Deficit of temporal dynamics of detection of a moving object during egomotion in a stroke patient: an MEG study

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Introduction

Using anatomically constrained MEG in conjunction with Granger causality in the time domain (DGC) and Phase Lag (PLV) in the frequency domain (Ω, β, and γ bands) we compared in a patient and 6 healthy controls the direction and dynamics of connectivity between the functional areas involved in detection of a moving object by a moving observer in two experimental conditions: visual only (unimodal) and cross-modal, visual augmented by an auditory cue co-localized to the moving object.

Stimuli and design

The stimuli (adapted from 1,2) consisted of: one second fade-in of nine textured spheres (1.5 degrees in diameter); one second static frame displaying the 9 static spheres; one second where 8 of the spheres, randomly selected, portrayed simulated forward motion of the observer, and the other sphere (target) moves independently with its own speed and location (forward or backward). In the following 3 seconds the spheres are again shown static but numeric labels (1-9) are shown on four spheres, one of which is the target. In a 4AFC subjects indicated via a button press which was the target sphere. Percent correct and reaction times were collected. Two conditions of the experiment were run: Visual-only (V-O), and Visual-audio (V-A).

Behavioral Results

Performance of all control subjects was significantly better when auditory cues were available (proportions threat V-O vs V-A: p=2.6 x 10^{-10})

Phase synchrony

Dynamic frequency-band correlations are discovered between each pair of ROIs through phase locking. The trial-by-trial phase synchrony is computed using the Uniform-Scores Test. The test statistic is fit to a t distribution (df=2) to obtain p-values, using Fisher’s method to combine controls. The frequency range included the Ω-band (5-15 Hz), the β-band (15-30 Hz), the low γ-band (30-50 Hz).

Discussion

• Dynamic Granger causality (Fig. 5.6) shows the direction and the time when pairs of ROIs influence each other. The patient PF has decreased significance of connections between V-O and V-A during T2 (representation) and T3-T4 (decision), and V-O and V-A (Fig 6.12). The DGC connection from MPFC to “aud” is suppressed in PF suggesting that the function of MPFC is important in regulating the feedback from MPFC and the auditory cue.

• In both V-O and V-A tasks, Ω, β, and γ band frequency band oscillations in healthy subjects are phase locked to widely separated cortical regions.

• In the lesioned hemisphere of PF, phase synchrony with V-A modulations (from MPFC), but not in patient PF.

MEG Acquisition

The MEG data were acquired with a 306-channel Neuromag Vectorview whole-head system (Eletta Neuromag Oy) comprising of 204 orthogonally oriented planar gradiometers and 102 magnetometers at 102 locations. The set up and data acquisition methods are routinely used in the Martinos Center studies.1,2,3

References

5. Vaina, L., et al., "Comparison of Eleven Methods for Interval Estimation for the Difference Between Independent Proportions: QuickTime™ and a decompressor are needed to see this picture.

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