THE 18TH CONFERENCE ON HUMAN BRAIN MAPPING (HBM), BEIJING, CHINA, 10–14 JUNE 2012

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The 18th annual conference on Human Brain Mapping (HBM) took place in Beijing on 10–14 June 2012. The conference program was prepared by a scientific committee composed of outstanding neuroscientists who ensured the lectures and tutorials met the highest scientific standards. The scientific committee included Maurizio Corbette from the University of Washington, Susan Bookheimer from UCLA, and John Ashburner from the Functional Imaging Laboratory, London.

The conference gathered a broad range of scientists, clinicians, engineers, and technicians who all use neuroimaging techniques – MRI, EEG, PET, and TMS – to investigate brain structure and function. HBM is the most important international meeting dedicated to the scientific and clinical application of neuroimaging methods. Each year 3000 people from scientific centers around the globe come together for the meeting.

Participants took part in sessions that included 6 full-day educational courses, 16 workshops, 7 plenary lectures, 16 oral sessions, 4 symposia, and 9 poster sessions. During the conference 184 lectures were given and 2201 posters were presented. Scientific posters occupied a total of four hourly sessions which were held each day. The meeting was accompanied by presentations from companies dealing with magnetic field equipment, EEG apparatus, and MRI hardware and software.

The conference saw new organisational and technical solutions. One innovation was a mobile app that helped participants create a conference schedule, receive news from conference organizers, and build social connections between scientists. In addition, each poster had a 2D bar code which allowed anyone to immediately download the corresponding abstract and extra information. This facility also allowed authors to automatically receive statistics about interest in their work.

During the first day of the conference, participants could attend one of six educational courses dedicated to: 1) fMRI analysis methods; 2) brain anatomy and its effecrts on interpretating fMRI images; 3) real-time fMRI; 4) imaging maps (a connectome) of neuronal connections in the brain; 5) imaging genetics, i.e., the use of functional neuroimaging methods to investigate genes that are expressed in the brain and are responsible for anatomical and functional differences; 6) imaging spontaneous brain activity, e.g. resting-state fMRI.

Due to an increasing amount of research conducted with the use of EEG-fMRI and resting state-fMRI, special attention was given to educational courses in them. The course on resting state-fMRI was made up of thirteen 45-minute lectures. The speakers presented recent data on: imaging changes in the pattern of spontaneous brain activity due to development, imaging changes in the pattern of brain activity related to psychiatric conditions, neurological disorders, and neurodegenerative diseases. Participants were shown how to design, analyse, and interpret resting state-fMRI images. The course also covered state-of-the-art methods of data analysis including:

– Principal Component Analysis;
– Independent Component Analysis, which enables identification of intrinsic interactions among multiple brain regions;
– regional homogeneity (ReHo), which investigates the congruency of the time series of a given voxel to adjacent ones;
– Amplitude of Low-Frequency Fluctuation (ALFF) which, like ReHo, is thought to reflect spontaneous neural activity;
– the seed-based approach, which selects a particular brain region of interest and finds other brain regions having correlated BOLD patterns. Correlations in BOLD signals indicate a functional connectivity between those particular brain regions.

One software demonstration attracted special attention. The REST software facilitates preprocessing, i.e. motion correction, coregistration, smoothing, and individual as well as group analysis of the data obtained from the ReHo and ALFF methods.

A real-time fMRI course was held for the first time this year. Brain imaging in real time and neurofeedback methods are well known in EEG studies, but for methods such as fMRI where acquisition times are long there is currently no standard approach. During the course currently available tools (e.g., Turbo Brain Voyager, AFNI) were outlined. Acquisition of an MR brain volume in around 100 ms, without any hardware modification, was described. This method is based on a commercially available product called Echo Volumar Imaging. Later, methods of incorporating patient feedback, based on information obtained from real time fMRI, were described. It was emphasised that it is very important to allow time for a patient to learn that the delay between his/her response and the reaction of the interface is significant. Subjects have to practice to get used to this delay. As well, the problem of physiological noise (including temperature drifts) and methods of coping with it was highlighted.

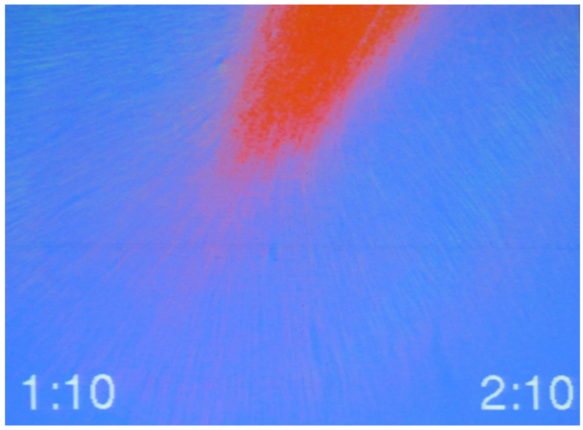
Some of the latest work on the brain–computer interface was presented. This subject is gaining media coverage, and the possibility has been raised of controlling a robotic arm by placing a microscopic set of electrodes on the surface of the cortex. During the presentation, unpublished results were shown of a case where a large number of electrodes covered the sensory cortex. This allowed information from the brain, say about what is being felt, to be sent straight to a robotic arm. With such a device patients could precisely use a robotic arm to control a clamping force.

The opening lecture was given by Prof. Mortimer Mishkin. He mentioned two topics that at first seem unconnected. First was the discovery of the FOXP2 gene, which is essential for voiced sound articulation. This gene have developed only in hominids over the last 300,000 years. Second was the puzzling absence of long-term auditory memory in monkeys, which contrasts with a fully developed long-term memory for visual and motor tasks. Connecting the two together, Prof. Mishkin tried to establish a theory that speech and long-term auditory memory are inseparably related.

A symposium on the influence of therapeutic intervention on brain plasticity in patients with brain injury was particularly popular. An emerging trend in research is to promote motor functions using physical therapy and to examine the resulting changes in functional connectivity. Christian Grefkes from the Max Planck Institute (Germany) gave a lecture on this topic which made an appreciable impact. In his innovatory study he demonstrated that abnormal interactions among cortical regions remote from the ischaemic lesion might also contribute to the motor impairment after stroke and result in less efficient motor function therapy. Grefkes began his talk by introducing the notions of functional and effective connectivity. The first refers to the temporal correlation (or covariance) between spatially remote neurophysiological processes. The second is operationally defined as the effect a neuron or neuronal population has on another. Grefkes then showed that the stroke may critically disturb the balance within the motor network. Therefore, efficient therapy should be aimed at re-establishing typical pattern of interaction within the brain network.

In order to achieve the aforementioned goals, transcranial magnetic stimulation (TMS) and motor therapy might be used. TMS enables the amplitude of evoked potentials from primary motor cortex to be inhibited. The effect of therapy might be examined using fMRI. Grefkes' lecture indicated a new trend in TMS and fMRI and it was also in line with an increasing number of studies looking at brain networks (connectomes).

Another lecture which attracted a lot of interest was given by Peter Fox from the University of Texas Health Science Center at San Antonio. His lecture covered state-of-the-art statistical methods used to create brain atlases. The method created by Fox – coordinate-based meta-analysis, CBMA – allows data sets referring to various brain regions to be merged, creating complex functional maps. Such atlases, combined with detailed anatomical and functional maps, will enable the results from different scientific centres to be compared. CMBA can be used to create connectivity maps.



Ultra high resolution image of white matter. Nerve tracts are marked in red.

An interesting lecture was given by Prof. Karl Zilles titled "Structural and Functional Architecture of the Human Cerebral Cortex: Multiscale and Multimodal Maps". During his talk he presented his own brain atlas based on ultra high resolution images of the postmortem brain. He also showed images from multiple MRI sequences that provided detailed information about anatomical structures. His opinion was that common Brodmann maps are imprecise and outdated. Brodmann maps were created in the 1920s by constructing 2D maps on the basis of a behavioral analysis and electrical stimulation of the cerebral cortex. The results presented by Prof. Zilles show how it is possible to create a brain atlas taking into account both single molecules and structures. The figure below illustrates one outcome in which single nerve tracts within white matter can be seen. The new atlas has been made possible by great strides in technological developments over the last few years. At the same time, brain structure and function based on Brodmann maps can lead to misinterpretation of neuroimaging data.

The HBM society meetings are a great opportunity for knowledge transfer. Modern technologies and current trends in exploring brain function are presented. Each year, leaders in the field and major manufacturers of hardware and software attend this conference. Joining with this group provides opportunities for sharing and can be great stimulation for further research.