Jackson Hole, WY

19th of June, 2013

Wyoming Department of Education Special Programs Division:

"Assessment and Strategies"

New research on brain development and Child Guided Strategies

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(prof. Emeritus)

We will start with an experiment:

Watch this picture

Watch this picture

What did these experiences teach us?

The presented objects:

- the rose
- the velvet
- the sandpaper
- the pictures
- the marmalade

They all provided us with ***KNOWLEDGE*** and ***EMOTIONS***

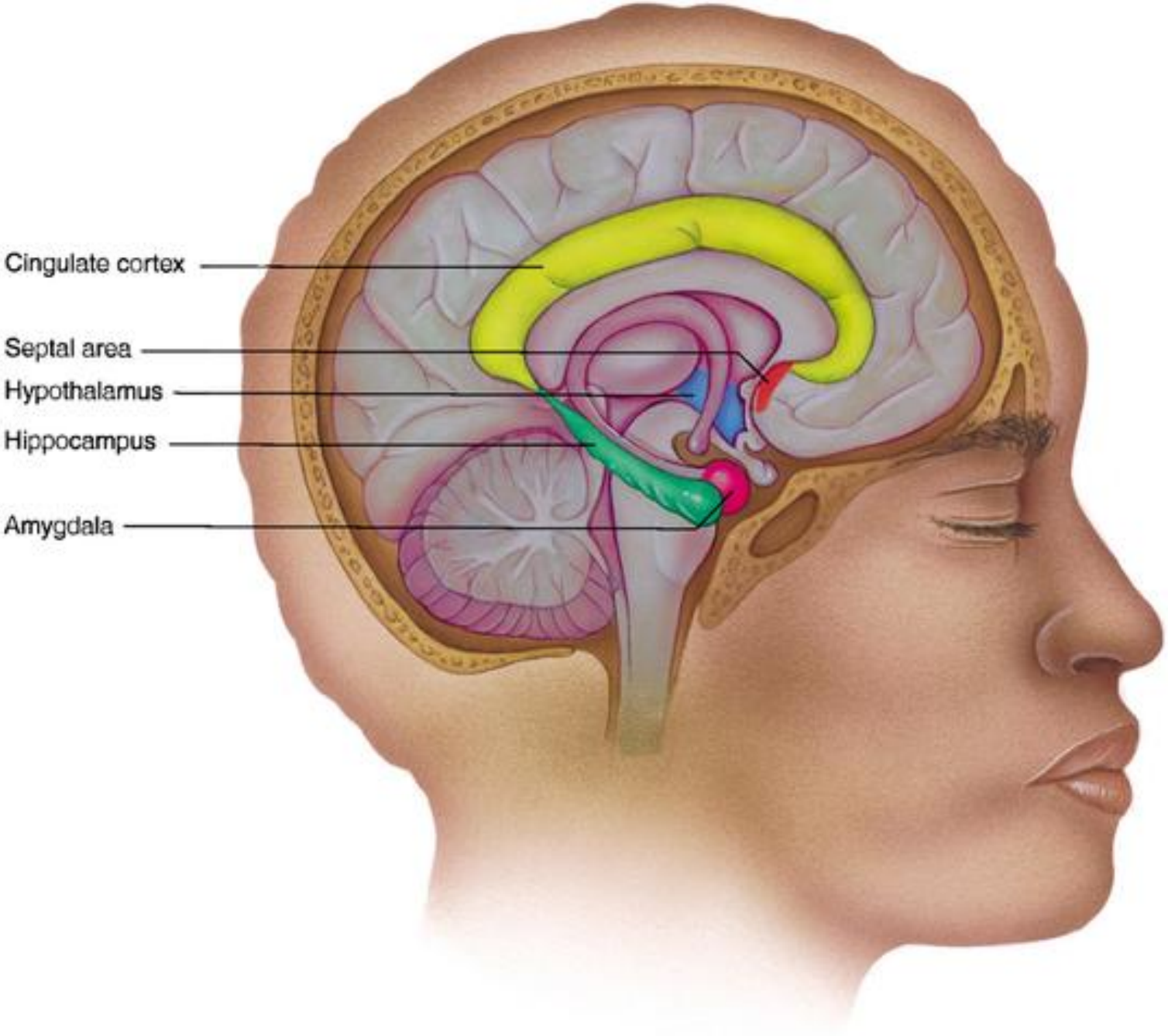
- It is clear that in perception, ***knowledge*** about the subject and ***memory of experiences*** play in important role for efficient processing of the information in the brain.
- In this perception process, adequate functioning of specific ***cortical*** areas in the brain is required.

- However, there is another dimension in perception.
- In looking at the “threatening” face, aversive *emotions* might have been triggered, and in looking at the angel you might have been “attracted” by the pretty face.
- You might have had aversive emotions when you saw ..... sticking her finger in the jar of marmalade. You felt bad for this person.

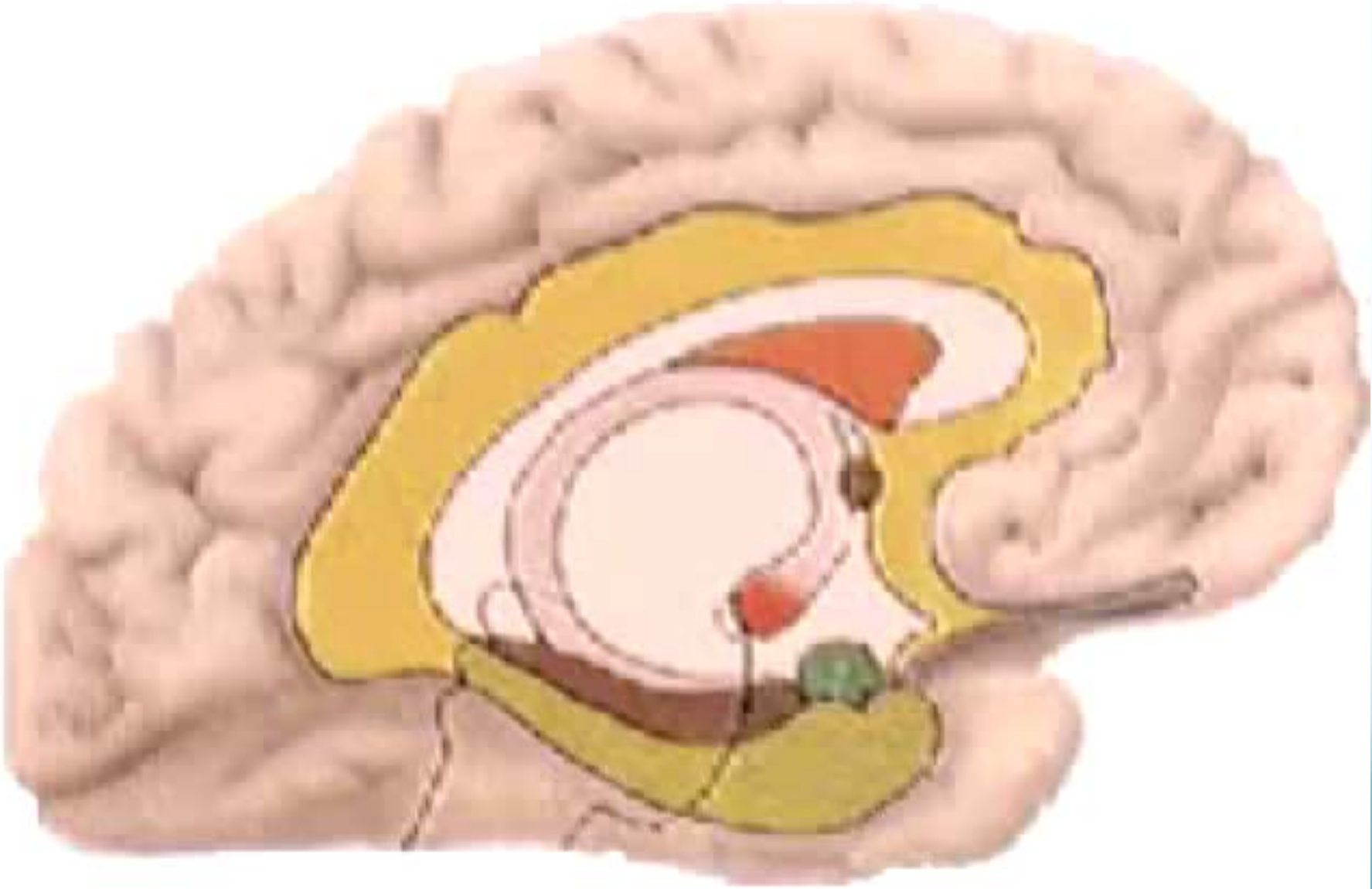
- The same probably counts for smelling pleasant odors of the soap and the repelling odors of the cheese.
- Just by watching another person's emotions, your own emotional system is triggered. This is made possible by our

***Mirror Neuron System** (MNS)*

- Brain studies have taught us that sensory stimuli not only carries information which is processed in the *cortical areas* of the brain, but is also associated with *emotions*.
- In processing these emotions a complicated structure in our brain plays an important role. This system is called the *Limbic System*


Cingulate cortex
Septal area
Hypothalamus
Hippocampus
Amygdala

“How the Body Works : Units of the Limbic System”



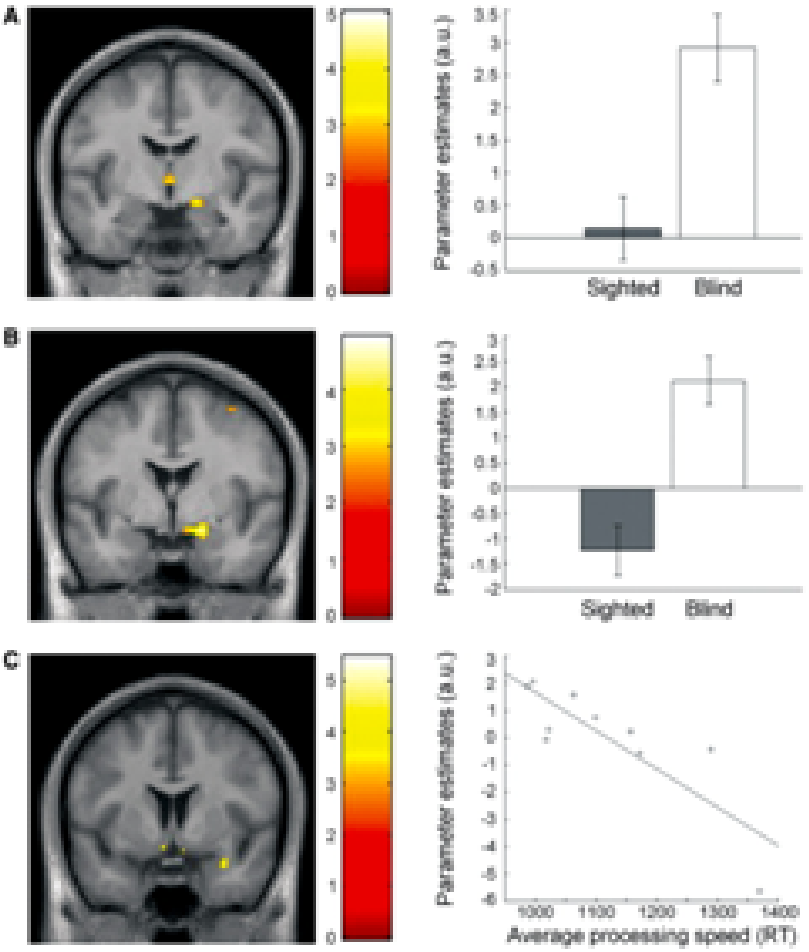
- The limbic system (Latin: limbus = arch) consists of structures in the brain which are involved in emotions, motivation, pleasure, and memory of emotions.
- In the evolution of mankind the limbic system developed quite early. It can be considered as belonging to the ”old” brain, but it also contains a few newer structures.

- Our conclusion so far is that the sensory input which enters our brain is strongly interwoven with emotions, in particular with feelings of “approach”, and of “withdrawal behavior”.

- This process plays an important role in the development of *attachment* behavior. The attachment person's touch, odor, facial expression, and intonation of the voice, leave their traces in important nuclei of the limbic system - in particular, in the amygdala and hippocampus (memory).

- A very interesting research finding concerning the Amygdala comes from Germany.
- Klinge et al (2010) found an increased activation of the Amygdala in congenital blind persons when emotional auditory stimuli (e.g. angry spoken syllables) were presented.

BOLD responses in the amygdala.



Klinge C et al. Brain 2010;133:1729-1736

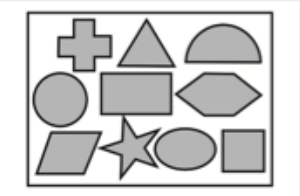
BRAIN A JOURNAL OF NEUROLOGY

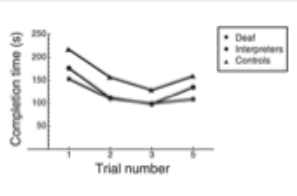
- It could be demonstrated that the amygdala of persons who are congenital deaf is very sensitive to threatening faces, which could explain sudden outburst of anger and aggression.
- There is emerging evidence that sensory loss re-organizes the human brain (Rick van Dijk 2012, Karns 2012).

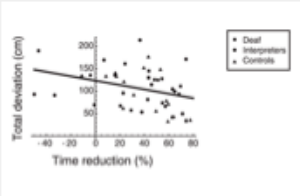
RESEARCH ARTICLE

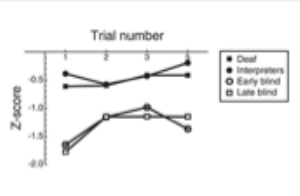
Haptic Spatial Configuration Learning in Deaf and Hearing Individuals

Rick van Dijk, Astrid M. L. Kappers, Albert Postma









Abstract

The present study investigated haptic spatial configuration learning in deaf individuals, hearing sign language interpreters and hearing controls. In three trials, participants had to match ten shapes haptically to the cut-outs in a board as fast as possible. Deaf and hearing sign language users outperformed the hearing controls. A similar difference was observed for a rotated version of the board. The groups did not differ, however, on a free relocation trial. Though a significant sign language experience advantage was observed, comparison to results from a previous study testing the same task in a group of blind individuals showed it to be smaller than the advantage observed for the blind group. These results are discussed in terms of how sign language experience and sensory deprivation benefit haptic spatial configuration processing.

Citation: van Dijk R, Kappers AML, Postma A (2013) Haptic Spatial Configuration Learning in

- In the next video clip you can observe Landon. The child is very delayed in his development. He functions at such an elementary psychological level, that cognitively he is unable to distinguish the touch of his mother from those of the assessor (Dr. Jan van Dijk).
- Despite this you can observe that Landon opens his hand for his mother and pulls it away when the assessor touches it.

- The “approach” and “withdrawal ” behavior of Landon can only be explained through the role of the Limbic System, in particularly of the amygdala, which “valuates” the sensory input according to the principle of “protection or safety” or “thread”.

- This sensitive mother was not aware how, through her behavior, she created a feeling of comfort and security for the child.
- These feelings are represented in the limbic structures, in particular the Amygdala and the Hippocampus, of the child.

- This can also be demonstrated in Matthew.
- In the first clip you can observe how he is attracted by the assessor's friendly approach.

- In the following clip you can observe what happens when the assessor touches Matthew's arm.

- It could be that Matthew's Amygdala has processed the assessor's touching as a thread. Every time that he observed the assessor approaching him it may have made the Amygdala send messages to the hypothalamus to produce the *stress hormone: cortisol*

- The Amygdala has many connections with the memory (hippocampus) and with other limbic and cortical structures. This could make a single traumatic experience generalize to many people and situations.

- Apparently Matthew's Limbic System has developed in such a way that the many positive emotional experiences "outweigh" the negative ones.

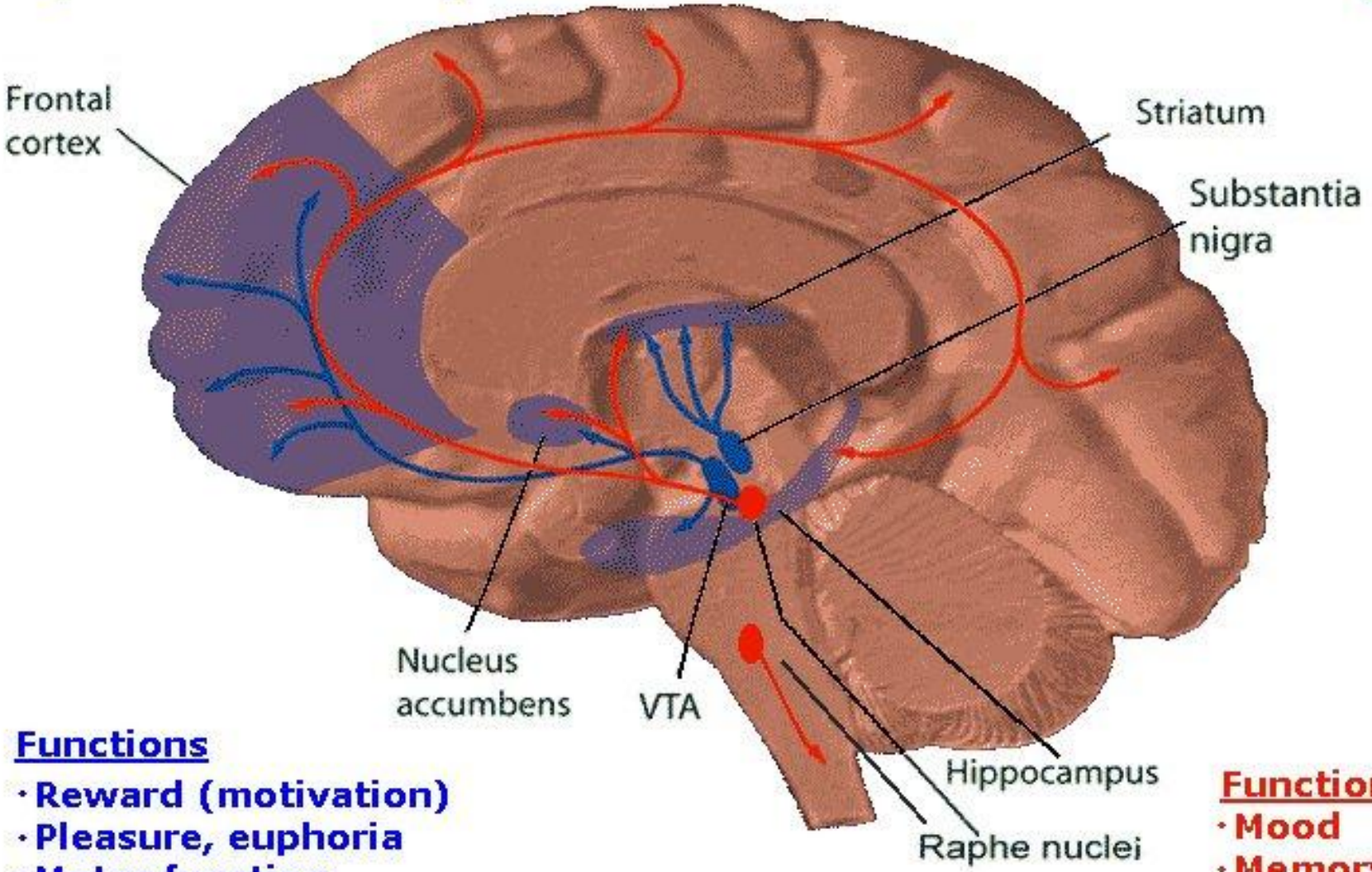
- Let's look at Landon again. You can observe that the mother *interprets his feelings* ("you are a happy boy"), and *resonates* with his voice ("ahhaaaa"), and *follows* his arm movements.

- In the process of interaction, the *mirror neurons for empathy* play a definitive and important role. But, there is more that makes this interaction a *happy* event

- When the mother *touches* Landon *endorphins* and *dopamine* are released in his brain. These *endorphins* reinforce attachment and pleasurable/rewarding feelings – the *dopaminergic reward processing system* is triggered.

Dopamine Pathways

Serotonin Pathways



Functions

- Reward (motivation)
- Pleasure, euphoria
- Motor function (fine tuning)
- Compulsion
- Perseveration

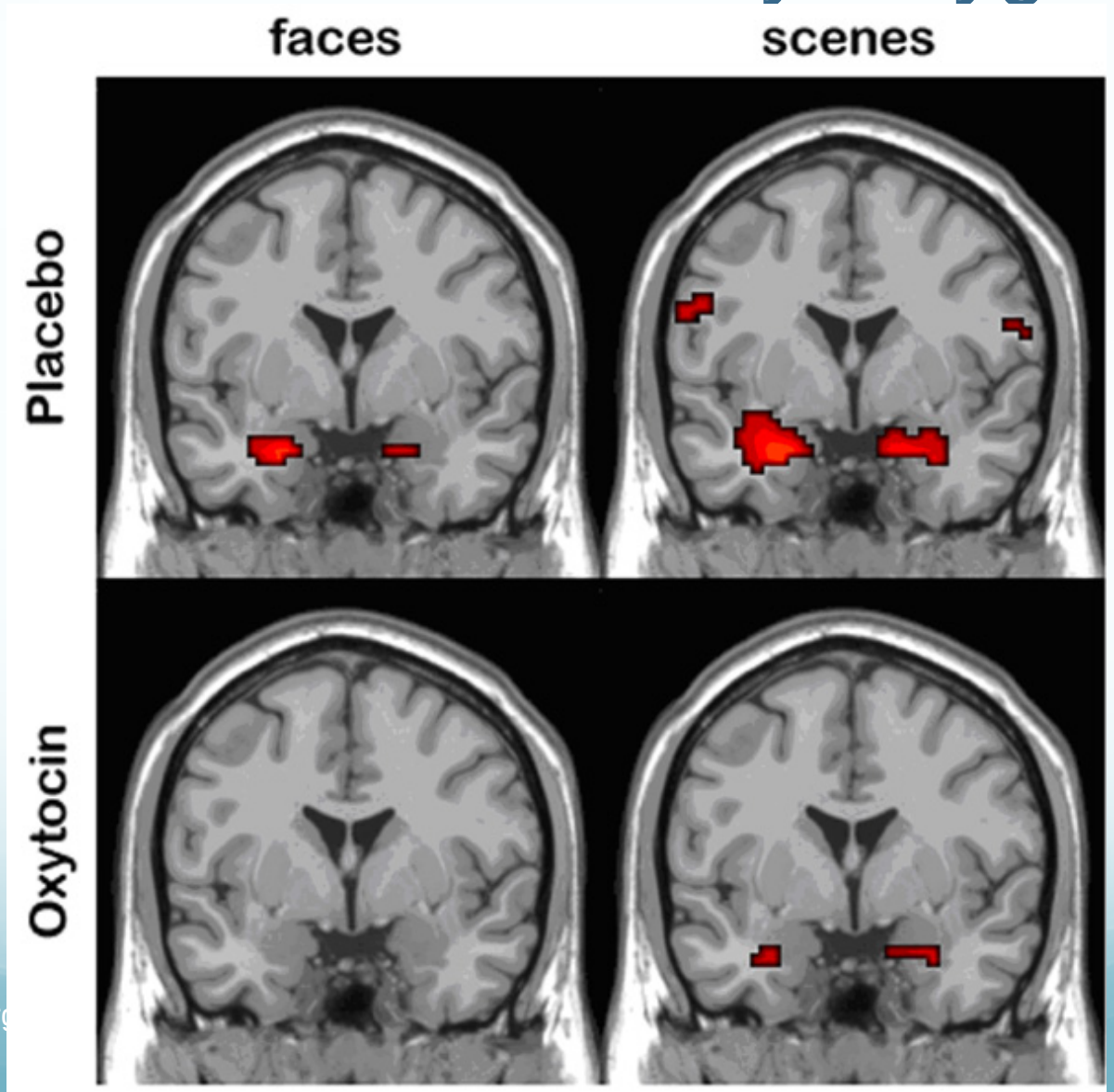
Functions

- Mood
- Memory processing
- Sleep
- Cognition

Also:

- *Oxytocinergitic* system is activated. (S*trathearn et al. 2009)* which adds to the complex bonding system.

Oxytocin reduces activity amygdala



- It has been shown that mothers of children with Charge Syndrome, with the most severe visual impairments, were under he most stress because of the mismatch of emotional status (Reda and Hartshorn, 2008)

- This mismatch is likely due to the fact that in children with very severe visual impairments the (visual) mirror system is very hard to activate. This causes stress both in the mother as well as in the child (Van der Gaag, 2007).

- In this case it is almost impossible for the child to understand the state of mind of the mother and as a consequence avoids the parent who wants to sooth the child (Macrae, 2003), who then “tries harder” to comfort the child (Howe, 2006).
- This can lead to “out-of-control care giving” and even abuse.

- The Mirror Neuron System is connected with the Limbic system via the insula.
- Showing pictures of emotions triggered brain activities (fmri) in areas of Mirror neurons ⇨ insula ⇨ Limbic system

Mirror neurons: An exciting Discovery

Drummer boy

- A normal child of 2½ years of age is unable to drum slower than 75-100 beats per minute.
- Kirchner & Tomasello (2008) asked the toddlers (N=36) to:
  - drum along with the experimenter
  - drum along with drumming machine, which allowed them to see the beat on the drum
  - to drum along with a radio

- The result of this experiment was that when the child drummed along with a person he was able to follow even when the tempo was < 75-100 beats.
- In the 2 other conditions this was not the case.
- It seems that is the *personal contact (joint attention) which* explains the rhythmical synchronization.

Monkey observing

- When one monkey observes, when sitting *motionless,* another monkey performing an *action,* it could be shown that a set of premotor neurons appeared to respond in both animals. (Rizzolatti et al. 2001)

- If you watch this picture it seems that the spider crawls on our own body. (“tactile empathy”, Keysers et al. 2004)
- Here also the observation of actions and experiences of others, activates the (premotor) cortex of the observer.

- These 3 examples show the essence of ***mirror neurons.***
- *"whenever individuals observe an action done by someone else, a set of neurons that code for that action is activated in the observer's motor cortex" (Rizzolatti et al.2009).*
- The observer is aware of the outcome of their motor acts, this means that he ***understands*** without cognitive mediation ***what the other*** is ***doing or feeling***

- Mirror neurons are not only localized in the pre-motor cortex, but also in areas involved in *vision and memory.*

- Let's visit our little girl next door: Nova
- She is a 7 weeks old baby.
- In the first clip you can observe that Nova attempts to mirror her mother's tongue protrusion

- The next clip is taken 4 minutes after the previous one.
- Mother looks at Nova. The baby put out her tongue as the mother has showed her before done

- Apparently the baby has remembered the previous occasion of mirroring her mother's tongue movements. Role of the hippocampus.
- It is likely that the baby after several days her memory will be activated when mother shows her face again in the same position.

- In the next clip, you can observe what happens when mother open and closes her hand. Notice that at some instance the baby put out her tongue as well

- There is no doubt how important the activation of the visual and motor mirror neuron system is.
- The foundation for motor and visual learning, in particular of imitation are very much dependent from the MNS.
- Through this system Nova will understand *emotions* of happiness or sadness when these are shown by the mother's face.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- MNS is responsible for the *joint attention* as shown in the drummer boy experiment, for *empathy, (*spider experiment*) social behavior and imitation* as demonstrated by Nova.

  All these behaviors are essential for developing *language.*

  When these behaviors fail to develop.....

- The child suffers from:
- Autism Spectrum Disorder.

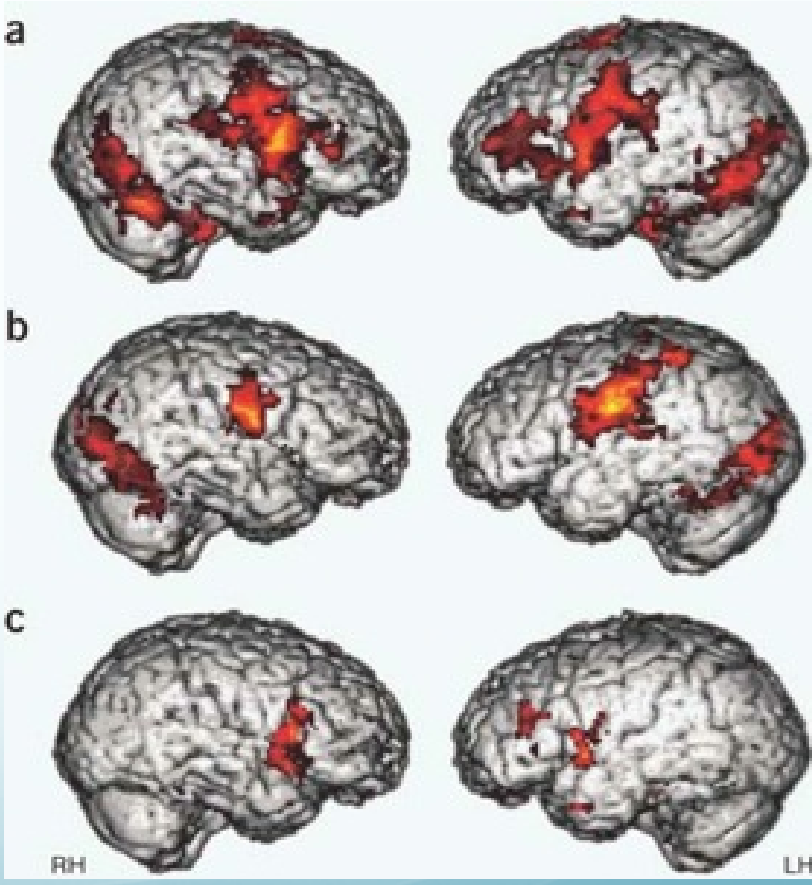
- There is a growing evidence that the MNS is disfunctioning in persons with ASD. This is well illustrated in EEG and fMri studies.
- The following clip reveals the difference in brain activity of high functioning persons with ASD and controls in an imitation task.

Reliable activity during imitation of emotional expression. Activity of the inferior frontal gyris is seen:

a. in typical developing group

b. but not in the ASD group

c. a between–group comparison revealed that this difference was significant (Dapretto et al. 2005)



- There is high prevalence of ASD in blind and deafblind children.
- Can this be explained by dys-functioning of the MNS?
- What role does vision and hearing play in the development of MNS?

- Cass (1996)and Sonksen (2002) studied 32 children whose vision had regressed between 16-27 months to blindness. However one group still could “recognize” a face, while the other had no “face recognition at all”.
- It was shown that in the latter group ASD features (lack of joint attention, imitation and referential language) were far more prominent ($p<.0001$).

- The (absent) role of the MNS in these behaviors is striking.
- Does this mean that we as human beings need vision to represent other people's action in our mind?
- The answer is "no"
- Ricciardi et al. (2009) found that through hearing and touch the MNS can recruit a part of the *visual* (extrastriate) cortex to represent actions of other persons.

- As been shown by Cass and Sonksen vision, in particular of the face (Van der Gaag, 2007) facilitate the imagery of other persons actions.

- How would this theory work for deafblind people?
- Principles of a curriculum based on Limbic Information
- If there is any vision or hearing left, which is often the case, by “resonance” activities the MNS both for vision and hearing can be activated.

- Watch the following clips of Jaap.

- In case of Sophie it is likely that Sophie wants to join in with the assessor's sounds. If she could produce sounds herself she would. Like in the drummer boy she follows the assessor's rhythm. This can be also observed in the father!
- Observe also how 'mirroring' is associated with pleasurable feelings.
- Watch the next clip of Sophie

The basic human emotions

- In *naming* the human being's fundamental feelings (words, gestures, pictures) the person learns to understand and share his emotions.

- In the following clip you can observe a deaf blind adolescent getting ready for his shower. Fore more then a decade he was very much prompt dependent; he has to be presented with a garment before he would make an attempt to put it on, etc.
- Particularly by sharing his feelings the vicious circle of prompt depend could be cut. His initiatives increase with 20 to 50% compared with baseline measures.

- Remarkably this improvement endures over a follow period of 8 months (Janssen & Van Dijk, 2003).
- We show you a short clip from the program “CONTACT” (Van den Tillaart & Janssen 2003).


06:05:73

- It has been mentioned that touch as it is used in every days activity are not sufficient to activate the MNS.
- However hand-*under*-hand and hand-*over*-hand touching may offer opportunity to understand each other's actions" read" each other's mind and sympathize with each other

- It is a challenge for all of us to develop intervention strategies to stimulate by applying “resonance-activities”, the development of the MNS for hearing, vision and touch.
- It can be hypothesized that this will help the child to reach the most important developmental *level of imitation*.

- It can also be assumed that through mutual touching the MNS which supports the development of *empathy* will be stimulated.
- This is the foundation for the growth of a balanced social-emotional life.

Take home message: (1)

1. It has been shown that 80% of the information which reaches the brain via the senses has emotional value
2. Quality of life can be defined as:

   Moments of Joy

3. The discovery of mirror neurons has great impact on designing a curriculum for children with multiple impairment.

Take home message: (2)

4. The role of the amygdala in the well being of a person cannot be over estimated.

5. The educational implications of the reorganisation of the brain of persons with sensory impairment should be persued in depth.

End

Discussion