



# Distinct neural substrates for the perception of real and virtual visual worlds

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Virtual environments have been frequently used for training and skill improvement. However, do real and virtual worlds engage the same brain states in human perceivers? Relative to baselines using random static images, the medial prefrontal cortex (MPFC) and the cerebellum were activated only by movie clips of other humans. In contrast, cartoon clips of human and non-human agents activated the superior parietal lobes, while movie clips of animals also activated the superior parietal lobes. Our fMRI findings suggest that the perception of real-world humans is characterised by the involvement of MPFC and the cerebellum, most likely for on-line representation of the mental states of others, whereas the perception of virtual-world agents engages the parietal cortex in attention to actions.

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**Keywords:** Virtual reality; Perception; Attention; fMRI; Brain activation

## Introduction

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## Material and methods

### Subjects

Twelve subjects (6 male; 21–41 years old, mean age 25.5) with no history of neurological or psychiatric disorders participated in the study.

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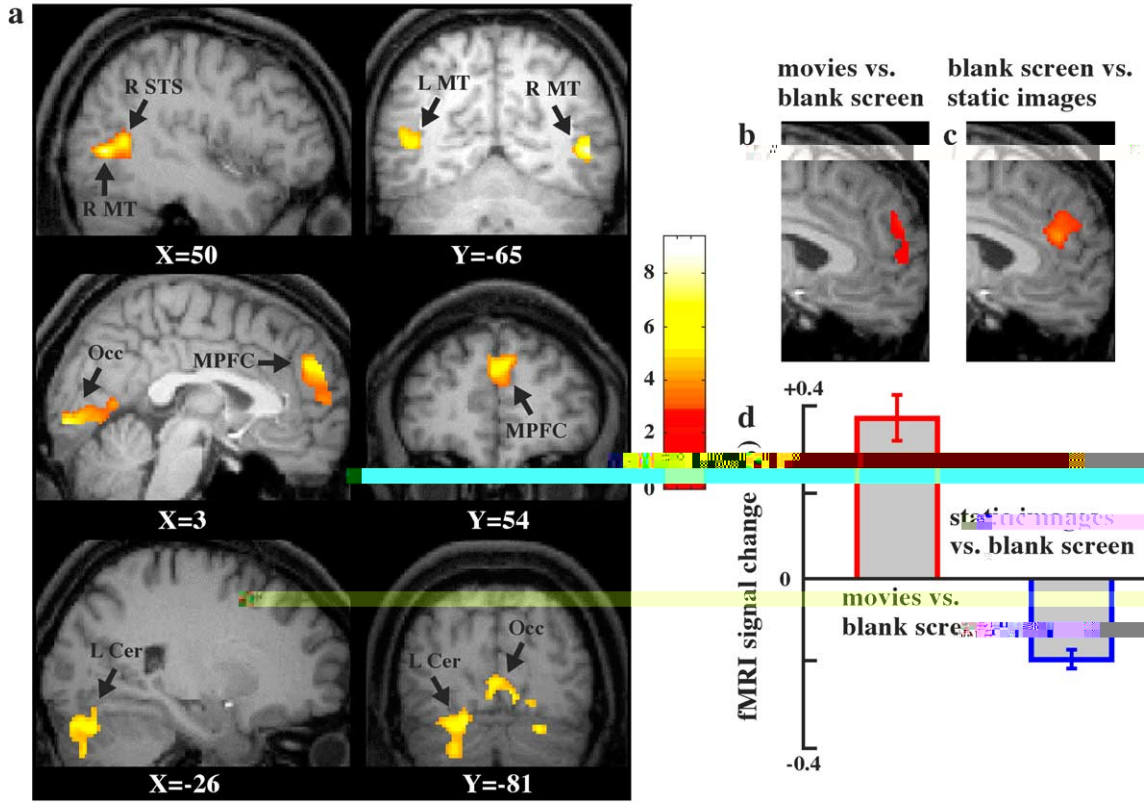
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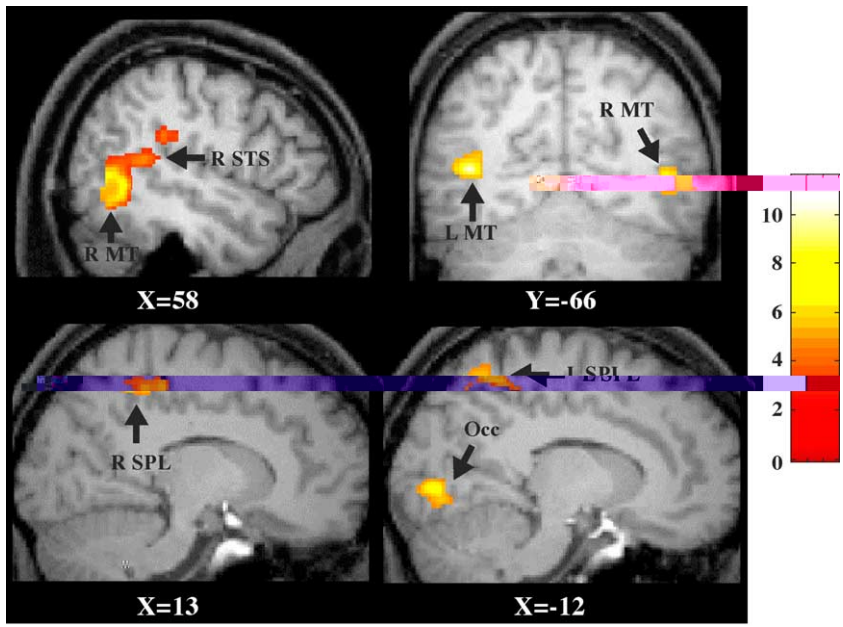


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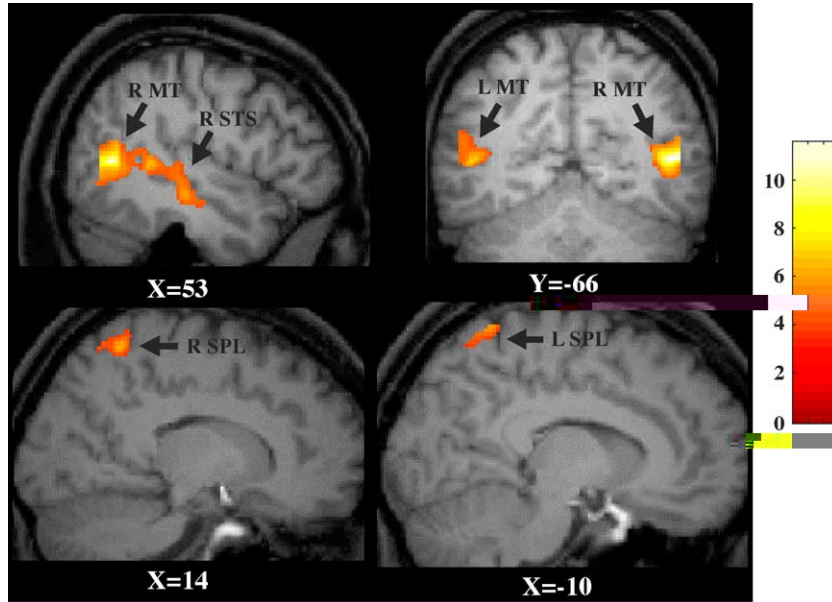


Fig. 6. Activation in the superior temporal sulcus (STS) and middle temporal gyrus (MT) during the task. The color scale represents the  $t$ -value. The purple bar indicates the location of the electrode array.

activation in the superior temporal sulcus (STS) and middle temporal gyrus (MT) during the task. The color scale represents the  $t$ -value. The purple bar indicates the location of the electrode array. The coordinates of the activation are:  $X=53$ ,  $Y=-66$ ,  $Z=61$ ,  $Z = 4.31$ ,  $P < 0.001$ ,  $X=14$ ,  $Y=-66$ ,  $Z=61$ ,  $Z = 4.39$ ,  $P < 0.03$ ,  $X=52$ ,  $Y=-67$ ,  $Z=61$ ,  $Z = 5.70$ ,  $P < 0.001$ ,  $X=51$ ,  $Y=-73$ ,  $Z=2$ ,  $Z = 5.39$ ,  $P < 0.001$ ,  $X=-91$ ,  $Y=-2$ ,  $Z = 5.74$ ,  $P < 0.001$ .

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Discussion

The results of this study show that the superior temporal sulcus (STS) and middle temporal gyrus (MT) are involved in the task. The color scale represents the  $t$ -value. The purple bar indicates the location of the electrode array. The coordinates of the activation are:  $X=53$ ,  $Y=-66$ ,  $Z=61$ ,  $Z = 4.31$ ,  $P < 0.001$ ,  $X=14$ ,  $Y=-66$ ,  $Z=61$ ,  $Z = 4.39$ ,  $P < 0.03$ ,  $X=52$ ,  $Y=-67$ ,  $Z=61$ ,  $Z = 5.70$ ,  $P < 0.001$ ,  $X=51$ ,  $Y=-73$ ,  $Z=2$ ,  $Z = 5.39$ ,  $P < 0.001$ ,  $X=-91$ ,  $Y=-2$ ,  $Z = 5.74$ ,  $P < 0.001$ .

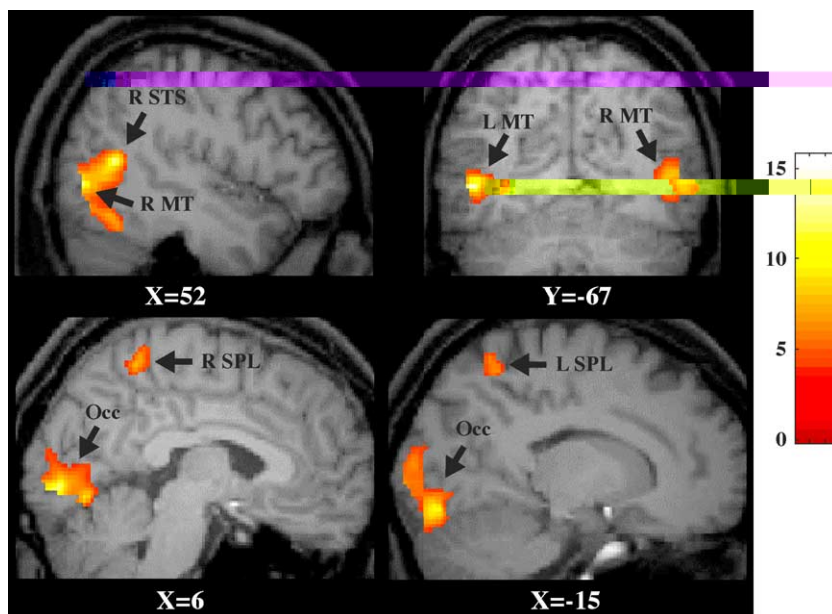


Fig. 7. Activation in the superior temporal sulcus (STS), middle temporal gyrus (MT), and occipital cortex (Occ) during the task. The color scale represents the  $t$ -value. The purple bar indicates the location of the electrode array.

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