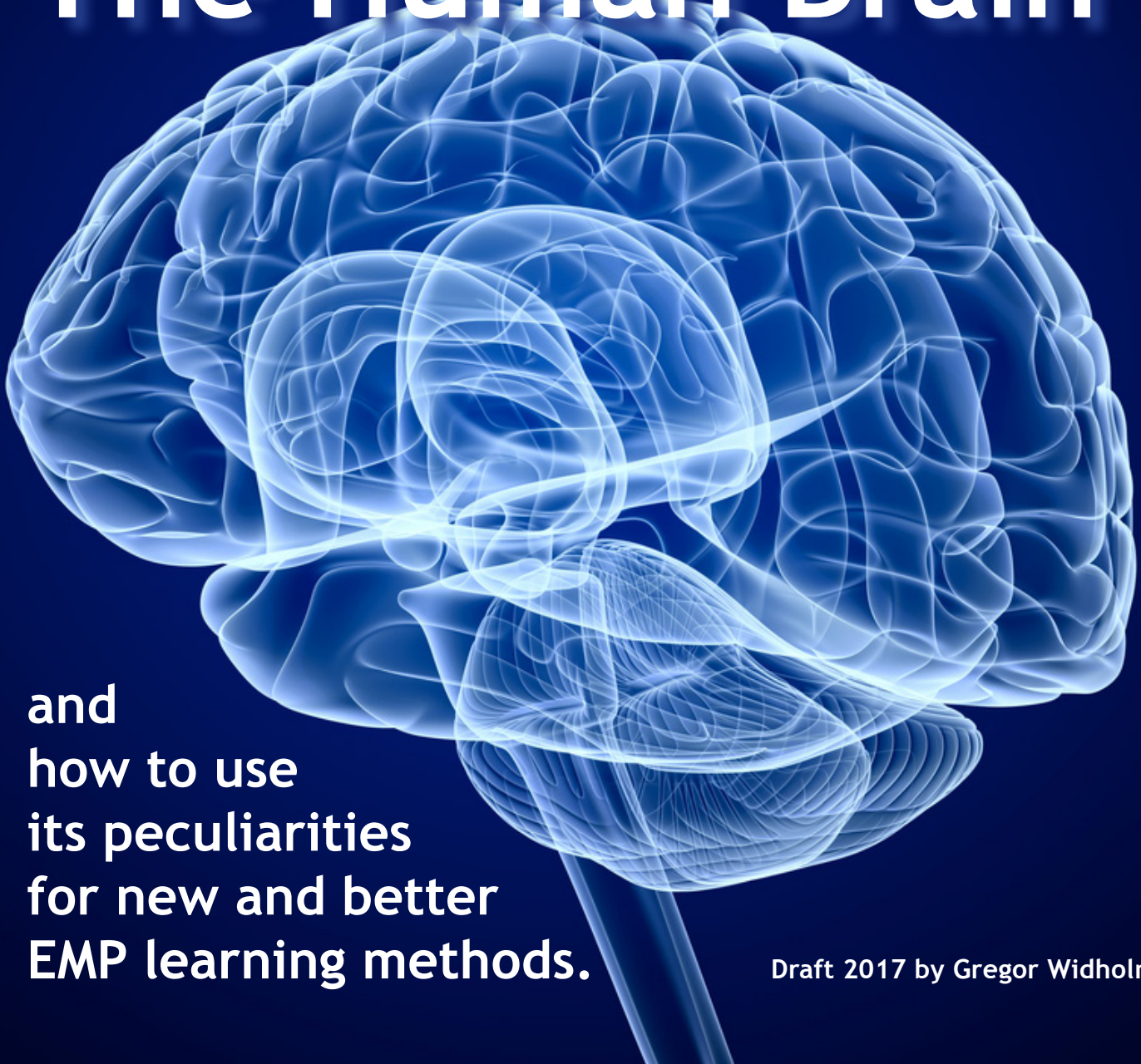
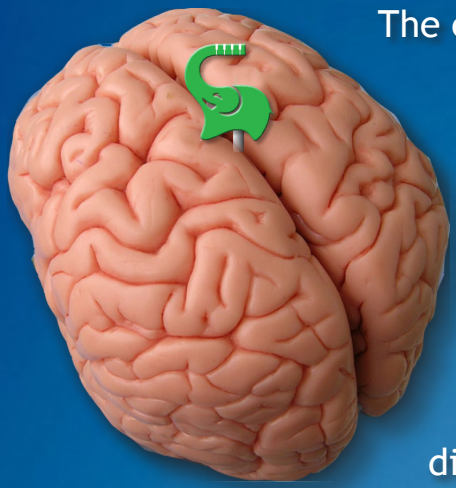
The Human Brain



and
how to use
its peculiarities
for new and better
EMP learning methods.

Draft 2017 by Gregor Widholm



The enormous progress in the last 10 years in brain research and improved neuroimaging methods like magnetic resonance tomography (MRI) make it possible to monitoring the working human brain in real time. We can see which regions are active (and how much) if we are singing, dancing, playing an instrument or, for us of particular interest: learning.

And it can be demonstrated, that the modifications of the children's brain structure caused by learning, differs according to whether modern EMP methods or the traditional methods developed in the past century are used.

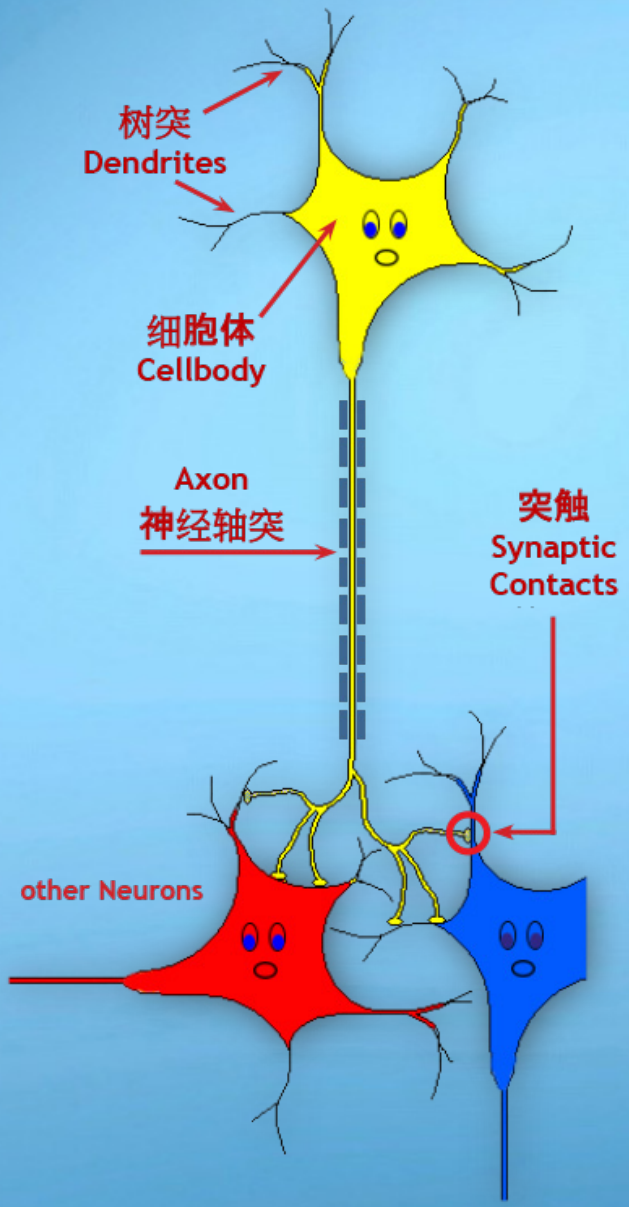
SHORT HISTORY

- Up to the middle of the 20th century the people thought that the human brain is a very complicated machine and our individual personality is primary formed by our DNA and to a certain extent by the social environment. This is WRONG!

- The next error about the functionality of the human brain happened in the second half of the past century and most people today still believe in this position: the complex neuronal network of our brain is the „hardware" and it is programmable. In other words: our brain with the 190 Billion neurons is a more than sufficient hardware resource and the social environment in combination with the individual experience of live, writes the „software". This theory can explain some effects, but fails in many details. It also is WRONG!

- Today we know that the neuronal structure, the „hardware" of our brain modifies itself continuously and permanently depending on the data delivered by our sensory organs (eyes, ears, sensors of our skin) and the feedback of our various body organs. This particular feature of our brain is called „NEUROPLASTICITY".

THE NEURONS



Our brain consists of 190 Billion nerve cells (190.000.000.000): 90 billion neurons and 100 billion glial cells which provide support and protection for the neurons.

- Each neuron has a „cell body“ where the incoming information signals are processed.

- Each neuron can be connected with ca. 200 - 10.000 other neurons by its „dendrites“ and the „axon“ using its „synaptic contacts“.

- The dendrites act like antennae, collecting the signals from other neurons.

- The axon can have a length up to 1.5m and acts as a „sender“ which pushes the signal of the cell body to the dendrites of other neurons.

- The communication between neurons work according to electrochemical principles.

NEUROPLASTICITY - how does it work?

Let‘s explain it by an example:

A five-years old child starts learning playing the violin and exercises one hour a day. If we look at the region of the child‘s brain which controls the movement of the fingers of the left hand, we can see that after only 1-2 weeks this region of the brain expanded and contains several thousands of new grown neurons more, sharing the task and doing now their job together!

The finger movement is now more accurate, precisely and particularly faster!

International studies on the brain of professional violin players showed, that the region of their brain being responsible for the fingers of the left hand is 1.5 – 3 cm larger than that of ordinary people.

• This means: several 100 millions of neurons more in this region and a significant better connectivity between the left and right hemisphere!

Neuroplasticity - the ability of the human brain to produce new neurons strongly depends on the age!

5-years old child: new neurons after 1-2 weeks playing
9-years old child: new neurons after 2-3 month playing
Adult person: new neurons after 1-2 years playing!

Please note:
If an adult person stops its activity playing an instrument, the additional grown neurons die and vanish within a few years - not so in the case of children!

If children stop their activities for the rest of their life, because „it is not cool“ to play a musical instrument, they nevertheless keep the increased amount of neurons and the advantage of a better connectivity for their whole life!

NEUROPLASTICITY - where does it happen?

The essential player are the synaptic contacts of the neurons (see page 2). This microscopic part of a neuron which connects it with other neurons does not work like a „fixed“ connection (see next page).

If a synaptic contact is used the first time by the cell body sending an electrochemical impulse to the synapse - nothing happens!

Only if this procedure is repeated again and again, it starts working better and better. This explains why musicians have to „exercise“ - playing one phrase again and again till it sounds perfect.

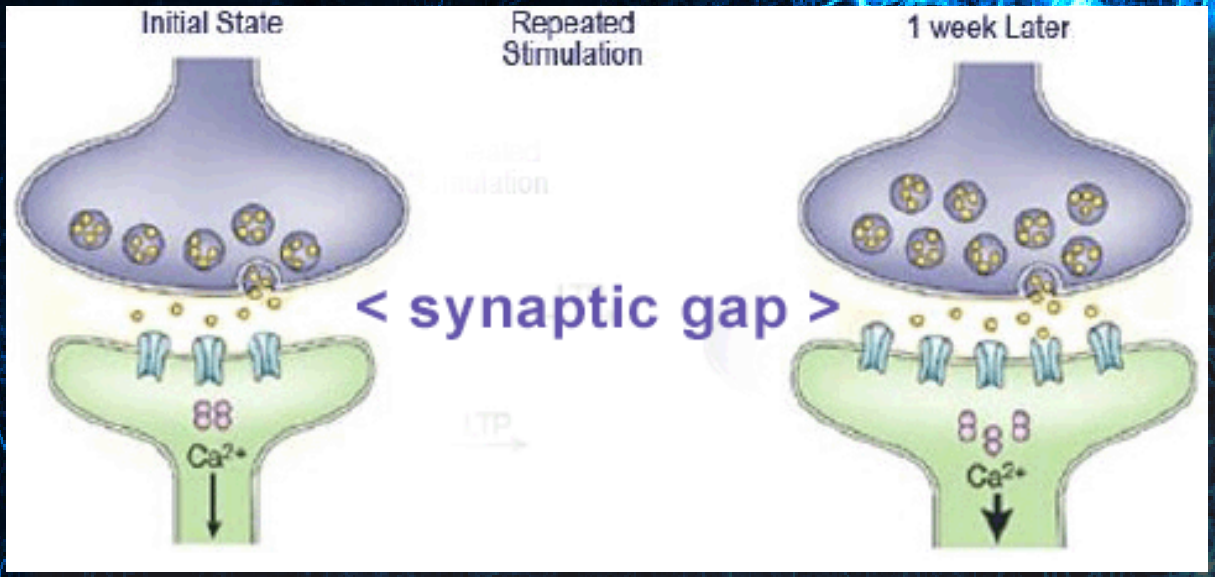
The reason for this effect is a small gap, the so called „synaptic gap“.

It is located between the membrane at the end of the active synapse and the membrane of the receiving neuron.

This gap has a width of 20 nm (nanometer) = only 20 millionth parts of a millimeter!

As it can be seen in the figure below, the active synapse emits some molecules of certain substances, called „transmitters“, which dock onto the membrane of the receiving neuron and open some ion channels - also called „sodium-potassium pump“.

The sodium ions of the surrounding brain fluid now flow through the opened ion channels into the receiving neuron and change its electrical potential. This is the way how neurons communicate. The information travels in the form of an electro-chemical impulse represented by molecules with different electrical potentials, the so called „ions“, from one neuron to the next.



- If this procedure is repeated again and again, new ion channels are growing (right part of the figure).
- The next step is the development of new additional synaptic contacts
- Continuing the use of these neurons, new neurons are generated!

NEUROPLASTICITY - how to support it?

The neurons of our brain have the ability to produce transmitter substances like Dopamine, Endorphins, Serotonin, Glutamate, Acetylcholine etc. by themselves.

All these chemical substances stimulate the development of new additional synapses and neurons and thus intensify the connectivity of the neuronal network in our brain.

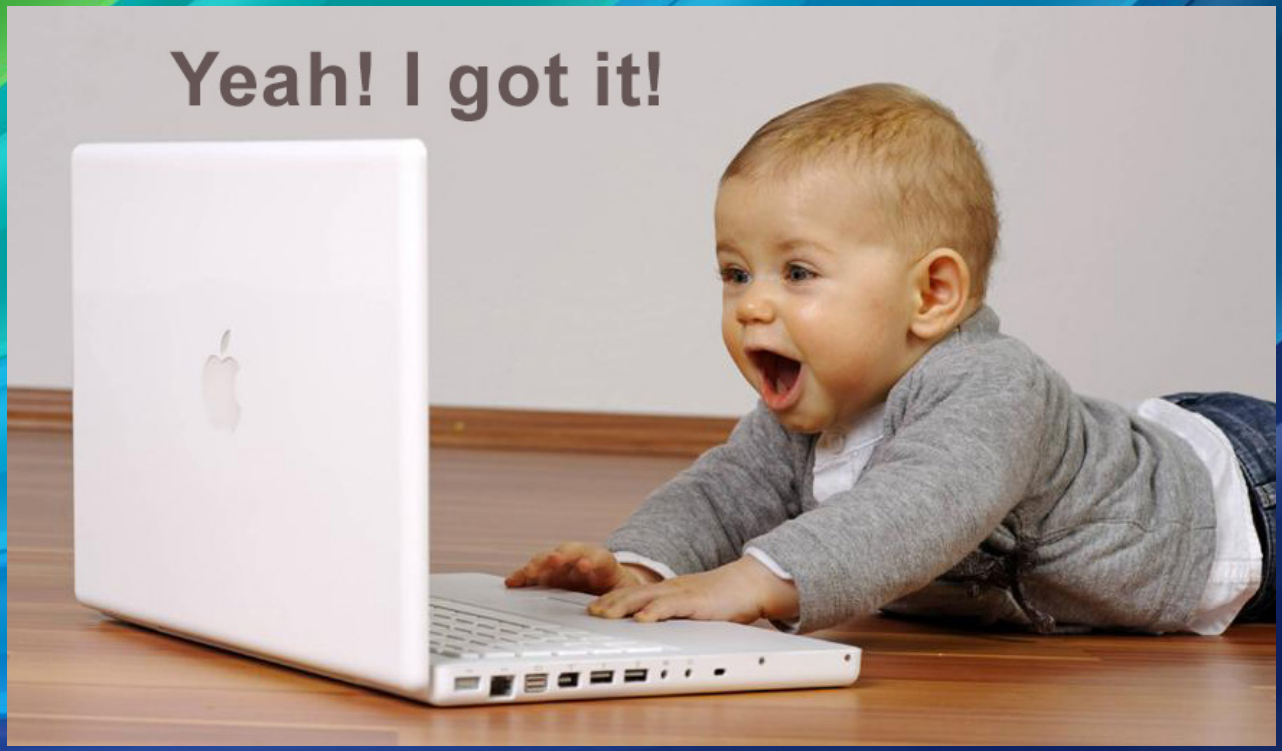
If such dopaminergic substances are emitted into the synaptic gap, it makes us feel „happy“.

What can we do in order to initiate the distribution of dopamine?

It must be something emotional –
and it must be something important for us!

For children, the most interesting and important matter is discovering the world around them. They are eager and really addicted to discover and try out new things.

And if they finally are successfully „Yeah! I got it“, a massive emission of dopamine follows and provokes them to try it again and again. It is like an intoxication by cocaine.



The activities described at the previous page are essential for the enhancement of the neuronal connectivity in the children‘s brain. Additionally the development of their individual creativity is supported.

If they are free to discover the world in their own way without being guided by adults in a constricting manner, then we speak of an „ideal learning situation“ and the new acquired knowledge and abilities will be sustainable stored in the child‘s brain!

Why is such a big difference between babies in their behavior and personality?

Is it the genetic code? No.
The individual genetic material can have an influence on the predisposition regarding diseases and disorders, but not on the behavior and subsequently on their personality.

The reason is an other one: Parts of the somatosensory system start to develop only a few weeks after conception.
By week 8 of pregnancy, the baby has developed touch receptors in his face — mostly on his lips and nose — which are connected to his growing brain.

Over the next few months touch receptors start to form in other places throughout the baby's body — his genitals, palms and the soles of his feet by week 12, and the full abdomen by week 17.

By week 20 the baby's ears are now fully working and transmitting the information on his acoustic environment permanently day and night, to the auditory cortex of the brain.

This explains the fact that new born babies are able to recognize the voice of their mother or other persons they met during the last 9 month without any difficulty. By week 32, every part of a fetus has gained a sense of touch that's sensitive enough to feel a single hair brushing across the body.

This means that the baby feeds its brain with information already during the pregnancy in a phase were the brain is rapidly growing.

Thus the structure of the brain „the hardware", starts being built up according to the baby's individual life experiences during the first nine month!

Left and Right Hemisphere

There is a broad consensus about the two parts of our brain working in a different way:

The left hemisphere processes the data serial, step by step. It works accurate, linear and analytically - but slowly.

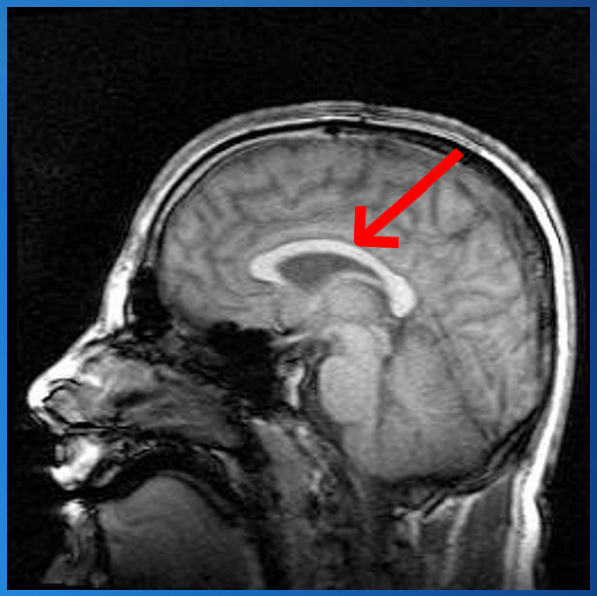
Its functions stand for:
analytic thought, logic, language, reasoning, science and math, written information and numbers skills.

The right hemisphere runs data processing parallel, acts very fast and in a holistic way. It stands for:

Art awareness, creativity, imagination, intuition, insight, holistic thought, music awareness and 3-D forms.

The Corpus Callosum

**The Corpus Callosum connects the two hemispheres of the brain.
It is a conglomeration of 200 million neurons with an extremely high connectivity:
Each neuron can be connected with up to 15.000 other neurons.**



Experiments and international studies showed that hearing music predominantly activates regions of the right hemisphere. But in the case of professional musicians and people who are making music themselves, both hemispheres are involved!

Such people have a significant larger corpus callosum which means: many millions of neurons more and a better connectivity between both hemispheres. Finally this leads to a higher potential of emotion, creativity and empathy.

Emotion is the most important element for embedding learning contents reliably and effectively in our brain, because it activates the dopaminergic system!