

The Brain

Human Brain

- Most complex biological entity in known universe
- 100 billion neurons + 1 Trillion “glial” support cells
- Incalculable number of connections

Brain Architecture

- Ascending, we get more recent evolution
- Brain stem: autonomic functions (breathing, T regulation)
- Mid-brain: emotions
- Top brain: grey matter, complex processing

Lower Brain and Stem

- Stem: general alertness and warning system
- Cerebellum: coordinates movement
- Thalamus: relays sensory info

The Limbic System

- Hippocampus: storage of memories
- Amygdala: emotional control and emotional memories
- Hypothalamus: motivation and homeostasis
 - Desires

The Cerebrum and Cortex

- The cerebrum is the white matter
- The cortex is the grey matter
 - Most recently evolved layer of the brain
 - Responsible for higher functions
- Know the lobes

Four Lobes

- Frontal: motor control, cognitive activities (planning, decisions, incentive)
- Parietal: sensations of touch, pain, temperature
- Occipital: visual information
- Temporal: hearing and sound processing

Primary Motor and Somatosensory Regions

Prefrontal Cortex

- Most recently evolved part of human brain
- Chief regulator of brain processes

- Evaluation of decision making
- Emotional impulses acted upon or not

Orbitofrontal Cortex

- Mission-control of limbic system
- Integrates and assesses info from many sensory inputs
- Balances with previous experience
- Responsible for gut reactions, assessing emotions

Neurons

- Body of the neuron is the soma

Nerve Transmission

- Ion channels include: Na⁺/K⁺ gates and Na⁺/K⁺ pumps
- Resting potential slightly negative (70mV)
- Action potential: polarity change inside neuron

Synaptic Transmission

- Nerve impulse reaches axon ending
- Neurotransmitters are packaged into vesicles
- Vesicles fuses with presynaptic knob of axon endings
- Neurotransmitter released into synaptic cleft
- Neurotransmitters bind to receptors and open ion channels
- Ions flood in and stimulate action potential
- Neurotransmitters degraded by enzymes
- Once a message has been transmitted from an upstream nerve cell to a downstream nerve cell, there's an excess of neurotransmitters leftover

Part 2

Humans have huge brains

- More developed regions (frontal lobe)
 - More developed motor control (bipedalism)

Humans Have Narrow Pelvis

- Be stronger and support upper body weight

Human Brain and Birth Canal

- At the end of gestation, head is widest part
- High risk of getting stuck
- Compromise: brain is relatively small and immature at birth

Soft Spots

- Bones in skull remain unfused until after birth
- Allows for squeezing of head through birth canal

Dependent/ Independent Young

- Humans have the most immature brain at birth of all mammals
- Other mammals are able to be independent shortly after birth

Allometric Growth

- $\frac{3}{4}$ of brain growth occurs outside of womb
- By age 3 brain is 90% adult size

Brain Development

- Brain is an expensive tissue
- Consumes 50% of body's glucose
- During 1st 2-3 years may consume 80%
 - Rapid growth
 - High brain:body size

Nature vs Nurture

- Genes dictate basic structure, developmental schedule, anatomy etc
- Environment sculpts and fine-tunes the systems that determine how it functions

Synaptic Pruning

- Brain growth is very responsive to certain stimuli
- Babies are very responsive to sound and sight
- Stimuli are required for proper brain development
- Brain development will slow down eventually to reach a manageable level (synaptic pruning)

Neuronal Wiring and the Environment

- 3 essential components critical to proper brain development:
 - Nutrition
 - Physical security
 - Consistent emotional nurturing

Evolved Mechanisms

- Babies cry to establish security and to satisfy their needs
- Irresistible to parents
 - Supported by oxytocin
 - Allows parents to maintain pleasurable love despite challenges and difficulties
- Basis of attachment relationship

Attachment

- Innate pursuit for closeness of others
- Survival mechanism in infants due to helplessness
- Most important factor in brain development

Infant Mental Health

- Brain development intimately tied to psychology of parent and quality interactions
- They feel stress, anxiety, happiness
- They read your pupils, body language, tension

Parental Nurturing

- Presence determines levels of good mood related chemicals
 - Serotonin (antidepressant)
 - Oxytocin (love chemical)
- Absence determines levels of harmful chemicals
 - Cortisol (stress hormone)
 - Vasopressin (high blood pressure)
 - Shrinks hippocampus (memory storage)
- Ability to regulate psychological and physiological stress affected
- Opioid attachment-reward system
- Dopaminergic incentive-motivation system
- Self-regulation of PFC
- Body-brain system of stress-response mechanism

Opioid Attachment System

- Develops through happy relationship-based emotional interactions
- Healthy growth leads to love, connection, pain relief, pleasure & attachment
- Stunted by stress, painful emotional experiences and trauma

Endorphins

- Alleviate physical pain
- Ease emotional pain
- Create parent-child bond
- Maintain social relationships
- Trigger feelings of intense pleasure
- All are integral to being a social human being

Dopamine System

- Governs motivation-incentive
- Built on stable experiences between infant and parent
- Neurons wired via social-emotional stimulation

Incentive-Motivation Apparatus

- Initiates activities related to pleasure

- Plays role in learning new behaviours
- Essential to human evolution
 - Initiating food foraging activities
 - Seeking sexual partner
 - Explore environment

Limbic System

- Dopamine and endorphins are integral to emotional brain
- Processes love, joy, pleasure, pain, anger, fear
- Necessary to initiate and maintain activities necessary to human survival

Incentive-Motivation Apparatus

- Triggered in the Ventral Tegment Apparatus (VTA)
- Nerve fibres stimulate Nucleus Accumbens (NA)
- Lab rats wired to VTA with a lever will over-stimulate to the point of exhaustion

Proximal Separation

- Children experience distress even when parent is physically present but emotionally absent
- Leads to stress and anxiety in infants

Stress and Anxiety

- Physiological response when an organism's coping mechanisms are overwhelmed
 - May be biological or psychological demands
 - Body attempts to maintain homeostasis
- Early childhood stress lowers threshold response
 - Triggered more easily, more anxious and distressed

Physiological Response

- Release of adrenaline and cortisol in almost every organ and tissue
- Creates a state of readiness to threats
- Fight or Flight origin
- In humans, most threats are emotional

SL 14:

Infants brain responds in the same way to emotional and physical pain
Addictions are rooted in PAIN; what is the source of this pain?

SL 15:

**know this def for midterm!

Harm can be psychological; social; personal; physical; and continuing the behavior = addiction

SL 16:

Are drugs addictive? Are they the problem?

Patients given serious drugs in hospital for high pain; the longitudinal study (study over a time)
Nothing in this study correlates to addiction (the people did not crave drugs after); they could wean people off the drugs as they left hospital

SL 17:

Vietnam war

High drug use during the wars

20% addicted to heroin because of their experience and war was damaging; drug numbed
1% after the war use; they didn't feel the need to use them (addictive behavior disappeared)

Has more to do with the psychology of the people involved

SL 18:

Crystal Meth!

If it was really that addictive; the number of people in the past year would be the same as the
number of people who have tried it

Why are some addicted and others not?

SL 19:

Captivity and non-social env is a constrained env; rats are social and they take the drugs to help
with their lack of companionship

SL 20:

Rat park: 200x more space to move around; social interactions; fun times; and they ignored a
morphine drop!

When stressed; females take more drugs than the males

When socialised; the rats didn't do drugs! Socialization is really the key to a healthy life (rats
and humans!)

Even when sugar added to the morphine; the rats still didn't fall for it!

Took the caged rats that were addicted and put them into rat park and they stopped taking
drugs!

SL 22:

If happy and healthy we don't feel the need to do drugs!

Neurobiology has more to do with which indiv will do drugs; if stressed = more likely to do drugs

SL 23:

Need social interactions throughout life to reduce stress

Cocaine = dopamine mimic and this will activate the dopamine receptors

SL 24:

Almost all people who do drugs have had abuse (physical, sexual, emotional)

Infant brain; deprived from attachments with caregiver; and the dopamine drugs make them feel “normal”

SL 25:

ACE; early life trauma

SL 26:

Women doing drugs = physical/ sexual abuse (100% correlation- PTSD lingers)

SL 27:

Development of the brain; some are more likely to take drugs to feel “normal” and make up with the deficiencies

SL 28:

Does not have enough receptors and fewer neurotransmitters (NT); from underdevelopment of limbic system in the brain

SL 30:

KNOW 4 SYSTEMS! (perhaps this will be a long answer q on the midterm)

Not enough receptors to stimulate the brain and drugs compensate (morphine; heroin)

SL 32:

Dopamine: get up and go do things; cocaine = prevents re-uptake (degradation) and overstimulates the receptors

SL 35:

The brain tries to avoid huge fluctuations in the brain; the brain will overcompensate and reduce stimulation if using artificial mimics and the brain kills off receptors; therefore it becomes more difficult to get off because the brain cannot uptake it

Need more drugs overtime to get back to the normal level

SL 36:

Alcohol diminishes the feelings of rejection from earlier on in life

SL 37:

If underdeveloped brain; then the brain is more likely to be impulsive

Cannot evaluate risks (very present thinking; cannot think about the future; no balance and rational decisions are not made)

Not capable of reading emotions

Cravings more important than anything; **impairs judgement**

Part 3

Drugs of Planet Origin

- Most drugs have a plant based origin
- They stimulate biological receptors in organisms
- Can mimic chemicals that are already in our body
- Aspirin (acetylsalicylic acid)
 - Salicylic means it comes from salix (willow trees)
 - Extract from bark of willow tree

Plant Secondary Compounds

- Chemicals in plants to protect them from their enemies
 - Microbial enemies
 - Degrade tissues
 - Insect enemies
 - Eat the plants
- Chemistry was evolved to protect plants
- Called secondary because they are not essential to the metabolism of a plant, but is helpful

The Spice of Life

- Spice is a result of the protective chemistry

Cultural Use of Spices

- Spices protect from rotting food, which helps human health

Spice Used by Region

- Increased heat and moisture increases risk of microbial rot

Silurian Land Plants

- 416-447 MYA
- Colonization of land
- Non-vascular mossy plants
- Insects quickly followed
 - First terrestrial animals

History of Insect Damage

Plant Defences

- Large herbivores deterred by physical defences
- Spines
- Glandular trichomes
- Siliceous spicules

Plant Defences

- Alkaloids
 - Nicotine
 - Caffeine
 - Morphine
 - Cocaine
- Terpenes
 - Citronella
 - Menthol
 - Camphor
- Phenolics
 - Cannabinoids
 - Capsaicin
 - Salicylic acid

Monoamine Neurotransmitters

- Most neurotransmitters are similar in their makeup
- Almost all animals have similar nervous systems

Non-specific Neurotoxicity

Plant Monoamines

FILL IN SLIDES YOU MISSED

There is Hope

- Brain is highly plastic
- Neurons that fire together wire together
- Solution
 - Not in withdrawing drugs from brain, but removing their need
 - Remove haunting effect of traumas and allow brain to build healthy emotions

Psychedelics and Serotonin

- Psychedelics have impacts on the serotonergic system of the brain
- Serotonin is a very common body chemical
- Psychedelics are thought to be an alternative way to access your emotions

Psychedelics and Therapy

- Used to treat addictions, depression, OCD, PTSD, anxiety
- ID, ego, superego

A connected Brain on LSD

Ayahuasca Psychotherapy

- Most potent psychedelic drug
- Able to target traumatic experiences and determine the source of them and the source of your behaviours