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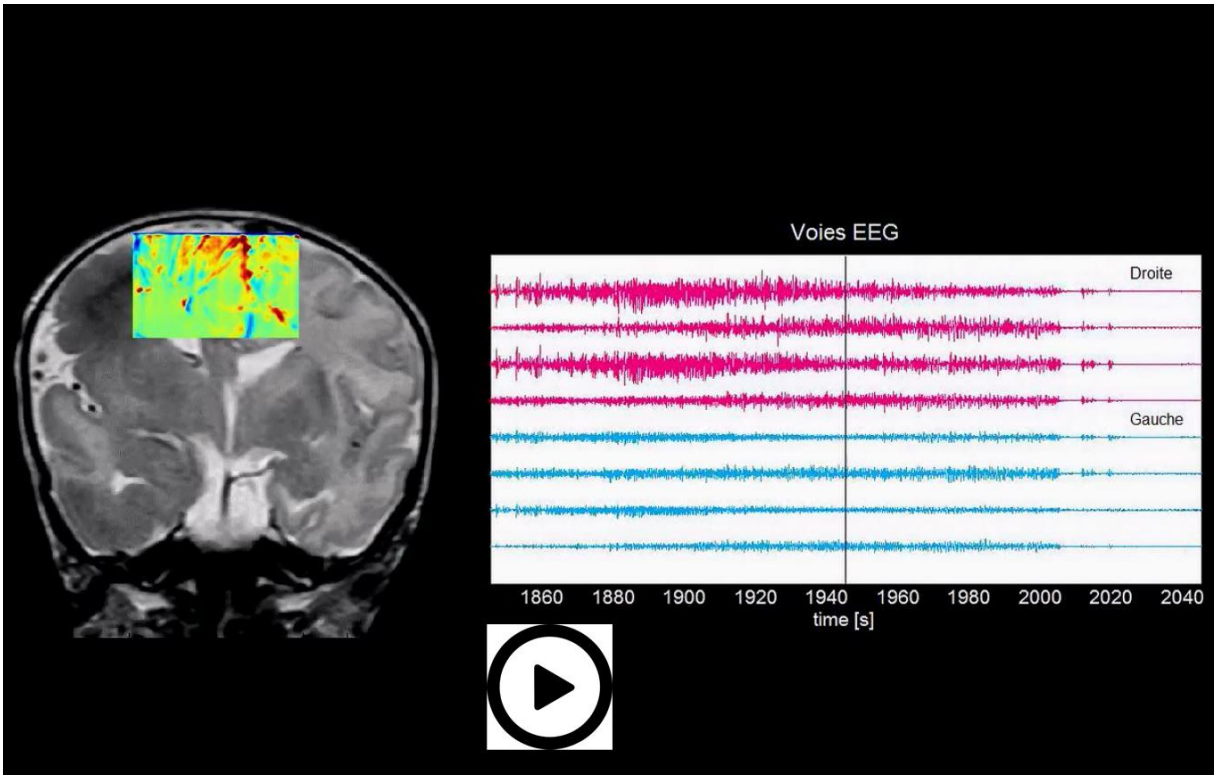
Press information

First clinical proof of concept for functional ultrasound imaging of brain activity in newborns

Physicians from Inserm Unit 979 "Wave Physics for Medicine" at the ESPCI Paris together with clinician researchers from the neonatal intensive care unit of Robert-Debré AP-HP pediatric hospital and Inserm Unit 1141 have just made a scientific and medical breakthrough: the non-invasive imaging of brain activity in newborns using ultrasound. This will open up new avenues for bedside neurological diagnosis in full-term and premature babies. The details of their research have been published in the October 11, 2017 issue of *Science Translational Medicine*.



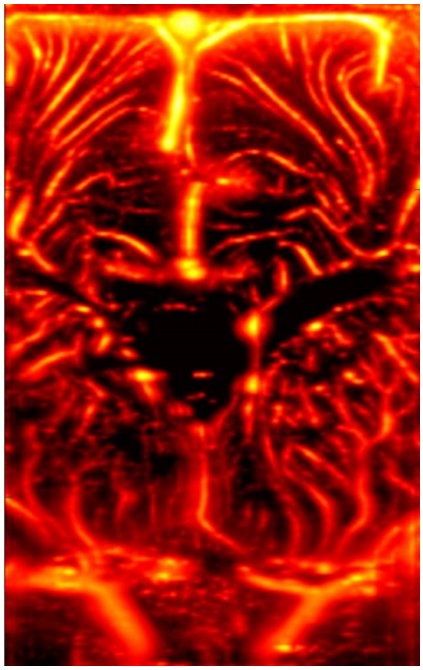
Voies EEG	EEG channels
Droite	Right
Gauche	Left

The technique used, called *functional ultrasound imaging of brain activity*, was invented in 2009 at the ESPCI Paris in Inserm Unit 979 "Wave Physics for Medicine", led by Mickael Tanter, Inserm Research Director. Its originality lies in the use of ultrasound technology which, unlike other methods of brain imaging, is simple and portable. Physicians generally use magnetic resonance imaging (MRI) or positron-emission tomography (PET) to image brain

activity. Although major technical progress has been made with these methods, they remain restrictive and costly, with long-waiting times for patients.

Similar in appearance to the ultrasound scanners used in obstetrics or echocardiography, the research prototype used has the particularity of being able to acquire images at very high speed. When combined with cutting-edge data processing algorithms, it is possible to map, with very high sensitivity, the subtle variations in blood flow in the small vessels of the brain, variations that are linked to neuronal activity. This new method combines ultrafast image acquisition with very high spatial resolution and a great depth of image. Until now, this had been applied only in pre-clinical studies, using animal models.

Therefore, the research published today establishes the first proof of concept of non-invasive functional ultrasound brain imaging in humans, performed in the neonatology and neonatal intensive care unit of Prof. Olivier Baud at Robert Debré Hospital, AP-HP, currently directed by Prof. Valérie Biran. The brain activity of premature neonates has been recorded in large regions of the brain, at rest and during seizures, at 1,000 images/sec and with a spatial resolution of 150 µm. These hitherto unheard-of data show propagation of cerebral blood flow between and during seizures, and make it possible to locate where they are coming from. Thanks to an ultrafast ultrasound prototype used at the patient's bedside, images are acquired non-invasively by placing an ultrasound scanner on the baby's head, above the fontanelle.



Coronal image of the brain vasculature of a premature neonate, obtained non-invasively using ultrafast Doppler ultrasound imaging. Photo credit: Inserm U979 "Wave Physics for Medicine", Langevin Institute - Waves and Imaging.

For Mickael Tanter and his colleague Charlie Demené, "*this first proof of concept of a non-invasive form of neuroimaging that makes it possible to record neuronal activity across an extensive area of the brain, marks the entry of ultrasound into the world of clinical neurosciences with a method that is highly sensitive, portable and can be used directly at the patient's bedside*".
This study demonstrates the potential of functional ultrasound imaging for the monitoring of premature neonates, who are tricky to examine and in whom it is difficult to diagnose neurological disorders. This technology is not heavy to handle and no patient transportation, contrast agents or ionizing emissions are needed. For Olivier Baud, "*functional ultrasound brain imaging could represent a genuine revolution in the field of medicine by bringing new*

knowledge of neurovascular dynamics, brain development and neuroprotection mechanisms, as well as more early diagnosis of brain functional connectivity alterations".

This study is part of the FUSIMAGINE project funded by the European Research Council (ERC) for the development of functional ultrasound brain imaging (http://fultrasound.eu)

Sources

"***Functional Ultrasound Imaging of Brain Activity in Human Newborns***"

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