20TH ANNUAL MEETING OF THE ORGANIZATION FOR HUMAN BRAIN MAPPING – A REPORT

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The 20th Annual Meeting of the Organization for Human Brain Mapping was held in Hamburg, Germany, from 8–12 June 2014. This year 3000 abstracts were submitted from 43 countries and there were 1200 oral presentations and posters, figures which have grown significantly from the first symposium in 1995 (in Paris), where there were about 700 attendees and 400 abstracts. In 2014 a new tradition was started, and the first 'Glass Brain' award for outstanding achievements in neuroscience was given to Prof. Karl Zilles from the Jülich-Aachen Research Alliance. The oral presentations at the OHBM 2014 meeting included 8 keynote lectures, 4 symposia, 16 morning workshops, and 16 regular oral sessions.

Selected highlights

Prof. Katrin Amunts, Director of the Vogt Institute for Brain Research, Heinrich-Heine University, Duesseldorf, and Director of the Institute of Neuroscience and Medicine, Research Centre Juelich. In the context of the 'BigBrain' project, her team aims to refine high-quality models of the human brain using ultra-high resolution magnetic resonance systems (7 T) to give direct insight into brain cytoarchitecture, myeloarchitecture, and cognitive function [see: http://www.fz-juelich.de].

Prof. Hanna Damasio, Director of the Dornsife Neuroimaging Center at USC, Los Angeles, member of the American Academy of Arts and Sciences, author of *Lesion Analysis in Neuropsychology* and *Human Brain Anatomy in Computerized Images*, published by Oxford University Press. Prof. Damasio emphasized the importance of historical brain lesion studies (by Joseph Dejerine, Paul Broca, Carl Wernicke, and others) which first assigned certain cognitive functions to particular brain regions. She underlined the neglect of neuroanatomical studies in neuroimaging, which are now feasible with modern imaging systems [see: http://www.usc.edu].

Prof. James Huxby, Director of the Center for Cognitive Neuroscience at Dartmouth and Professor at the Center for Mind/Brain Sciences (CIMeC), University of Trento. Prof. Huxby focuses on neural decoding using multivariate pattern analysis (MVPA), an alternative to standard approaches to image analysis. He considers individual neural activity as a set of multi-dimensional vectors (based on voxels) that can be transformed back and forth between the common vector space of all brains and individual brains. He claims that MVPA distinguishes individual brain responses more specifically than currently used brain atlases [http://dartmouth.edu/].

Prof. Yaniv Assaf, Director of the Strauss Center for Computational Neuroimaging of Tel Aviv University. Prof. Assaf explores the mechanisms of neuroplasticity, including long-term-potentiation, synaptogenesis, and cell genesis. With the use of diffusion-tensor imaging (DTI), his team has investigated structural brain plasticity, both in rats (induced by training them to make spatial decisions in a maze) and in humans (by playing a video racing game). The team has found changes in brain structures, such as the amygdala, the hippocampus, and the cingulate, indicating adaptation mechanisms occurring after only 90 mins of training (and more so following 5 days of training). Prof. Assaf believes that structural plasticity involves, principally, swelling of existing glial cells and development of new astrocytes, as well as an increased production of myelin by oligodendrocytes [http://www.tau.ac.il/].

Selected symposia

Brain machine interfaces: foundations and perspectives

Dr Christian Buchel from the University Medical Center Hamburg-Eppendorf organized a symposium on the following ICT solutions in brain studies:

- systems providing real-time fMRI brain–computer neurofeedback (based on machine learning classifiers and functional connectivity measures) which allow subjects to learn to change their own brain activity during fMRI (such training can serve as a therapeutic intervention for patients with neurological and psychiatric diseases);
- real-time fMRI used to decode spatio-temporal brain activity patterns as letters of the alphabet in individuals performing mental tasks (patients with motor impairments can 'spell' words on the PC screen);
- algorithms to extract the exact neuronal representation of an intended movement in monkeys, who use a special interface to grasp and manipulate objects with a prosthetic arm linked *via* electrode arrays to their sensorimotor cortex – the aim here is to restore motor function in paralyzed human patients.

Novel uses of natural viewing paradigms in EEG, fMRI, and fcMRI

Dr Tamara Vanderwal (Yale Child Study Center, New Haven, Connecticut, USA) has gathered together scientists you use cinema movies to study brain function. Their findings indicate that, so long as the audience is attentive, individual brain responses recorded with EEG and fMRI while watching a film have audience-wide synchronization. In this way, the time course of luminance and sound intensity in the movie can be used to further explore neuronal activity. A major advantage is that, by showing a movie to a subject, the data acquisition time can be made very long, provided head movements are very limited. This approach is especially useful in pediatric studies.

The many faces of "top-down": an integrative perspective

Colleagues of Dr Tobias Donner from the Department of Psychology, University of Amsterdam, the Netherlands, argued that:
- based on neural response histories and spike counts, human choices can be predicted, with familiar objects increasing neuronal firing rates (although too much exposure decreases it);
- even the activity of the primary visual cortex is attention-modulated and some of its subregions seem to turn off when an individual expects no reward after visual fixation;
- reward expectations are strongly related to fMRI BOLD changes in the dopamine brain system and depend on the probability of the reward.

Selected morning workshops

Is there a continued role for PET in studies of normal human cognition? (Moderator: Barry Horwitz, NIDCD/NIH, Rockville, USA)

Positron emission tomography (PET) is still indispensable for studies of neurotransmitter distribution in the brain.

1. There are 11C-raclopride (agonist of dopamine D2 receptors) studies which show (a) a high positive correlation between dopamine levels and the fMRI BOLD signal changes; (b) that in healthy individuals the available levels of dopamine serve as a learning signal (*go vs. no go*), but these effects are very specific in patients with Parkinson disease and in impulsive individuals; (c) expectations shape dopamine release in areas, such as the striatum, caudate and putamen; (d) recent neuromarking studies indicate two mental states determined by dopamine expression: tonic (motivation) and phasic (reward expectation), that can serve as predictors of product purchase.
2. Combined PET and fMRI functional connectivity studies indicate that the more that 5HT2 serotonine receptors are blocked, the greater will be the increase in the connectivity between the orbito-frontal cortex and the left hemisphere amygdala, a mechanism that seems to lead to individual decision-making tending towards the less risky.
3. rCBF (regional cerebral blood flow) PET is employed in language studies, since, as opposed to fMRI, there are no susceptibility effects around the brain's temporal lobes (crucial for language processing) and tissue borders, noise of the PET scanner is not high (language auditory studies), and movement artifacts are of minor importance.
4. Multiple FDG PET studies to explore tissue metabolism of glucose are being performed worldwide, e.g. in cancer, seizure location, and atherosclerosis.
5. 11C-PIB PET serves to investigate the accumulation of amyloid deposits in early Alzheimer disease and brain injuries, and might in the future provide some prognostic data in patients with minimal cognitive impairment (MCI).
6. The new method of multimodal PET-MR imaging is promising in studies investigating neurodegeneration, brain ischemia, and neurooncology.

Mobile brain/body imaging (MoBI). New directions in human neuroscience (Moderator: Klaus Gramann, Berlin Institute of Technology)

Imaging human brain function in moving participants has become possible with electroencephalography (EEG). Evidence shows that: a) there are stable patterns of N2–P3 potentials in gait control in young individuals, whereas there is no such pattern in the elderly, the implication being that lack of the potential increases the tendency to fall; b) while dual-tasking (walk/balance/run and perform a demanding spatial working memory task) there is no change in the performance and EEG brain responses in the young, but the old show changes in the EEG signal, as well as behavioral deterioration.

The predictive power of neuroimaging (Moderator: Hugh Garavan, University of Vermont, Burlington, VT, USA)

Neuroimaging techniques (f/MRI, PET, EEG) can help predict important clinical and developmental outcomes in humans. This in turn can improve diagnostic assessment and define specific risk factors in a population. However, in individual cases these methods are of limited power and reliability, and seem to show group-derived tendencies only. Example findings: (a) there is decreased D2/3 receptor binding (raclopride-C11 PET) in people prone to drug addiction and an increase in the binding potential in addicted patients who positively respond to cognitive-behavioral therapy; (b) it has been shown that the existence of cofactors – such as the structural loss of the hippocampus and the entorhinal cortex, low results in the mini mental state examination questionnaire (screening for dementia), and vast amyloid deposits in the fronto-temporal regions of the brain – does not allow one to predict the development of Alzheimer's disease. On the other hand, relatively quick deterioration within all these measures in patients with minimal cognitive impairment does allow prediction; (c) using structural MR and DTI (diffusion tensor imaging to evaluate white matter integrity), it is possible to determine the age of a particular individual with 95% certainty.

Mapping the human language network: development, disorder, and culture-specific research (Moderator: Angela Friederici, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany)

1. There are two brain pathways that have been suggested to subserve language processing: (a) the dorsal pathway (mapping sound to articulation), including the operiuculum area of the inferior frontal gyrus (BA44) and posterior areas in the superior temporal gyrus/sulcus; (b) the ventral pathway (mapping sound to meaning), consisting of the triangular region of the inferior frontal gyrus

(BA45) and the anterior superior and middle temporal gyri. It has been proven that processing syntax is strongly left-hemisphere lateralized, with semantics represented bilaterally in the superior and medial temporal gyri.
2. fMRI/DTI examinations show that structural connections are a better predictor of accuracy in syntactic decisions than the percent relative BOLD change; the basic DTI measure, functional anisotropy, however, has to be corrected for age as this parameter increases with advancing age.
3. With the use of DTI, human temporal cortices have been parcellated in detail, producing a number of clusters within the Wernicke area, which up till now has been considered one region (cf. the Brainnectome Atlas).
4. Anatomical correlates of language depend on the specific language and cultural factors. For example, in the Mandarin language the right-hemisphere superior temporal gyrus/sulcus and the left prefrontal areas subserve spelling, whereas in Western languages the left inferior frontal gyrus, inferior parietal lobe and occipitotemporal cortex are involved. Similarly, the left-lateralised fusiform and angular gyri are crucial for reading in Mandarin (with additional bilateral inferior frontal engagement in users of Western languages).

Selected oral sessions

Session	Main Topics
Multivariate modelling and machine learning	support-vector machines, pattern recognition
Imaging physiology	resting-state fMRI, functional connectivity, diffusion-tensor imaging
Learning and memory	memory encoding and retrieval; motor sequence learning
Psychiatric disorders	depression, psychosis
Lifespan development	fetal functional brain connectivity, thalamo-cortical connectivity during infancy, white matter development across the lifespan, resting-state magneto-encephalography (MEG)
Neuroanatomy	7 Tesla MR DTI; connectivity-based brain parcellation
Imaging methods	neurite orientation dispersion and density imaging (NODDI); submillimeter resting-state functional connectivity
Higher cognitive functions	working memory, attention
Genetics	heritability of intrinsic connectivity networks in the human brain (12 ICNs determined); gene–environment interactions (e.g. affecting the individual hippocampal volume); oxytocin receptors and brain connectivity
Brain stimulation	transcranial direct current stimulation (TDCS) to boost analytical thinking, auditory word comprehension and performance in children with ADHD
Resting-state networks and functional parcellation	functional network dynamics; numerous determined networks in the brain, e.g. default, visual, auditory, sensori-motor, limbic, attention
Perception and attention	visual system, auditory system, cross-modal plasticity
Developmental disorders	autism (disrupted structural and functional brain connectivity and increased amounts of oxytocin receptors in the nucleus accumbens)
Social neuroscience	self-orientation; joint action in EEG; theory of mind in fMRI
Modeling electrophysiology	Magnetoencephalography (MEG), electro-corticography (ECoG)
Emotion and motivation	reward-related memory in the hippocampus; pupil dilation and the BOLD signal
Neurologic disorders	preclinical Alzheimer's disease (negative correlation between levels of the YKL protein [glial inflammation] with DTI functional anisotropy; positive correlation with DTI mean diffusivity in the splenum, cingulate, and the middle temporal lobe); transcranial magnetic stimulation (TMS) in stroke (improved motor skills within a week)

Polish contribution

The team of the Biomedical Imaging Center, IPPH, submitted five posters to OHBM 2014. Presenters were assigned to be present at the posters at certain times to explain their work to interested conference attendees. The posters presented were:

1. Tonotopic organization of the primary auditory cortex in partial deafness (K Ciesla, T Wolak).
2. Tonotopic organization of the primary auditory cortex in patients with chronic tinnitus (M Lewandowska, T Wolak).
3. Effectiveness and reproducibility of two fMRI tasks for determining language lateralization (A Pluta, T Wolak).
4. Verification of alpha rhythm hemispheric dominance: simultaneous EEG–fMRI registration (M Rusiniak, T Wolak).
5. A shadow in the dark: what is hidden in GLM residuals? A simultaneous EEG–fMRI alpha rhythm study (M Rusiniak, T Wolak).

All the posters generated interest with conference participants and new opportunities arose for future scientific collaborations.

Conclusions

The annual meetings of the Organization for Human Brain Mapping are essential for scientists using neuroimaging techniques to explore brain structure and function. The gatherings provide an ideal forum for exchange of experience and to learn about the current major advances in research, as well as directions and trends. Due to an explosion of the field, OHBM is expanding quickly and their annual meetings have become the biggest international neuroimaging conference.