

TITLE: ConnectHomo: From finding connections among functions in the brain to identify similarities among individuals in the world

ABSTRACT:

The present project is built up on a fundamental challenge for systems neuroscience, namely investigating the inter-relations between distinct human functions and quantitatively relate them to brain activity and connectivity measurements [1]. The project's aim is threefold:

1) Identifying the relationships among cognition, behaviour, personality, physical and sociodemographic measures in order to establish how different domains influence each other. To do so, we will first analyze existing big data sets (e.g., Human Connectome Project, HCP [2]), which represent the elective subject of study as they comprise a huge amount of data belonging to different domains. Different multivariate analysis and clustering methods [3,4] will be applied to the data to highlight similarities and dissimilarities in patterns of variables defining individuals' profiles. Moreover, we will collect psychophysiological and behavioural data by means of EEG and eye-tracking experiments to explore how cognitive and personality factors influence brain mechanisms and human behaviours [5], such as exploration of real-world scenes or recollection.

2) Investigating whether the variability of human behaviour might be effectively described by a few behavioural clusters. In other words, we will answer the question: is it possible to identify few recurrent 'behavioural styles' among individuals? These styles will thus provide a more holistic description of human behaviour, taking into account diversity and similarity of the individuals in multiple aspects.

3) Studying how such behavioural styles are mapped into the brain networks classically observed in resting-state conditions. We will use already collected fMRI measures (by the HCP) as well as *ad hoc* collected high-density EEG data to elucidate how these behavioural styles are expressed into resting-state functional connectivity.

REFERENCES:

1. Mill RD, Ito T, Cole MW. From connectome to cognition: The search for mechanism in human functional brain networks. *Neuroimage*. 2017;160:124-139. doi:10.1016/j.neuroimage.2017.01.060.
2. Barch DM, Burgess GC, Harms MP, et al. Function in the human connectome: Task-fMRI and individual differences in behavior. *Neuroimage*. 2013;80:169-189. doi:10.1016/j.neuroimage.2013.05.033.
3. Smith S, Nichols T, Vidaurre D, et al. A positive-negative mode of population covariation links brain connectivity, demographics and behavior. 2016;18(11):1565-1567. doi:10.1038/nn.4125
4. Szekely P, Korem Y, Moran U, Mayo A, Alon U. The Mass-Longevity Triangle: Pareto Optimality and the Geometry of Life-History Trait Space. *PLoS Comput Biol*. 2015;11(10):1-19. doi:10.1371/journal.pcbi.1004524.
5. Hoppe S, Loetscher T, Morey SA, Bulling A. Eye Movements During Everyday Behavior Predict Personality Traits. *Front Hum Neurosci*. 2018;12(April):1-8. doi:10.3389/fnhum.2018.00105.

PARTICIPANTS:

PI: Maurizio Corbetta

co-PI: Giorgia Cona, Samir Suweis, Livio Finos

Externals: Amos Maritan, Andrea Zangrossi

EXPERIMENTAL DATA:

To be acquired	x
Already acquired (ready to be used)	x

The present project will involve both the analysis of already collected data (i.e., from the Human Connectome Project), and the collection of behavioural and psychophysiological data (i.e., by means of eye-tracker and high-density EEG) in resting-state and task-based conditions.

In particular, two ongoing experiments are described in the following:

- 1) Eye-tracking experiment: N=100 subjects, collection of eye movements in resting-state condition, during the exploration of a set of real-world pictures and during the free recall of a subset of the same pictures. In addition, a battery of neuropsychological tests and personality questionnaires will be acquired for each subject. This study is already approved by the Ethical Committee.
- 2) High-density EEG experiment: N=100 subjects, EEG recording in resting-state condition, during the exploration of a set of real-world pictures and during the free recall of a subset of the same pictures. After this session, a battery of neuropsychological tests and personality questionnaires will be acquired for each subject. This study is not approved by the Ethical Committee yet (expected time response: 2 months).

Ethics committee:

Obtained	x
Conditioned submission*	Expected time response (in months):
Not required	

* request will be submitted only if a PhD student will be associated to the project