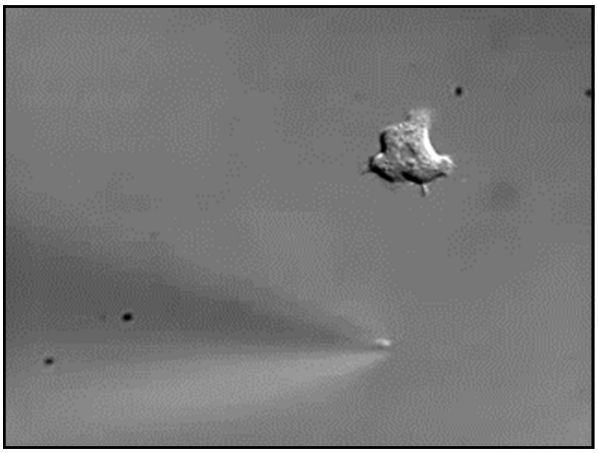
Neurotransmitters Made Easy: Chemistry and Addiction

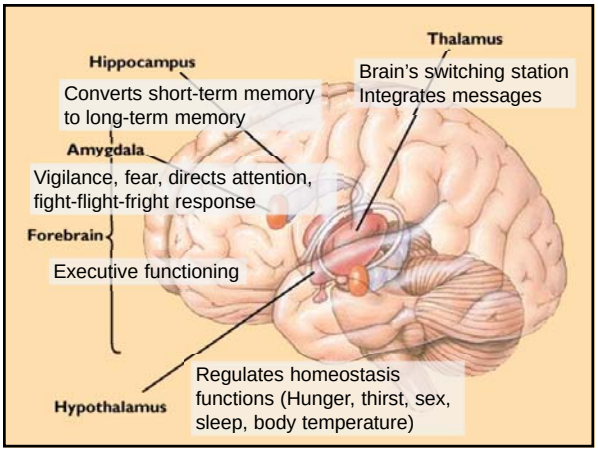
Brad Lander PhD, LICDC
Clinical Director / Psychologist

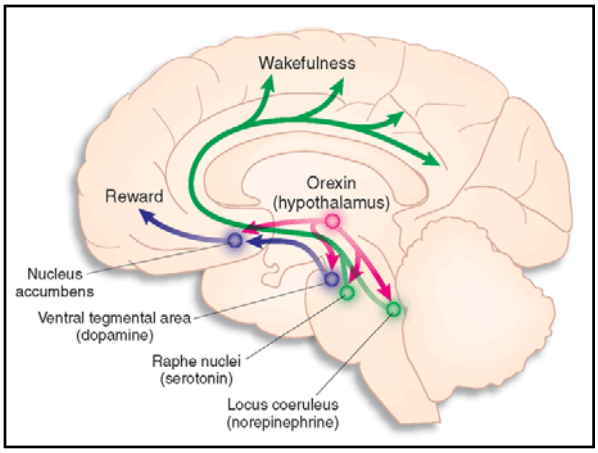
Talbot Hall – Addiction Medicine at The Ohio State University Wexner Medical Center

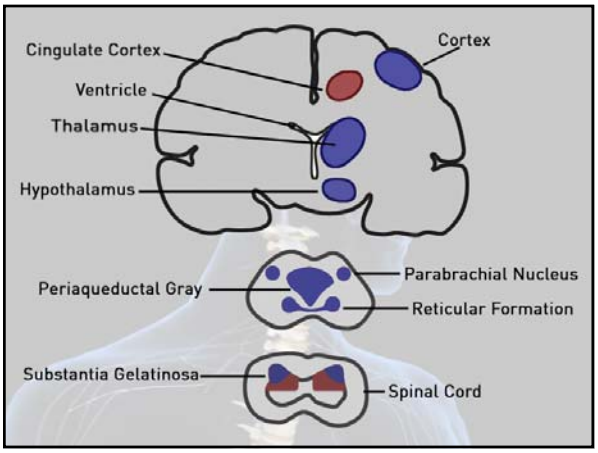


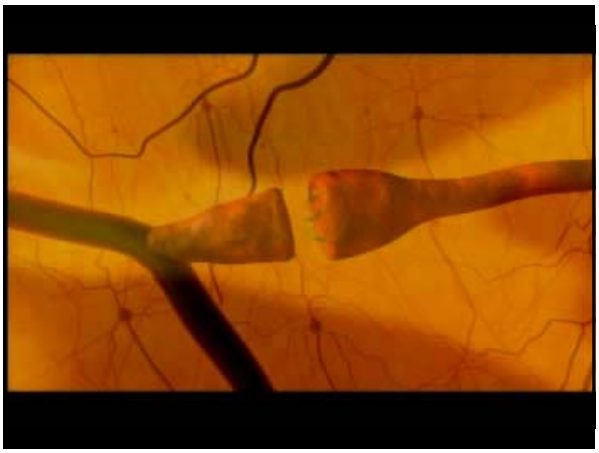
Key Point #1

Thinking and mood are controlled by brain chemicals (neurotransmitters)







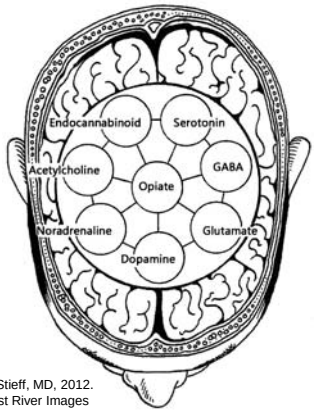


Two Functions

- Excitatory - ↑ excitability of a nerve cell
- Inhibitory – Slows down activity

Key Point #2

We are born with genetically determined receptor sensitivity



Taken from Fred Von Stieff, MD, 2012.
Brain in Balance, Ghost River Images

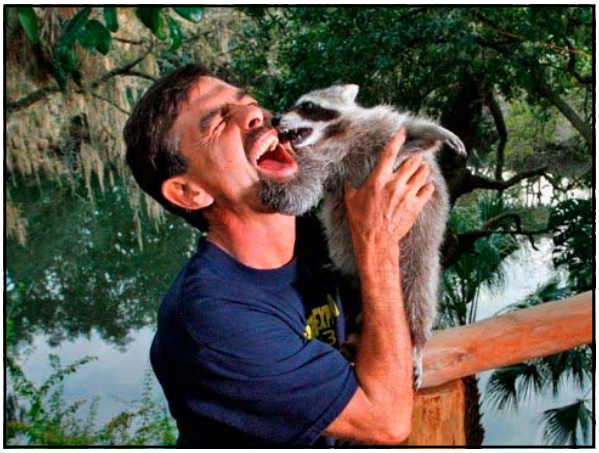
Serotonin

5-hydroxytryptamine (5-HT)

- Well-being
- Calm mood
- Self-regulation
  - Sleep, appetite, libido
- Social bonding
- Empathy

Glutamate

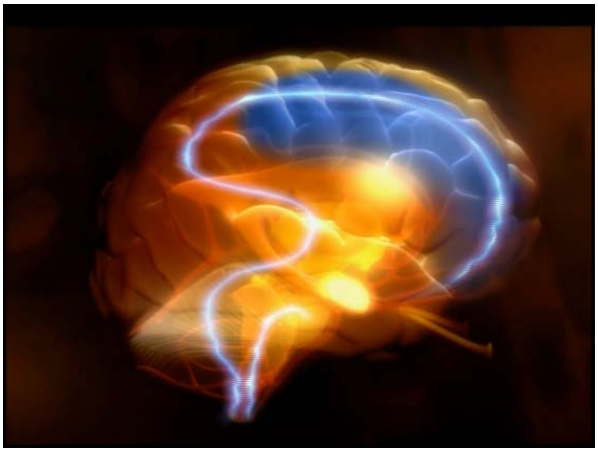
- Excites other neurons
- Opposed by GABA
- Associative learning
- Associative memory



GABA

gamma-aminobutyric acid

- Slows activity of other neurons
- Opposes glutamate
- Allows calming from fear created in the amygdala



Dopamine (DA)

- Pleasure
  - Food, water, sex
- Reinforcement
- Motor control

Norepinephrine/ noradrenaline -(NE)

- Warning/vigilance
- Alarm
- Fight – flight – fright
- Decreases nerve pain

Acetylcholine (Ach)

- Sympathetic nervous system
- Memory (rote)
- Attention
- Peripheral nerves, Internal organs, and muscle/nerve connection

Nicotine

- ↑ acetylcholine, noradrenalin, & dopamine levels and, at higher doses ↑ serotonin & opiate levels
- Increases alertness and energy
- Speeds nerve transmission "volume control"
- Profile changes from stimulant to sedative/pain killer with increasing dosages

Endocannabinoid

- Movement
- Cognition
- Memory
- Pain perception
- Appetite

Opiate

- Analgesia
- Sedation
- Decrease rate of body functions

Endorphin & Enkephalin

- Endogenous morphine
- Reduce pain
- Euphoria & well-being
- Transmission of pain impulses

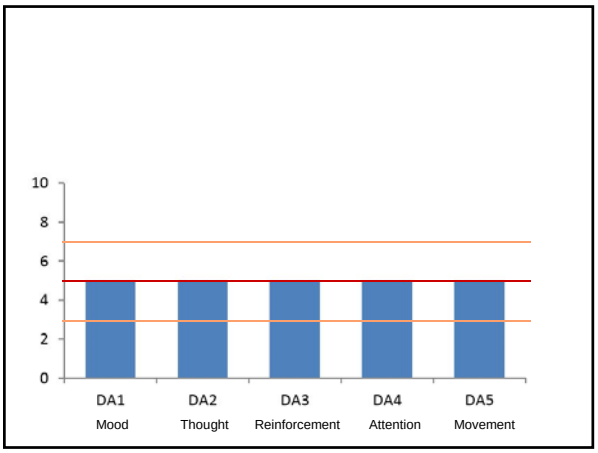
Factors Affecting Neurotransmitter Systems

- Diet
- Body states (fatigue, hunger, illness)
- Events
- Thoughts
- Drugs/medicines
- Hormones

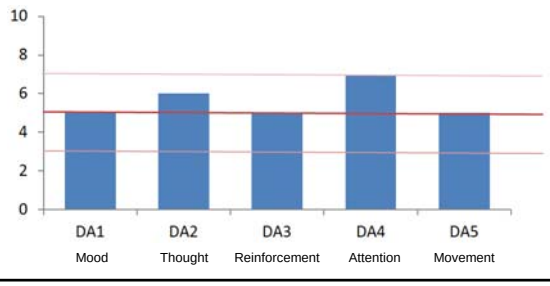
Key Point #2

We are born with genetically determined receptor sensitivity

(Temperament vs. Personality)

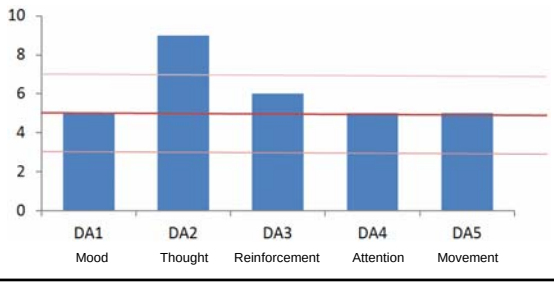


Creative, High-energy



Depression

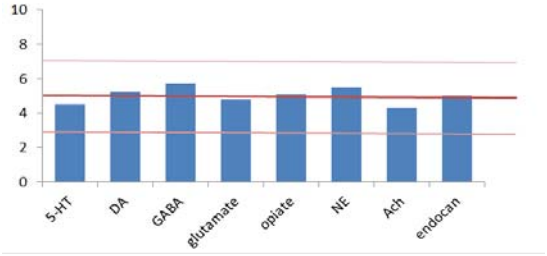
Schizophrenia



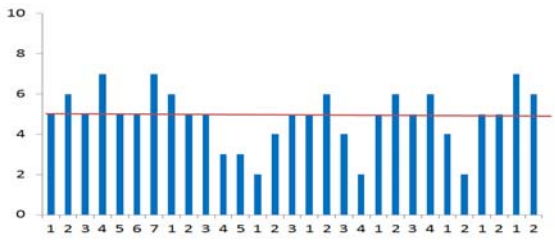
ADD

Parkinson's Disease

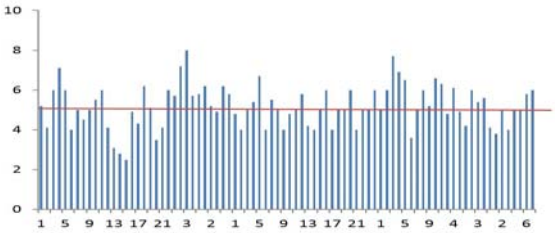
Eight Neurotransmitter Systems



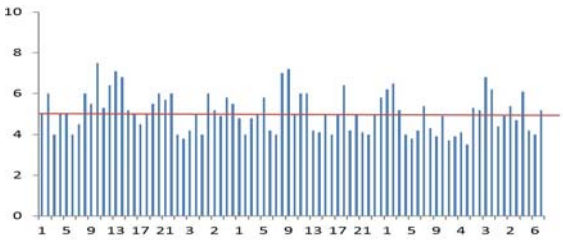
29 primary subtypes



83 variations



83 variations



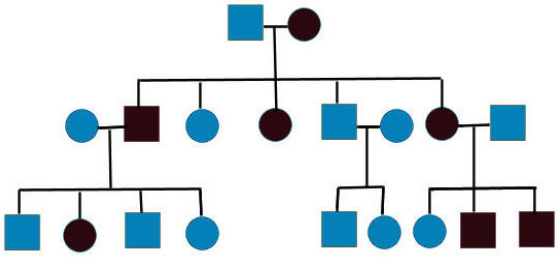
Associated Mental Disorders

Serotonin	Depression
GABA	Anxiety disorder
Glutamate	OCD/PTSD
Dopamine	Psychosis
Acetylcholine	Alzheimer's disease
Endocannabinoid	Amotivational syndrome
Opiate	Chronic pain disorder

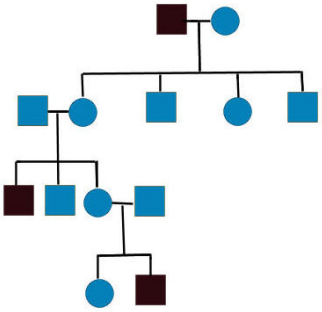
Predisposition for Addiction

- Serotonin deficiency
- B57 rats

Alcoholic Family Tree 1



Alcoholic Family Tree 2



Drugs Affecting Serotonin

Well-being
Calm mood
Self-regulation
Sleep, appetite, libido
Social bonding
Empathy

- Ecstasy
- MDMA
- LSD
- Cocaine

Drugs Affecting GABA

Slows activity of other neurons
Opposes glutamate
Allows calming from fear created in the amygdala

- Alcohol
- Benzodiazepines
- Barbiturates

Drugs Affecting Glutamate

Excites other neurons
Opposed by GABA
Associative learning
Associative memory

- Phencyclidine (PCP)
- Ketamine
- Dextromethorphan (DMT)

Drugs Affecting Dopamine

Pleasure
Reinforcement
Motor initiation

- Cocaine
- Amphetamine
- Methamphet-amine

Drugs Affecting Norepinephrine

Warning/vigilance
Alarm
Fight – flight - fright
Decreases nerve pain

- Cocaine
- Methamphetamine

Drugs Affecting Acetylcholine

Sympathetic nervous system
Memory (rote)
Attention
Peripheral nerves and Internal organs

- Nicotine

Drugs Affecting Endocannabinoid

- Movement
- Cognition
- Memory
- Pain control
- Appetite

- Tetrahydrocan-nabinol (THC)

Drugs Affecting Opiate

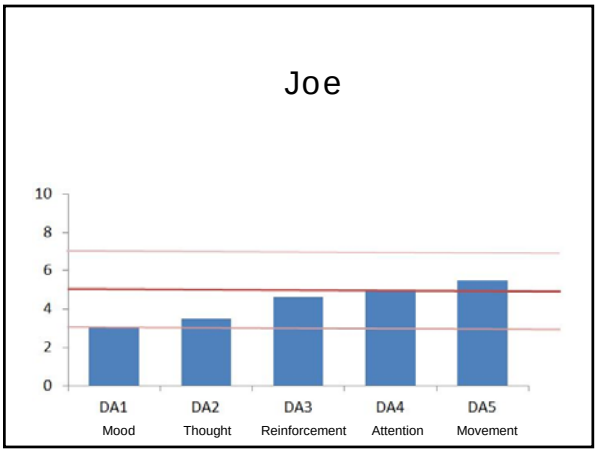
Analgesia
Sedation
Decrease rate of body functions

- Morphine
- Hydrocodone
- Oxycodone
- Heroin
- Codeine
- Methadone
- Fentanyl
- Tramadol

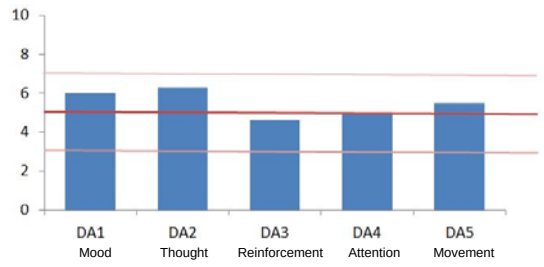
A person's drug of choice is the one that lines up best with the receptors

Key Point #3

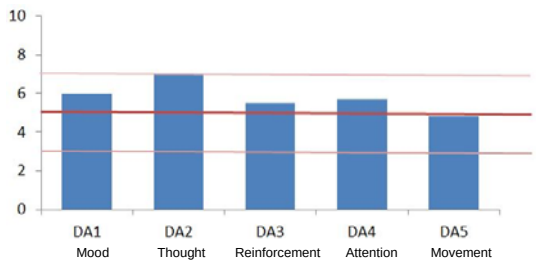
Drug use is motivated by
"correcting deficits"
and
Feeling better



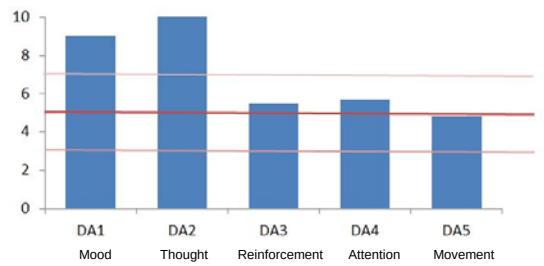
Joe + Meth



Jane

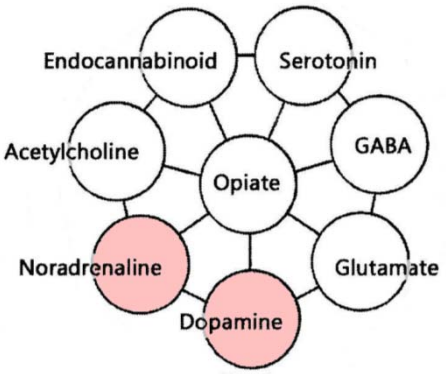


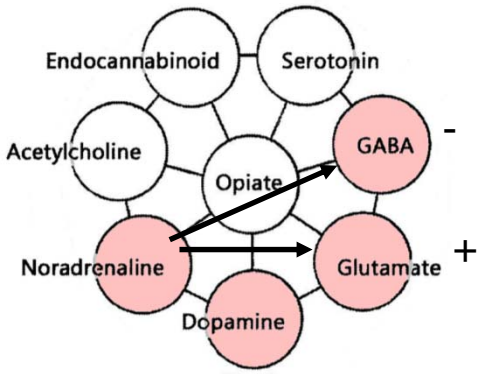
Jane + Meth

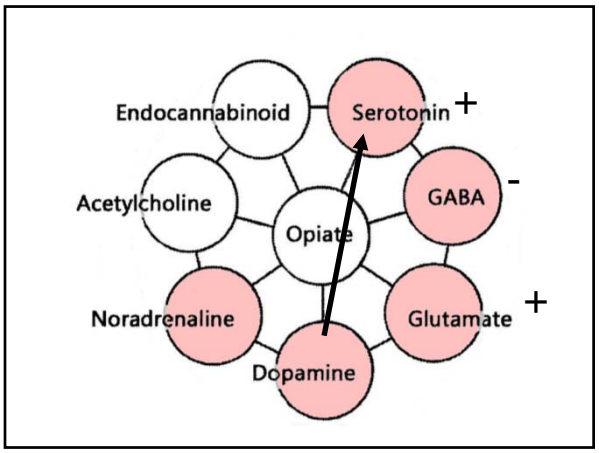


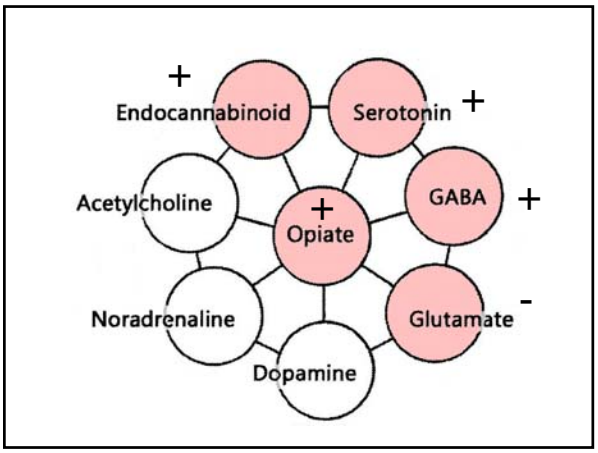
Key Point #4

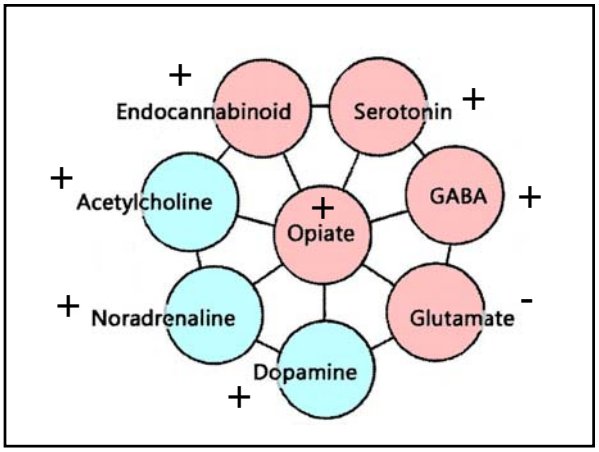
Affecting any one system affects many other systems





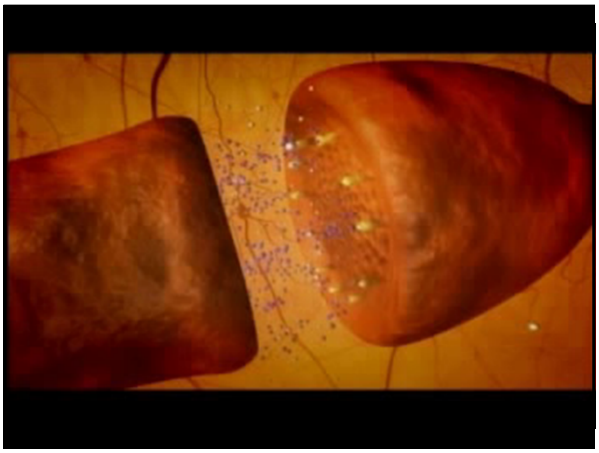






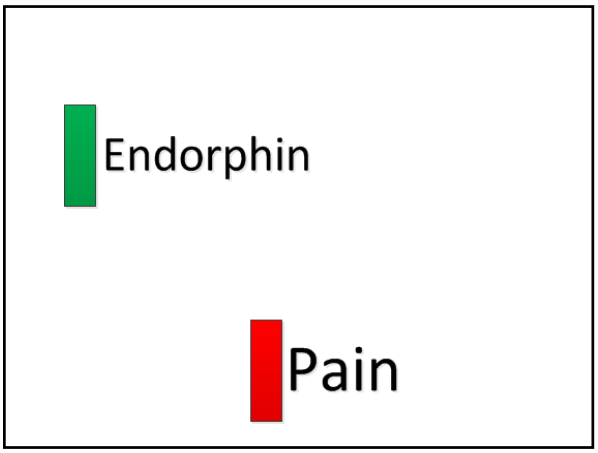
Key Point #5

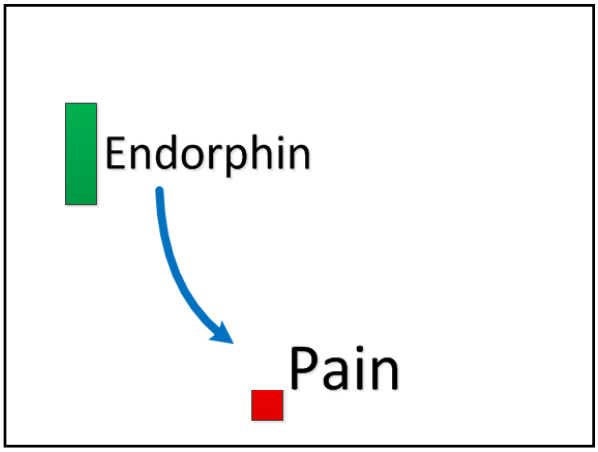
Tolerance is the down-regulation of neurons trying to "right" the drug-created imbalance

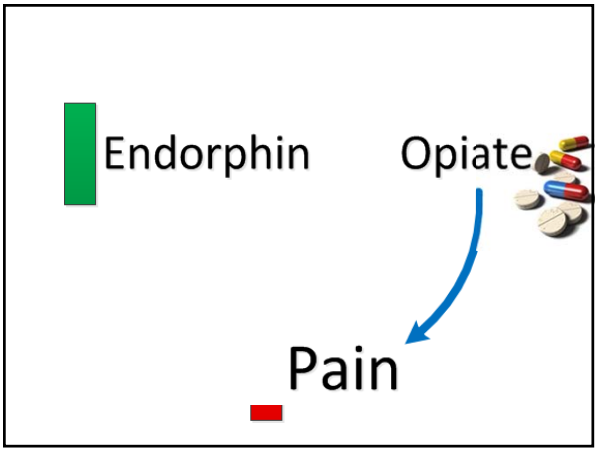


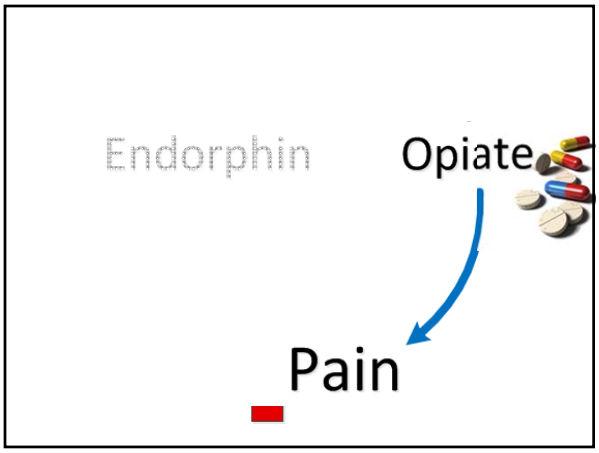
Endorphin

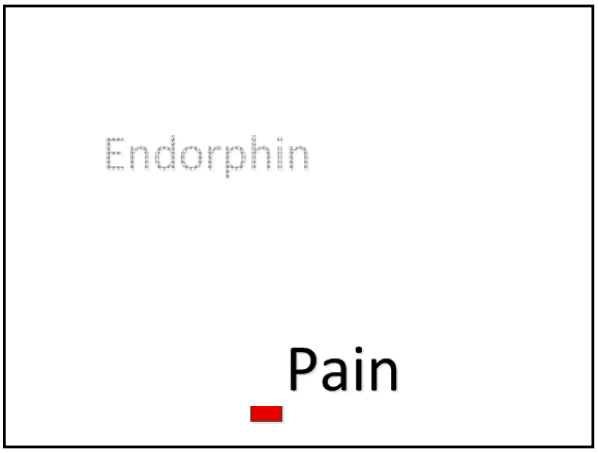

USA
32:40
@SBNATION


Endorphin
Pain


Endorphin
Pain


Endorphin
Opiate
Pain


Endorphin
Opiate
Pain


Endorphin
Pain

Endorphin

Pain

Endorphin

Pain

Endorphin

Pain

Key Point #6

Withdrawal is the up-regulation process of undoing tolerance

Key Point #7

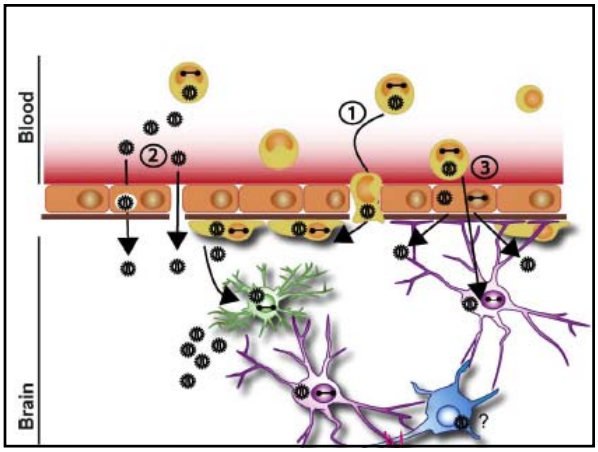
Treatment Involves attention to neurotransmitter systems

Change neurotransmitter balance

- Diet
- Wellness (sleep, exercise, relaxation)
- Environment
- Thoughts
- Medication

Two Types

- Amino acid – from food
  - Glutamate, GABA
- Biogenic – made in the brain
  - Dopamine, serotonin, norepinephrine, endorphin



Phenylalanine
↓
Tyrosine
↓
DOPA
↓
Dopamine
↓
Norepinephrine
↓
Epinephrine

L-phenylalanine
L-Tyrosine
L-DOPA

fish, poultry, meat, eggs legumes, cheese, milk, tofu, fruits, vegetables

vitamins C, E

ginseng
nettles
red clover
dandelion
peppermint

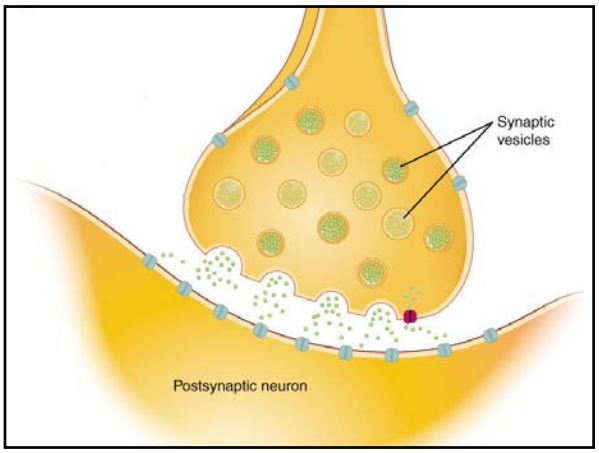
Medications for Serotonin

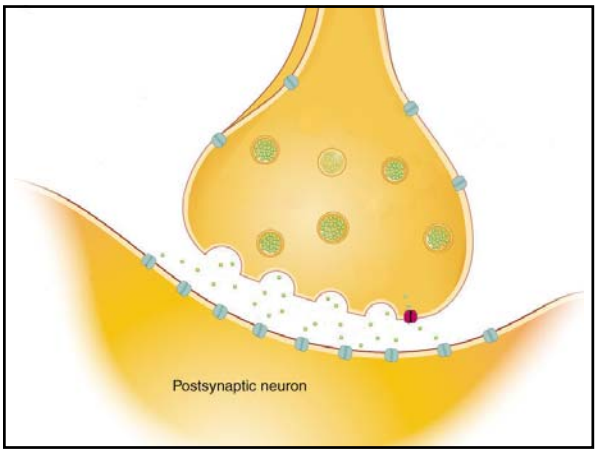
Selective serotonin uptake inhibitors (SSRIs)

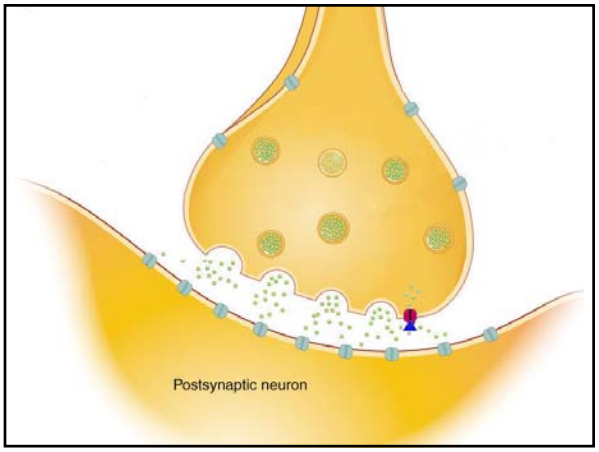
- Prozac, Paxil, Celexa, Lexapro

Monoamines oxidase inhibitor (MAOI)

- Parnate, Nardil, Marplan



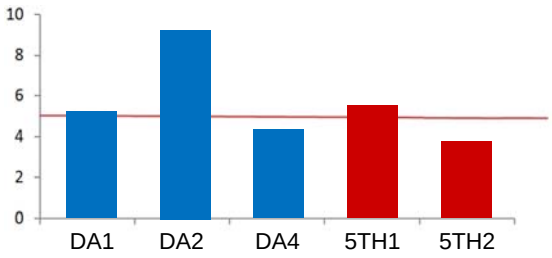




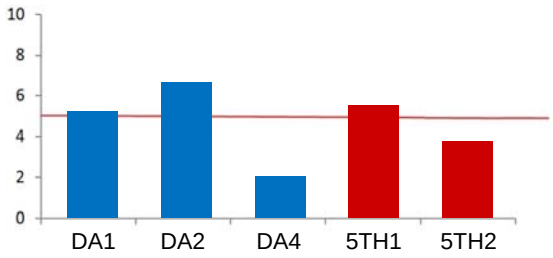
Dopamine

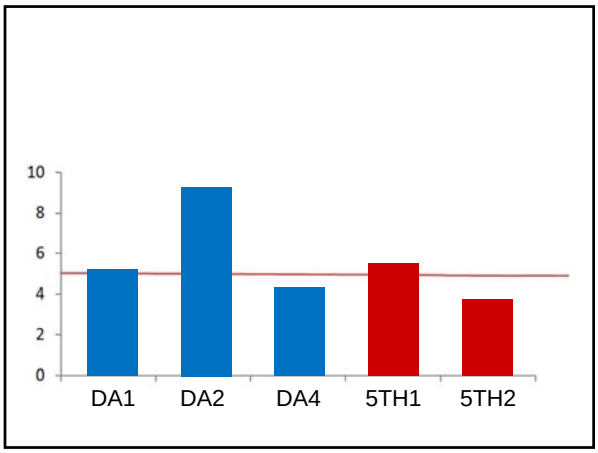
- Abilify
- Wellbutrin
- Haldol
- Gabapentin
- Tramadol

Schizophrenia

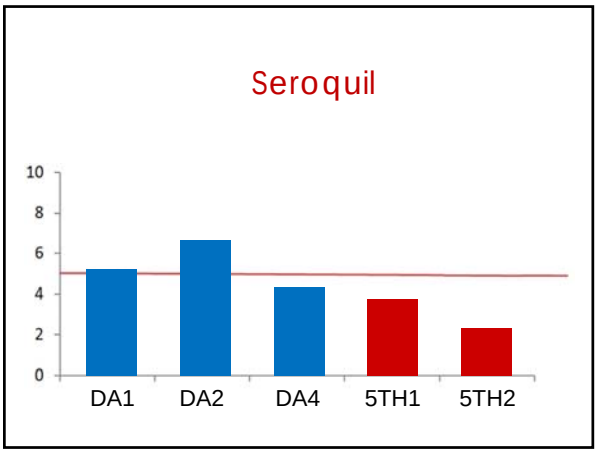


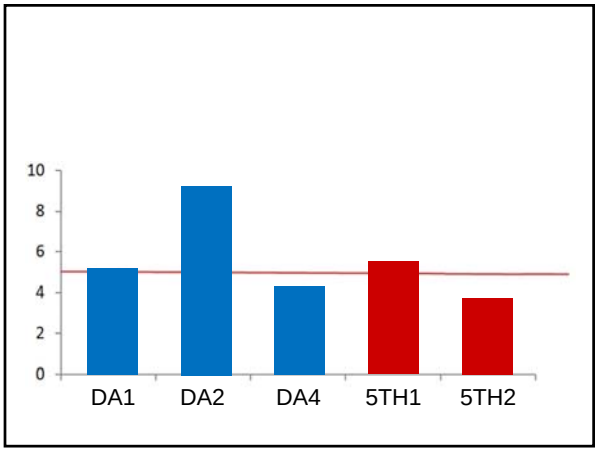
Haldol



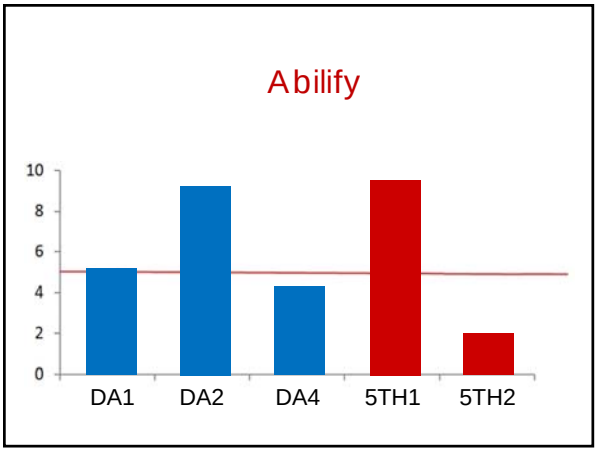


Seroquil





Abilify

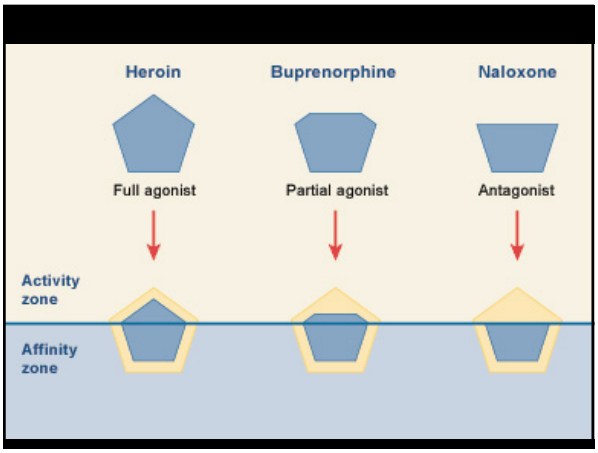


Opiate

Partial agonists
- Buprenorphine Suboxone, Subutex

Full agonist
- Methadone

Antagonist
- Naltrexone, ReVia, Vivitrol



Points to Remember

1. Thinking and mood are controlled by brain chemicals
2. We are born with genetically determined receptor sensitivity
3. Drug use is motivated by "correcting deficits"
4. Affecting any one system affects many other systems

Points to Remember

5. Tolerance is the down-regulation of neurons trying to "right " the drug-created imbalance
6. Withdrawal is the up-regulation process of undoing tolerance
7. Treatment Involves attention to neurotransmitter systems

References

- *Psychopharmacology: Drugs, the Brain, and Behavior*. Jerrold S. Meyer &, Linda F. Quenzer. Sinauer Associates, 2005.
- *Brain In Balance: Understanding the Genetics and Neurochemistry Behind Addiction and Sobriety.* Fredrick Von Stieff M.D. Kenyon Hill Publishing, 2012.
- *The Secret Life of the Brain*. Richard Restak, M.D. Joseph Henry Press, 2001.