Introduction

"You need memory to keep track of the flow of conversation" [1]

Maybe the interaction between memory and language does not seem very obvious at first, but this interaction is necessary when trying to lead a conversation properly. Memory is the component for storing and retrieving information. So to remember both things just said and information heard before which might be important for the conversation. Whereas language serves for following the conversational partner, to understand what he says and to reply to him in an understandable way.

This is not a simple process which can be learned within days. In childhood everybody learns to communicate, a process lasting for years.

So how does this work? Possible responses to the question of language acquisition are presented in this chapter. The section also provides an insight into the topic of malefunctions in the brain. Concerning dysfunctions the following questions arise: How can the system of language and memory be destroyed? What causes language impairments? How do the impairments become obvious? These are some of the topics dealt with in this chapter.

Up to now, the whole profoundness of memory and language cannot be explored because the present financial resources are insufficient. And the connection between memory and language mostly becomes obvious when an impairment arises. So certain brain areas are explored when having a comparison between healthy brain and impaired brain. Then it is possible to find out what function this brain area has and how a dysfunction becomes obvious.

Basics

Memory

Memory is the ability of the nervous system to receive and keep information. It is divided into three parts: Sensory memory, Short-term memory and Long-term memory. Sensory memory holds information for milliseconds and is separated into two components. The iconic memory is responsible for visual information, whereas auditory information is processed in the echoic memory. Short-term memory keeps information for at most half a minute. Long-term memory, which can store information over decades, consists of the conscious explicit and the unconscious implicit memory. Explicit memory, also known as declarative, can be subdivided into semantic and episodic memory. Procedural memory and priming effects are components of the implicit memory.
Brain regions:

<table>
<thead>
<tr>
<th>Brain regions</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal lobe, parietal lobe, dorsolateral prefrontal cortex</td>
<td>Short-term Memory/ Working Memory</td>
</tr>
<tr>
<td>Hippocampus</td>
<td>Short-term Memory → Long-term Memory</td>
</tr>
<tr>
<td>Medial temporal lobe (neocortex)</td>
<td>Declarative Memory</td>
</tr>
<tr>
<td>Amygdala, Cerebellum</td>
<td>Procedural Memory</td>
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</tbody>
</table>

For detailed information see chapter [Memory](#edit)

**Language**

Language is an essential system for communication which highly influences our life. This system uses sounds, symbols and gestures for the purpose of communication. Visual and auditory systems of a human body are the entrance-pathway for language to enter the brain. The motor system is responsible for speech and writing production, it serves as exit-pathway for language. The nature of language exists in the brain processes between the sensory and motor systems, especially between visual or auditory income and written or spoken outcome. The biggest part of the knowledge about brain mechanism for language is deduced from studies of language deficits resulting from brain damage. Even if there are about 10 000 different languages and dialects in the world, all of them express the subtleties of human experience and emotion.

For detailed information see chapters [Comprehension](#edit) and [Neuroscience of Comprehension](#edit)

**Acquisition of language**

A phenomenon which occurs daily and in everybody’s life is the acquisition of language. Anyhow scientists are not yet able to explain the underlying processes in detail or to define the point when language acquisition commences, even if they agree that it happens long before the first word is spoken. Theorists like Catherine Snow and Michael Tomasello think that the acquisition of language skills begins
at birth. Others claim, it already commences in the womb. Newborns are not able to speak, even if babbling activates the brain regions later involved in speech production. The ability to understand the meaning of words already begins before the first birthday, even if they cannot be pronounced till then. The phonological representation of words in the memory changes between the stage of repetitive syllable-babbling and the one-word stage. At first children associate words with concrete objects, followed by an extension to the class of objects. After a period of overgeneralisation the children’s system of concept approaches to the adults’ one. To prove the assumption of understanding the meaning of words that early, researches at MIT let children watch two video clips of “Sesame Street”. Simultaneously the children heard the sentences “Cookie Monster is tickling Big Bird” or “Big Bird is tickling Cookie Monster”. The babies consistently looked more at the video corresponding to the sentence, what is an evidence for comprehension of more complex sentences, than they are able to produce during the one-word period. The different stages of speech production are listed in the table below.

<table>
<thead>
<tr>
<th>Age</th>
<th>Stage of Acquisition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th month</td>
<td>Stage of babbling:</td>
<td>da, ma, ga</td>
</tr>
<tr>
<td></td>
<td>- systematic combining of vowels and consonants</td>
<td></td>
</tr>
<tr>
<td>7th – 10th month</td>
<td>Stage of repetitive syllable-babbling:</td>
<td>mama, dada, gaga</td>
</tr>
<tr>
<td></td>
<td>- higher part of consonants → paired with a vowel – monosyllabic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reduplicated babbling</td>
<td></td>
</tr>
<tr>
<td>11th – 12th month</td>
<td>Stage of variegated babbling:</td>
<td>bada, dadu</td>
</tr>
<tr>
<td></td>
<td>- combination of different consonants and vowels</td>
<td></td>
</tr>
<tr>
<td>12th month</td>
<td>Usage of first words - John Locke(1995):</td>
<td>car, hat</td>
</tr>
<tr>
<td></td>
<td>- prephonological → consonant-vowel(-consonant)</td>
<td></td>
</tr>
</tbody>
</table>

Locke’s theory about the usage of the first word is only a general tendency. Other researchers like Charlotte Bühler (1928), a German psychologist, think that the age of speaking the first word is around the tenth month, whereas Elizabeth Bates et al. (1992) proposed a period between eleven and 13 months. The one-word stage described above can last from two till ten months. Until the second year of life a vocabulary of about 50 words evolves, four times more than the child utilises. Two thirds of the language processed is still babbling. After this stage of learning the vocabulary increases rapidly. The so
called vocabulary spurt causes an increment of about one word every two hours. From now on children learn to have fluent conversations with a simple grammar containing errors.

As you can see in the following example, the length of the sentences and the grammatical output changes a lot. While raising his son, Knut keeps a tally of his son’s speech production, to see how fast the language develops:

Speech diary of Knut’s son Andy:

(Year; Month)
2;4: See marching bear go? Screw part machine. That busy bulldozer truck.
2;5: Now put boots on. Where wrench go? Mommy talking bout lady. What that paper clip doing?
2;6: Write a piece a paper. What that egg doing? I lost a shoe. No, I don’t want to sit seat.
2;7: Where piece a paper go? Ursula has a boot on. Going to see kitten. Put the cigarette down. Dropped a rubber band. Shadow has hat just like that. Rintintin don’t fly, Mommy.
2;8: Let me get down with the boots on. Don’t be afraid a horses. How tiger be so healthy and fly like kite? Joshua throw like a penguin.
2;10: Look at that train Ursula brought. I simply don’t want put in chair. You don’t have paper. Do you want little bit, Cromer? I can’t wear it tomorrow.
2;11: That birdie hopping by Missouri in bag? Do want some pie on your face? Why you mixing baby chocolate? I finish drinking all up down my throat. I said why not you coming in? Look at that piece a paper and tell it. We going turn light on so you can’t see.
3;0: I going come in fourteen minutes. I going wear that to wedding. I see what happens. I have to save them now. Those are not strong mens. They are going sleep in wintertime. You dress me up like a baby elephant.
3;1: I like to play with something else. You know how to put it back together. I gon’ make it like a rocket to blast off with. I put another one on the floor. You went to Boston University? You want to give me some carrots and some beans? Press the button and catch it, sir. I want some other peanuts. Why you put the pacifier in his mouth? Doggies like to climb up.
3;2: So it can’t be cleaned? I broke my racing car. Do you know the light wents off? What happened to the bridge? When it’s got a flat tire it’s need a go to the station. I dream sometimes. I’m going to mail this so the letter can’t come off. I want to have some espresso. The sun is not too bright. Can I have some sugar? Can I put my head in the mailbox so the mailman can know where I are and put me in the mailbox? Can I keep the screwdriver just like a carpenter keep the screwdriver? 

Obviously children are able to conjugate verbs and to decline nouns using regular rules. To produce irregular forms is more difficult, because they have to be learnt and stored in Long-term memory one by one. Rather than the repetition of words, the observation of speech is important to acquire grammatical skills. Around the third birthday the complexity of language increases exponentially and reaches a rate of about 1000 syntactic types.

Another interesting field concerning the correlation between Memory and Language is Multilingualism. Thinking about children educated bilingual, the question arises how the two languages are separated or combined in the brain. Scientists assume that especially lexical information is stored independently for
each language; the semantic and syntactic levels rather could be unified. Experiments have shown that bilinguals have a more capacious span of memory when they listen to words not only in one but in both languages.

**Disorders and Malfunctions**

Reading about the disorders concerning memory and language one might possibly think about amnesia or aphasia, both common diseases in the concerned brain regions. But when dealing with the correlation of memory and language we want to introduce only diseases which affect loss of memory as well as loss of language.

**Alzheimer's Disease**

Alzheimer’s disease

Discovered in 1906 by Alois Alzheimer this disease is the most common type of dementia. Alzheimer’s is characterised by symptoms like loss of memory, loss of language skills and impairments in skilled movements. Additionally other cognitive functions such as planning or decision-making which are connected to the frontal and temporal lobe can be reduced. The correlation between memory and language in this context is very important because they work together in order to establish conversations. When both are impaired, communication becomes a difficult task. People with alzheimer’s have reduced working memory capability, so they cannot keep in mind all of the information they heard during a conversation. They also forget words which they need to denote items, their desires and to understand what they are told. Affected persons also change their behaviour, they become anxious, suspicious or restless and they may have delusions or hallucinations. In the early stages of the disorder sick persons become less energetic or suffer little loss of memory. But they are still able to dress themselves, to eat and to communicate. Middle stages of the disease are characterised by problems of navigation and orientation. They do not find their way home or even forget where they live. In the late stages of the disease the patients’ ability to speak, read and write decreases enormously. They are no longer able to denote objects and to talk about their feelings and desires. So their family and the nursing staff have great problems to find out what the patients want to tell them. In the end-state the sick persons do not show any response or reaction. They lie in bed, have to be fed and are totally helpless. Most of them die after four to six years after diagnosis, although the disease can endure from three to twenty years. A cause for this is the difficulty to distinguish Alzheimer’s from other related disorders. Only after death when seeing the shrinkage of the brain one can definitely say that the person was affected by Alzheimer’s disease.

"Genetic Science Learning Center, University of Utah, [http://learn.genetics.utah.edu/](http://learn.genetics.utah.edu/) A comparison of the two brains:

* In the Alzheimer brain:
  * The cortex shrivels up, damaging areas involved in thinking, planning and remembering.
  * Shrinkage is especially severe in the hippocampus, an area of the cortex that plays a key role in formation of new memories.
  * Ventricles (fluid-filled spaces within the brain) grow larger.
Scientists say that long before the first symptoms appear nerve cells that store and retrieve information have already begun to degenerate. There are two theories giving an explanation for the causes of Alzheimer’s disease. The first describes plaques as protein fragments which defect the connection between nerve cells. They arise when little fragments release from nerve cell walls and associate with other fragments from outside the cell. These combined fragments, called plaques, append to the outside of nerve cells and destroy the connections. Then the nerve cells start to die because they are no longer provided with nutrients. As a conclusion the stimuli are no longer transferred. The second theory explains that tangles limit the functions of nerve cells. They are twisted fibers of another protein that form inside brain cells and destroy the vital cell transport made of proteins. But scientists have not yet found out the exact role of plaques and tangles.

"Genetic Science Learning Center, University of Utah, http://learn.genetics.utah.edu/
- Alzheimer tissue has many fewer nerve cells and synapses than a healthy brain.
- Plaques, abnormal clusters of protein fragments, build up between nerve cells.
Dead and dying nerve cells contain tangles, which are made up of twisted fibers of another protein.

Alzheimer’s progress is separated into three stages: In the early stages (1) tangles and plaques begin to evolve in brain areas where learning, memory, thinking and planning takes place. This may begin 20 years before diagnosis. In the middle stages(2), plaques and tangles start to spread to areas of speaking and understanding speech. Also the sense of where your body is in relation to objects around you is reduced. This may last from 2-10 years. In advanced Alzheimer’s disease(3) most of the cortex is damaged, so that the brain starts to shrink seriously and cells begin to die. The people lose their ability to speak and communicate and they do not recognise their family or people they know. This stage may generally last from one to five years.

Today more than 18 million people suffer from Alzheimer’s disease, in Germany there are nearly 800,000 people. The number of affected persons increases enormously. Alzheimer’s is often only related to old people. Five percent of the people older than 65 years and fifteen to twenty percent of the people older than 80 years suffer from Alzheimer’s. But also people in the late thirties and forties can be affected by this heritable disease. The probability to suffer from Alzheimer’s when parents have the typical old-generation-Alzheimer’s is not very high.

[edit] Autism

Autism is a disease which causes neurodevelopmental disorders in several fields. Autistic people for example have restricted perception and problems in information processing. The often associated intellectual giftedness only holds for a minority of diseased people, whereas the majority possesses a normal amount of intelligence or is below the average.

There are different types of autism, i.a.:

- Asperger’s syndrome – usually arising at the age of three
- Infantile autism – arising between nine and eleven months after birth

The latter is important because it shows the correlation between memory and language in the children’s behaviour very clearly. Two different types of infantile autism are the low functioning autism (LFA) and the high functioning autism (HFA). The LFA describes children with an IQ lower than 80, the HFA those with
an IQ higher than 80. The disorders in both types are similar, but they are more strongly developed in children with LFA.

The disorders are mainly defined by the following aspects:

1. the inability of normal social interaction, e.g. amicable relations to other children
2. the inability of ordinary communication, e.g. disorder of spoken language/idiosyncratic language
3. stereotypical behaviour, e.g. stereotypical and restricted interests with an atypical content

To demonstrate the inability to manage normal communication and language, the University of Pittsburgh and the ESRC performed experiments to provide possible explanations. Sentences, stories or numbers were presented to children with autism and to normal children. The researchers concluded that the disorders in people with HFA and LFA are caused by an impairment in declarative memory. This impairment leads to difficulties in learning and remembering sentences, stories or personal events, whereas the ability to learn numbers is available. It has been shown that these children are not able to link words they heard to their general knowledge, thus the words are only partially learnt, with an idiosyncratic meaning. This explains why LFA and HFA affected children differ in their way of thinking from sane children. It is often difficult for them to understand others and vice versa. Furthermore scientists believe that the process of language learning depends on an initial vocabulary of fully meaningful words. It is assumed that these children do not possess such a vocabulary, thus their language development is impaired. In a few cases the acquisition of language fails completely, therefore in some cases the children are not able to use language in general. The inability of learning and using language can be a consequence of an impairment of declarative memory. It might also cause a low IQ because the process of learning is language-mediated. In HFA the IQ is not significantly lower than the IQ of sane children. This correlates well with their better understanding of word meanings. They have a milder form of autism. The experiments have also shown that adults do not have problems with the handling of language. A reason for that might be that they have been taught to use it during development or maybe they acquired this ability through reading and writing. The causes of autism are not yet explored appropriately to get some idea how to help and support those people having autism in everyday-life. It is still not clear whether the diseases are really caused by genetic disorders. It is also possible that other neurological malfunctions like brain damages or biochemical specialties are responsible for autism. The research just started to get answers to those questions.

[edit] References and Resources

2. ↑ S. Pinker, The Language Instinct, p.269f

Books

Gisela Klann-Delius: Spracherwerb; Sammlung Metzler, Bd 325; Verlag J.B.Metzler; Stuttgart, Weimar, 1999; ISBN 3476103218

Links

http://de.wikipedia.org/wiki/Ged%C3%A4chtnis
http://en.wikipedia.org/wiki/Memory
http://www.cogsci.rpi.edu/CSJarchive/1980v04/i03/p0243p0284/MAIN.PDF
http://www.quarks.de/gedechtnis/gedechtnis.pdf
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