 **1. Date, place, and title of the Symposium**	**SCIENTIFIC AND FINANCIAL REPORT OF THE GLOBAL BRAIN CONSORTIUM SYMPSIUM ENTITLED** **Neural basis of the human consciousness: phenomena, paradigms, and exploring techniques** **June 12th, 2019; time: 03:00 – 06:00 p.m.** Room A (Building of Pharmacology, CU024, entrance in Viale Regina Elena, 334, Rome) Department of Physiology and Pharmacology "Erspamer" Sapienza University of Rome https://globalbrainconsortium.org/
2. Abstract	The Symposium addressed a major objective of the Global Brain Consortium: to understand the neurophysiological brain dynamics underpinning human consciousness as a basis for improving our knowledge of brain disorders affecting consciousness and thinking such as the Dementias, Schizophrenia, and Major Depression. In the Symposium, speakers introduced some promising evidence, concepts, phenomena, paradigms, and exploring techniques for understanding the neural basis of human consciousness and its disturbances. This was followed by a discussion between speakers and participants.

3. Scientific program and report	**03:00-03:30 pm. Talk 1.** Prof. Claudio Babiloni, Sapienza University of Rome, Italy: **“Primary visual consciousness of qualia: the neural basis.”** Babiloni summarized the EEG experiments of his group about human primary consciousness and qualia. An experiment tested the idea that **cortical alpha rhythms (8-12 Hz)** was a reflection of neurophysiological oscillatory mechanisms underpinning the regulation of general brain arousal and vigilance, a basic pillar of human consciousness. In one experiment alpha rhythms were investigated during primary visual consciousness (stimulus self-report). Conscious and unconscious visuospatial processes have been related to parietooccipital cortical activation as revealed by late visual-evoked potentials. Here the working hypothesis was that a *specific pattern of pre- and poststimulus theta (about 4-6 Hz) and alpha (about 6-12 Hz) rhythms may be differently represented during conscious compared with unconscious visuospatial processes*. Electroencephalographic (EEG) data (128 channels) were recorded in normal adults during a visuospatial task. A cue stimulus appeared at the right or left (equal probability) monitor side for a "threshold time" inducing about 50% of correct recognitions. It was followed (2 s) by visual go stimuli at spatially congruent or incongruent position with reference to the cue location. Left (right) mouse button was clicked if the go stimulus appeared at the left (right) monitor side. Then, subjects said "seen" if they had detected the cue stimulus or "not seen" if missed (self-report). Sources of theta and alpha rhythms during seen and not seen EEG epochs were estimated by low-resolution electromagnetic brain topography software. Results showed that the pre-stimulus "low-band" (about 6-10 Hz) alpha rhythms in frontal, parietal, and occipital areas were stronger in power in the seen than in the not seen trials. After the visual stimulation, the power of the "high-band" (about 10-12 Hz) alpha rhythms in parietal and occipital areas decreased more in the seen than in the not seen trials. Those results suggested that visuospatial consciousness covary – presumably with a facilitatory effect – with the power of both pre- and post-stimulus alpha rhythms. The **causal role** of that visuospatial cortical network in the experience of visual primary consciousness was tested by **repetitive transcranial magnetic stimulation (rTMS)** in 18 normal subjects to investigate whether the ventral posterior parietal cortex (PPC) is pivotal for visuospatial attention and primary consciousness and whether these 2 functions may be linearly correlated with each other. Two distinct experimental conditions involved a similar visual stimuli recognition paradigm. In the "Consciousness" experiment, number of consciously perceived visual stimuli was lower by about 10% after rTMS (300 ms, 20 Hz, motor threshold intensity) on left or right PPC than after sham (pseudo) rTMS. In the "Attentional" Posner's experiment, these stimuli were always consciously perceived. Compared with a sham condition, parietal rTMS slowed of about 25 ms reaction time to go stimuli, thus disclosing effects on endogenous covert spatial attention. No linear correlation was observed between the rTMS-induced impairment on attention and conscious perception. Results suggested that PPC may play a slight, but significant, causal role in both visuospatial attention and primary consciousness. Furthermore, these high-level cognitive functions, as

	modulated by parietal rTMS, do not share either linear or simple relationships. In another experiment, the hypothesis that *cortical alpha rhythms (about 8-12 Hz) are related to conscious perception in normal subjects* was tested evaluating the hypothesis that these rhythms may be abnormal in **persistent vegetative state (PVS) patients**, who are awake, but not aware, of self and environment. Clinical and resting-state, eyes-closed electroencephalographic (EEG) data were extracted from a clinical archive. Additional data were recorded in 50 PVS subjects (level of cognitive functioning – LCF score: I-II) and in 30 cognitively healthy subjects. Rhythms of interest were delta (2-4 Hz), theta (4-8 Hz), alpha 1 (8-10.5 Hz), alpha 2 (10.5-13 Hz), beta 1 (13-20 Hz), and beta 2 (20-30 Hz). Cortical sources were estimated by low-resolution electromagnetic tomography (LORETA). Based on LCF score at 3-months follow-up, PVS patients were retrospectively divided into three groups: 30 subjects who did not recover (NON-REC patients; follow-up LCF: I-II), 8 subjects classified as minimally conscious state patients (MCS patients; follow-up LCF: III-IV), and 12 subjects who recovered (REC patients; follow-up LCF: V-VIII). Results showed that occipital source power of alpha 1 and alpha 2 was high in healthy subjects, low in REC patients, and practically zero in NON-REC patients. A Cox regression analysis showed that the power of alpha source predicted the rate of the follow up recovery, namely the higher its power, the higher the chance to recover consciousness. Furthermore, the MCS patients showed intermediate values of occipital alpha source power between REC and NON-REC patients. Keeping in mind these results, we suggested that cortical sources of alpha rhythms may be related to the chance of recovery at a 3-months follow-up in patients in PVS. With the same paradigm of visual stimuli given at sensory threshold to produce “seen” and “not seen” stimuli, three experiments tested the hypothesis that primary visual consciousness (stimulus self-report) is related to enhanced cortical neural synchronization as revealed by **cortical event-related potentials (ERPs)**. ERP peak latency and sources were compared between "seen" trials and "not seen" trials, respectively related and unrelated to primary visual consciousness. Three salient features of visual stimuli were considered (visuospatial, emotional face expression, and written words). Results showed the typical visual ERP components in both "seen" and "not seen" trials. There was no statistical difference in the ERP peak latencies between the "seen" and "not seen" trials, suggesting a similar timing of the cortical neural synchronization regardless of visual consciousness. In contrast, ERP sources showed different behavior between "seen" and "not seen" trials. For **visuospatial stimuli**, the primary consciousness was related to higher activity in dorsal occipital and parietal sources at about 400 ms post-stimulus. For **emotional face expressions**, there was greater activity in parietal and frontal sources at about 180 ms post-stimulus. For **written letters**, there was higher activity in occipital, parietal and temporal sources at about 230 ms post-stimulus. These results hint that primary visual consciousness is associated with enhanced cortical neural synchronization having entirely different spatiotemporal characteristics as a function of the features of the visual stimuli and possibly, the relative qualia using a broad definition of the term (i.e., visuospatial, face expression, and words). In this

framework, the dorsal visual stream may synchronize in association with the primary consciousness of visuospatial and emotional face contents. Analogously, both dorsal and ventral visual streams may be synchronized in association with the primary consciousness of linguistic contents. In this line of reasoning, the ensemble of the cortical neural networks underpinning the single visual features would constitute a type of multi-dimensional palette of colors, shapes, regions of the visual field, movements, emotional face expressions, and words. The synchronization of one or more of these cortical neural networks, each with its peculiar timing, would produce the primary consciousness of one, or more, of the visual features of the scene.

Babiloni proposed that this kind of EEG experiment based on the paradigm of "seen" and "not seen" may be extended to the study of brain neurophysiological mechanisms underpinning visual primary consciousness of **qualia in social contexts**. These **experiments** could be developed in the framework of the **Global Brain Consortium**.

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Babiloni C, Vecchio F, Buffo P, Buttiglione M, Cibelli G, Rossini PM. Cortical responses to consciousness of schematic emotional facial expressions: a high-resolution EEG study. Hum Brain Mapp. 2010 Oct;31(10):1556-69. doi: 10.1002/hbm.20958.

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03:30-04:00 pm. Talk 2. Prof. Aina Puce, Indiana University, USA: **"Consciousness and Social representation in the brain."** Puce introduced and discussed the processing of implicit versus explicit social information, how this relates to various discrepancies in the literature, and what implications this has for the conscious awareness of one's social environment. She developed these concepts summarizing EEG and MEG experiments of her group based on **visual cortical event-related responses** in healthy subjects.

Puce framed her work in the context that social primates continually monitor behaviors of other species members, so that they can appropriately respond in a social interaction. Our ability to do that depends critically on decoding our visual environment, including important information carried by the face, the eyes and gaze changes of others in the social environment. An individual's gaze direction transmits a wealth of information not only as to their focus of spatial attention, but also about their intention to approach or withdraw from other people in the scene, therefore conveying both visuospatial and social information to the observer about their conscious states to the observer.

Keeping in mind the above premises, Puce emphasized crucial differences between **direct** and averted gaze social meaning. Direct gaze towards the observer mainly signals that the observer is the likely recipient of a directed behavior and is indicative of the **conscious intention of the person we are observing to start a communicative interaction with us**. In other words, the direct gaze towards the observer mainly conveys social information to him/her. On the contrary, **averted gaze** of the observed person transmits both **social and spatial information to the observer**. Specifically, gaze cueing experiments indicate that averted gaze of the observed person serves as a powerful stimulus for altering the observer's focus of visuospatial attention; yet there appears to be a difference in how the brain treats visual cues consisting of eyes *vs* control stimuli (e.g., arrows with similar physical features compared with eyes). Lesions to the right superior temporal sulcus or the amygdala in the observer disrupted the processing of gaze, but not arrow, cueing of the observe person. In contrast to arrows, averted gaze obviously conveys to the observer a range of social meanings about the observed person including for instance, his/her shyness, dishonesty, the intentionality of the gazer, and their emotional state. Consequently, modulations of brain activity in the observer by gaze direction of the observed person have been accounted for by either a change in social and/or visuospatial attention. This double level of the visual stimulus processing of the observer suggests that gaze processing may be sensitive to task-based manipulations of participants' **attention toward either a social or a spatial dimension**. Consistently, the task being performed by the observer is increasingly important in the processing of social stimuli such as gaze or facial expressions of the observed person(s).

The human brain of the observer possesses specialized mechanisms for the processing of gaze and other important information conveyed by the eyes of the observed person. Indications of specialized processes dedicated to the perception of gaze of the observed person come from functional magnetic resonance imaging (fMRI) and event-related potential (ERP) studies. Originally, the **face-sensitive negative ERPs peaking about 170 ms post-stimulus** (**N170**) also showed sensitivity to static eyes of an observed neutral face, typically being larger and later for eyes shown in isolation. Some studies have shown N170 modulation to emotional faces with direct gaze that show an emotion. That said, some subsequent studies reported a larger N170 or its magnetic counterpart (M170) of the observer to averted gaze of the observed person, some to direct gaze whereas others reported no modulations of the N170 of the observer by gaze direction of the observed person. Inconsistent results in the study of gaze perception of the observed person in emotional contexts are also reported in fMRI investigations. Discrepancies between studies have been loosely attributed to tasks and stimulus features representing the gaze of the observed person(s). Gaze perception studies have used single tasks consisting of either **passive viewing** tasks, *or* **'social' judgment tasks**, where observers reported **conscious experience** whether the gaze of the observed person was oriented away or toward them.

Most studies have manipulated gaze of the observed person in **static displays**, even though gaze is rarely static in natural situations, and social information important for non-verbal communication is often conveyed to the observer via dynamic gaze changes of the observed person. The use of dynamic stimuli poses challenges in neurophysiological studies as they may not have clear onsets and can potentially elicit a continuous and dynamic neural response. To overcome this problem, apparent face motion stimuli, which allow eliciting clear ERPs to dynamic stimulation, were developed by Puce's lab. Apparent face motion stimuli of the observed person have a precise stimulus onset for performing traditional ERP analyses, while conserving the dynamic and more ecological aspects of perception in the observer. More specifically, a series of experiments in Puce's lab have investigated the effect of task on neural responses of the observer to **dynamic gaze changes** of the observed person: away and toward transitions (resulting or not in eye contact). In the experiments, observers performed, in random order, social (away/toward them) and non-social (left/right) judgment tasks on the gaze of the observed person. Overall, in the *non-social task*, larger N170s occur to gaze aversion relative to gaze returning to look at the observer. In the *social task*, however, this N170 difference was no longer present in the right hemisphere, likely reflecting an enhanced gain in sensory pathways when an observer makes an explicit social judgment.

Keeping in mind those data and considerations, Puce concluded that the available behavioral and ERP data indicate that when the observer performs **social judgments** on the gaze of the observed person, there is an **enhancement of conscious processes** related to the saliency of gaze motion of the observed person toward the observer, even those eye behaviors of the observed person that did not result in gaze contact towards the observer. To account for that phenomenon, Puce proposed two brain modes of processing social visual information: (1) a '**default mode**' that may focus on spatial information of gaze and (2) a '**socially aware mode**' that is activated when social judgments about observed persons must be made, that arise from increased sensory gain and a potential interaction between attentional and conscious processes.

A rapid switch from one mode to the other is proposed. This model can be objectively tested by **new EEG or magnetoencephalographic experiments** that could be developed undere the framework of the **Global Brain Consortium**.

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	processing of external sensory input and interaction with the world. In this vein, the Speaker encouraged future magnetic resonance imaging and EEG studies not only focused on the structural or functional topography of brain correlates of consciousness disorders, but also on brain connectome. *Essential bibliographic references* Blanke O, Landis T, Spinelli L, Seeck M. (2004) Out-of-body experience and autoscopy of neurological origin. Brain. 127(Pt 2):243-58. Blanke O, Ortigue S, Landis T, Seeck M. (2002) Stimulating illusory own-body perceptions. Nature. 419(6904):269-70.Le Gal F, Lebon S, Ramelli GP, Datta AN, Mercati D, Maier O, Combescure C, Rodriguez MI, Seeck M, Roulet E, Korff CM. (2014) When is a child with status epilepticus likely to have Dravet syndrome? Epilepsy Res. 108(4):740-7. doi: 10.1016/j.eplepsyres.2014.02.019. Heydrich L, Lopez C, Seeck M, Blanke O. (2011) Partial and full own-body illusions of epileptic origin in a child with right temporoparietal epilepsy. Epilepsy Behav. 20(3):583-6. doi: 10.1016/j.yebeh.2011.01.008. Heydrich L, Dieguez S, Grunwald T, Seeck M, Blanke O. (2011) Illusory own body perceptions: case reports and relevance for bodily self-consciousness. Conscious Cogn. 2010 Sep;19(3):702-10. doi: 10.1016/j.concog.2010.04.010. Erratum in: Conscious Cogn. 20(2):487. Lopez C, Heydrich L, Seeck M, Blanke O. (2010) Abnormal self-location and vestibular vertigo in a patient with right frontal lobe epilepsy. Epilepsy Behav. 17(2):289-92. doi: 10.1016/j.yebeh.2009.12.016. Park HD, Bernasconi F, Salomon R, Tallon-Baudry C, Spinelli L, Seeck M, Schaller K, Blanke O. (2018) Neural Sources and Underlying Mechanisms of Neural Responses to Heartbeats, and their Role in Bodily Self-consciousness: An Intracranial EEG Study. Cereb Cortex. 28(7):2351-2364. doi: 10.1093/cercor/bhx136. **04:30-05:00 pm. Coffee break** **05:00-06:00 pm. General discussion.** Chairman: Prof. Alan Evans, McGill University, Montreal, Canada