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Real-time insight into our brain

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Combining two imagine technologies, such as MRI for structure and MEG for activity, could provide a new understanding of our how our brain works.

New advances related to new uses of imaging technologies could help scientists uncover the brain's mysteries. Now, European scientists have successfully combined magnetic resonance imagining, or MRI, scanning with an emerging imaging technology called magnetoencephalography, or MEG. There have thus bundled two ways of imaging the brain in one helmet-like device. Because MEG records the magnetic fields produced by our brain, as brain cells fire off messages to one another, it gives scientists a real-time insight into our brain as it processes its world around it. MRI, meanwhile, gives structural images of the brain by looking at blood flow and oxygenation levels. Combining these techniques is precisely what the MEG-MRI project, funded by the EU, did.

Ultimately, these new advances in technology imaging could help doctors understand what is happening in the brains of patients, such as those with epilepsy. Another potential application would be in helping guide brain surgeons away from critical areas of a patient's brain. It could help visualising areas of the brain that light up when a patient talks, for example.

How does it work? "You can look at streams of information as someone is reading or looking at visual images," explains Risto Ilmoniemi, professor of biomedical engineering at Aalto University in Finland and the lead scientist in the project. "MRI gives the location, but not the sequence of when things happen." For MEG to pick up the electrical currents, at least a thousand neurons firing is needed. "They are sending signals to each other and there are electrical currents involved, produced by neurons, and these currents can be measured. MEG measures what comes out of the brain, the electromagnetic field generated," Ilmoniemi explains. The MEG machine is formed like a bicycle helmet, but contains hundreds of sensors inside.

Other scientists have previously been using MEG, and separately followed up using so-called functional MRI (fMRI). The latter measures brain activity related to a given function by detecting associated changes in blood flow. "We use a variety of imaging techniques for the brain, but I prefer to use MEG for a number of reasons," says Thomas Elbert, professor of neuropsychology at the University of Konstanz in Germany. "First of all, the brain operates much faster than blood oxygen levels would indicate [which is what fMRI detects]," he tells youris.com, adding: "Also fMRI is too slow and too gross when you are looking at activity, it just finds peaks of activities rather than the complex range of mountains." So the full range of peaks and valleys can be better seen through the use of MEG.

Therefore, experts see a real benefits in combining the two imagine techniques. "Doing simultaneous recordings is often very valuable scientifically and clinically: measuring different types of signals at different times means you're not sure if they're measures of the same events," says Gregory Miller, clinical psychologist at University College California, Los Angeles. "When the machines are separate, the patient or research participant has to be removed from the equipment and the procedure repeated, which means the recordings are done under different circumstances. For example, there can be changes due to practice, boredom, or fatigue."

There are other advantages as well. "Combining MEG and MRI in a single instrument would likely provide cost savings, which means not only saving money but making the technology more widely available. This is particularly important because MEG is severely underutilised, in clinical practice and in research," observes Miller. "Second, the combination would greatly reduce the footprint in space-constrained labs and clinics, again making the capabilities available to more scientists, clinicians, and patients. Third, the combination would potentially allow near-simultaneous recordings of very different types of biological signals."

Miller notes that MEG is safer than fMRI, provides enormously better temporal resolution than fMRI and sometimes can image more deeply in the brain than another method, called scalp electroencephalography (EEG). "So, having more access to MEG would let me study fast neural activity in deeper brain structures than I can with fMRI or EEG. This would help us address key issues about brain networks – brain circuitry – in depression, anxiety, and schizophrenia," Miller says.

Debates about whether imagine techniques such as EEG, MEG, MRI, positron emission tomography (PET), or optical is generally the best imaging method are "silly," says Miller. "It's been common to assume that a scientist has to choose which type of imaging method is best, but that's like trying to decide whether a hammer or a chisel is better. For some jobs, one is clearly better. For other jobs, you need both." The European project has now produced a prototype that combines MEG and MRI. They hope to make improvements and have it suitable for the clinic in four to five years. The benefits should flow for patients, doctors and brain researchers.

More information: www.megmri.net/

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