DEFAULT MODE NETWORK ACTIVITY DURING SPONTANEOUS MOVEMENT EVENTS

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TARGET AUDIENCE: Neuroimaging researchers and neuroscientists.

INTRODUCTION: The Default Mode Network (DMN) is known to anti-correlate with task-positive networks in block and event task paradigms. However, little is known about the DMN's response to spontaneous events in the brain that are not task driven. This study investigates DMN activity during non-task-based spontaneous events that are attributed to motor movements and activity in the Somatosensory Motor Network (SMN). Sparse paradigm free mapping, a regression technique based on linear haemodynamic convolution, is used to provide timing and spatial distribution of task-based and spontaneous events in the DMN and SMN without prior timing information[1].

AIM: To compare DMN activity during spontaneous events compared to short and long motor tasks.

METHODS: Seven subjects were scanned on a Philips 7T Achieva system. The experiment consisted of two runs: RUN1 (5 minutes of resting state, followed by 10 minutes of 3 s short motor task, repeated four times randomly) and RUN2 (6 minutes of 10 s long motor task, no repetition). A fixation cross was displayed during inter-stimulus intervals in both runs, which was replaced by a visual cue to instruct the subjects to perform each movement. Motor tasks involved six discrete movements - right or left toe, right or left hand, eye and swallowing movements. Electromyography (EMG) [Brain Products, Munich, Germany] bipolar electrode pairs were placed on legs, hands, face and the neck to record muscle activity during the scan. EMG data were corrected for gradient and pulse artefact [Brain Vision Analyzer2], and were visually inspected to identify peaks/waveform patterns reflecting movements from subject's EMG pre-trial run. fMRI data was realigned [SPM8], physiological noise corrected [RETROICOR], spatially smoothed with a 4x4x4 mm Gaussian kernel, low frequency drift corrected, normalised to compute percentage signal change and registered to MNI space [FLIRT, FSL]. Sparse paradigm free mapping (SPFM) was performed to obtain voxel-wise Activation Time Series, which were then convolved with canonical HRF [SPM8]. 10 mm radius spherical region of interests (ROIs) were located at the core regions of the Default Mode Network (precuneus, PCC, MPFC, L/RMTG)[2], the SMA [Harvard-Oxford cortical atlas], and five centre of gravity SMN locations of Activation Likelihood Estimates from a meta-analysis of hand (H1-RH,H2-LH), foot (F1) and mouth movements (M1,M2) [BrainMap[3,4]]. SPFM signals from each ROI were averaged. Muscle activity detected by the EMG during rest state and task runs that were not related to the visual cue (excluding eye movements) was considered as spontaneous movements. SPFM time frames consisting of 3 conditions: (i) long, (ii) short motor tasks and (iii) spontaneous movements were averaged according movement type before averaging across subjects.

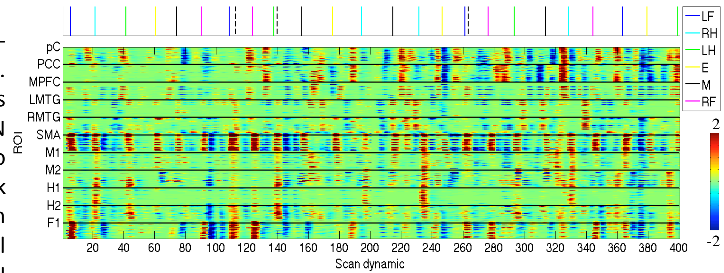

Figure I: Subject 1 Activation Time Series convolved with canonical HRF from voxels in all the selected ROIs (see method). Stimulus (3s movement) shown in solid lines on the top row and spontaneous movements detected by EMG denoted with dashed lines. Colours in legend indicate movement type. LF: left foot, RH: right hand, LH: left hand, E: eye, M: mouth, RF: right foot

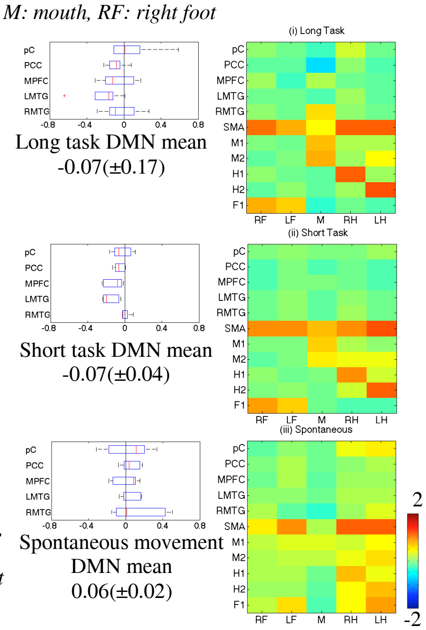

Figure II : (First column) Boxplot of DMN ROIs averaged across movement types for long, short and spontaneous events. The average of all DMN ROIs across subjects and movement type are displayed below the boxplot. (Second column) Subject average SPFM signals from DMN and SMA ROIs. DMN activity in long and short tasks is more deactivated compared to spontaneous events. SPFM signal at SMA is elevated for all movement types. pC: precuneus, PCC: posterior cingulate cortex, MFPC: medial prefrontal cortex, L/RMTG: left/right middle temporal gyrus

RESULTS AND DISCUSSION: *Figure I* displays the SPFM signals (HRF convolved ATS) from ROIs of Subject 1 for the short motor task experiment from RUN1. Events detected in the SMA and meta-analysis ROIs correspond to the timing of motor movements. Activation in the DMN areas is sparse, with occasional activations during the inter-stimulus time interval. *Figure II* shows the subject average comparison between long task, short task and spontaneous movements for different tasks. The overall SPFM signal DMN SPFM percentage mean across subjects and movement types relative to baseline for spontaneous movements is 6%(±0.02), while for long and short movements it is deactivated at -7%(±0.17) and -7%(±0.04) respectively, indicating that spontaneous movements have elevated activity level in the DMN compared to long or short task events. In terms of mean DMN signal across subjects, there is no significance difference in T-test between short and long tasks, but there is trend for a difference between short and spontaneous movements (p value=0.07, alpha=0.1). There is a trend for DMN mean signal for short tasks to be significantly elevated above baseline (p value=0.07). DMN was below baseline for right foot (p value=0.06) and mouth (p value=0.09) short task movements, and above for right hand (p value=0.09) and left hand (p value=0.05) spontaneous movements for alpha=0.1. **CONCLUSION**: The DMN behaves homogenously for spontaneous movements with slight elevation of activation compared to task motor movements. The ability of SPFM to detect spontaneous events can be further used to analyse modulations with the DMN. **REFERENCES:** 1. Caballero Gaudes *et al.*, HBM. 2011;34(3): 501-18. 2. Laird *et al.* J. Neuroscience 2009; 29(46) 14496-14505. 3. Eickhoff HBM 2009; 30, 2907-2926. 4. Laird *et al.* Neuroinformatics 2005; 3, 65-78. **Acknowledgements**: This work was funded by the Medical Research Council.