Cognitive Control Neural Networks

Resilience performance and maintaining proper mental health

Across many levels (from subcellular components to social systems) most complex adaptive systems follow common structural organizational principles required to resolve tensions between adaptability and resilient function and to maintain proper mental health.

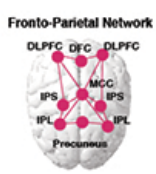
For individuals, this process is related to how the brain adapts to environmental change

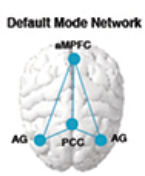
Related to task performance we adopt internal task-related strategies to achieve goals by learning to overcome adversity through environmental needs and/or confilcts simultaneously allowing the brain to remain resilient to local perturbations due to stress or damage. Spaceflight neuro-adaptations are due to a changing space environment.

Basic action occurs through various brain network interactions

Consisting of flexibile hubs in conjunction with working memory, (*Working Memory is the workspace in which mental opterations occur*) regulated by four primary control systems that exercise self-regulatory cognitive control:

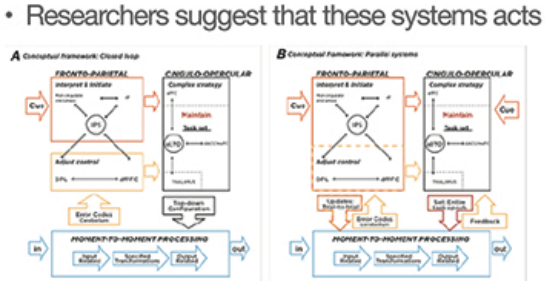
1. **Fronto-parietal Network (FPN)**
   Initiates and adjusts control to acheive a task
2. **Salient Network (SN)**
   Focuses attention and contributes to conscious awareness
3. **Congulo-opercular Network (CON)**
   Provides stable 'set-maintenance' over entire time
4. **Default Mode Network (DMN)**
   Resting state - provides access to internal references

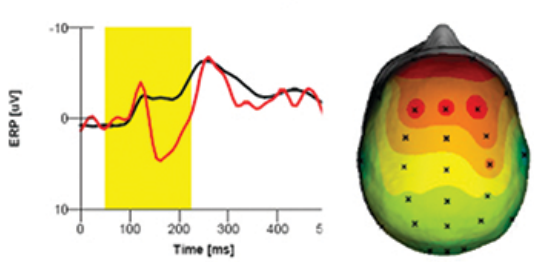




Studies are reporting alterations of this control system across a range of mental diseases

- Leading researchers suggest the brain's primary control system plays a critical role in promoting and maintaining proper mental health
- Ansel et al. demonstrated that cumulative life time adversity can be associated with
  - major mental illnesses
  - smaller gray matter volume in
    - medial prefrontal cortex (mPFC)
    - insular cortex
    - subgenal anterior cingulate regions
    - all key integral structures located within the FPN/CON networks
- Researchers suggest that these systems acts much like an ***"immune system of the mind"***





Dual-network hypothesis of task control. Thin arrows schematize strong functional connections, ovals schematize hubs, and thick arrows schematize putative flow of information. (1) information may flow between the fronto-parietal and cingulo-opercular networks, such that the stable control networks receives control intitiation signal from the adaptive control network at the beginning of a task period, as well as adjustment signals during task perfromance. (6) Alternatively, the frontoparietal and cingo-opercular networks mar be organized in parallel, both networks might interpret cues, implement top-down control, and process bottom-up feedback. The fronto-parietal network may adjust task control on a trial by trail basis, whereas the singuloopercular network might affect downstream, processing in a more stable fashion. Framework intermediate between A and B are also consistent with the data.