Back to Knowledge Base

advanced Cognition 32 min read

Attention and the Default Mode Network

Advanced review of attentional networks, the default mode network, resting-state connectivity, and their clinical implications in neuropsychiatric disorders.

default mode network attentional networks resting-state fMRI DMN functional connectivity salience network mind-wandering ACC

Attention and the Default Mode Network

Attentional Networks

Attention is not a unitary construct. Three independent attentional networks have been identified:

1. Alerting Network

- **Function**: Achieving and maintaining a state of readiness
- **Structures**: Locus coeruleus (norepinephrine), thalamus, right frontal/parietal cortex
- **Modulated by**: Norepinephrine (NE)

2. Orienting Network

- **Function**: Selecting information from sensory input (top-down and bottom-up)
- **Structures**: Superior parietal cortex, temporal-parietal junction (TPJ), frontal eye fields
- **Two modes**:
  - Dorsal frontoparietal network: Top-down, voluntary orienting
  - Ventral frontoparietal network (right TPJ/IFG): Bottom-up, stimulus-driven

3. Executive Control Network

- **Function**: Monitoring and resolving conflict
- **Structures**: Anterior cingulate cortex (ACC), lateral PFC
- **Modulated by**: Dopamine

The Default Mode Network (DMN)

The DMN is a large-scale brain network that shows **deactivation during external attention tasks** and **activation during rest and self-referential processing.**

Core Nodes

- Medial PFC (mPFC)
- Posterior cingulate cortex (PCC) / Precuneus
- Angular gyrus
- Hippocampal formation
- Lateral temporal cortex

Functions of the DMN

1. **Self-referential processing**: Thinking about oneself
2. **Mind-wandering**: Spontaneous thought generation
3. **Episodic memory retrieval**: Mental time travel to past events
4. **Future simulation**: Imagining future scenarios
5. **Social cognition**: Theory of mind, mentalizing

Task-DMN Anticorrelation

During externally-focused cognitive tasks:

- Task-positive networks (dlPFC, parietal cortex) activate
- DMN deactivates
- Failure of DMN suppression → cognitive failures (mind-wandering during tasks)

Resting-State fMRI and Functional Connectivity

Low-frequency BOLD signal fluctuations (~0.01–0.1 Hz) at rest reveal intrinsic functional networks:

| Network | Key Nodes | Function | |---------|-----------|----------| | Default Mode | mPFC, PCC, Angular gyrus | Self-reference, memory | | Central Executive | dlPFC, posterior parietal | Goal-directed cognition | | Salience | ACC, insula | Threat detection, switching | | Sensorimotor | M1, S1 | Motor/sensory processing | | Visual | V1–V5 | Visual processing |

Clinical Relevance

- **Alzheimer's disease**: DMN is the first network affected; PCC shows early hypometabolism

- **ADHD**: Abnormal DMN suppression during tasks; increased DMN-task network conflict
- **Schizophrenia**: Disrupted salience network → aberrant assignment of significance
- **Depression**: Hyperactivity of DMN subregions → rumination
- **Autism**: Altered DMN-social cognition network connectivity

Practice Flashcards | Take Assessment