



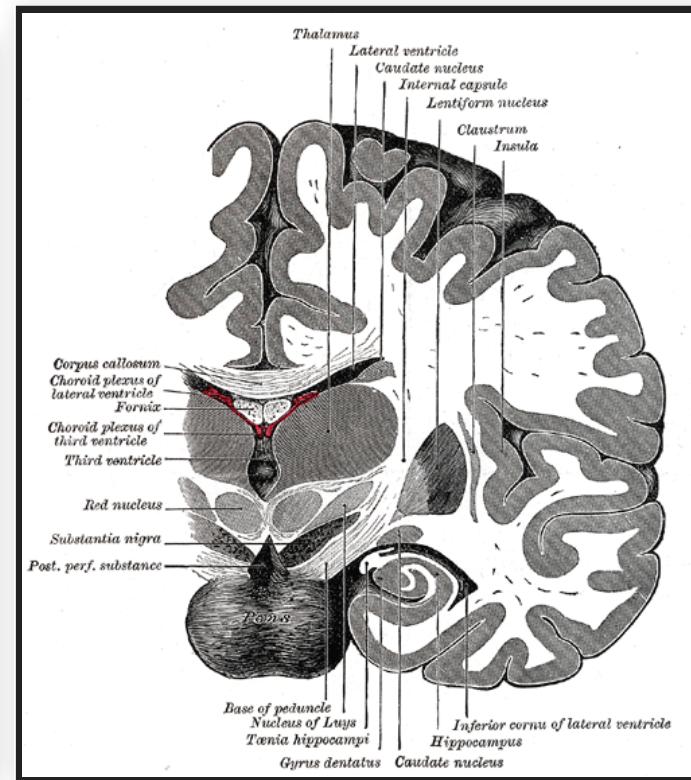
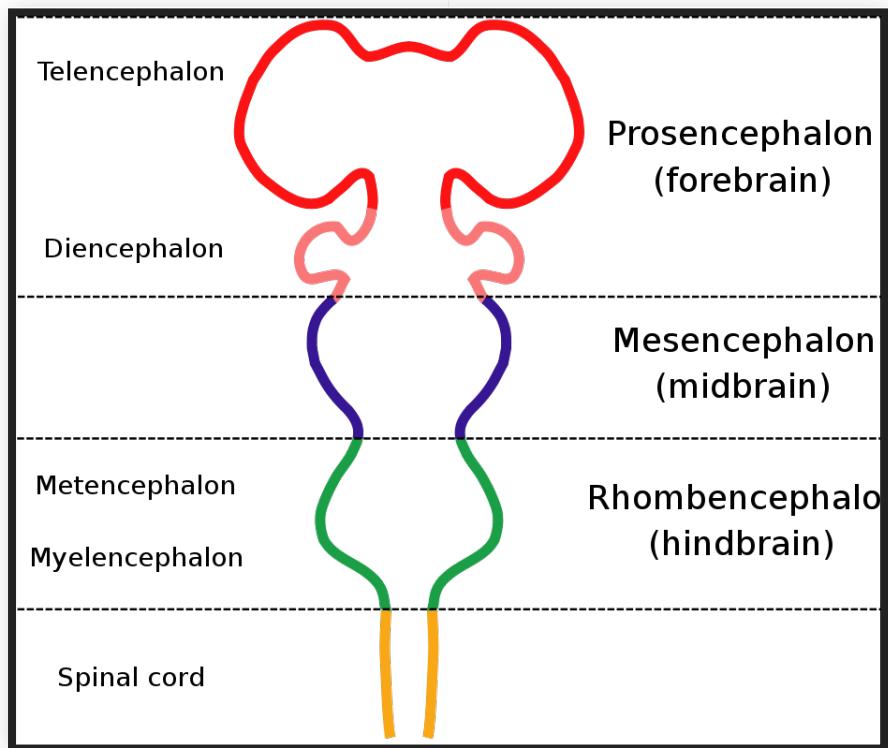
# **Simulation of Biological Neural Networks**

## **Topological Networks**

**{r.pauli|morrison}@fz-juelich.de**

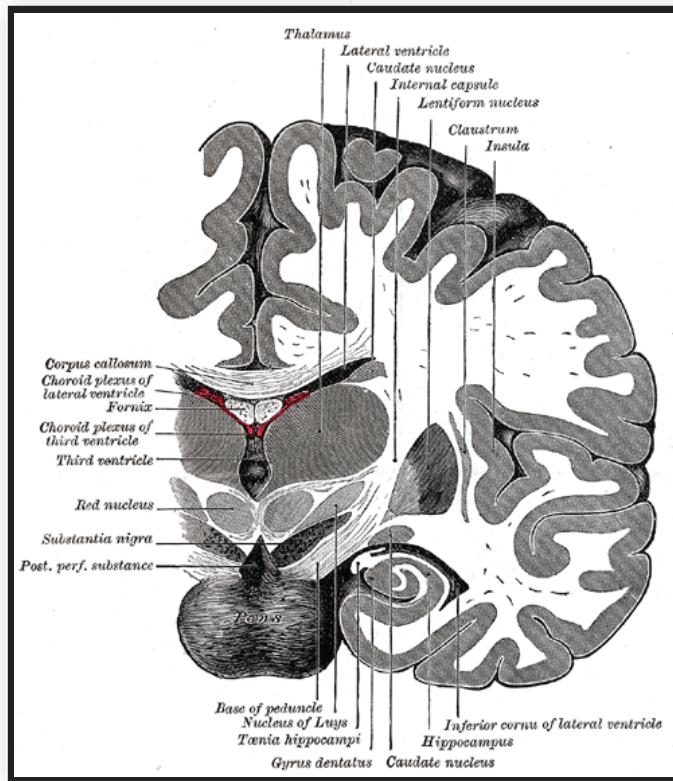
# **Brain structure from Macro- to Microscopic scale**

# Macroscopic structure: the Forebrain



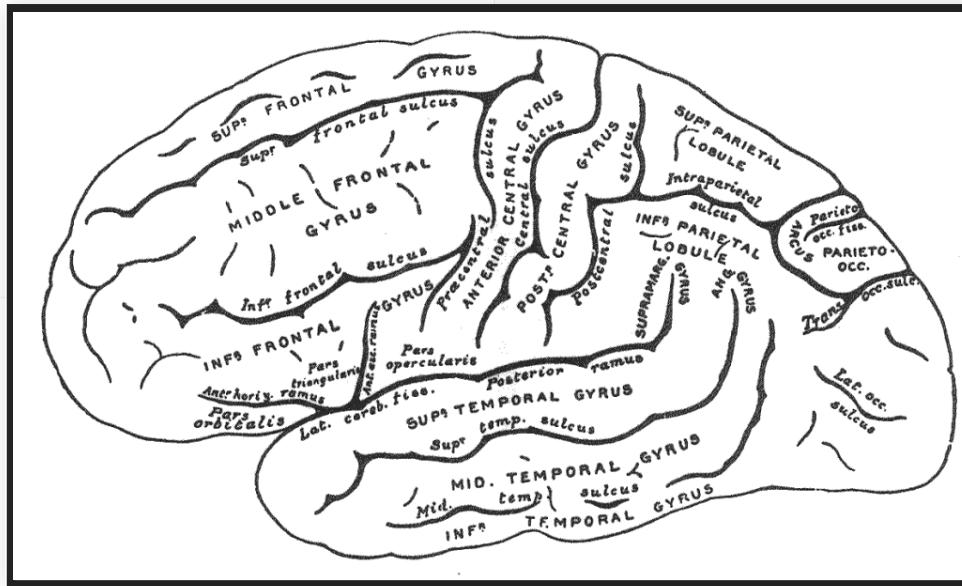
- Diencephalon: e.g. thalamus, hypothalamus
- Telencephalon (cerebrum)
  - basal ganglia (motor control, learning etc.), amygdala (emotions)
  - olfactory bulb (smell), cerebral cortex (archeocortex, **(neocortex)**)

# Macroscopic structure: cortex folds



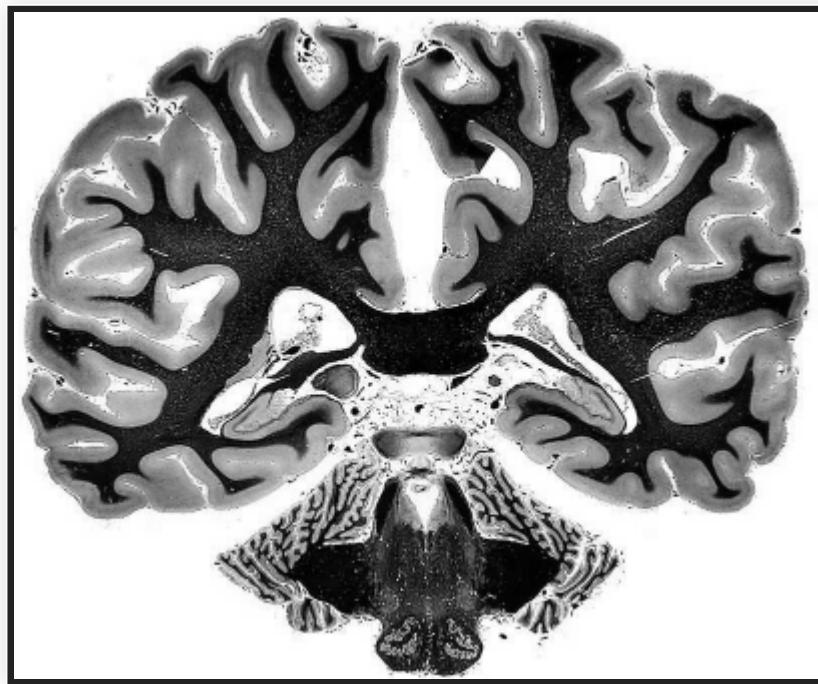
- neocortex: surface of mammalian brain (gray matter)
- strongly folded in 'higher' mammals
  - larger surface (relative to volume)
  - efficient wiring through white matter

# Macroscopic structure: cortex folds



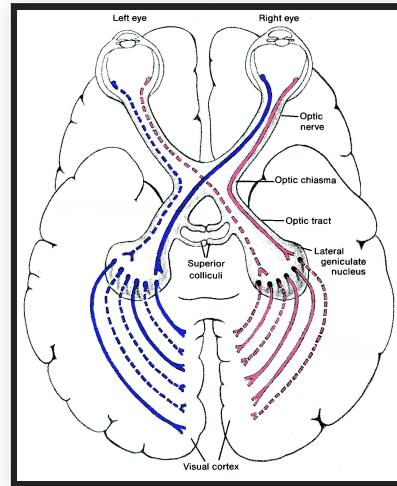
- neocortex: surface of mammalian brain (gray matter)
- strongly folded in 'higher' mammals
  - larger surface (relative to volume)
  - efficient wiring through white matter
- folds='sulci'
- region between folds: gyrus
- location of deep sulci highly conserved

# Macroscopic structure: cerebral hemispheres



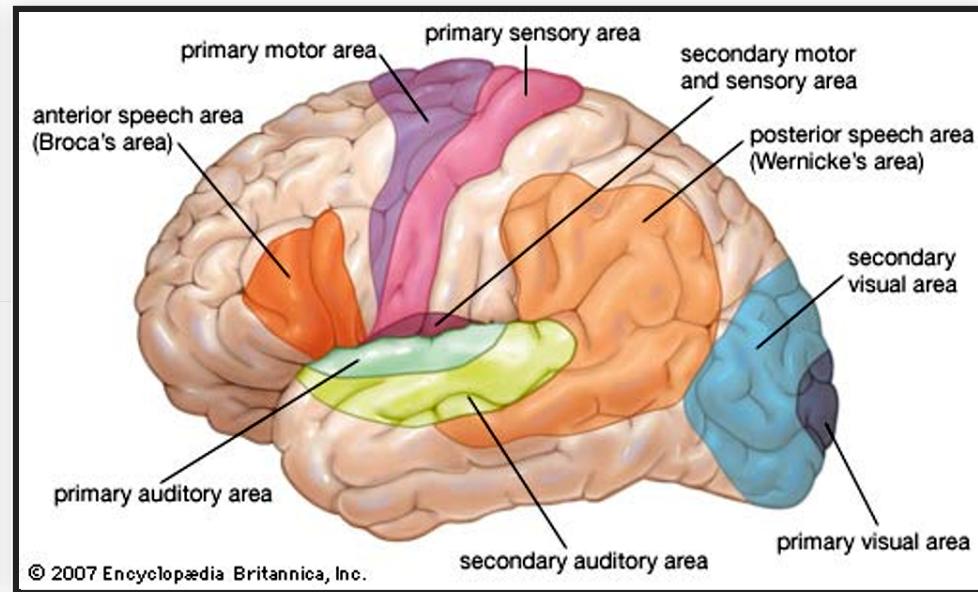
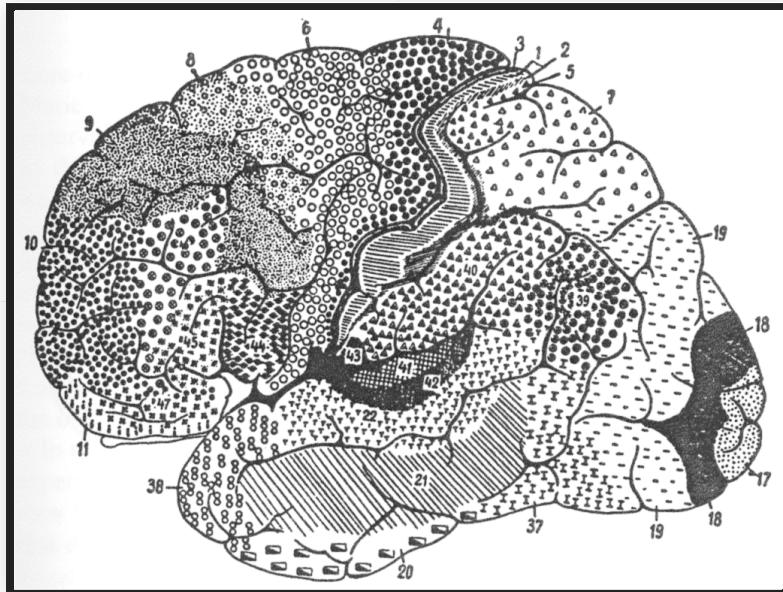
- two (largely) symmetric hemispheres
- Interconnected via Corpus callosum (white matter)

# Macroscopic structure: cerebral hemispheres



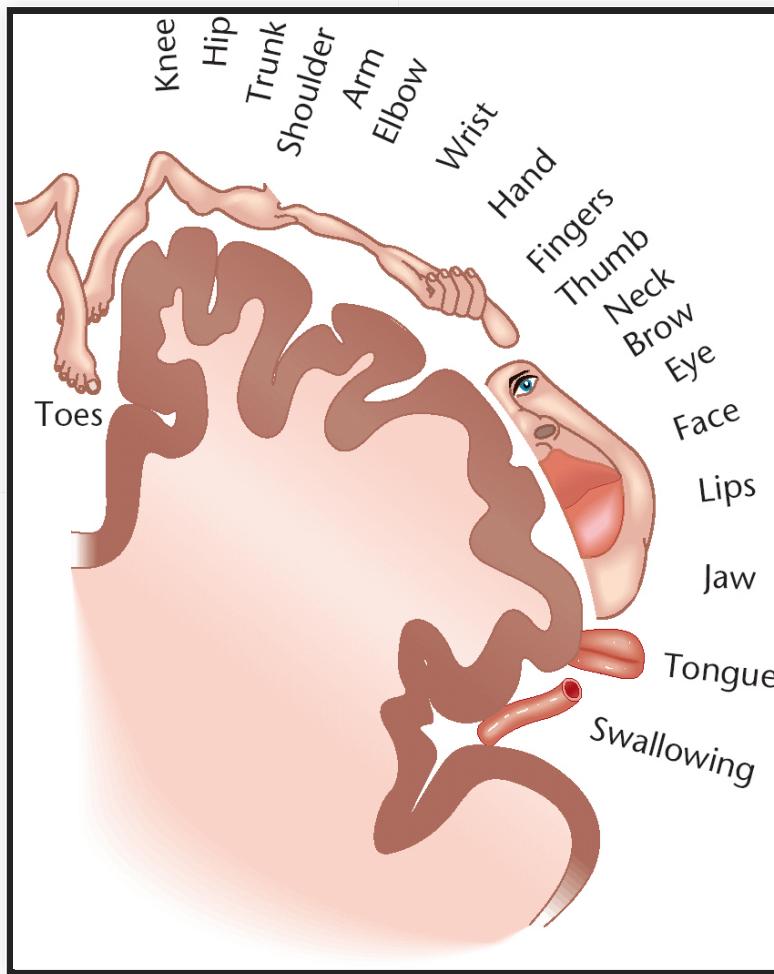
- Brain function is sometimes lateralized (preference for one hemisphere)
- in general involvement of both hemispheres
  - e.g. visual processing: each hemisphere receives information from both eyes however, preference of input from left part of the visual field for right hemisphere (and vice versa)

# Cortical areas



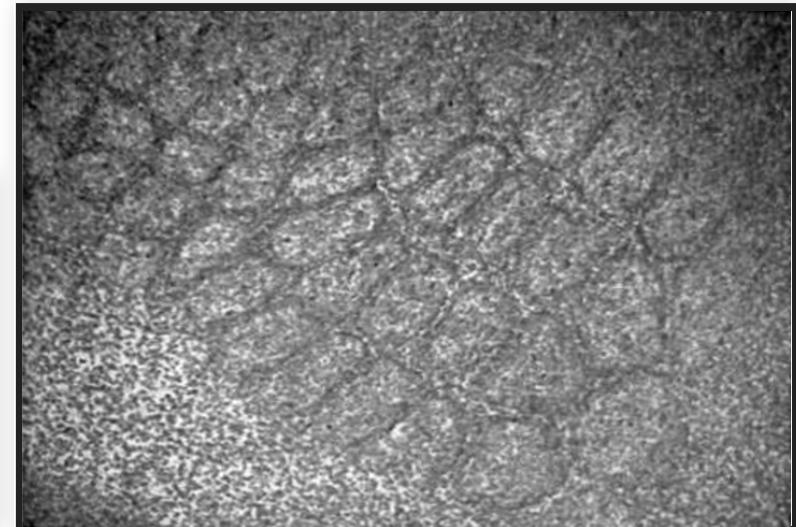
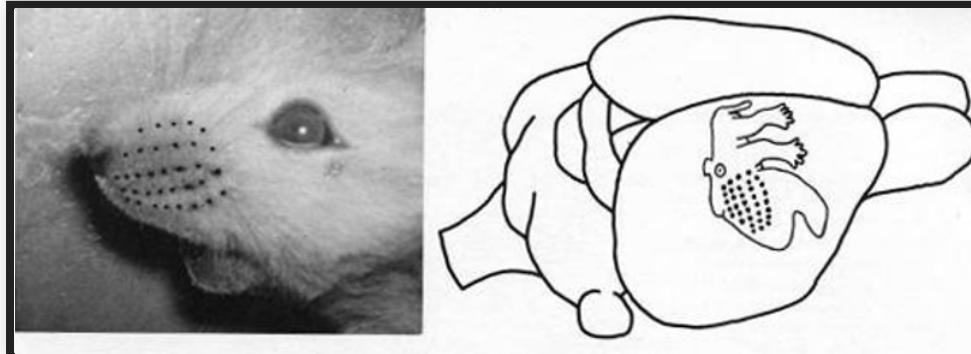
- Subdivision of cortex into areas based on:
  - anatomy (histological cytoarchitectural features)
  - functional properties
- frequent coincidence: primary visual cortex and Brodman area 17

# Cortical areas



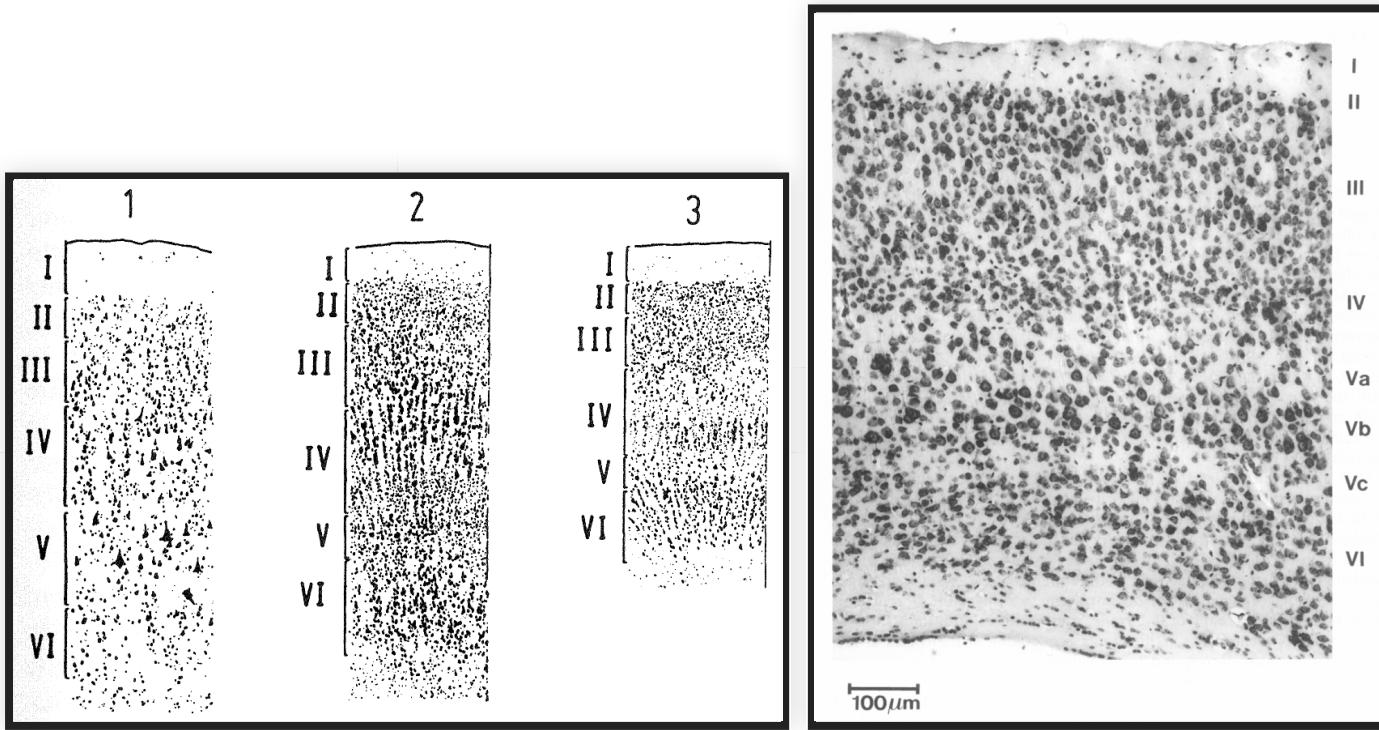
- Further subsegmentation into sub areas
- somatotopic maps, also in e.g. rats, star mole etc.

# Cortical areas



- Further subsegmentation into sub areas
- somatotopic maps, also in e.g. rats, star mole etc.

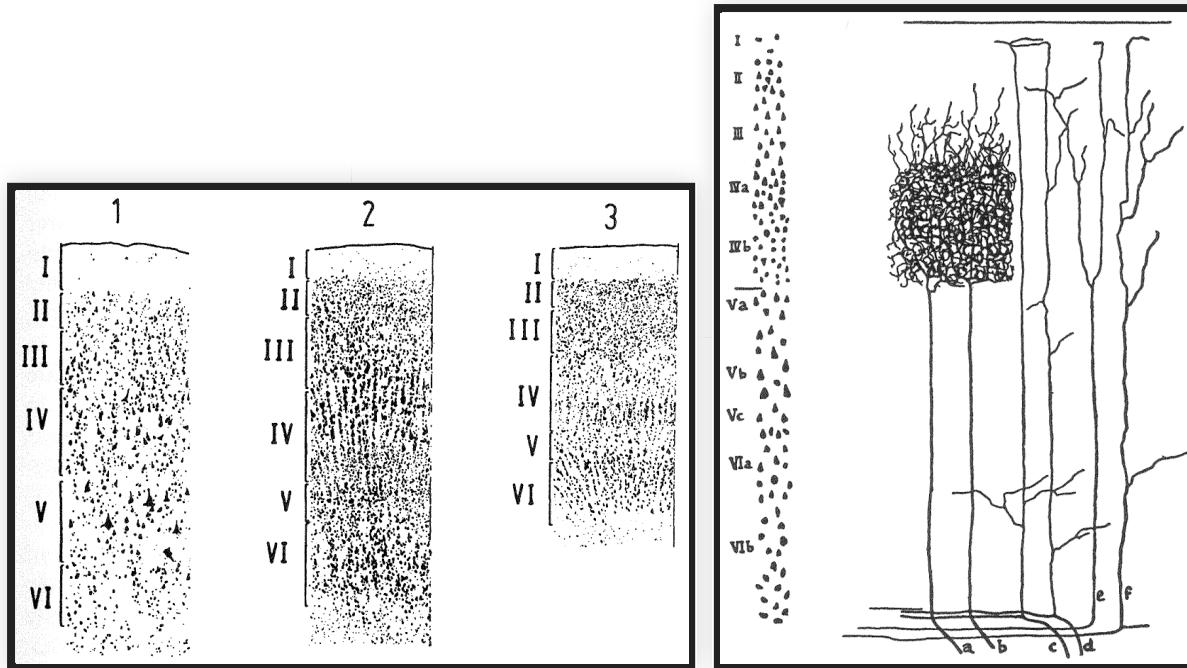
# Cortical layers



- highly conserved structure of layers
- connections from neurons in local vicinity

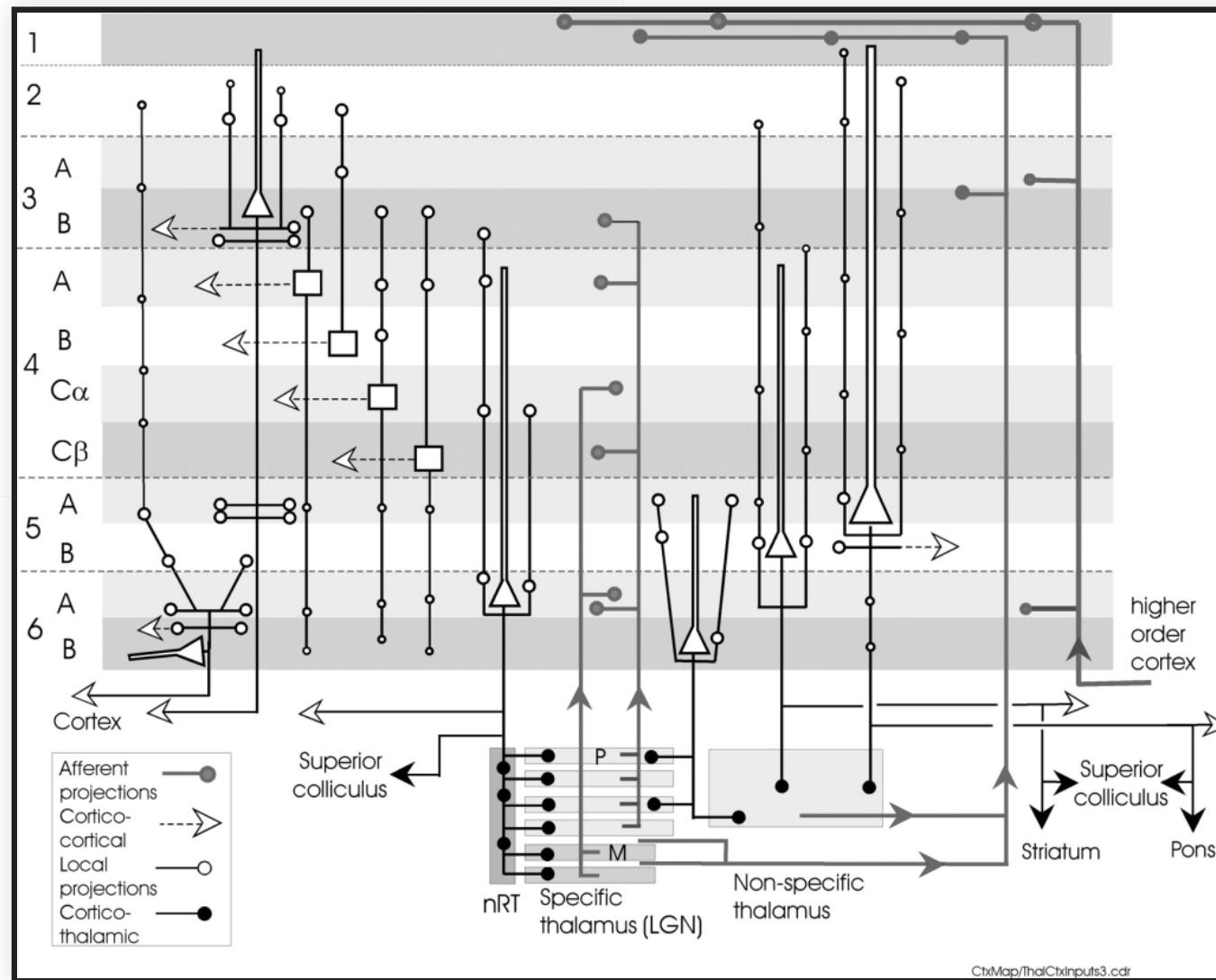
**How are all the neurons  
connected?**

# Cortical layers

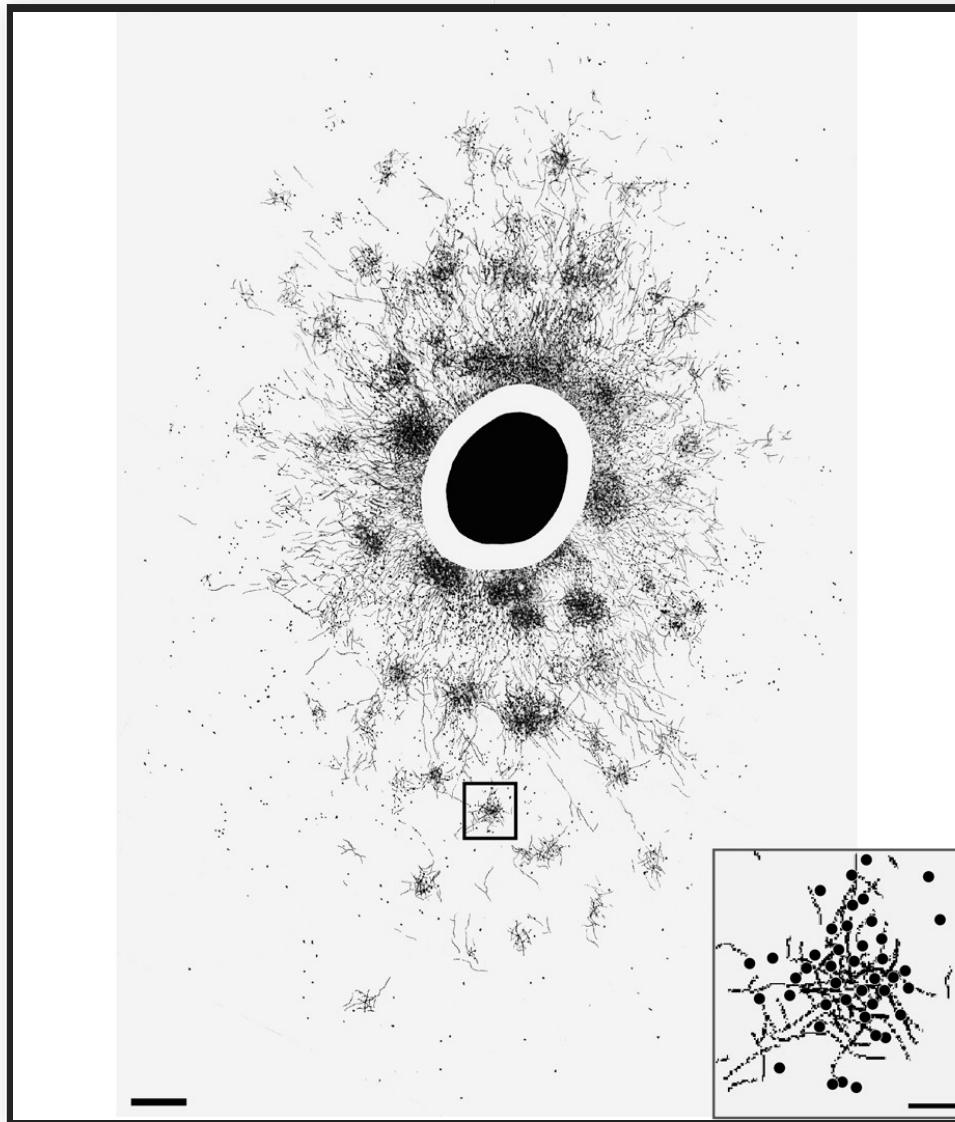


- highly conserved structure of layers
- connections from neurons in local vicinity
- external non-local input from
  - thalamus
  - distant cortical areas

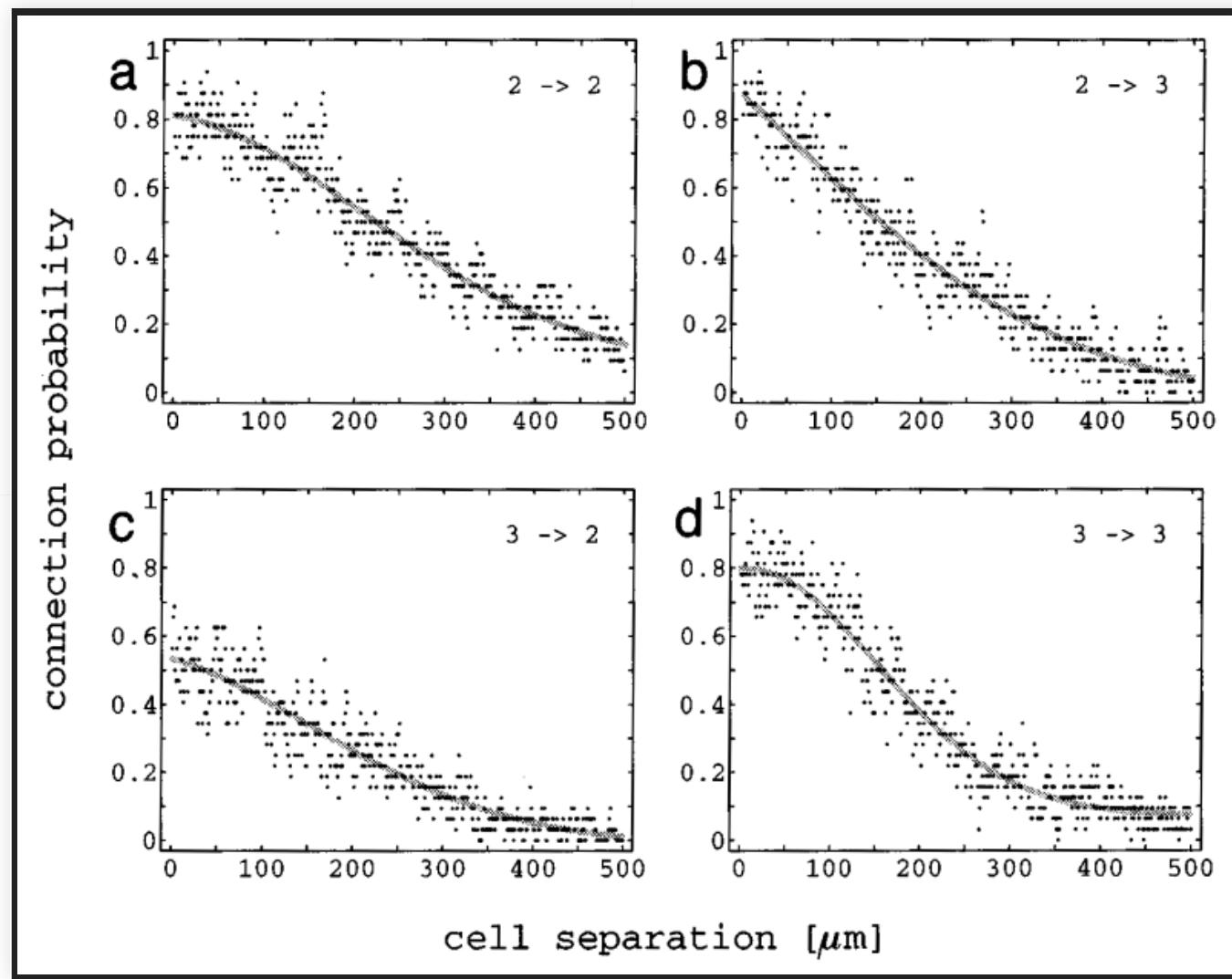
# Layer and cell type specific connections



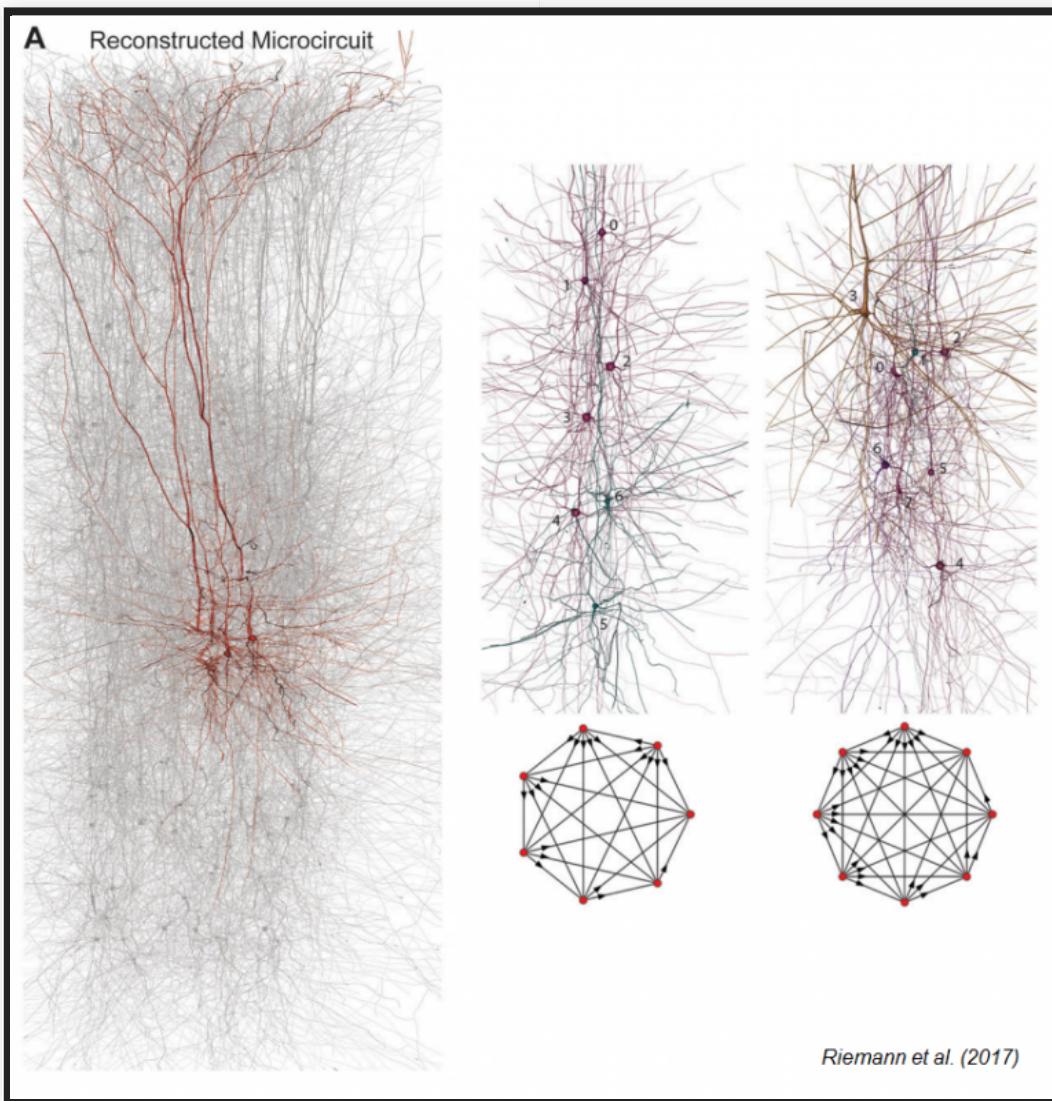
# Horizontal connectivity



# Distant dependence of connections

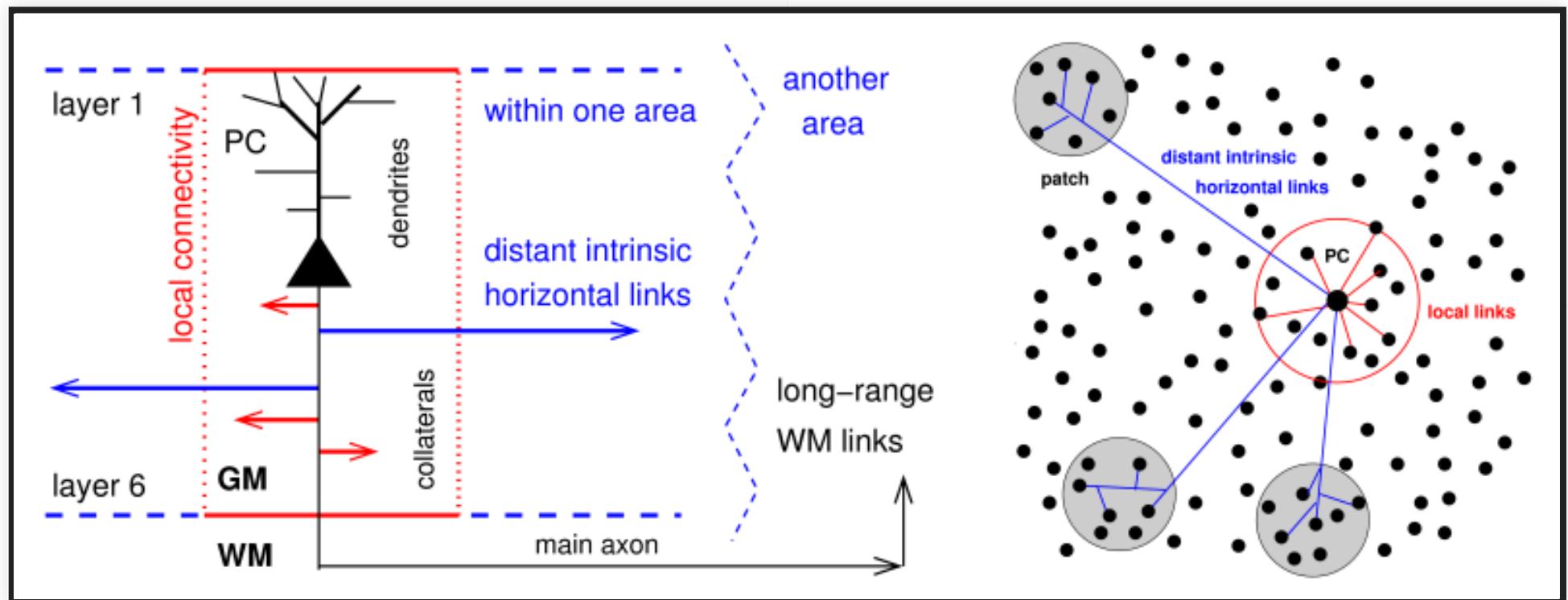


# Higher order motifs

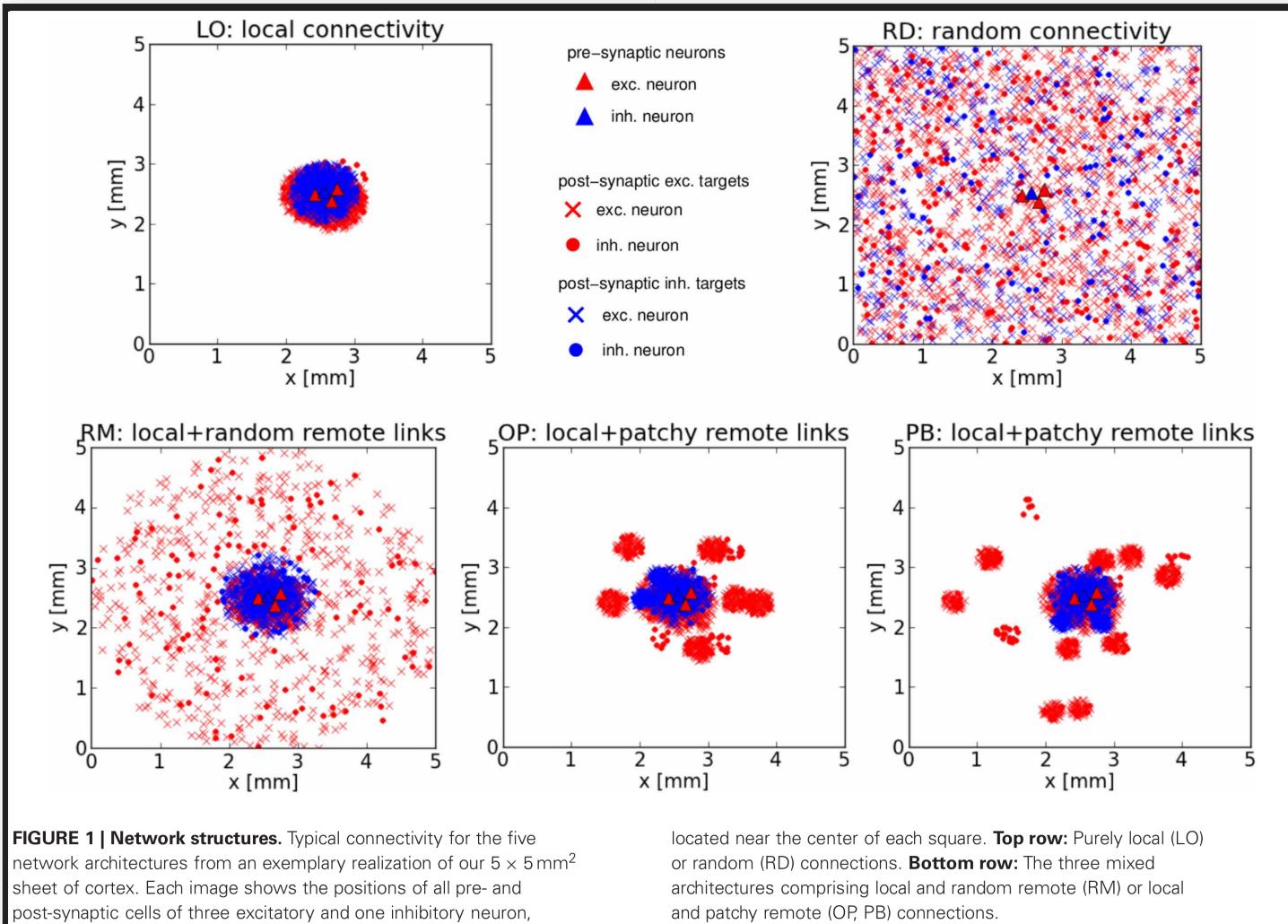


**Is it important?**

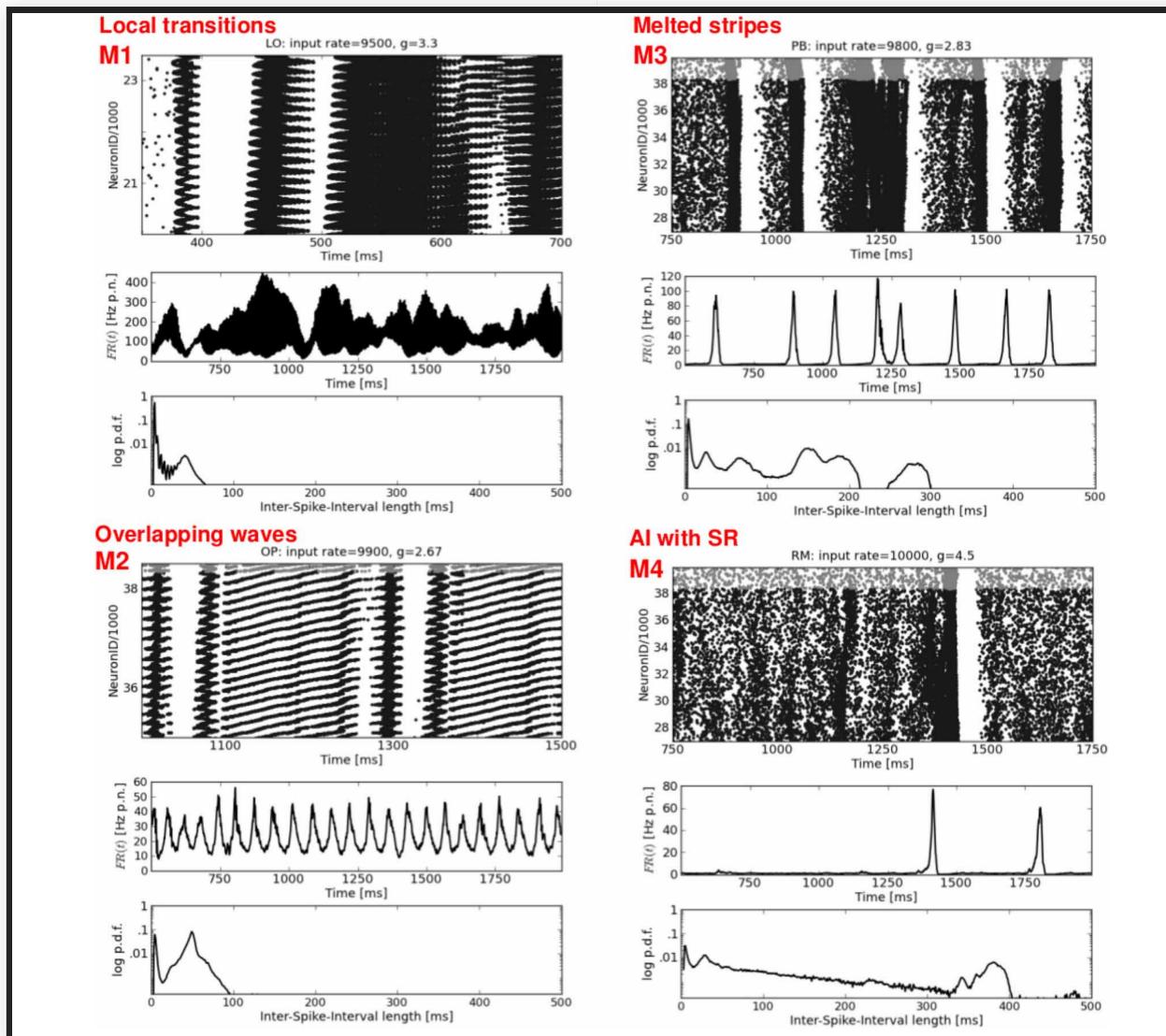
# Horizontal connectivity



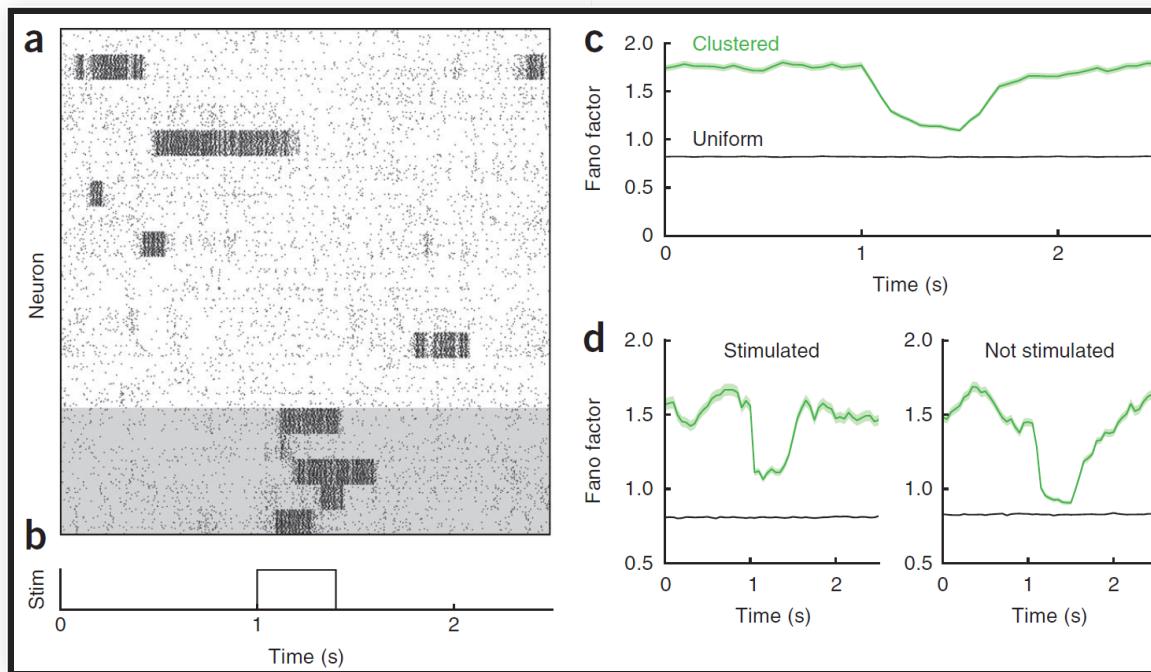
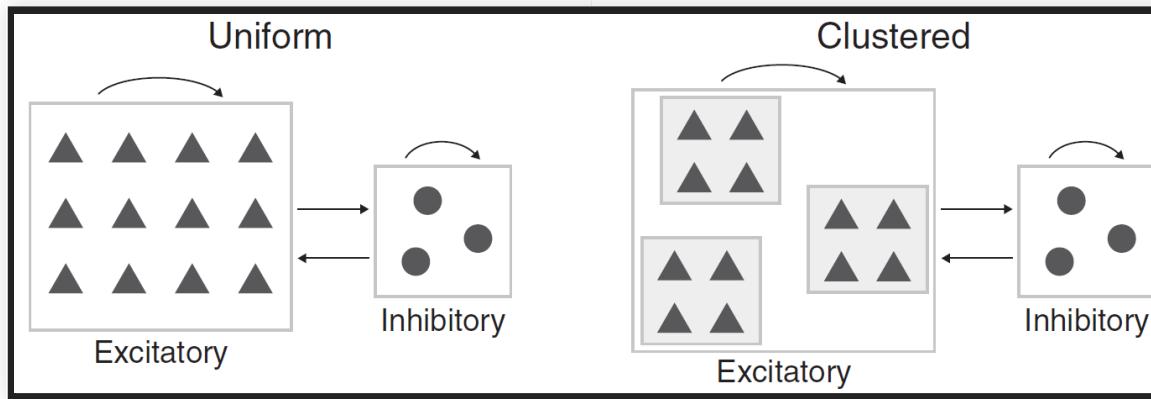
# Modelling influence on dynamics



# Modelling influence on dynamics



# Reproduce some experimental findings



# Winnerless competition

