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Chronic Brain Stimulation Using Micro-Electrocortiographic Devices

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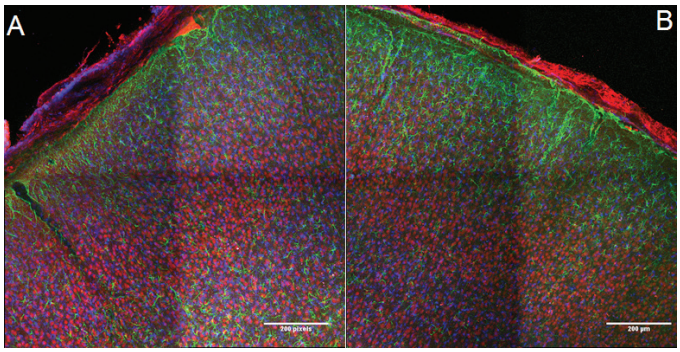
The ability to record from and stimulate neurons is key to our further understanding of the nervous system. Not only is it vital to many areas of research, but many clinical techniques rely on the ability to stimulate and record in the long term. Many medical devices rely upon this technology (e.g., cochlear implants that restore hearing, anti-epilepsy "pacemakers," and artificial limbs). However, precise recording inside the brain is difficult. Most current devices penetrate the brain's protective layers and cease to function within a month due to the scar tissue that encapsulates the implant and the death of neurons near the implant. Most human implants compensate by being very large, recording from large numbers of neurons at a time.

We evaluated a new type of micro-electrocortiographic implant that could be used as an effective stimulator over chronic periods of time. These devices sit on the protective layers of the brain inside of the skull but do not penetrate it. They were developed by the lab of Justin Williams at the University of Wisconsin. We assessed the electrical characteristics of the devices daily and trained the rats to respond to the electrical stimulus as part of an adaptive task, which rewarded them with water. We found that the implants were stable and functioning, even six months into the study, with no apparent signs of rejection. Histology has corroborated this, with very little sign of rejection. An attempt to place the implants without dura (a protective layer) present resulted in heavy inflammation, however. This study suggests that these implants and other μECoG devices can be viable tools to investigate the nervous system, even over very long timescales.

Research advisor Roy Lycke writes, "During his time as my mentee, Hayden Carney demonstrated great skill and professionalism in training, handling, and experimenting with rodent animal models. In addition to excellent lab work, Hayden demonstrated skill in analyzing data and developing new experiment designs, adding his own academic contributions to all the studies he worked on."



Two histological preparations from one animal. A is auditory cortex that was implanted over with a device, B is the complementary region from the same animal that was not implanted. Red indicates neurons stained with NeuN, blue is IBA1-activated astrocytes, and green indicates GFAP-labeled microglia. The lack of immune response to the implant can be seen, as both cortices show normal cell distribution.

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