Action and Cognition I

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1 What we are doing

An action potential is an action potential and we can not discriminate differences in an ap from visual or from auditive cortex. Nevertheless, we experience a difference from the output, depending on the input. How can this be? In this lecture (and the seminar), we will try to analyze this phenomens mainly with the example of the visual stimuli and its full pathway in the brain from the retina to the visual cortex and up to its interpretation in the higher cortex regions of cognition.

2 Cognitive Models

The main cognitive model used since the 50's is

$$\begin{array}{c}\text{Perception}\\ \downarrow \\ \text{Decision}\\ \downarrow \\ \text{Action}\end{array}$$

It is still widely used, but confronts us with certain problems, such as we can (as mentioned above) sometimes not discriminate where on thins starts or where it ends within the brain. For example, from the retina to the visual cortex, the information stream passes an area where active filtering is happening. This is within the perception "pathway", but yet influences decision and action.
This and other similiar problems supported the postulations of other models such as the unified approach:

$$\text{Perception} \rightarrow \text{Decision} \rightarrow \text{Action}$$

In this model, the 3 components are not seperated but within on process. But this approach showed some argumentative problems. Testing this model lead to contradictions, which could only be fully solved by seperating the components again.
Until now, there is no closed, no all explaining description of the mechanisms in the brain avaible. We will look at these models again later and discuss their weaknesses in the seminar.

3 The myterious brain

Looking at several brains of mamals, we discovered that there seems to be no major difference (evolutionary seen this is clear). The cell types are similiar, even the brain regions are often similar. The main difference is the size of the cortex.

Elephant	6,000 gr
Human	1,300 gr
Monkey	97 gr
Dog	72 gr
Cat	30 gr
Rabbit	10 gr
Owl	2.2 gr

We can clearly see, that the size of "lower"developped animals is much much smaller than the ones of humans and other animals. But the correlation of IQ and brain size is not a strong one. For example, a elephant has a big brain, yet the IQ of a elephant without training is not higher than 50 p. This due to the fact, that the mass of the brain substances cotrolling muscle movements and body regulative systems is much higher then in the human brain.

Looking at the brain of other mamals, we can still make predictions about the human brain.

4 Orientation in the Brain

If we are looking at the brain, we need some kind of map and compass to orietate and travel along its pathways. For that reason, neurologist have developped several methods:

4.1 Mapping

- **Cytoarchtechtonics** In this approach we map the brain areas due to there cell type. The first attempt to do so was done by Korbinian Brodmann in 1909. He found 52 areas (nowadays called Brodmann-areas.) His foundings are still relevant, but disputed. He used only 4 brains for the mapping. A colleague, doing a similiar experiment, found independedly 102 areas.

- **Fuctionality** The Broadmann research stimulated further research. It showed, that there are indeed areas, which seemed to be reponssible for a certains task. Most famous for such an area is the Broca center. If the Broca area is destroyed, the patient can still understand language, but his abillity to form language is deranged. It is not fluently anymore and disconnected. Sadly, the Broca area is not a Brodmann area, but rather a overlapping area of Brodmann area 44 and 45 (in short BA44,45). Also, the Wernicke aphasia is widley known, where the speech is fluently but absolutly incomphreensible. Yet the area of this certain speech abillity is even wider stretched from a BA view. It is including BA 39-40,21-22 and partly 37.

- **Cortical active areas** After the dilemma of combining histological and functional approaches, the modern brain research uses a more empirical method. Using imaging methods, we try to map the brain in accordance of the active funtions areas. Nowadays, we can furter divide the Broca are into severeal subareas. For such research we use modern imaging techniques, such as

  - fMRI (functional Magnetic Resonance Imaging)
  - EEG
  - TMS
  - ...

  Evaluating the results of such research revealed, that there some equaly good models are possible and that these are useful. Each with a certain view on the brain and ,depending on the research, more or less helpful.

  - Cytoarcitectonics (e.g. V1, M1)
  - Anatomical connectivity (e.g. MT)
  - Topographic maps (e.g. V1, A1)
  - Cellular response properties (e.g. xIP)
  - Regional response properties (e.g. FFA)
  - Gross anatomy (e.g. AIP, CIT, PIT)

  We will get to know them in more detail in the lecture, while we are walking through the pathways.

4.2 Directions and Orientation

Talking about a brain in the vat is sometimes difficult. We need to name directions and places. Concerning directions, we will us a certain convention from the biologist:

- frontal areas - anterior
- backward areas - posterior
- side areas - lateral
- top view - dorsal
- view from the below - ventral
- line of the middel - medial

Furthermore there are 2 other ways to describe the directions. They are taken from the directions the brains developps from the neural tube.

- away from the neural tube - rostral
- towards the neural tube - caudal