

VISUALLY DRIVEN FUNCTIONAL NETWORKS IN THE BRAIN



CLAUDIA VARGAS & DANIEL FRAIMAN



MacLinc/USP

CAPES

NeuroMat

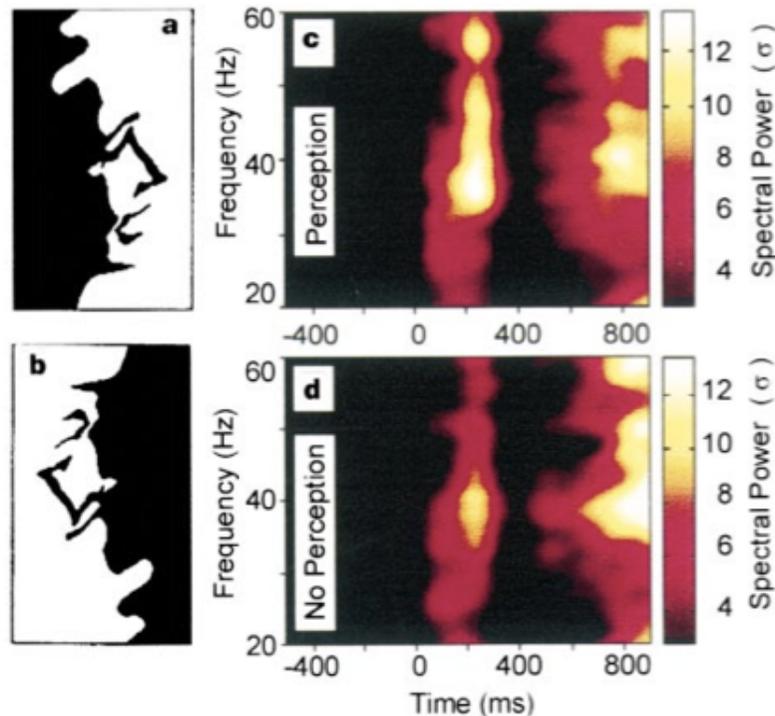


Perception's shadow: long-distance synchronization of human brain activity

Eugenio Rodriguez, Nathalie George,
Jean-Philippe Lachaux, Jacques Martinerie,
Bernard Renault & Francisco J. Varela

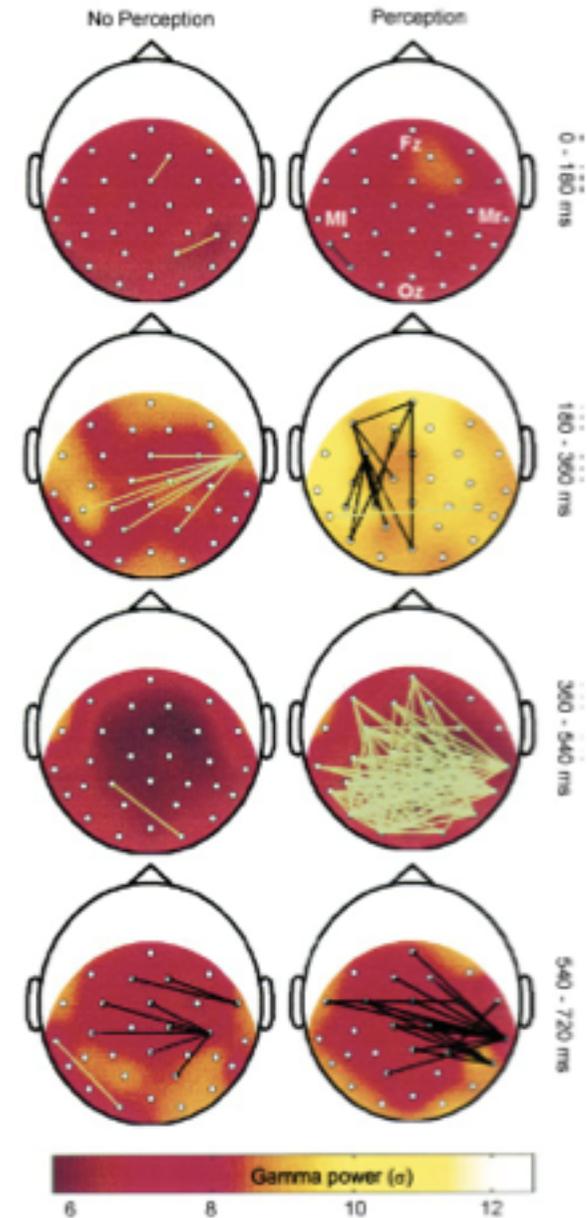
Laboratoire de Neurosciences Cognitives et Imagerie Cérébrale (LENA),
CNRS UPR 640, Hôpital de la Salpêtrière, 47 Boulevard de l'Hôpital,
75651 Paris Cedex 13, France

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Phase Synchrony

Increase
decrease



Scale-Free Brain Functional Networks

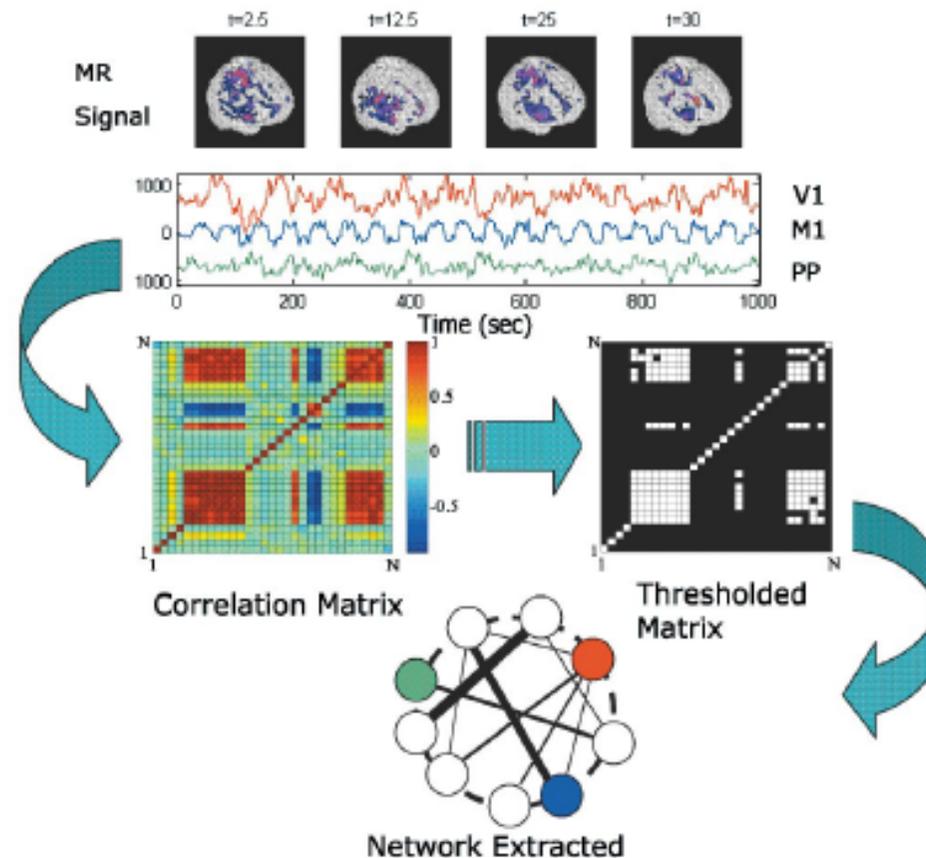
Victor M. Eguíluz,¹ Dante R. Chialvo,² Guillermo A. Cecchi,³ Marwan Baliki,² and A. Vania Apkarian²

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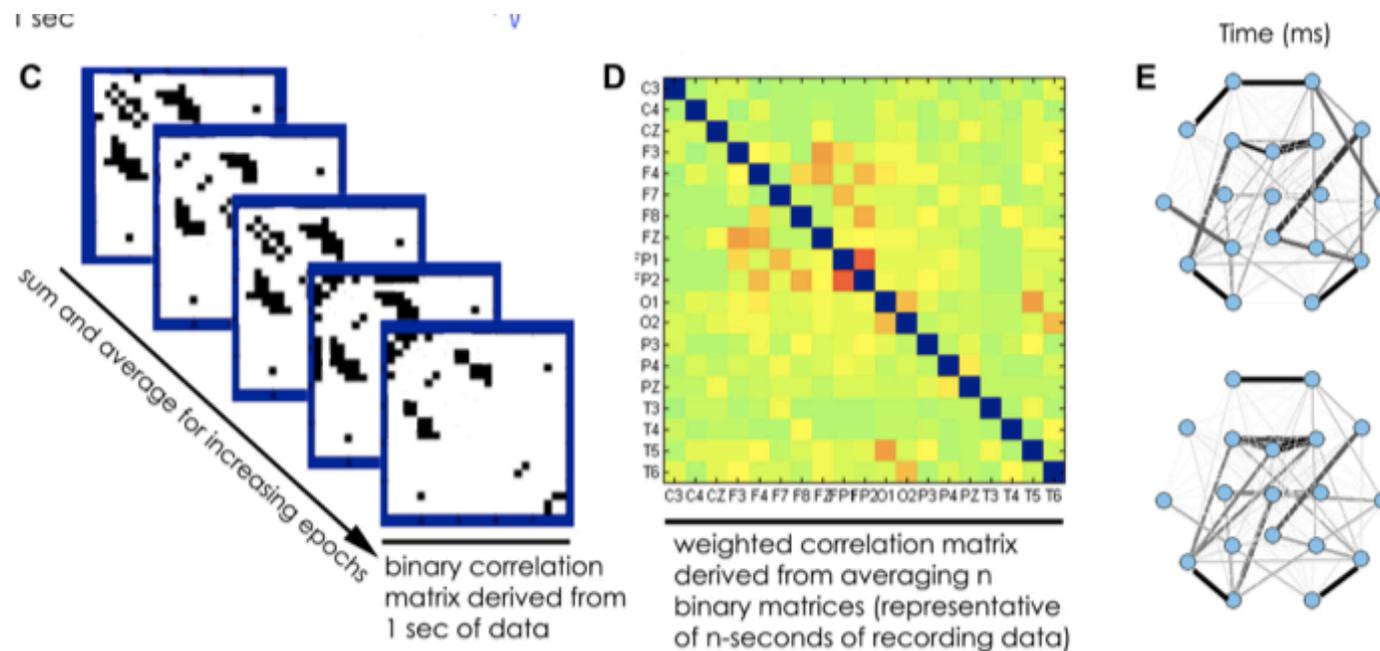


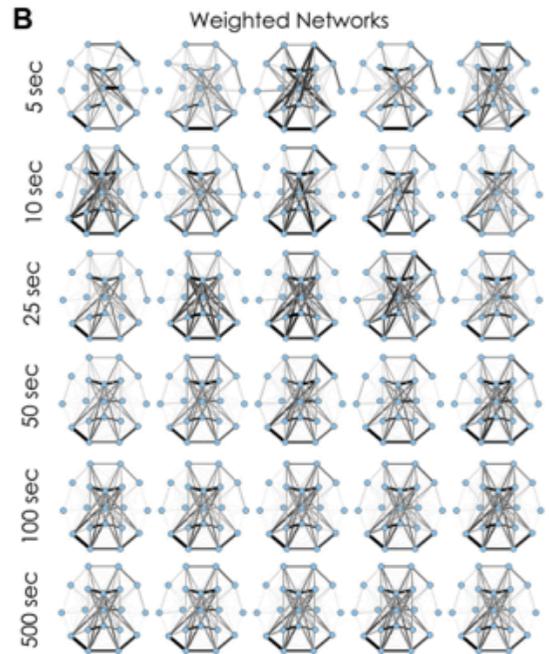
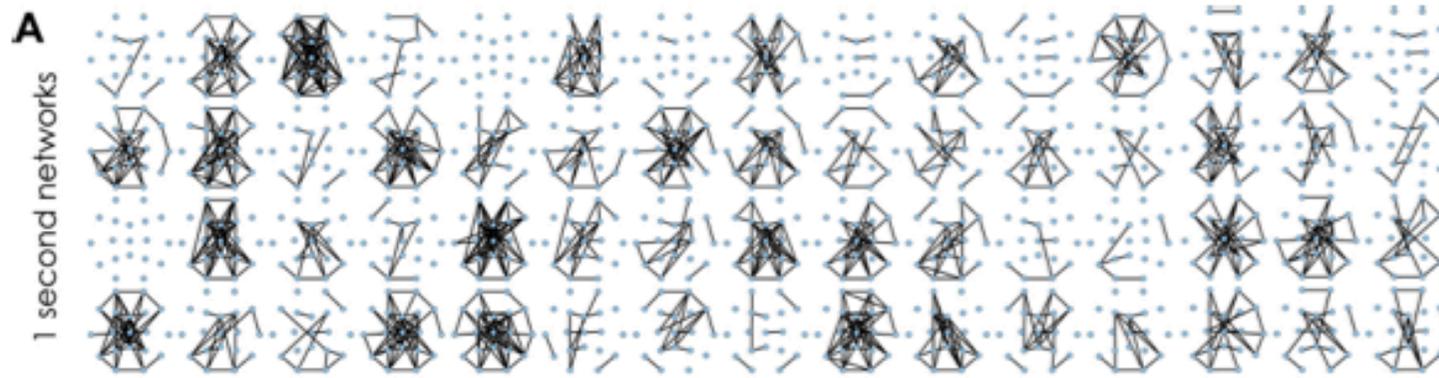
Emergence of Stable Functional Networks in Long-Term Human Electroencephalography

Catherine J. Chu,^{1,2} Mark A. Kramer,³ Jay Pathmanathan,^{1,2} Matt T. Bianchi,^{1,2} M. Brandon Westover,^{1,2} Lauren Wizon,³ and Sydney S. Cash^{1,2}

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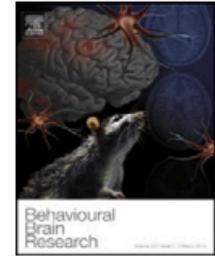
A core EEG network



Contents lists available at SciVerse ScienceDirect

Behavioural Brain Research

journal homepage: www.elsevier.com/locate/bbr



Research report

Electrophysiological correlates of biological motion permanence in humans

Ghislain Saunier^{a,b}, Eduardo F. Martins^a, Elisa C. Dias^c, José M. de Oliveira^a,
Thierry Pozzo^{d,e,f}, Claudia D. Vargas^{a,*}

ACTION OBSERVATION/MOTOR COGNITION

which networks?



Point light display (Johansson, 1973)

EXPERIMENTAL SET UP

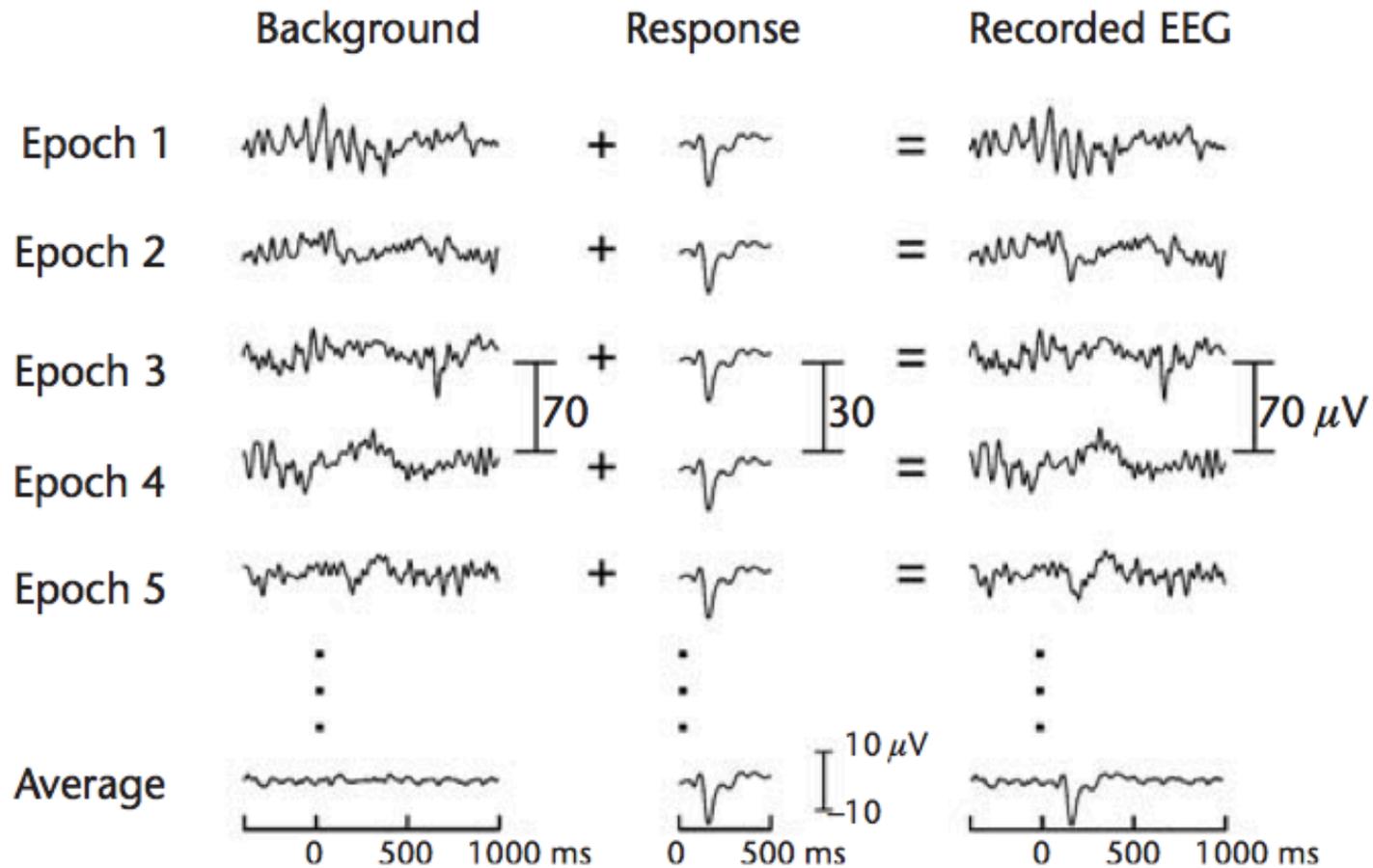


Biological Motion (BM)

Scrambled Motion (SM)

- Sixteen subjects
- Fifty repetitions of BM and SM randomized in two blocks
- Event related potentials (ERP) measured in 20 channels

EVENT RELATED POTENTIALS



IN: Quantitative EEG Analysis Methods and Clinical Applications

Ed. By Martin L. Yarmush, Christopher J. James (2009).



Contents lists available at SciVerse ScienceDirect

Behavioural Brain Research

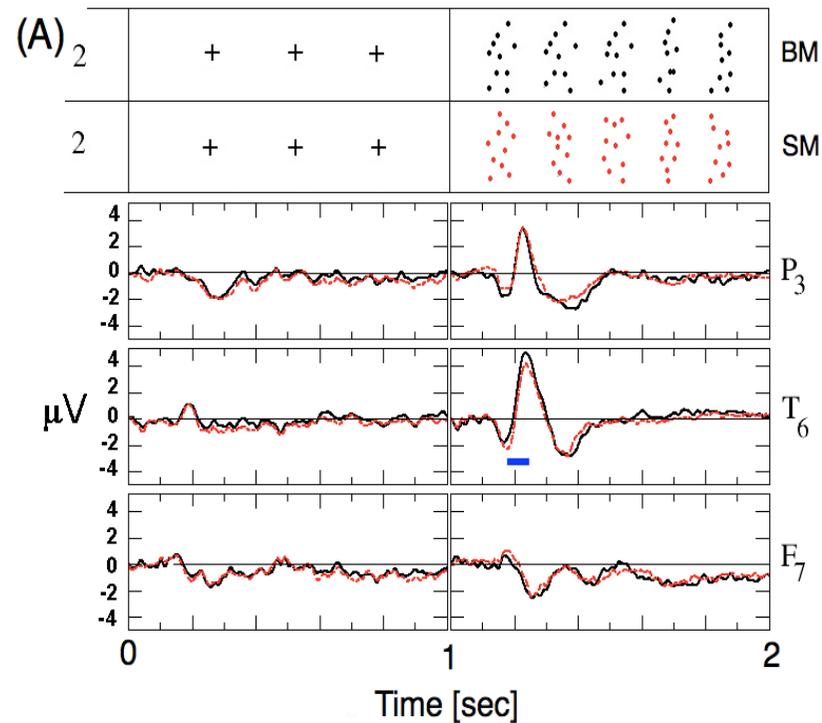
journal homepage: www.elsevier.com/locate/bbr



Research report

Electrophysiological correlates of biological motion permanence in humans

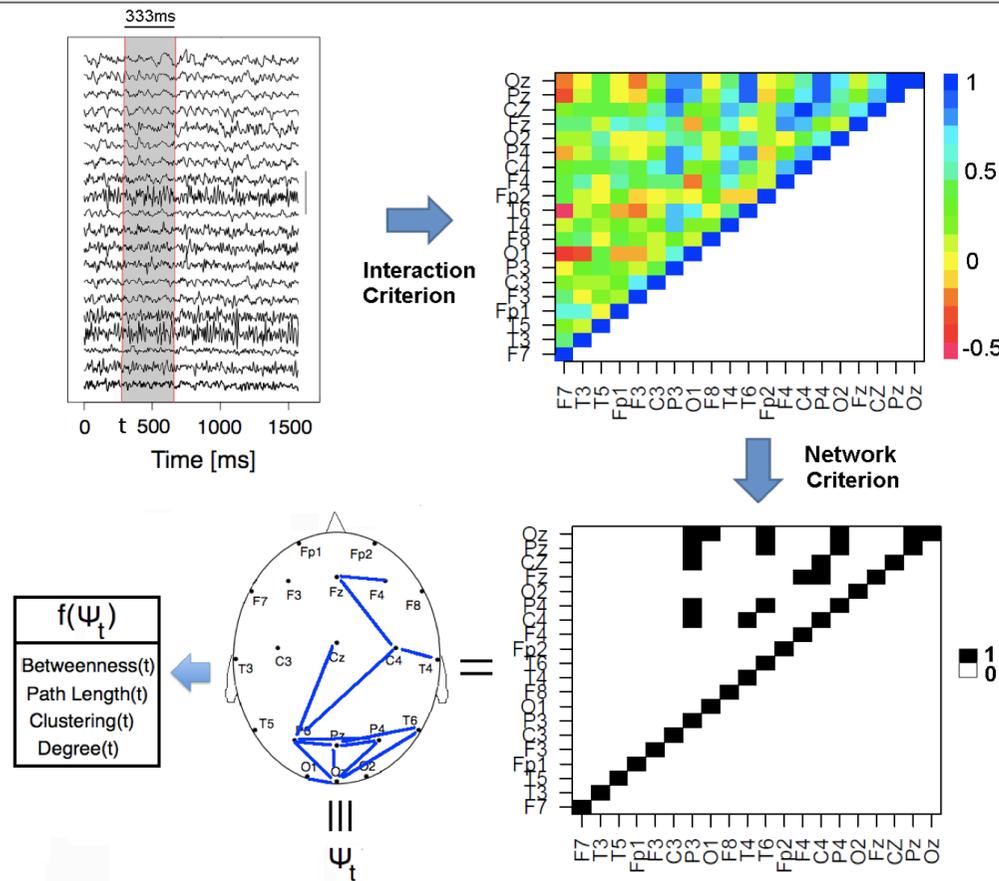
Ghislain Saunier^{a,b}, Eduardo F. Martins^a, Elisa C. Dias^c, José M. de Oliveira^a,
Thierry Pozzo^{d,e,f}, Claudia D. Vargas^{a,*}



Biological Motion Coding in the Brain: Analysis of Visually Driven EEG Functional Networks

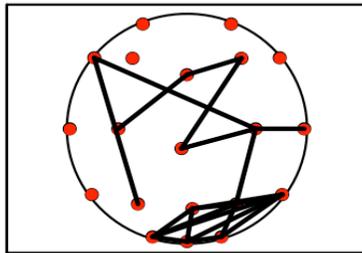
Daniel Fraiman^{1,2}, Ghislain Saunier^{3,4}, Eduardo F. Martins³, Claudia D. Vargas^{3*}

1 Laboratorio de Investigación en Neurociencia, Departamento de Matemática y Ciencias, Universidad de San Andrés, Buenos Aires, Argentina, **2** CONICET, Buenos Aires, Argentina, **3** Laboratório de Neurobiologia II, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal de Rio de Janeiro, Rio de Janeiro, Brasil, **4** Instituto de Ciências Biológicas, Universidade Federal do Pará, Belem, Brasil

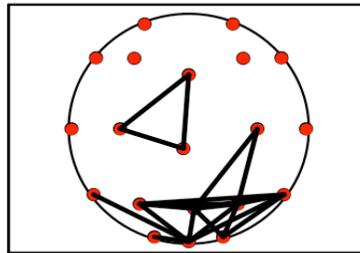


INTERACTION CRITERION:

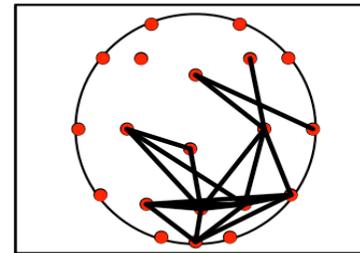
(A)



t=55.6s

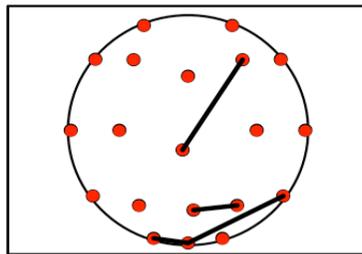


t=55.9s

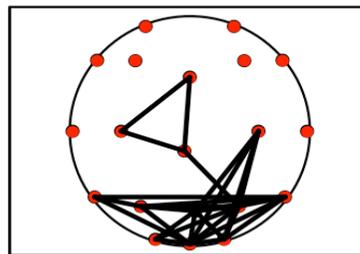


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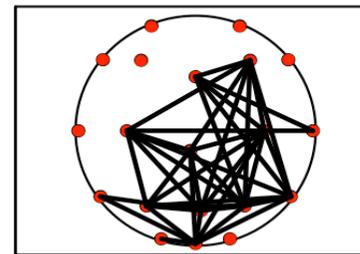
Fixed number of
links
 $K=20$



t=55.6s



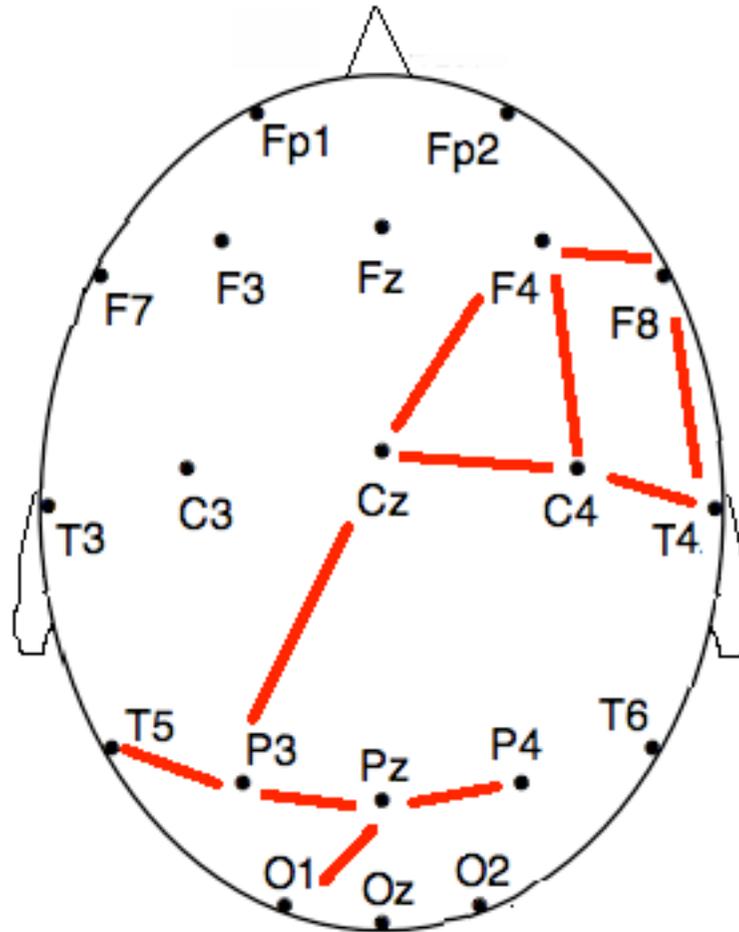
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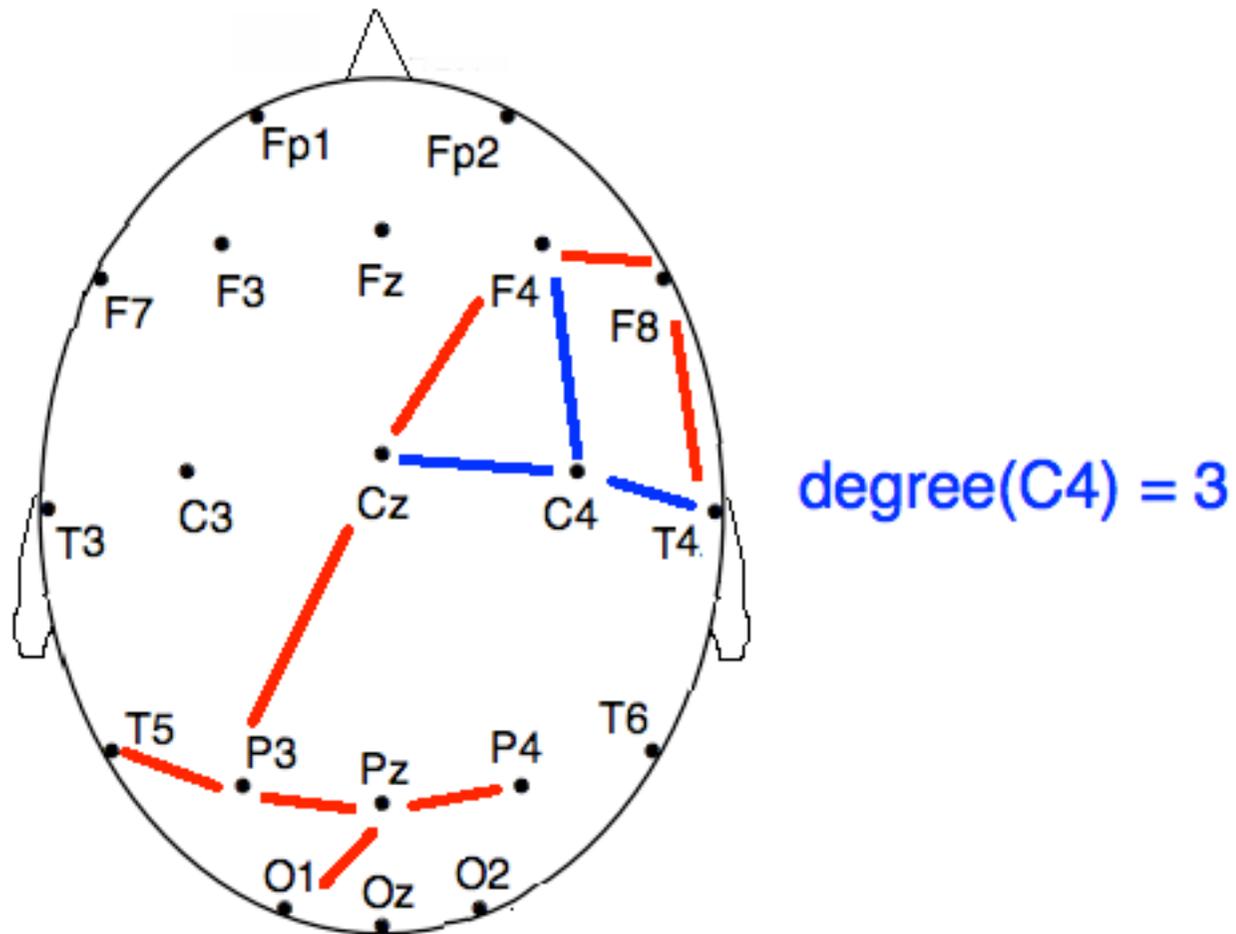
t=321.9s

Fixed correlation
threshold
 $\rho=0.7$

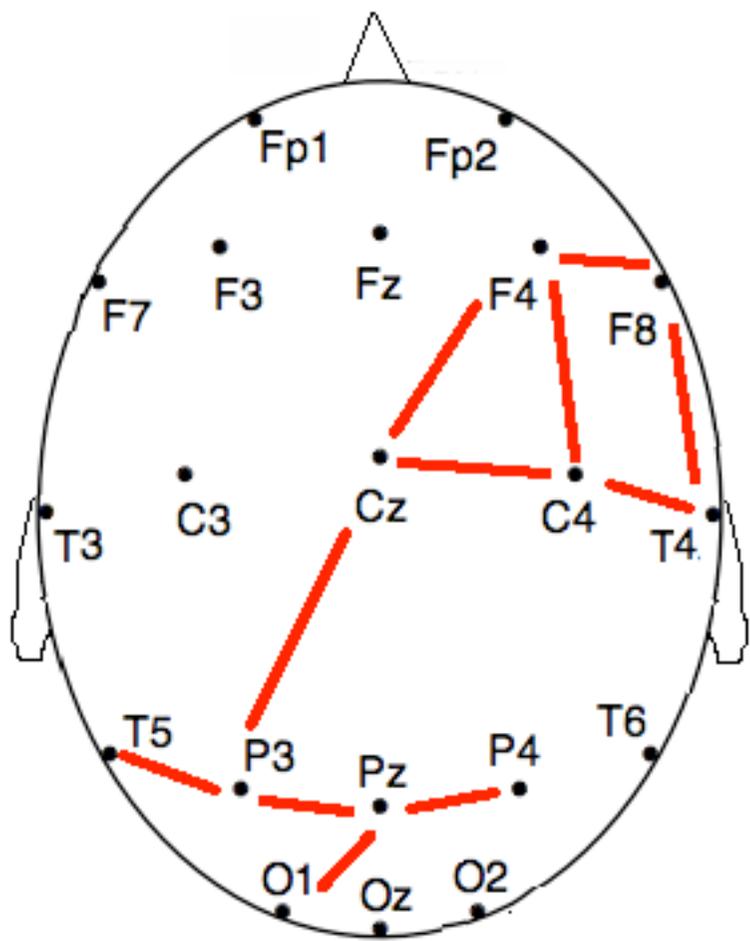
NETWORK PROPERTIES

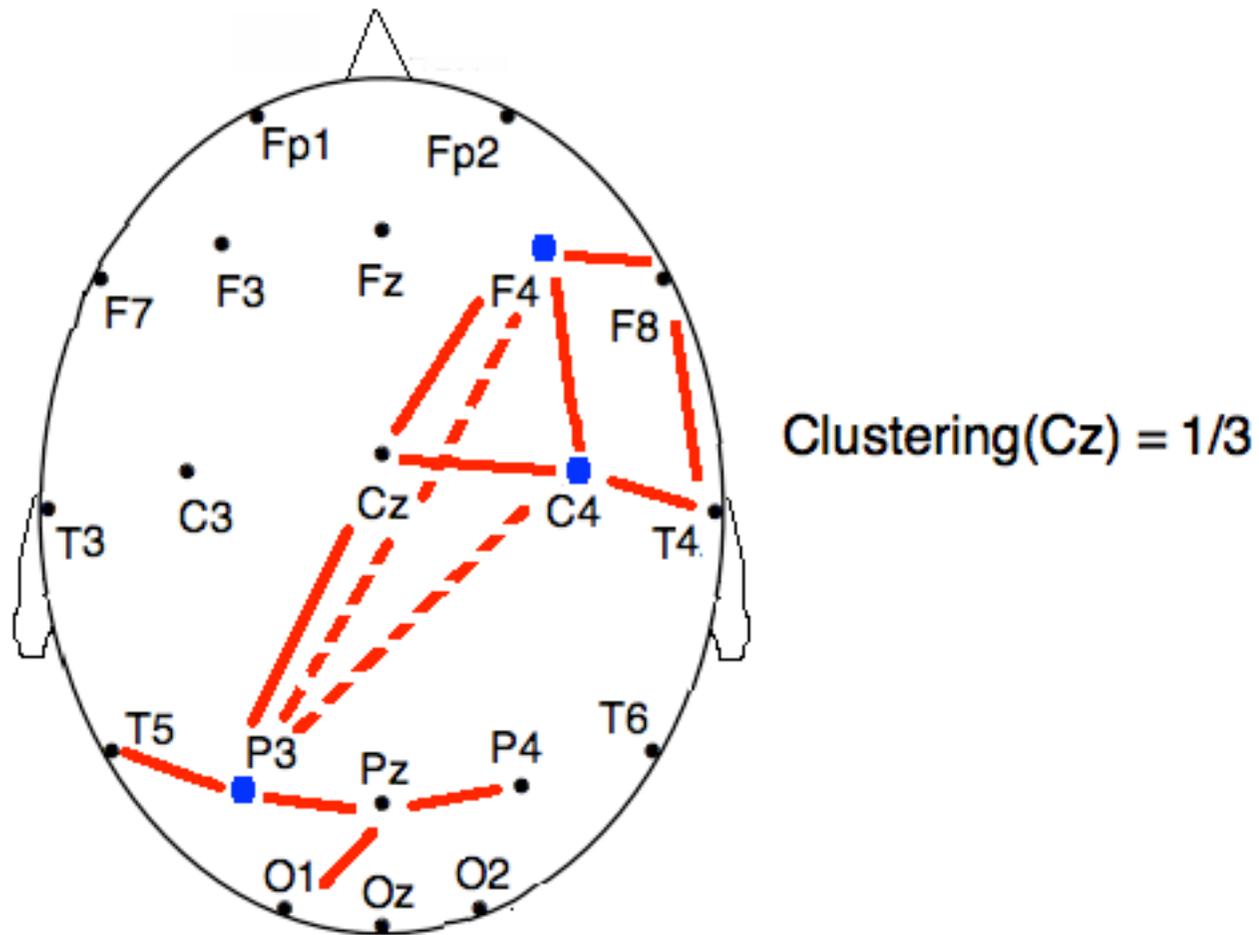


- **Average path length (L)**, defined as the average number of steps along the shortest paths for all possible pairs of network nodes
- (i.e., the number of people you will have to communicate through, on an average, to contact a complete stranger).

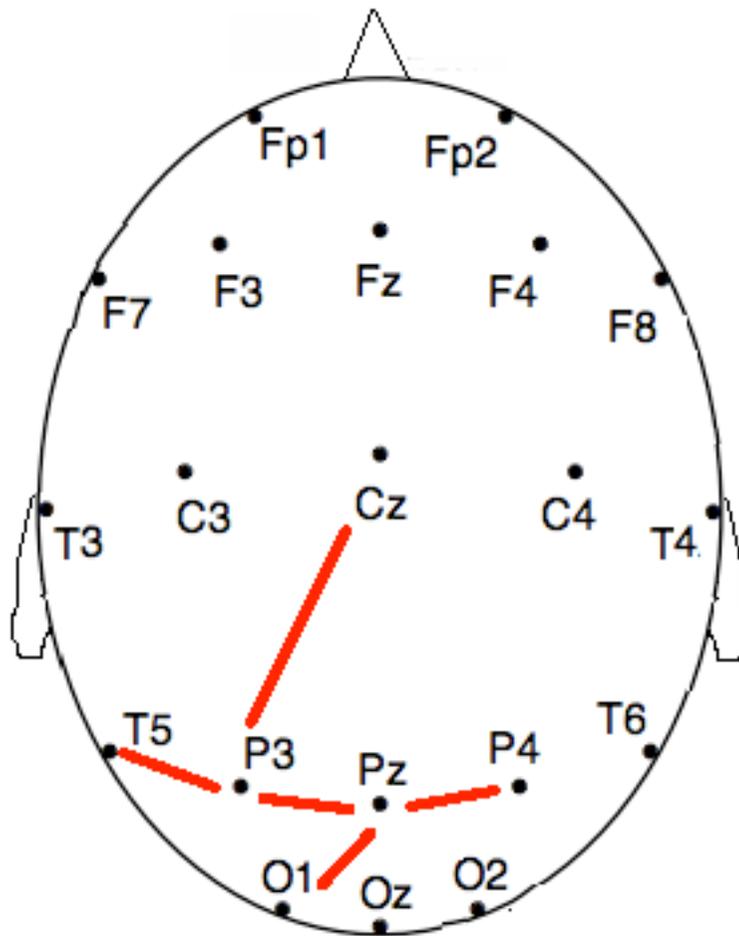


- **Degree centrality (D)**, defined as the number of links incident upon a node (i.e., the number of ties that a node has, or how influential a person is within a social network).

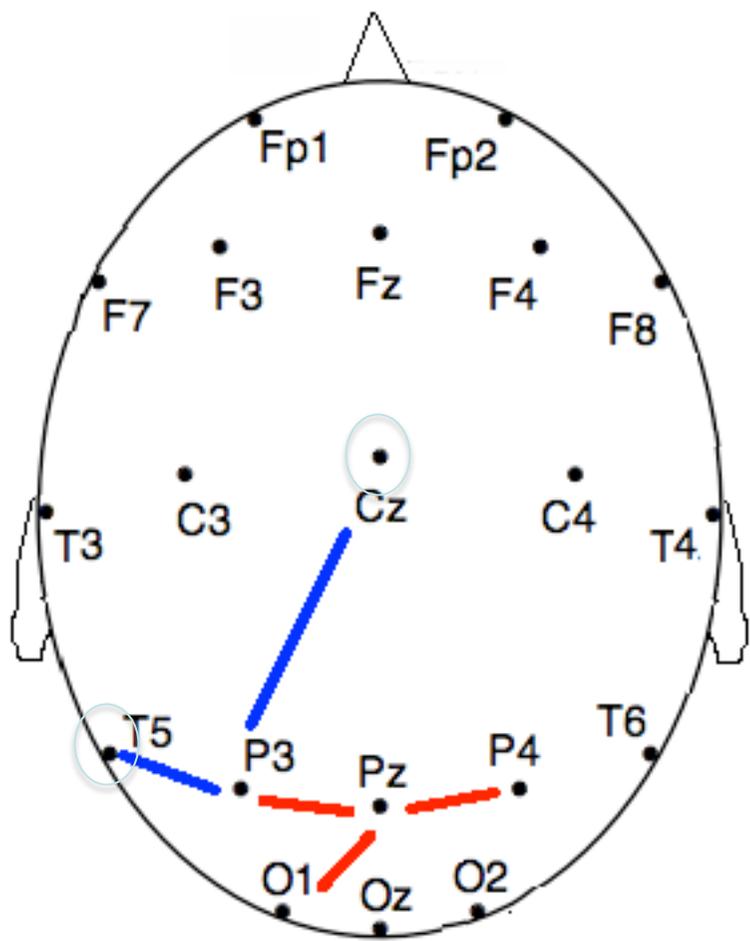




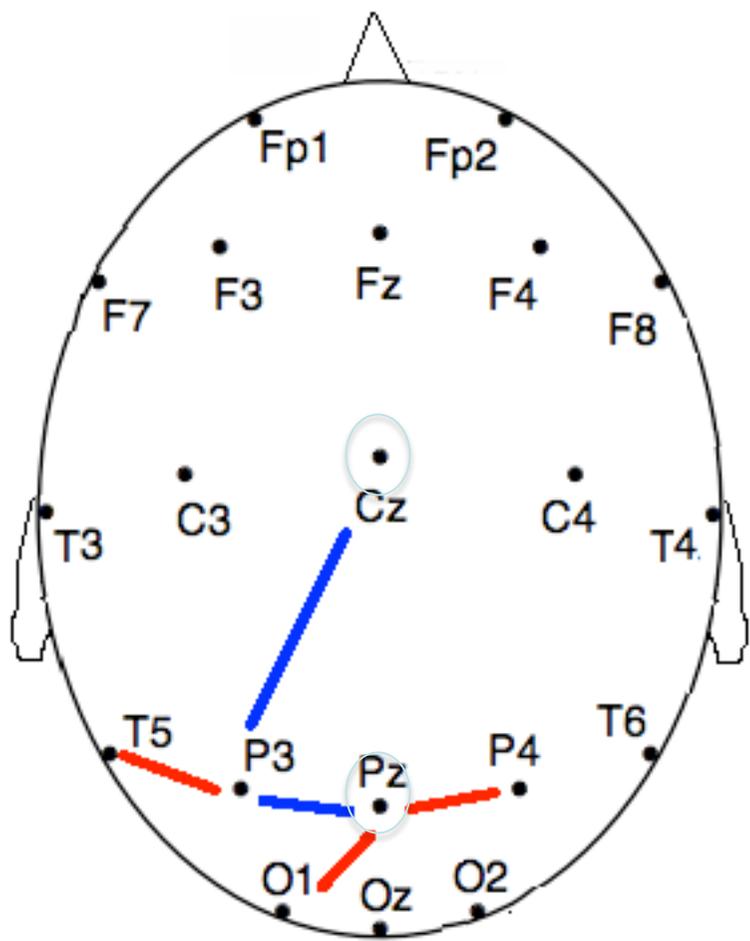
- **Clustering coefficient (C)** is a measure of how likely it is that node neighbors are connected to each other.



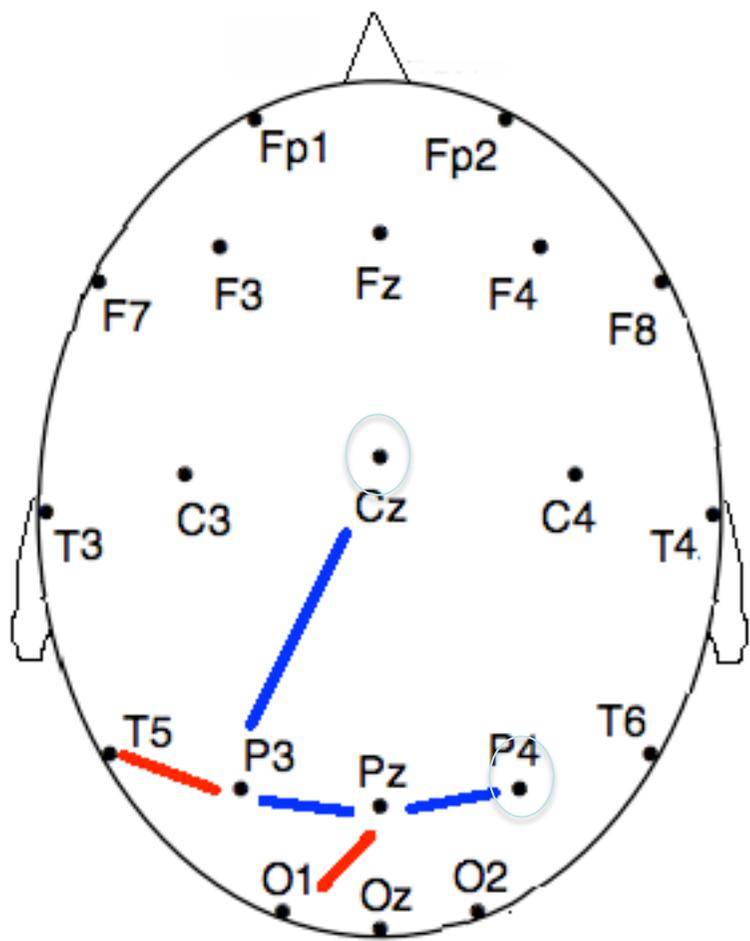
Betweenness (P3) = “proportion of all shortest paths that pass through P3”



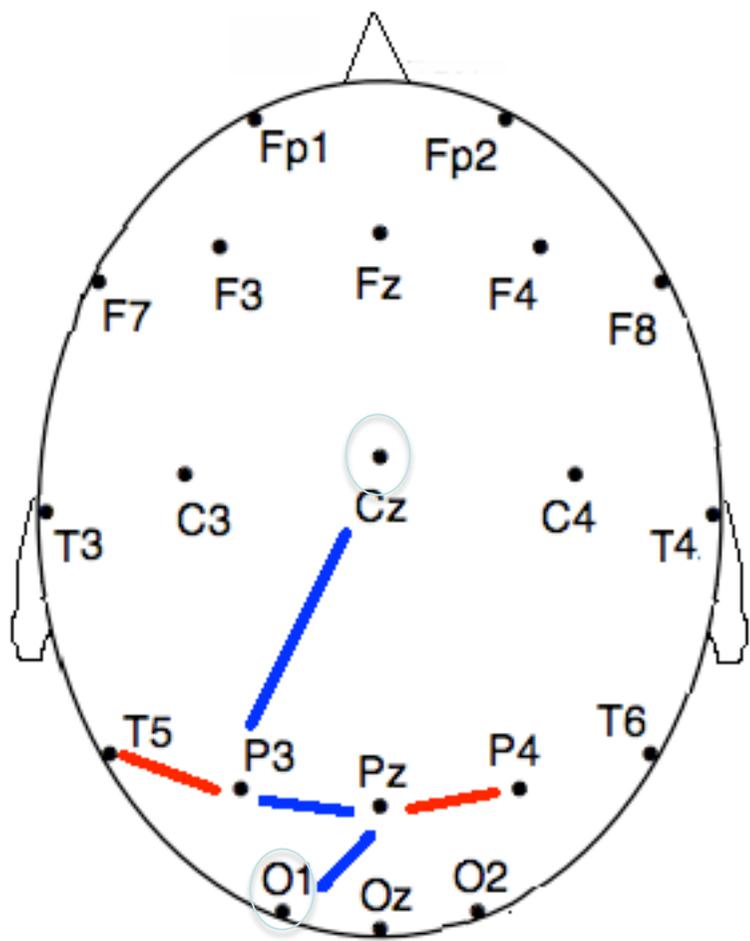
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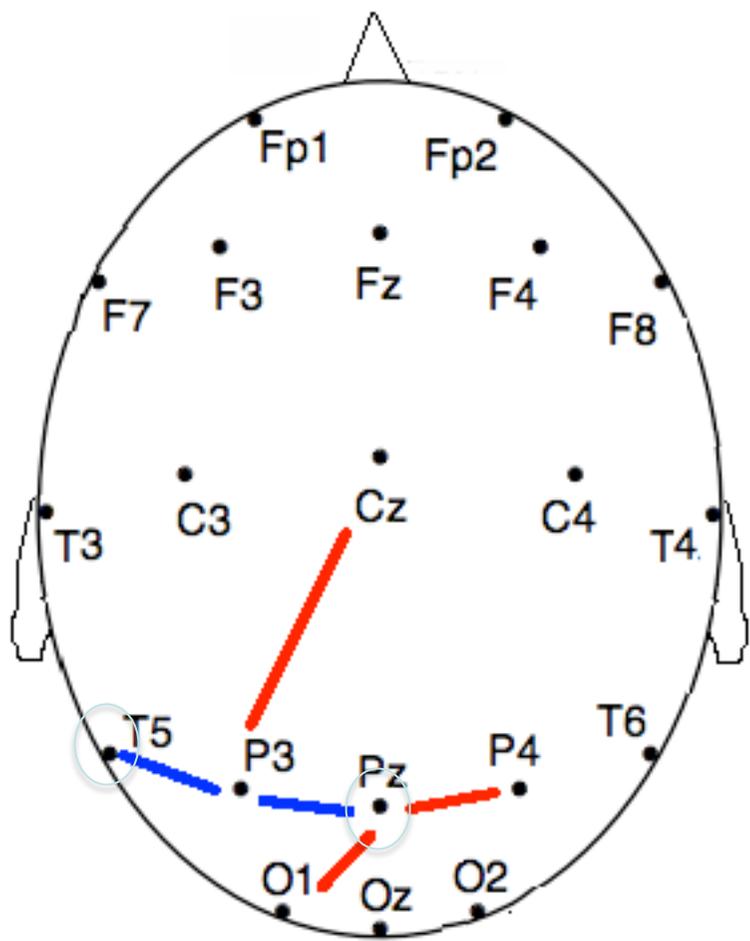
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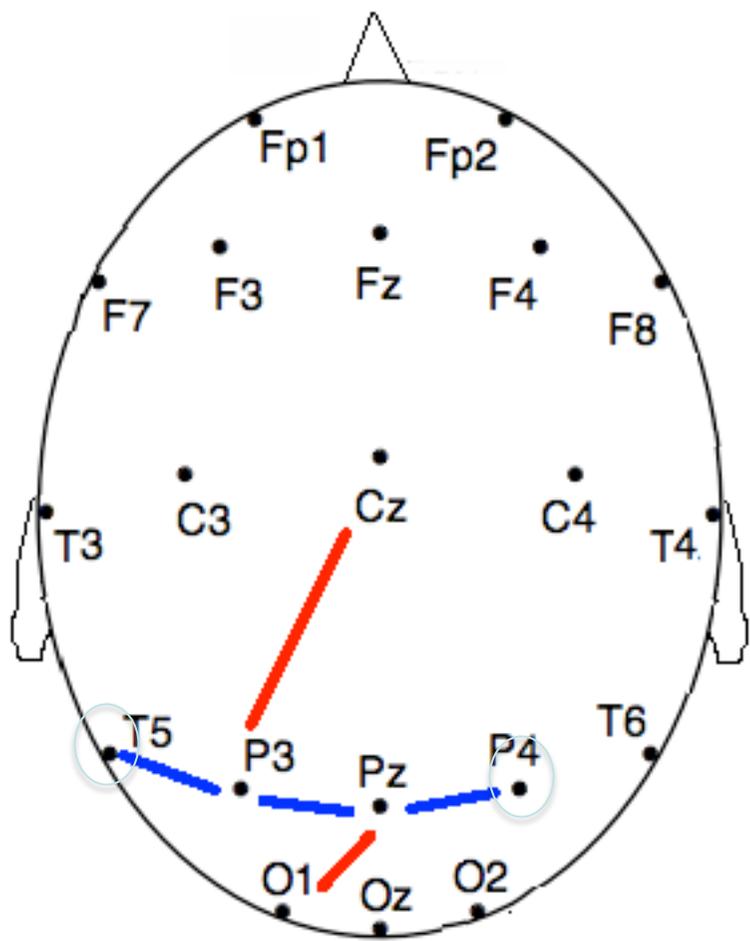
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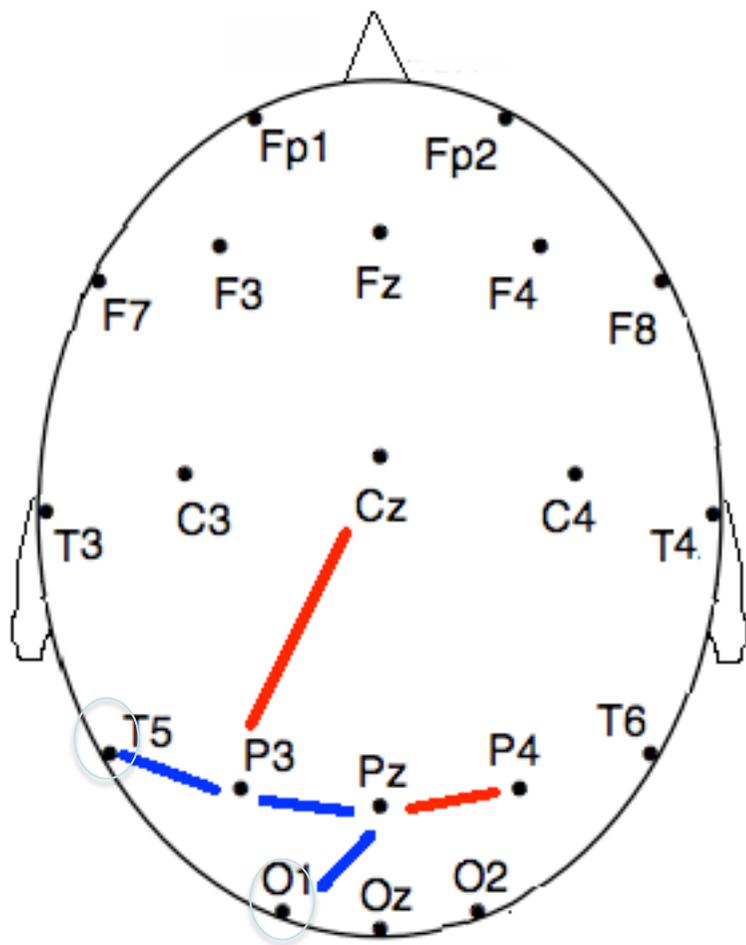
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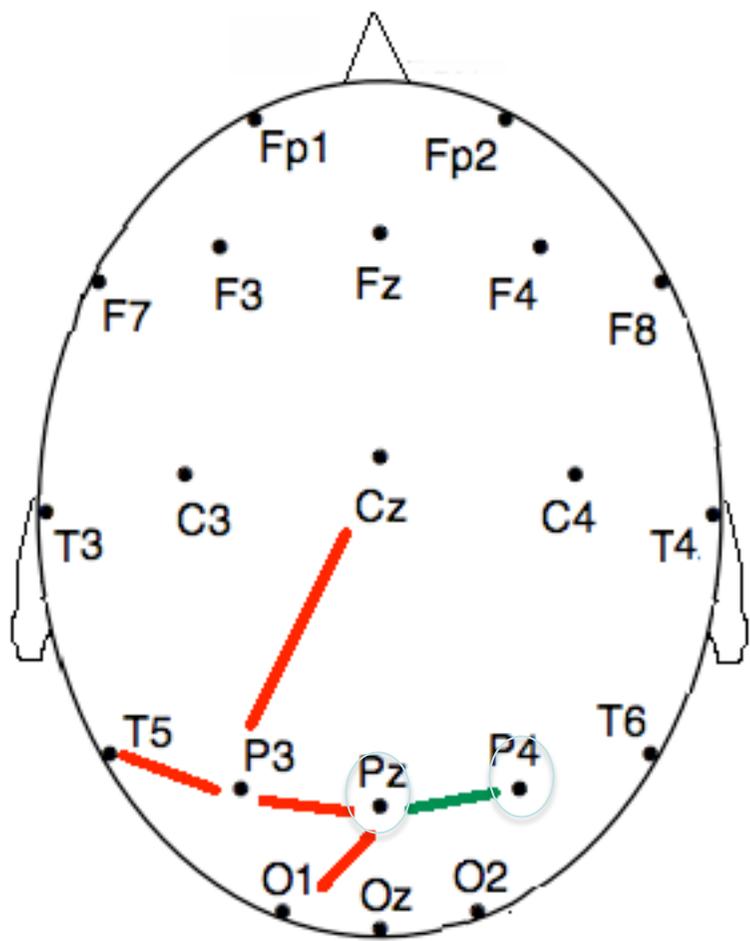
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6

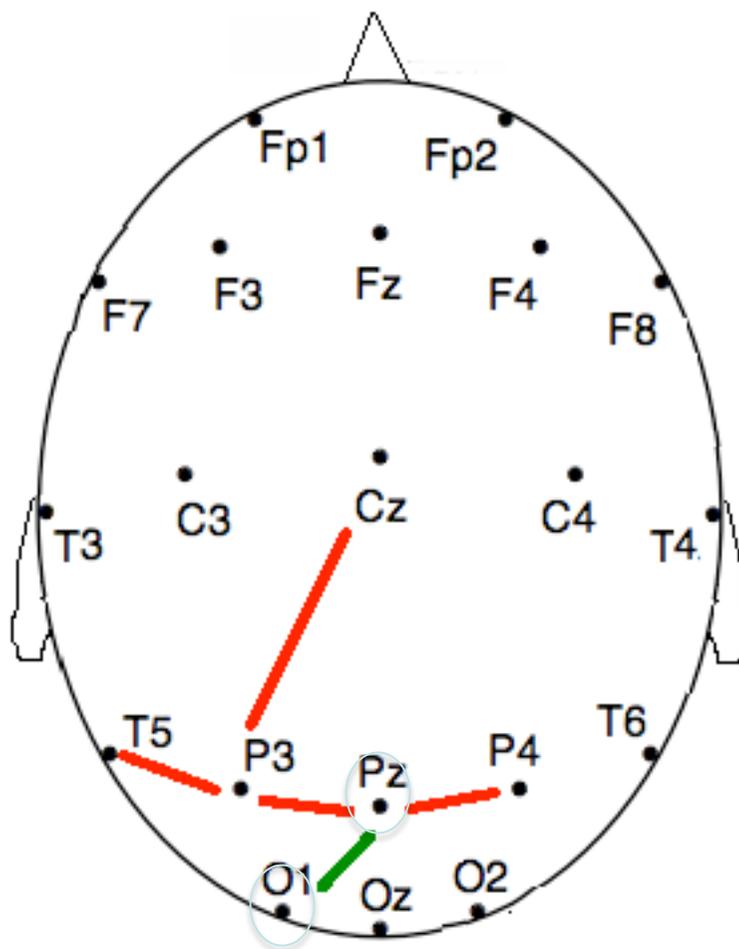


7



7

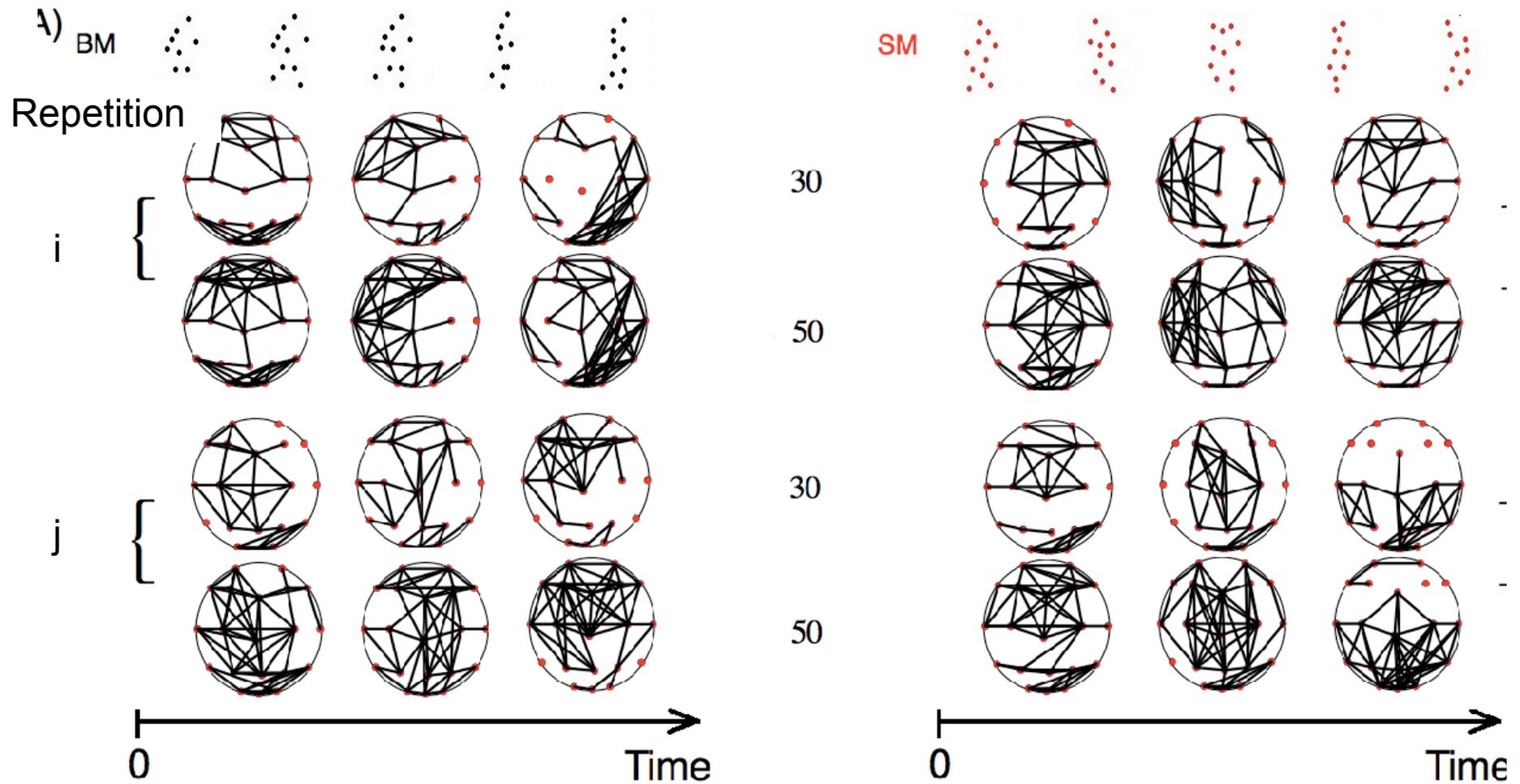
Betweeness(P3)=7/9



7

RESULTS

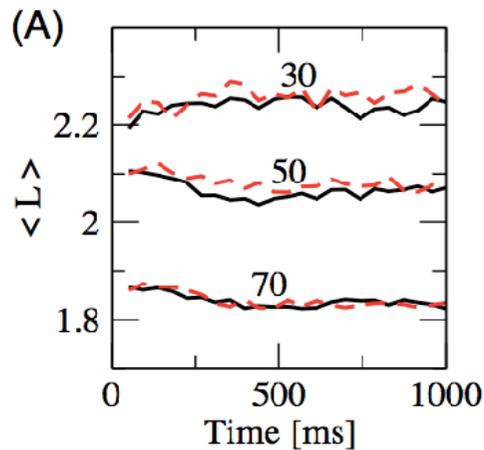
I Global network properties



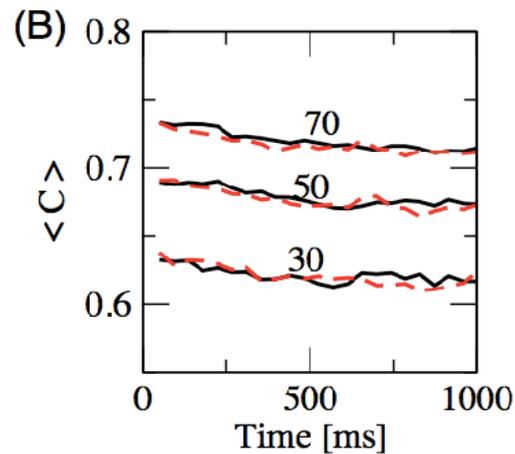
HIGH VARIABILITY INTER-TRIAL /BETWEEN CONDITIONS

Comparing global properties of *Biological motion (BM)* vs *Scrambled motion (SM)*.

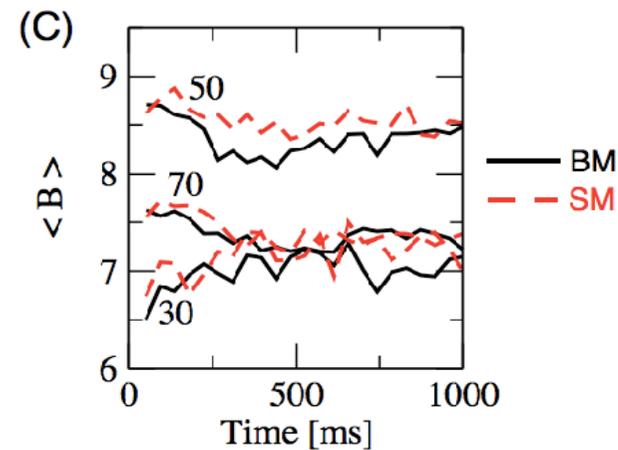
Path length



Clustering

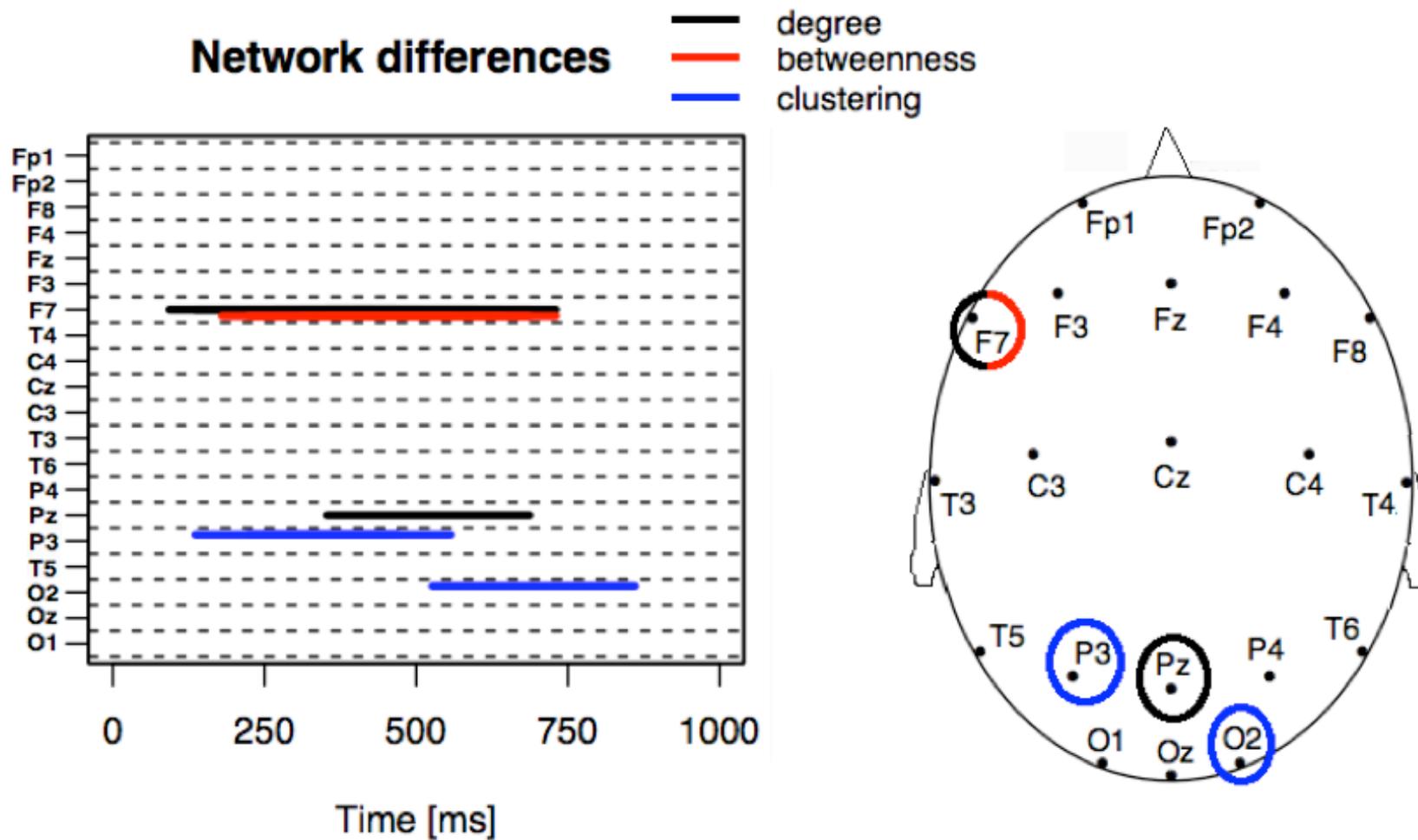


Betweenness

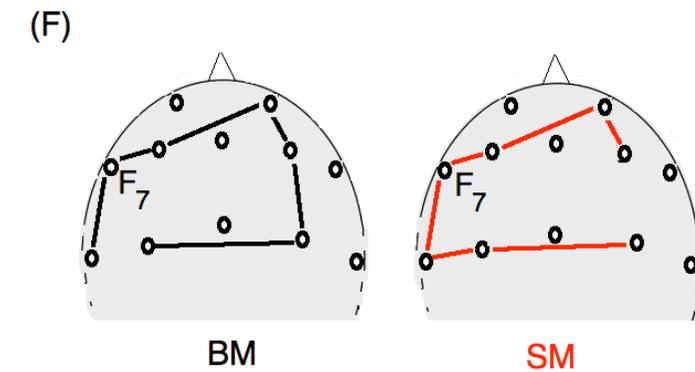
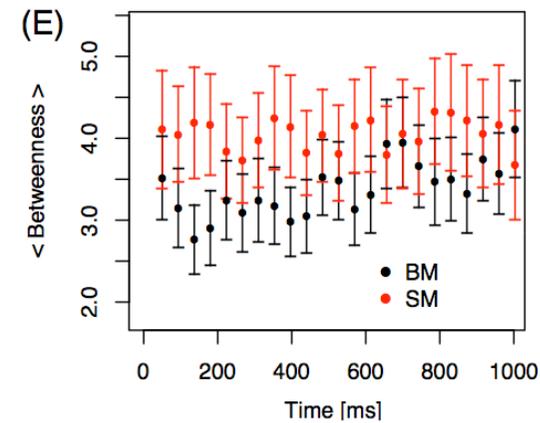
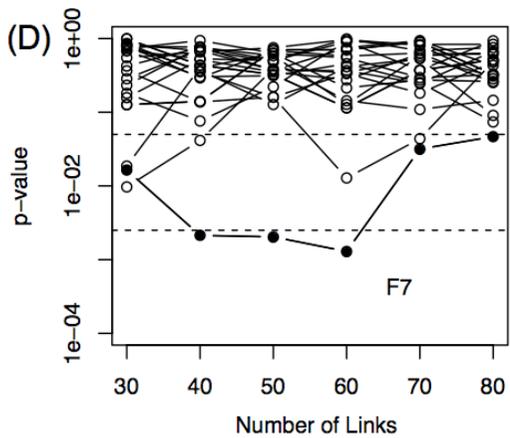
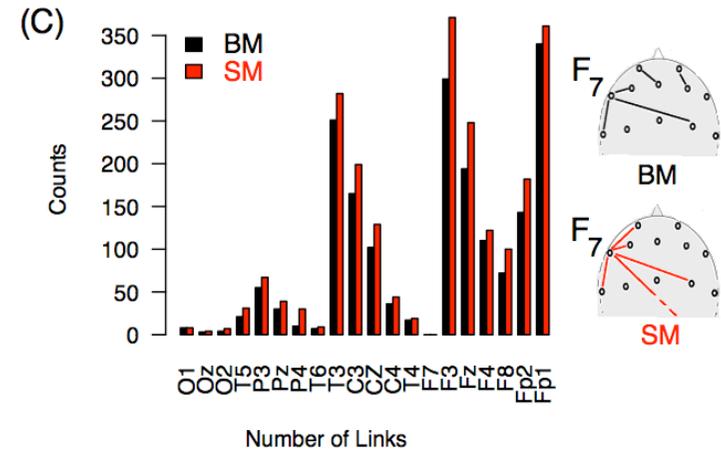
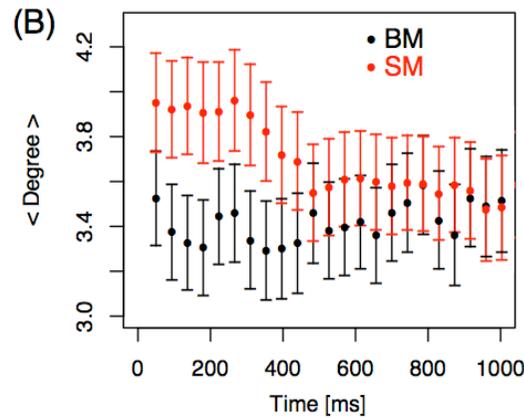
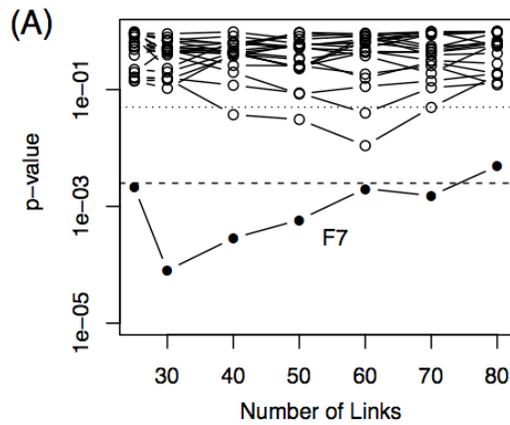


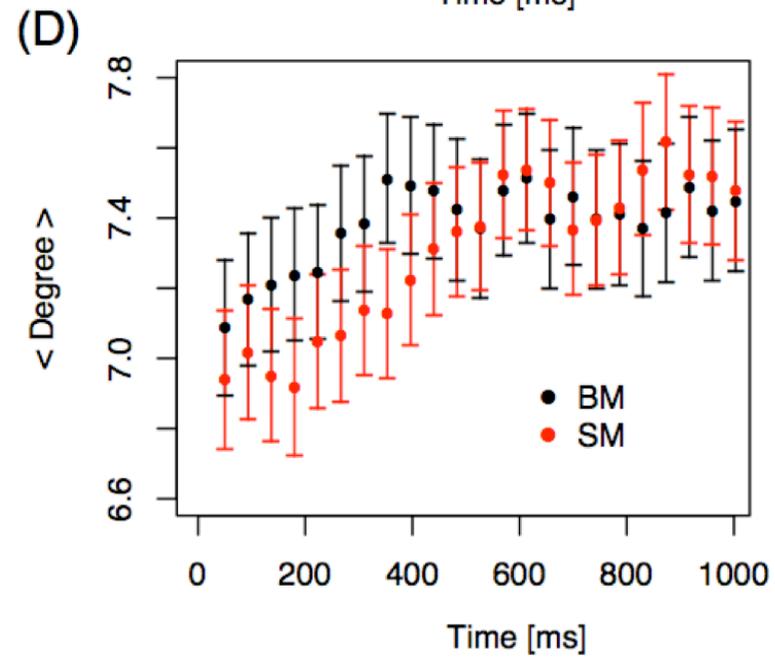
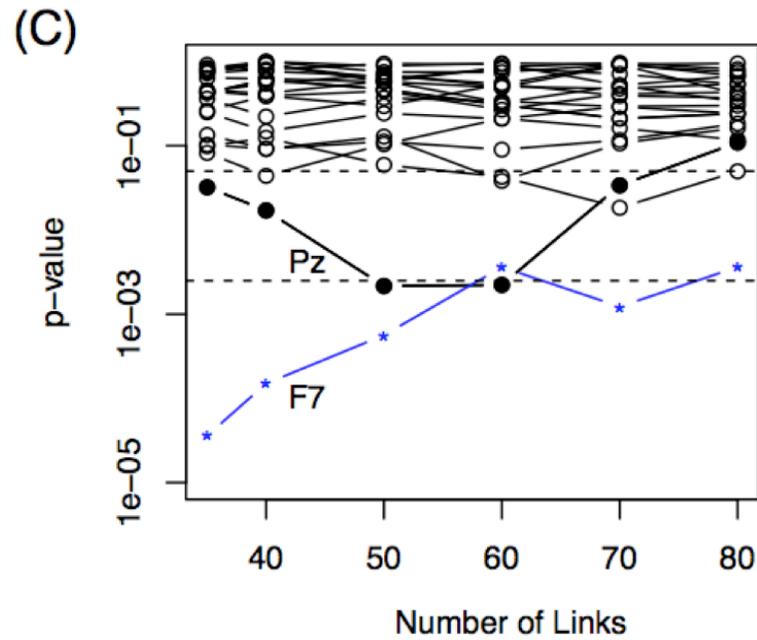
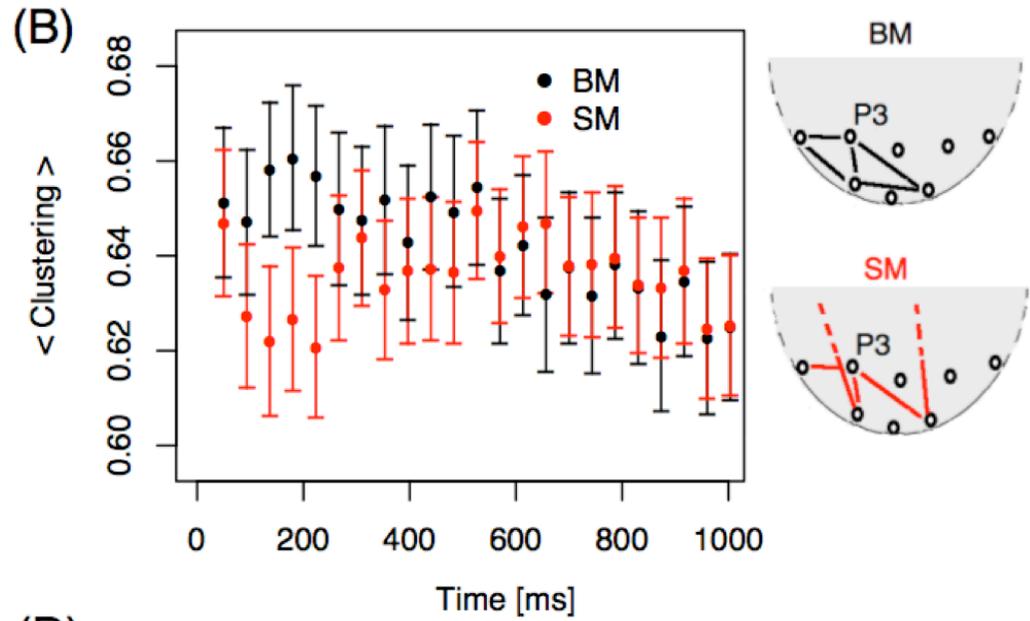
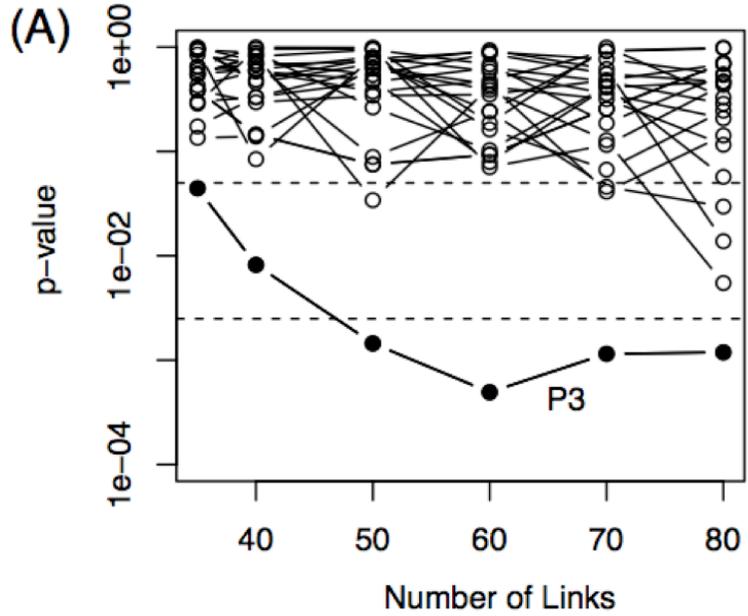
.....No difference in global properties regardless of the number of links!

II Local network properties



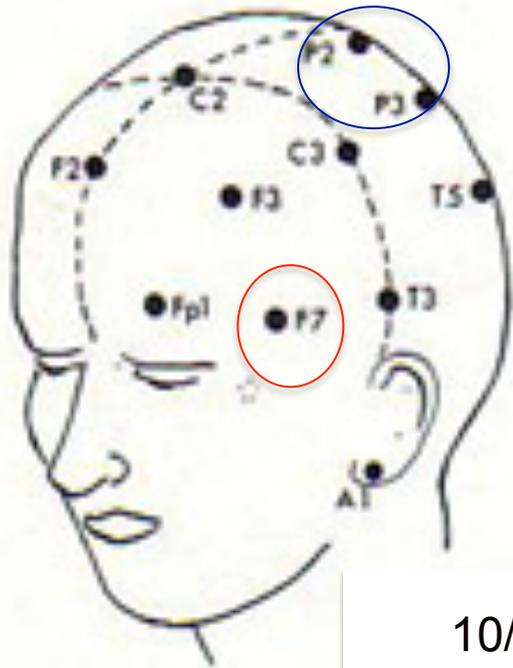
II Local network properties



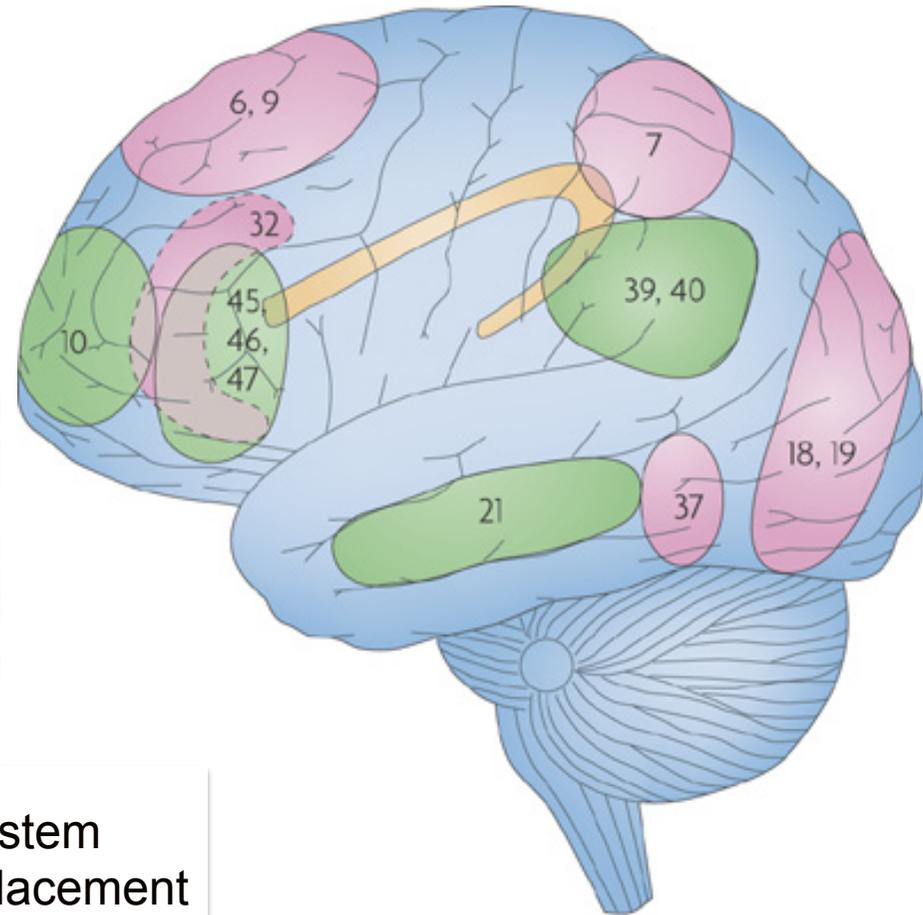


The Parieto-frontal circuit codes biological movement in primates and humans

(Kalaska et al., 1990; Desmurget et al., 2012)

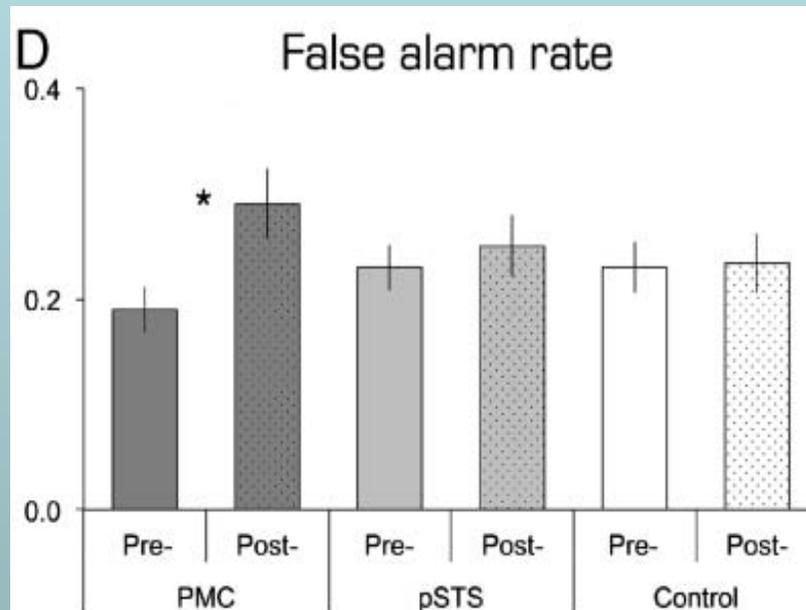
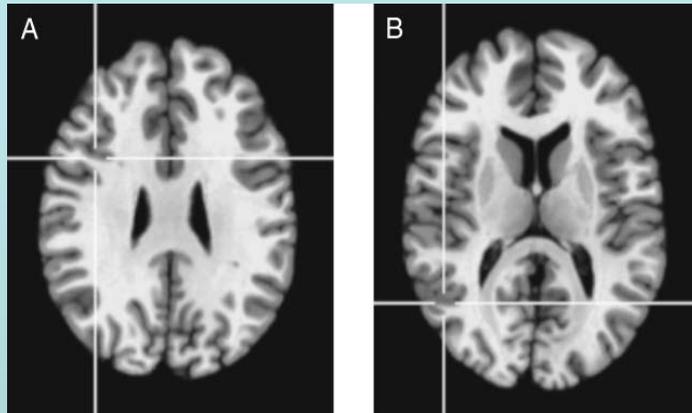


10/20 system
Electrodes placement





Theta-burst TMS



TMS in PMC (corresponding roughly to F7 region) affected participants' response bias to biological motion stimuli by increasing the tendency to respond that biological motion was present when it was not.

B. van Kemenade, N. Muggleton, V. Walsh, A. Saygin (2012)

Summary

- The use of a new fast-scale network methodology was herein proposed for the mapping of functional networks extracted from electroencephalographic activity driven by visual stimulation.
- Local network graph parameters of degree, betweenness, and clustering allowed us to distinguish between biological and scrambled motion conditions in precise moments in time and for specific node points.
- Thus, the functional network approach is a suitable method for studying brain function on the time scale of cognitive processing and it allows for a new level of understanding of the complex phenomena associated with brain function.

