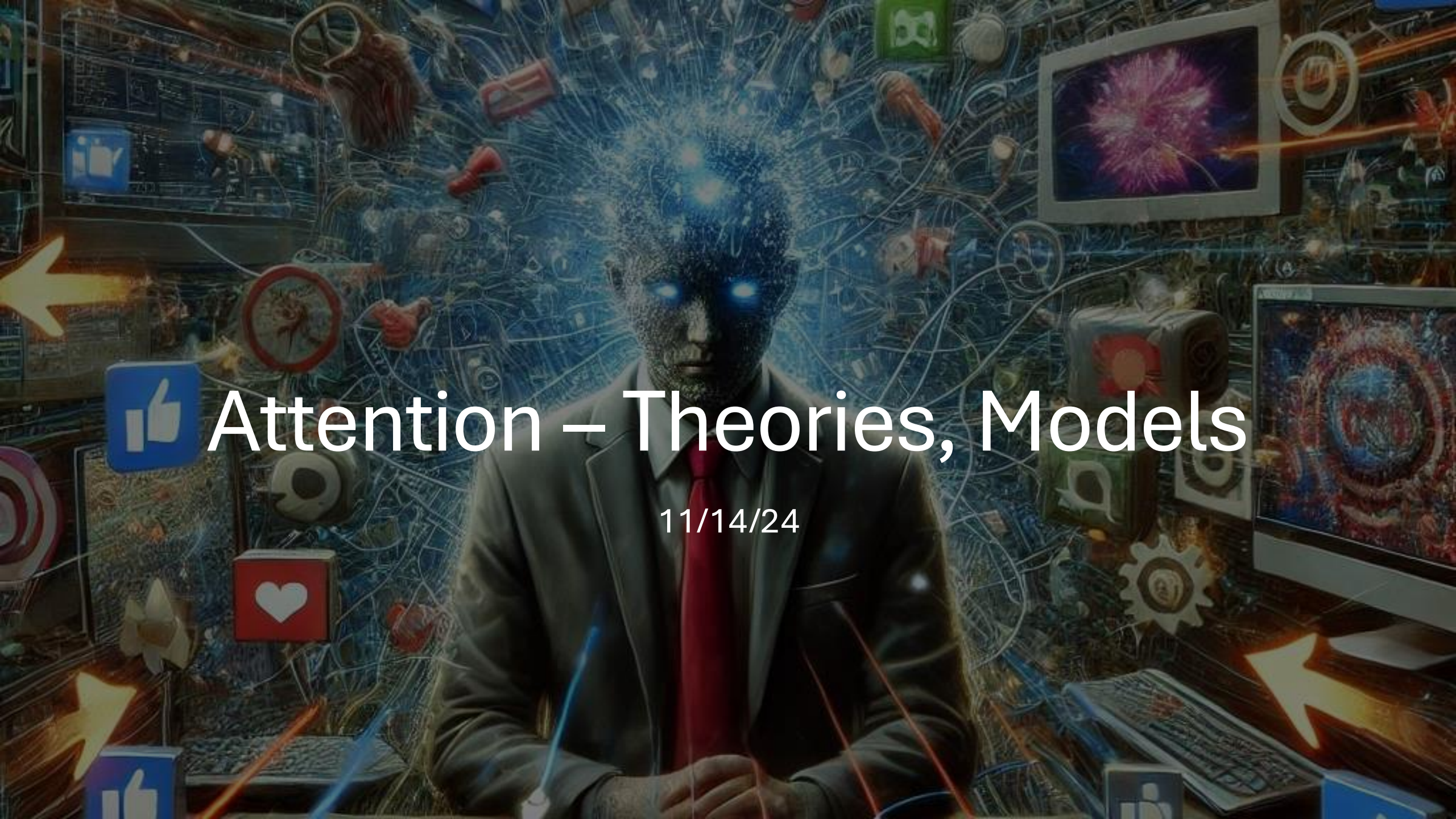




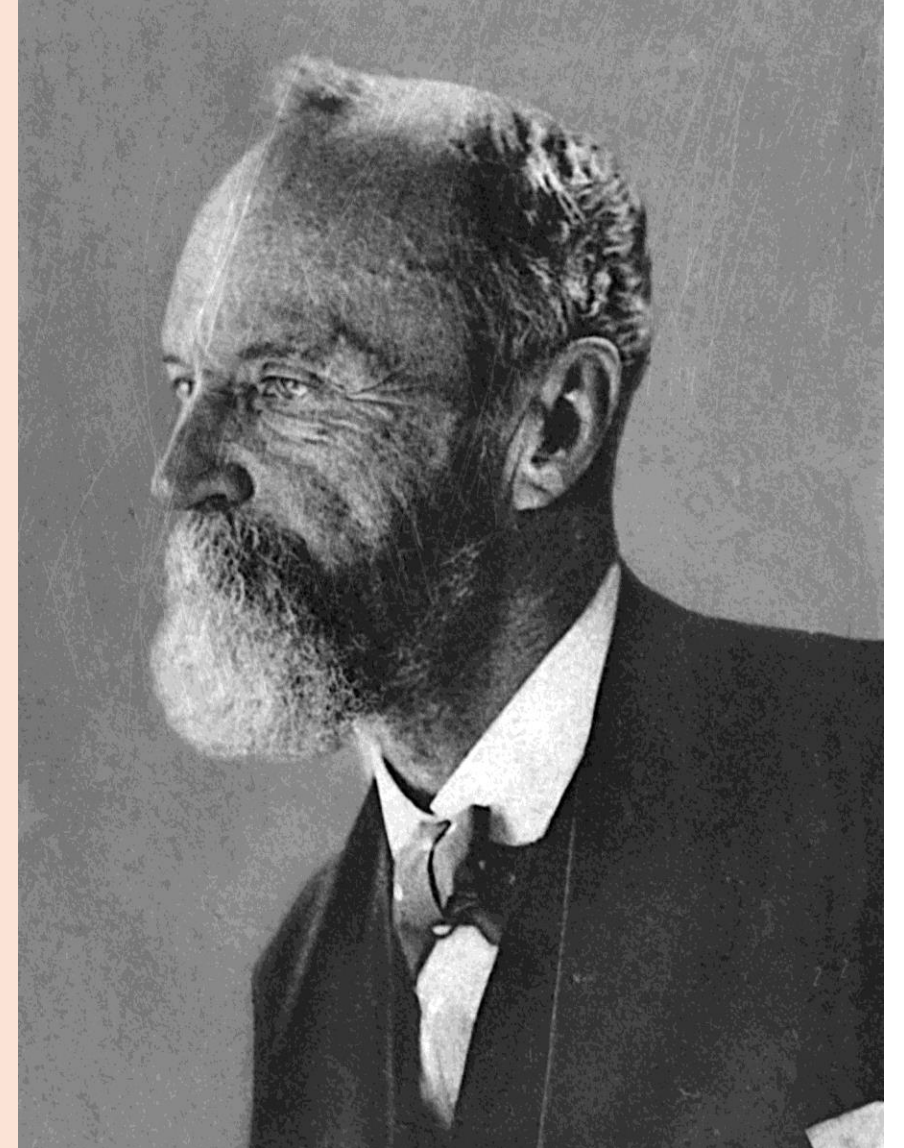
# Attention – Theories, Models

11/14/24

# What is attention?

*Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called distraction, and in German. Zerstreutheit*

-- William James



# Attention in philosophy

- In **phenomenology** (the study of experience itself), attention brings forth the world – it is that in which subjects and objects arise
  - That which you attend to you fundamentally interact with
  - Attention is a moral act – that which you attend to is your world
    - Do you attend to rage? Lust? Your own or someone else's narcissistic self-story?
- Esoterically, attention is described as an emanation, an energy, or light, that connects with, shapes, and influences the self and/or the world
  - Practices like prayer and meditation cultivate attention, training the practitioner in how to focus and direct it
  - Your ability to sustain and redirect attention is fundamentally related to freedom

## Edmund Husserl's *Pure Phenomenology*

“[The] first outlook on life...[is] the natural standpoint. I am aware of the world, spread out in space endlessly, and in time becoming and become, without end. I am aware of it, that means, first of all, I discover it immediately, intuitively. I experience it. Through sight, touch, hearing etc., in the different ways of sensory perception, corporeal things somehow spatially distributed are for me simply there, in verbal or figurative sense “present,” whether or not I pay them special attention by busying myself with them, considering, thinking, feeling, willing.”

Husserl, Edmund. 1913 [2002]. *Ideas: General Introduction to Pure Phenomenology*.  
Translated by W. R. B. Gibson. London UK: Routledge. P. 51.

# Attention asks: How are you engaging with experience?

- Narrowly or broadly? Actively or passively? With focus or openness?
- Are you tuned to the external environment, internal thoughts, body sensations, or a blend of these? Are you more tuned in to one domain of perception (i.e., sight, sound)?
- Are you attending to an object (the apple)? The broad context (who is holding the apple)? A feature (the redness of the apple)? A goal (eating the apple)? A process (the eating of the apple)? A thought (the idea of the apple)? An act of consciousness (the seeing of the apple)?



# Properties of Attention

- **Aperture:** Like the width of a lens or a spotlight, how broad or narrow is your focus?
  - A focused attention practice might focus on the sensation of breath on the nose, while an open monitoring practice might broadly monitor all that arises in the field of experience
- **Stability:** Is there continuity to your attention? How easily perturbed is it? How easily does it fluctuate?
  - High stability is usually something sought after, however you can also have high stability to rumination
- **Clarity:** How vivid and unambiguous are the features of your experience? How sensitive are you to subtle changes?
  - Can be inferred from tasks like detecting faint auditory or visual stimuli, or ability to feel heartbeat, or ability to feel affective states
- **Meta-awareness:** Awareness of awareness itself, the ability to recognize your mental state
  - The ability to recognize “I am having a thought” or “I am seeing”
  - **Reification:** the consideration of an experience as something concrete
    - The subtle difference between recognizing experience as some kind of mental process, rather than reality itself



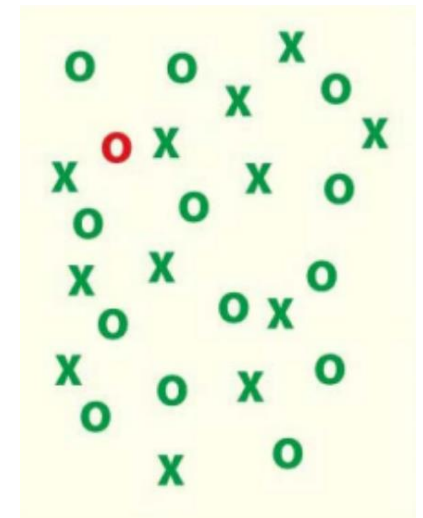
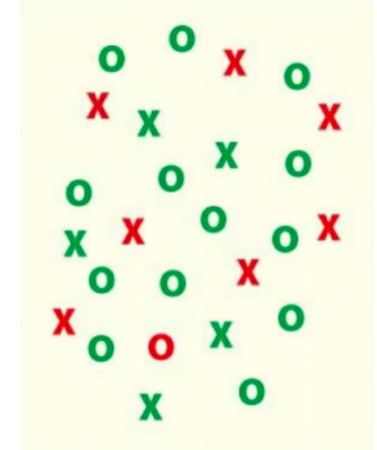
# Your Attention is Limited

- There is a **filter** or **bottleneck** associated with attention, meaning you have limited **resources** or **attentional load** – you can only attend to a small amount of information at a time
  - Scarcity of resource creates efficiency – this forces us to sort priorities
- **Selective** or **focused attention** – focusing on a specific stimulus or task while filtering out distractions
  - Reading a book, chasing a prey animal
- **Vigilance** or **sustained attention** – maintaining focus over time to monitor for rare but important signals, where quick responses are necessary
  - Driving a car, monitoring for predators
- **Divided attention** – managing multiple tasks or stimuli simultaneously, rapidly alternating between multiple points of focus
  - Texting and driving, listening to two conversations at once



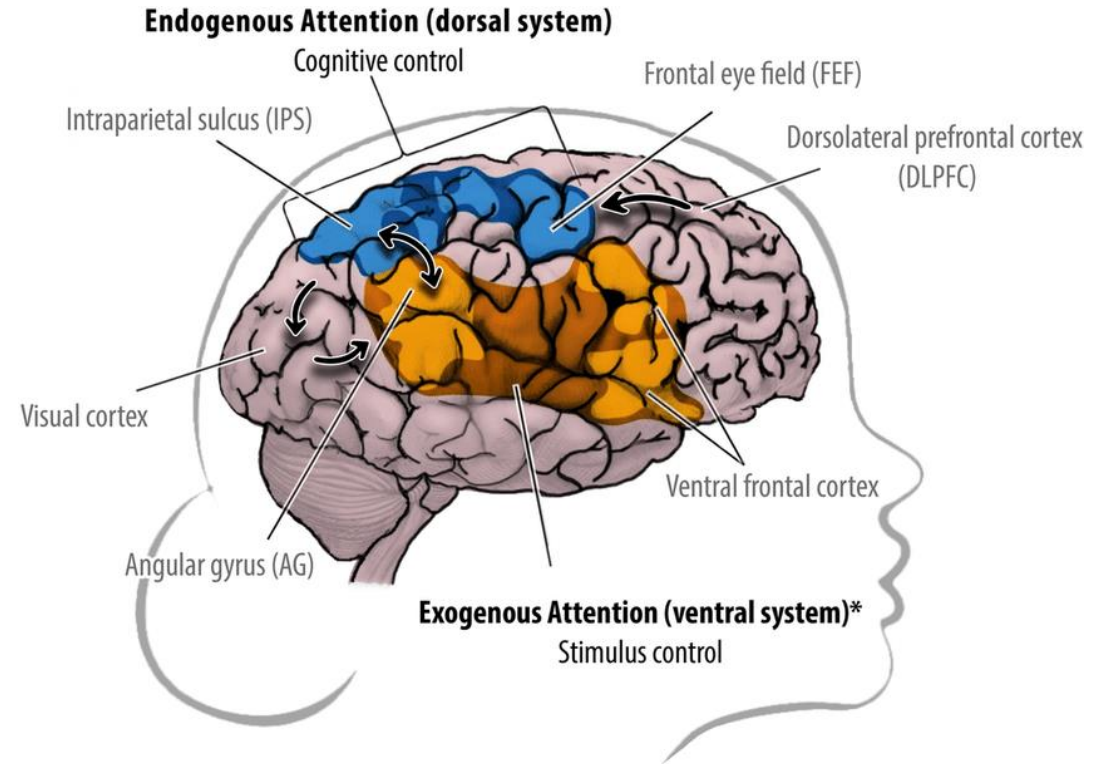
# Attention in cognitive neuroscience

- Two distinct modes of attention:
  - **Top-down** – endogenous, volitional, goal-driven, slow – when you choose to focus on something
  - Top image: find the red O
  - **Bottom-up** – exogenous, salient, stimulus-driven, fast – when something captures your attention
  - Bottom image: find the red O
- These are separate systems



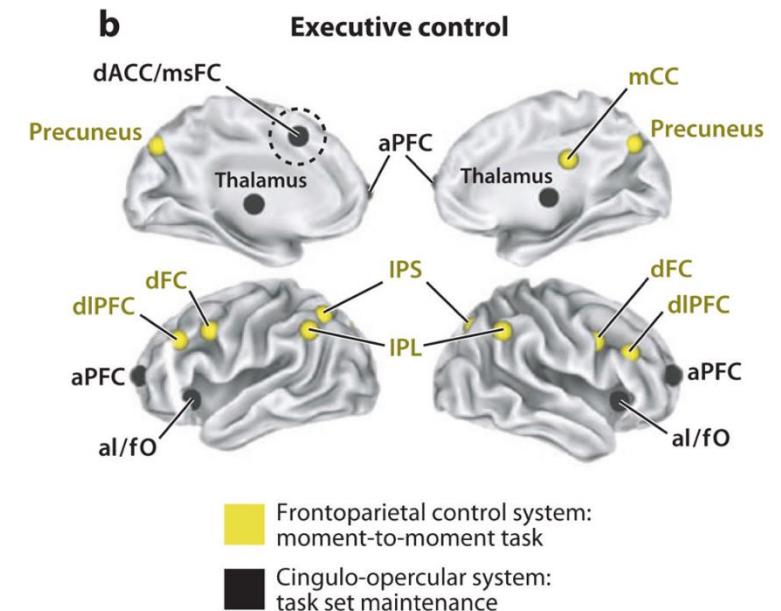
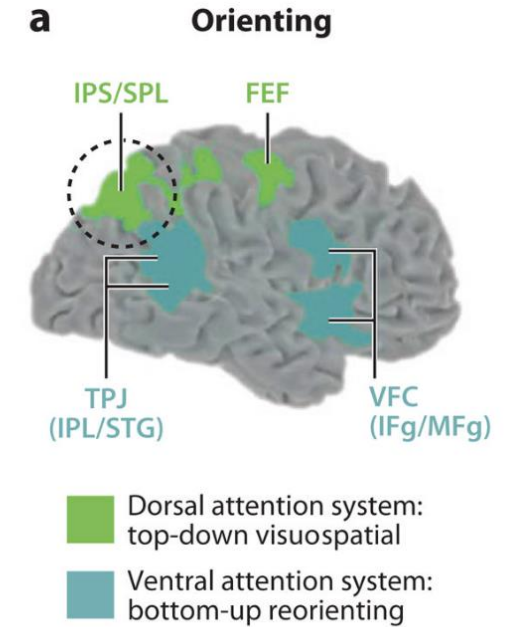
# Two Attention Networks

- **Dorsal Attention Network (DAN):**
  - Top-down control of attention, filtering out irrelevant stimuli, maintaining focus
  - Mostly bilateral, leans left
- **Ventral Attention Network (VAN):**
  - Bottom-up, stimulus-driven attention, activated when stimuli appear unexpectedly
  - Mostly right-lateralized



# Posner Model of Attention Uses Three Interlocking Systems

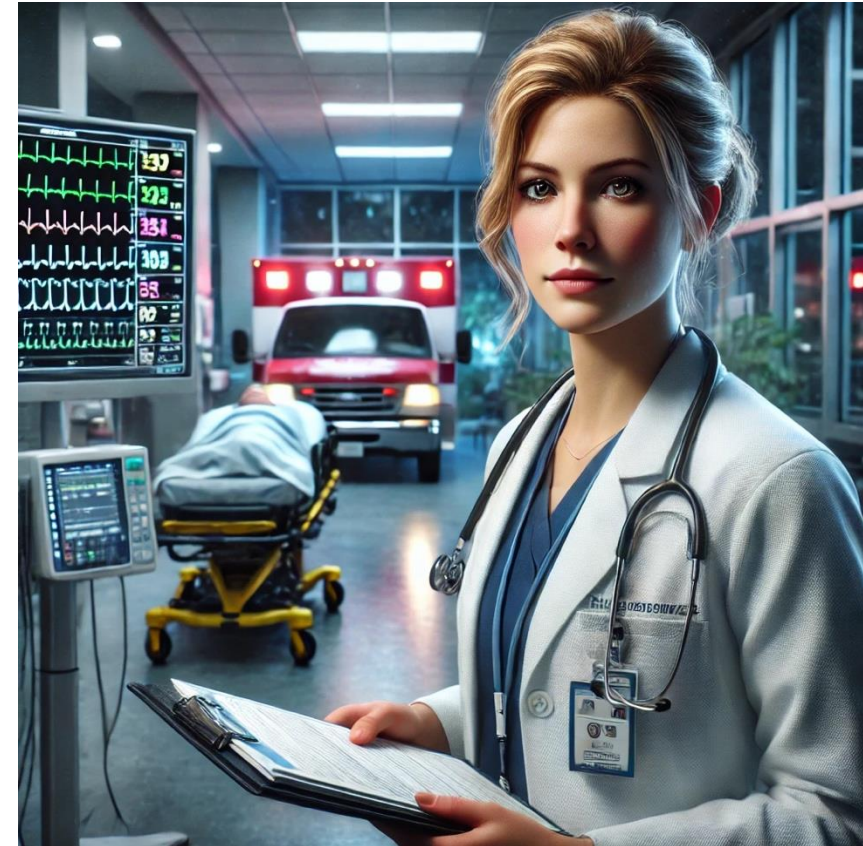
- **Alerting:** achieving and maintaining a state of readiness to respond
  - Primarily uses **norepinephrine**
  - Arousal system, anchored in **locus coeruleus** of the **brain stem** that projects to right frontal and parietal cortex
  - Right-lateralized
- **Orienting:** directing attentional resources to specific points of focus
  - Primarily uses **acetylcholine**
  - Two subsystems: **DAN** and **VAN**
- **Executive Control:** managing decision-making, regulating responses, conflict
  - Primarily uses **dopamine**
  - Two subsystems: **Frontoparietal control** and **cingulo-opercular**



# Illustration of Posner Model

Sarah is a doctor working overnight in the ER

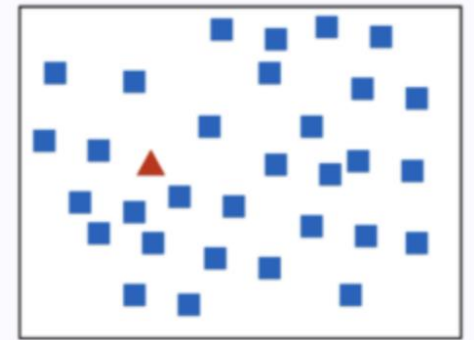
- **Alerting:** Sarah maintains an alert state, maintaining an “on-call” state of vigilance in case anything urgent happens
- **Orienting:** She hears lots of commotion, and she orients her attention towards the sounds, recognizing an ambulance has arrived with an incoming patient. She orients to hear the paramedics’ description of the patient’s state.
- **Executive Control:** As Sarah is trying to treat the patient, she is regulating her responsiveness to alarms, questions from the nurses, her own thoughts, and the condition of the patient. She is prioritizing what to focus on as she makes critical decisions



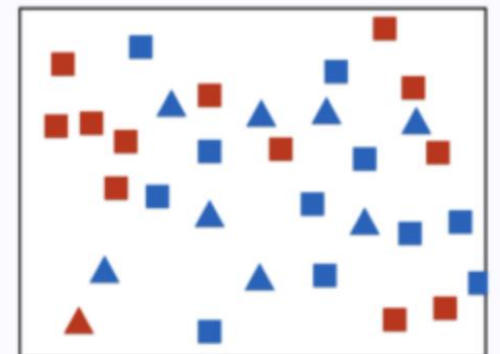
# Feature Integration Theory (FIT)

- Cognitive model that explains how attention can be used to integrate different features into a single, unified whole
- **Pre-attentive Processing:** Features like color, shape, and size are processed automatically and in parallel across the visual field without focused attention
- **Focused Attention** is needed to "bind" features together into a coherent perception of an object
- Find the red triangle:
  - **Feature Search:** fast, doesn't require much focus
  - **Conjunctive Search:** slow, requires focus to bind features

Feature Search

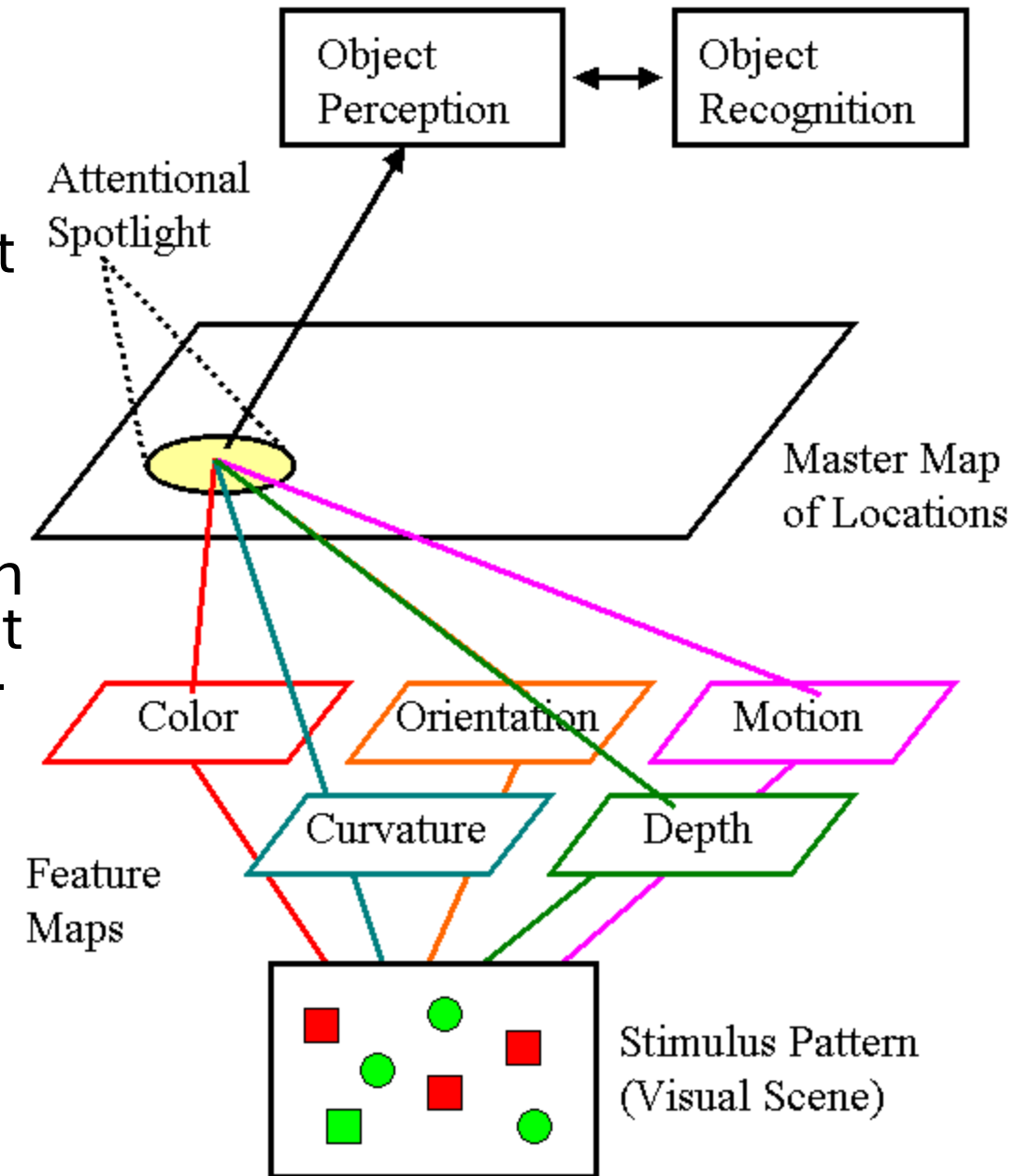


Conjunction Search



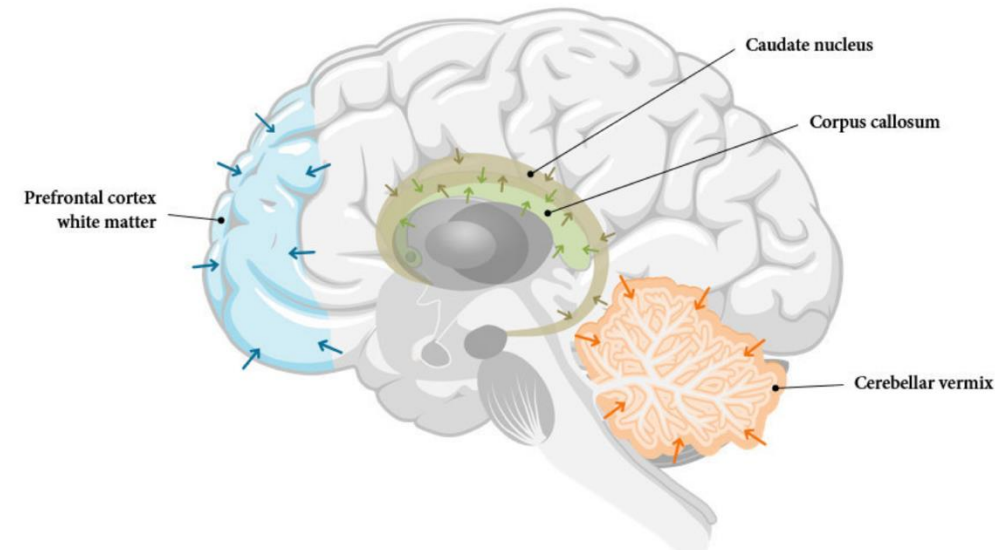
# Limitations of FIT

- It is possible to integrate features without using attention
- Expectations and prior knowledge guide attention, an extra element in feature binding that FIT does not include
- FIT is usually only tested/demonstrated in simple, artificial tasks, that don't account for the complexity and dynamism of real-world experience
- Many features are processed in parallel across regions, indicating a more distributed binding mechanism than FIT suggests

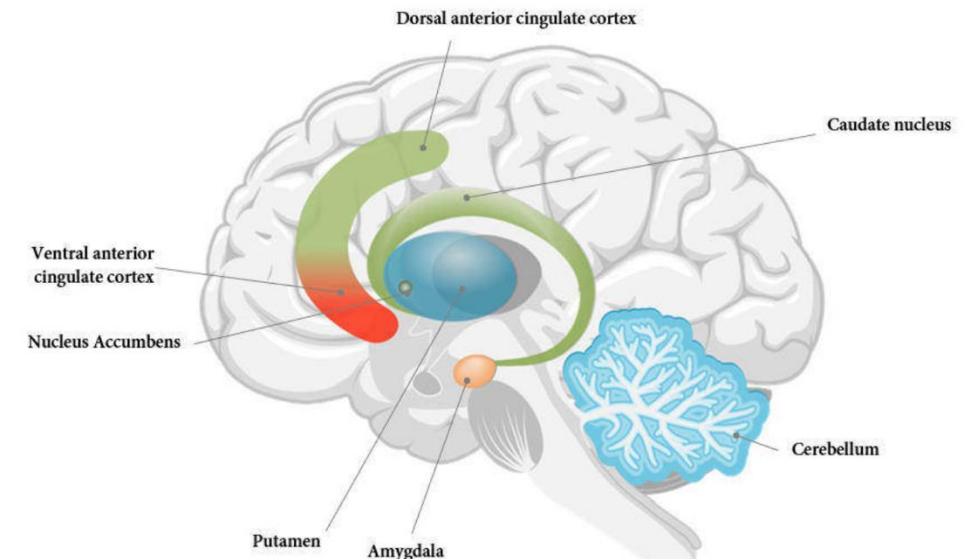


# Attention-Deficit/Hyperactivity Disorder (ADHD)

- Neurodevelopmental disorder characterized by persistent inattention, hyperactivity, and impulsivity
- Reduced total volume in **prefrontal cortex, basal ganglia, and cerebellum**
- Reduced grey matter in **prefrontal cortex** and **anterior cingulate cortex**
- Reduced white matter integrity in **frontostriatal pathways** (connects **PFC** to **basal ganglia**), **corpus callosum** (connects **hemispheres**), and **cingulum** (connects **PFC** to **limbic system**)



## Frontostriatal Circuit



- The ventral anterior cingulate cortex and the dorsal anterior cingulate cortex control affective and cognitive components of executive control. Along with the putamen, nucleus accumbens and caudate nucleus they form the frontostriatal circuit.
- In ADHD there are abnormalities in the frontostriatal circuits which extend to the amygdala and cerebellum

# ADHD Types

- ADHD-Inattentive (ADHD-I):
  - Deficits in **dorsolateral prefrontal cortex (dlPFC)** – critical node in **DAN**, which regulates top-down attention
  - Overactive **default mode network (DMN)** – leads to mind-wandering, rumination, interference with focus
  - Reduced **dopamine** and **norepinephrine** in **frontostriatal pathways** – more difficult to maintain attention, motivation, alertness
- ADHD-Hyperactive (ADHD-H):
  - Overactivity in **premotor cortex** and **basal ganglia** – motor control is overactivated, leading to restlessness and hyperactivity
  - Reduced activity in **ventral striatum** (including **nucleus accumbens**) – poor regulation of **dopamine**, which organizes motivation and executive control
  - Reduced development in **inferior frontal gyrus** – reduced self-regulation and behavioral inhibition
- ADHD-Combined (ADHD-C):
  - Dysfunction in **frontoparietal network (central executive network)** – reduced attentional control, task-switching
  - Weaker connectivity between **prefrontal cortex** and subcortical areas like **basal ganglia** – reduced impulse control
  - Dysregulation of both **dopaminergic** and **noradrenergic** pathways – reduced motivation processing (**dopamine**), and reduced ability to regulate arousal (**norepinephrine**)

