The Neurobiology of Addiction

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Learning Objectives

Identify key neurotransmitters, brain pathways, and brain structures implicated in addiction and addiction treatment.

Outline

Neurotransmitters

The Basic Model

The New and Improved Model

Treatments

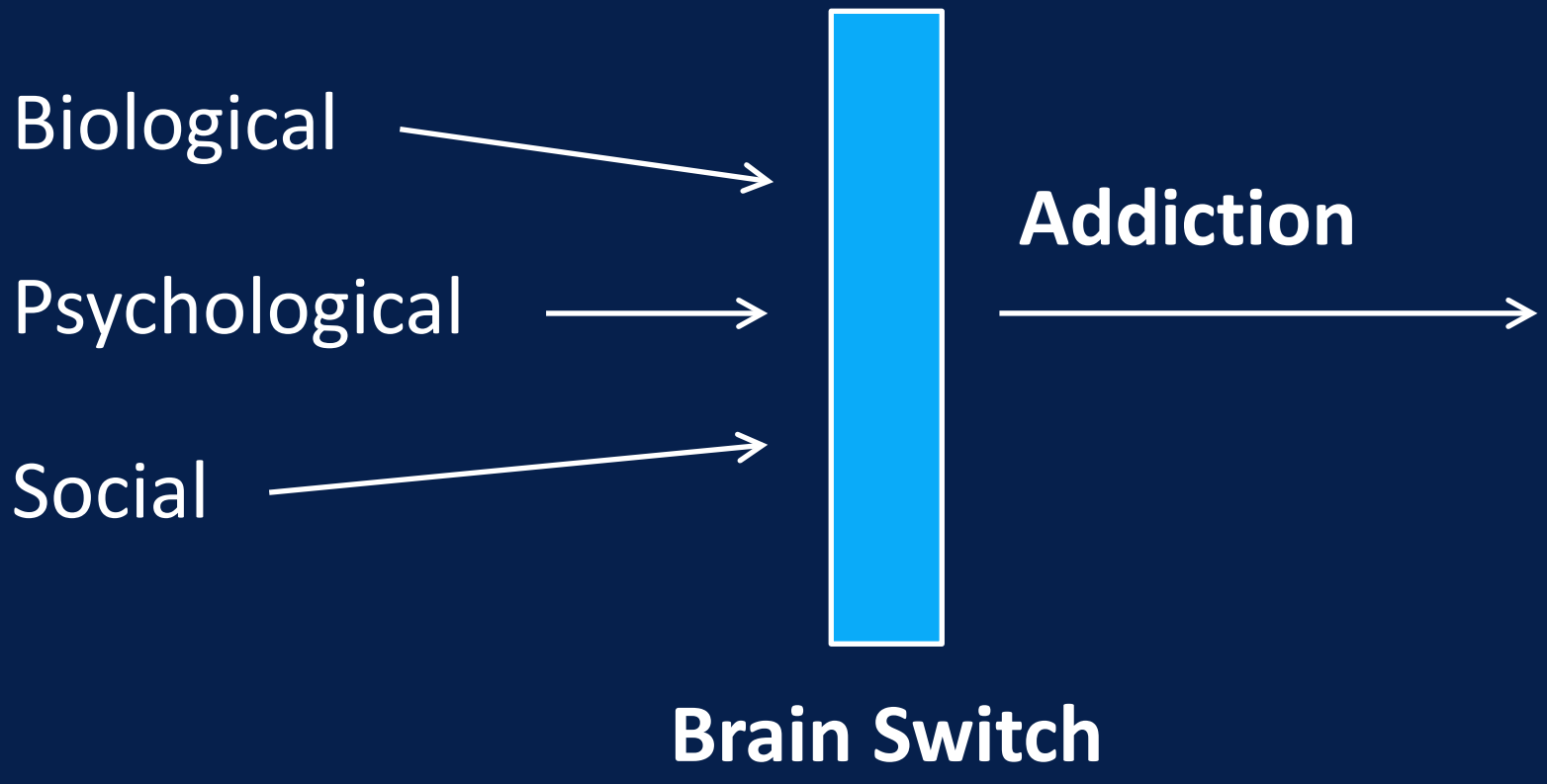
Neurotransmitters

Drug of Abuse	Endogenous Neurotransmitter
Alcohol	GABA / Glutamate*
Amphetamines & Cocaine	Dopamine
Benzodiazepines & GHB	GABA
Cannabis	Anandamide
Hallucinogens & MDMA	Serotonin
Nicotine	Acetylcholine
Opioids	Endorphins
Phencyclidine & Ketamine	Glutamate*

*Drug acts as an antagonist at the NMDA subtype of the glutamate receptor.

The Basic Model

Addiction: A Biopsychosocial Illness



Olsen and Levounis, Sober Siblings, 2008.

The Root Cause of the Disaster

ADDICTION RARE IN PATIENTS TREATED WITH NARCOTICS

To the Editor: Recently, we examined our current files to determine the incidence of narcotic addiction in 39,946 hospitalized medical patients[1] who were monitored consecutively. Although there were 11,882 patients who received at least one narcotic preparation, there were only four cases of reasonably well documented addiction in patients who had no history of addiction. The addiction was considered major in only one instance. The drugs implicated were meperidine in two patients,[2] Percodan in one, and hydromorphone in one. We conclude that despite widespread use of narcotic drugs in hospitals, the development of addiction is rare in medical patients with no history of addiction.

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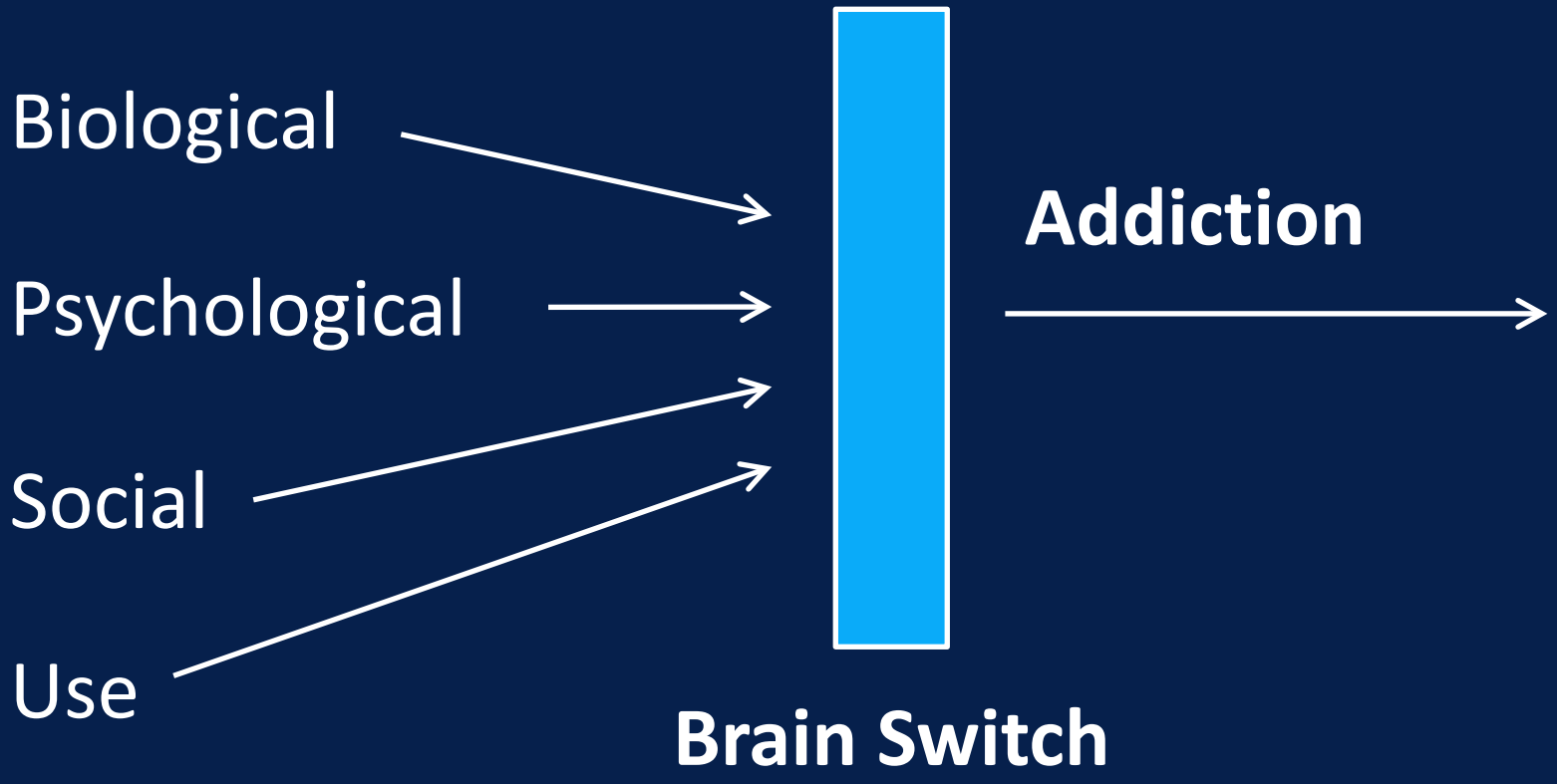
1. Jick H, Miettinen OS, Shapiro S, Lewis GP, Siskind Y, Slone D. Comprehensive drug surveillance. JAMA. 1970; 213:1455-60.
2. Miller RR, Jick H. Clinical effects of meperidine in hospitalized medical patients. J Clin Pharmacol. 1978; 18:180-8.

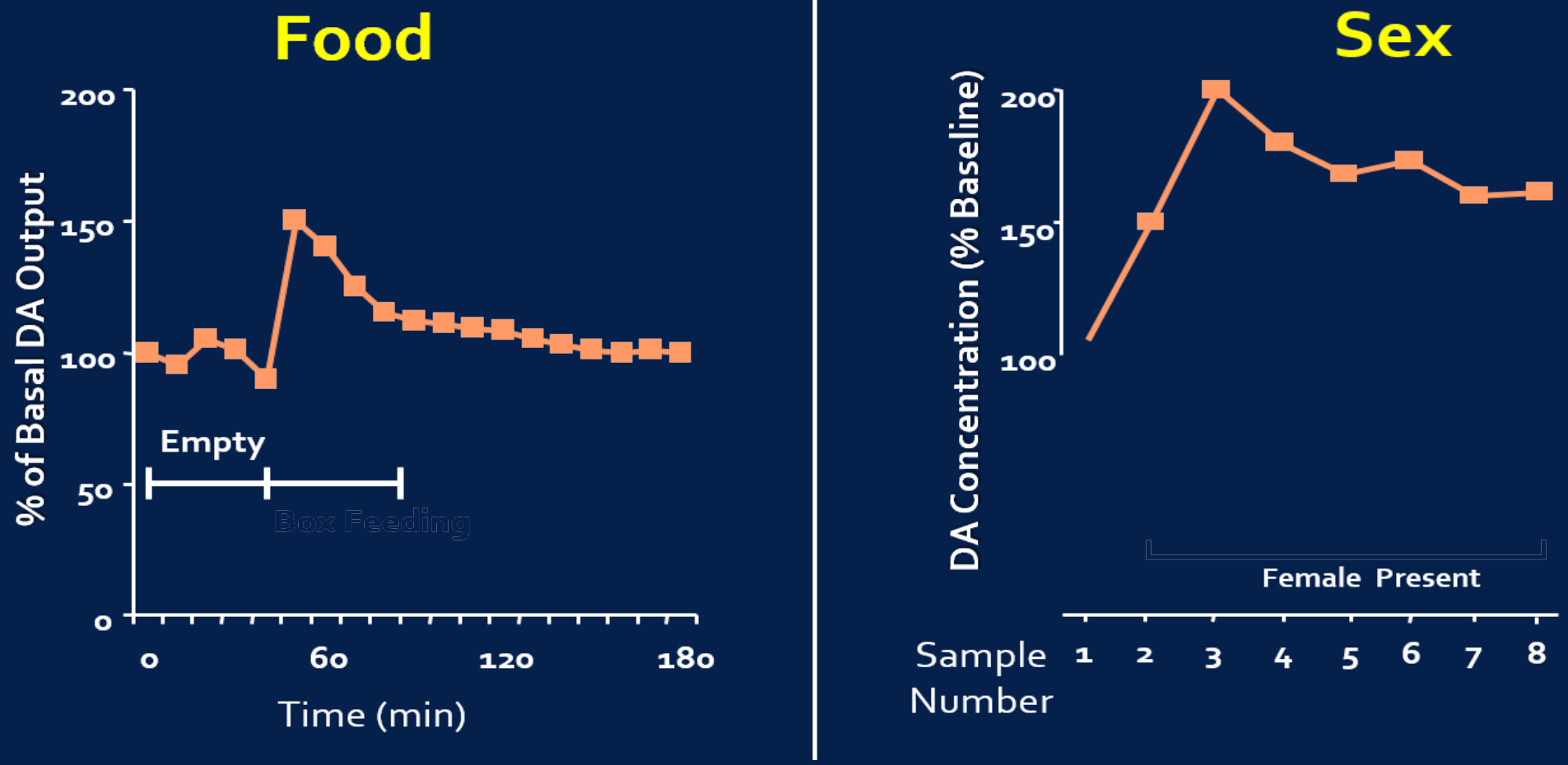
Porter and Jick, N Engl J Med, January 10, 1980.

Addiction: A Biopsychosocial Illness



Olsen and Levounis, Sober Siblings, 2008.

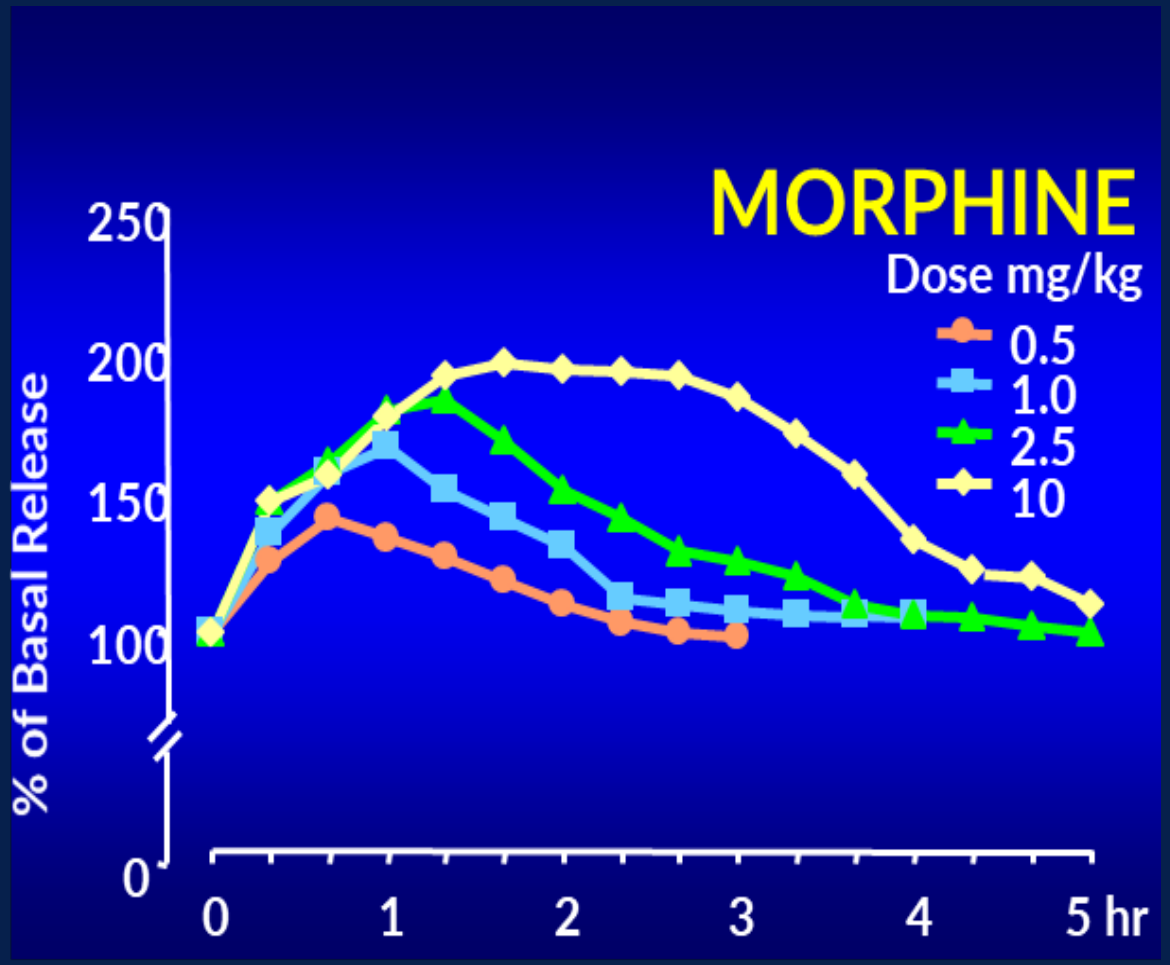
Salience and Natural Rewards

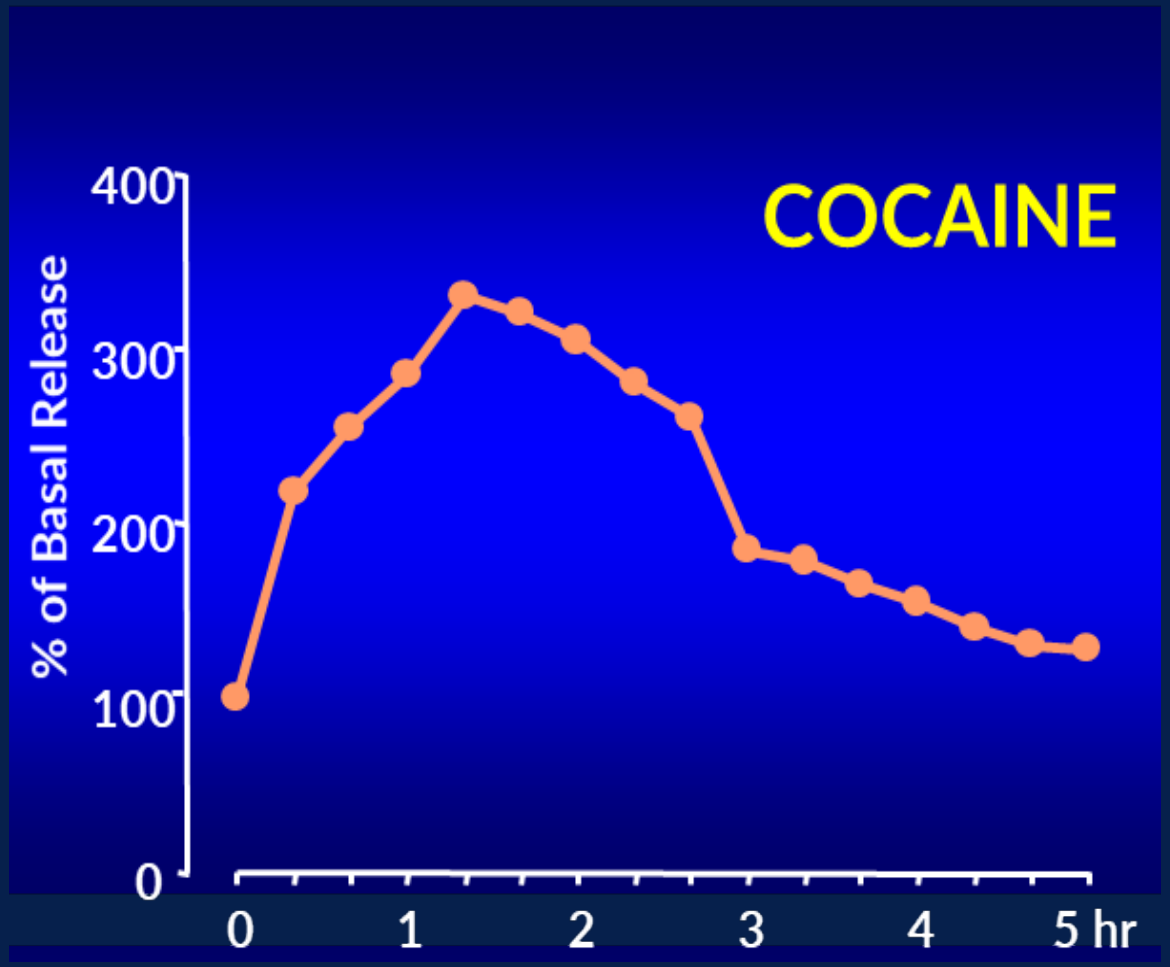


Adapted from: Di Chiara et al, Neuroscience, 1999.

Adapted from: Fiorino and Phillips, J Neuroscience, 1997.

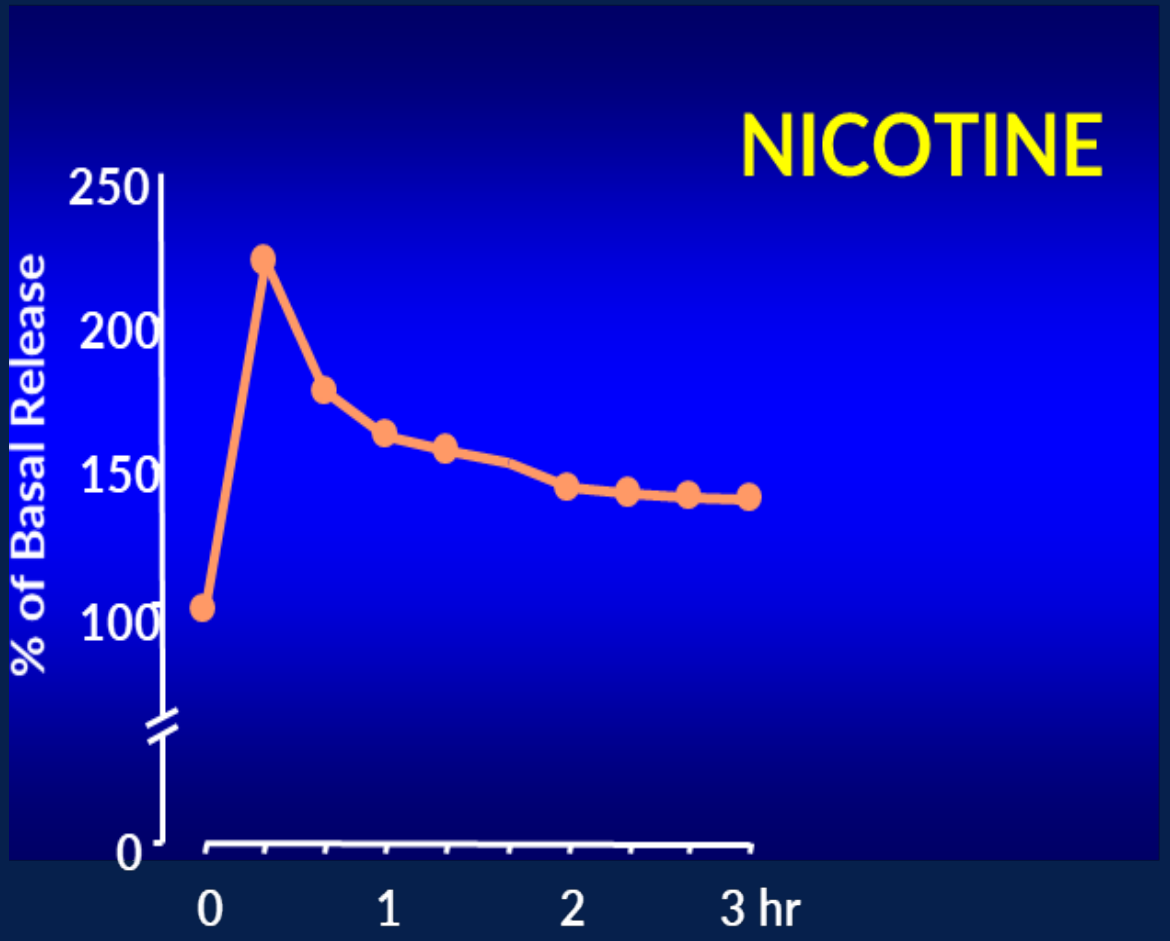
Effects of Drugs on Dopamine Levels

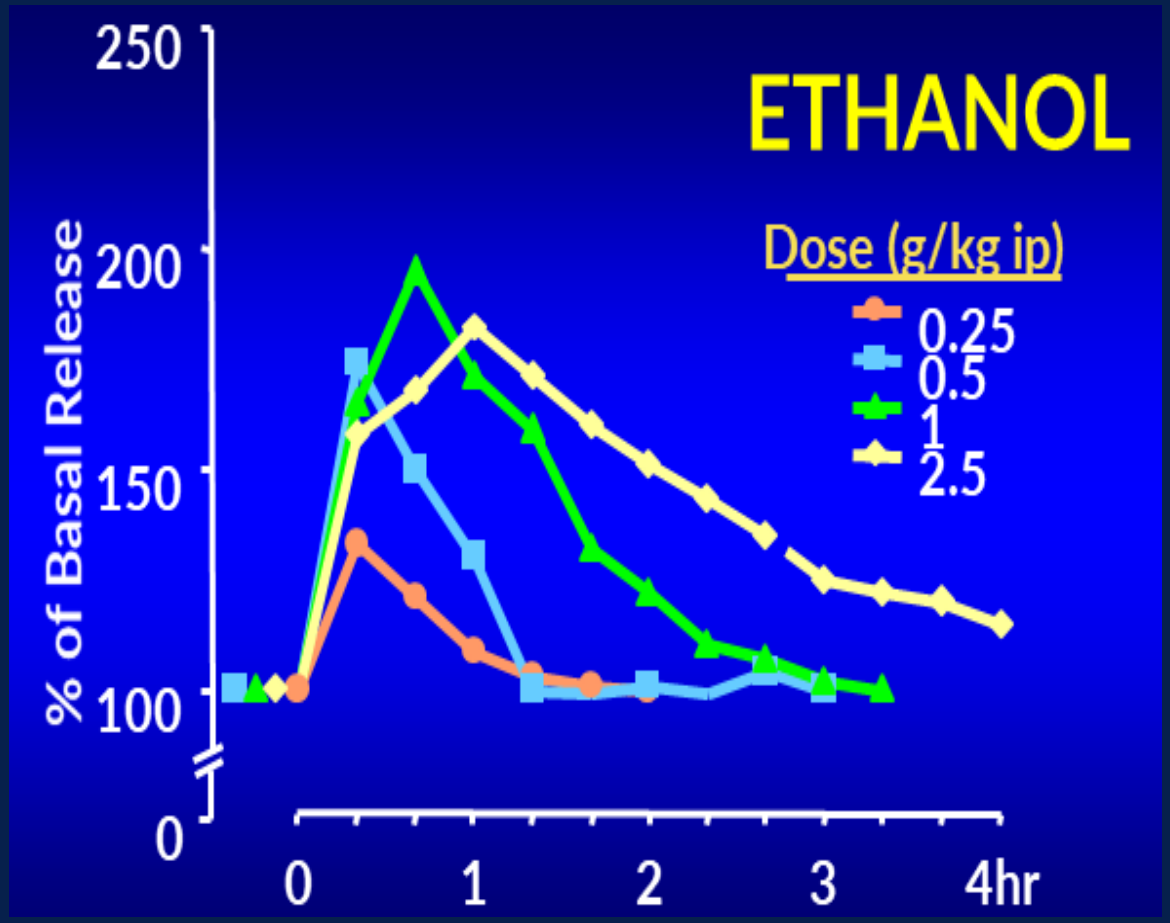




Adapted from: Di Chiara and Imperato, Proceedings of the National Academy of Sciences USA, 1988; courtesy of Nora D Volkow, MD.

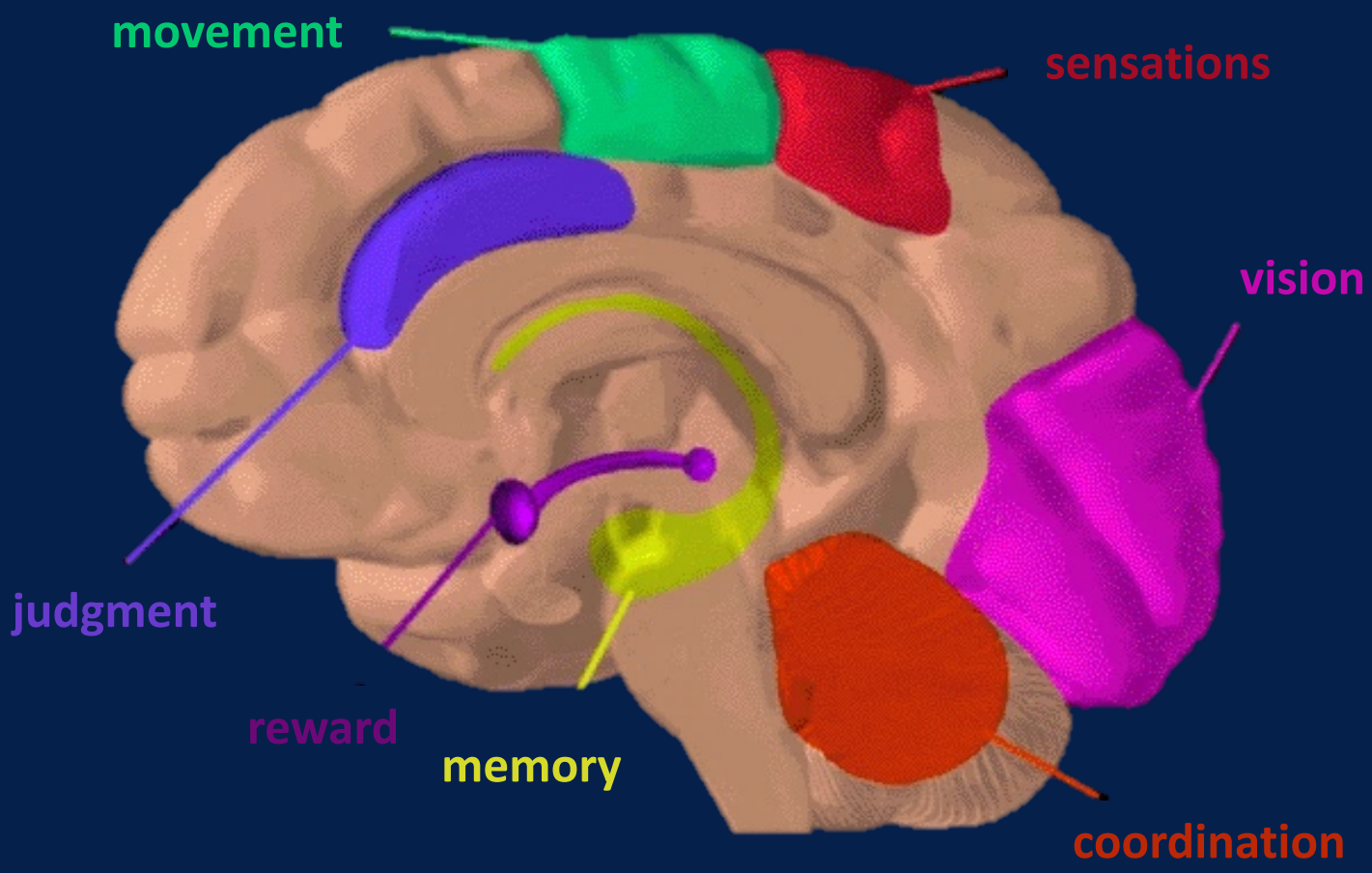
Effects of Drugs on Dopamine Levels





Adapted from: Di Chiara and Imperato, Proceedings of the National Academy of Sciences USA, 1988; courtesy of Nora D Volkow, MD.

Executive Function



National Institute on Drug Abuse, NIDA.NIH.gov, 2000.

The New and Improved Model

Three Novel Areas

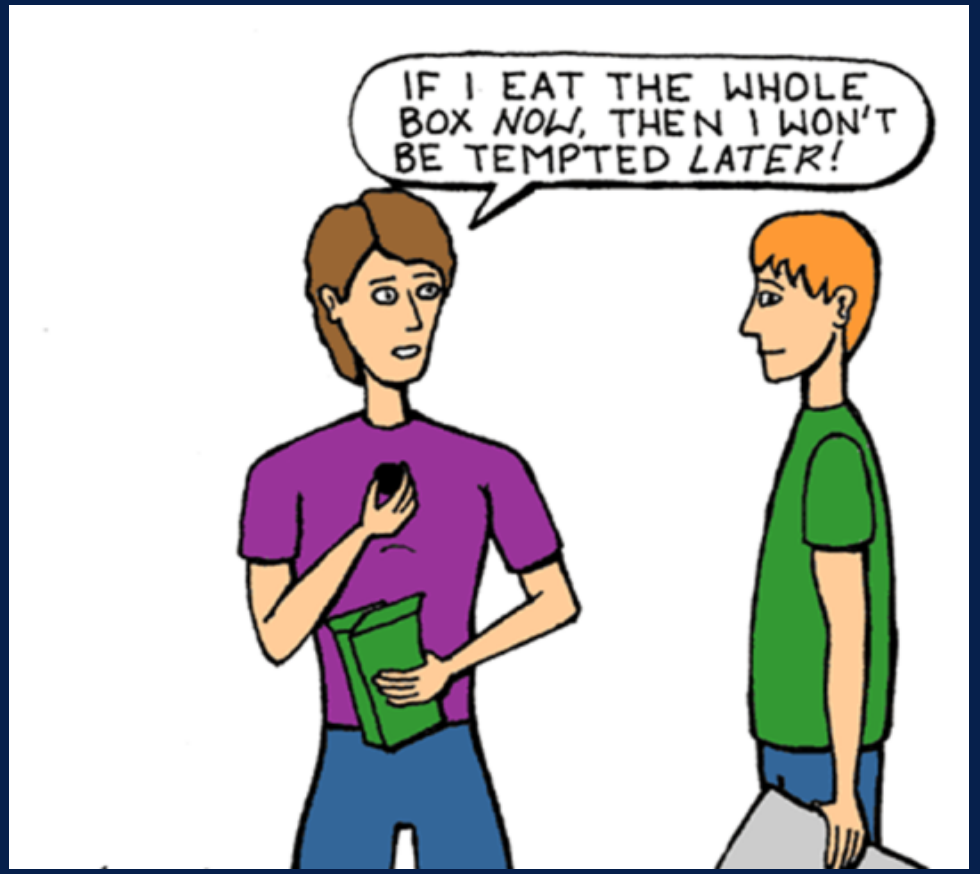
Motivational Circuitry

Antireward Pathways

Interoception

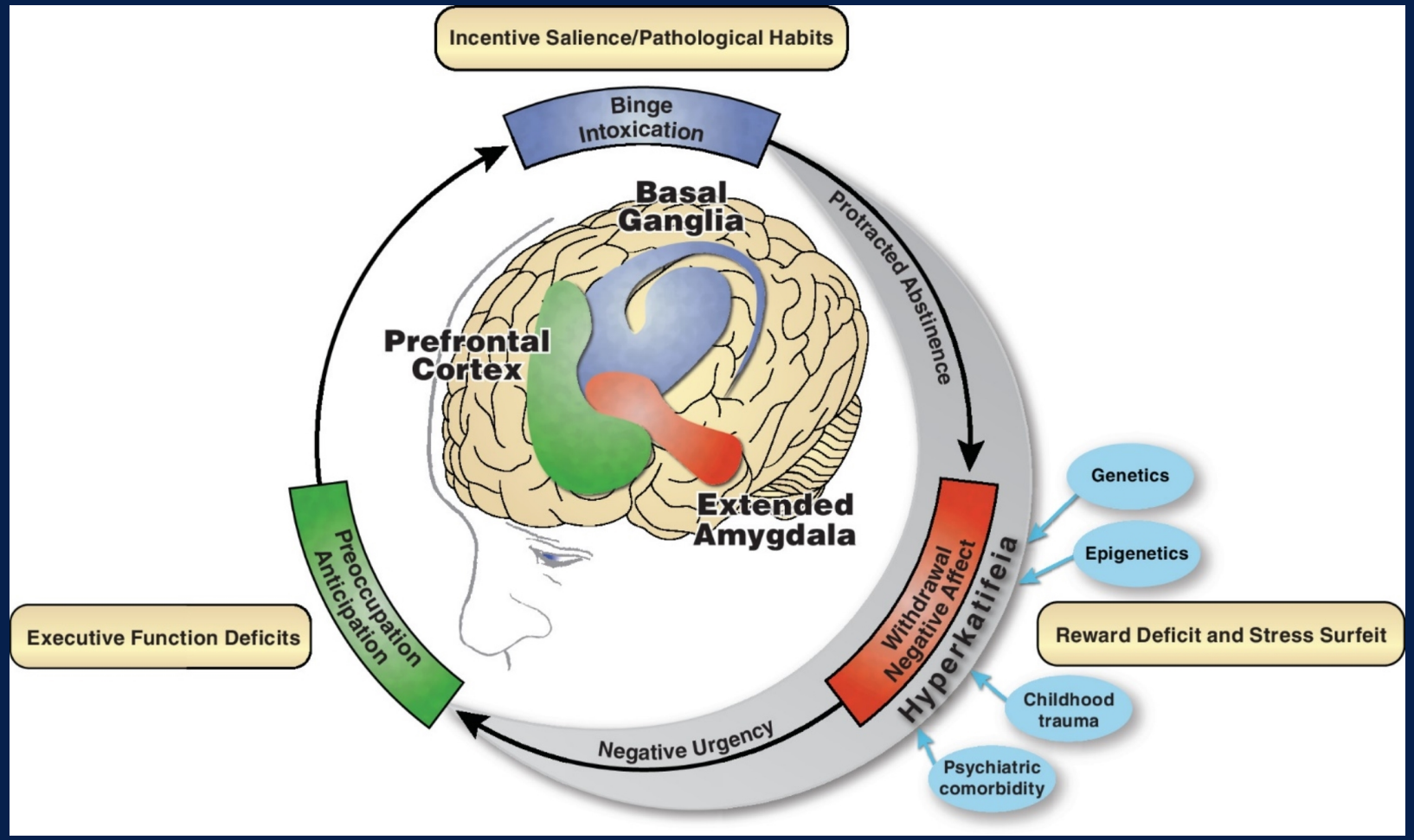
Levounis, Journal of Medical Toxicology, 2016.

Preoccupation - Anticipation



Levounis, Arnaout, and Marienfeld, Motivational Interviewing for Clinical Practice, 2017.

From Reward to Relief



Koob, American Journal of Psychiatry, 2020.

Reward Systems

Game #1

A. A sure gain of $250
B. 25% chance to gain $1,000, 75% chance to gain nothing.

Adapted from: Tversky and Kahneman, Science, 1981.

Reward Systems

Game #1

A. A sure gain of $250 **84%**

B. 25% chance to gain $1,000, 75%
chance to gain nothing **16%**

Adapted from: Tversky and Kahneman, Science, 1981.

Reward Systems

Game #2

A. A sure loss of $750
B. 25% chance to lose nothing, 75% chance to lose $1,000.

Adapted from: Tversky and Kahneman, Science, 1981.

Reward Systems

Game #2

A. A sure loss of $750 **13%**

B. 25% chance to lose nothing, 75%
chance to lose $1,000. **87%**

Adapted from: Tversky and Kahneman, Science, 1981.

Human Nature

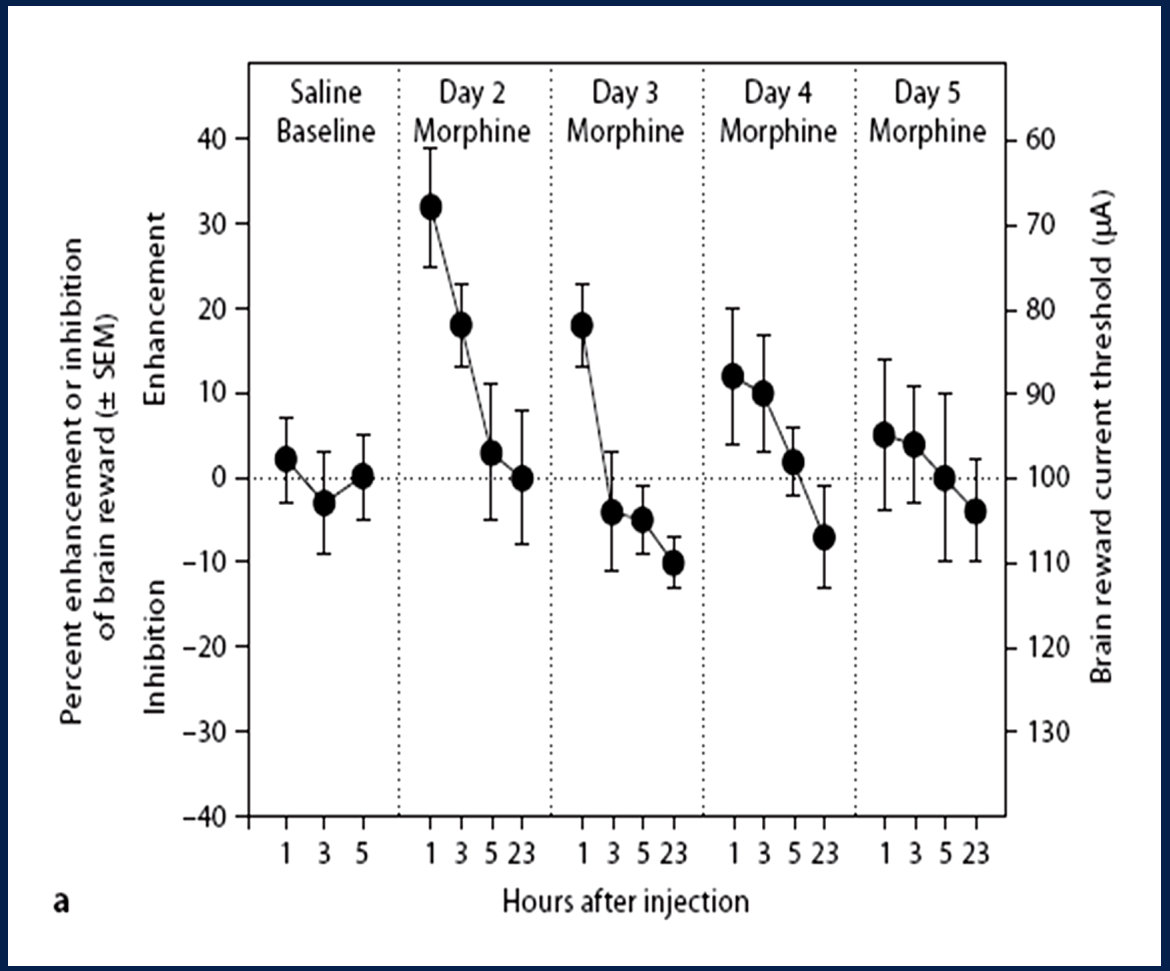
People avoid risks to ensure gains.

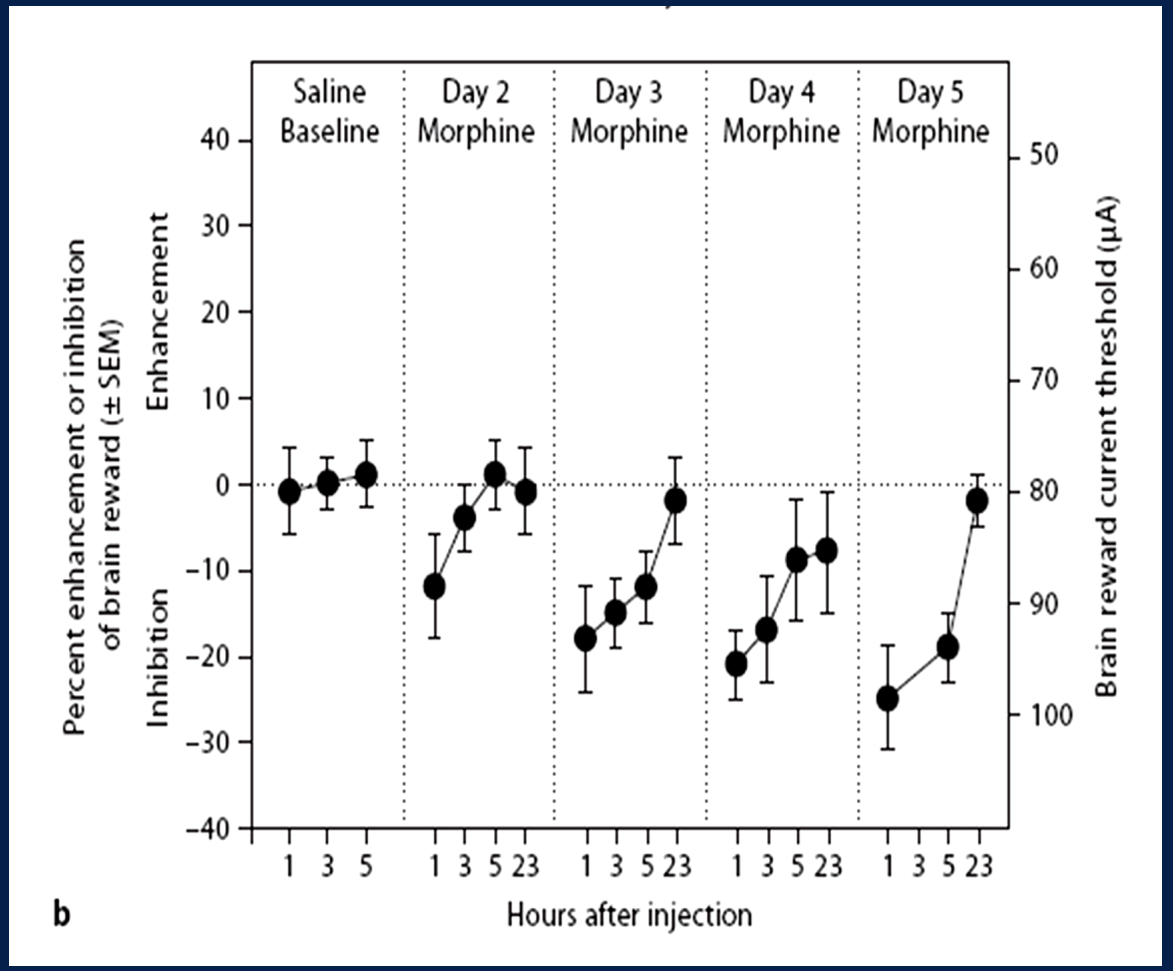
People avoid risks to ensure gains.

Psychology trumps probability.

Ascher and Levounis , The Behavioral Addictions, 2015.

Withdrawal – Negative Affect



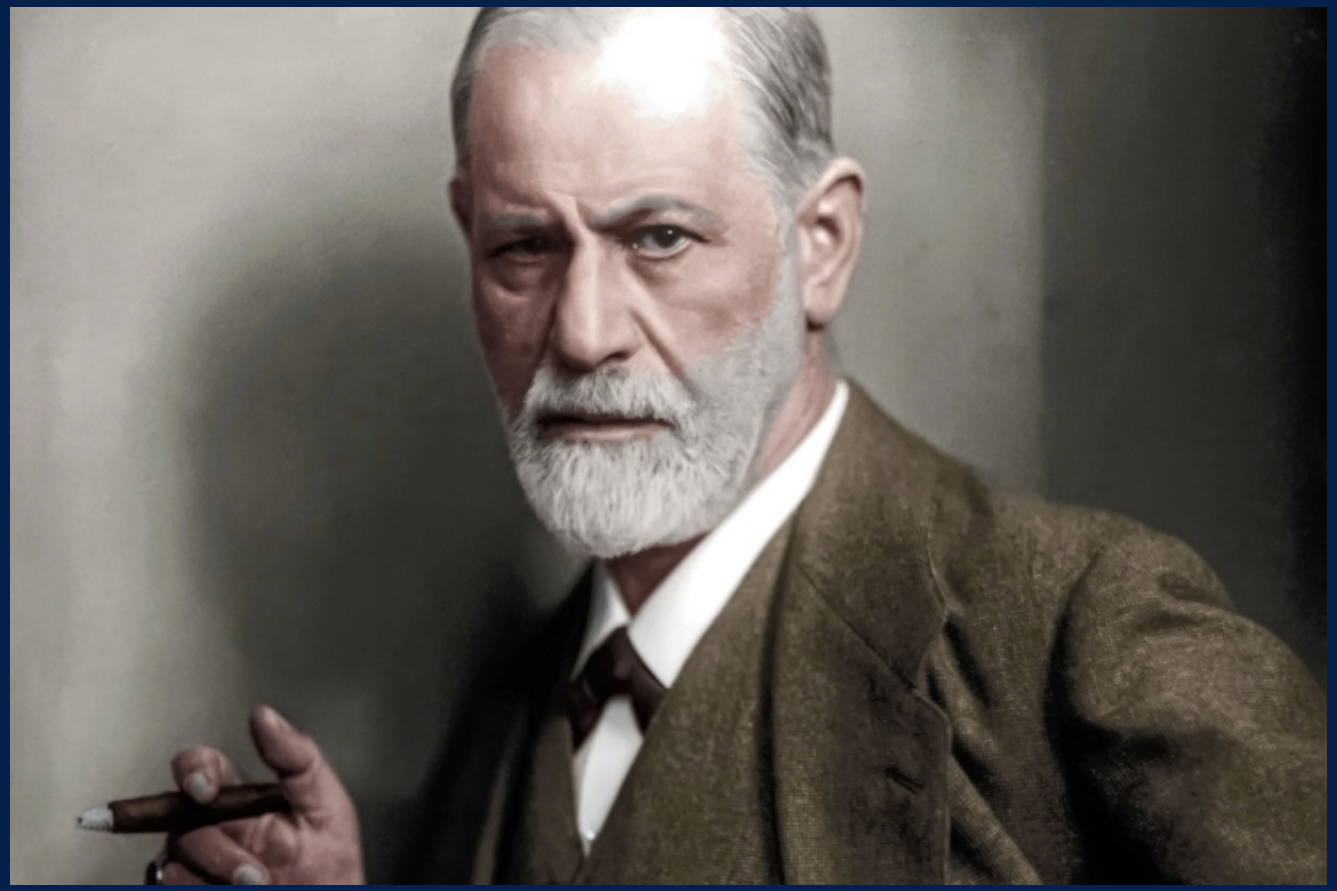


Gardner, Chronic Pain and Addiction, 2011.

Zerbo, Schlechter, Desai, and Levounis, Becoming Mindful, 2017.

Treatments

1st Wave: Psychoanalysis



2nd Wave: Boot Camps

The prototype, synanon, was founded in California in 1958 to address heroin addiction. The goal was to:

- break down defenses,
- bust through denial, and
- reshape the addict's personality.

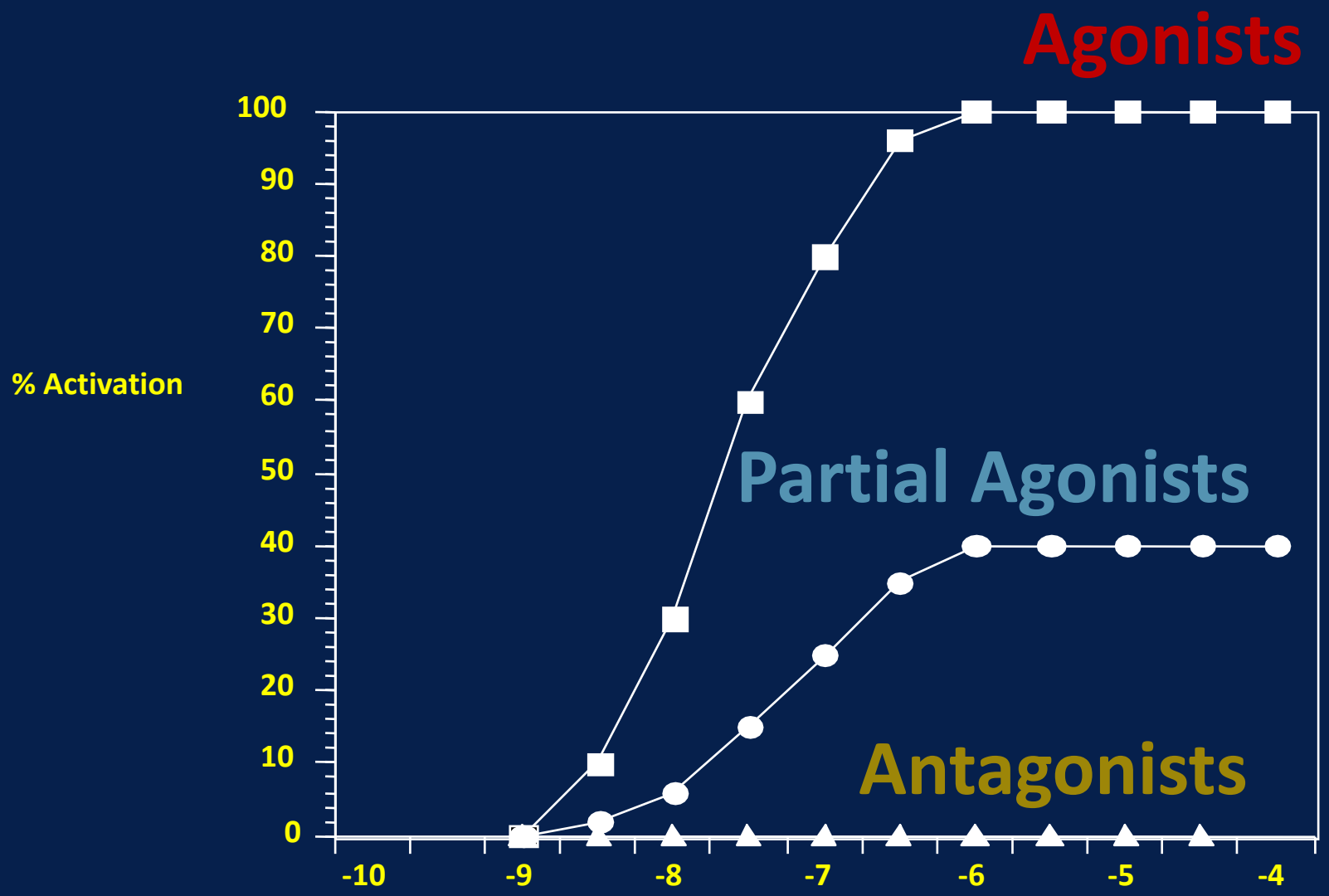
3rd Wave: Current Treatments

Medications

Mutual Help

Psychotherapy and Counseling

Medications



Mutual Help: Medical Staff

1. Housing	2. Government Services	3. Medical Services	4. Outpatient Treatment
5. Job	6. Community	7. Trusting People	8. Inner Peace
9. God	10. Spirituality	11. AA	

Goldfarb, Am J Drug Alcohol Abuse, 1996.

Mutual Help: Patients

1. Inner Peace
2. God
3. Medical Services
4. AA
5. Housing
6. Spirituality
7. Outpatient Treatment
8. Community
9. Government Services
10. Trusting People
11. Job

Goldfarb, Am J Drug Alcohol Abuse, 1996.

Mutual Help: What Medical Staff Think Patients Think

1. Housing	2. Outpatient Treatment	3. Medical Services	4. Job
5. Trusting People	6. AA	7. Inner Peace	8. Community
9. Government Services	10. Spirituality	11. God	

Goldfarb, Am J Drug Alcohol Abuse, 1996.

Cognitive Behavioral Therapy & Motivational Interviewing

Levounis, Zerbo, and Aggarwal, Pocket Guide to Addiction Assessment and Treatment, 2016.

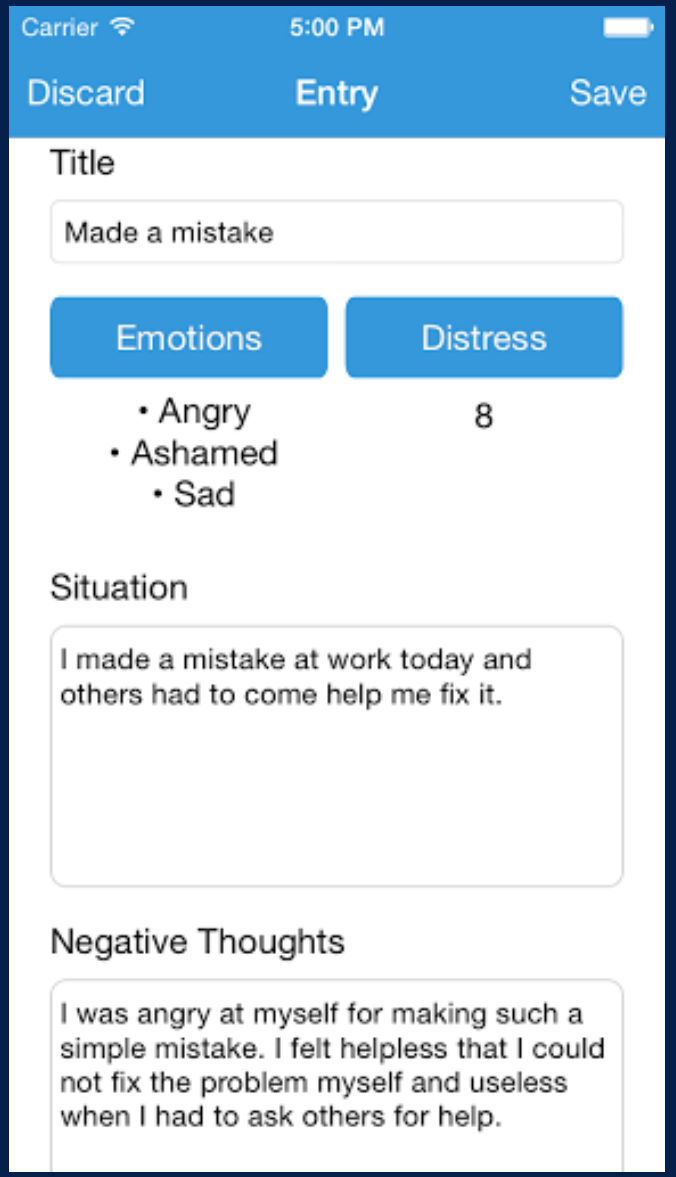
4th Wave: Mindfulness

"Between stimulus and response there is a space. In that space is our power to choose our response. In our response lie our growth and our freedom."

Victor E. Frankl

Frankl, Man's Search for Meaning, 1959.

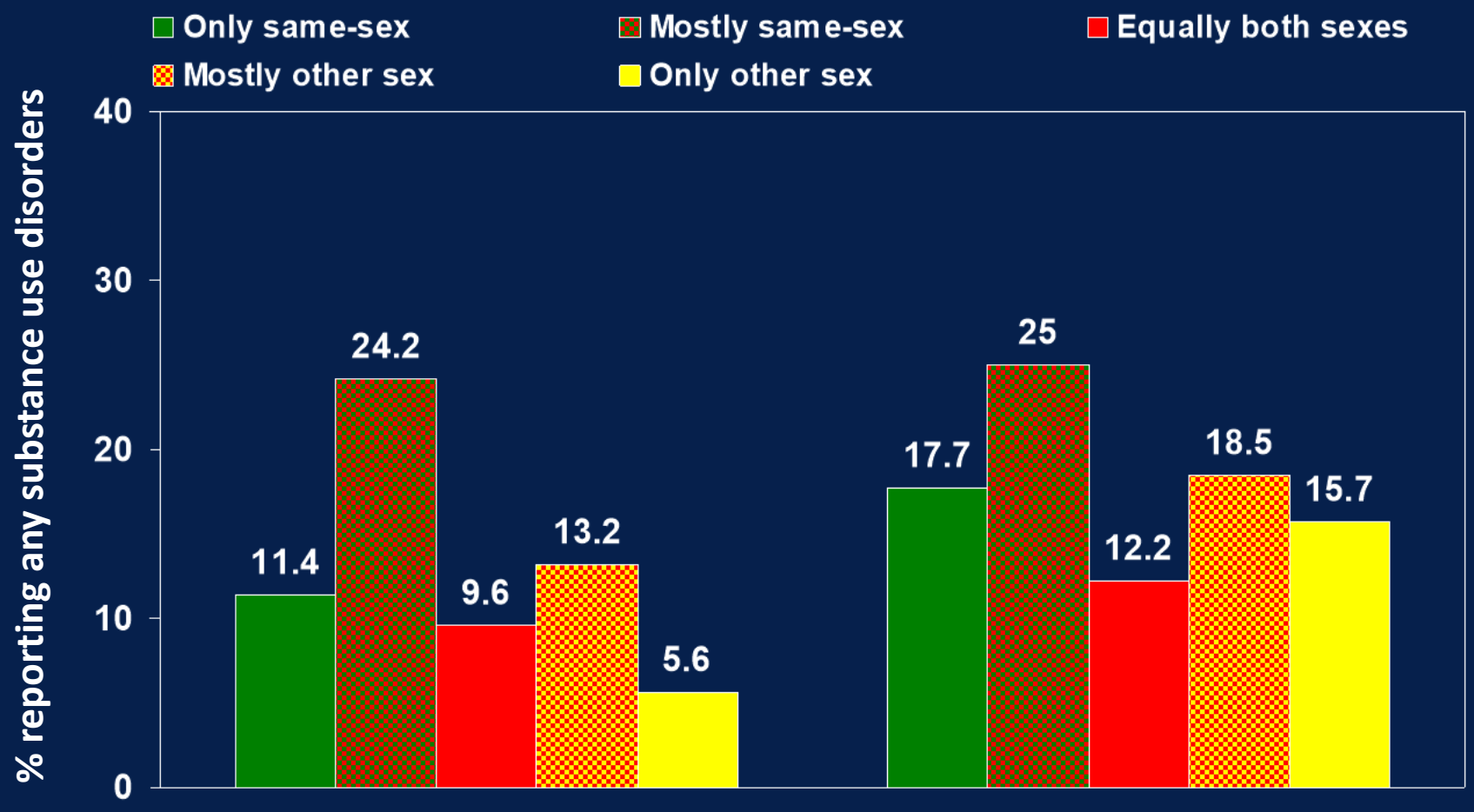
Zerbo, Schlechter, Desai, and Levounis, Becoming Mindful, 2017.



CBT Apps

Mood Tools.org

And Back to Psychodynamics . . .



McCabe, Addiction, 2009, Courtesy of Sean E. McCabe, PhD.

Levounis and Yarbrough, Pocket Guide to LGBTQ Mental Health, 2020.

Neurotransmitters

Drug of Abuse	Endogenous Neurotransmitter
Alcohol	GABA / Glutamate*
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Nicotine	Acetylcholine
Opioids	Endorphins
Phencyclidine & Ketamine	Glutamate*

*Drug acts as an antagonist at the NMDA subtype of the glutamate receptor.

In Summary

Addiction is the war between the hijacked salience and reward pathways of the basal ganglia and the executive function of the prefrontal cortex.

Motivational circuitry, the anti-reward pathways, and interoception complete the 2021 model of addiction.

Pharmacological Treatments:

agonists, antagonists, and partial agonists.

Psychosocial Treatments:

mutual help, CBT, Motivational Interviewing, and mindfulness.

Know your neurotransmitters!

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