



**RESEARCH PROJECT**

“The Brain from Within”

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## The brain from inside

Johannes Hedemann is enrolled in the Elite Graduate Program “Biomedical Neuroscience“ at the Technical University of Munich. His project during a research internship abroad at the University College London focused on optimizing invasive brain research.

### **Who exactly is speaking, when we listen to the brain?**

As fascinating as the human brain may be to neuroscientists, intimate insights in its inner working are rare. However, sometimes a window opens in particularly challenging cases of epilepsy when surgeons implant electrodes into the affected region of a patient’s brain to prepare for its planned surgical removal. This opportunity is entirely unique for neuroscientists who can otherwise only place their electrodes on the outside of the head.

Once the so-called micro-wires have been implanted, the next hurdle arises: How can we determine which nerve cell is responsible for which signal? Johannes Hedemann set out to answer this central question. In mouse models, researchers use spatial information from the electrodes they have implanted to unambiguously assign a single signal to a specific cell. Without this advantage, alternatives must be found for use in humans.

The idea is simple: The medial temporal lobe, an important brain region deep within the forebrain, contains so-called concept cells. When we hear, read, or see a given concept – for example, “Jennifer Aniston” or “FC Bayern Munich” – the corresponding concept cell is strongly activated. Occasionally, the mere “sound” of neural activity is not enough to distinguish cells from one another. If multiple candidates are activated by the same concept, there is most likely a single cell involved. The concept information can therefore be used to analyze brain measurements more accurately.

### **Precisely stimulating oscillations in the epileptic brain**

Slow oscillations are an important tool of the brain, for example, in the long-term storage of memories. If a short tone is played at exactly the right moment, these brain waves and their function can be enhanced. For epilepsy patients who suffer from memory problems, the stimulation of slow oscillations represents a promising approach.

However, pathological waves that are similar to healthy slow oscillations also occur in the epileptic brain. These so-called epileptiform discharges may even be the cause of memory deficits. Therefore, the stimulation system must be able to distinguish between good and bad oscillations, even before the optimal time for stimulation has passed. To achieve these two goals, Johannes Hedemann characterized both types of brain waves and identified factors that distinguish the two oscillation types from one another.

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