1-6-7: Assessment of the phase reset hypothesis on intracerebral recordings in the visual areas

Julien Krieg1, Agnes Trebuchon Da Fonseca1, Boris Burle2, Patrick Marquis1, Catherine Liegeois-Chauvel1, *Christian-G. Benar1

1INSERM U751, Universite Aix-Marseille 2, Marseille, France, 2CNRS UMR 6155, Universite Aix-Marseille 1, Marseille, France

Several authors have proposed that part or all of the evoked potentials measured on scalp EEG originate from a phase reset of background oscillatory processes (Basar et al J, Biomed Eng 1980, Makeig et al, Science 2002). Such phase reset may appear on the average potential/field as a surge of activity dissociated from a flat background. In parallel, other authors have suggested an influence of background alpha rhythm on the amplitude of the evoked activity (Brandt and Jansen Int J Neurosci 1991). All these observations speak against the commonly accepted "signal plus independent noise" model.

These claims on background/evoked activity relationship have lead to a controversy. In particular, some authors have observed a preserved phase of the alpha rhythm following the evoked potential, and that a simple additive process on top of an asymmetrical modulation of alpha could result in an alpha/evoked field relationship (Mazakeri and Jensen 2006, 2007). Although several recent studies have explored the phase reset hypothesis, on EEG or MEG recordings (e.g. Min et al Int J Psychophysiol. 2007) or on mathematical models (Yeung et al Psychophys 2004), the conclusions are still disputed.

We explored the relationships between background alpha and evoked potentials within the visual areas during a visual target detection protocol. Recordings were performed with intracerebral electrodes placed for presurgical evaluation of three epileptic patients, as well as with MEG in two of these patients. Contrary to what is often assumed, phase-reset
and the additive model do not seem mutually exclusive, since, depending on the patient and recording site, we observed both additive processes and indications of phase-reset phenomena.

1-6-8: Predicting performance in an orientation discrimination task from pre-stimulus gamma band activity in human visual cortex

*Benjamin T. Dunkley¹, Gareth Barnes¹, Avgis Hadjipapas¹

¹The Wellcome Trust Laboratory for MEG Studies, Aston University, Birmingham, UK

Recent research on primate visual cortex suggests that pre-stimulus gamma band activity affects psychophysical performance (Womelsdorf, et al, 2006). Specifically, gamma band power preceding a stimulus change significantly predicts psychophysical performance on a speed of change detection task measuring response latency (Hoogenboom, et al, 2007). Additionally, invasive data suggests that strong gamma activity preceding stimulus changes concurs with faster and more synchronized neuronal responses (Fries et al, 2001). Hence, it is possible that gamma network states during static stimulation serve to facilitate salient detection of subsequent change. Using MEG, we set out to test the hypothesis that the pre-stimulus gamma state in human visual cortex predicts performance in a subsequent task of orientation change discrimination. Subjects viewed an obliquely oriented Gabor grating at 45 degrees presented in either the lower left or right quadrant of the visual field. Stimulus orientation was rapidly switched by a variable amount. Using 2 alternate forced-choice, observers respond with their decision as to whether the change in orientation was clockwise or anti-clockwise. Preliminary results have localized induced, post-transient, sustained gamma oscillations to contra-lateral extrastriate cortex which last the duration of stimulus presentation.


1-6-9: Do stimulus specific gamma states in visual cortex facilitate behavioural and evoked responses to subsequent stimulus changes?

*Avgis Hadjipapas¹, Keith Duncan², Ben Dunkley¹, Gareth R Barnes¹

¹The Wellcome Trust Laboratory for MEG studies, Aston University, ²Department of Psychology, University College London

Our recent studies have shown that gamma activity localized to primary visual cortex represents a stimulus specific state, which is sustained for as long as the stimulus is static¹². Invasive data, suggest that strong gamma activity preceding stimulus changes concurs with faster and more salient neuronal³ and behavioural⁴ responses. Combined these results suggest that sustained gamma states represent a record of the visual world, which may be necessary for rapid and salient responses to changes. Here we experimentally induce stimulus-specific gamma states in primary visual cortex by varying the orientation of small grating stimuli, which we then treat as a baseline. We examine whether subsequent behavioural and evoked responses to stimulus changes depend on the degree of stimulus specificity during baseline. We study the effects of the baseline a) on subsequent stimulus offset evoked transients within a passive viewing paradigm² and b) reaction time and evoked transients to subsequent changes in stimulus orientation. A measure of stimulus specificity can be obtained using a support vector machine. For a pair of stimulus conditions, a multivariate space is spanned by the pattern of gamma spectra and then a separating hyperplane is fitted adaptively such that it maximizes the margin between conditions. Once this hyperplane is defined, one presents the algorithm with unknown data and for each data sample the normal distance to the hyperplane serves as a measure of stimulus specificity. We present a method to obtain time varying measures of this distance. Initial results suggest that baseline trials with larger gamma power and increased stimulus specificity give rise to larger evoked responses. 1. Hadjipapas,A. et al. Neuroimage 35, 518-530 (2007)2. Duncan et al, submitted.3. Fries,P. et al. Nature Neuroscience 4, 194-200 (2001).4. Womelsdorf et al. Nature 439, 733-736 (2006).

1-6-10: Effects of gum chewing on alpha band activity during human working memory: a Magnetoencephalographic study

*Kanako Dowaki¹, Yumie Ono², Atsushi Ishiyama¹, Minoru Onozuka², Naoko Kasai³

¹Graduate School of Advanced Science and Engineering, Waseda University, Japan, ²Dept. of Physiology and Neuroscience, Kanagawa Dental College, Japan, ³National Institute of Advanced Industrial Science and Technology, Japan

Recent functional brain imaging (fMRI) studies revealed that gum chewing facilitates brain activities associated with
working memory (WM) processing. We here studied the effect of gum chewing on WM-related oscillatory brain activity using magnetoencephalogram (MEG). We used a 306-channel system (Vectorview, Elekta Neuromag) to collect MEG data from 12 young healthy subjects (21-24 yrs). Two blocks of 60 visually-presented Sternberg task trials were presented to every subject, and they had a 3 min of inter-block interval. During the interval, subjects were instructed to perform any of the three tasks of: (1) stay still (STAY), (2) chew a gum (GUM) or (3) repetitive hand exercise (HAND), with their heads fixed in the MEG dewar. Regardless of the inter-block task, strong alpha band oscillation was observed in occipital, right temporal-parietal and left prefrontal areas. Mean alpha band power during WM maintenance period was extracted from each trial and was compared between the blocks of the same subject. Six of eight subjects in GUM condition showed an increase of alpha band power after gum chewing. We also found that the ratio of correct answers in the Sternberg task tended to increase in the subjects with increased alpha band activity after gum chewing. Results of source localization of the alpha band activity, behavioral scores and further discussions will be presented on site.

1-6-11: Imaging Maturation of the Brain’s Default Mode with Spontaneous Neuromagnetic Signals

*Jing Xiang1, Yang Liu1, Yingying Wang1, Elijah Kirtman1, Xiaolin Huo1, Hisako Fujiwara1, Nat Hemasilpin1, Douglas F. Rose1

1Department of Neurology, Cincinnati Children's Hospital Medical Center, USA

Spontaneous cerebral signals recorded from subjects without any task may reflect the resting state of brain activity or the default mode of brain function. The objective of this study was to investigate the maturational signatures of the default mode in the child’s brain. 60 healthy children (6-17 years, 30 female and 30 male) and 20 adults (21-49 years, 10 female and 10 male) were studied using a whole head CTF 275-Channel magnetoencephalography (MEG) system. MEG data were digitized at 12,000 Hz without filtering. Three-dimensional magnetic resonance imaging (MRI) was obtained with a 3T scanner. The frequency features of the spontaneous brain activation were analyzed with Morlet continuous wavelet transform. A global field spectral power was calculated for each subject for revealing the spectral change of the entire brain. Magnetic sources of focal increase of spectral power were volumetrically estimated with wavelet based beamformer transform. In comparison to MEG results from adults, MEG results from the child’s brain had (1) stronger Theta activation (3-7 Hz); (2) weaker Beta activation (14-30 Hz); (3) lower frequency in Alpha activation (8.5 Hz vs 10.5 Hz); (4) significant intermingle between Delta, Theta and Alpha activation in terms of frequency range; (5) Spatially symmetric distribution of Alpha activation; (6) high frequency activation in 80-120 Hz, 240-300 Hz and 860-1000 Hz were detectable. Volumetric source estimation showed that spontaneous neuromagnetic activity in the child’s brain had sparse spatial and temporal cohesiveness. Comparison of three age groups (6-9, 10-13 and 14-17 years) indicated that spontaneous brain activation was spatiotemporally integrated cohesively over development. The maturational changes of the brain’s default mode may lay a foundation for identification of developmental delay in children.

1-6-12: Neuromagnetic gamma rhythm during mental rotation

*Blake W. Johnson1

1Macquarie University

OBJECTIVE: We examined the spatiotemporal dynamics of parietal lobe activity during a mental rotation task by measuring spectral perturbations of the human magnetoencephalogram (MEG), termed event-related desynchronizations (ERD) and event-related synchronizations (ERS). METHOD: 160 channel MEG (Yokogawa Electric Corp., Tokyo, Japan) was measured from nine healthy right-handed participants (five females). Stimuli were outline drawings of human hands presented in six different angular departures from the upright. In the mental rotation condition, subjects were required to decide whether the stimulus was a left or right hand. In the control condition, subjects were required to decide if it was the palm or back of a hand. RESULTS: Mean reaction times systematically increased with stimulus orientation in the mental rotation condition only, supporting our interpretation that participants were performing a mental rotation of the hand images. MEG measurements over parietal cortex showed ERS in the high gamma band (60-80 Hz) but not in the low gamma band (35-45 Hz). Gamma band response (GBR) amplitude over right parietal cortex was double that of the left parietal GBR in both conditions. GBR peaked at a latency of about 225 ms after stimulus onset followed by a slow decay until stimulus offset. In the right hemisphere, the mental rotation GBR showed a mean 34% higher amplitude compared to the control GBR during a latency region of 400-1600 ms. There was no significant GBR increase in the mental rotation condition for left hemisphere sensors. CONCLUSIONS: Imagined rotations of hands were associated with increased synchronization of EEG oscillations in the high gamma frequency range in the right hemisphere, an observation that is consistent with previous reports of right parietal dominance in mental rotation. We suggest that the high-frequency GBR may index the dynamical reorganization of the cortical networks in right parietal cortex involved in spatial computations.