

## **Perceptual memory in the human visual system**

### **Results:**

In this Project, we have investigated memory mechanisms in the human visual system, by employing a combination of psychophysics and functional magnetic resonance imaging (fMRI) methodologies to identify the neural correlates of different types of learning processes. For this purpose, we implemented and optimized a number of fMRI visual mapping paradigms in order to identify the visual brain areas of interest.

We first observed the adaptive functional reorganization of visual memory in a population of temporal lobe epilepsy patients with right unilateral hippocampal sclerosis. We used fMRI to measure brain activity changes during the episodic encoding of abstract line drawings and found that the patients engaged the left hippocampus more than controls and that the level of engagement was correlated with their memory recognition scores. These finds suggested functional reorganization of visual memory with an adaptive role, as a consequence of prolonged disease. We also found that familiar items activated visual cortical areas more than novel items, suggesting a reinstatement of visual information as a consequence of learning.

In a second study, we implemented a visual learning paradigm whereby subjects performed a face discrimination task on faces presented in multiple orientations, in order to investigate the hypothesis that the human visual system contains specialized processing mechanisms that are more engaged by upright faces than by inverted faces or non-face objects, as a result of extensive practice with upright faces. Our psychophysics experiments showed that participants gave more errors and were slower in their responses as faces were rotated away from 0°. In addition, performance was improved when participants underwent periods of training, both for trained and untrained orientations. Consistently with the expertise hypothesis, we also found a parametric modulation of fMRI activity in specialized visual brain areas, according to the quadratic behavioural effect of face orientation.

### **Published work:**

Full papers in international peer reviewed journals:

- Figueiredo P, Santana I, Teixeira J, Cunha C, Machado E, Almeida, E., Sales, F., Castelo-Branco M (2008) Adaptive visual memory reorganization in right medial temporal lobe epilepsy. *Epilepsia* 49(8):1395-1408.

Abstracts in international conference proceedings:

- Saiote C, Silva J, Gomes C, Lauterbach M, Reimão S, Figueiredo P (2010) Parametric fMRI correlates of multiple face orientations. 16<sup>th</sup> Annual Meeting of the Organization for Human Brain Mapping, June 2010, Barcelona, Spain.
- Gomes CA, Mendes M, Figueiredo P. (2009) Perceptual learning for multiple face orientations. *Perception*, 38S, p. 79. 32<sup>nd</sup> European Conference on Visual Perception (ECPV 2009), Regensburg, Germany.

- Cruz P, Teixeira J, Figueiredo P. (2009) Reproducibility of a rapid visual brain mapping protocol. 15th Annual Meeting of the OHBM, June 18-23, 2009, San Francisco, US.
- Martins R, Andrade A, Figueiredo P, (2008) Slice timing correction in BOLD fMRI data. 14th Annual Meeting of the OHBM, Melbourne, Australia.
- Figueiredo P, Cavaco S, Almeida I, Van Asselen M, Massano J, Cunha C, Machado E, Santana I, Castelo-Branco M (2007) Dissociable memory impairments after selective bilateral fornix damage. International Neuropsychological Society, Spain.
- Figueiredo P, Santana I, Teixeira J, Cunha C, Machado E, Almeida, E., Sales, F., Castelo-Branco M (2007) Visual memory reorganization in right medial temporal lobe pathology. 13th Annual Meeting of the OHBM, Chicago, USA.
- Figueiredo P, J. Teixeira, J. Xavier, I. Santana, M. Castelo-Branco (2006) Modulation of activity throughout visual cortex during episodic memory retrieval. 12th Annual Meeting of the OHBM, Florence, Italy.
- Figueiredo P, I. Santana, E. Machado, C. Cunha, A. Pinto, M. Castelo-Branco (2005) Dissociating the neural correlates of verbal and visual episodic memory in normal subjects and in patients with medial temporal lobe pathology. Program No. 191.12. *2005 Abstract Viewer/Itinerary Planner*. Washington, DC, USA. Society for Neuroscience, 2005. Online.
- Figueiredo P., Machado, E., Santana, I., Castelo-Branco, M. (2005) Retrieval of abstract line drawings modulates activity in retinotopic visual areas. 28th Annual Meeting: European Conference on Visual Perception, A Coruña, Espanha.

### **Area(s) of interest:**

Functional brain imaging, memory and learning in the visual system

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