and the rest of the nervous system are composed of many different types of cells, but the primary functional unit is a cell called the **neuron**.

2. All sensations, movements, thoughts, memories, and feelings are the result of signals that pass through neurons.

3. Neurons consist of four parts.
   1. Cell body
   2. Dendrites
   3. Axon
   4. Presynaptic terminals

Neurotransmitters are chemicals that brain cells use to talk to each other. They relay messages across the synaptic gap between nerve cells.
How does communication happen in the brain?

- Some neurotransmitters make cells more active (called excitatory) while others block or dampen a cell’s activity (called inhibitory).

Neurotransmitters

1. More than 60 distinct types of neurotransmitters in the human brain have been identified to date – Kayt Sukel, 2019.

2. Several neurotransmitters have been identified as associated with the actions of psychoactive drugs.
Neurotransmitters

1. Dopamine
2. Acetylcholine
3. Norepinephrine
4. Serotonin
5. GABA
6. Glutamate
7. Endorphins

Reward/Control Pathway

1. A combination of several structures in the brain that compels us to do things for our survival.
   - Food, sex, love, friendship, novelty
   - These actions promotes survival.

2. Principal parts of RCP are the ventral tegmental areas, the nucleus accumbens septi (“go” switch), hypothalamus, prefrontal cortex (“stop” switch).
“Go” and “Stop” Circuits

Go Circuit

The **(NAc)** – a powerful motivator (reinforcer).

- It gives all mammals certain feelings that drive them to action.

(Olds & Milner, 1954; Gardner, 2005)

1. Tells us that what we are doing is necessary for survival.
2. Tells us to remember what we did to survive.
3. “Do more of whatever you did. Do it again, until you are satisfied; it’s necessary for your survival.”

This constant message increases the importance of the action, so the craving is pumped up to make us feel it more urgently.
“Go” and “Stop” Circuits

Stop Circuit - prefrontal cortex

When the craving has been satisfied, the pain relieved, or the imbalances rectified/satiated, shuts down the do it more message. – Koob & Le moal, 2001.

Localization

versus

Plasticity
Localization - Phrenology

1. Pioneered by Franz Joseph Gall (1758-1828) in 1796.
2. The notion that the adult brain is hardwired by the end of infancy to perform functions in fixed locations. These functions are “localized” or hardwired to certain brain areas; each area of the brain had its own responsibilities.
3. Therefore, if something is hardwired then it is fixed and not capable of change.
4. Once damaged, the brain could not repair itself.

The limitations of Localization
Plasticity

The brain can change its own structure and function through thought and activity. Doidge, 2007; Douyou, 2019

“From the time the brain begins to develop in utero until the day we die, the connections among the cells in our brains reorganize in response to our changing needs.” Campbell, 2009

Plasticity

- Whereas various parts of the brain tend to control and monitor certain functions, the brain is plastic, areas overlap, or assume one another’s functions.

- “The brain is not an inanimate vessel that we fill: rather it is more like a living creature with an appetite, one that can grow and change itself with proper nourishment and exercise.” Doidge, 2007
Neuroplasticity and addiction

How does addiction happen?
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Dopamine

• Dopamine, the “pleasure” molecule is the main neurotransmitter involved.
• It provides the drive to pursue potential pleasure (healthy or unhealthy).
• The reward pathway is boosted up by dopamine.
• All rewarding drugs stimulate dopamine in the reward pathway.
• Dopamine rises in seeking and searching for pleasure and not pleasure itself.

“Go” and “Stop” Circuits

Go Circuit (NAc)
1. Tells us that what we are doing is necessary for survival.
2. Tells us to remember what we did to survive.
3. “Do more of whatever you did. Do it again, until you are satisfied; it’s necessary for your survival.”

Stop Circuit - prefrontal cortex
When the craving has been satisfied, the pain relieved, or the imbalances rectified/satiated, shuts down the do it more message.
How addiction happens

- Psychoactive drugs/behavior stimulate the NAc - Heath, Olds, J. 1956;
  - drugs interfere with the way neurons send, receive, and process signals via neurotransmitters. NIH, 2020

- “Repetition deepens the impression”
  - heavy use of a drug (behavioral add.) alters neurochemistry which makes the NAc far more sensitive to the drug and to relapse.

Neuroplasticity and Addiction

Some drugs, such as marijuana and heroin, can activate neurons because their chemical structure mimics that of a natural neurotransmitter in the body.

Drugs, such as amphetamine or cocaine, can cause the neurons to release abnormally large amounts of natural neurotransmitters or prevent the normal recycling of these brain chemicals by interfering with transporters. This too amplifies or disrupts the normal communication between neurons.

This allows the drugs to attach onto and activate the neurons.

NIH, 2020
Neuroplasticity and Addiction

“One of the key imbalances with chronic overstimulation, and ultimately addiction, is that wanting, and cravings increase while pleasure of liking decrease.

The addicted brain want “it” more, but gradually likes is less.

Addiction may be thought of as wanting run amok – Robinson & Berridge, 2008.
How addiction happens

1. The reward/control pathway becomes hijacked!

2. Addiction is an aberration from the brain’s core function of survival.

3. The drug thrill becomes the raison d'ètre!

“The brain reacts in a certain way not because of negative environment (peer pressure, trauma*, bullying, abuse, etc.), but because of the way it’s designed, especially the reward/control pathway.”

(Kohen and Inaba, 2007)
Neuroplasticity: The Yin and Yang of Addiction and Recovery

Addiction is a problem of neuroplasticity!

Neuroplasticity and Recovery

If addiction is a problem of neuroplasticity,

then

recovery from addiction is also a solution of neuroplasticity.
Implications for professional practice

1. Treatment and Interventions

2. Hope: How important is hope in recovery?
   - Expectancy & relationship – twins of effectiveness of therapy
   - Placebo

3. Resiliency.

4. Homeostasis.

5. The brain can learn to heal itself.
Implications for professional practice

1. Brain exercises may be as useful as drugs to treat diseases as severe as schizophrenia.

2. Plasticity exist from the cradle to the grave
   - Far-reaching improvements in cognitive functioning; how we learn, think, perceive and remember – are possible even in the elderly.

3. Practicing a new skill, under the right conditions, can change hundreds of millions and possibly billions of the connections between the nerve cells in our brain maps. (Neuroverse™, - Phillip Douyou, 2019)

   Dr. Michael Merzenich; Norman Doidge; Douyou, 2019

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4) Environments saturated with novelty, focused attention, and challenge are vital in promoting neuroplasticity, and can provoke growth and positive adaptation long after the “critical learning period” of early childhood and young adulthood is over (Kempermann et al., 2002; Vemuri et al., 2014);

5) As few as ten ~1-hour sessions of cognitive training over 5 or 6 weeks have the potential to reverse the same amount of age-related decline that has been observed in the same time period (Ball et al., 2002);

6) Physical activity and good physical fitness can prevent or slow the normal age-related neuronal death and damage to the hippocampus, and even increase the volume of the hippocampus (Niemann et al., 2014);

7) Intermittent fasting can promote adaptive responses in synapses (Vasconcelos et al., 2014);

8) Chronic insomnia is associated with atrophy (neuronal death and damage) in the hippocampus, while adequate sleep may enhance neurogenesis (Joo et al., 2014).
SUD Professionals as neurplasticians

1) The practice of the SUD and mental health counseling is an engagement in neuroscience.

2) SUD professionals are, by nature of their work, neurplasticians!

3) We tell, teach, train, encourage, cajole the brain to live again!

Implications for professional practice
What ifs?

1. What if we assume addiction to be an injury rather than a disease?
2. What if we taught society that addiction is not a simple behavioral issue, but a brain injury of sorts?
3. What if we developed technology to aide the “stop” circuit in the reward pathway?
4. What if a brain implant could interact with the “go” circuit and dampen its drive?