

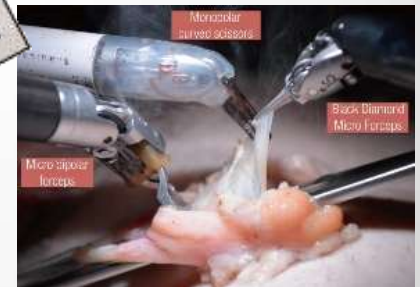
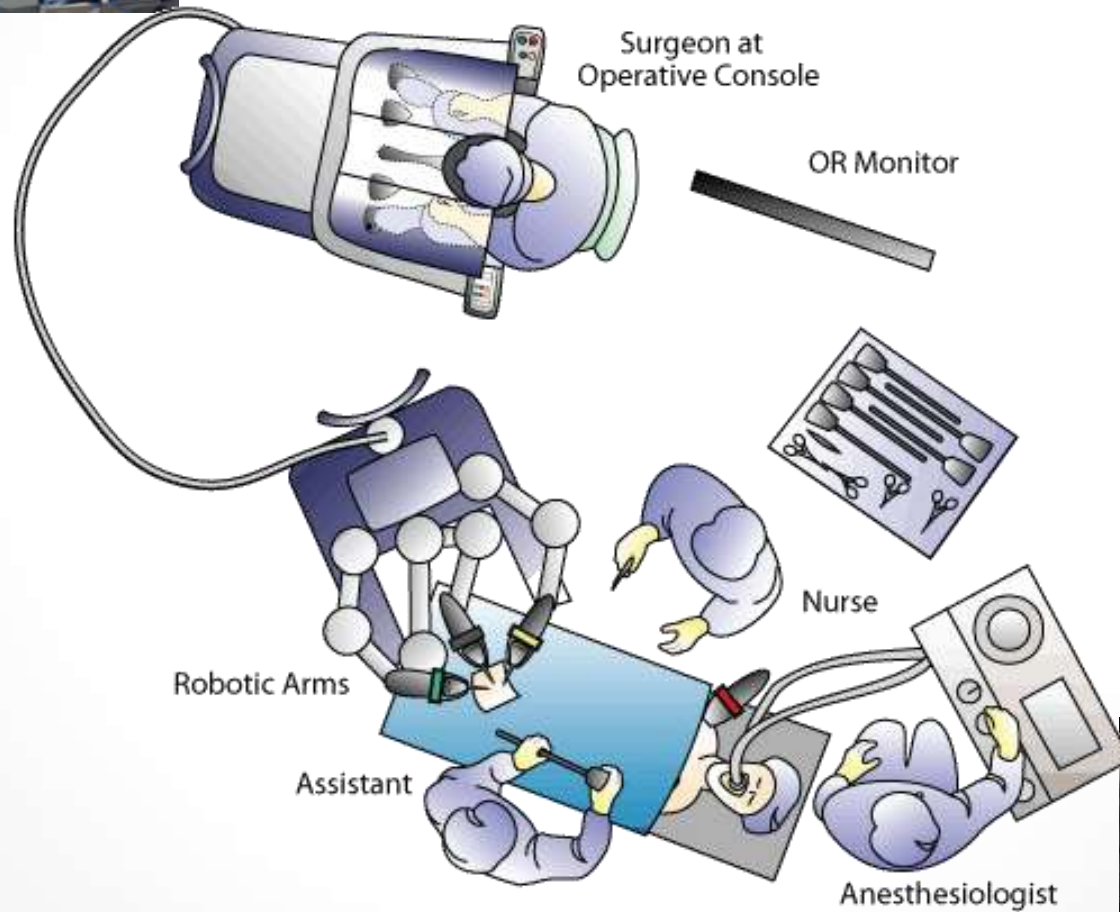
# Where Are We Going?

- Robotics
- Neurotransplantation
- Neuroprostheses
- Neuromodulation
- Genetics

# Artificial Intelligence

- The brain is the only commanding system
- Only the brain has „intelligence“ – creativity, emotions, individuality, intuition. The brain is able to look for relations and is able to generalise, the brain is able to calculate the predictive error.
- The most sophisticated technology is able to learn only what we programme it to learn. It does not have individuality characteristics. It is able to learn but creativity and emotions are absent. Turings machine only (Enigma)
- **In order to build an artificial intelligence the biological matter (brain) must be the basic unit with technology serving as a secondary circuits only (carbon based, not silicon! Carbon Valley)**
- The brain will not be connected to technology but vice versa





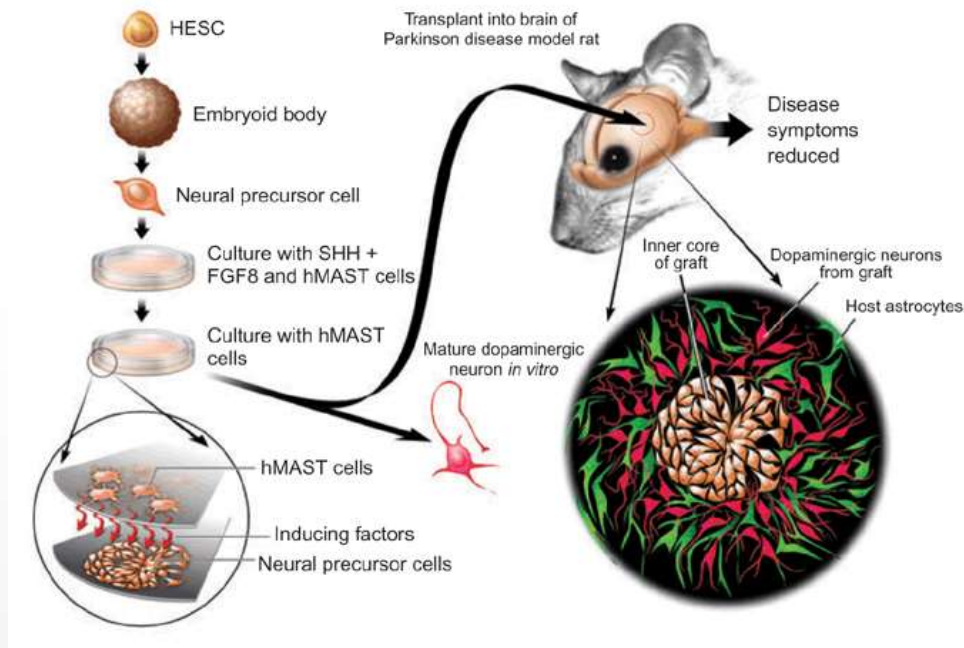
# Neurotransplantation – Tissue Transplants





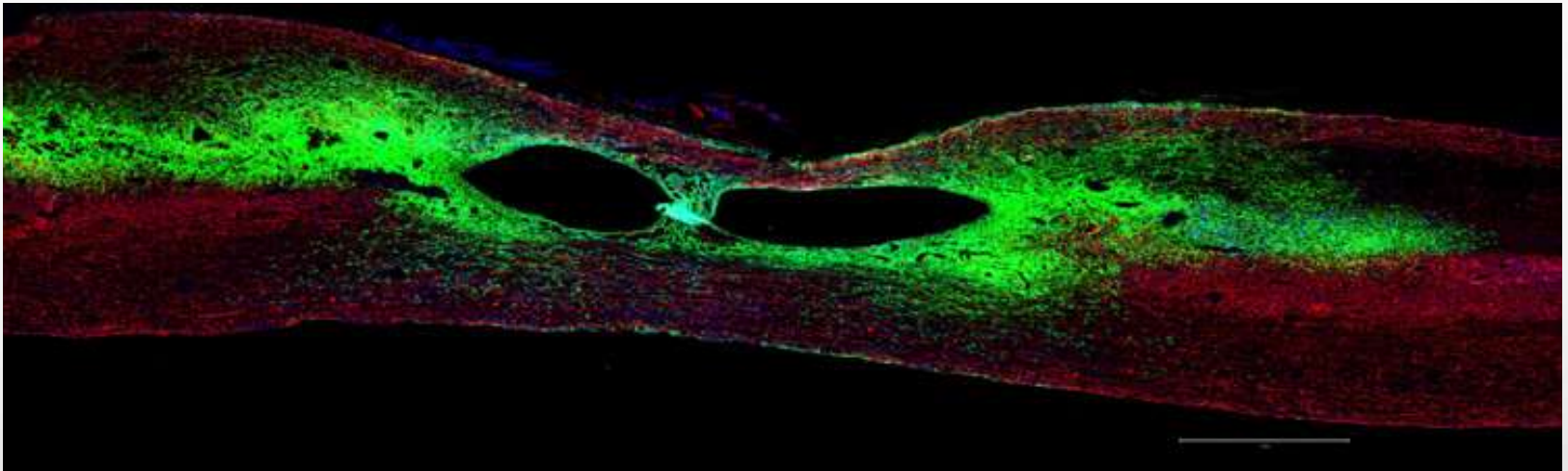
# Neurotransplantation

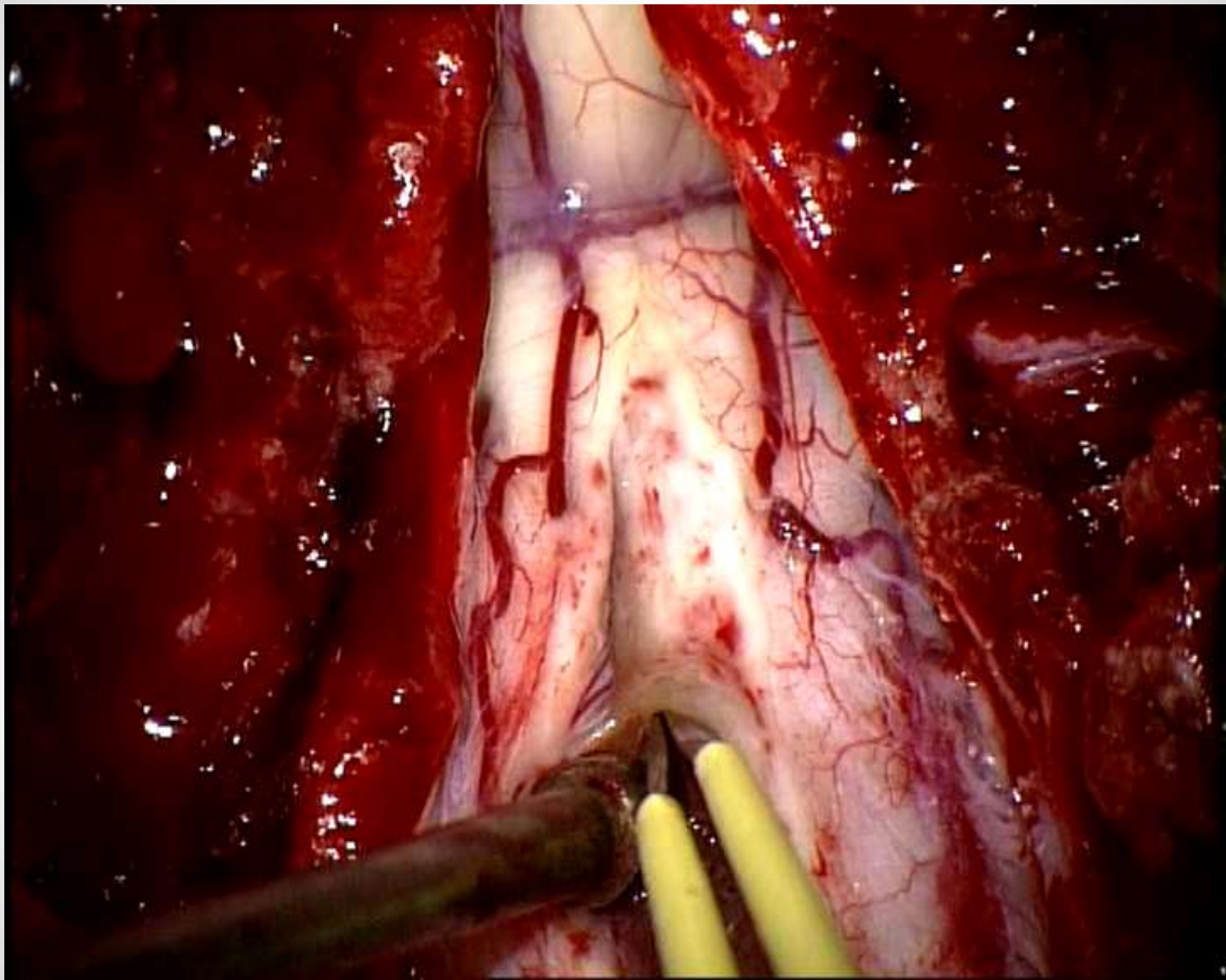
- A. Hormonal – pituitary - nonpractical
- B. Humoral – dopaminergic neurons (Parkinsons) - very good experimental data, clinical trials in 1990s failed. Abandoned



# Neurotransplantation

- C. Circuits and pathways (SCI, ALS, MS, Stroke) – poor experimental data, no clinical effect proved. Commerce esp in developing countries

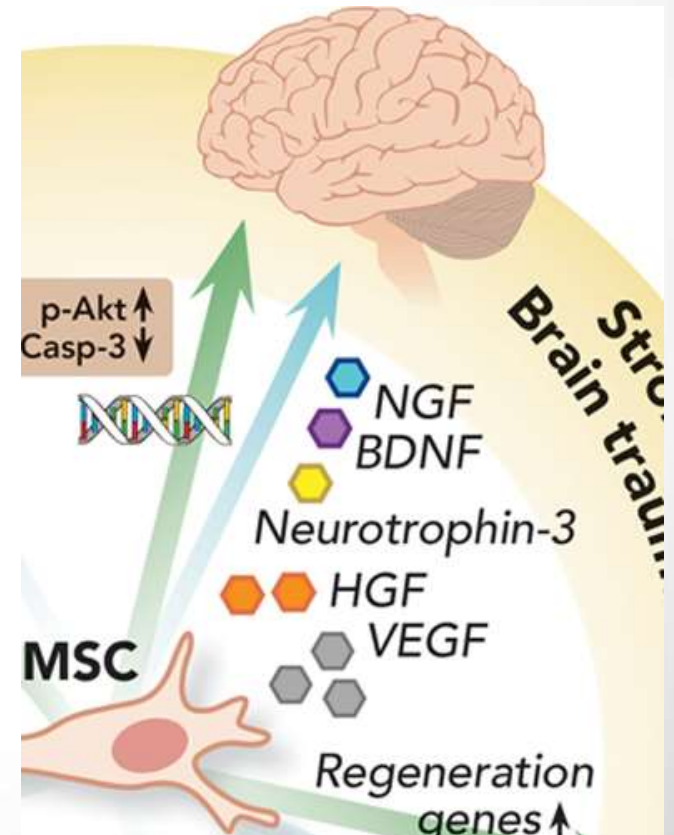
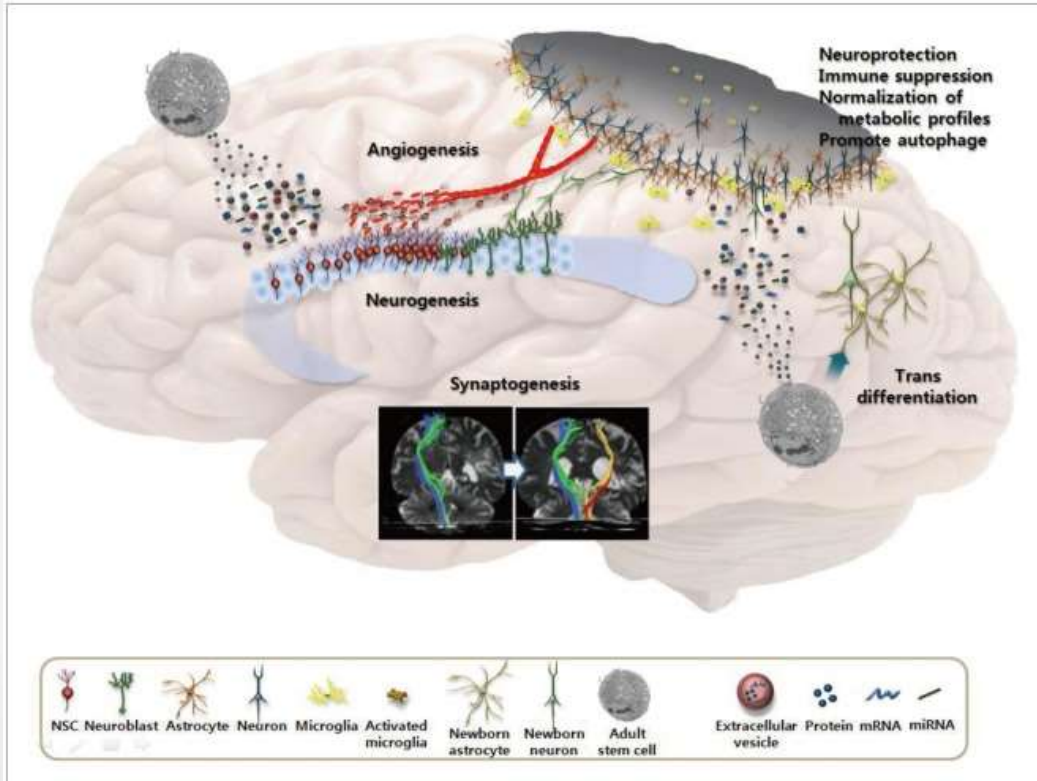






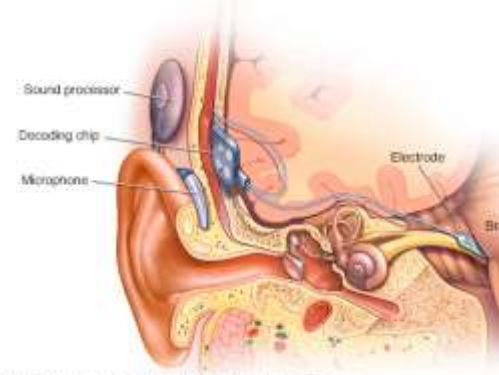
Stroke (some 200 pts/year in US), neither regeneration, nor reconstruction

Very potent growth factors!!

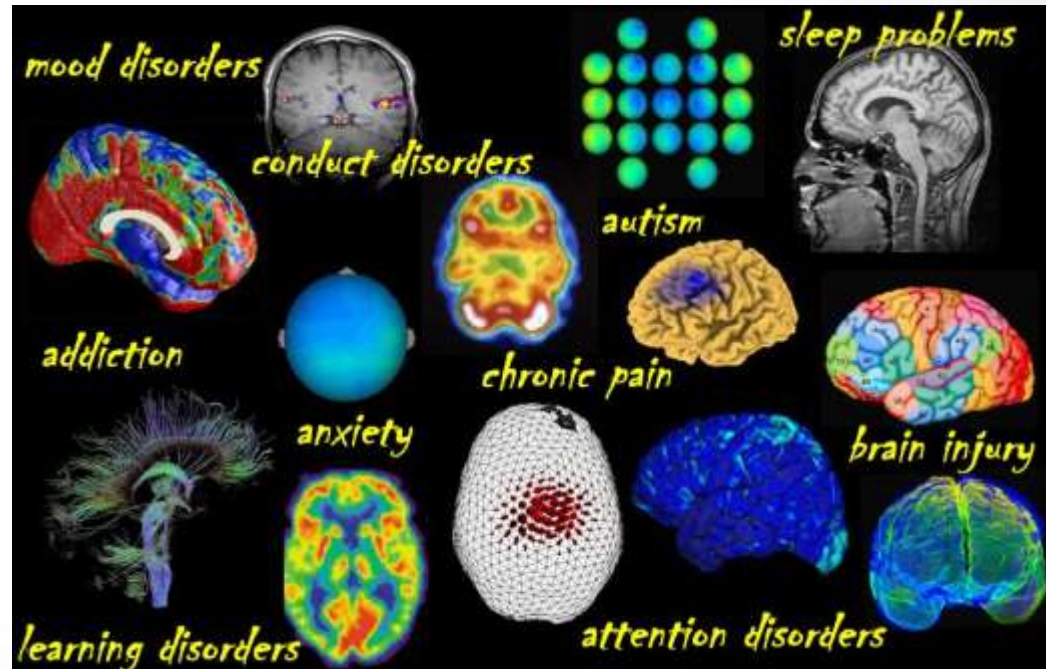
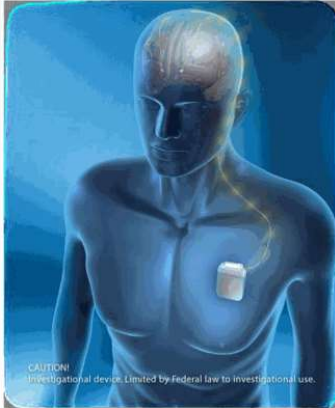




# Neuroprostheses



# Neuromodulation (Parkinson)



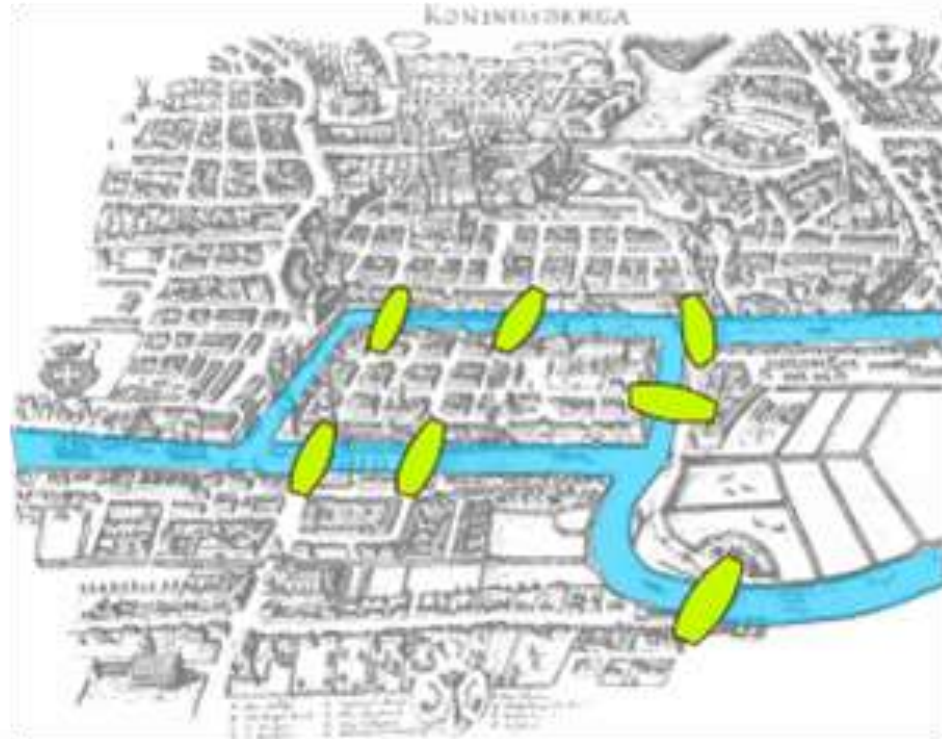
# Neuromodulation

- Target definition (functional MR, DTI, 7T MR)
- Logical in focal functions with well defined centres
- Difficult in global functions (consciousness, memory, creativity, etc)
  
- Modulation of brainstem nuclei responsible for blood pressure (ádieu arterial hypertension)



# Graph Theory

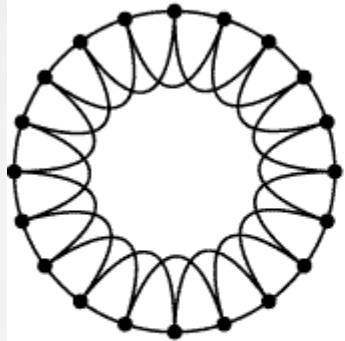
- Leonhard Euler, Königsberg
- How to cross 7 bridges once only and end up at the original point



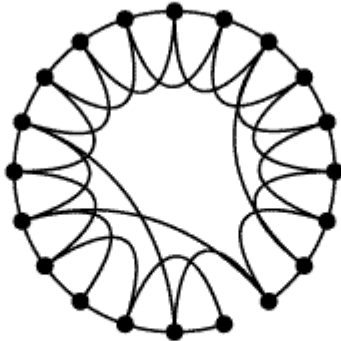


# Small world system - nodes

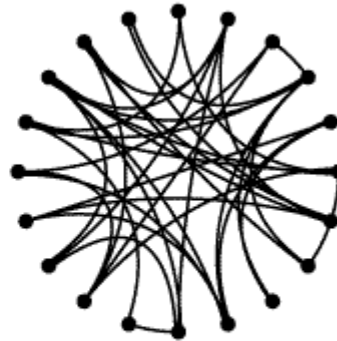
Regular



Small-world



Random

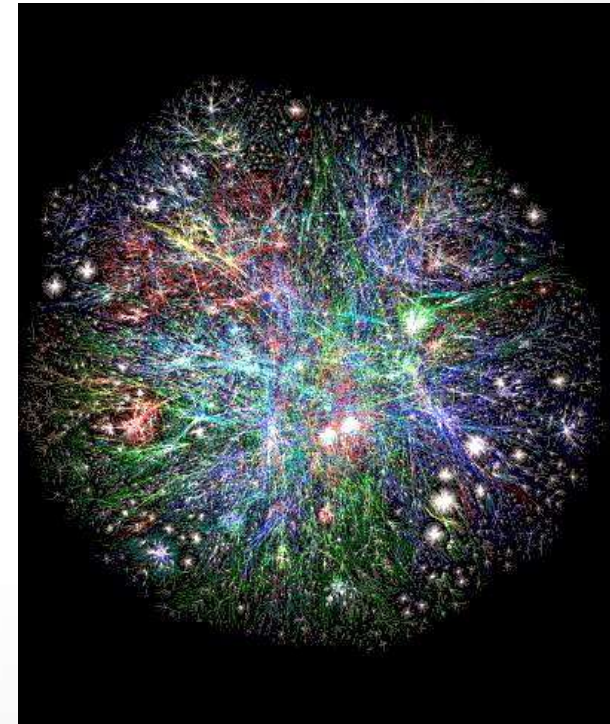


$p = 0$

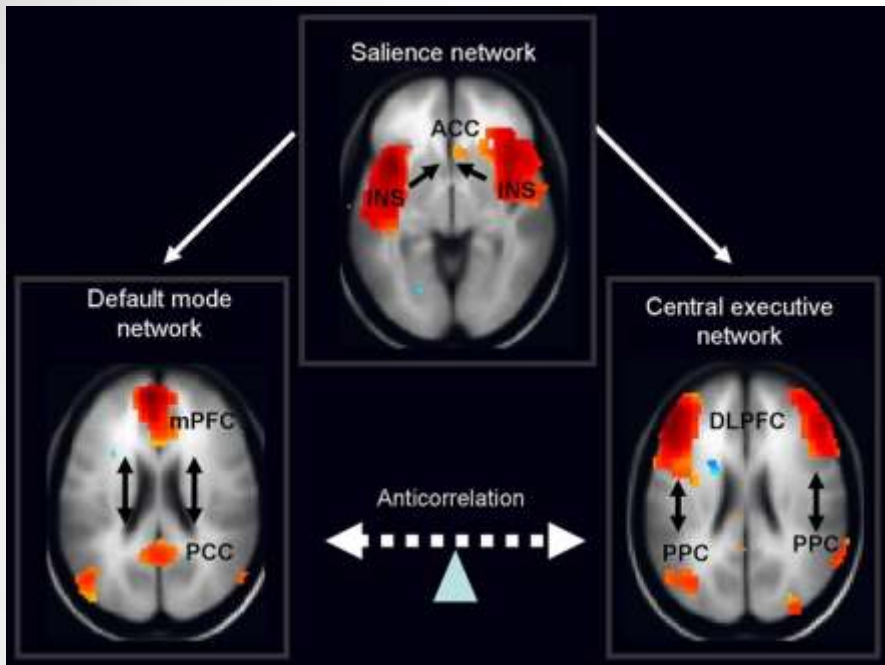


$p = 1$

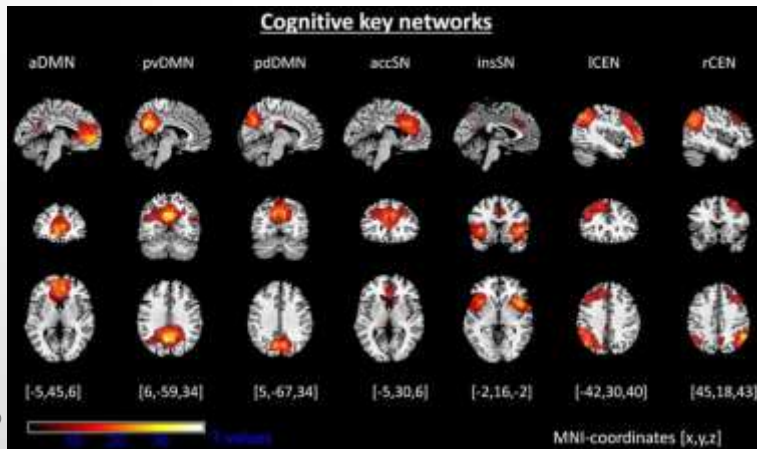
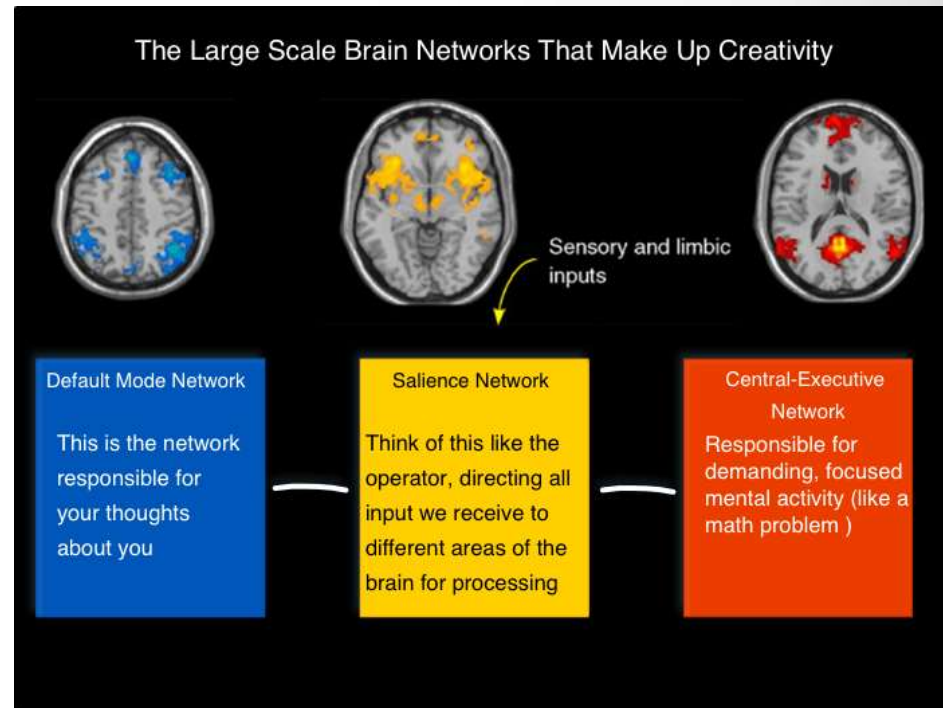
Increasing randomness



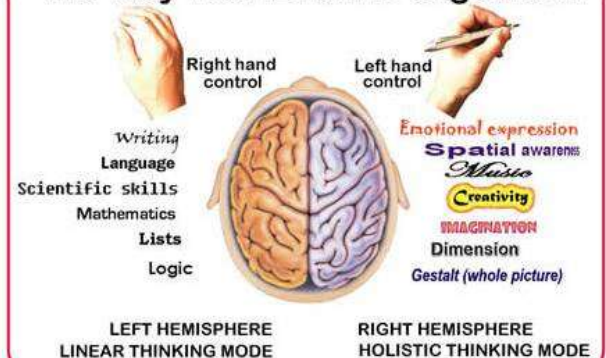
# Brain networks



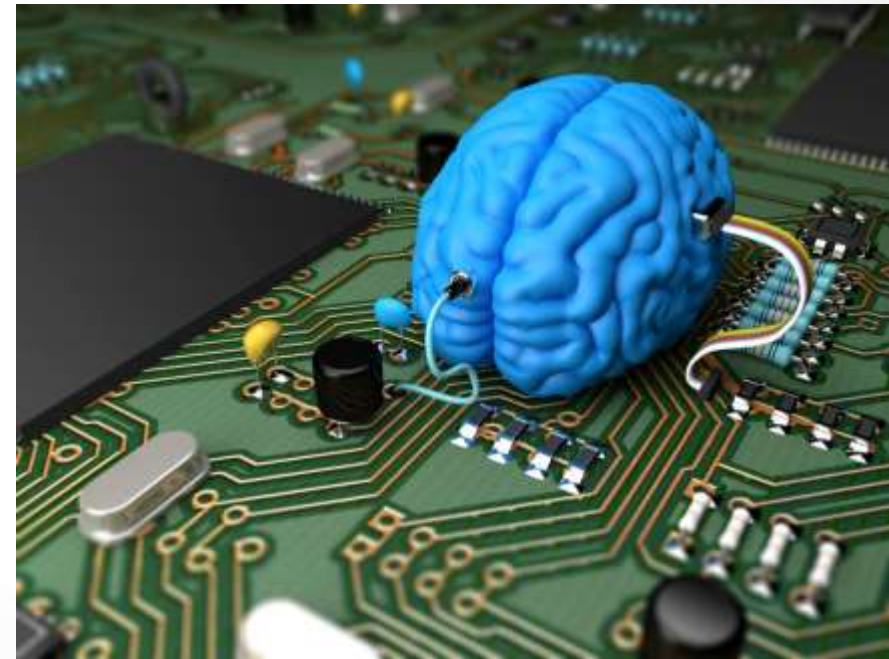
## The Large Scale Brain Networks That Make Up Creativity



## The Way Your Brain Is Organised



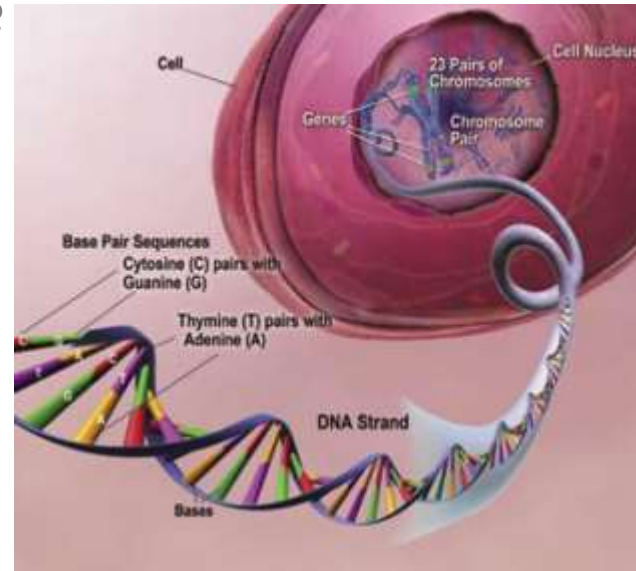
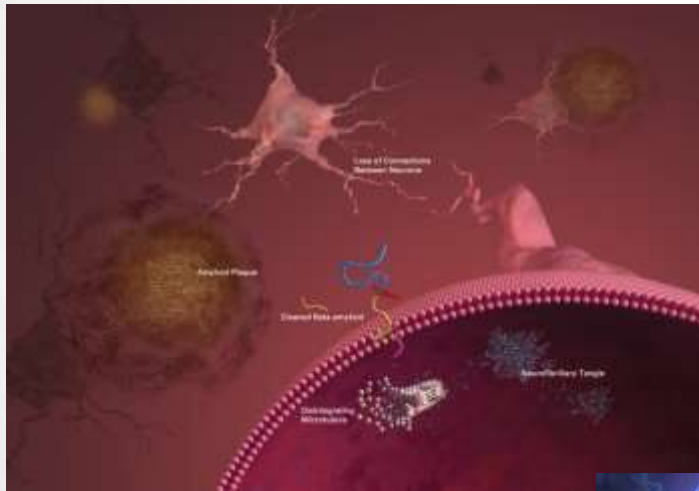
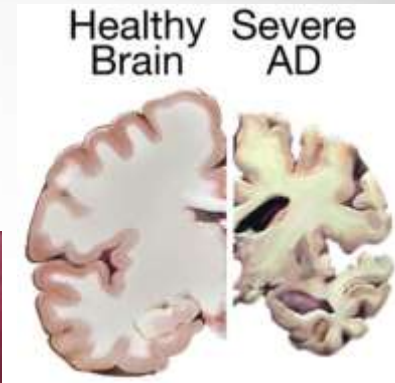
# Aldous Huxley





# Genetics

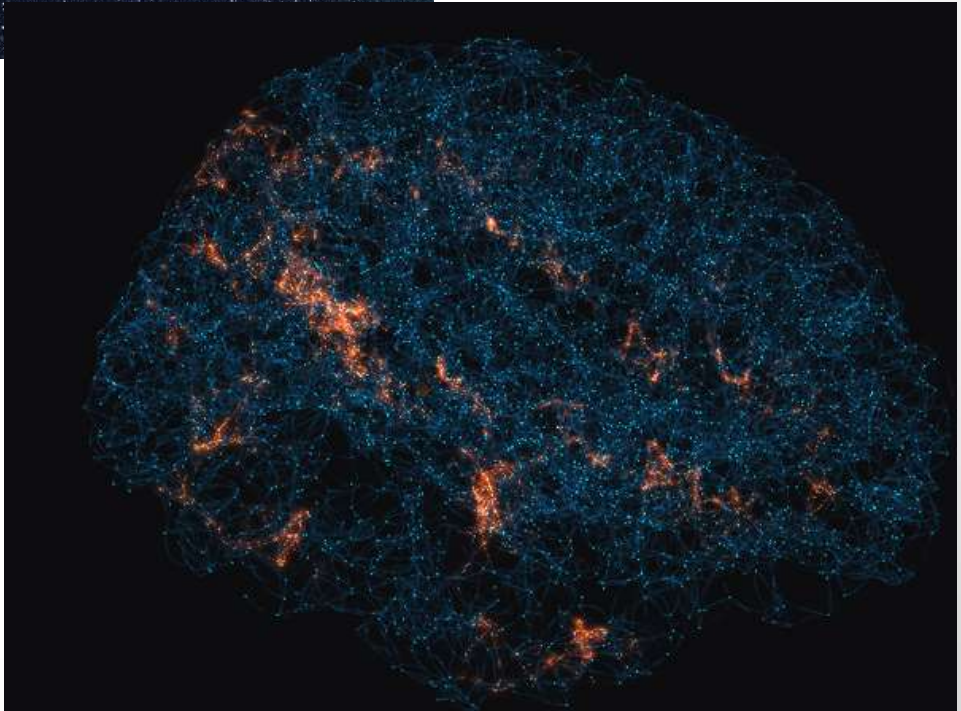
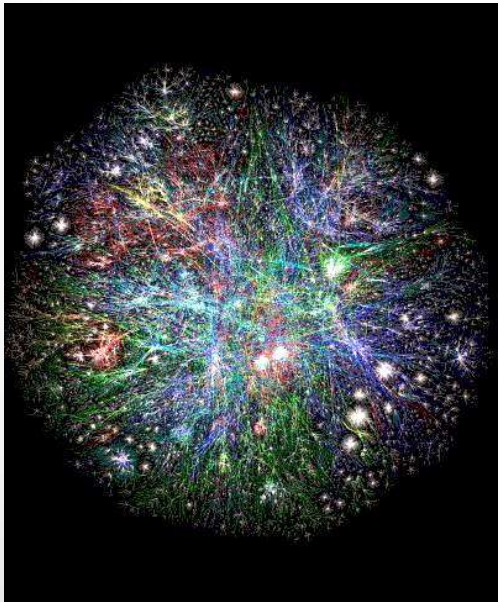
- Research only
- Gene manipulation ?
- Prevention in future





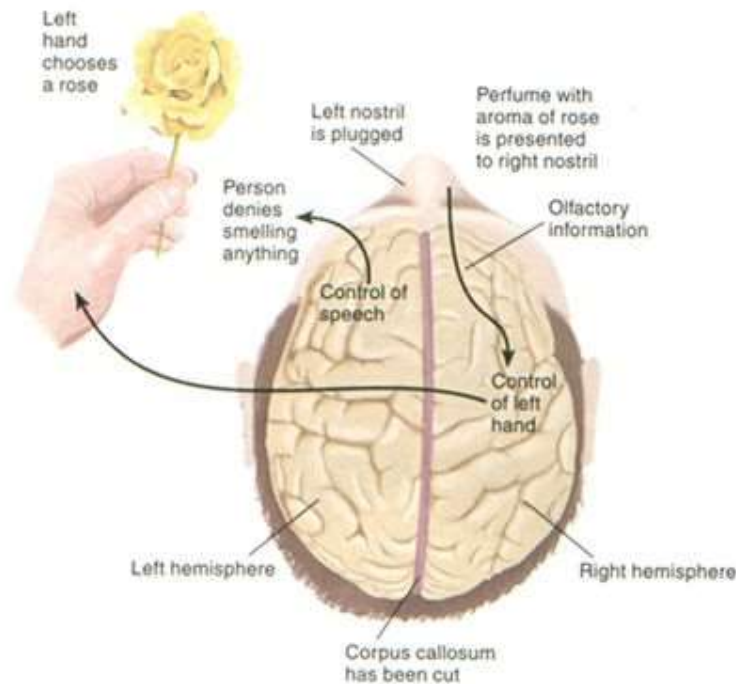
# Homo sapiens development

- Cognitive revolution      70 000 yrs ago
- Agricultural revolution    12 000 yrs ago
- Scientific revolution        500 yrs ago
  
- Brain revolution              in ??? Yrs
- Homo technologicus



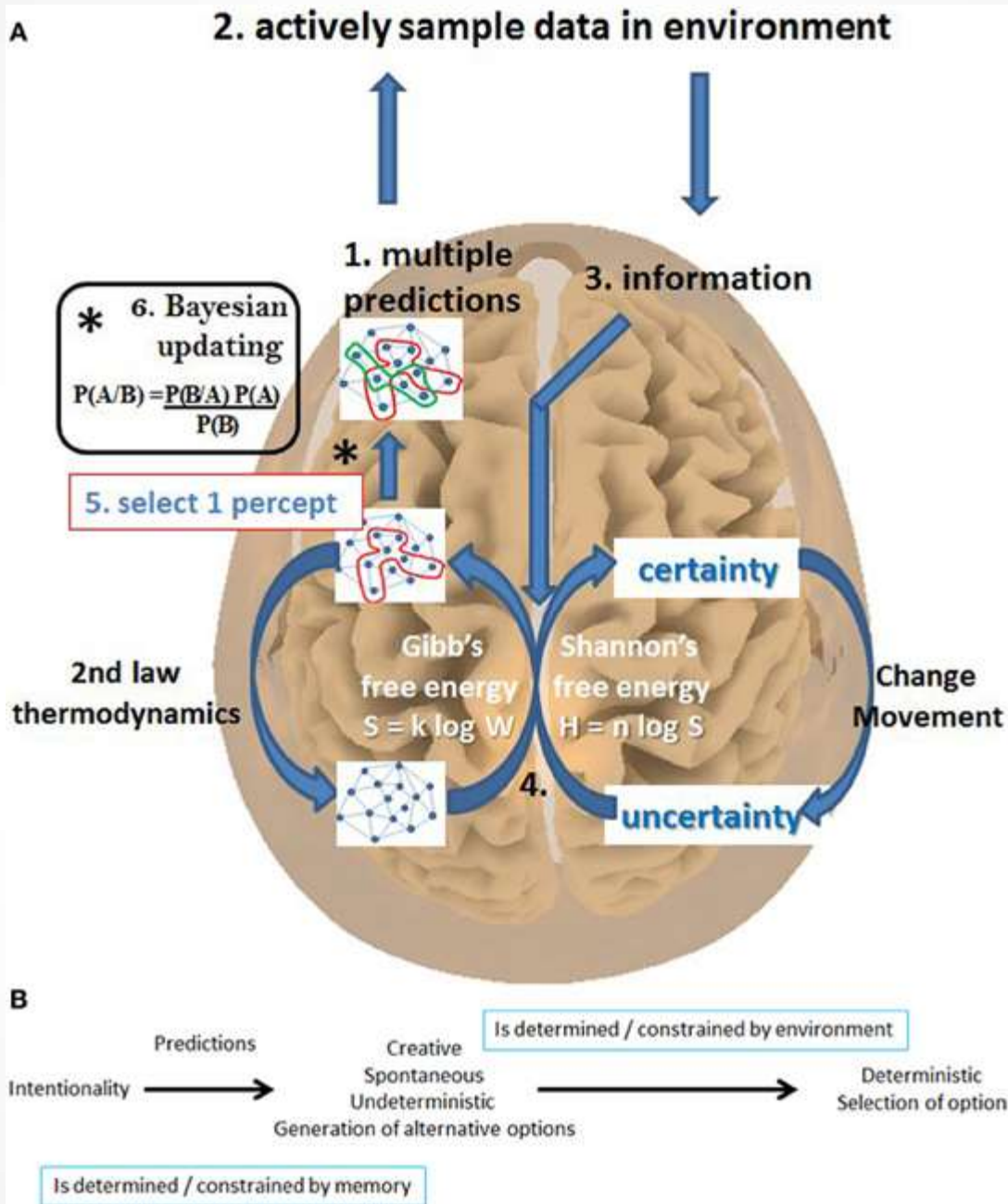


# “Bayesian brain” theory



- **Bayesian brain** is a term that is used to refer to the ability of the nervous system to operate in situations of uncertainty in a fashion that is close to the optimal prescribed by Bayesian statistics.





# Prediction error

- Learning doesn't occur from a mistake happening, but from when the result differs from your expectation
- Reinforcement learning works on the basis of the creation of prediction error. When the actual outcome following a decision is different from what is expected to occur, the brain (in the basal ganglia) calculates a prediction error. When there is a difference in value between the current state and the preceding state, the brain calculates a prediction error.

# Prediction error

- Prediction errors can be positive and negative. If you expect something to happen, but things turn out to be better than expected, then a positive prediction error is calculated. When something bad happens that is unexpected, a negative prediction error occurs. However, when exactly what you expect to happen happens, there is no prediction error.
- Learning from these prediction errors occurs in a two step process:
  - 1) Calculation of the prediction error
  - 2) The brain updates the previous value of the stimulus.