Dynamic eye-movement encoding in human cortex using ultra-high field fMRI (7Tesla)

ABSTRACT:

Background
Eye movements are a paradigmatic example of a sensory change, induced by the motor system. In human vision the eyes actively sample the environment. If we were to perceive the world exactly as it is displayed if front of our eyes, the visual scene would seem a sequence of frequent and large jumps, making any matching attempts between them impossible. The visual system needs to distinguish 'jumps' that are due to saccades as opposed to changes in the external world. The oculo-motor system provides a warning of an upcoming eye movement (corollary discharge); thus, the visual system can compensate for it and achieve the stability of the visual input across eye movements during active vision.

Aims
To characterize i) how the visual system keeps track of sensory changes over time by means of gain fields - that is, gain modulated responses in visually responsive cortex, coupled with eye position, allowing to infer eye position at any given time from a population level. ii) Characterize how kinematic properties are mapped within human neocortex.

Method
High-field imaging at 7T, measuring BOLD signal in human neocortex. Data was acquired using a 7T Magnetom Terra MRI scanner (Siemens, Erlangen, Germany) and 32-channel head coil (Nova Medical Inc., Wilmington, MA, USA) at the Imaging Centre of Excellence (University of Glasgow, UK). The analysis incorporated state of the art forward modelling techniques. 12 participants took part in the first stage of the investigation (Eye movement topography, 3 MRI session for each participant) and 11 participants took part in the second stage of the investigation (Gain field estimation, 3 MRI session for each participant).

Results
Gain fields can be observed throughout human visual cortex. Saccade kinematics is mapped specifically in human parietal cortex.

Conclusions
Human neocortex keeps track of sensory changes via the gain field mechanism. Distributional features of gain fields and saccade kinematics are topographically arranged in human neocortex.

Keywords
Gain-fields, Saccade kinematics, Human neocortex, High-field imaging

Published Work:

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Researcher's Contacts:

Alessio Fracasso, Ph.D.,
School of Psychology and Neuroscience
University of Glasgow
62 Hillhead Street, Room 610
G12 8QB, Scotland, UK

Phone: 0141 330 4915
Email: alessio.Fracasso@glasgow.ac.uk