Trouble Letting Go: Understanding Addiction and the Developing Brain

CABHP 20th Annual Summer Institute

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I Have a Time Challenge!

• 6 hour workshop in about 75 minutes!
• We’ll hit the major highlights…
• For a copy of the full Power Point, email me at: frank@kroslearninggroup.com
Today’s Itinerary

1. Cortisol: The Mysterious Motivator Known as “Stress”

Today’s Itinerary

1. **Cortisol: The Mysterious Motivator Known as “Stress.”**
What is Stress?

Stress is a physiological response to a perception of a lack of control over an aversive situation, person or event.
It’s All About the Stress Response

• **Stressors** knock you out of homeostatic balance.

• **Stress Response** works to put you back in balance.

• **Too much** of the stress response is not good for the brain or body.
The Amygdala uses Cortisol to activate your stress response.

Cortisol is a steroid hormone, more specifically a glucocorticoid. It is released in response to stress.
Traumatic Stress = “Distress”

“Distress” = Too Much Cortisol
The Paradox of Cortisol

**Too Little**
- Weak memory formation (encoding)

**Too Much**
- Strong encoding for emotion
- Weak encoding for detail
- Poor recall
- In extreme, cell death

**Just Right**
- Moderate cortisol improves the formation of detailed memory for facts and events
- Low cortisol promotes efficient and effective recall
Too Much Cortisol

Excess cortisol kills cells in the hippocampus, the brain’s memory maker. Excess cortisol also shrinks the corpus callosum and the frontal lobes.
Effects of Too Much Cortisol

- Brain Damage
- Poor Social Skills
- Low Verbal Skills
- Memory Impairment

- Aggression
- Impulsiveness
- Anxiety
- Dissociation
Distress Impact on Neurons

Dendrites taken from rat PFC show effects of distress.

How much (time) exposure to distress would you predict it would take for neurons to wither as shown?

a.) 2 hrs./day for 2 months
b.) 30 min./day for 7 wks
c.) 1 hr./day for 10 weeks
d.) 10 min./day for 5 days

(Brown et al. 2005)
Distress Affects Neurons

There is strong evidence of withering and retraction of dendritic branching within ...

a.)
b.)
c.)
d.) **10 min./day for 5 days!**

(Brown et al. 2005)
Let’s Think About Memory...

All Learning = Making a Memory
• Slumber
• Siesta
• Doze
• Nap
• Deep
• Nightlight
• Snooze
• Wake

• Rest
• Night
• Sound
• Tired
• Snore
• Dream
• Yawn
• Bed
• Slumber
• Siesta
• Doze
• Nap
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• Nightlight
• Snooze
• Wake

• Rest
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• Snore
• Dream
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• Bed

“SLEEP” IS NOT ON THE LIST
The Stress Response - Overview

- Find Energy
- Get it to Where it is Needed
- Shut-off Long-Term Projects
- Suppresses Digestion, Immune Response, Growth and Reproduction
- Sharpens Cognition, Alertness and May Increase Pleasure **BUT** ...Short-Term Only
- Designed for emergencies
Yerkes-Dodson Law

As stress increases, performance initially rises, and then declines.
Basic Brain Chemistry

- **Cortisol** - “UH-OH”
- **Adrenaline** - “YIKES!”

VS.

- **Serotonin** - “AHH..”
- **Dopamine** - “YAHOO!”

These pairs do not play well together…
Basic Brain Chemistry: The Drive for Homeostasis
Let’s Connect!

• Stress is designed to be compelling, uncomfortable and of short duration.
• As stress intensifies and/or endures, the drive for homeostasis (“yellow box”) activity is very powerful.
• If an individual cannot immediately solve the problem causing the perceived threat, the brain urges escape.
Let’s Connect!

• The drive for homeostasis is achieved if enough dopamine and/or serotonin can be produced.

• Escape = any activity that produces dopamine and/or serotonin in significant quantities to “flush” cortisol and adrenaline.
What are Your ESCAPE Activities?
What are the ESCAPE Activities for a youth who may be/become addicted?
Substances and behaviors that produce “Dopamine-on-Demand” when a youth is stressed create vulnerability to abuse and addiction.
Today’s Itinerary

3. Addiction in the Brain: The 4 “What’s”
The 4 “Whats” of Addiction

1. What’s the Brain Got to Do With It?
2. What Happens in the Brain When Someone is “Getting High?”
3. What is Addiction in the Brain?
4. So What?
The 4 “Whats?”

1. What’s the Brain Got to Do With It?
Why the Brain? Reason #1

Because the brain is involved in **EVERYTHING** humans do!
Brain Science Can (and Has)... 

- Provided a new, researched-based perspective on chronic human problems.
- **Reinforced** the reasons many traditional practices work.
A New View of Drug Abuse

Cocaine

Methamphetamine
ADHD Brain at Rest
ADHD Brain: Concentration Under Stress/Threat
Why the Brain? Reason #2

Because knowledge about the brain is **EVERYWHERE** these days…
One of My Favorites...
How We Get Addicted

Alcohol. Drugs. Gambling... New brain research is helping us understand why we get hooked—and how we may get cured. By Michael D. Lenoxick

They’re the most powerful painkillers ever invented. And they’re creating the worst addiction crisis America has ever seen.

By Massimo Calabresi
POKER FACE

HOW WASHINGTON OPENED THE Floodgates TO ONLINE GAMBLING. OK, WHO'S IN?
Knowledge About the Brain

- **Knowledge** impacts our **Thinking** (Our beliefs about how things work)
- **Thinking** determines our **Behavior**
- **We Each Become What We Think About**
Knowledge About the Brain

• Knowledge about the brain can impact how we think about the brains we serve and, directly and indirectly, how we behave toward them.

• Our focus today: How and Why Addiction Happens in the Brain.
Why the Brain? Reason #3

Because the brain is where addiction does its insidious work…
Both the “High” and the “Addiction Response” Happen Here!
Why the Brain?

1. It is *where* addiction works its potent power.

2. If you know what happens in the brain, then you will understand why addiction makes you/them *feel and behave* the way you/they do.

3. You can judge whether you/they are in *control* or whether the addiction is in control.

4. If you know the physiological actions of addiction, you can *strategize how to fight back* when your/their brain craves more, even when you/they want less.
The 4 “Whats?”

2. What Happens in the Brain When Someone is Getting High?
Natural Highs

Sunshine On My Shoulders
The Best Of John Denver

TranZed Institute
Voluntary behavior in animals (including humans) is motivated by the avoidance of pain and the pursuit of pleasure.

The motivation to pursue a beneficial act to enhance survival is driven in part by the brain giving a brief squirt of **euphoria** — the reward system.
The Pursuit of Pleasure

This euphoric feeling is caused by the secretion of endorphins in the brain. The most important of which is the neurotransmitter dopamine.
The Pursuit of Pleasure

This reward system has evolved over thousands of years to enable the brain to sort through the variety of stimuli that bombard the senses and choose the ones that enhance survival (i.e., eating, sex, social interaction). *When these stimuli are encountered, the brain secretes dopamine.*
The Power of Reward

• The first clues about the power of pleasure were discovered by accident in the 1950’s.

• In an experiment on surgical techniques, an electrode placed in rat’s brain provided pleasurable stimulus when rat pressed a lever. *In other words, the rat could get a secretion of dopamine whenever it wanted it.*
The Power of Reward
Nudge a Neighbor Time!
Nudge a Neighbor Time!

1. How many times did the rat hit the lever?

2. What made it stop?
The Power of Reward

Results –

Rat would:

• Press the lever up to 5,000 an hour.
• Choose dopamine experience over food (even when starving).
• Cross an electrified grid (painful!) for a chance to press the lever.

Only **death** stopped the rat from pressing the lever.
What activities result in enhanced dopamine levels in our society?
What activities result in enhanced dopamine levels in our society?

<table>
<thead>
<tr>
<th>Romantic Love</th>
<th>Inflicting punishment on a known enemy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual Orgasm</td>
<td>Looking at beautiful faces</td>
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<tr>
<td>Music</td>
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<td>Humor</td>
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* Obviously, a partial list!
Take Home Message

• Dopamine feels good! (It is supposed to feel good).
• This is the brain’s normal system of reward.
• The brain is stingy with dopamine because the euphoria is a powerful motivator.
• Many activities naturally give us dopamine.
Chemically-Induced Highs

CAFFEINE INTOXICATION

$LD_{50} = 10g$

17 more Expresso's
+ 19 more energy-drinks

And I Am So There...
What *chemicals* result in enhanced dopamine levels in our society?

- Chocolate
- Cocaine
- Alcohol
- Amphetamines
- Nicotine
- Methylphenidate
Boosting Dopamine Levels

- **Chocolate**
  - 150% boost in dopamine levels at MAc over baseline of first administration.
  - On second administration, boost in dopamine level is no longer significant.
Boosting Dopamine Levels

- **Cocaine**
  - 400% boost in dopamine levels over baseline at first administration.

[Image of cocaine]
Boosting the Messenger

• METH
  – 1500% boost in dopamine levels at NAc over baseline at first administration.
The 4 “Whats?”

3. What is Addiction in the Brain?
Addictions Change the Brain

For much of human history, most of the pleasurable activities that we are wired to pursue occur in nature in limited supply, making it hard to overindulge.
Addictions Change the Brain

But modern life provides a smorgasbord of temptations that activate the reward system.
Addictions Change the Brain

Drugs of abuse, in particular, overwhelm and fundamentally alter the neurons that were never intended to experience such supra-physiological levels of neurotransmitters (dopamine).
Addictions Change the Brain

Some drugs have direct effects on the dopamine pathways while others work indirectly.
Addictions Change the Brain

Stimulants and Nicotine and METH
Dramatically increase dopamine levels
— DIRECT IMPACT!
ENHANCED TRANSMISSION

1. Dopamine vesicles released
2. More dopamine in the space
3. Stronger signal transmission

TRANSMISSION

- Dopamine
- Postsynaptic dopamine receptor
- Dopamine reuptake transporter
Addictions Change the Brain

Opioids, Alcohol and METH suppress the inhibitory neurons that modulate (limit the amount of dopamine metabolized). With less inhibition, more dopamine is available — **INDIRECT IMPACT!**
ENHANCED TRANSMISSION

1. BLOCKED DOPAMINE RECEPTOR RECEPTORS

2. BLOCKED DOPAMINE RECYCLING

3. INCREASED DOPAMINE IN THE SPACE

4. INCREASED SIGNAL TRANSMISSION

STRONGER NERVE SIGNAL

DOPAMINE
BLOCKED DOPAMINE
POSTSYNAPTIC DOPAMINE RECEPTOR
DOPAMINE REUPTAKE TRANSPORTER

TranZed Institute
METH presents a “double-whammy” to the natural reward system. The amount of dopamine secreted is increased AND the dopamine modulators are prevented from working. This could be the most explosively powerful reward response that currently exists.
Addiction Changes the Brain

Damage to Dopamine Receptors

Excessive use of hedonic substances results in a decrease (shut down) of dopamine receptors.
Addiction Changes the Brain

Damage to Dopamine Receptors
With fewer dopamine receptors, the addicted brain:

1. Will develop tolerance and the need to take more;
2. Will have difficulty experiencing pleasure with natural reinforcers.
Tolerance

Functionally...

Dopamine D2 Receptors are Decreased by Addiction
Addiction Changes the Brain

Genetic Protection

Genetic expression is also stimulated to produce substances (gaba) and activate glial cells (remove glutamate) that further dampen the reward circuitry and induce tolerance. Drug addiction changes genes!

- **Glutamate** = Neurotransmitter that creates cellular excitement! “The Life of the Party.” When glutamate is present, cells pay attention!

- **Gaba** = Neurotransmitter that dampens cellular excitement and moderates cell excitement. A real wet blanket!
Take Home Messages

- Never underestimate the high.
- Addiction is the brain’s physiological response to too much dopamine.
- Dopamine receptors close and genes crank-up to dampen the reward system.
- If the abuse continues, permanent damage can occur.
4. So What?
Addiction Treatment Implications

1. Delayed Experimentation (Montana Meth Project).
2. Early Intervention. Damage happens faster in younger brains.
3. Abstinence (w/motivation) will heal many brains.
4. Medications are the future. (Ironic, isn’t it?)
5. Identify and reinforce healthy activities that stimulate the reward system.
Delayed Experimentation

Addiction is a Developmental Disease: It Starts Early
Alcohol Abuse

4 Years

20 Years
Take Home Messages

Help everyone you know find healthy ways to produce dopamine!
Bottom Line

Enduring recovery from addiction is unlikely if consistent behaviors that naturally produce dopamine are not substituted for the substances producing the addiction.
Healthy Dopamine Squirts

- Positive Relationships
- Vigorous Physical Play
- Goal Achievement
- The Arts
- Helping Others
If you benefited from today’s workshop, Please Tell Someone!

We provide more than two dozen stimulating, cutting-edge workshops designed to help transform child and youth care practice.

Contact:
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