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RESEARCH

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# MEG differentiates functional brain disease

**Assessing the functional status of the brain is far from straightforward. Unlike other organs of the body, there are currently no good tests of brain function available; instead, physicians have to rely on behavioural examination. That could be about to change, however, with the demonstration that magnetoencephalography (MEG), the non-invasive measurement of magnetic fields associated with neuronal activity, can be used to diagnose functional brain disorders (*J. Neural Eng.* 4 349).**

In a study led by Apostolos P. Georgopoulos, professor in the neuroscience and neurology departments at the University of Minnesota Medical School (Minneapolis, MN), researchers used MEG to evaluate patterns of neural activity in volunteers with a range of brain conditions. As described in their research paper *Synchronous neural interactions assessed by magnetoencephalography: a functional biomarker for brain disorders*, the team demonstrated that interactions among neuronal populations - an essential aspect of brain function - can potentially act as biomarkers for several brain diseases.

If such a capability can be transferred into a routine clinical application, MEG could one day provide a fast and simple screening test for brain disease, or be used to differentiate brain disorders with similar symptoms. "For the first clinical applications, we have targeted the diagnosis of multiple sclerosis and Alzheimer's disease," Georgopoulos told *medicalphysicsweb*.

## Magnetic means

Georgopoulos and co-workers (including researchers from the Veterans Affairs Medical Center in Minneapolis) used MEG to examine a total of 142 subjects. The volunteers comprised 89 healthy controls, plus patients with multiple sclerosis, Alzheimer's disease, schizophrenia, Sjögren's syndrome (presenting with cognitive problems), chronic alcoholism and facial pain, as diagnosed by specialists in the respective fields.


MEG

MEG data were recorded for between 45 and 60 s, during which time the subject lay with their eyes fixed on a bright spot in an attempt to stabilize brain activity. The 248-sensor MEG system used in the study (the Magnes 3600 WH from 4-D Neuroimaging of San Diego, CA) provided a temporal resolution of 1 ms.

The researchers initially studied 52 subjects in six disease categories and used a series of advanced numerical and statistical analyses to examine the vast amount of resulting MEG data (45,000-60,000 data points per sensor per subject). The goal: to find parameters of neural activity that can identify different disease types.

The first step involved calculating the level of synchronous coupling (when synaptic events occur simultaneously) between neuronal populations at each pair of sensors. The team then searched these results and identified several thousand subsets with such synchronous couplings that could correctly classify all 52 subjects to their respective disease groups.

Of course, the real test of the technique's clinical potential is whether the predictors (i.e. subsets of synchronously-coupled sensors) derived from one group of subjects can accurately diagnose disease within a second group. With this in mind, the researchers examined a further 46 subjects in five of the disease categories. Many of the predictor subsets that gave 100% classification in the first group also correctly classified more than 90% of subjects in the second sample.

### Cross check

Subsequently, the Minneapolis team examined a further 44 subjects in six disease categories, and again successfully identified thousands of predictor subsets that correctly grouped all subjects according to disease. Analysis of the full MEG data set from all 142 subjects identified many subsets yielding 100% correct classification of every subject to its respective group. The number of such subsets was in the thousands (for 20 predictors), and even as few as 16 predictors could give 100% correct classification results.

As this work is ongoing, the team has not yet attempted to identify the one particular predictor subset that will correctly categorize the largest percentage of subjects. "Since we are studying subjects on a daily basis, we want to wait until we reach hundreds of them first," Georgopoulos explained.

However, the results so far - along with the group's previous findings that the brain pattern of partial correlations is extremely similar among healthy subjects - imply that changes in patterns of neural activity may provide a powerful indicator of different brain diseases.

The authors point out that the long-term utility of these subsets in classifying new subjects remains to be assessed within the context of a large population-based case-control study. "We want to acquire data from a large numbers of subjects - patients and matched controls - before we initiate a Phase II trial," added Georgopoulos. "Since the throughput of this MEG test is large - one can test easily 20 subjects a day, clinical applications can become reality in a year or two."

The University of Minnesota has established a start-up company, Orasi Medical, to commercialize Georgopoulos' technology.

## About the author

Tami Freeman is science editor on *medicalphysicsweb*.