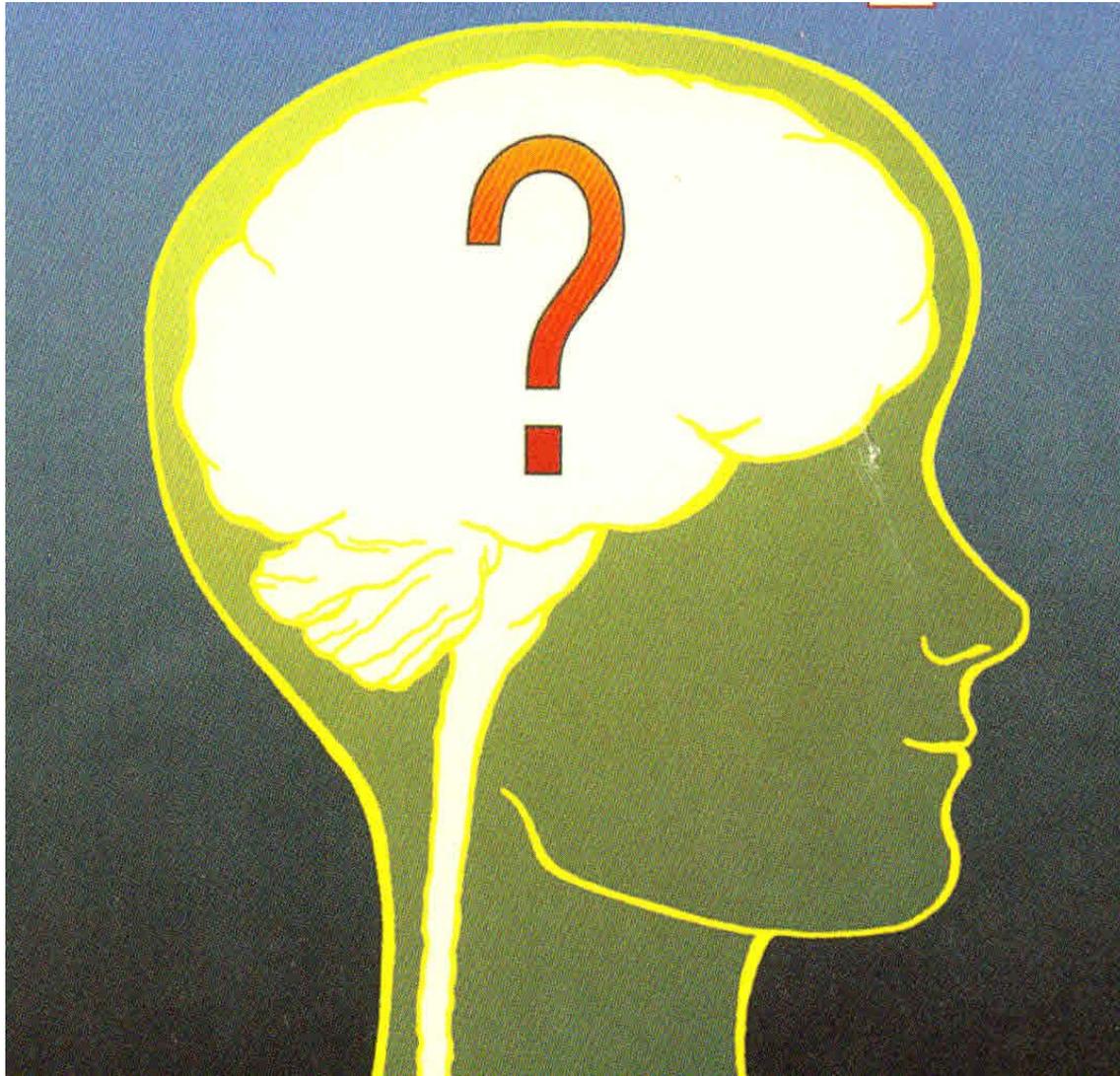


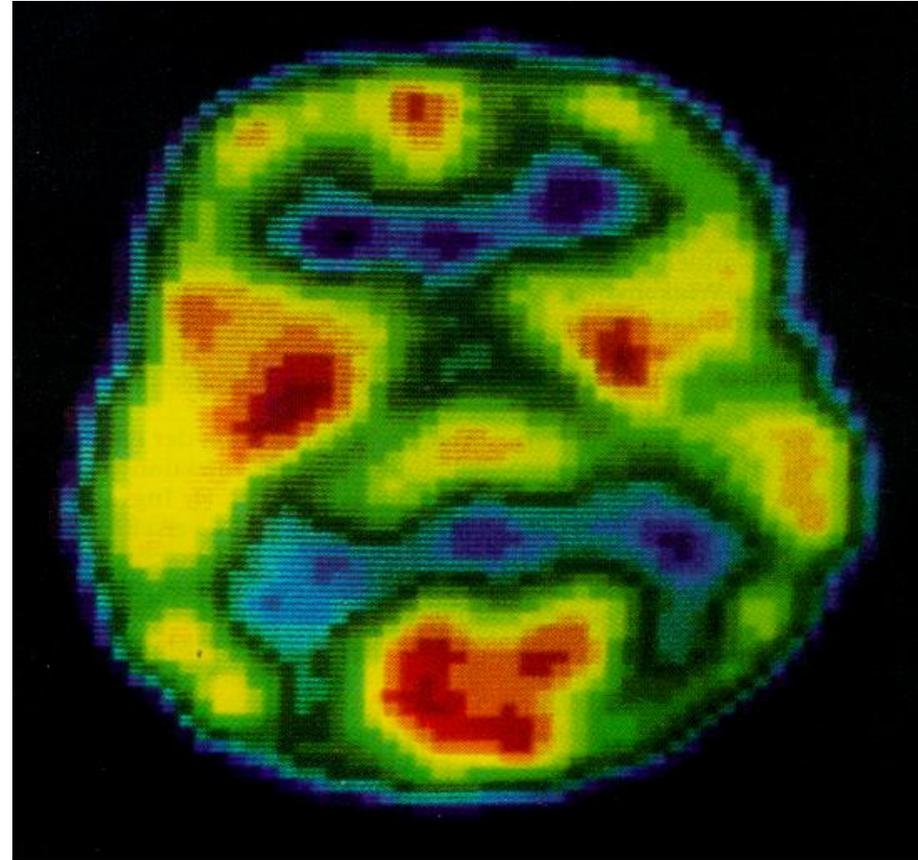
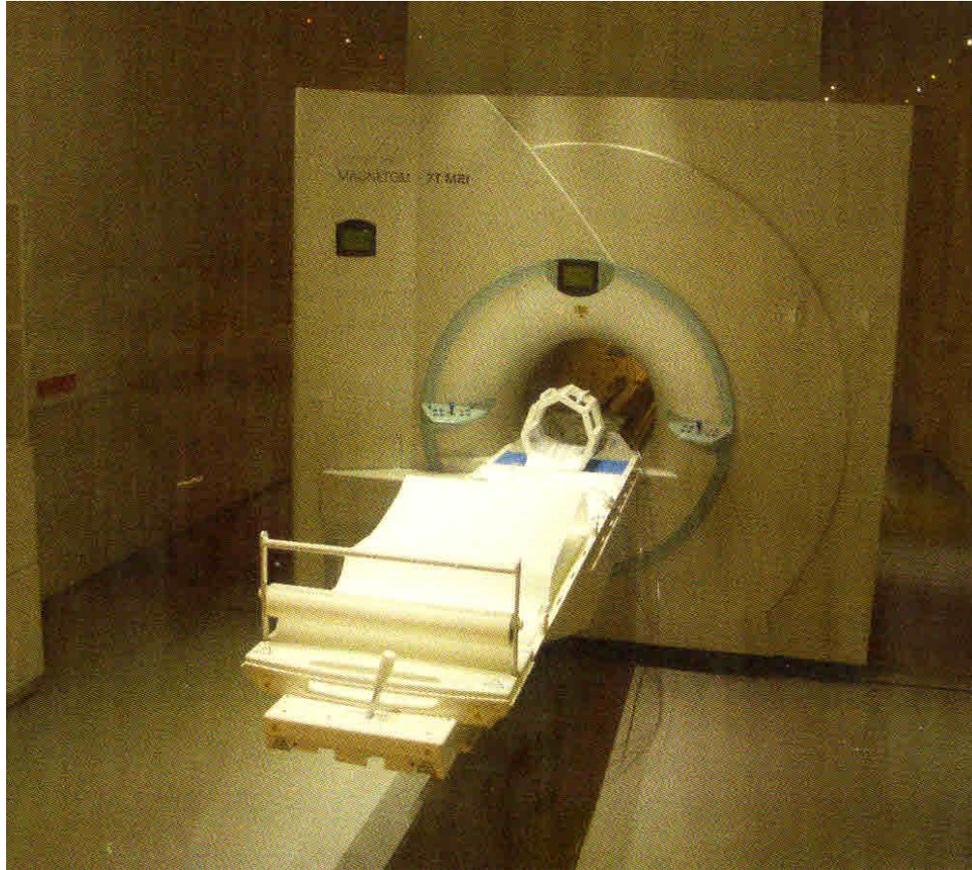
What do we have in our head?

Principles of brain-based teaching and learning

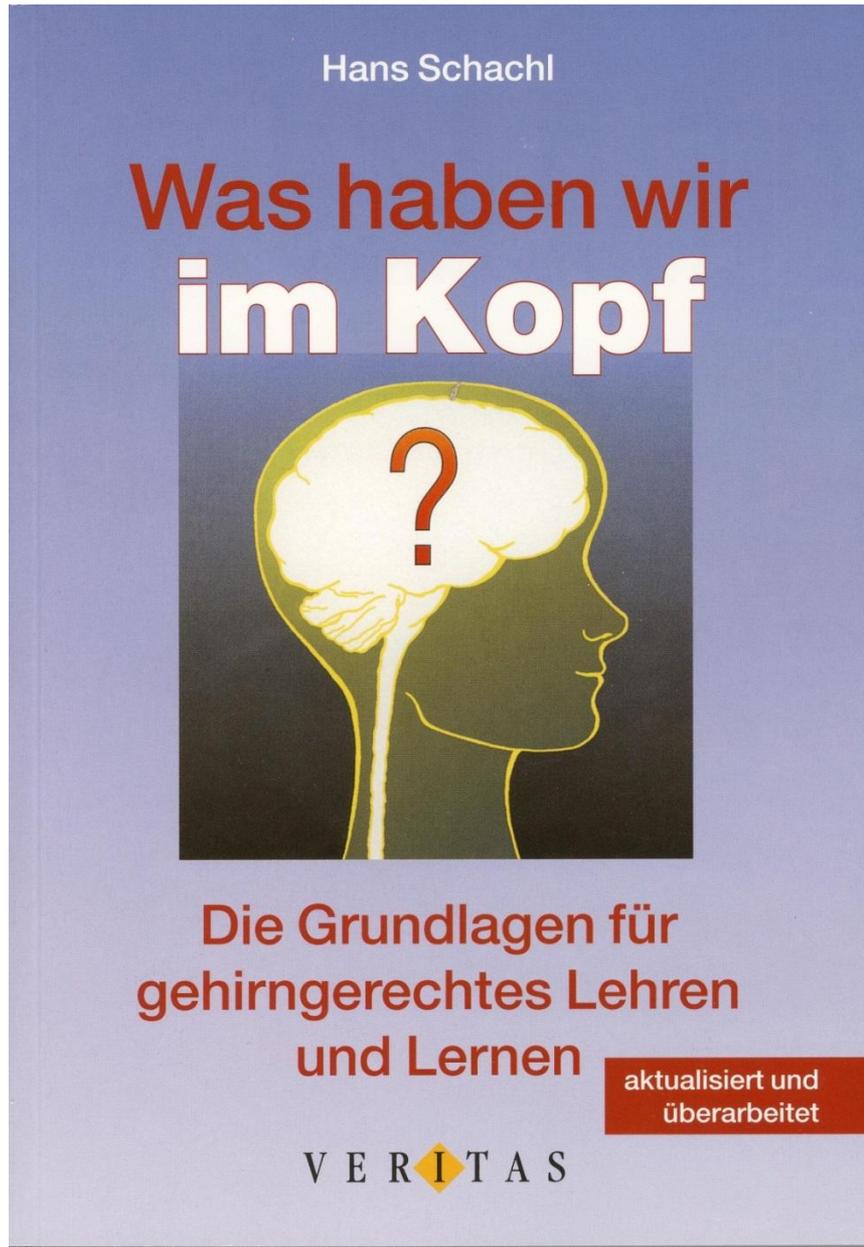
Riga, 28. October 2016



Methods like fMRI, PET and others



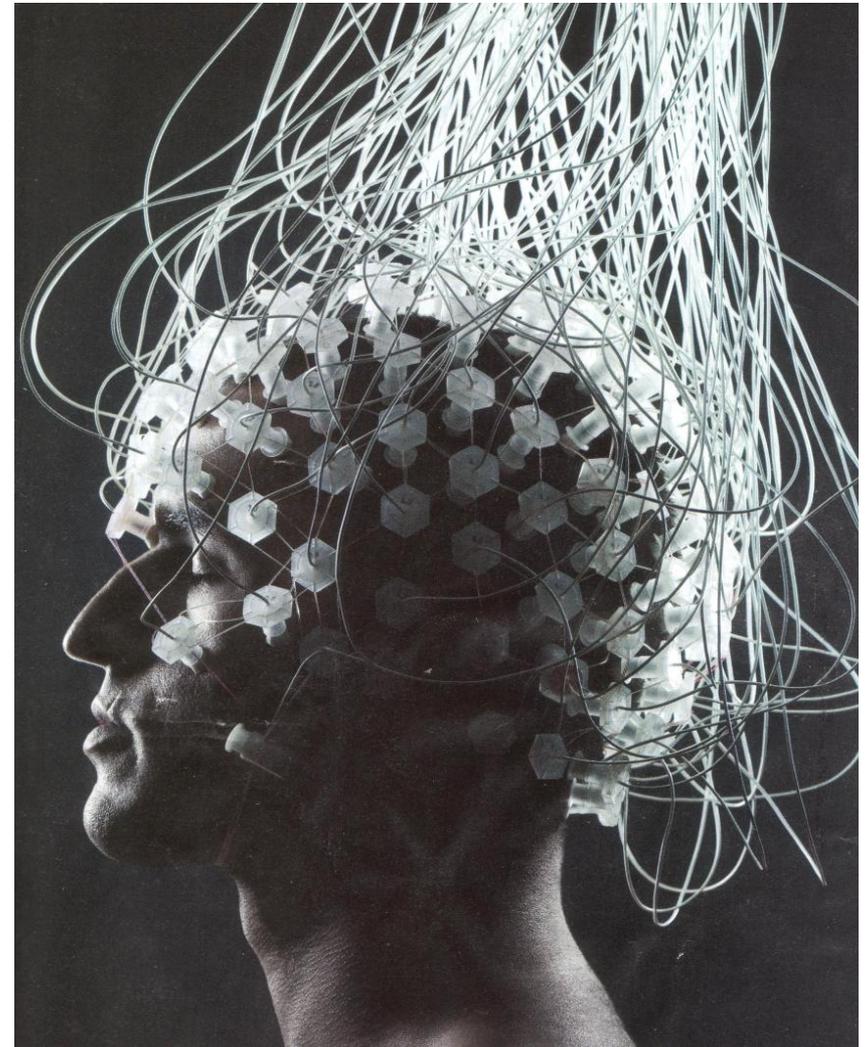
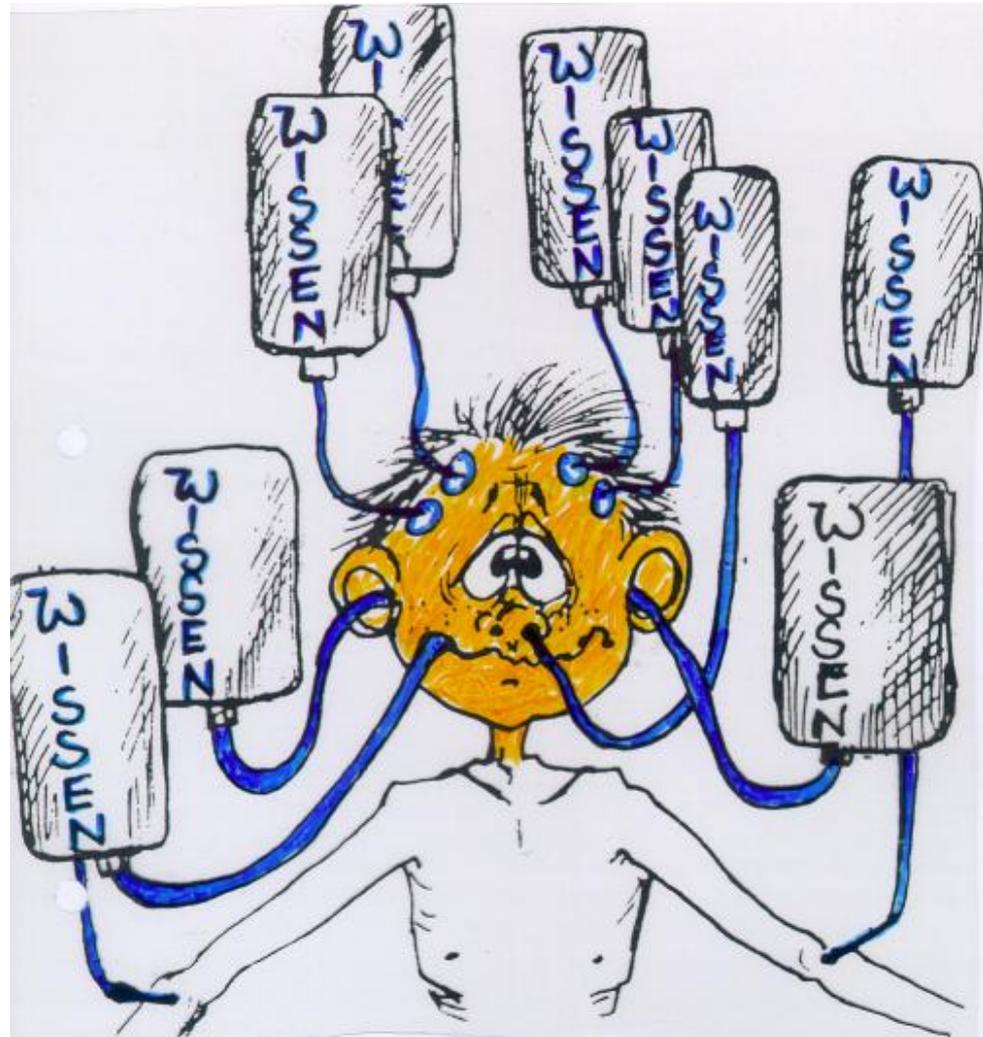
Learning must be „brain-based“!



- But how does it work?
- We have to deal with the topics:
Into the brain!
Cognition and Emotion!
Memory!

Into the brain! But not so!

Gaining knowledge is an **active** process and depends on **what already is in** the brain!



Perception depends on „what already is in the brain“!

- **It depends on genetic and epigenetic basics,**
- **environment and education (leading to attitudes and pre-knowledge),**
- **lastly on our whole **personality** (curiosity, interests, self-confidence, patience, controlling of emotions, attention, cooperativity, intelligence, motivation, ...)**
- **That means for learning: **it is very individual!****

**We must not teach all with the same methods,
at the same time, the same contents,
but we have to **individualize and differentiate!****

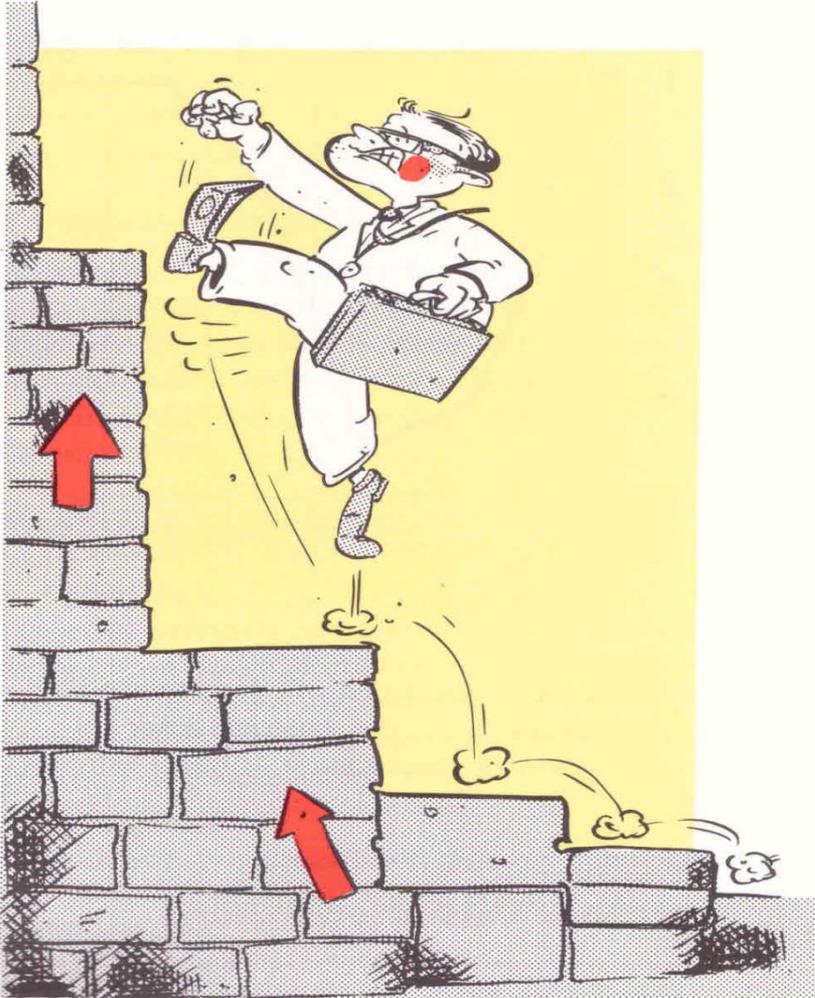
That means:

Set reachable goals, steps!

Focus on different potentials!

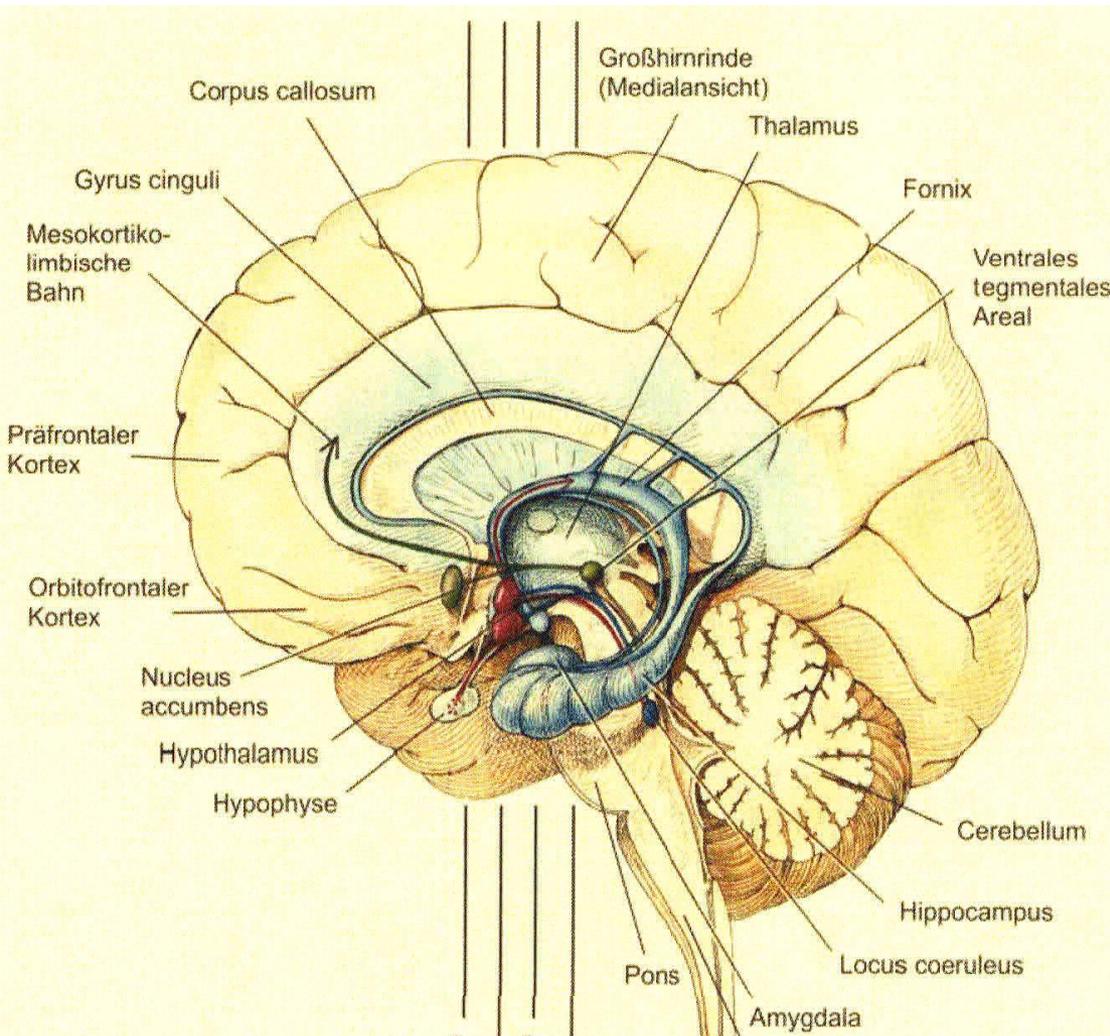
Focus on strenghts!

Help correcting the weaknesses!



Cartoon: Schachl, 1991, 23

Cognition and Emotion



The parts of **Cognition** (Hippocampus, Frontal Cortex, ...) are strongly influenced by

the parts of **Emotion** (Limbic System with Amygdala, Rewarding System with Nucleus accumbens and Ventral Tegmental Area, Hypothalamus...)!

Ventromedial Prefrontal Cortex (vmPFC)

(Lin et al., 2016, Fig. 4)



- An increased activity in vmPFC was found for items with higher subjective value, with personal significance! The vmPFC plays a role in the generation of „**affective meaning**“ with „greater emotional self-relevance“!
- A „connecting link“ between cognition (memory, thinking, decision making ...) and emotion!

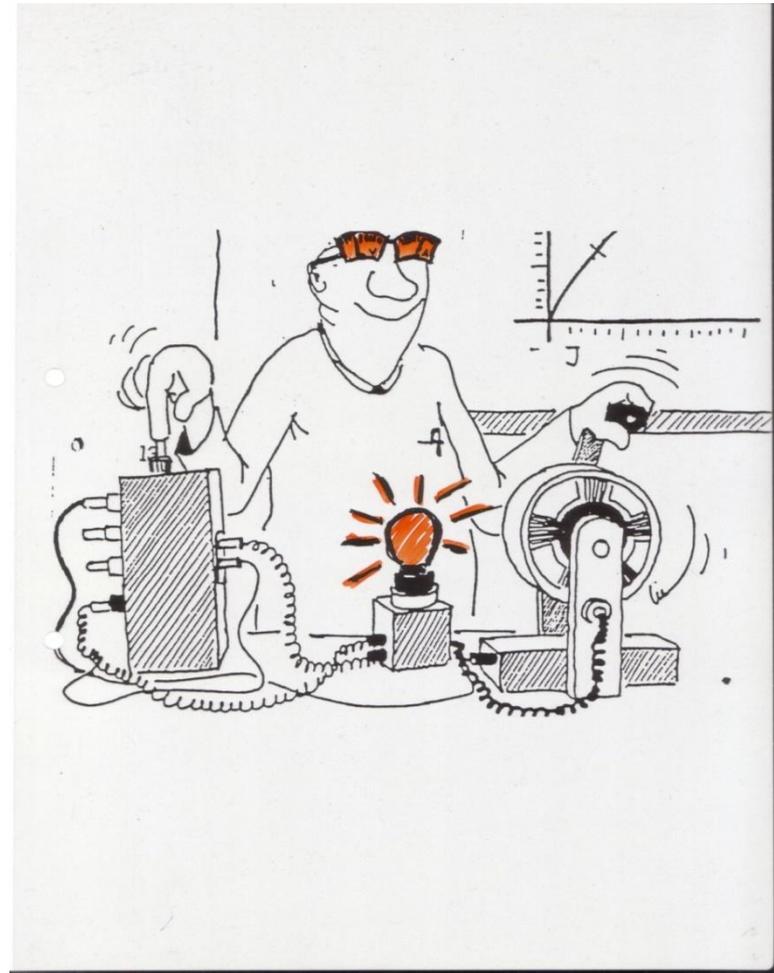
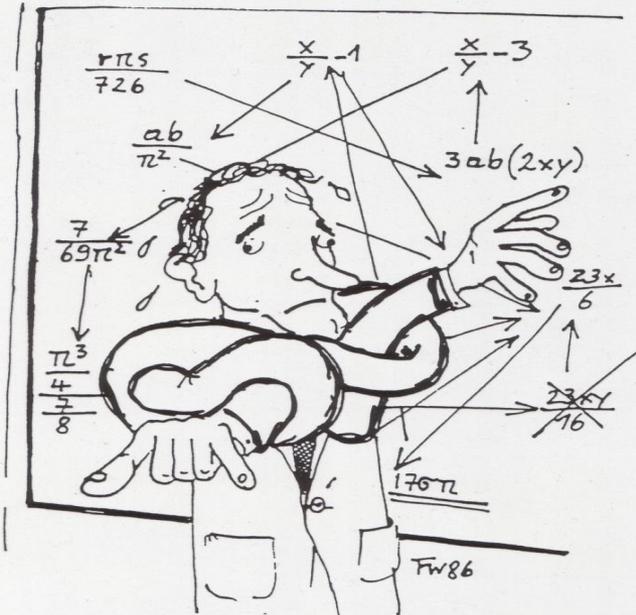
Very important and nothing new: The brain needs **Sense!**

- Why should I learn?
- I want to understand!
- How does it fit to other contents?
- And very important:
Teach and Learn with **Joy!**

Joy can be lost or diminished by the **kind of teaching**

Take care of
comprehension!

Teach with enthusiasm!
And make the pupils „curious“!



The most important duty of teachers



- Don't forget the human being!
- Principle:
Make humans strong and clarify the facts!

Cartoon by Silvia Brodacz

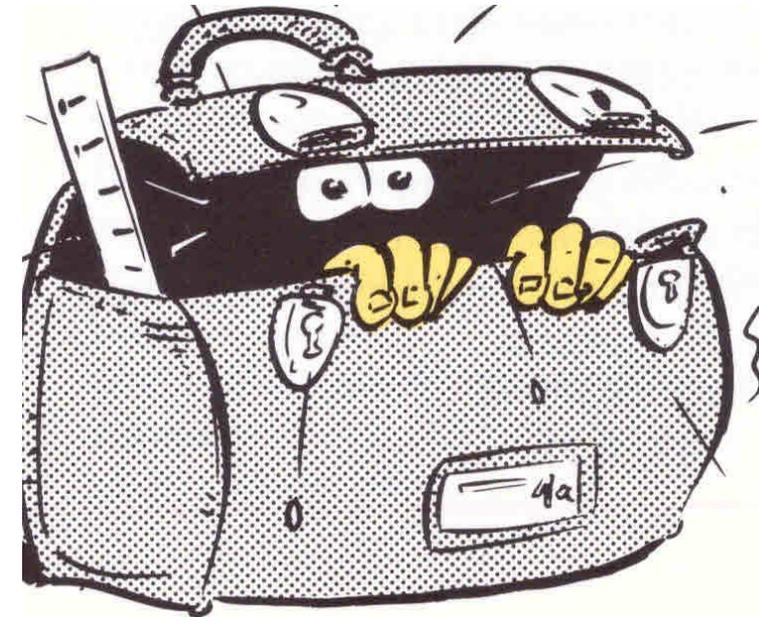
Translation: I make you to a snail!

Stress with Learning



- Emotions and light stress (challenges, unexpected and new information) have **positive** effects on memory formation!
- Severe and prolonged stress, especially anxiety, **impairs** recalling and updating and leads to stronger storing of negative events (bad exams, interpersonal conflicts with parents, teachers, peers)!
- Negative **attitude** towards school and learning!
- Very bad: Developing a „**loser**“-mentality („Learned Helplessness“)!

What must be done?



- First of all: Anxiety and stress must be **reduced!**
For that: Teachers, parents and students must be informed and be aware of the effects of stress on learning and life!
- And second: We must learn to **cope** with stress!

Guiding principles

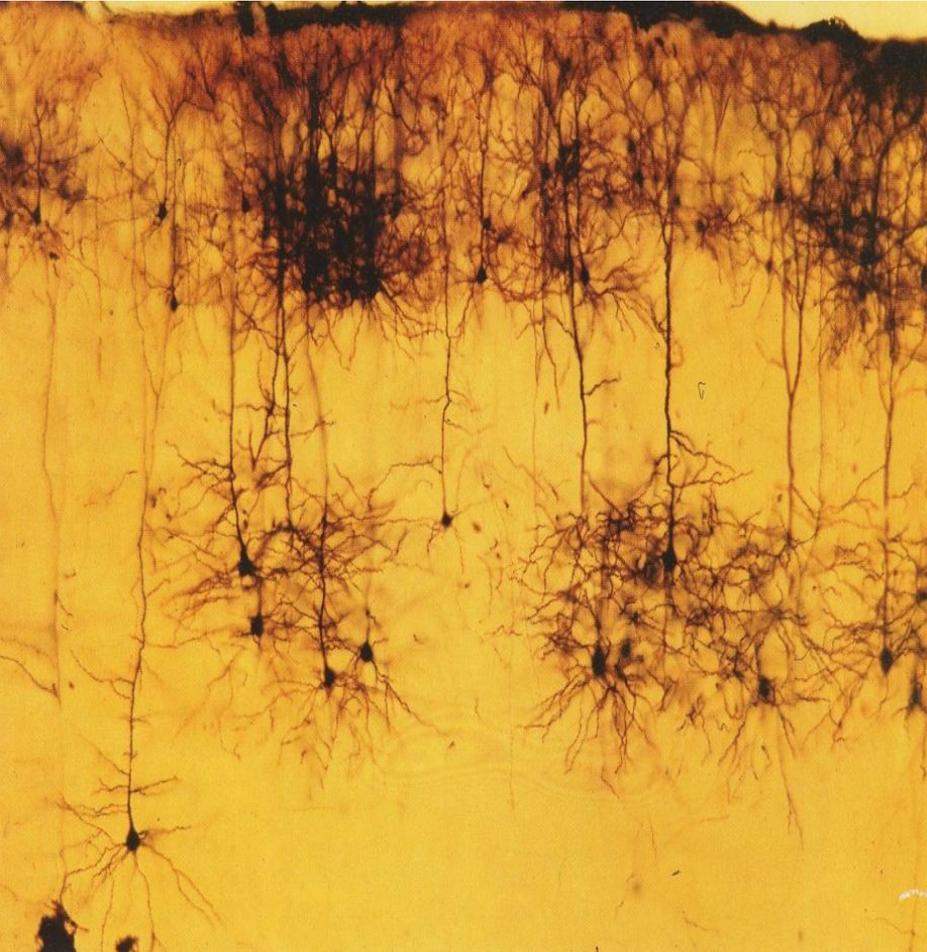
derived from the topic „emotion“



- Foster positive emotions
- Arouse interest and curiosity
- Promote physical activity
- Take and allow breaks
- Teach coping with stress
- Teach with „variety“ and multisensory approach
- Enable learning by doing

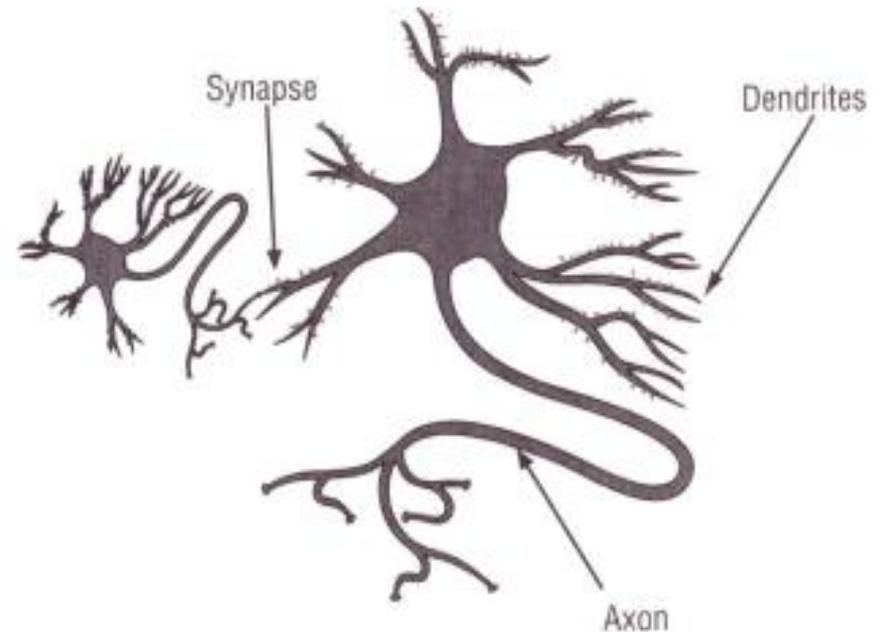
Photo: Andreas Röbl

Mind, Thinking, Memory, Feelings are „made“ by our nerve cells!

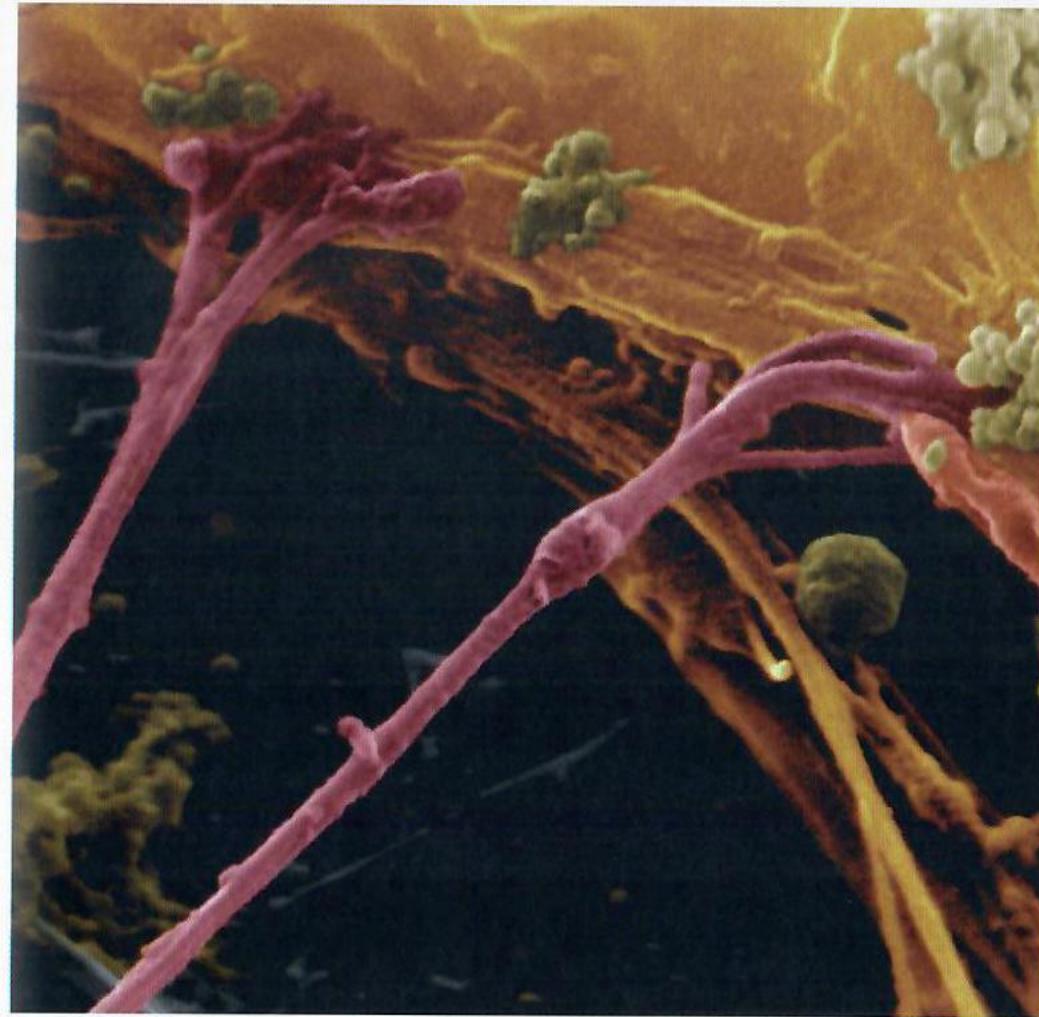


- About 86.000.000.000 neurons (15 Billions in the Cortex), and the same number of glia cells!
- **Working principle** (Jensen, 2008, 17):

TWO NEURONS CONNECTING



The gigantic number of synapses

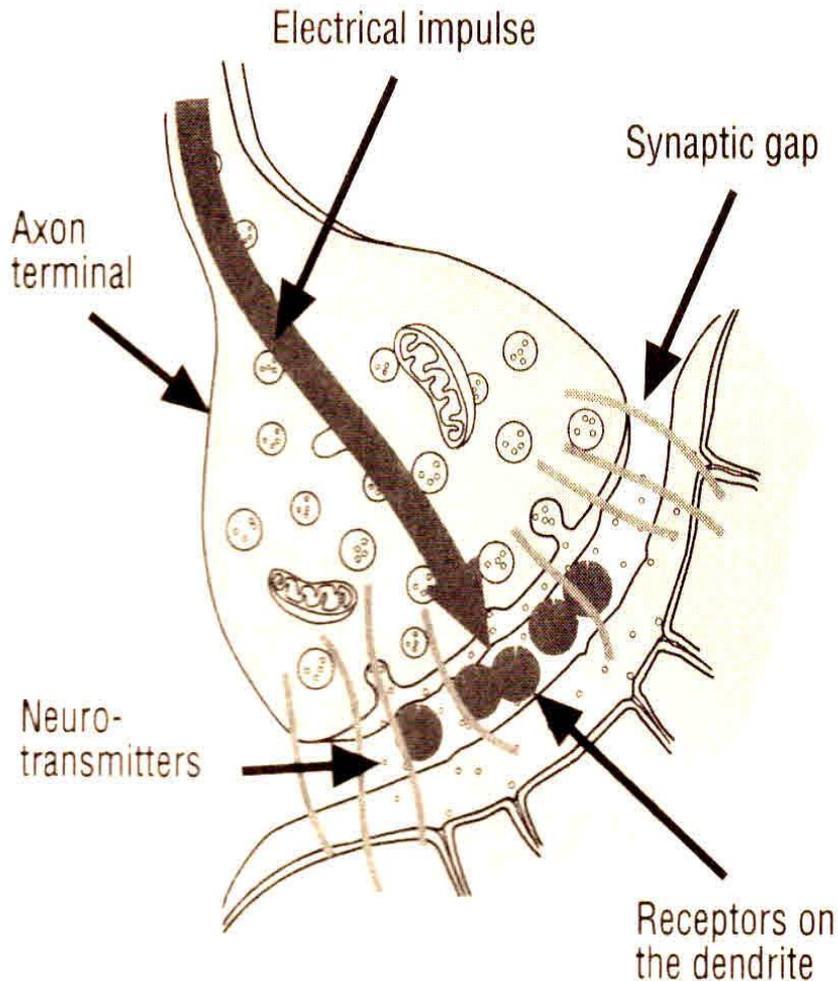


Ein Nervenausläufer (rötlich) verzweigt sich mit zwei Fasern, die von unten links ins Bild kommen. Sie bilden an ihrem Ende kleine Büschel aus, die über Synapsen an die Zielzelle (gelb) andocken.

- Up to 20.000 (30.000?) **synapses** per neuron in the Cortex (upper layer of the brain)!
- 86 billions x 10.000 (average) = 860 000 000 000 000 (860 billiards) synapses in the whole brain!
- In addition: glia and communication between neurons and glia!

The “Language of Brain” is Chemistry

THE SYNAPSE—WHERE LEARNING TAKES PLACE



The message (electrical impulse) of the first cell releases – by the help of Calcium - „**Transmitters**“ into the synaptic gap.

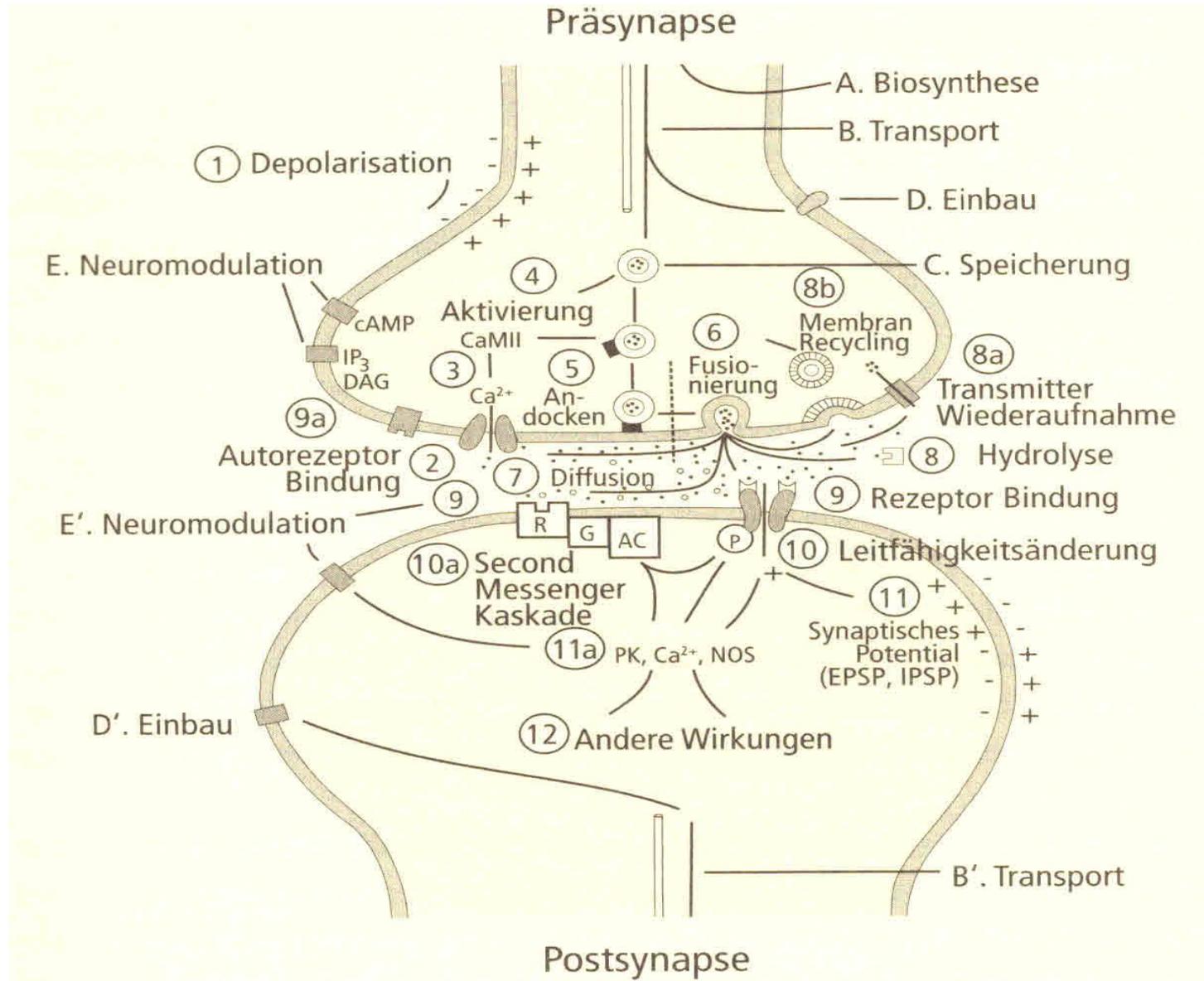
These Transmitters are taken up by the **Receptors** of the second cell! This leads to streaming of Natrium into the second cell!

With learning the Synapse is **changed** and **stabilized**!

Storing is done by chemical processes, with contribution of genetical processes (with genes like CREB, RbAp48, discovered by Kandel)!

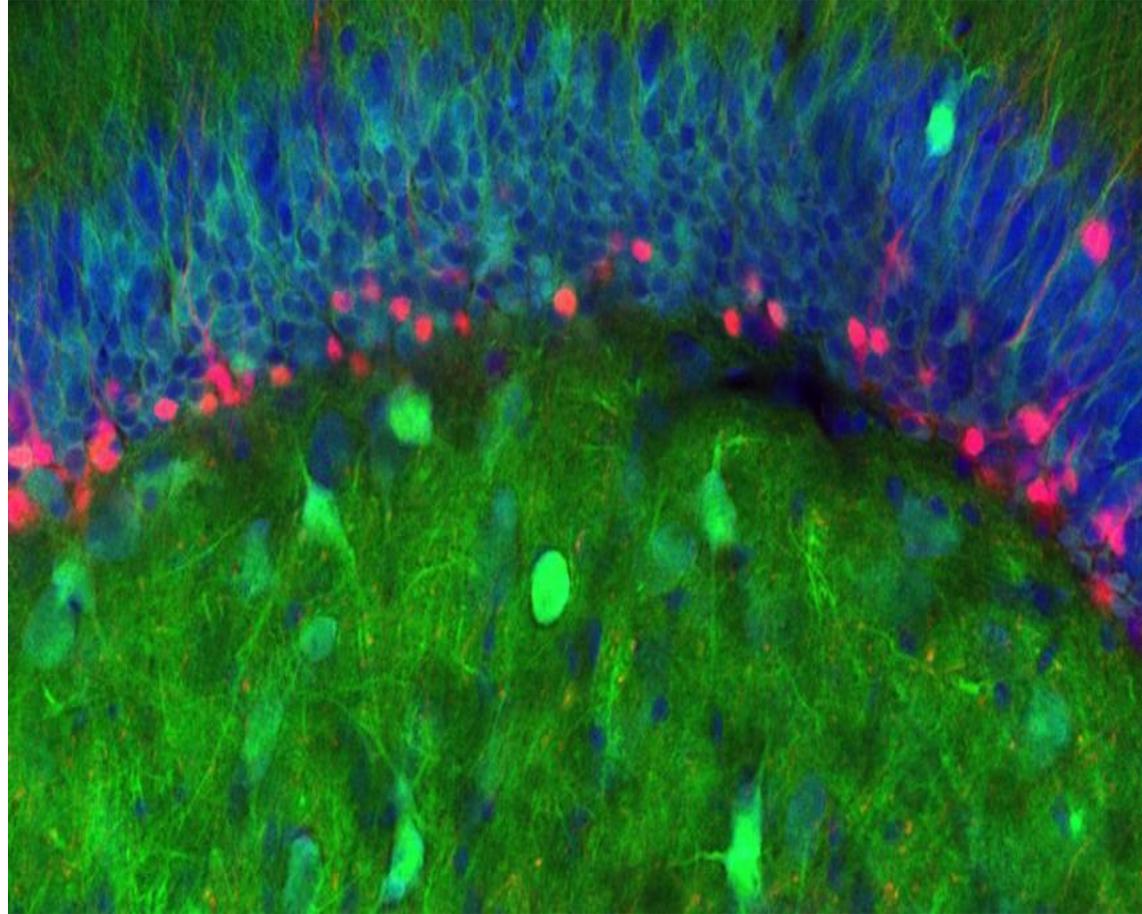
Very complicated!

(Roth-Strüber, 2015, 52)



Learning makes . . .

- sprouting of dendrites,
- increasing the number of synapses,
- strengthening and stabilizing the synapses,
- and, very surprising and fascinating, also neurogenesis, that means new neurons are built!



Guiding principles against forgetting



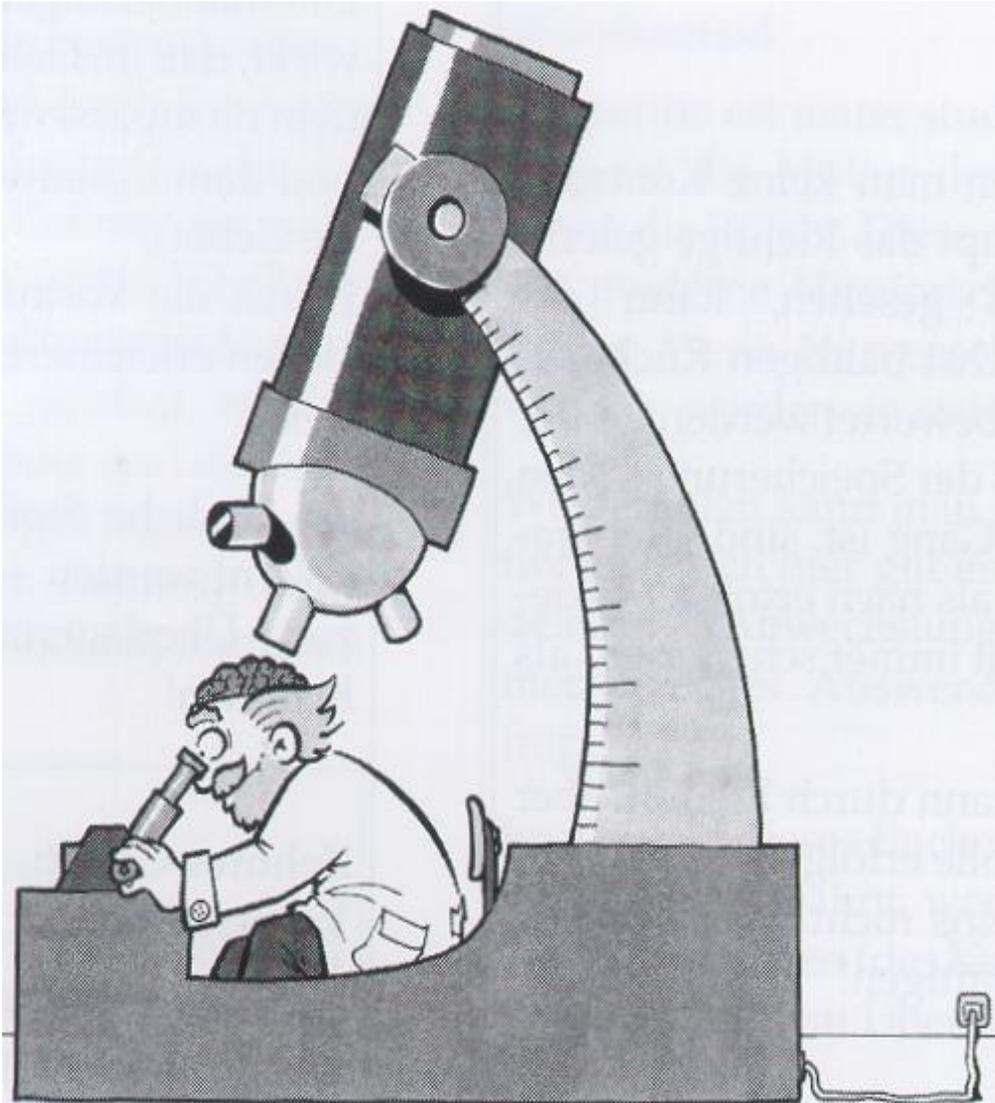
- Because of the chemistry at the synapses and because of the networks we must
- **Repeat**
- **Take breaks (the best is sleep)**
- **Give Feedback**
- **Protect - especially young brains - against chemicals (like alcohol and other drugs), electromagnetic radiation, accidents**
- **Link ideas and topics to Associative Networks and initiate cross-subject teaching**

The **Neuroscientific Approach** to Learning

- Traditional or innovative?
- Some „guiding principles“ of „brain-based teaching and learning“ like arouse interest, take breaks, give positive feedback, foster physical exercise, repeat, avoid anxiety, learn coping with stress, and others, are not new!
- Therefore:
Old wine in new tubes?



The Contribution of Brain Research?



Some principles are
„Old Wine“,

but
confirmed
well by
Neuroscience!

Cartoon: Schachl, 2012, 10

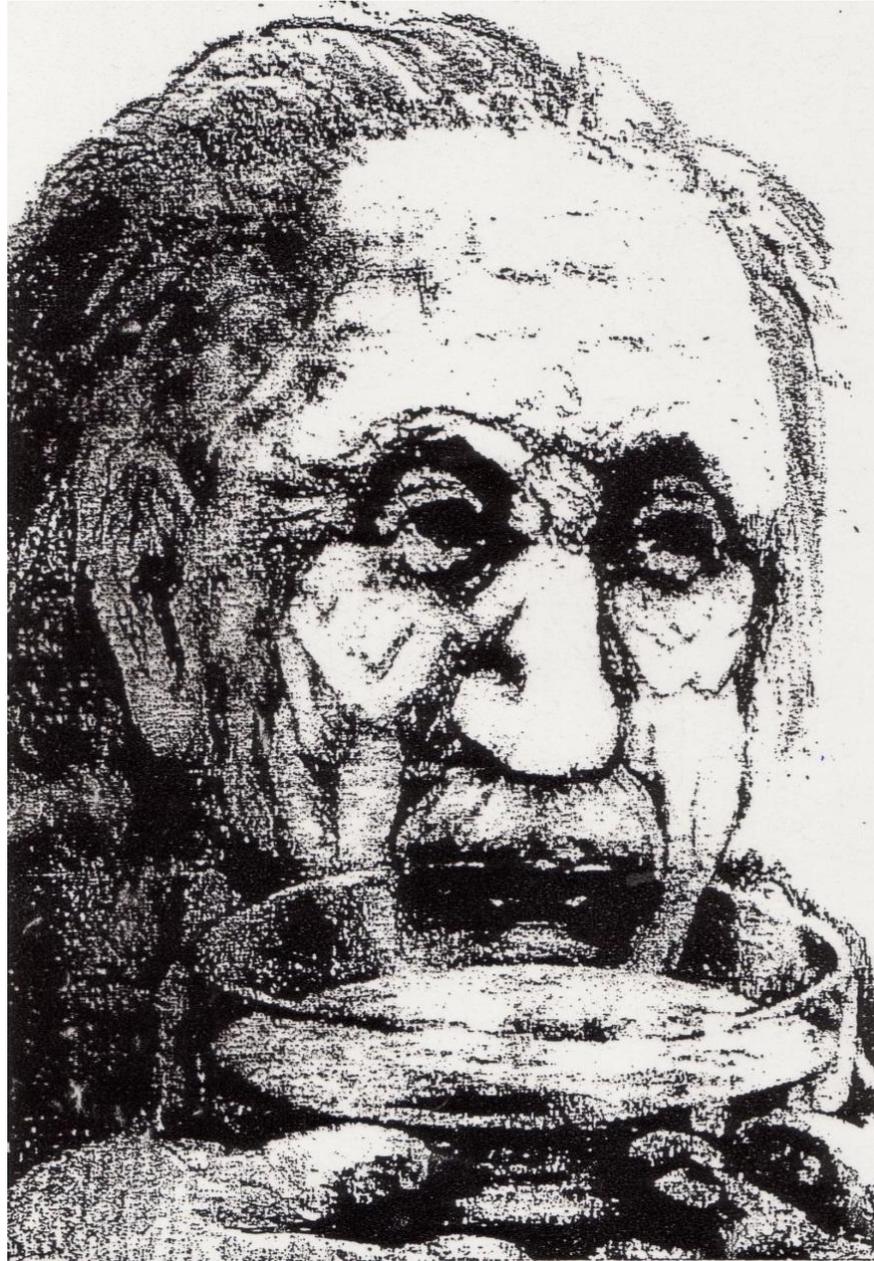
Research and Education for the Future



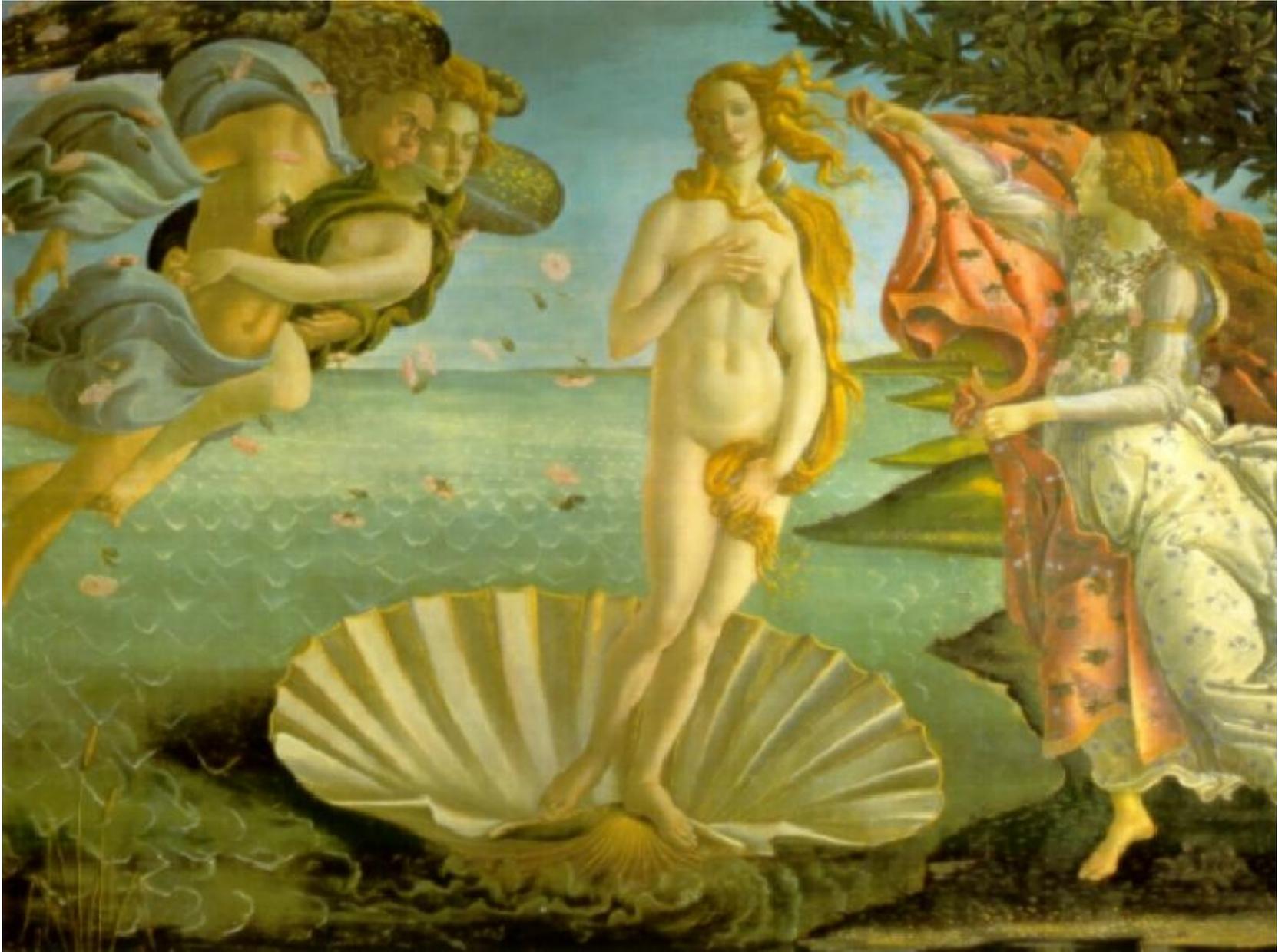
- “The goal is, that in schools must be less noise, less frustration, less boredom, and not useless work, but more freedom, more joy, more happiness, and therefore more real success!” (Comenius)
- This is, what I wish you too!



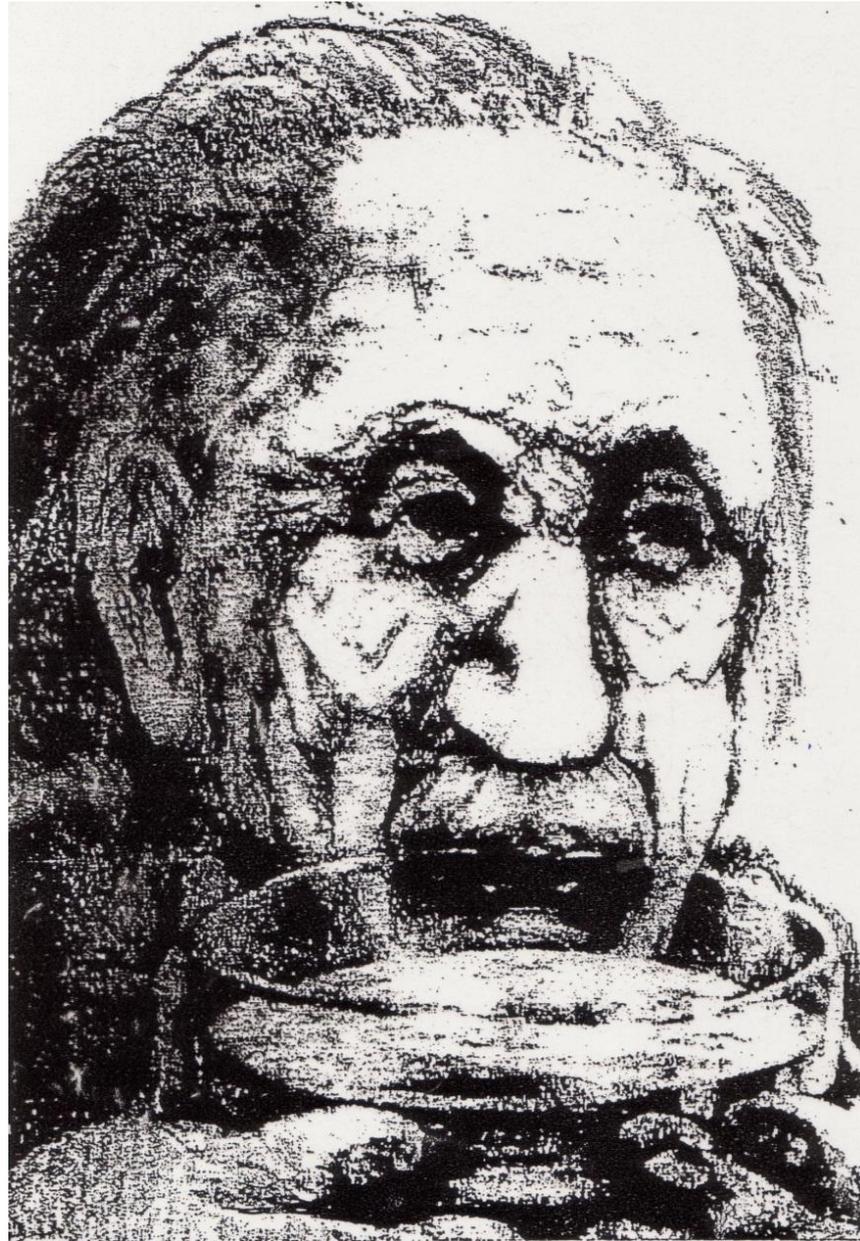
Ein famous Scientist (Physics)!



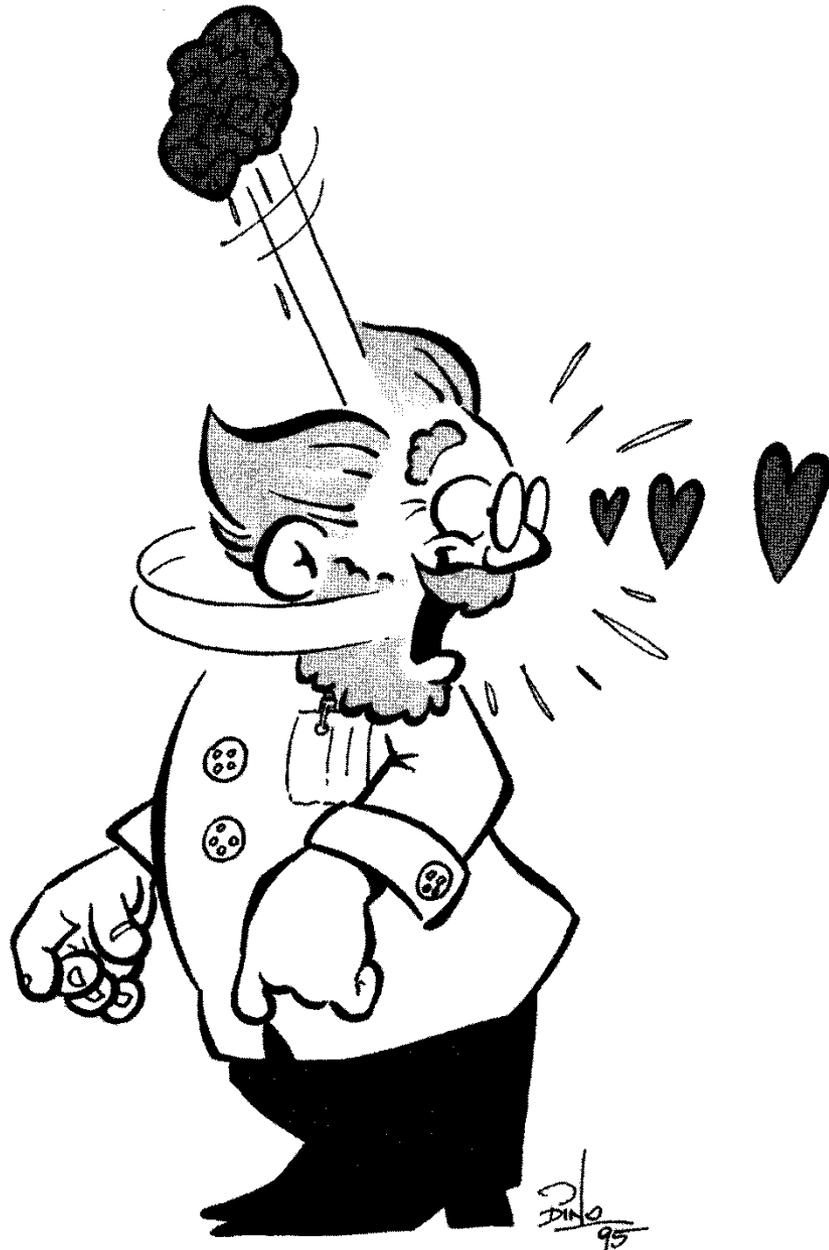
Sandro Boticelli's Venus



Famous Scientist?



Cognition and Emotion

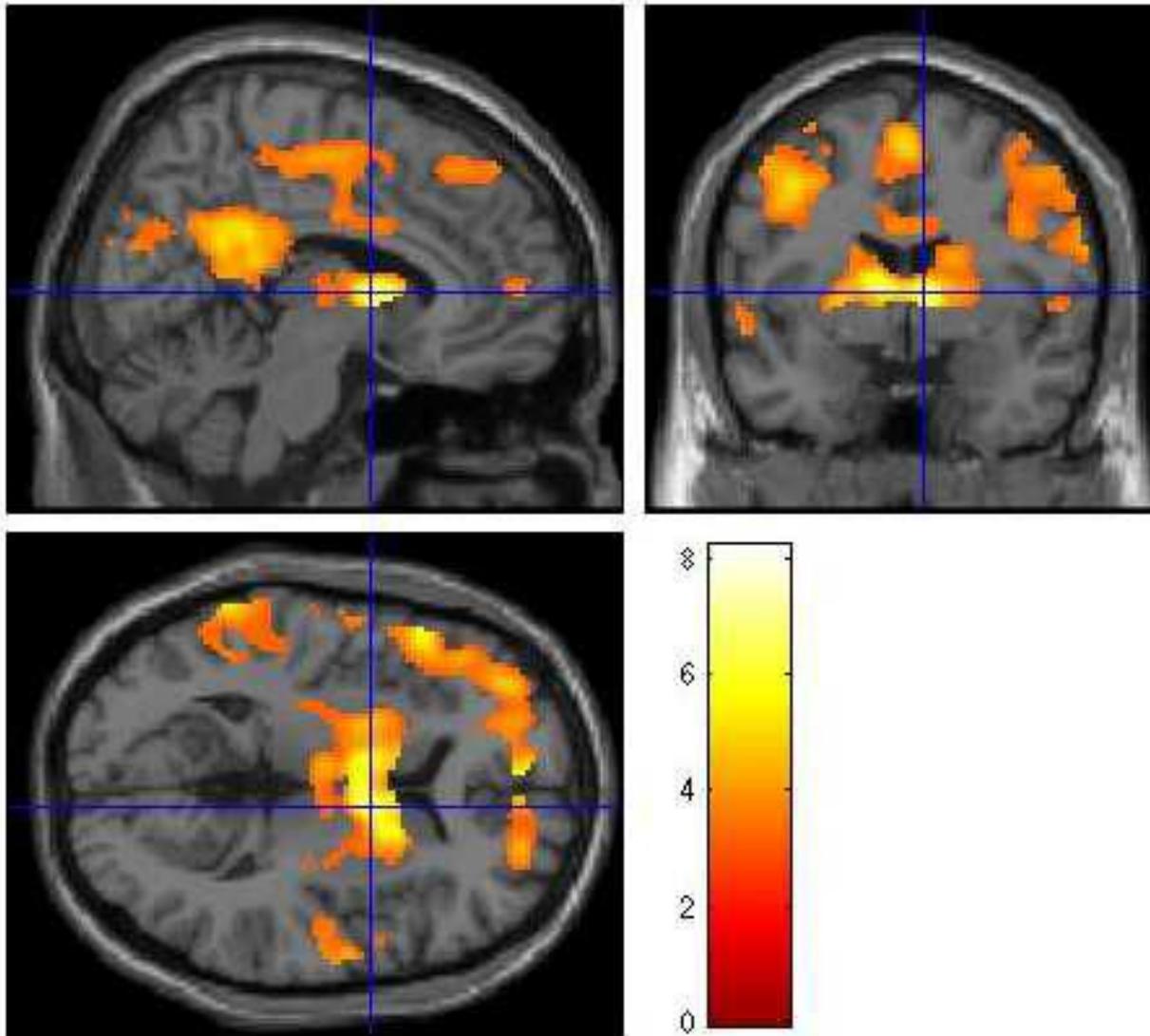


**There are two
„souls“ in my heart
(brain)?**

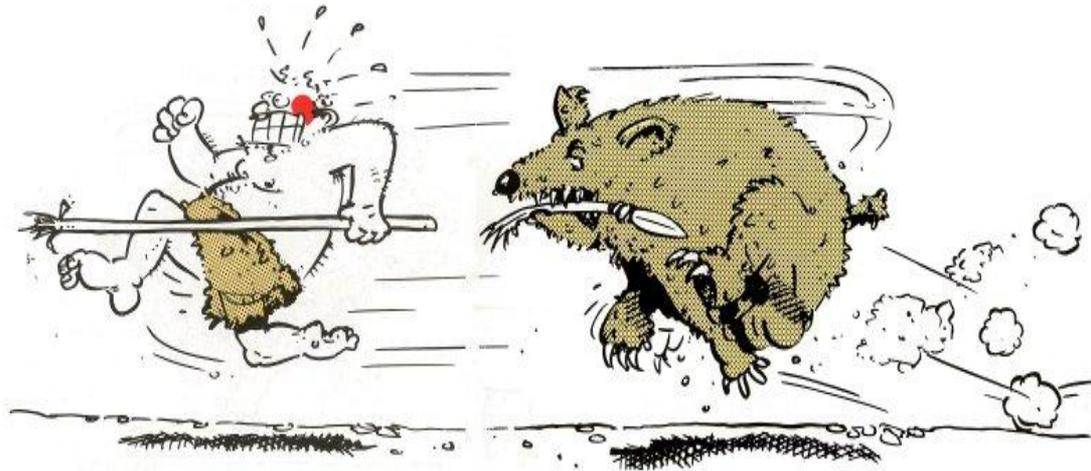
Cartoon: Schachl, 2012, 19

Activation of Nucleus accumbens by right solved tasks

(Krick, 2016, 21)



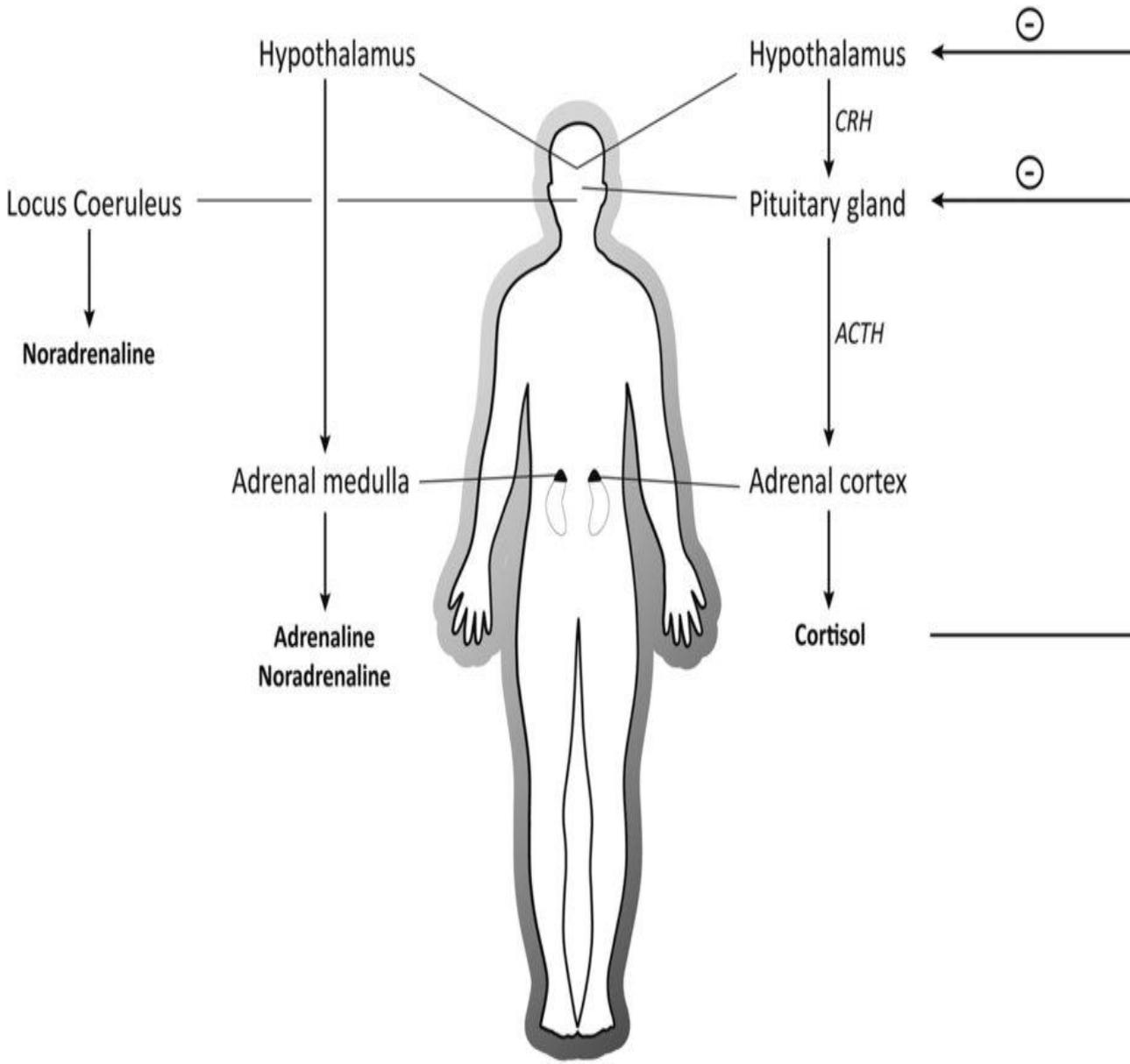
Fight or flight!



- **Necessary for survival**
- **Activation** of brain, heart (blood, oxygen), breathing, sweating, muscles, blood pressure, energy; of pain- and immune-tolerance, of blood-coagulation!
- **Reduction** of digestion, of saliva-production in the mouth; of libido!

Systems activated in response to stress

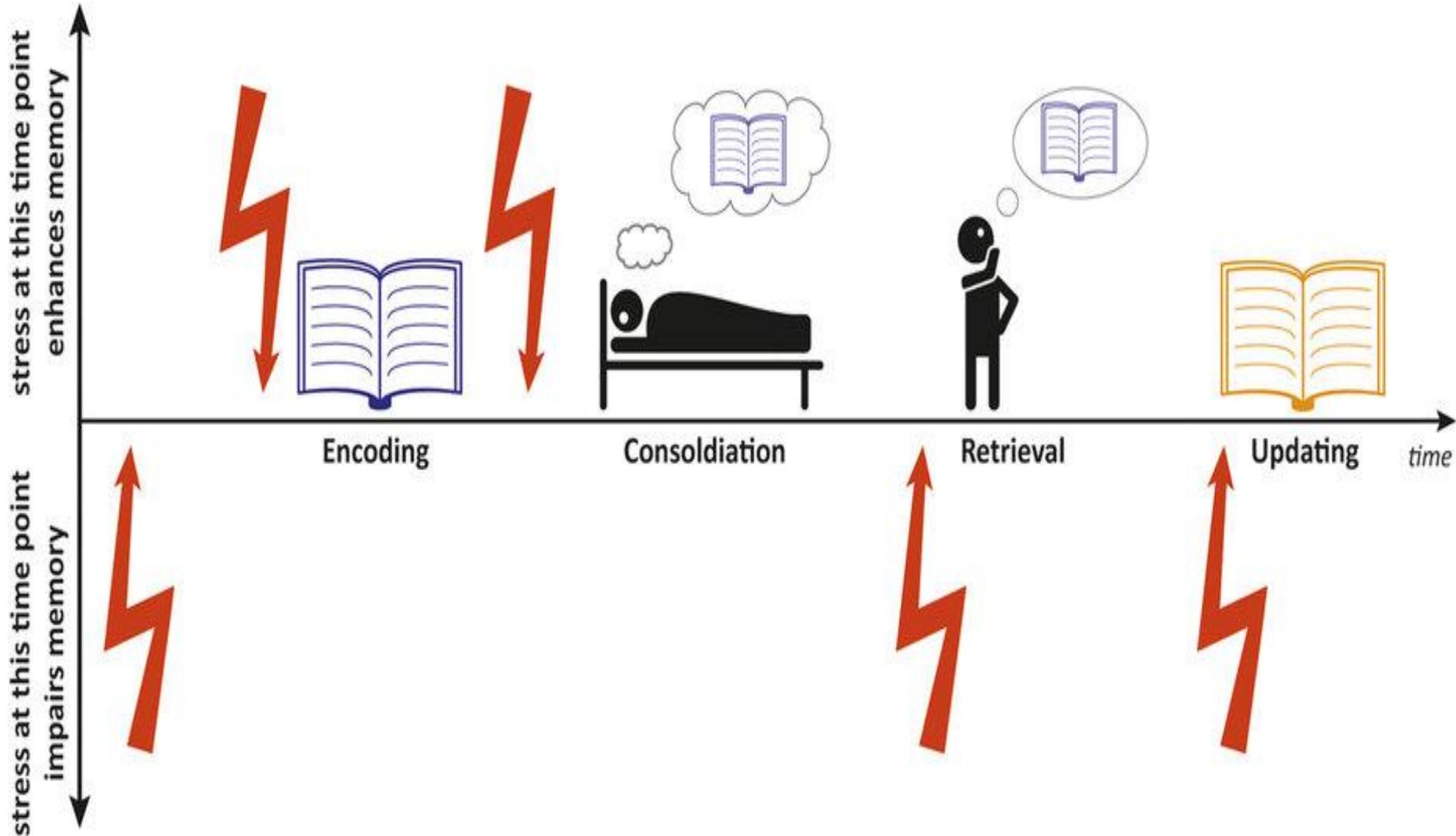
(Vogel/Schwabe, 2016)



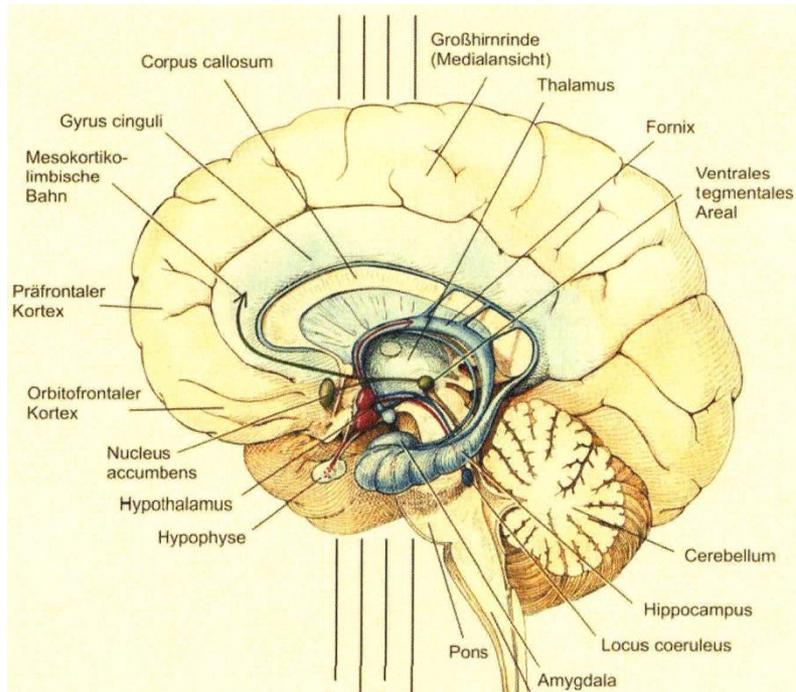
- **Autonomous Nervous System** (with Adrenalin and Noradrenalin) for fight and flight! Effects on attention, working memory and long-term memory too!
- **Hypothalamus–Pituitary–Adrenal Axis:** CRH, ACTH, Cortisol! Affects cognition and behaviour!

Effects of Stress on Learning and Memory

(Vogel/Schwabe, 2016)



The vulnerability of Hippocampus

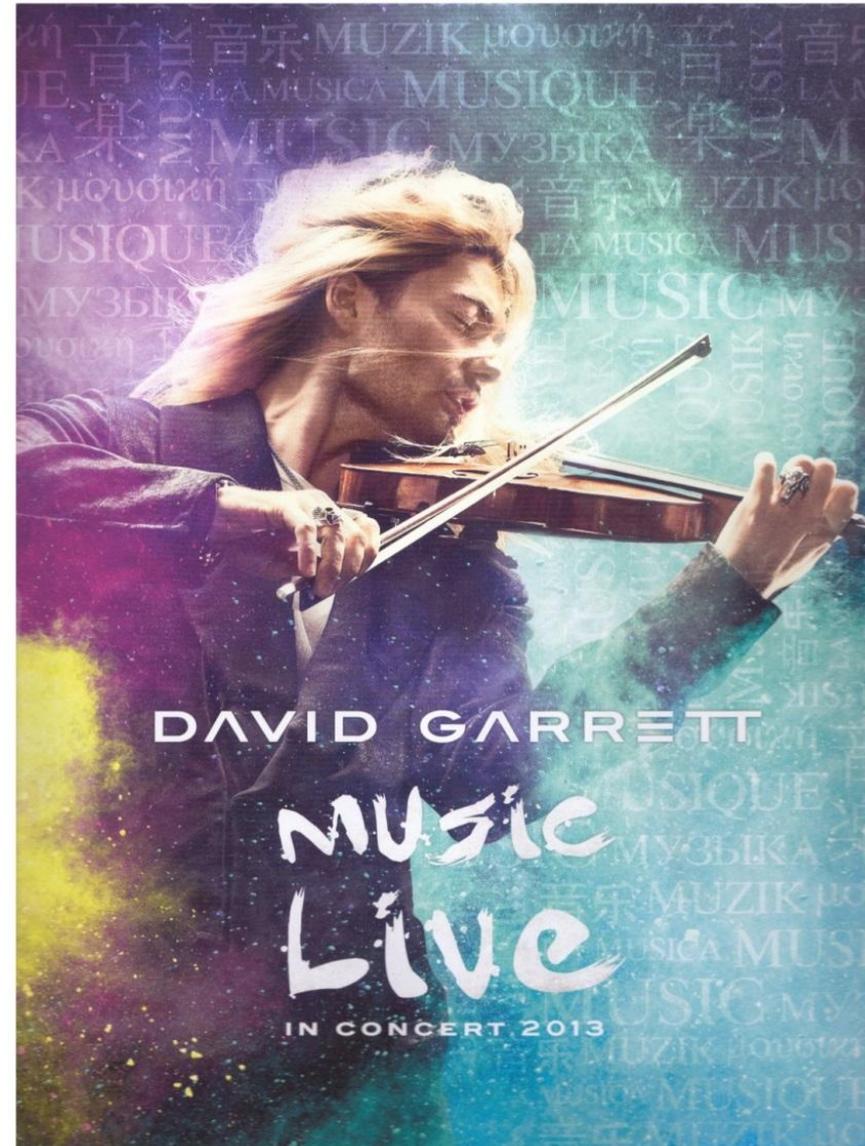


- **Severe and prolonged stress** leads to reduction of volume, loss of dendritic spines, less neurogenesis, reduction of BDNF (brain derived neurotrophic factor)!
- Stress affects negatively important proteins (like CREB)!
- **Therefore:** poorer performing in learning tasks and deficits in memory!
- Oxytocin as an „antidote“:
Importance of positive social relations!

Contradiction between hard work and joy?

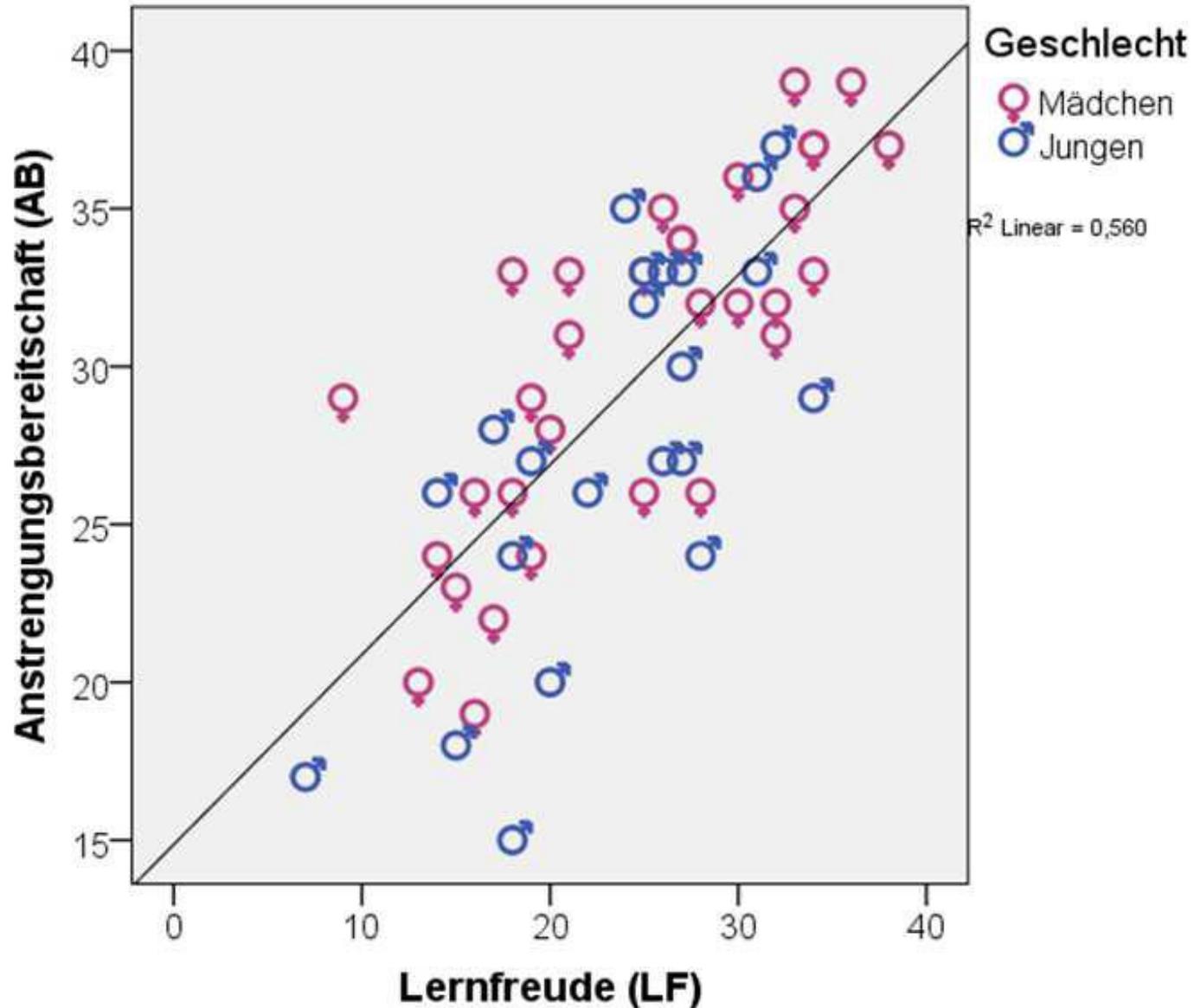
- **No!**

**Joy we get by success,
and for that we have to
work!**

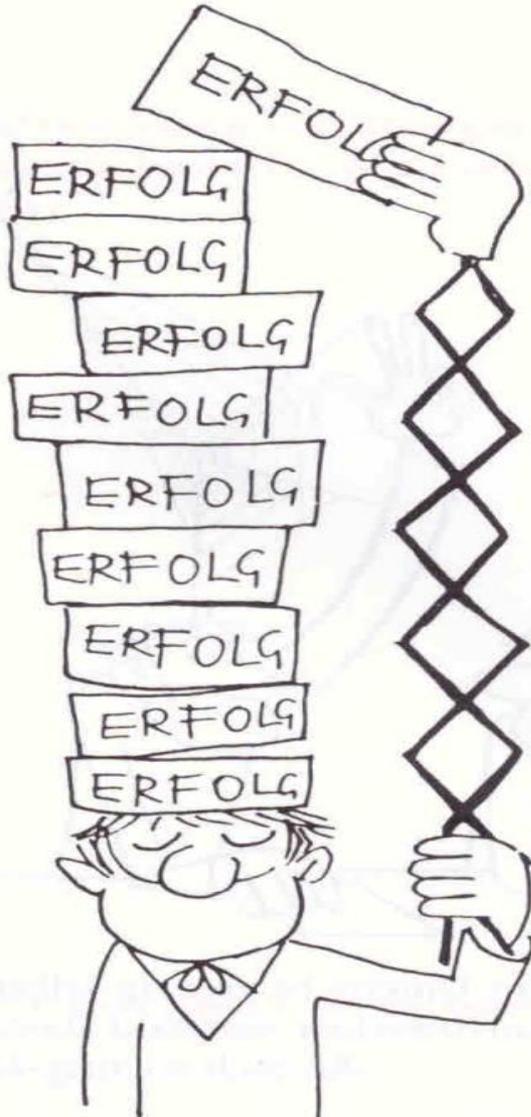


More readiness to work with joy!

(Krick, 2016, 24)



Help students to succeed!



Joy

by

Success!

Coping with stress

(Kaluza)



- **Instrumental management of stress:**
Learn to learn and self management (planning, organizing, preparation for exams in time, establishing a good working place, ...)
- **Mental management**
of stress:
„Change of thinking“ (exams as challenges, not as threats).
Self „affirmations“; critical analysis of the own appraisals (I am a loser?)
- **Regenerative management of stress:**
Relaxing, Yoga, Meditation, Breathing, Autogen Training, Jacobson's „Progressive Muscle Relaxation“, Physical Exercise!

Physical exercise is a natural „basic need“



- Important for **health** of the whole body: muscles, circulation, breathing, immune system, and so on!
And also for **brain**, therefore for mental health and
- for **learning** too: mens sana in corpore sano (Juvenal)
Multisensoric Integration
Increasing of attention
Positive impact on synapses and on neurogenesis
Reduction of Cortisol, therefore reduction of stress
Positive impact on „chemistry of soul“:
Stimulation of Dopamin, Endorphines and Endocannabinoids!
Positive impact on behaviour (also of school pupils)

Fascinating Memory



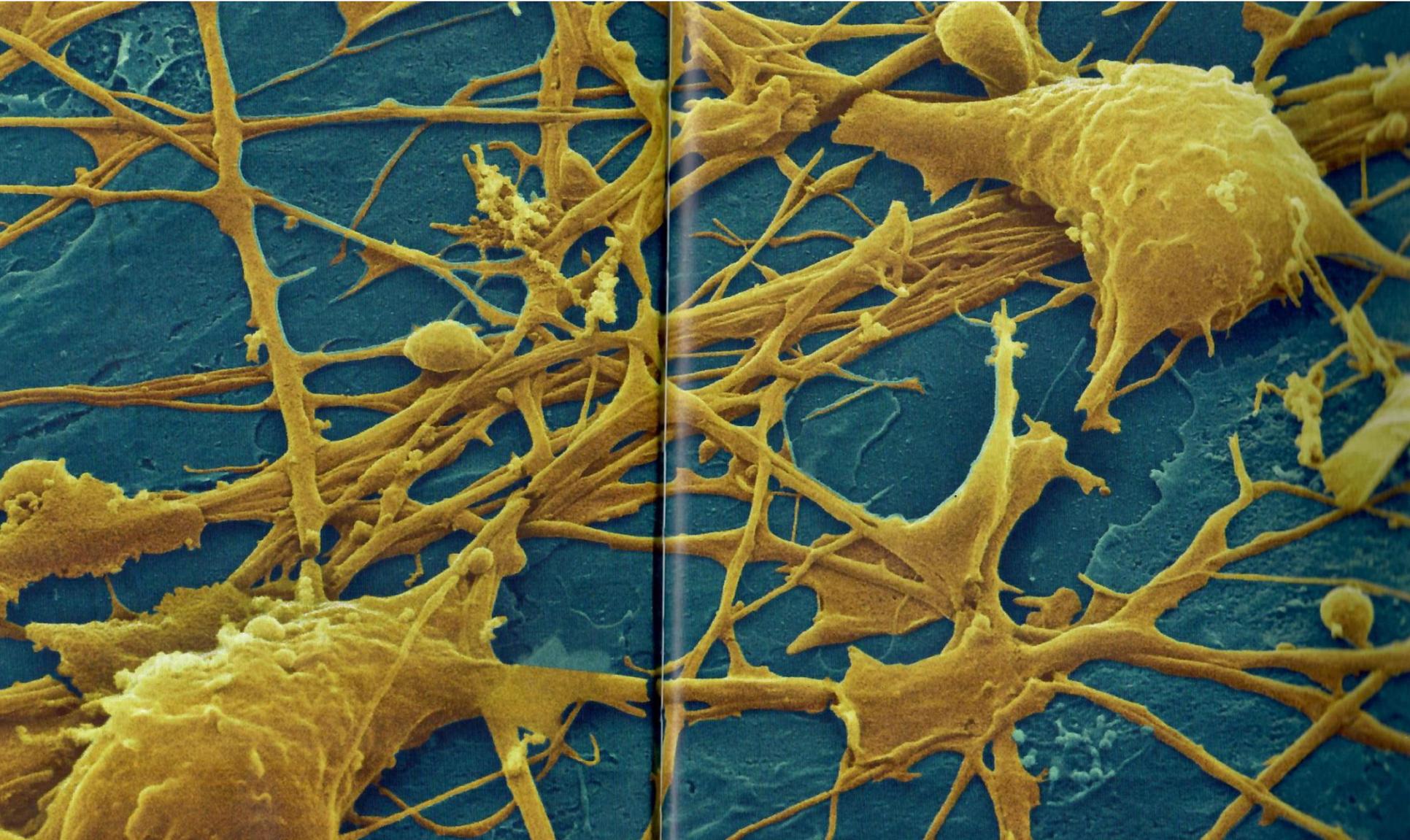
The Synapse

(Beck/Anastasiadou/Meyer zu Reckendorf, 2016, 110)



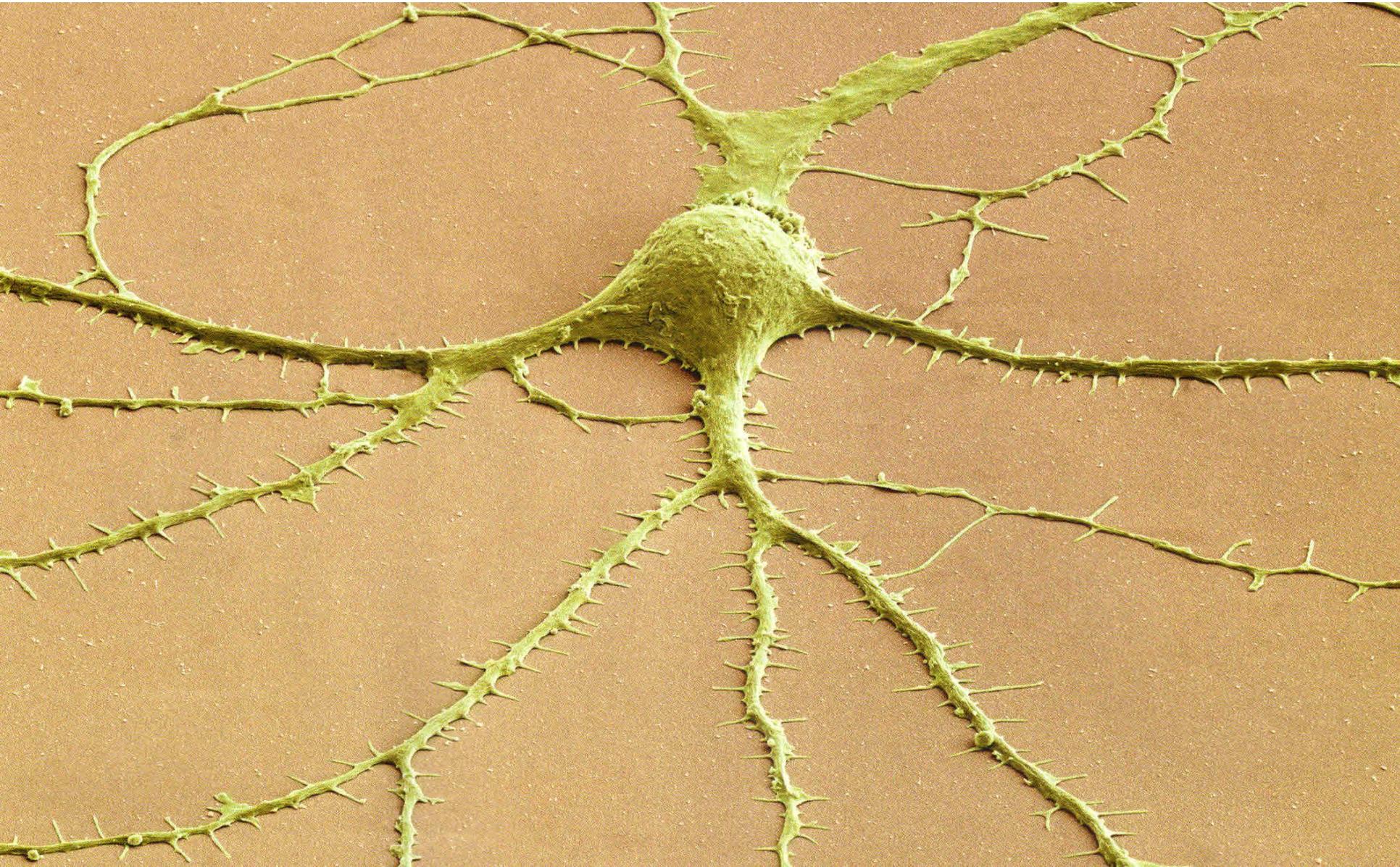
Elektronenmikroskopische Aufnahme von wachsenden Nervenzellen

(Beck/Anastasiadou/Meyer zu Reckendorf, 2016, 308-309)

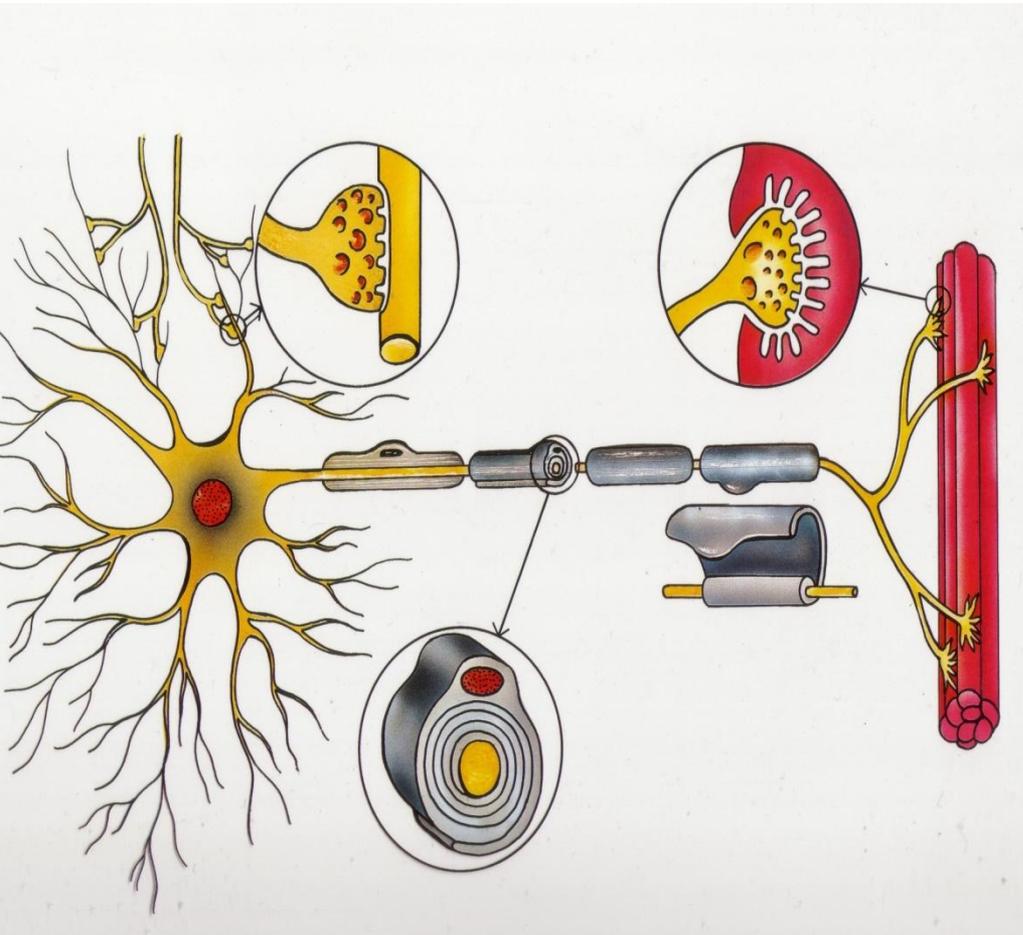


Many „Spines“

(Gehirn&Geist, 2014, 5, 43)



Myelination



Diese elektronenmikroskopische Aufnahme zeigt den Querschnitt eines Nervenfaserbündels. Das Innere der Nervenfaser ist orange-rot, die isolierende Schutzhülle, das Myelin (in diesem Fall durch Oligodendroglia gebildet) hingegen hellbraun.

The „Traces“ of Learning in the Brain

Without learning

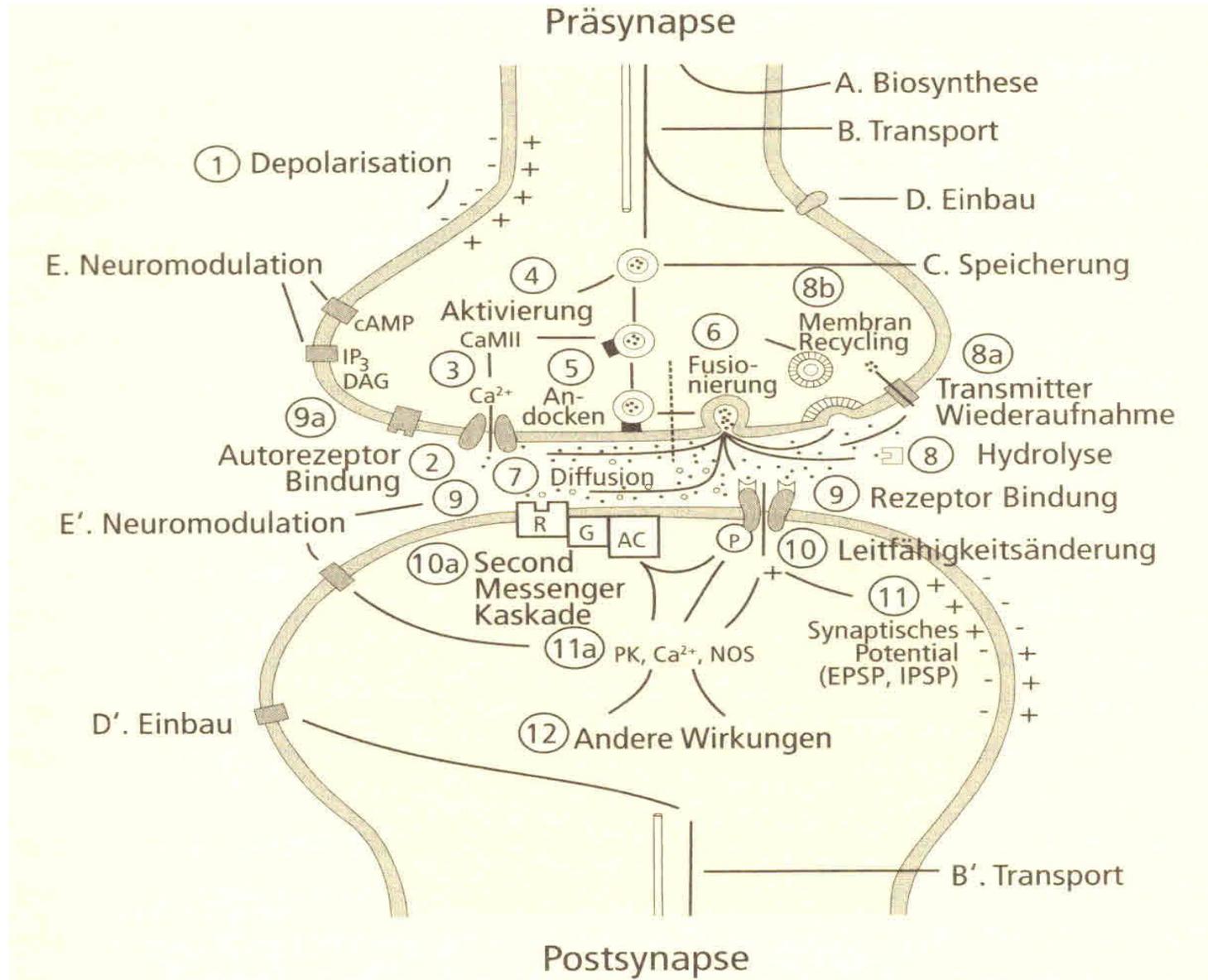


With learning



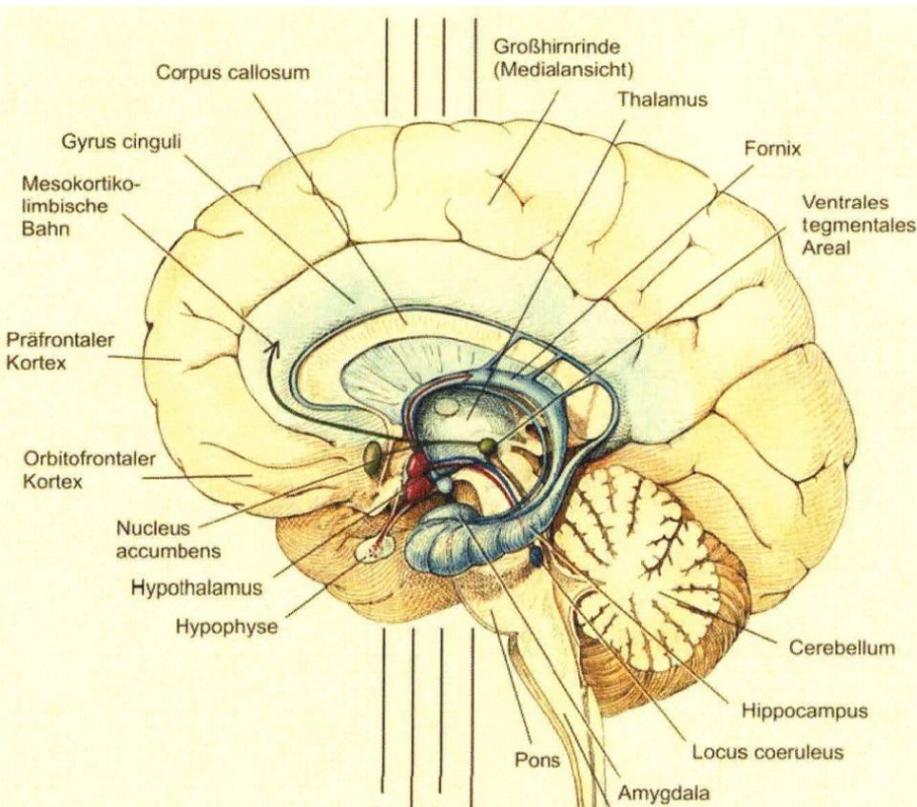
Very complicated!

(Roth-Strüber, 2015, 52)



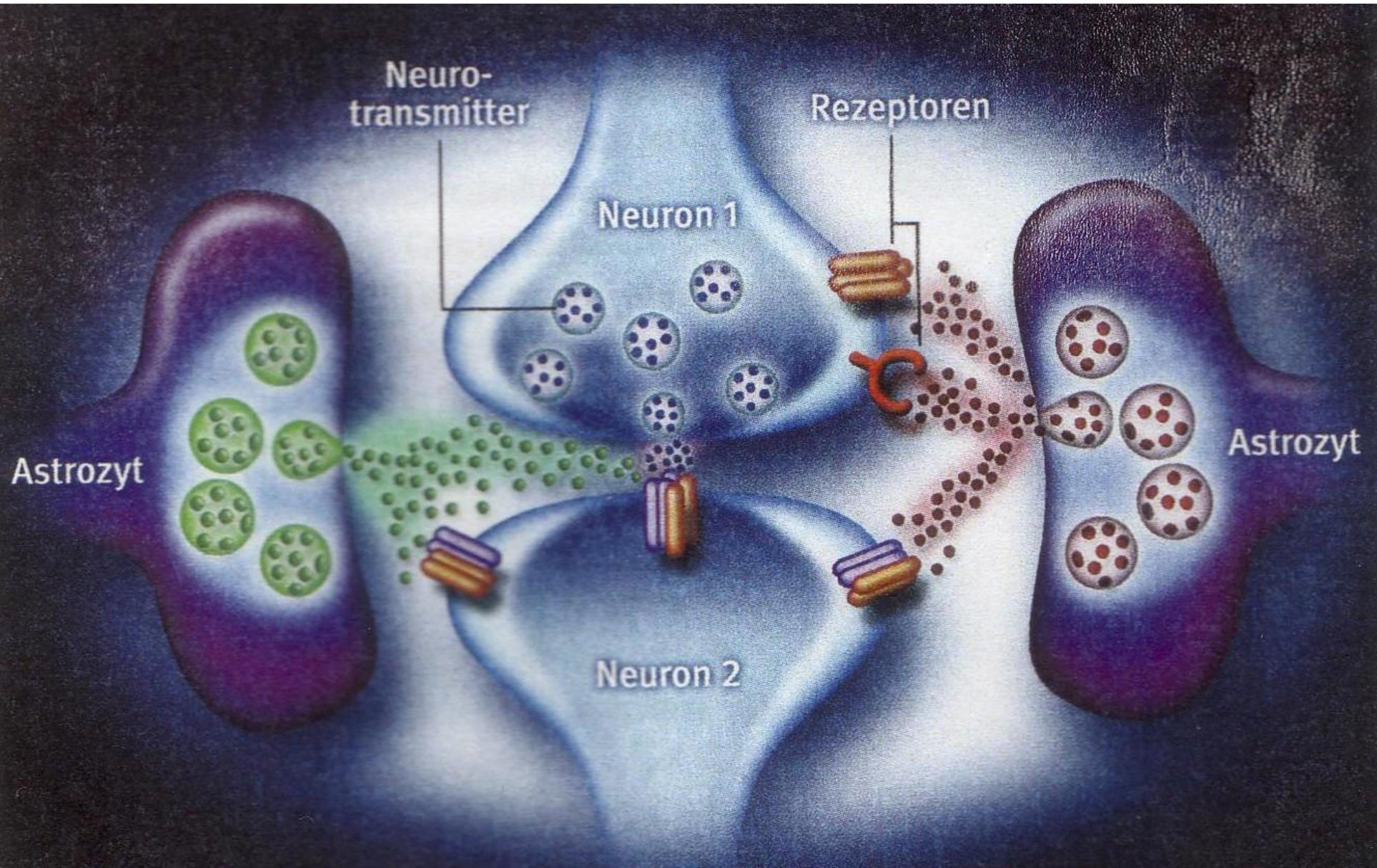
The Language of Brain is Chemistry

(Roth-Strüber, 2015, 95ff.)



- **Dopamin**
- **Endorphins**
- **Oxytocin**
- **Vasopressin**
- **Noradrenalin**
- **Serotonin**
- **Acetylcholin**
- **Glutamat**
- **GABA**
- **Cortisol**
- **Endocannabinoids**

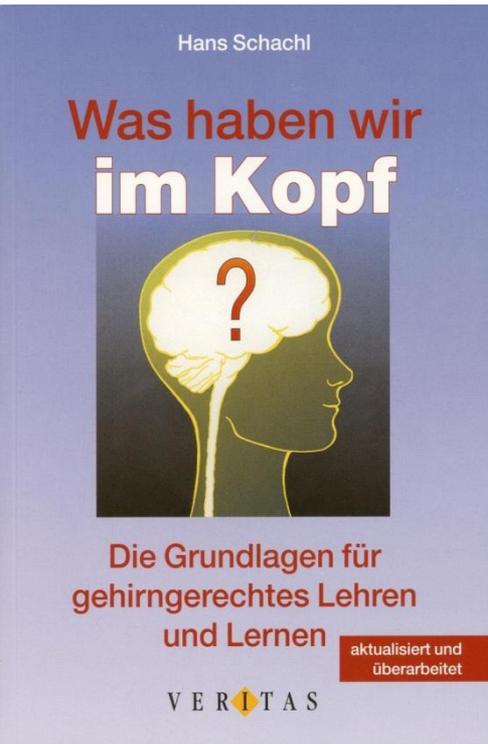
Glia – Neuron - Communication



Summary: 12 Guiding Principles

for Brain Based Teaching and Learning

- Overview before details
- Clear teaching and learning aims
- Arouse interest
- Repetition
- Multi-sensory Approach
- Feedback
- Breaks
- Sequencing in Teaching and Learning
- Associative Networks
- Specific Aptitudes
- Affective Factors
- Good Model



As a very short „summary“



Little „Hans“ should learn

**important contents with
sense,**

with good methods

and with joy!

**Then he will be able and
willing to learn all his life!**

“What” should be learned? The “Central Philosophy”!

- Beside tests, examinations of all kind



- the „old teachers wisdom“ is nowadays important too:

Not only learning the alphabet with reading and writing is important, and not only languages, mathematics, etc., but very important is “**wisdom**”. And all must be done with fun and joy!

„**Wisdom**“ means:

Education is not only education for the jobs, it is more, like thinking, problem solving, reflecting the own life, creativity, music, sports, social attitudes, and so on!