Role of magnocellular and parvocellular visual pathways in object and word recognition

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Introduction

How do the different properties of the main visual pathways influence visual recognition?

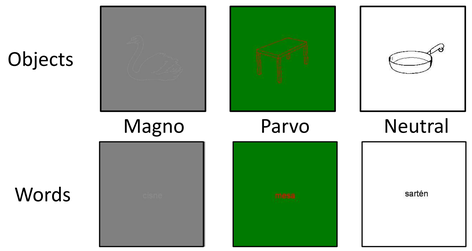
- Magnocellular dorsal stream is involved in detecting spatial relationships and rapid changes, being highly sensitive to motion[1]
- Parvocellular ventral stream is responsible for visual resolution and chromatic processing[2]
- The magnocellular pathway appears to be involved in text perception and reading[3]
- Deficits in both the magnocellular and parvocellular pathways have been observed in children with dyslexia[4,5]
- Little is still known about their specific contribution to typical visual recognition and reading.

Aim: Unravel the functional involvement of magnocellular and parvocellular visual pathways in object and word recognition

Methods

Participants: 34 healthy adults aged 18-35 years.

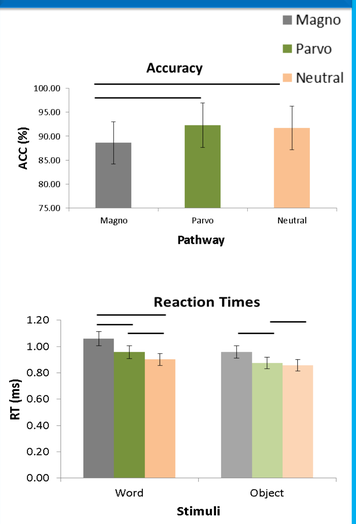
fMRI Task: Hybrid design where participants made natural/artificial judgments to object images and words that were presented under the following conditions: (i) magno-biased: low-luminance contrast and achromatic; (ii) parvo-biased: isoluminant (red-green) and chromatically defined; or (iii) neutral: not sensitive to low-luminance-contrasts and achromatic or red-green[6].



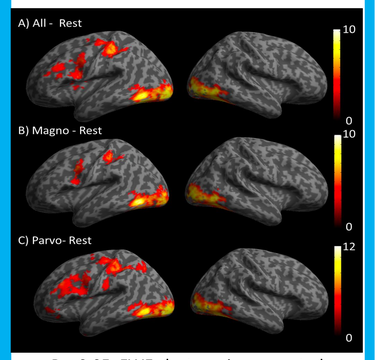
MRI Data Acquisition and Analysis: 3T Siemens PRISMA MRI scanner, using a 64-channel head coil. 1 functional run. 64 2.4 cubic isotropic axial slices 10% inter-slice gap. TR= 1000 ms, TE= 35 ms, FA= 56º, FoV= 210 mm, 880 multiband volumes. Also, a structural T1-weighted MPRAGE sequence was acquired: TR= 2530 ms, TE= 2.36 ms, FA= 7º, FoV= 256 mm, resolution= 1 mm^3, 176 slices.

SPM12 preprocessing and analysis routines on individual subject space. FreeSurfer's Aparc2009 and Benson's atlas used to extract ROIs individually. Middle and posterior ventral occipitotemporal cortex (vOTC) ROIs identify individually by means of an adapted functional localizer[7]. Functional pairwise connectivity analysis using beta-series correlation method[8].

Behavioral Results



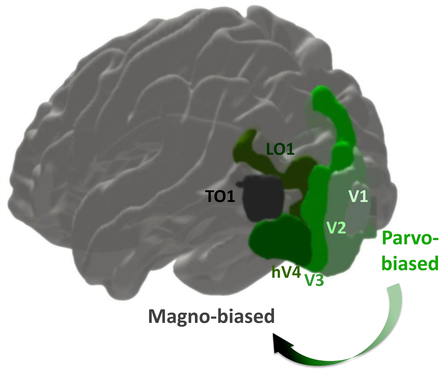
Whole-Brain Contrasts



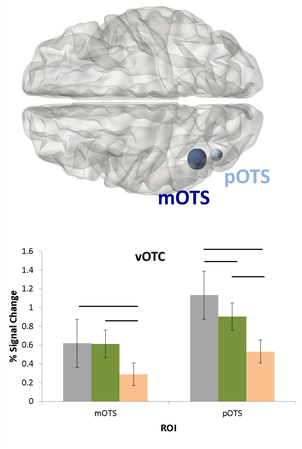
P < 0.05, FWE cluster-wise corrected

Region-of-Interest (ROI) Analyses

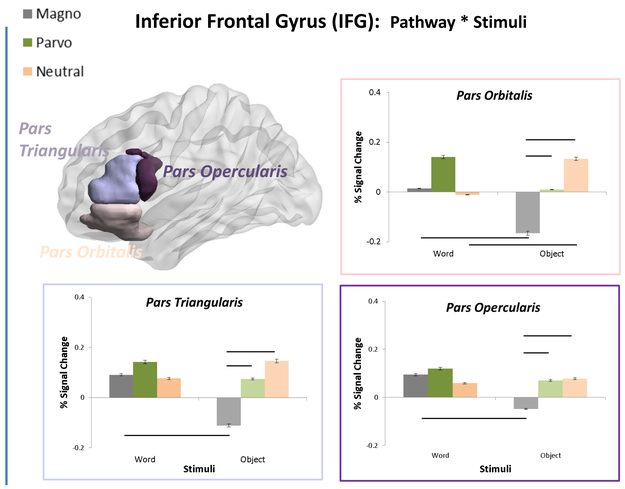
Visual Cortex: Objects > Words



vOTC: Words > Objects

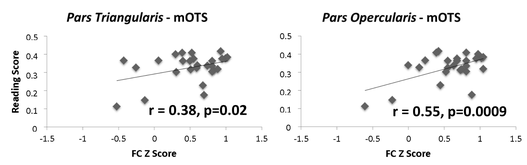


Inferior Frontal Gyrus (IFG): Pathway * Stimuli

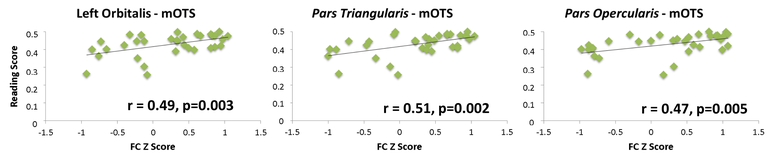


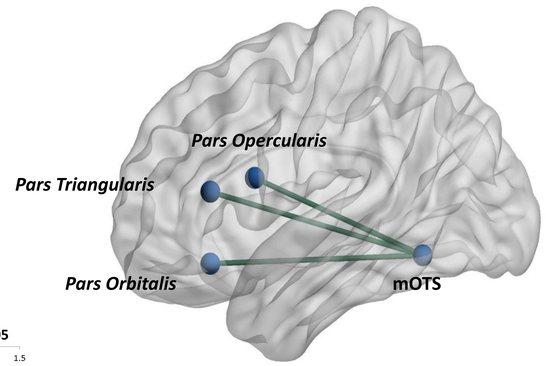
Associations between Reading Ability and Functional Connectivity

MagnoWord



ParvoWord





Conclusions

- Parvocellular-biased and neutral non-biased stimuli advantage compared to magnocellular-biased stimuli in accuracy and RTs.
- Differential engagement of visual cortex regions as a function of pathway, with earlier visual regions showing stronger engagement for parvocellular-biased stimuli and peripheral visual regions being more recruited for magnocellular-biased stimuli.
- Ventral occipitotemporal cortex also showed a differential engagement as a function of pathway for the posterior occipitotemporal sulcus (pOTS) and the middle occipitotemporal sulcus (mOTS) with the former being more strongly recruited during the processing of magnocellular- than parvocellular-biased words and the latter being similarly recruited for both parvocellular- and magnocellular-biased words.
- The IFG is involved in semantic-related word processing, exhibiting a stronger recruitment for magnocellular-biased words than for magnocellular-biased objects.
- Strong associations between participants' reading abilities and mOTS-IFG functional connectivity during word processing.
- Our findings further extent previous evidence from visual recognition to typical reading processes underscoring the interplay among visual cortex, vOTC and IFG regions

References and Acknowledgements

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