



Executive Function – Decision Making, Free Will

11/21/2024

What is a decision?

- Out of a set of possible options (**affordance competition hypothesis?**), you select one to implement
- In most instances, life forces you to make a decision
 - Remember, not acting is also a choice
- What is going to influence your decision?
 - Context, expected rewards, past experience, uncertainty, risk assessment, emotional state, sociocultural influence, the amount of available time to respond, the limits of your imagination



There are tons of theories about how we make decisions

- Rational choice theory
- Expected utility theory
- Dual-process theory
- Prospect theory
- Drift diffusion model
- Reinforcement learning theory
- Bounded rationality
- Somatic marker hypothesis
- Bayesian decision theory
- Neuroeconomics
- Ecological rationality
- Sensation-seeking theory
- Fuzzy-trace theory

Some themes:

Deliberate/conscious vs. intuitive/automatic

- How much conscious thought is involved? Can the person explain their reasoning, and is that explanation accurate?

Value basis

- Idea of expected reward/loss. What is deemed most important and valuable and why?

Computational approaches

- Is there a quantitative framework for predicting choices? How are options weighted?

Emotion/context

- How much do external and internal influences affect the weight of decisions?

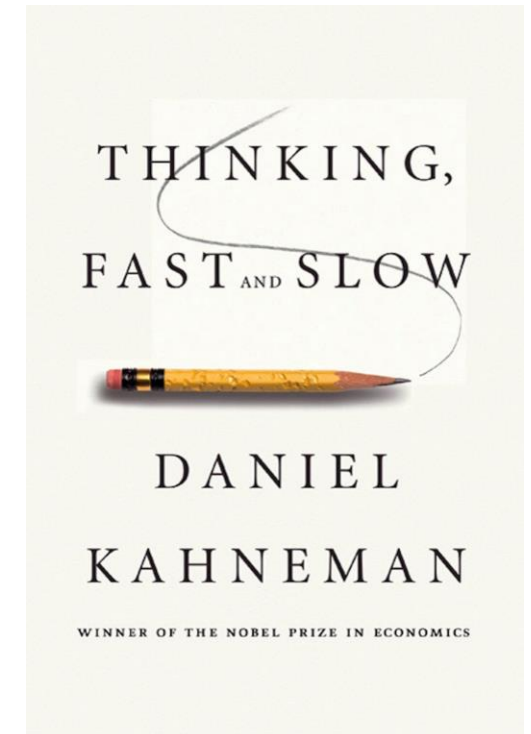
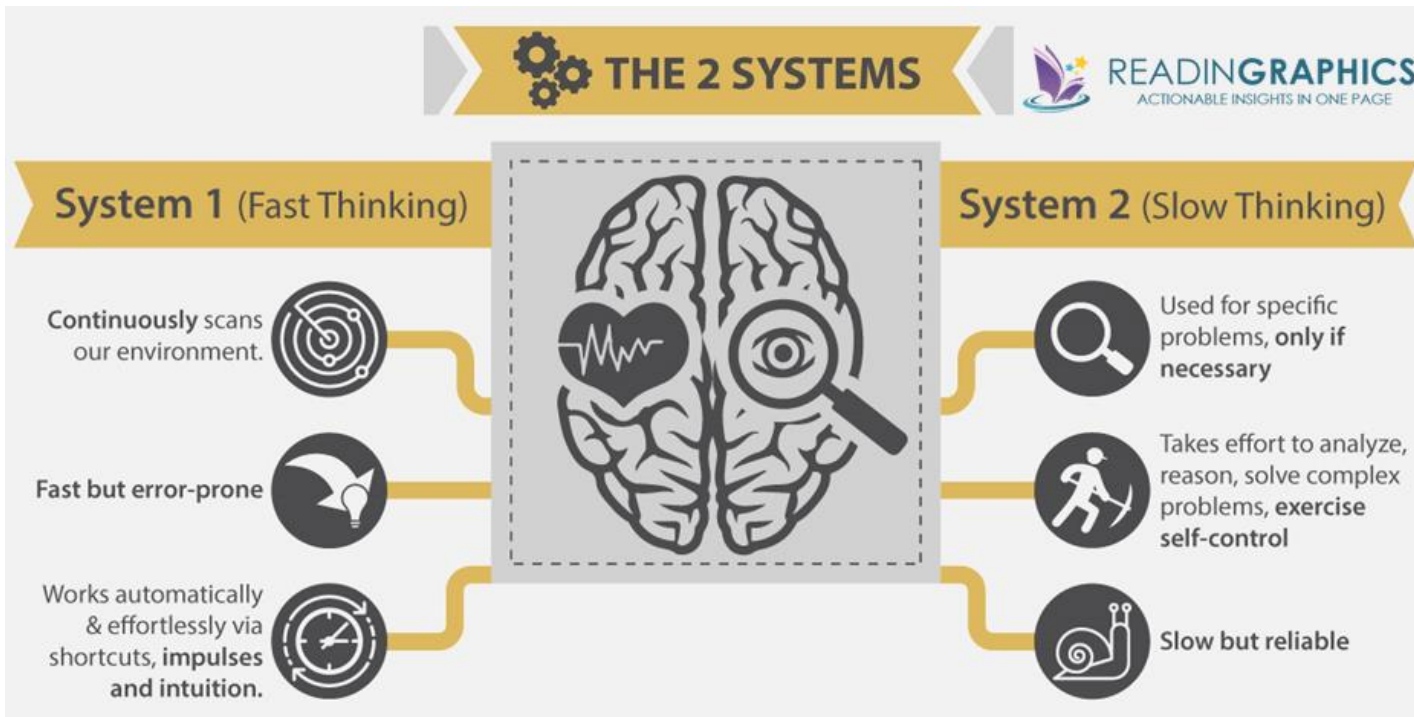
Limited information

- How do we account for the limited and imperfect information we have about a situation?



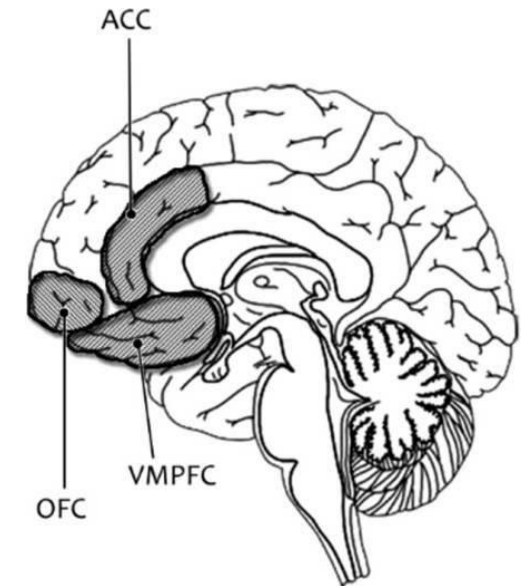
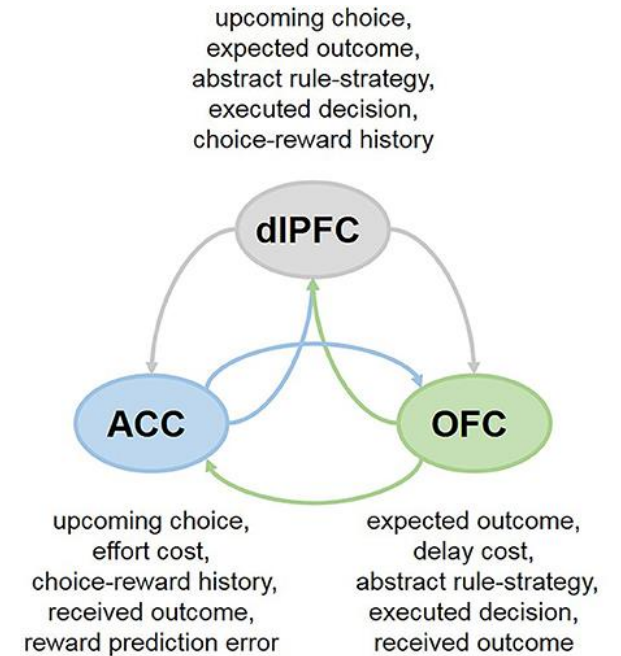
Dual Process Theory

- This model was popular when it debuted, but it has gradually fallen out of favor due to the idea that there are not two distinct systems in the brain, rather there is a continuum of automaticity
- Nevertheless, it remains well-regarded as a good way to think about your own decision making
 - Consciously slowing down to avoid an automatic reaction can be extremely useful!



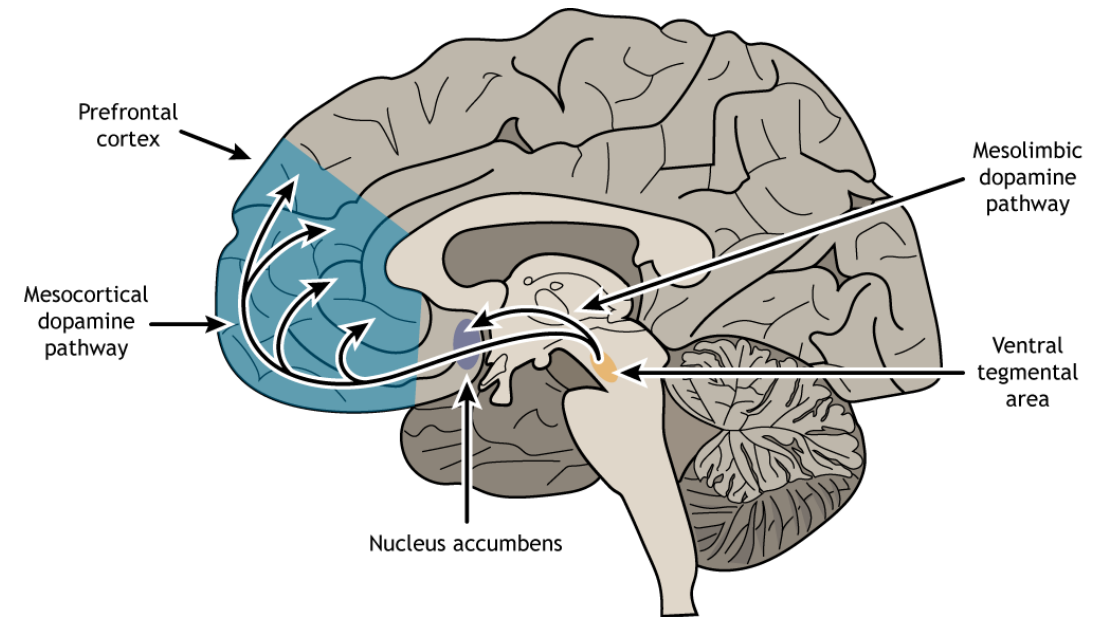
Decisions in the brain

- **Dorsolateral prefrontal cortex (dlPFC):** cognitive control, working memory, goal orientation
 - Needed for evaluating abstract rewards or delayed gratification
- **Orbitofrontal frontal cortex (OFC):** valuation, reward expectation
 - Connects with **amygdala** to evaluate emotional salience
- **Anterior cingulate cortex (ACC):** monitors conflict between competing choices
 - Activity in **ACC** is linked with effort



Risk/Reward is a motivational signal

- Recall the **mesolimbic dopamine pathway**
- Dopaminergic expectations of reward drive our decision calculation and our motivation to take risk
- Would you rather have a guaranteed \$10 or a 50% chance for \$20?
- Higher dopamine will increase your likelihood to take the chance



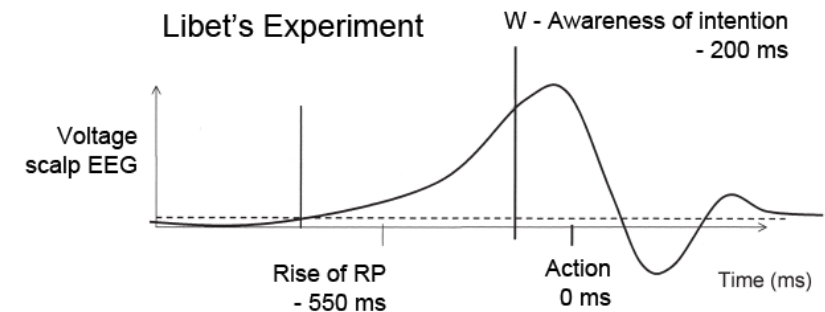
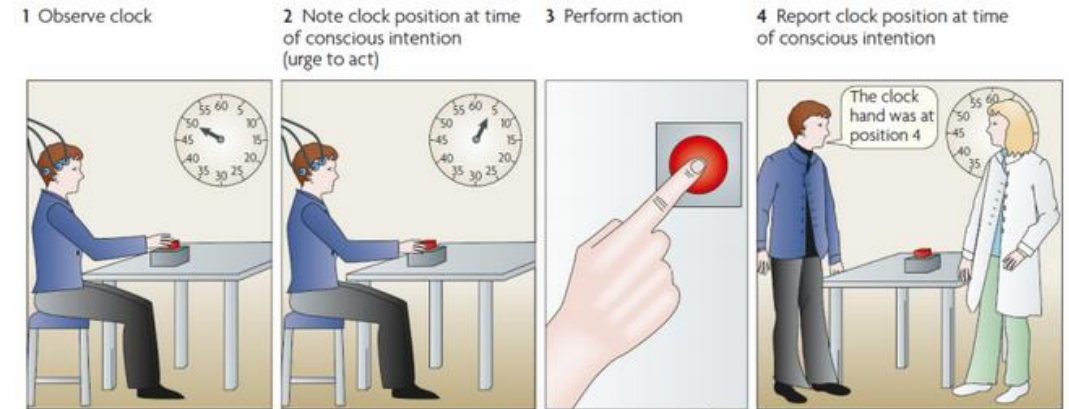
Neurotransmitters

Dopamine	Serotonin
Motivation/reward sensitivity – encodes an expectation of reward	Helps reduce emotional reactivity, allowing for more cautious, deliberate choices
Increased dopamine in PFC drives motivation to continue pursuit of a goal	Increased serotonin in PFC can support cognitive control over impulsive urges
Increased dopamine receptor sensitivity (when they are easier to activate) can also drive higher risk-taking behavior	Heightens sensitivity to loss, promoting risk aversion
Low dopamine can lead to anhedonia (lack of pleasure), excessive risk aversion	Low serotonin can drive amygdala hyperactivity, increase, impulsiveness and reduce emotional regulation, leading to heightened loss sensitivity
High dopamine can drive pathological impulsiveness, risk-taking, or reward pursuit (gambling and addiction)	High serotonin can promote excessive risk aversion, an unwillingness to act

- Healthy serotonin and dopamine allows for good balance of risk and reward

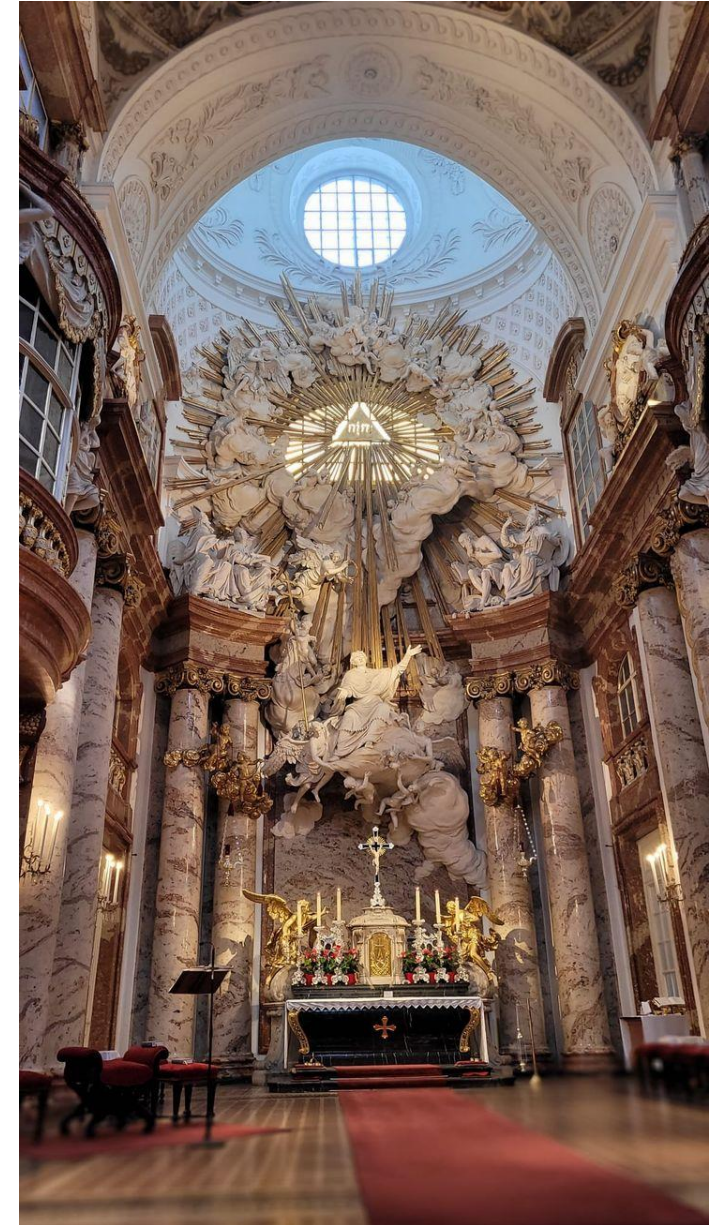
When do we consciously make a choice?

- The Libet experiment is a notorious and controversial experimental design that inspects when the feeling of intent arises in consciousness
- Participants are asked to press a button whenever they feel like it, and then report when they got the feeling to press it
- The ERP results show that there is a **readiness potential** that arises roughly 550 ms before the action, and **awareness of intention** arises only 200 ms before the action
 - Is awareness of intent downstream of the brain making the decision to act? Does this mean that the sense of conscious agency is an epiphenomenon?



Do we have free will?

- Plato and Aristotle emphasized the idea of the rational soul, the part of the soul that is capable of deliberation, as something that grants humans the ability to act freely
- A common theme across the world's religions is the ethical challenge of one's ability to align with higher principles, creating the paradox that true freedom emerges from one's ability to harmonize with the cosmos (the Tao) or one's duty (dharma) or God's will
 - Not aligning with the divine is sin, or a source of suffering
 - Thus, freedom is a necessary condition for you to consciously choose virtue
- It is necessary to presuppose, whether implicitly or explicitly, the idea of individual agency, in order to have a society that is capable of enforcing an ethical system



But what does free will mean?

- Individual agency suggests the ability to make choices independent of causal, deterministic forces
 - The ability to hold your hand in the pain box despite every deterministic force in your body telling you to remove it
- Is the brain completely deterministic, implying free will is impossible?
 - Many neuroscientists say this, and it is a popular position within contemporary neuroscience to say free will does not exist
- Others say that quantum biology can rescue free will by inserting a nondeterministic, noncomputable process into the mechanism



How quantum brain biology can rescue conscious free will

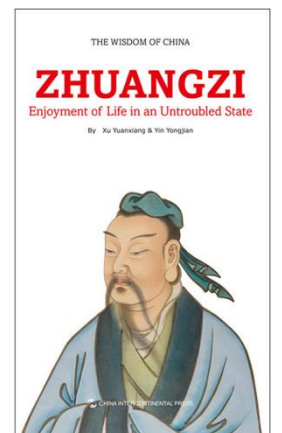
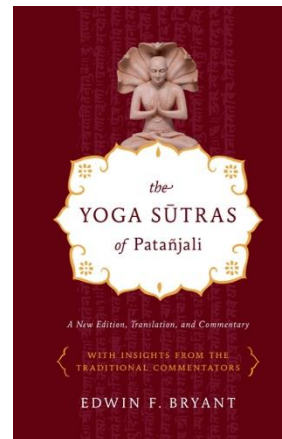
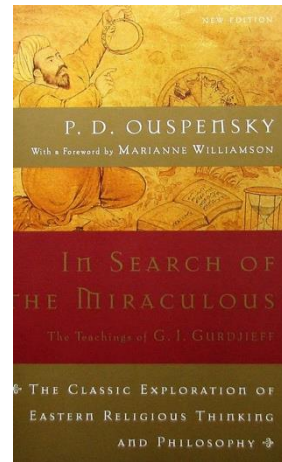
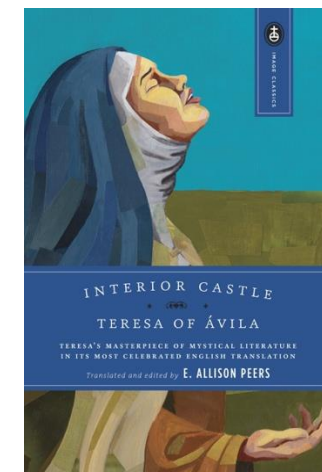
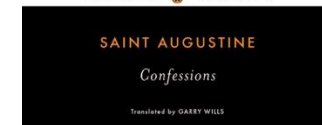
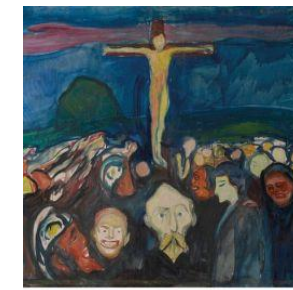
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Freedom as a capacity

- Unlike the modern world, most traditions are not stuck on a binary idea of whether free will exists or not
- Of course we are enmeshed in biological drives, social forces, and other contingencies that limit our ability to act
- The question of our capacity for choice is embedded in our relationship with our deepest selves and a higher order
 - It is not a metaphysical or mechanical question but a moral one
- Freedom is something that is cultivated in one's spirit through struggle and work
 - It is not about the ability to make arbitrary choices, but the capacity to master one's drives and direct one's energy towards virtue



Neuroscience of morality

- Mapping how the brain makes moral choices reveals underlying mechanisms
- Dual-process theory:
 - Utilitarian – moral value depends on outcome
 - More conscious, rational
 - Deontology – moral value depends on adherence to moral norms
 - More intuitive, emotional
- There is also a virtue ethics approach to morality that focuses on the underlying virtue and character, rather than just the rules and consequences of moral choices
 - Neuroscience is probably not ready for this kind of approach

