Project title: Learning and memory: From gene networks to brain activation patterns

Project leader: Prof. Dr. E. Formisano

Function: Professor

Collaborators: Prof. Dr. P. de Weerd, Dr. M. Moerel

Proposal (250 words):

Introduction: With the emergence of large datasets that combine human neuroimaging with genetic screening results, the challenge arises to integrate the knowledge from different realms of science and thereby create new insight into human brain function. Here, we aim to connect processes that affect learning and memory at the small spatial scale of molecular pathways to those observed at the large scale of interacting neuronal networks.

Hypothesis and Objectives: We expect to identify key genes and molecular pathways that are linked to learning-induced changes in functional and structural connectivity in effective and less effective learners.

Setting and Methods: The candidate will work at the Maastricht Centre for Systems Biology (MaCSBio), a young, interdisciplinary institute at Maastricht University aiming to integrate biological data from different empirical domains. Three studies will be executed. In study 1 and 2 you will work with existing data from the Human Connectome Project consisting of behavioral, neuroimaging (EEG, MEG, MRI), and genetic data of 1,200 twins and their non-twin siblings. Computational models will be employed to test effects of selected cellular pathways on neuronal network interactions and associated cognitive behaviors, thereby integrating observations across spatial scales and disciplines. In study 3 you will design and execute a follow-up study using ultra-high field fMRI linking variation in participants' learning performance to variation in their genetic profile.

Impact: The combination of analyzing a rich database along with the design and execution of a tailored experiment provides a unique opportunity to achieve novel insights into the living human brain.

Requirements candidate: Highly motivated student with good English communication skills, with a proactive and resolute attitude. A background in neuroscience, engineering, systems biology, or related fields, and good programming and data analysis skills are required.

Top 5 selected publications:

1. Moerel M, De Martino F, Kemper VG, Schmitter S, Vu AT, Uğurbil K, Formisano E, Yacoub E. (2017) Sensitivity and specificity considerations for fMRI encoding, decoding, and mapping of auditory cortex at ultra-high field. Neuroimage. doi: 10.1016/j.neuroimage.2017.03.063.
2. Santoro R, Moerel M, De Martino F, Valente G, Ugurbil K, Yacoub E, Formisano E. (2017) Reconstructing the spectrotemporal modulations of real-life sounds from fMRI response patterns. Proc Natl Acad Sci U S A 114: 4799-4804.
3. De Martino F, Yacoub E, Kemper V, Moerel M, Uludag K, De Weerd P, Ugurbil K, Goebel R, Formisano E (2017) The impact of ultra-high field MRI on cognitive and computational neuroimaging. Neuroimage. doi: 10.1016/j.neuroimage.2017.03.060.
4. Ley A, Vroomen J, Hausfeld L, Valente G, De Weerd P, Formisano E (2012) Learning of new sound categories shapes neural response patterns in human auditory cortex. J Neurosci. 32: 13273-80.
5. Vallès A, Boender AJ, Gijsbers S, Haast RA, Martens GJ, de Weerd P (2011) Genomewide analysis of rat barrel cortex reveals time- and layer-specific mRNA expression changes related to experience-dependent plasticity. J Neurosci. 31: 6140-58.