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Evolution II

According to Gerald Schneider. *9.14 Brain Structure and Its Origins, Spring 2014*. (Massachusetts Institute of Technology: MIT OpenCourseWare), <http://ocw.mit.edu> (Accessed).
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Basic cellular mechanism

Endogenous activity

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Irritability

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Movement

Basic cellular mechanism

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Irritability

Movement

Secretion

Basic cellular mechanism

Endogenous activity

Irritability

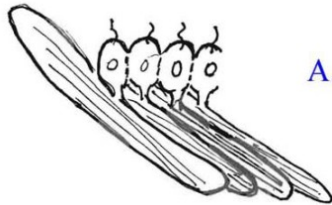
Movement

Secretion

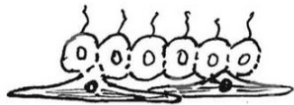
Integrative activity

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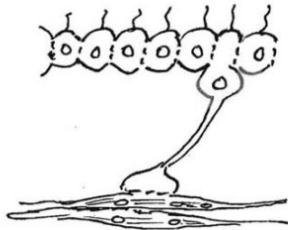
Input → Integration → Output



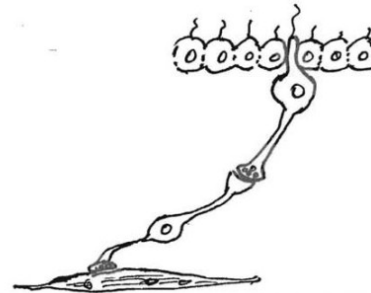
A. Myoepithelium:
contractile epithelial cells
responding to stimulation and
interconnected by electrical
synapses (gap junctions)



B. Protomyocytes separate
from sensory epithelium,
all connected by electrical
synapses

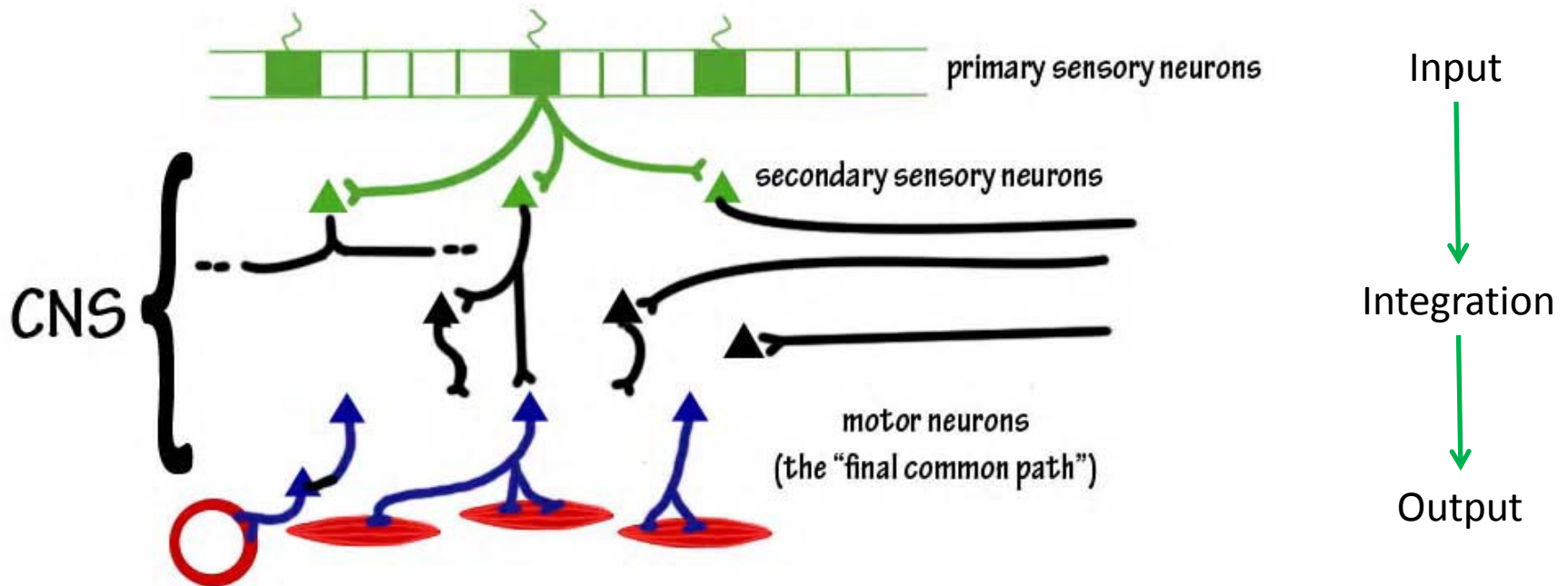


C. Protoneurons appear,
sensory and connected to
separate contractile cells



D. Neurons appear, separate
from both neurosensory cells
and contractile cells.
Chemical synapses appear.

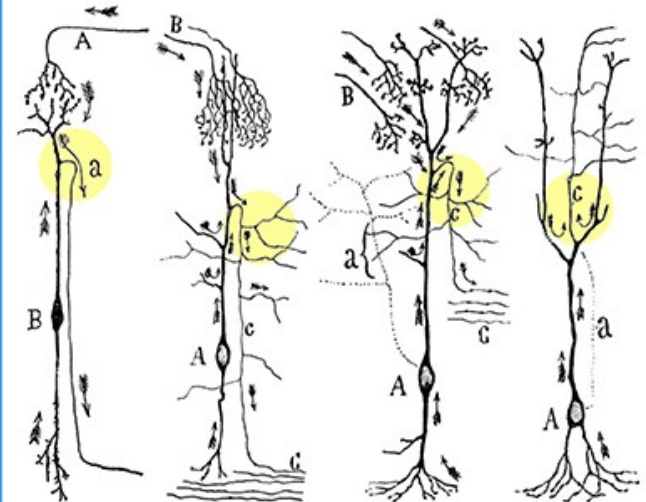
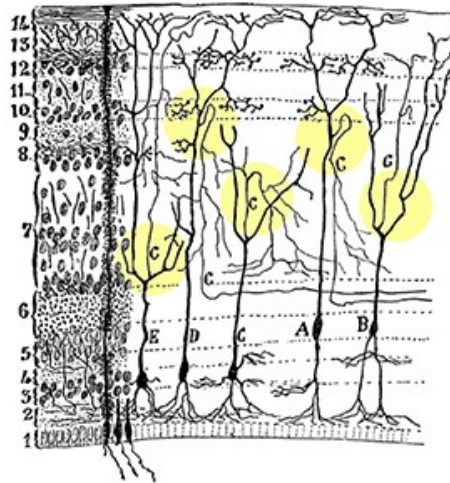
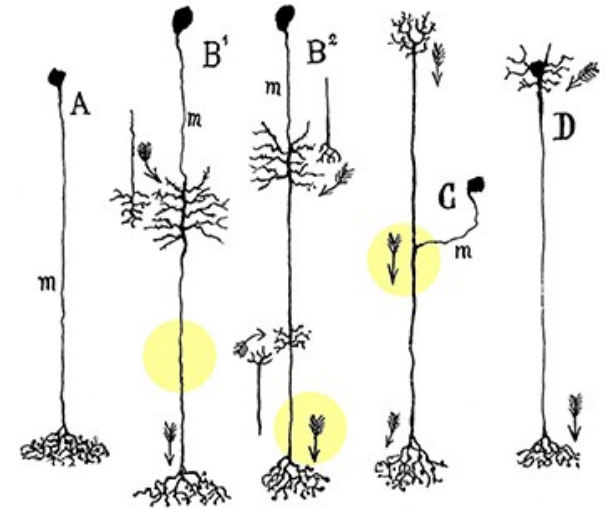
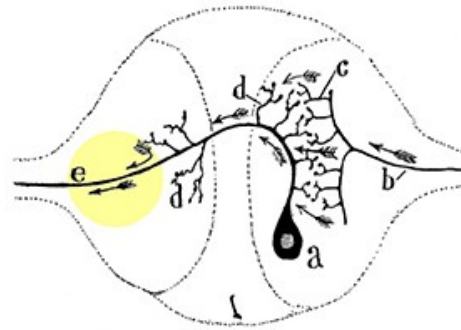
Integrative activity



Integrative activity

Stimulus – response model

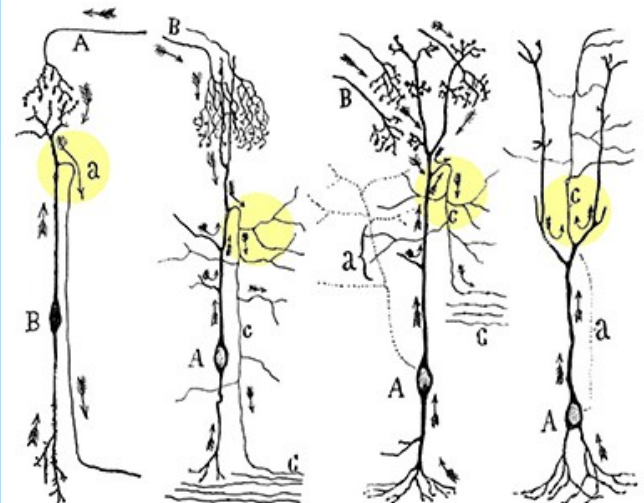
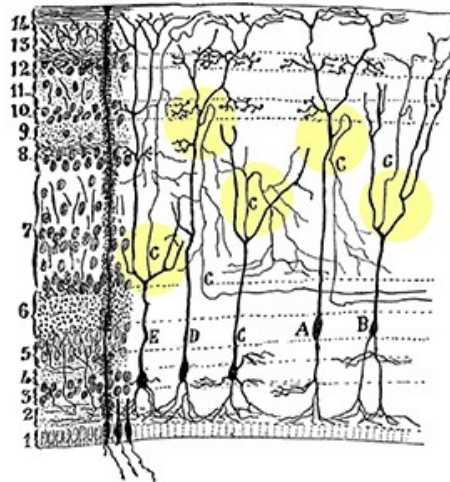
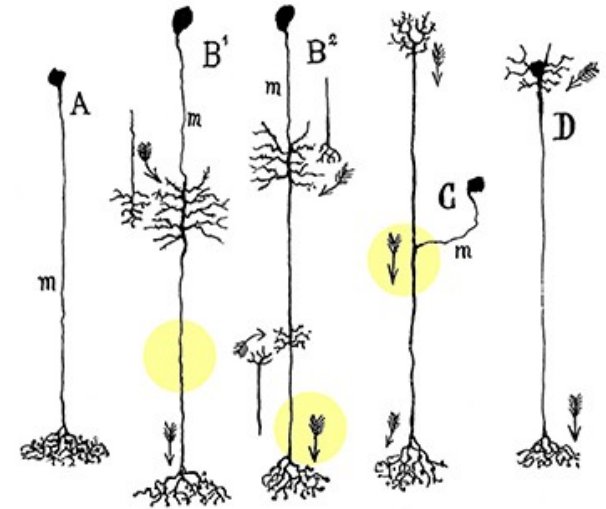
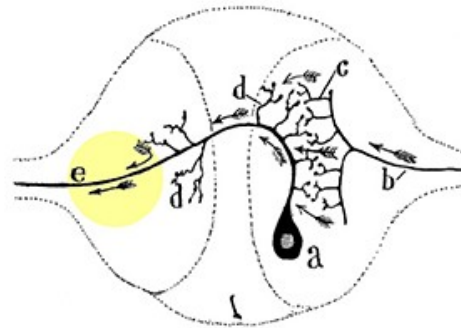
- Based on philosophy of Rene Descartes
- action-reaction



Integrative activity

Stimulus – response model

- Based on philosophy of Rene Descartes
- action-reaction
- Reflex pathway first described by Ramon y Cajal
- Pavlov demonstrated that reflexes are plastic – could be changed by learning



Inadequacy of S-R model

- When Karl Lashley saw slides of frog's brain, he told „If I could use this kind of material to see all of the connections, it would be possible to explain the frog's behavior“

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- Endogenous activity also does not fit S-R model (motivational system may initiate motor activity independently of external stimuli)

Basics of behavior enabling survival

- **Multipurpose movements**
 - The most basic actions of individual organisms
 - ***Locomotion***: to approach or to avoid something
 - ***Orienting***: towards or away from something
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- **Motivation**

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- **Sensory analyzing mechanisms**
 - Connected to inputs from cranial nerves
- **Associated motor apparatus**
 - For directing the receptors (orienting movements)
 - For controlling alterations in posture and locomotion under guidance from these receptors

CNS structures

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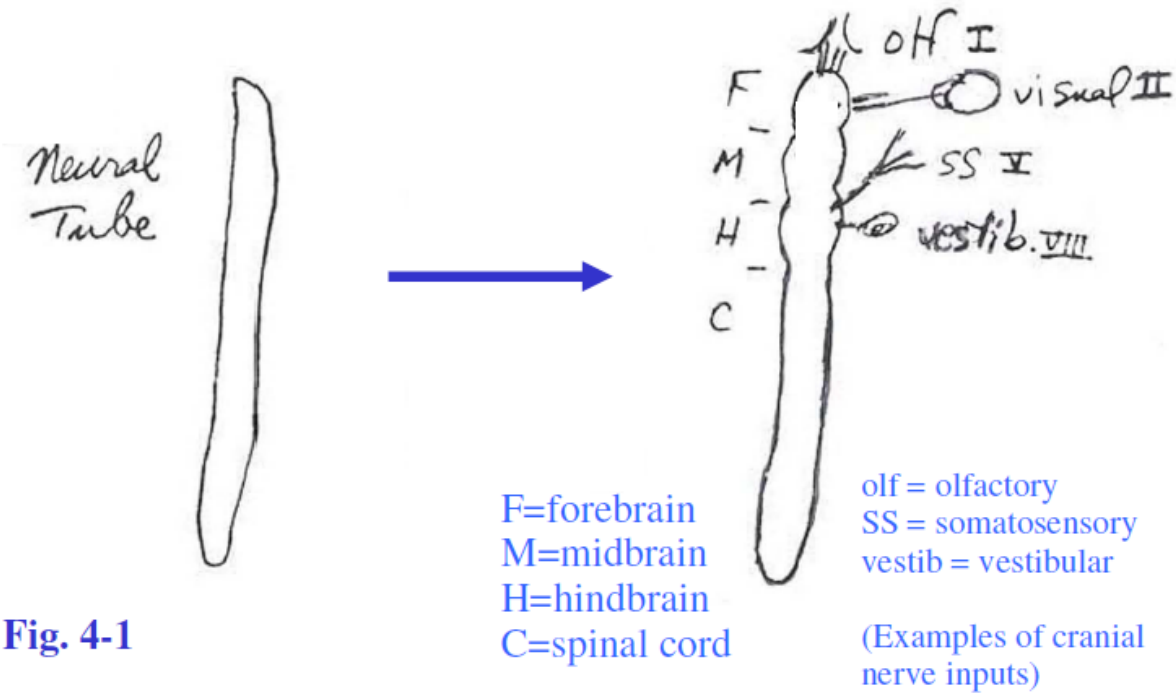
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 - **Olfactory & visual inputs**
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Evolution of the brain

- Neural tube
- Locomotion
- Rostral receptors



Evolution of the brain

- **Expansion of hindbrain**

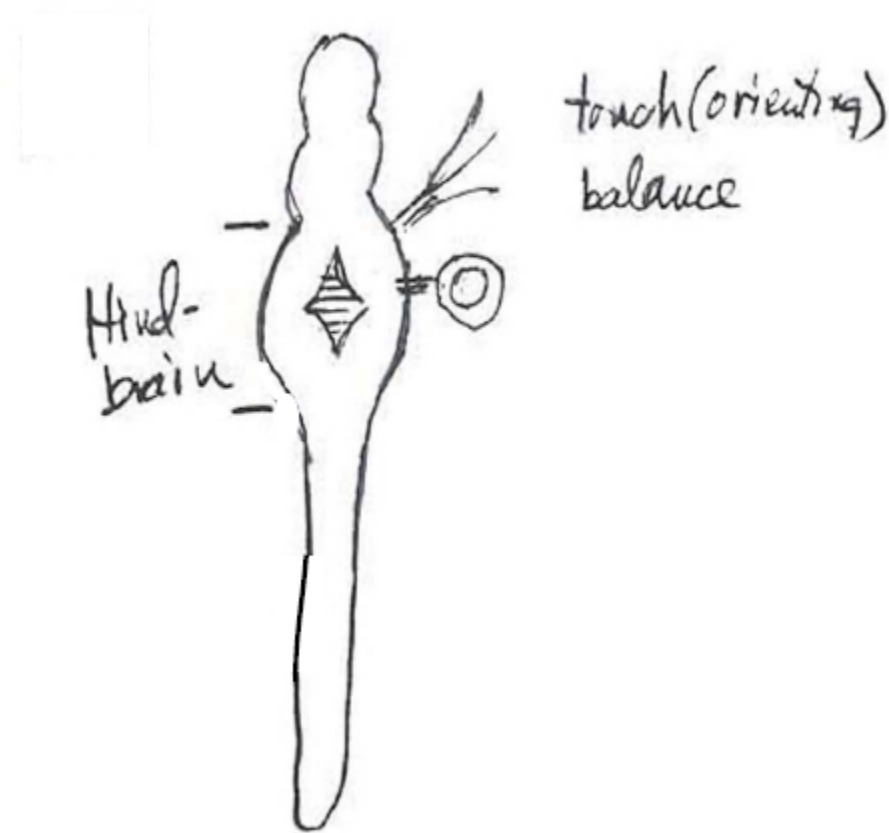
(Rhombencefalon - Medula oblongata, pons Varoli, cerebellum)

- **Input**

– Information from head sensors

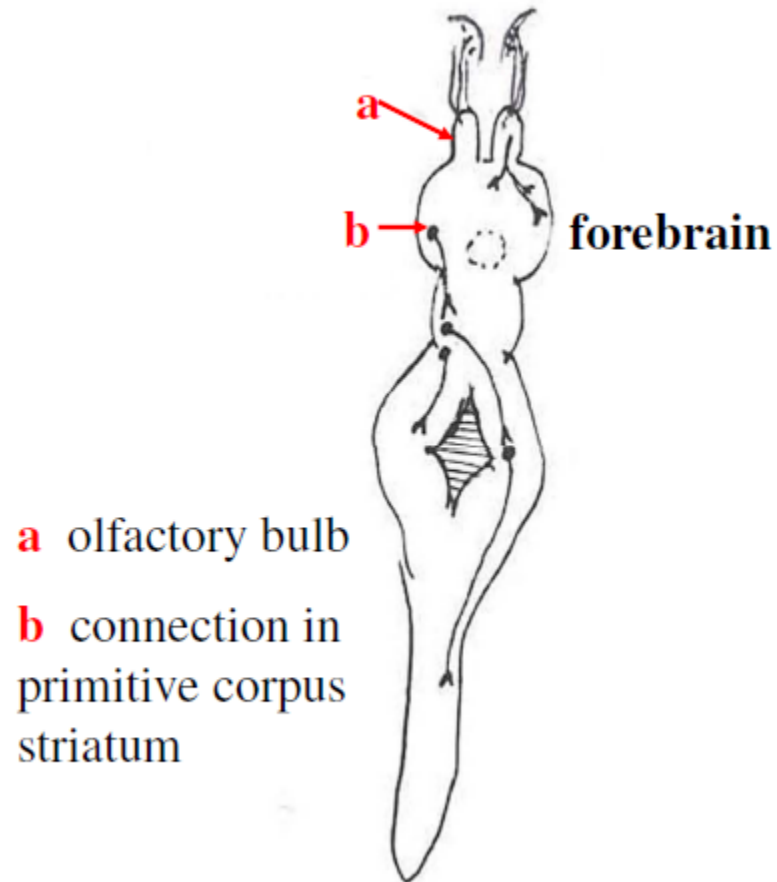
- **Output**

– Motor system
(Fixed action pattern - reflex/instinct behavior)



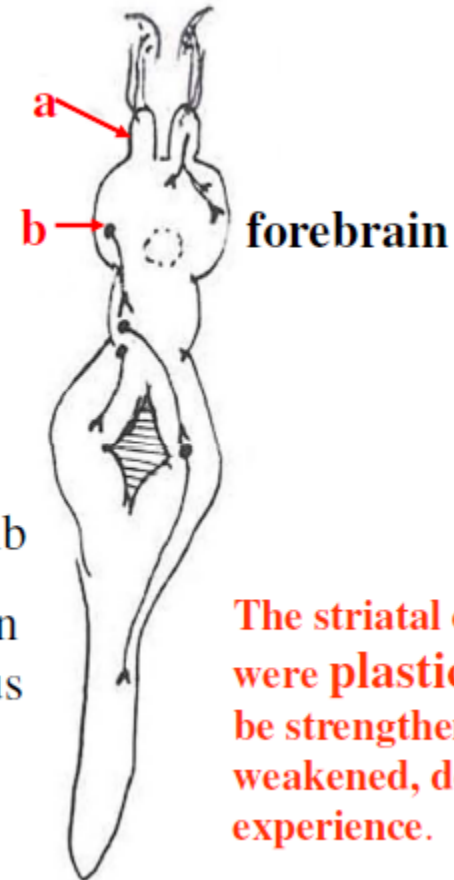
Evolution of the brain

- **Expansion of forebrain 1**
(Prosencephalon - diencephalon, telencephalon)
(simultaneously with hindbrain)
- **Input**
 - Olfaction
(Approach/avoidance)
- **Output**
 - Motor system
(via corpus striatum)



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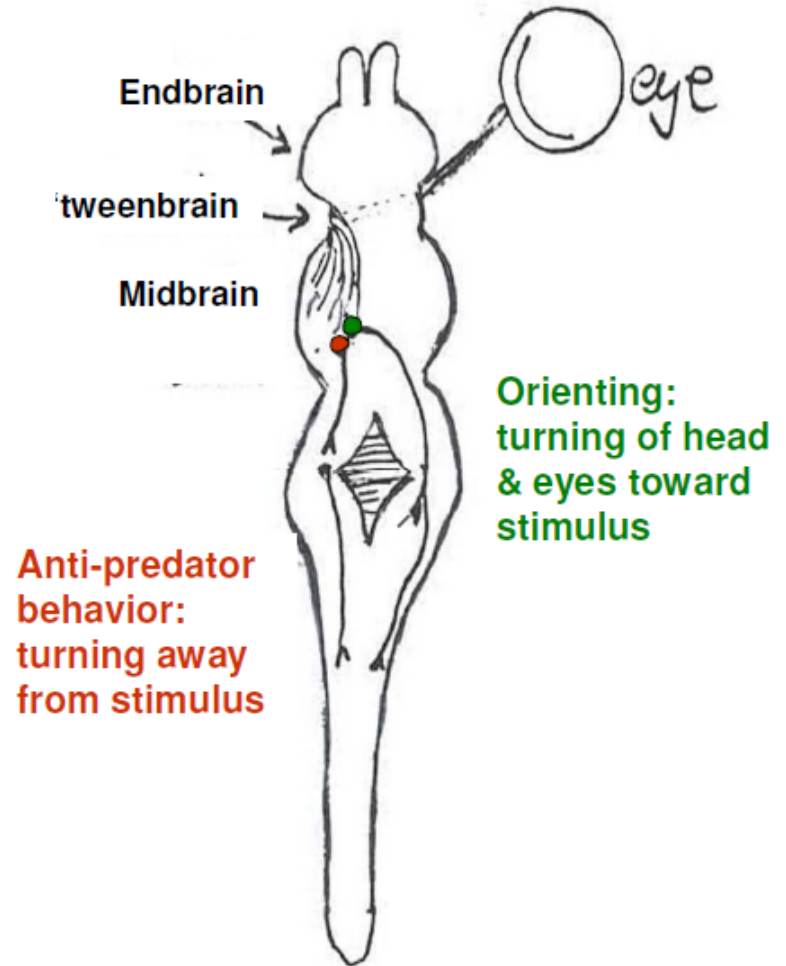


a olfactory bulb
b connection in primitive corpus striatum

The striatal connections were plastic: They could be strengthened or weakened, depending on experience.

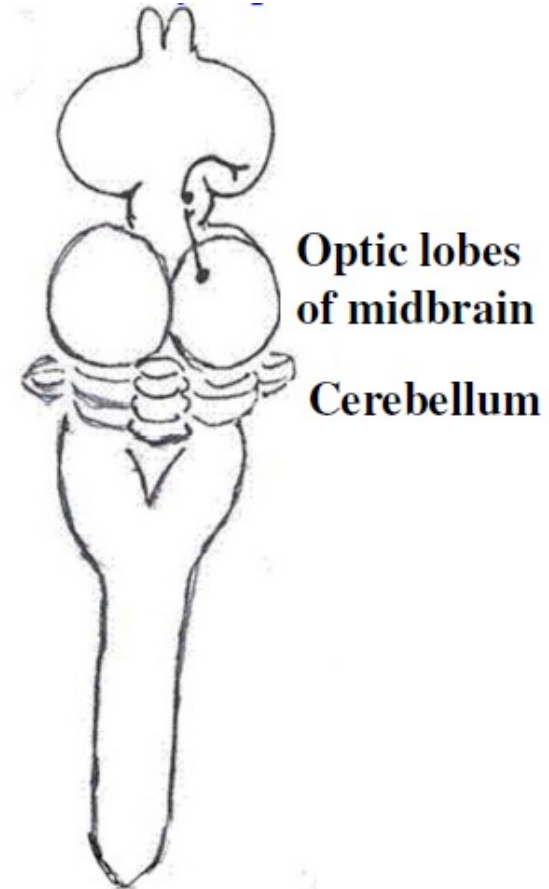
Evolution of the brain

- **Expansion of midbrain**
- **Input**
 - Vision, sense of hearing
(distant senses)
- **Output**
 - Motor system
(Approach – contralateral m.)
(Avoidance – ipsilateral m.)
- **Advantage**
 - Speed
 - Acuity



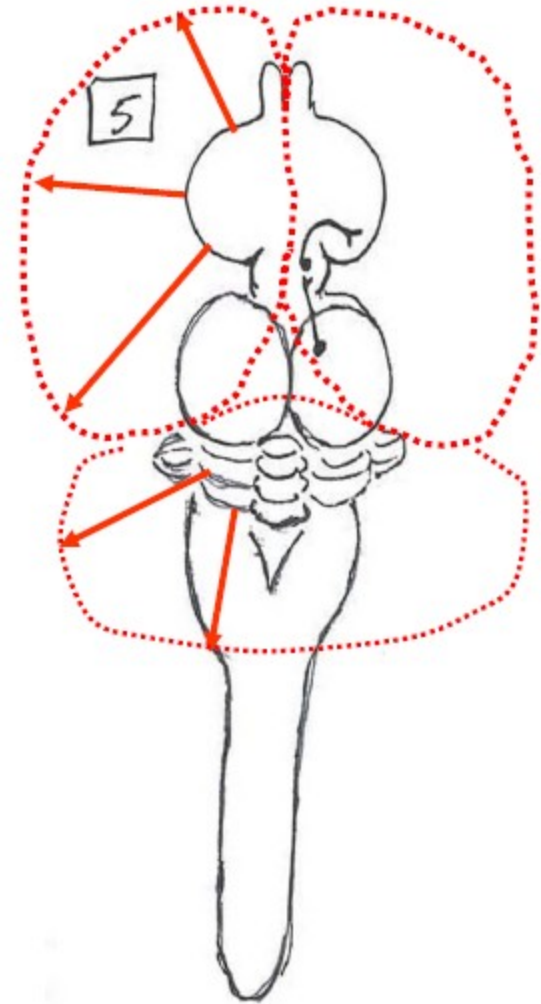
Evolution of the brain

- **Expansion of forebrain 2**
(Prosencephalon - diencephalon, telencephalon)
- **Input**
 - Nonolfactory systems connected to forebrain
 - Mainly vision and hearing
- **Advantage**
 - Plastic connections of forebrain
- **Thalamus**
 - Gating
(Corpus striatum and cortex)



Evolution of the brain

- **Expansion of forebrain 3**
- Neocortical expansion
- Simultaneous expansion of
 - Neostriatum
 - Neocerebellum
- Advantage
 - „High resolution“ information processing
 - Anticipation



Learning and memory

- Connections of striatum and hippocampus are plastic
- Plasticity is a base of learning
- Learning is a forming of long- term memory
- Declarative memory (explicit)
 - Based on hippocampus
 - Explicit information is stored and later recollected
 - „Construction of the maps (relationships)“ – spatial or abstract
- Procedural memory (implicit)
 - Based on striatum
 - Habitual learning – motor skills, but also social habits
 - „Construction of the algorithms“

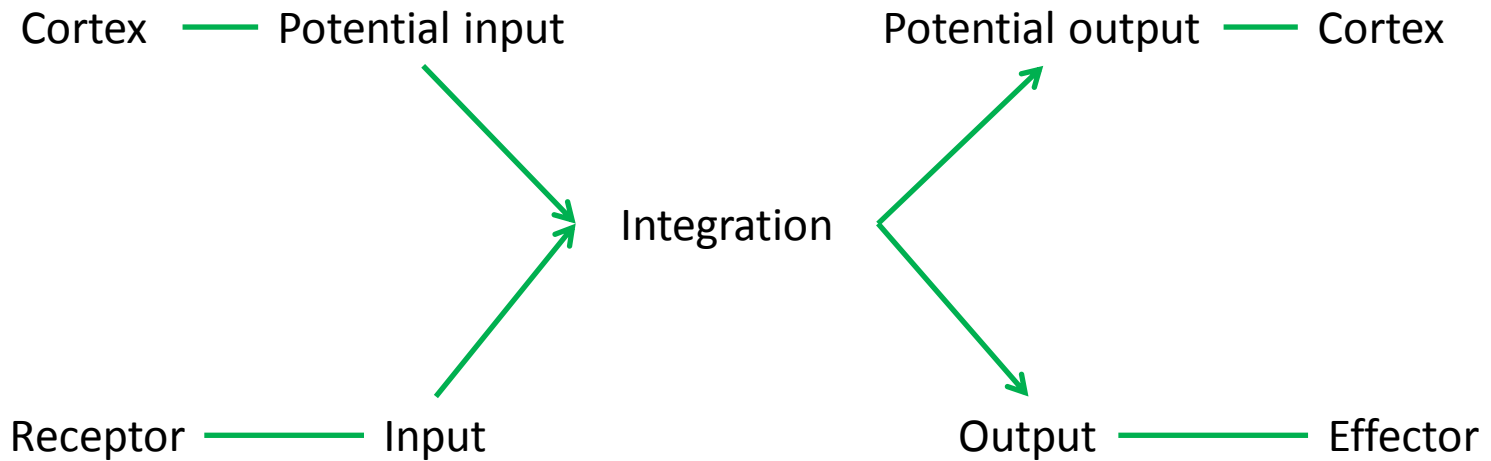
Working memory
– „RAM“
Long term memory
– „Hard disk“

Location oriented:
Where am I and what has happened here?

Object oriented:
Can I eat it and how to eat it?

The role of nervous system

ANTICIPATION



REGULATION