BRAIN ACTIVITY IN THE EAR

A discreet ear device makes it possible to record brain activity in the everyday life.

Conventional measurements of brain activity are restricted to hospital or laboratory settings, in which the user is not able to move freely. However, in order to understand the nature of the human brain better we need to move the recordings to the everyday life. Many have attempted to develop portable devices, but the devices all have the disadvantage of being clearly visible and uncomfortable to wear over a longer period of time.

As a team of biomedical engineers at Aarhus University, we are exploring the use of a new methodology, measuring brain activity with a custom-made earpiece inserted into the ear. Small silver electrodes on the surface of the earpiece have electrical contact to the skin and enable measurements of the electrical activity in the brain. Measurements of the electrical activity in the brain are called electroencephalography (EEG), and thus we call the new technology EarEEG. The EarEEG device looks very similar to a hearing aid, and is comfortable to wear. The technology has the potential to perform 24 hours monitoring of brain activity, and facilitates new clinical and research applications of EEG.

One application of EarEEG is monitoring of patients with diabetes. Approximately 20% of patients with insulin-requiring diabetes are not able to feel when they have low blood glucose levels. Some patients may not even wake up if their blood glucose levels drop during the night. A low blood glucose level in the brain can lead to hypoglycaemia, also called insulin shock. Effects of hypoglycaemia can range from discomfort to more serious issues i.e. seizures and unconsciousness. Hypoglycaemia can be avoided by the intake of sugar, however during hypoglycaemia the patient will normally not be able to act accordingly. Currently no equipment is available to alarm about an impending hypoglycaemia.

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In case of low blood glucose levels, characteristic changes appear in the EEG. We hope to be able to use the EarEEG technology to measure these changes, and by using advanced algorithms give an alarm to the patient before the hypoglycaemia appears. This will enable the patient to eat sugar and avoid the hypoglycaemia.

We are currently working on the development of an EarEEG device that is comfortable to wear and easy to insert into the ear. To reach this goal we are developing dry electrode technology. With this technology, the user will no longer need to apply gel to the surface of the electrode to gain high quality EEG recordings. In order to find the optimal dry electrode material, we have characterized the interface between a number of different electrode materials and the skin. We have also designed a custom-made chip that is adapted to the challenges in a dry electrode interface. Simultaneous with the development of the EarEEG device we are working to establish recognition of the EarEEG technology in the scientific and clinical world. A part of this process is to stimulate the brain and compare EarEEG recordings of the response to recordings performed with conventional EEG equipment. This is an important step in the development of a clinical EarEEG device, as it provides crucial knowledge of the limitations and advantages of the EarEEG technology.

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