Brain Effects of Vaping and Nicotine Use

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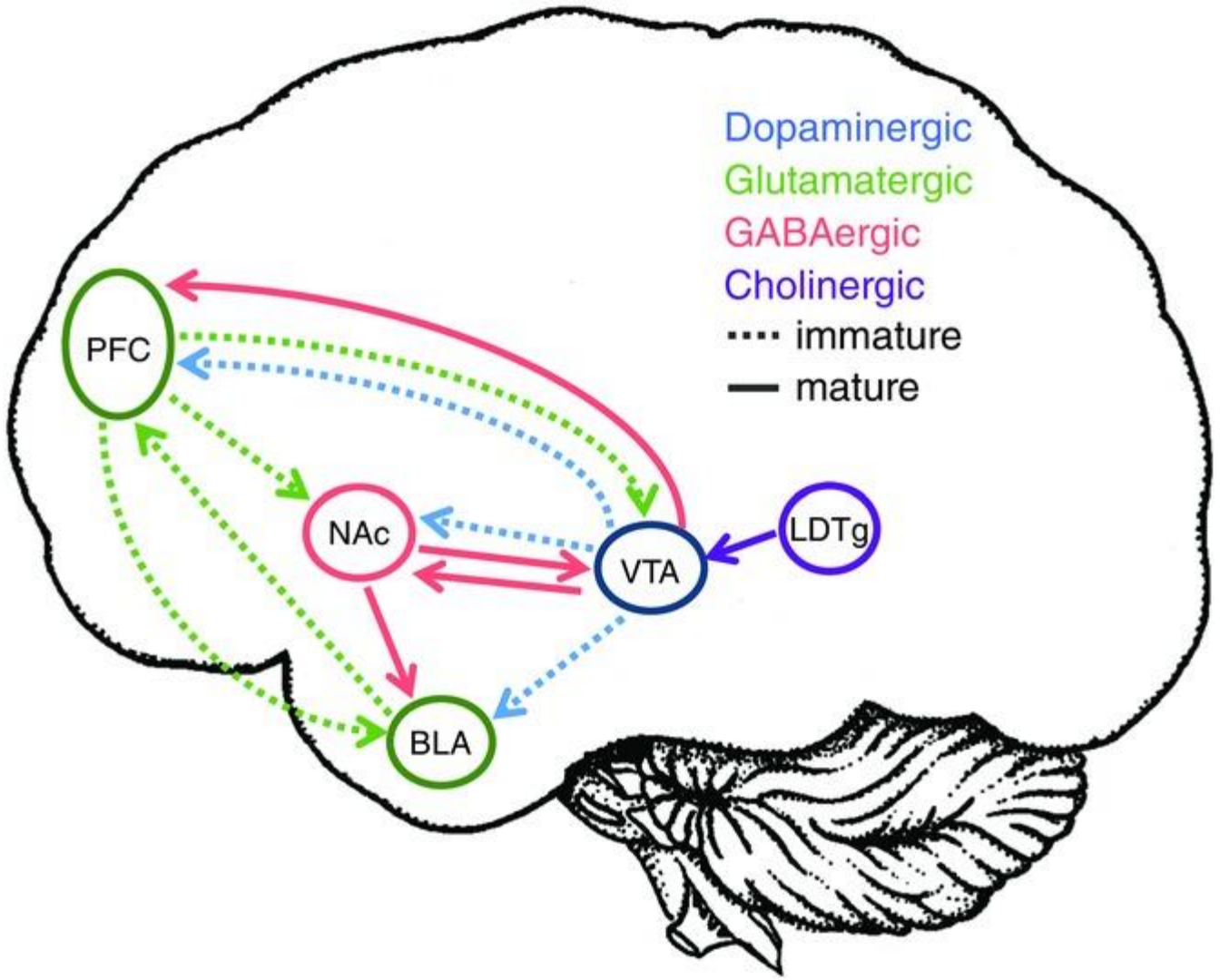
Disclosure

I have no conflicts to disclose.

Vaping

- Nicotine
- Cannabis (THC or CBD)
- Flavors
- Additional substances:
  - Delivery solvents
  - Flavors
  - Carbonyl Compounds
  - Alkaloids (tobacco related)
  - Nitrosamines (Tobacco specific)
  - Reactive oxygen species
  - Metals
  - Other Toxins not defined

Normal Adolescent Brain Development



Nicotine

- Known neuroteratogen
  - Alters cell proliferation and differentiation
  - Cell damage
  - Interferes with synapse maturation and intercellular communication
- Damage occurs despite frequency or concentration of use

- Animal Studies:
  - Cell loss
  - Decreased DNA concentration
  - Decreased Neuron projections
- Forebrain and Midbrain
  - Nicotinic acetylcholine
  - Serotonergic
  - Dopaminergic
  - Glutamatergic

Nicotine

- Upregulation of nicotinic acetylcholine receptors (nAChRs)
- Increased dopamine in Mesocortical limbic regions
- Glutamate system – increased fast excitatory synaptic transmission
- Decreased serotonin and dopamine in the prefrontal cortex

- Expression of arc mRNA and plasticity genes
  - Arc – gene important for synaptic plasticity (thus learning and memory) – expressed higher in specific cortical regions of adolescents
  - c-fos
- Cellular plasticity

Subsequent Effects of Nicotine

https://medium.com/parkinsons-uk/protecting-brain-cells-the-story-of-nicotine-b3b51f5b8259

- Learning
- Memory
- Behavioral changes
- Addiction

- Psychiatric Concerns
  - Anxiety
  - Depression

Cannabis

- Levels of THC in cannabis have increased in potency – 4% in 1995 to 12% in 2014
- In utero:
  - Impaired central nervous system development → cognitive and behavioral deficits
    - Prefrontal cortex
- Adolescence:
  - Decreased volumes
    - Whole brain, gray matter, and hippocampus
  - Prefrontal cortex – increased and decreased volumes
  - Decreased prefrontal and insular cortical thickness
  - Larger amygdala volumes (in females)

http://420intel.ca/articles/2020/03/10/barriers-studying-marijuana-qa-dr-thorsten-rudroff

Cannabis

- Endocannabinoids
  - Can inhibit GABA-ergic and glutamatergic synapses – role in balancing neuronal activity
- CB1 receptor - expressed in a high density in cerebral cortex, hippocampus, basal ganglia and cerebellum
- Exogenous cannabinoids disrupt adolescent neuronal development
- Disrupted glutamate release
  - Interferes with neurotransmitter release
- Decreased cannabinoid receptors

Subsequent Effects of Cannabis Use

- Impaired Memory
- Impaired Cognitive Functioning
  - IQ Loss – Average 8 pts
  - Memory, Learning
- Impaired Executive functioning
  - Impulsivity
  - Externalizing Behaviors

- Psychiatric Concerns
  - Psychosis – hallucinations
  - Paranoia
  - Schizophrenia
  - Anxiety
  - Depression
  - Suicidal Ideation

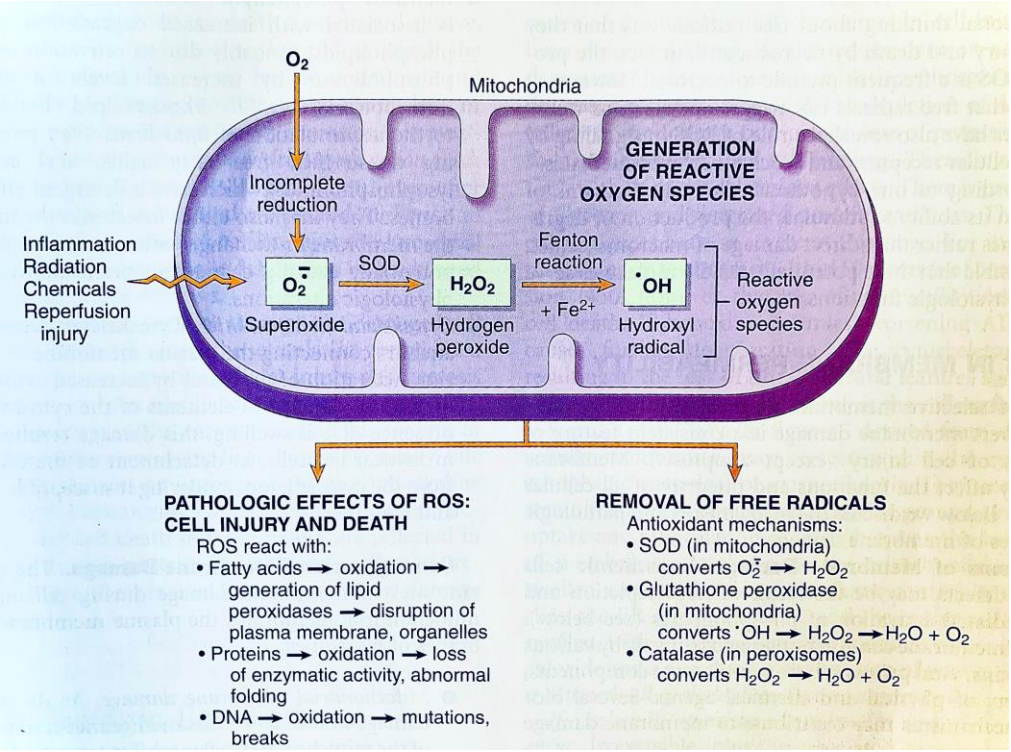
Oxidative Stress

- Free Radicals, Reactive oxygen or nitrogen species
  - Flavors
  - Heavy Metals
  - Nicotine
  - Aerosols
  - Cannabis

Tully, S (2019). “Coach Kathleen on Antioxidants and Free Radicals!” https://i2.wp.com/crossfittiltiii.com/wp-content/uploads/2019/07/Picture8.jpg?ssl=1

Oxidative Stress

- Damage to cells
- Disrupted antioxidant/scavenger system
- Disrupted DNA repair system
- Contributes to addiction, inflammation, and more oxidative stress
- Developing brain is particularly vulnerable
  - Cerebral cortex, Prefrontal cortex
  - Hippocampus



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Summary of Brain Effects of Oxidative Stress

- Disrupted Brain Development: Cerebral Cortex- Prefrontal Cortex and Hippocampus
- Decreased MAO-A gene expression – correlated with aggression and impulsivity
- Decreased dopamine expression
- Suppressed serotonin expression
- Oxidative stress as part of the molecular mechanisms for development of depression, sleep disruption and aggressive/impulsive behaviors

Subsequent Effects of Oxidative Stress

- Social maladjustments
  - Sleep disruption
  - Attention changes
  - Aggression
  - Impulsivity
  - Cognitive and memory impairment
- Psychiatric concerns
  - Depression
  - Suicidal Ideation

Resources

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