Emotional brain, University of Alberta, October 17, 2011.

Dr Jan van Dijk
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 cheese
- 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 an 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**.
• 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**.
“How the Body Works: Units of the Limbic System” (YouTube)
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
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 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.

• This is not the case with Kiril
Kiril is a Russian 9 year old boy with multiple sensory impairments. He was born prematurely and raised in a very unfavorable educational situation. In pure despair his foster father “dropped” him at a Children's Home for Deafblind children.

The filming of the following clip took place 2 days after Kiril’s arrival at the Centre.
• Notice that he puts his arms in front of his face when people approach him.

• The Amygdala triggers a fear reaction which has been developed in the past.
There is reason to assume that:

- **Stress** was present during his mother’s pregnancy and as a consequence of this his *brain growth* was arrested
- The *stress-regulation system* is unbalanced
- *Reduction of neurons* in the hippocampus (memory impairment)
Results of these unfavorable factors:

• Irritable and difficult to sooth baby.
• High levels of stress hormone (cortisol) in mother and child.
• Atypical diurnal cortisol levels.
• Hyper arousal which causes challenging behaviors.
Research on blind children and adolescents with severe multiple disabilities and challenging behaviors showed:

- Stress regulation system severely disorganized (Sterkenburg 2008)
- Attachment problems
STRESS can be described as:

The feeling of the individual to be unable to *cope* with the situations of daily life. There exists a general feeling of not being *in control* and of *helplessness*. 
In studies with blind and foster care children (Schuengel et al. 2010), it could be shown that unfavorable stress levels could be lowered when the therapist was able to establish a secure bond with the child, and took her time to get to know the child.

Also games of “leaving and coming back” added to this.
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

Frontal cortex

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

Serotonin Pathways

Striatum
Substantia nigra
Nucleus accumbens
VTA
Hippocampus
Raphe nuclei

Functions
- Mood
- Memory processing
- Sleep
- Cognition
Also:

- *Oxytocinergic* system is activated. *(Strathearn et al. 2009)* which adds to the complex bonding system.
oxycotin
Reduces
Activity
amygdala
It has been shown that mothers of children with Charge Syndrome, with the most severe visual impairments, were under the 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 soothe 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

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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)
Spiders on body
• 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

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• 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 opens and closes her hand. Notice that at some instance the baby puts 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.
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 dys-functioning 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.
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 (extrastriatic) 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?

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.
• 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
Assessment expertise

The Van Dijk Approach to assessing children or adults with multiple disabilities is unique, but it can be successfully implemented after a relatively short period of training.

Please direct requests for training to me. Materials can be obtained in the Webshop.

“No intervention, without Assessment”
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- Articles:
  - Deafblindness general
  - Syndromes
  - Challenging Behaviour
  - Assessment

- Actual News - weblog

- Webshop

- Forum

- Community
<table>
<thead>
<tr>
<th>Main DB Forum</th>
<th>Topics</th>
<th>Posts</th>
<th>Last post</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deafblindness general</strong></td>
<td>4</td>
<td>10</td>
<td>by vrs per on Feb 10, 2011, 01:45</td>
</tr>
<tr>
<td><strong>Challenging Behaviours</strong></td>
<td>1</td>
<td>2</td>
<td>by Jan van Dijk on Nov 04, 2010, 22:54</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>1</td>
<td>2</td>
<td>by Jan van Dijk on Aug 29, 2010, 17:21</td>
</tr>
<tr>
<td><strong>Syndromes</strong></td>
<td>0</td>
<td>0</td>
<td>No posts</td>
</tr>
<tr>
<td><strong>CD and DVD</strong></td>
<td>0</td>
<td>0</td>
<td>No posts</td>
</tr>
</tbody>
</table>

DB related topics belong in above categories

Board index

The team • Delete all board cookies • Delete style cookies • All times are UTC + 1 hour [ DST ]

Browse Groups

Categories

- All Groups
- DB General (4)
- Assessment (0)
- Syndrome (0)
- Challenging Behaviours (0)

Sort by:
- Latest Groups
- Alphabetical
- Most Discussed
- Most Wall Posts
- Most Members
- Most Active

All Groups

**Mirror Neurons Group**
Welcome to the group "Mirror Neurons". Anybody can join this open group if you are interested in the function of the Mirror Neurons. Specific goals for this group will be published soon here by ma. Jan van Dijk.
Created on: Friday, 15 April 2011
1 Member 0 Discussions 0 Wall Posts

**Parent Support Group**
The idea of this group is to create a match between a parent seeking personalized support from another parent who has experienced the same challenges. We are parents willing to listen, provide emotional support and information through shared, similar experiences. Together, we can decrease stress on the family, and increase knowledge.
Created on: Saturday, 20 November 2010
0 Members 1 Discussion 3 Wall Posts

**Expert Team - Forum panel**
This group is the Forum Panel and Expert Team of this website. The members are co-authors of the text of this website; they work together intensively with several studies and project. They publish articles together and visit international events.
Created on: Wednesday, 30 June 2010
9 Members 1 Discussion 1 Wall Post
End

Discussion