The organ of the self:
An overview of the structure and function of the brain of relevance to psychiatry in 60 minutes

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Outline

History
Brain structures – 4 brains in one
Brain function - What function & how do we study it?
Connectomes – What are they & what do they mean?
Genes, circuits, molecular pharmacology & drug development
Psychiatric diagnosis – now & future

Estimated timeline for the brain’s evolution

<table>
<thead>
<tr>
<th>Taxonomic Level</th>
<th>Neural Structure</th>
<th>Age (millions of years, mya)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prokaryotes</td>
<td>Membrane proteins and channels</td>
<td>~2000 mya</td>
</tr>
<tr>
<td>Porifera</td>
<td>Neural net and protofilaure</td>
<td>1100 mya</td>
</tr>
<tr>
<td>Chordates</td>
<td>Homenbra, placodes &amp; spinal cord</td>
<td>&gt;800 mya</td>
</tr>
<tr>
<td>Classic Reptiles</td>
<td>Midbrain</td>
<td>270 mya</td>
</tr>
<tr>
<td>Late Reptiles</td>
<td>Palaeocortex</td>
<td>120 mya</td>
</tr>
<tr>
<td>Early Mammalians</td>
<td>Lienocortex</td>
<td>60 mya</td>
</tr>
<tr>
<td>Primate-hominoids</td>
<td>Cortex</td>
<td>~40 mya</td>
</tr>
<tr>
<td>Hominids</td>
<td>Neo-cortex</td>
<td>1-2 mya</td>
</tr>
</tbody>
</table>

 Ancient Greeks
When the gods want to curse a man, they steal his brain.

Hippocrates - On the Sacred Disease
Goats in the field are afflicted with this disease. When you cut open their skulls, you find their brains foul smelling and sweaty. That is how you know the affliction is caused by disease and not by gods.
"The difference in mind between man and the higher animals, great as it is, certainly is one of degree and not of kind."

Charles Darwin, Descent of Man, 1871

"[For] knowledge of mental diseases ...one must have: (a) knowledge of the physical changes in the cerebral cortex, and (b) [knowledge of] the mental symptoms associated with them."

"Until this is known, we cannot hope to understand the relationship between...symptoms of disease and the...physical processes underlying them..."

Emil Kraepelin, 1915

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Triune Brain Model of Paul MacLean, M.D.,

- **Protoreptilian formation** (including basal ganglia, midbrain, and brainstem): Genetically encoded instinctual action plans related to primitive survival issues such as exploration, feeding, aggression, dominance, and sexuality.

- **Paleomammalian formation** (including the amygdala, hippocampus, hypothalamus and other structures in the so called limbic system): Innate emotional and motivational systems shape behavioral responses to incoming stimuli based on instincts and past experience; mediates the social emotions, playfulness, and maternal nurturance.

- **Neomammalian formation (neocortex)**: Declarative knowledge about the world derived especially from sight, sound and touch.

Affective and Cognitive Neuroscience

"There appear to have been relatively long periods of stability in vertebrate brain evolution, followed by bursts of expansion."

The three evolutionary strata of the mammalian brain reflect these progressions:

The basic reptilian core is of similar relative size in all mammals (as long as we account for body size). Other vertebrates also have an abundance of this tissue in their small brains.

While the limbic system is comparatively small in reptiles, it is large in all mammals and of relatively similar size across different mammalian species.

In contrast, the degree of mushrooming of neocortex varies widely among mammalian species, being modest in rodents and reaching massive proportion in the cetaceans (whales and porpoises) and great apes (e.g., gorillas, chimpanzees) and attaining its pinnacle in humans.

It is the storehouse of our cognitive skills."

Affective Cortical-Striatal Circuits

**Limbic System**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Location</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amygdala</td>
<td>Deep inside anterior end of each temporal lobe</td>
<td>Controls behavior for each social occasion</td>
</tr>
<tr>
<td>Hippocampus</td>
<td>Medial border of each cerebral hemisphere</td>
<td>Determines which sense information will be committed to memory</td>
</tr>
<tr>
<td>Mamillary body</td>
<td>Posterior to hypothalamus</td>
<td>Perhaps helps to determine mood and degree of wakefulness</td>
</tr>
<tr>
<td>Septum pellucidum</td>
<td>Midline of cerebrum anterior and superior to</td>
<td>Perhaps helps to control temper and autonomic nervous system</td>
</tr>
<tr>
<td></td>
<td>hypothalamus</td>
<td></td>
</tr>
<tr>
<td>Limbic cortex, cingulate</td>
<td>Ring of cerebral cortex in medial part of cerebrum</td>
<td>Conscious components in the control of behavior</td>
</tr>
<tr>
<td></td>
<td>gyri, insula, and parahippocampal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>gyrus</td>
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AC Guyton Basic Neuroscience: Anatomy and Physiology, Saunders
Klüver-Bucy syndrome
Constellation of behavioral response changes following amygdaloid lesions in the monkeys and humans consisting of hypersexuality, a change in dietary habits, a decrease in anxiety toward fear-producing objects, a tendency to explore and contact orally inedible objects, and visual agnosia.

Septal rage
Intensified specie specific aggressive response following lesions placed in the septal area and septum pellucidum including humans.
The septal area is a limbic structure representing a major relay nucleus of the hippocampal formation.
Korsakoff’s syndrome

Memory disorder (usually associated with damage to the fornix or its projection targets) in which the patient displays amnesia (memory loss) of both anterograde and retrograde memory.
**Functional Areas**

**Motor areas**  Located in the posterior frontal lobe

**Motor cortex**  Controls discrete muscle activities

**Premotor cortex**  Controls patterns of coordinate muscle

**Broca's area**  Controls speech

**Wernicke's area**  Superior posterior temporal lobe

Analyzes sensory information from all sources

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**Short-term memory area**  Inferior portions of temporal lobe

**Prefrontal area**  Anterior half of frontal lobe – “elaboration of thought”

**Somesthetic cortex**  Parietal lobe detects tactile and proprioceptor sensations

**Visual area**  Occipital lobe detects visual sensations

**Auditory area**  Superior temporal lobe detects auditory sensations

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