Introduction

One of the most fundamental social skills is the ability to take similar mental perspective with other people (Frith and Frith, 2003). Perspective taking serves the purpose of mutual understanding, and it enables us to predict how other people will behave. Inter-subject correlation (ISC) methods have been applied to studying the similarity of brain activity across subjects during viewing of natural movies (Hasson et al., 2004; Jääskeläinen et al., 2008), and such synchronized brain activity may provide the basis of mutual understanding of the environment. Top-down modes of information processing can influence both brain activity (Lamm et al., 2007) and eye movement patterns (Henderson, 2003). Here we show that perspective taking modulates intersubject synchronization of gaze patterns and brain activity during natural audiovisual stimulation.

Methods

Subjects: MRI – 20 subjects. Eye gaze – 31 subjects not participating in MRI. All subjects were healthy, and informed written consent was obtained before participation.

Brain imaging: GE Signa Excite 3T MRI, EPI sequence, TR 2 s, 64 x 64 matrix, 3.4 x 3.4 mm resolution, 28 slices (4 mm thickness, 1 mm gap). Each session consisted of 310 functional volumes.

Stimulus and task: Participants were asked to view first 10 minutes of a television show (Desperate Housewives) pretending that they were either Forensic investigators (Forensic) or Interior/exterior decorators (Decorator). In Forensic condition the participants had to evaluate which persons act suspiciously and could be potential suspects for murder. In Decorator condition the participants had to evaluate how they could improve the interiors and exteriors seen in the movie in order to make them more comfortable. All subjects watched the movie in both perspectives. Half of the subjects started with Forensic condition while other half started with Decorator condition. In a post-experiment questionnaire the subjects evaluated their focus of attention in each condition.

Analysis: Correlation matrices for each brain voxel across subjects were calculated in MNI space using ISCOtoolbox (Kauppi et al., 2010). Group- and session-specific correlation coefficients were calculated by selecting the appropriate entries of the matrix. Gaze patterns were estimated by creating a 2D Gaussian kernel corresponding to the visual angle of the fovea at each fixation point for each subject during each scene of the video. Pair-wise differences of the fixation plots were calculated to quantify the dissimilarity of gaze locations across subjects. The differences in both gaze patterns and ISC were tested using 2-sample t-tests assuming unequal variances, and paired t-tests. Fisher Z-transform was applied to the correlation coefficients to make them normally distributed.

Results

1. Perspective taking modulates visual sampling of the video

2. Both perspective taking conditions result in significant ISC

3. Perspective taking modulates the strength of ISC

Conclusions

Differences across perspectives were observed in both gaze patterns and ISC of brain activity

Perspective taking showed consistently higher similarity of gaze patterns and significantly higher ISC in posterior brain areas compared to Decorator perspective and ISC across perspectives.

We propose that ‘tuning in’ with others by means of perspective taking increases ISC, and this synchronization of brain activation may provide the neural basis of mutual understanding of the environment.

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References


Hasson U. et al. 2006. Inter-Subject Synchronization of Prefrontal Cortex Hemodynamic Activity During Natural Viewing. Open Neuroimaging J. 2:14–19

Jääskeläinen I.P. et al. 2006. Intera-Subject Correlation of Neural Activity in the Dorsolateral Prefrontal Cortex (DLPFC) across Perspectives. Front Hum Neurosci. 2:18–24

Jääskeläinen I.P. et al. 2006. Intera-Subject Correlation of Neural Activity in the Dorsolateral Prefrontal Cortex (DLPFC) across Perspectives. Front Hum Neurosci. 2:18–24

Kauppi J.P. et al. 2010. Intera-Subject Correlation of Brain Hemodynamic Responses during Watching a Movie: Localization in Space and Frequency. Front Neuroinformatics. 4
