Spatial vision & representation of space

Visual stability and coordinate systems

Visual experience is stable and continuous in spite of the repeating movements of our head, eyes, body and objects in our surroundings. Production of a coherent representation in such conditions may be achieved by transforming ?retinotopic? representations that are centered around the fovea (thus changing with eye movements) to ?spatiotopic? representations that encode the objects? absolute location in space (or at least its location to the head or body).

Using advanced fMRI techniques such as MVPA and adaptation analysis we investigate the conditions in which such representations may emerge and be sustained, as well as the parts of the cortex that are recruited for that purpose. Spatiotopic information, may be very beneficial when interacting with our surroundings for example. To explore this notion, we had subjects view videos of hands manipulating objects, while changing the location of the gaze, videos, or both between conditions. This allowed us to check if the activity in certain brain regions is changing with the video?s absolute location (Spatiotopic) or relative location relative to the gaze position (retinotopic). In this case we found that representation is retinotopic along the occipital and parietal cortices, and that this mapping is strongest early in the processing stream.
In a different project we checked if the emergence of Spatiotopic representations may be linked to spatial attention, and to the level of certainty as to the location of the next stimulus. We found that regions in the Parietal Cortex are less active for objects appearing in a repeating (and therefore expected) Spatiotopic position in space. In addition, some Occipital regions showed higher level of adaptation to object identity when the object repeated in the same Spatiotopic position.

Visual stability and saccadic suppression

Visual stability is also challenged by frequent saccades, which are interspersed between fixations and can cause blurry image. This is achieved in part by an effective filtering of the visual information during saccades, termed “saccadic omission”. To better characterize this phenomenon we design a novel gaze-contingent paradigm, in which upon detecting the initiation of a saccade, a shape is presented very briefly, such that it disappeared before the saccade was completed. The subject’s task was to perform a discrimination task (e.g. decide if the flashed ellipse was vertical or horizontal). We followed the performance of the subjects as they repeated this task over several days. Performance became dramatically better, showing that peri-saccadic perception can be improved at will, with appropriate training.
Publications

Viewed actions are mapped in retinotopic coordinates in the human visual pathways

Sensitivity to spatiotopic location in the human visual system

Learning to avoid saccadic suppression

Practice Improves Peri-saccadic Shape Judgment but does not Diminish Target Mislocalization

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