Windows to the Brain: Introduction to Circuits

Cortical Association
Prefrontal-Subcortical
Papez
Brainstem

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Major Long Cortical Association Tracts

**superior fronto-occipital (subcallosal) fasciculus**
orbital & medial prefrontal cortex ↔ parietal cortex
akinet mutism; disordered initiation & preparation of speech movements; transcortical motor aphasia; anomia & reduction of spontaneous speech with normal articulation

**cingulum - short fibers**
cingulate cortex ↔
frontal, parietal, occipital & temporal cortex
Anterior - lack of emotional affective response to pain; anxiety; OCD; depression; panic; akinetic mutism

**cingulum - long fibers**
cingulate cortex ↔
temporal cortex
Posterior - impaired integration of visuospatial & memory processing

**superior longitudinal (arcuate) fasciculus**
frontal cortex ↔ parietal, occipital & temporal cortex
R - left hemispatial neglect; L - conduction aphasia (fluent aphasia with impaired repetition, mostly preserved language comprehension); ideational apraxia (can’t carry out skilled movements and/or commands); depression; speech arrest; anomia; Posterior - transcortical sensory aphasia (impaired auditory comprehension, intact repetition & fluent speech)

**uncinate fasciculus**
orbital & polar prefrontal cortex ↔ anterior temporal cortex
deficits in retrieval of past information: R - episodic context-dependent memory, personal experiences, autobiographical; L - context-free memory, general knowledge of facts

**inferior fronto-occipital fasciculus**
ventrolateral & dorsolateral prefrontal cortex ↔ posterior temporal & occipital cortex
R>L - impaired orienting of attention; visual recognition abnormalities; R+L - impaired pursuit eye movements; inaccurate reaching under visual guidance; impaired motion perception; R or R+L - impaired seeing/selecting in crowds; impaired spatial relations; visual agnosia & poor visual memory; impaired recognition of places & directions to get there; getting lost

**inferior longitudinal fasciculus**
temporal pole ↔ occipital cortex
disorders in recognition (visual agnosia) impaired visual recent memory; R or R+L - impaired face recognition (prosopagnosia), visual object agnosia, visual hypoemotionality if cue presented visually; R+L or L>R - contralateral deficit in color vision (hemiachromatopsia); L-bilateral misnaming of objects presented by touch (tactoverbal dysfunction)

Major Prefrontal - Subcortical Circuits

In psychiatry, the prefrontal cortex is generally divided into three principal areas. Each area has reciprocal connections with subcortical structures that form cortico-subcortical circuits.*

- Dorsolateral circuit mediates executive functions such as organization, planning & attention
- Orbitofrontal circuit mediates socially appropriate behavior, impulse control & empathy
- Anterior cingulate circuit produces motivation by balancing the inhibitory input of the supplemental motor area with its own stimulus that supports wakefulness & arousal

In psychiatry, the prefrontal cortex is generally divided into three principal areas. Each area has reciprocal connections with subcortical structures that form cortico-subcortical circuits. These prefrontal-subcortical circuits are formed by chains of neurons with cell bodies in gray matter structures (both cortical and subcortical) connected by the axons which form the white matter. Recently the evidence supporting a similar reciprocal circuit to the cerebellum has strengthened, although its functions are still controversial.

**Dorsolateral circuit** mediates executive functions such as organization, planning and attention

**Orbitofrontal circuit** mediates socially appropriate behavior, impulse control, and empathy

**Anterior Cingulate circuit** produces motivation by balancing the inhibitory input of the supplemental motor area with its own stimulus that supports wakefulness and arousal
Circuit of Papez

A schematic diagram of the emotion and memory circuit of Papez is color-coded to match the summary of subcortical structures and the sectional atlases. The location and extent of the Anterior Cingulate cortex (light gold), fornix and mammillary body are indicated on a midline sagittal magnetic resonance image. The locations of the remaining structures are shown on a coronal magnetic resonance image.
Brainstem - Amine Neurotransmitters

These small brainstem nuclei project very widely in the brain. They provide essential modulation of the brain systems that subserve multiple functions including behavior, cognition and mood. The approximate locations and extents of nuclei that are important sources for a particular neurotransmitter are color-coded onto a sagittal magnetic resonance image.*

Neurotransmitters: dopamine, acetylcholine, serotonin, norepinephrine

Neurotransmitters - Acetylcholine

basal forebrain
ventral tegmental area
amygdala
hippocampus
thalamus
hypothalamus
laterodorsal tegmental & pedunculopontine areas
Neurotransmitters - Serotonin
Neurotransmitters - Dopamine

- caudate & putamen
- septal nuclei & ventral striatum
- amygdala
- hippocampus
- substantia nigra & ventral tegmental area