

Pleasure systems in the brain

Can we make people happy by stimulating a brain region?

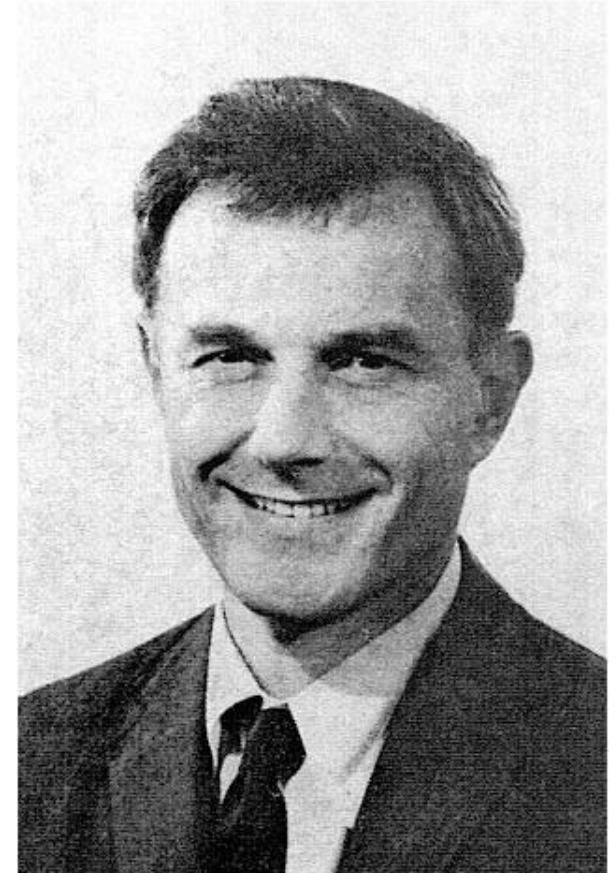
송석호 최가현 허권

Pleasure center

- The dopamine synapse and the notion of 'pleasure centers' in the brain – Roy A. Wise

James Olds

- Existence of specific circuitry for reward function by observing work with electrical stimulation
- Called reward site as “pleasure center”
- But stimulating cell somata, not fiber → withdrawn his opinion
- However, recent study supports this result



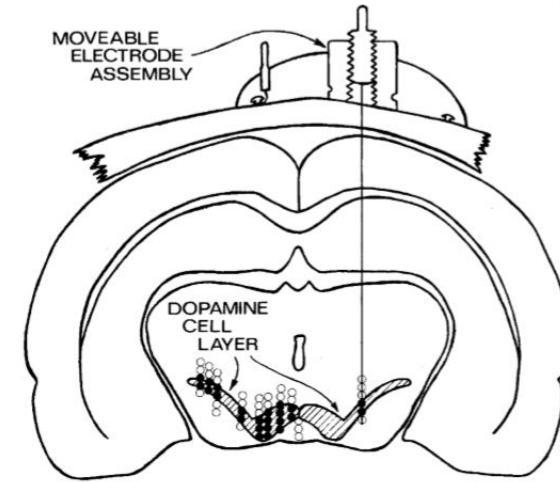
James Olds

Pleasure center

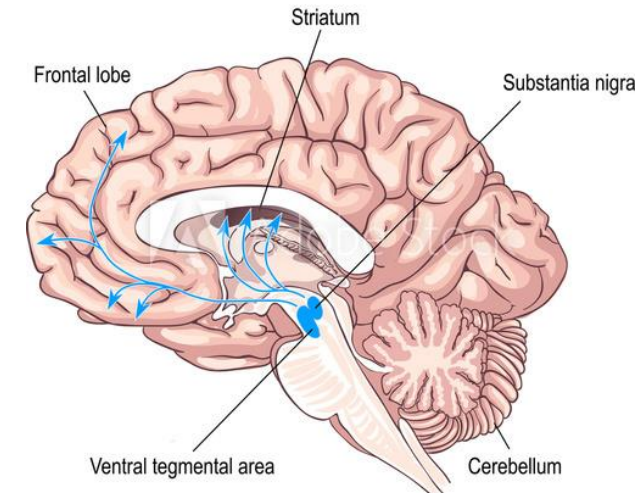
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Brain stimulation reward and dopamine anatomy

- The fibers of the ascending dopamine system
 - observed to be the highest at best self stimulation site (Olds study)
- According to Crow's study, self stimulation at dopamine system highly related to dopamine anatomy (ventral tegmental and substantia nigra areas)



DOPAMINE SYSTEM



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Dopamine pharmacology and brain stimulation reward

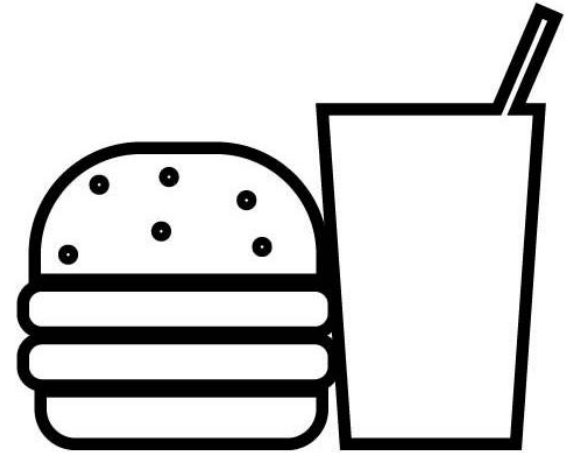
- Pharmacologically, preventing dopamine synthesis and receptor prevents self stimulation
- Blocking dopamine needs more electric current for maintaining reaction
- Blocking dopamine prevents reward message
 - activation of pleasure experience from stimulation can be block in advance

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Dopamine and food and water reward

- Does natural reward (food or water), not artificial reward affect dopamine?
- No specific brain system for reward from drug or brain stimulation
- Pleasure on food or water decreases as blocking dopamine
(mean response from mouse after feeding, day 1 – 200, day 2 – 150, day 3 – 100)



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The dopamine synapse as 'pleasure center'

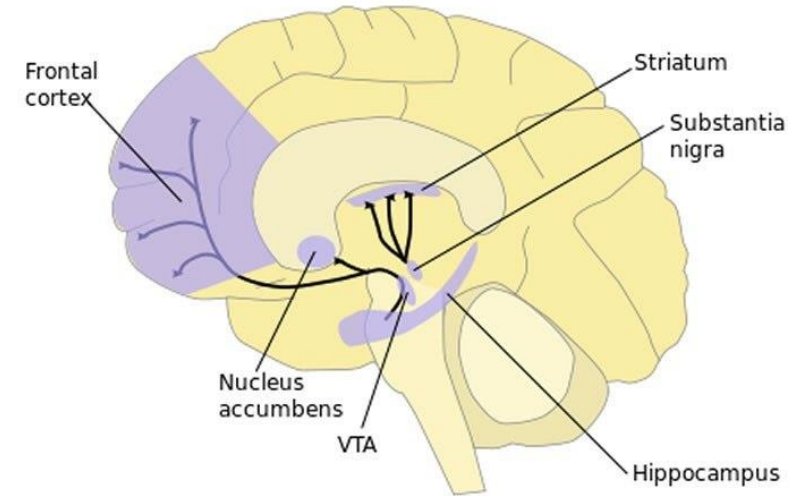
- Blocking of dopamine synapse can block rewarding impact → reward by direct activation of synapse
- Qualitatively change on dopamine terminal field synapse while transferring
- Impact of stimulation induced at specialized central substrate from some variation of sensory message
- Dopamine influences on reward and dopamine synapse generally shows synaptic method for reward event

Pleasure center

- Nucleus accumbens (Nacc) as pleasure center (The Neuroscience of Pleasure and Addiction)

James Olds (1954) – nucleus accumbens (Nacc)

- implanted electrodes -> rats become addicted to pushing lever that stimulate Nacc
- electrical stimulation of ventral tegmental area (VTA) triggers release of dopamine in nucleus accumbens in same way that addictive drugs and natural reinforcers triggers
- pleasure center is involved in reward-driven reinforcement of learning and addiction

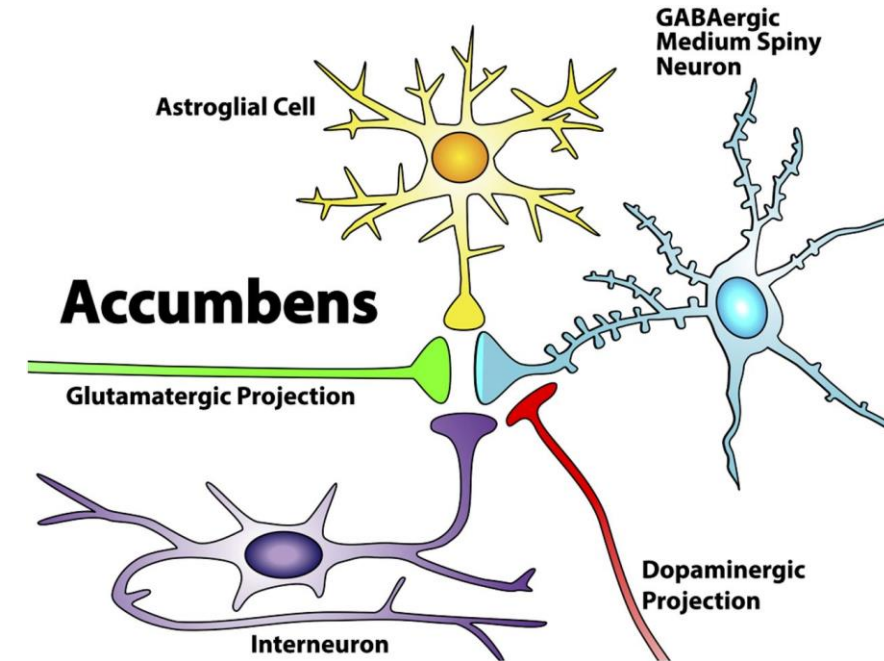


Pleasure center

- Nucleus accumbens (Nacc) as pleasure center (The Neuroscience of Pleasure and Addiction)

Jonathan Britt (2014) – nucleus accumbens with glutamate system

- By optogenetics, identify that nucleus accumbens integrates dopamine dependent reinforcement signals with environmental stimuli, which depend on a second neurochemical ; glutamate
- pleasurable associations of a reward -> synapses with addition of glutamate



Pleasure center

- Feeling of happiness through brain stimulation (Can Electrically Stimulating Your Brain Make You Too Happy?)

Matthis Synofzik (2012) – electrodes in central part of brain reward system; nucleus accumbens

- experimented with settings from one to five volts
- 1V: happy 2 anxiety 8, 2V: happy 3 anxiety 6, 4V: happy 10 (maximum) anxiety 0 (absence)
- 5V: feeling of ecstasy (anxiety up to 7, out of control)
- left patient at normal level -> next day patient felt that he needed to be “little happier”

Pleasure center

- Feeling of happiness through brain stimulation (Can Electrically Stimulating Your Brain Make You Too Happy?)

Journal Pain (1986) – single electrode placed in part of thalamus on right side with self-stimulator

- patient with insufferable chronic pain -> use when pain was too bad
- patient discovered when turned it up almost to pull power makes her feel good
- but ignored all other discomforts; developed atrial fibrillations due to exaggerated stimulation, nothing interest her at all, ignore personal needs and hygiene in favor of self-stimulation

Pleasure center

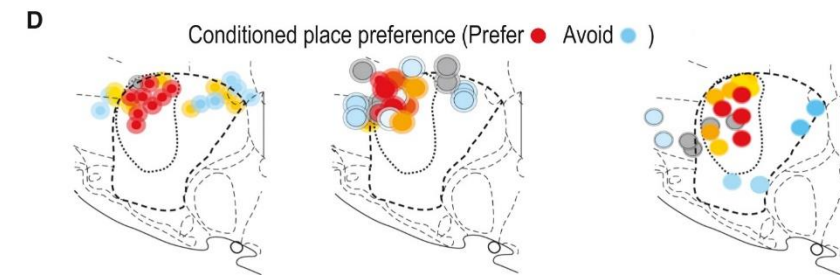
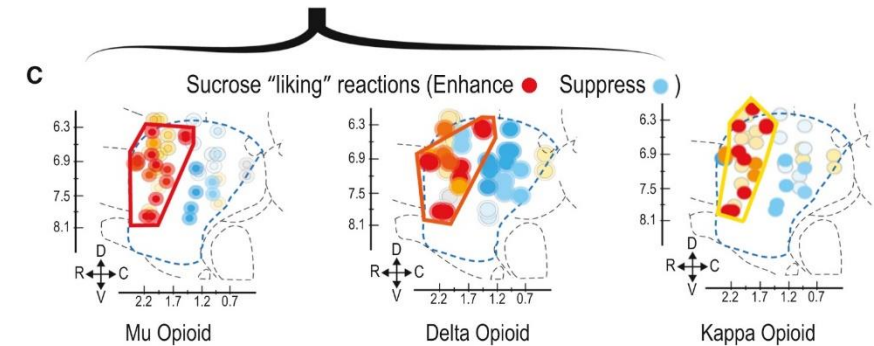
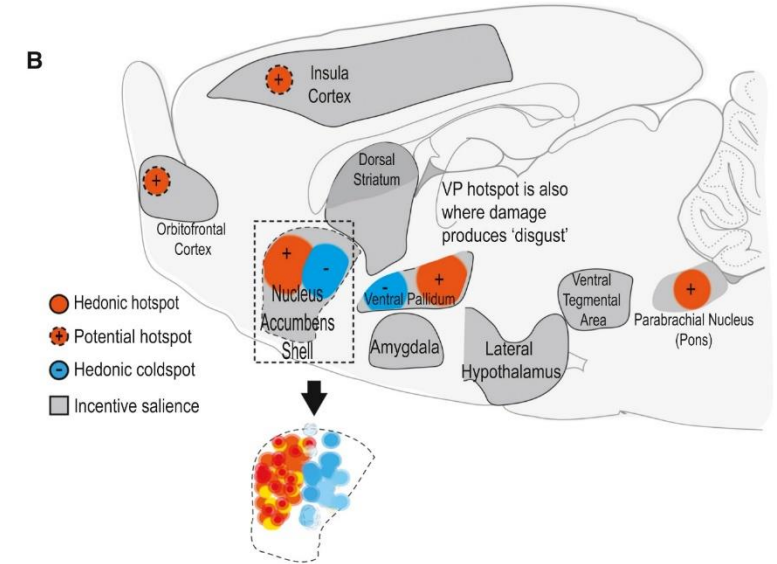
- Pleasure systems in the brain (Kent C. Berridge)

describe as **“liking = pleasure itself”**

→ hedonic hot spot of limbic system related to liking is the circuit that has direct relevance to pleasure

- Hotspot can be built in anatomical pattern of nucleus accumbens which cause desire (versus dread)

- breakdown of hedonic system could be the cause of disease related to pleasure such as anhedonia (lack of pleasure) or dysphoria (negative affect)



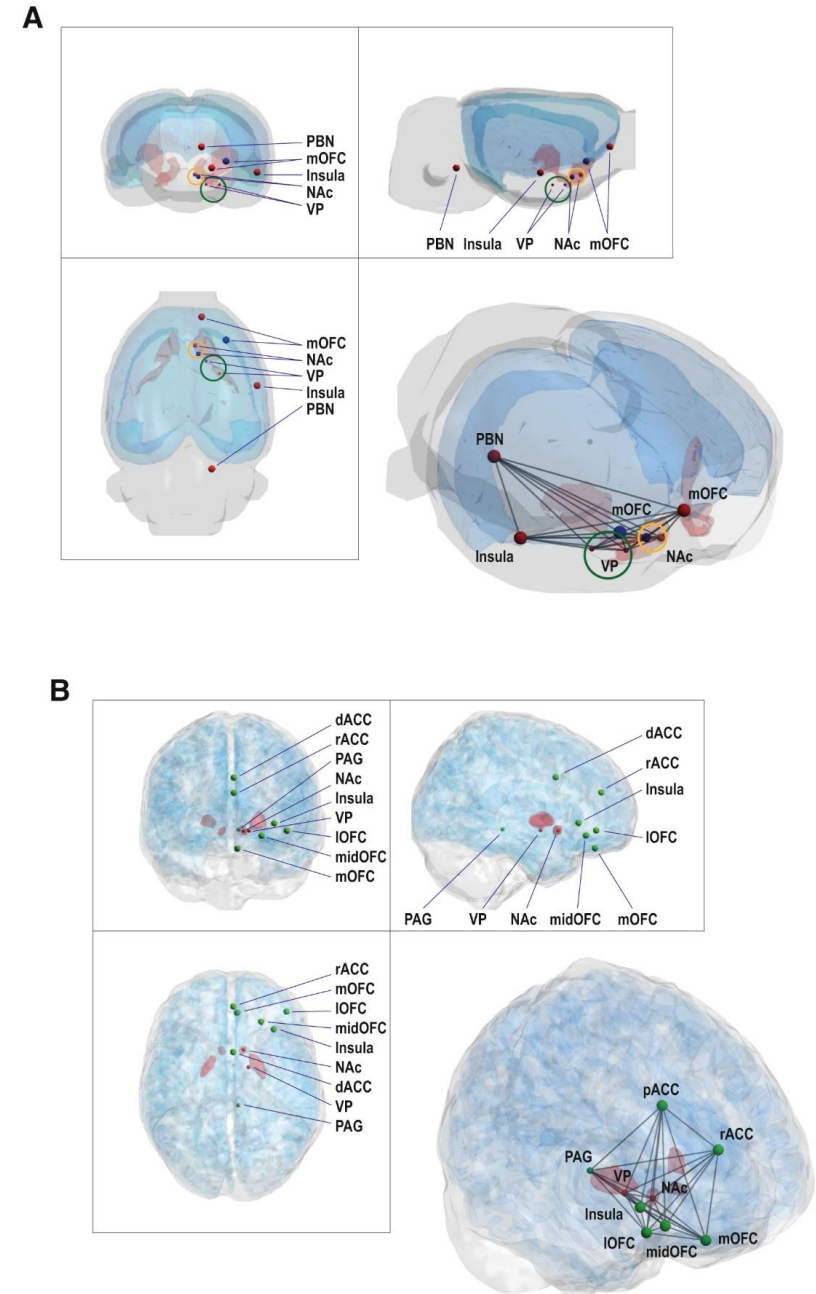
Pleasure center

- Pleasure systems in the brain (Kent C. Berridge)

Human also has **hedonic system** (but only **result from fMRI**)

- Some correlational neuroimaging activity may reflect causal mechanisms for pleasure, while other may be a consequence, rather than cause

- because many brain regions active during a normal pleasure may not actually generate that pleasure per se, but activate as a step to causally generating their own different functions, such as cognitive appraisal, memory, attention, and decision making about the pleasant event.



Pleasure center

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Mapping Brain Pleasure Generators

- A useful starting distinction is between causation of loss versus gain of function of hedonic function; Some neural mechanisms may mediate only one, for example, able to produce gains of function that enhance pleasure reactions without being needed for normal pleasure.
- entire limbic regions of human prefrontal cortex appear surprisingly unnecessary for the causal generation of normal pleasure.
- Subcortical structures may be surprisingly competent to generate many normal hedonic reactions and are consistent with many animal studies

Discussion - What will happen if we feel everything happy

- Happiness from lack and dissatisfaction, no meaning of life (ex. Need of self-actualization)
- Insensitive to danger, mechanism for preventing harm?
- Maintaining happiness is a work and consumes energy -> eventually happiness will not last
- Sustained stimulation causes desensitization; infinity happiness is impossible

Discussion - Future (if feeling happiness from brain stimulation is possible)

Acceptable?

- Reasons of “like”? (food <-> celebrity) → specific happiness (ex. Rock music) is acquired, not innate
- Happiness triggered to specific feature and as it repeats, studied to feel happiness toward very specific thing
- Brain stimulation may cause people to study that the stimulating situation is happy
→ what if they study with other specific situation with stimulating situation?
- therefore, more gain on hedonic system may have greater side effects (abuse)
- For patient, control lack, not gain, on hedonic system could be one solution (regulating unhappiness)

Discussion - Future (if feeling happiness from brain stimulation is possible)

Ethical issues

- If you have direct access to the reward system and can turn the feeling of euphoria up or down, who decides what the level should be? The doctors or the person whose brain is on the line?
- Who can have an access to brain stimulation? Patient with chronic or mental diseases or anybody who wants to have?

Thank you

Reference

1. The dopamine synapse and the notion of 'pleasure centers' in the brain (Roy A. Wise)
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2. The Neuroscience of Pleasure and Addiction <https://www.psychologytoday.com/us/blog/the-athletes-way/201405/the-neuroscience-pleasure-and-addiction>
3. Can Electrically Stimulating Your Brain Make You Too Happy?
<https://www.theatlantic.com/health/archive/2018/03/pleasure-shock-deep-brain-stimulation-happiness/556043/>
4. Pleasure systems in the brain (Kent C. Berridge) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4425246/>