Activity in the dorsal and ventral attention systems during natural viewing

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Introduction:

The focus of our attention is determined by top-down controlled and bottom-up triggered signals that have been related to activity in the dorsal and ventral attention systems, respectively (Corbetta and Shulman 2002). There is evidence that the activity in these networks is modulated by contextual factors such as social or emotional contents of the stimulus environment (Corbetta et al. 2008, Nummenmaa and Calder 2009). However, the influence of such factors on the activity of the dorsal and ventral attention systems during natural viewing is relatively unknown. Our hypothesis was that measuring this activity when the subjects are watching a movie and then correlating this activation back to the events in the movie could provide a tool (1) to measure attention in a naturalistic setting and (2) to reveal the contextual factors that affect allocation of attention.

Methods:

10 healthy subjects watched a movie (The Match Factory Girl, Aki Kaurismäki 1990) during 3T-fMRI scanning. Spatial Independent Component Analysis (ICA) was used to extract consistent (bootstrapped with 100 runs) brain networks from the data. The number of components was further reduced by temporal correlation analysis of each subject's individual component time course, and selecting only those components for closer scrutiny for which pairwise correlation between each pair of subject was found to be significant.
The measure for top-down controlled attention was defined based on the voluntary attentional tracking episodes (e.g., when the subjects followed some moving objects) captured by eye-tracker when watching the movie. Episodes that were assumed to demand bottom-up triggered attention were defined based on combination of the eye-movements triggered by salient changes in the movie and subjectively annotated measures of the stimulus novelty and saliency.

Results:

Areas belonging to the dorsal and ventral attention systems were segregated to four ICA components (ICs). Two of these components included areas in the intraparietal sulcus/superior parietal lobule (IPS/SPL), frontal eye field (FEF) and additional areas in the widely distributed areas of the visual cortex (Figure 1a). These components were strongly lateralized (Figure 1a, yellow and red). Another two ICs included areas of the right temporoparietal junction (TPJ) and ventral frontal cortex (VFC), and also some visual areas (Figure 1b). Time series of activation in these ICs was correlated with measures of attention (see Methods section). Our preliminary results suggest a clear correspondence between the movie events associated with top-down controlled and bottom-up triggered attention and activation in the described ICs.

Conclusions:

Our results suggest that the activity in the dorsal and ventral attention systems can be extracted by data-driven analysis methods when the subjects are viewing natural stimulation. Furthermore, based on our preliminary findings naturalistic setting may provide a useful tool to examine the contextual factors that modulate attentional processing.
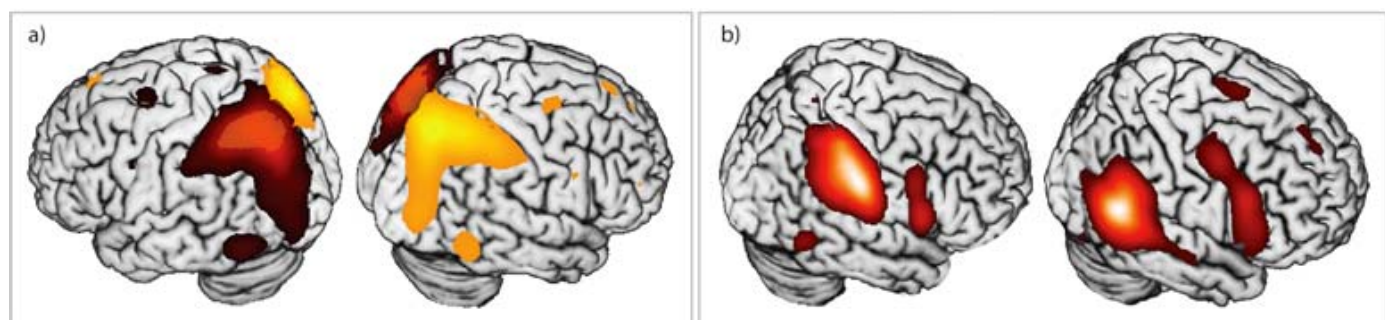

Figure 1. ICs extracted when 10 subjects were watching a movie. a) shows the two (red and yellow) ICs that included areas of the dorsal attention system (IPS/SPL, FEF), and b) shows the two (left and right) ICs in the right hemisphere that included areas of the ventral attention system (TPJ and VFC). Time series of activity in these areas were correlated with measures of top-down controlled and bottom-up triggered attention.

References:

Corbetta, M. (2002), 'Control of goal-directed and stimulus-driven attention in the brain', *Nature Reviews Neuroscience*, vol. 3, pp. 201-215.
Corbetta, M. (2008), 'The reorienting system of the human brain: from environment to theory of mind', *Neuron*, vol. 58, pp. 306-324.

Nummenmaa, L. (2009), 'Neural mechanisms of social attention', *Trends in Cognitive Sciences*, vol. 13, pp. 135-143.

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