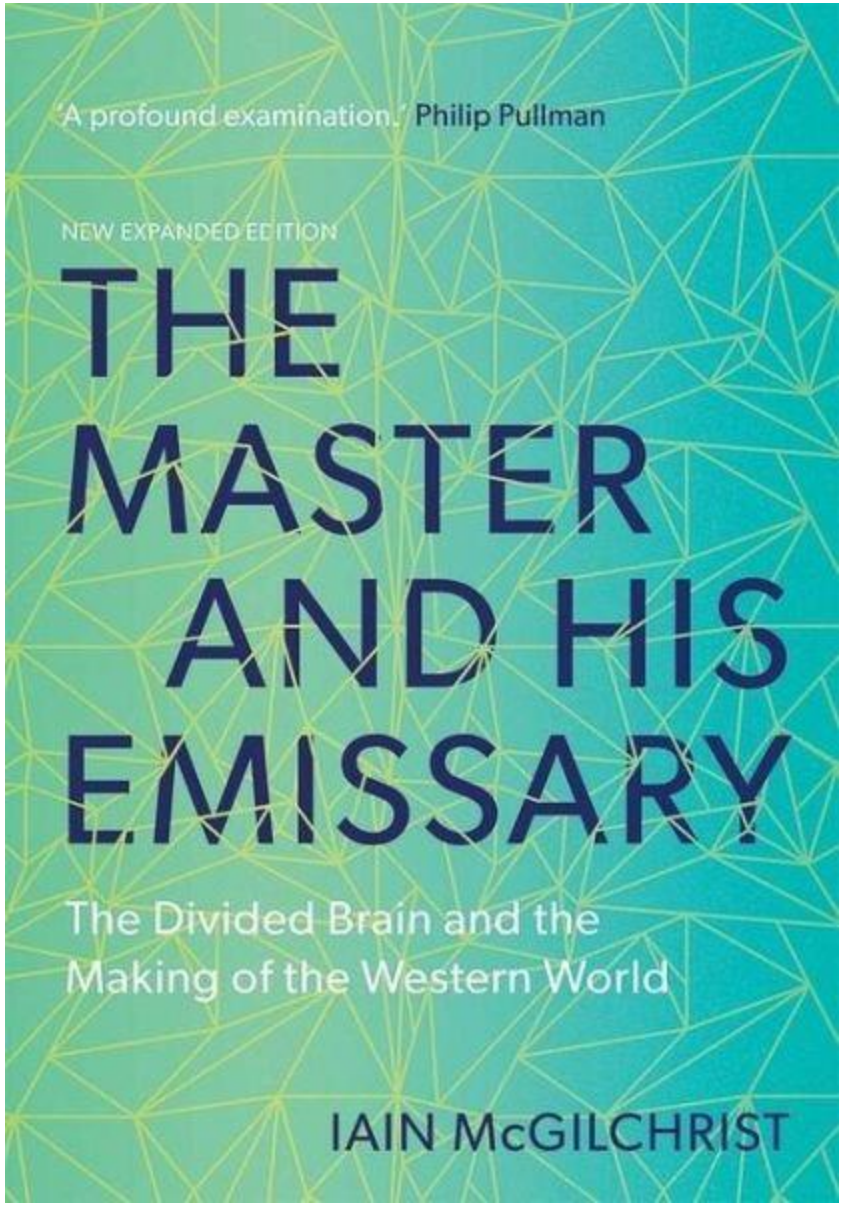
Hemispheres and Networks

9/19/24

The Master and His Emissary

- The two hemispheres create two different, complementary ways of being, ways of processing the world
  - not different functions, but ways of processing
- These differences between the hemispheres can be found at the very foundation of the human experience
- McGilchrist argues that the West has come to increasingly favor left hemisphere modes of thinking – analytical, mechanistic, reductionistic – leading to an imbalance in society, creating a culture that overlooks nuance and interconnected nature of human experience



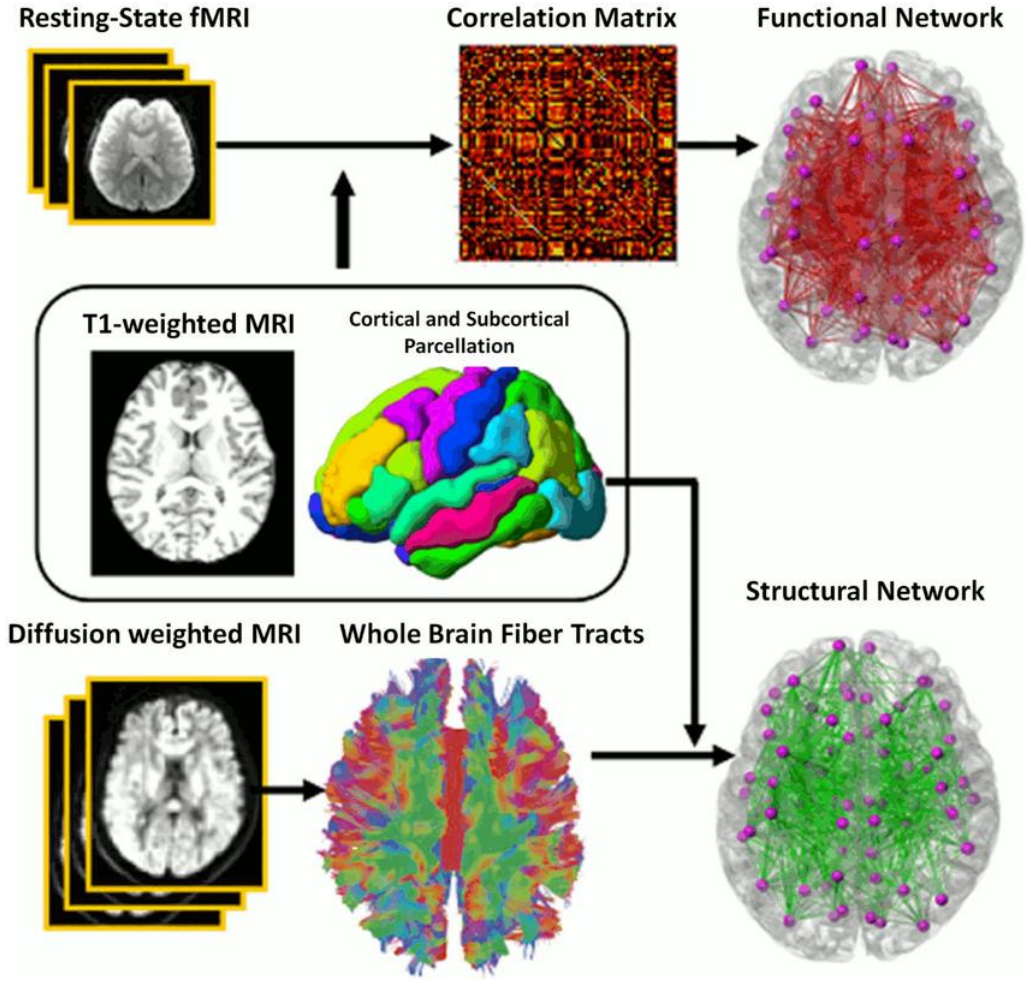
Left vs Right

- Abstract knowledge
- Denotative language
- Power to manipulate things that are known
- Grasping, manipulating
- Fixed, details, parts, literal, isolated, explicit
- Decontextualized, general, categorization, sequential
- Object, ultimately lifeless

- Grounded, experiential knowledge
- Metaphorical language, prosody of speech, tone
- Holistic, individual, changing, evolving, interconnected, implicit
- Context of lived world, but never fully graspable, always imperfectly known
- Open, receptive, ambiguous

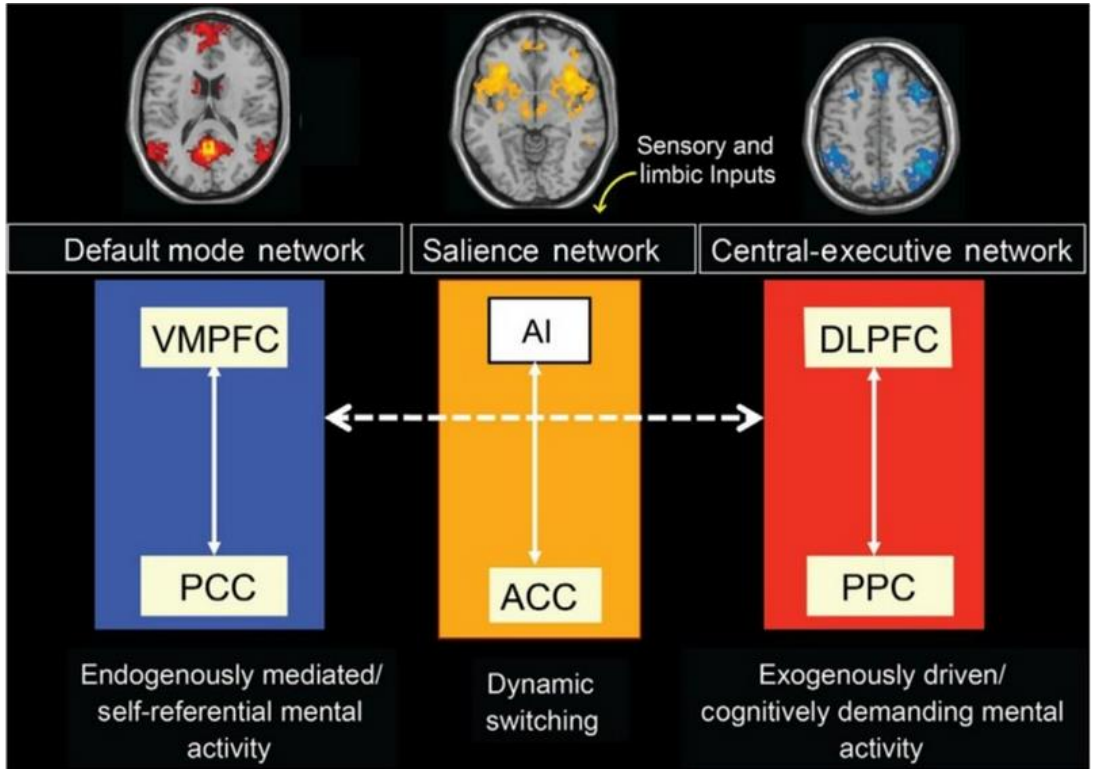
Functional Networks

- **Functional network**: patterns of co-activity or synchronization between different brain areas
- Networks can be activated by different tasks, pointing to their function underlying various cognitive, emotional, sensorimotor functions
- Disruption in functional connectivity of networks can be linked to psychiatric disorders
  - This understanding enables better diagnostics and treatments
- Future research is mapping these networks with increasing precision and specificity
  - Individualized mapping reveals individual-scale differences and idiosyncrasies



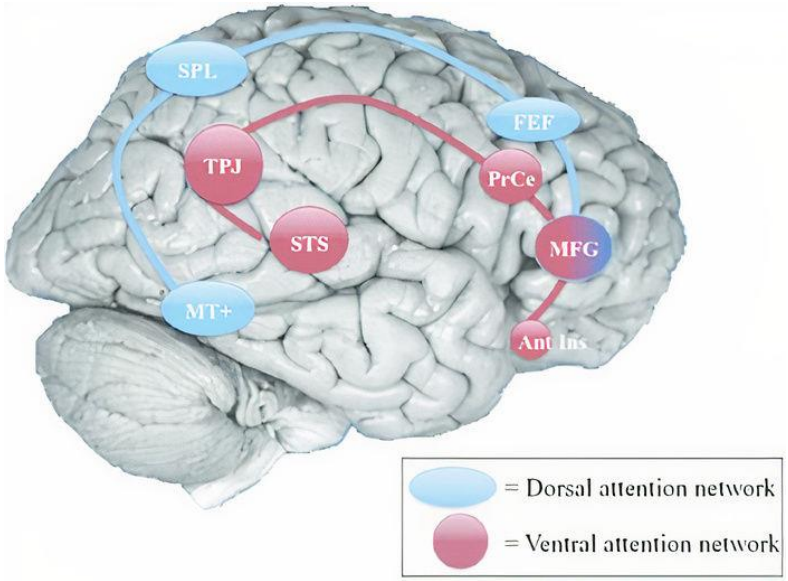
Triple Network System

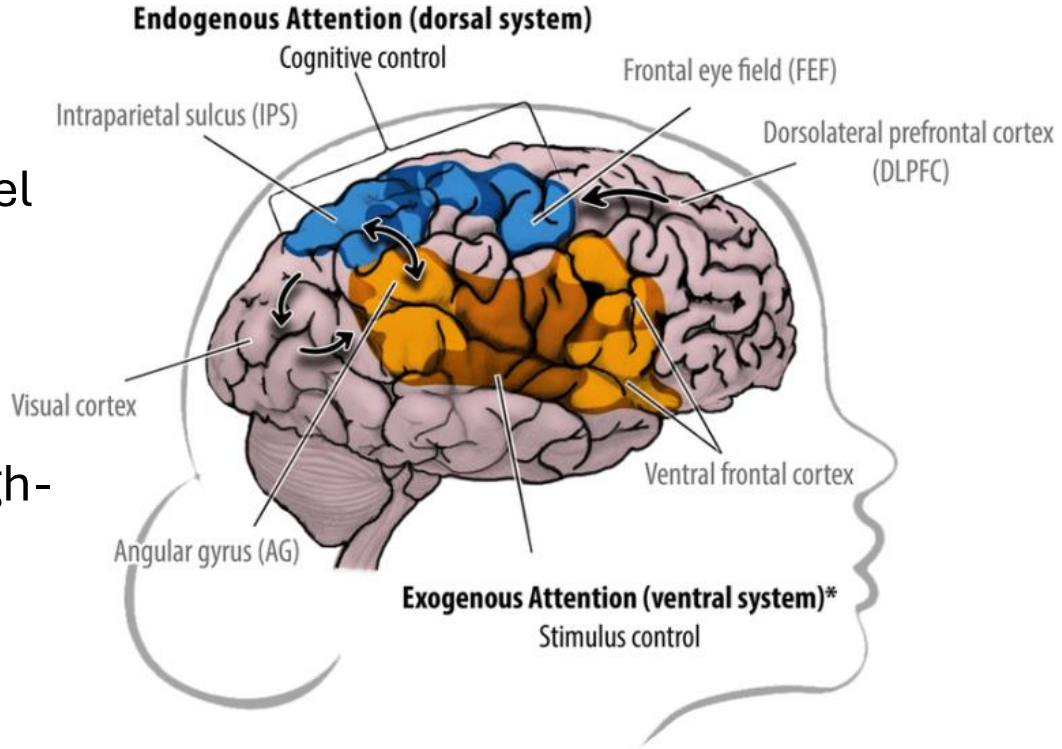
- The “top of the hierarchy” of brain network functioning is a tripartite network system, sometimes called the **triple network**
- **Default Mode Network (DMN)**
  - Intrinsic thought, self-referential and narrative thinking, planning, mind-wandering, social cognition
  - Medial prefrontal cortex, posterior cingulate cortex, inferior parietal lobule
- **Central Executive Network (CEN)**
  - Working memory, problem-solving, cognitive control, decision making, goal-oriented behavior, task engagement
  - Dorsolateral prefrontal cortex and posterior parietal cortex
- **Salience Network (SN)**
  - Detects and filters relevant stimuli, helping shift attention between internal thought and external task-orientation, assesses relevance
  - Anterior insula and anterior cingulate cortex
- DMN and CEN are **anti-correlated** with each other – either one or the other



Attention Networks

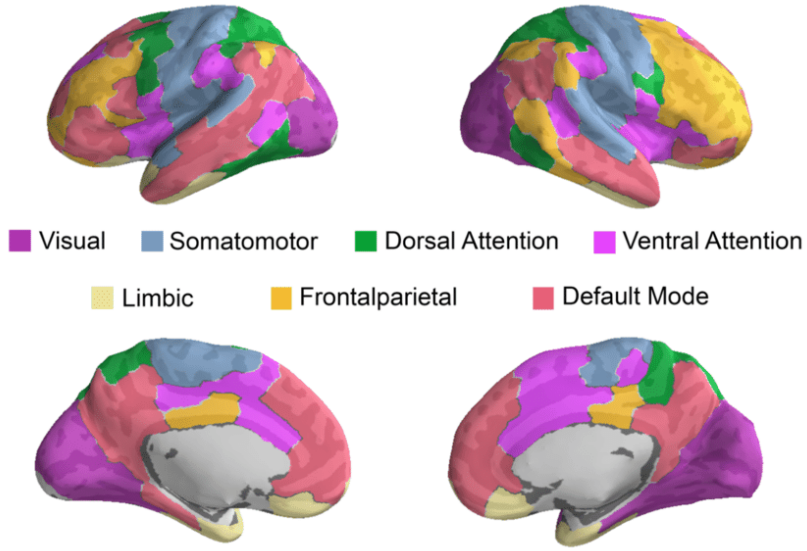
- Dorsal Attention Network (DAN) – voluntary, top-down attention, maintaining focus on goal-directed tasks
  - Often works with CEN to focus attention, while CEN processes information and makes decisions
  - SN can modulate DAN, signaling it to shift attention to a new stimulus
  - DAN can modulate SN, guiding what it will be sensitive to (top-down control!)
- Ventral Attention Network (VAN) – stimulus-driven, bottom-up attention, allowing for reorientation to novel stimuli
  - SN will signal to VAN that attention must be reoriented, interrupting DAN
  - VAN will give feedback to SN, reinforcing or adjusting SN's evaluation
- CEN manages input from DAN and VAN to execute high-order cognitive tasks





Other Networks

- Visual Network
  - Processing visual stimuli – color, motion, what, where, face recognition
  - Provides input to SN, and CEN during tasks involving visual attention
- Cortico-Limbic Network
  - Emotional processing, memory formation, motivation
  - Links with DMN to process self-referential signals, SN for emotional salience
- Auditory Network
  - Auditory processing – sound, speech perception, music, localization
  - Provides input to SN, or language-related executive function (CEN)
- Somatomotor Network
  - Processing sensory information, coordinating motor functioning
  - Input to SN, works with CEN to develop motor planning and execution



A Story

- You are driving. Your sensory organs gather information and route those signals through the primary sensory cortices for processing. That processed information is continuously monitored by the SN.
- Meanwhile, your DAN is operating continuously to maintain your focus on the road, monitoring other cars, objects, and traffic signals. It is continuously sending top-down engagement signals to orient your system towards the sensory input it expects to encounter. Your CEN integrates this to focus on your full driving context, monitoring and integrating information. It guides specific problem-solving when needed, such as to slow down or plan a turn.
- Suddenly, a pedestrian steps onto the road – your SN evaluates this as a salient event, activating the VAN to reorient your attention. Once the VAN has reoriented your attention, the CEN integrates the information to come up with a solution. That command "brake now!" is sent to the premotor cortex and supplementary motor area to translate it to a specific motor sequence (moving the foot to the brake pedal). Once the motor plan is composed, that signal is relayed to the primary motor cortex to be initiated. The motor command is sent through the basal ganglia and cerebellum to be filtered and fine-tuned so the action is well-coordinated. Those signals and then transmitted down the spinal cord to the muscles.