The relationship of fMRI and sEMG data in stroke patients

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Introduction

- There is clinical interest for quantitative evaluation of therapeutic responses or rehabilitation schemes
- Can modern imaging methods be used to measure certain performance in stroke medicine?

Aims of the study

- To investigate brain and muscle functionality in stroke patients
  - Brain activity measured with functional magnetic resonance imaging (fMRI)
  - Muscle activity measured with surface electromyography (sEMG)
- Factors and relationship
  - Affected /non-affected limb
  - Movement speed (fast/medium/slow)

Methods

- 7 stroke patients (one arm paretic)
- Same sEMG and fMRI task: passive flexion-extension of the arm at 3 rates
  - Fast = 0,67 Hz (every 1,5s)
  - Medium = 0,48 Hz (every 2,1s)
  - Slow = 0,33 Hz (every 3s)
- Block design

Methods

Data analysed by speed and arm

sEMG

- Power of signal
- Normalised

$$\frac{(\mu sEMG_{moto}) - \mu sEMG_{rest})}{\sigma sEMG_{rest})}$$

- BrainVision Analyzer

FMRI

- Preprocessing
- $Z>2.0$; $p=0.05$, corrected
- Inclusive masking
- Z scores in BA areas
- FSL

Results: sEMG speed and paresis

m. biceps brachii

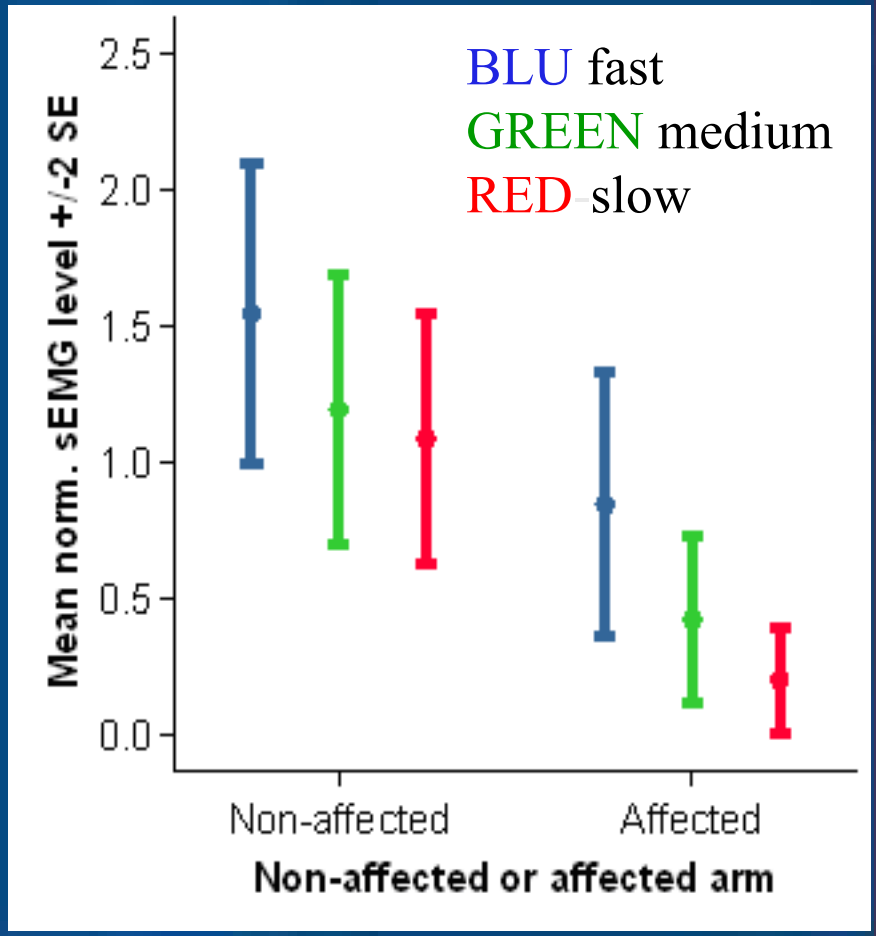
Technique sensitive to speed and paresis

- Fast >medium>slow

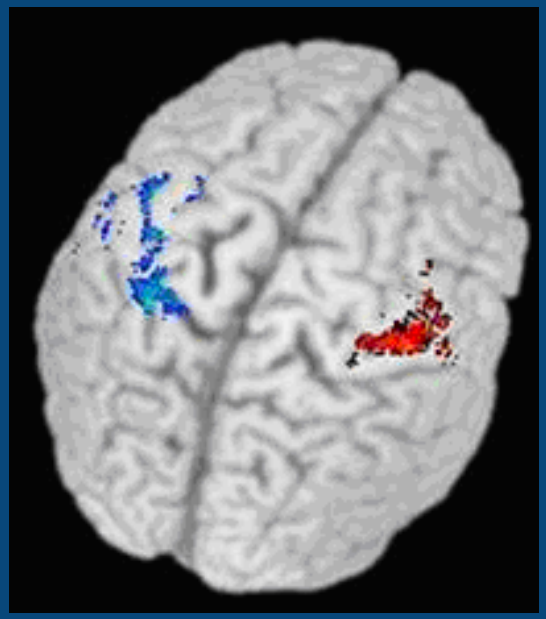
$F_{6,21}=13.09$, $p<0.001$

- Non affected >paretic

$F_{6,21}=33.1$, $p<0.001$

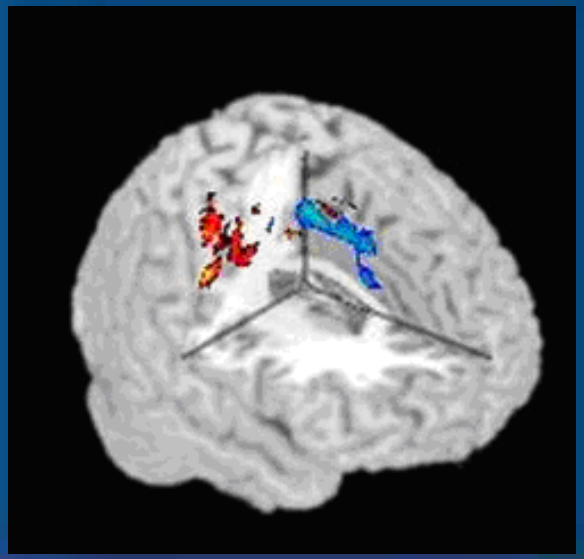


Results: fMRI side & location



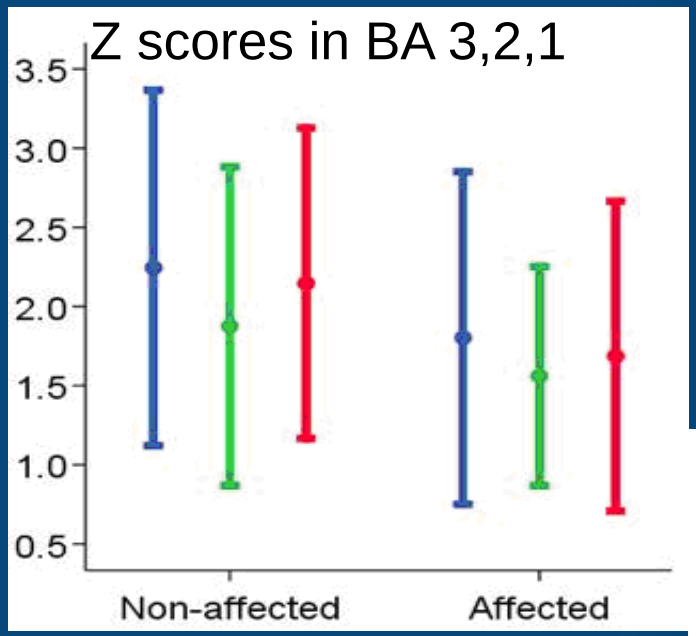
Technique sensitive to side and able accurately to localize sensorymotor areas

Blue right arm
Red left arm
Right arm 1<Z<4.42
Left arm 1<Z<3.93



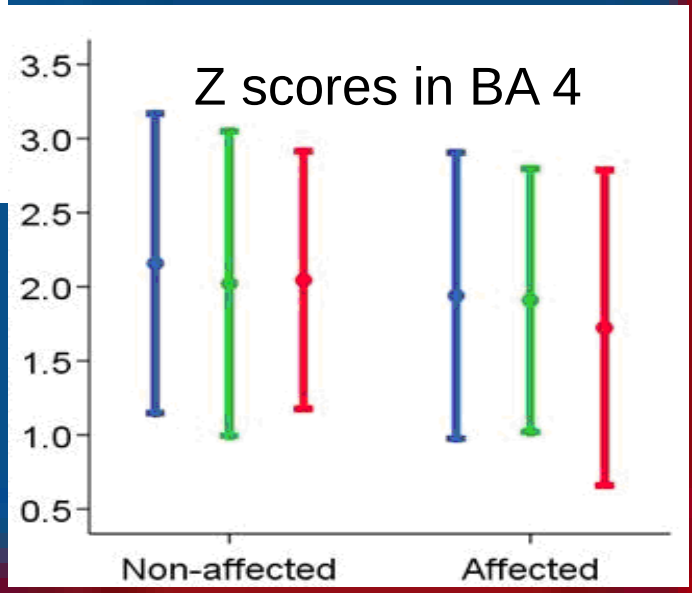
Voxels shown on rendered image 6 voxels in depth

Results: fMRI speed and paresis



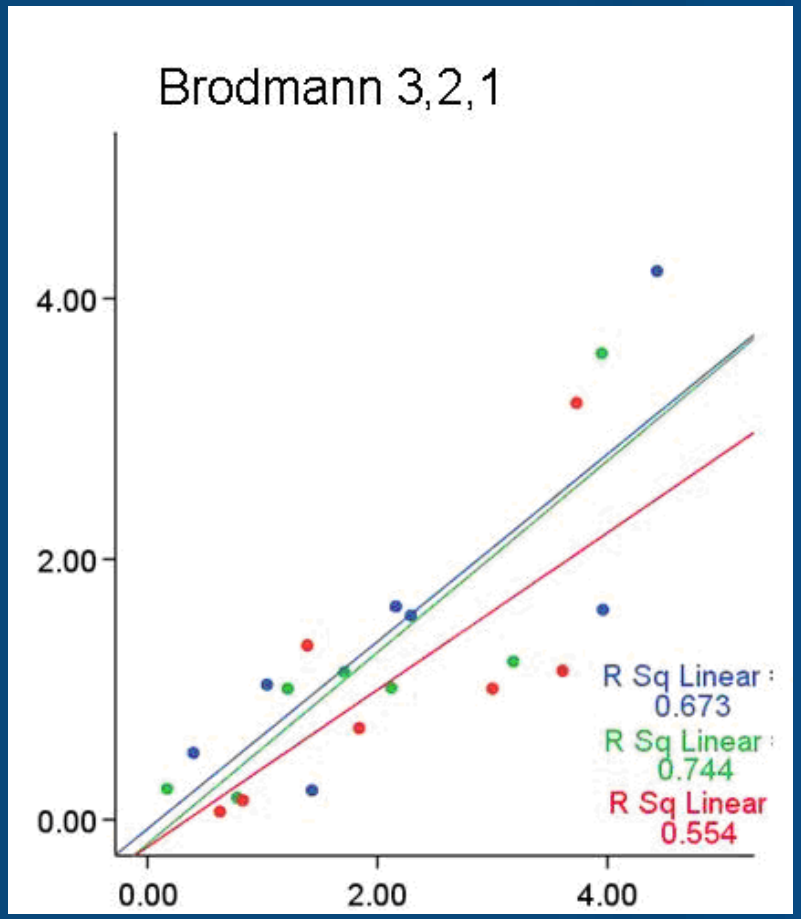
Technique relatively insensitive to speed and paretic condition across functional areas

Blue fast
Green medium
Red slow



Trends not significant

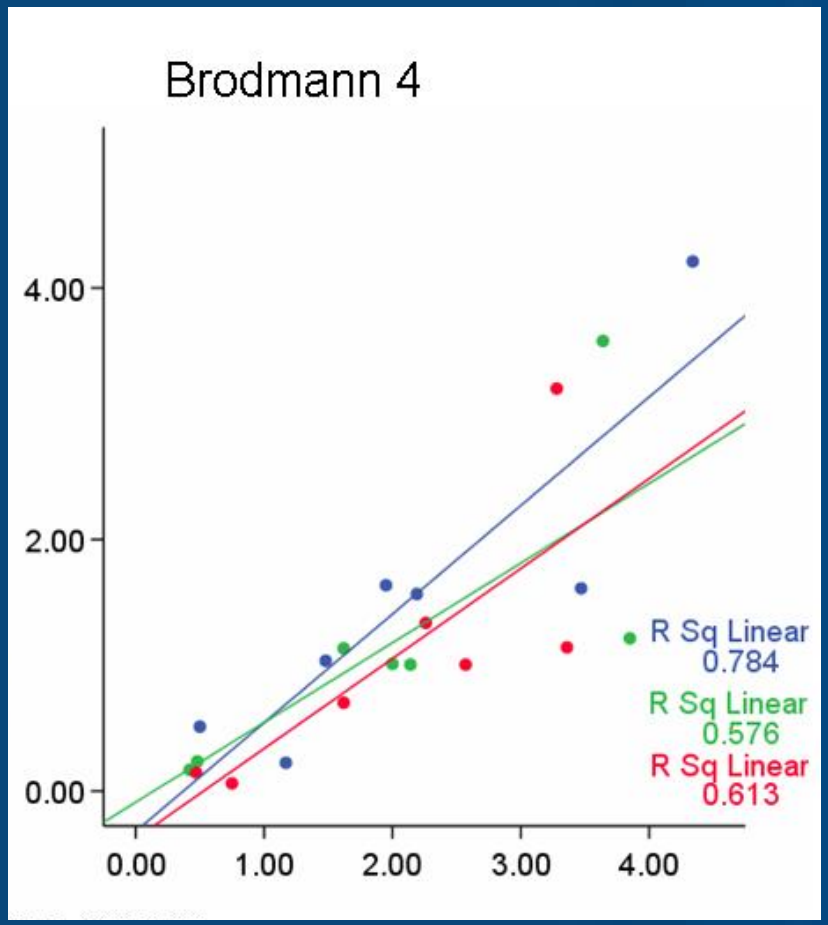
Results: sEMG-fMRI correlation



Non-affected arm

- Fast motor block (blue) coefficient 0.82 (p=0.024)
- Medium motor block (green) coefficient 0.86 (p=0.012)
- Slow motor block (red) coefficient 0.75 (p=0.055)

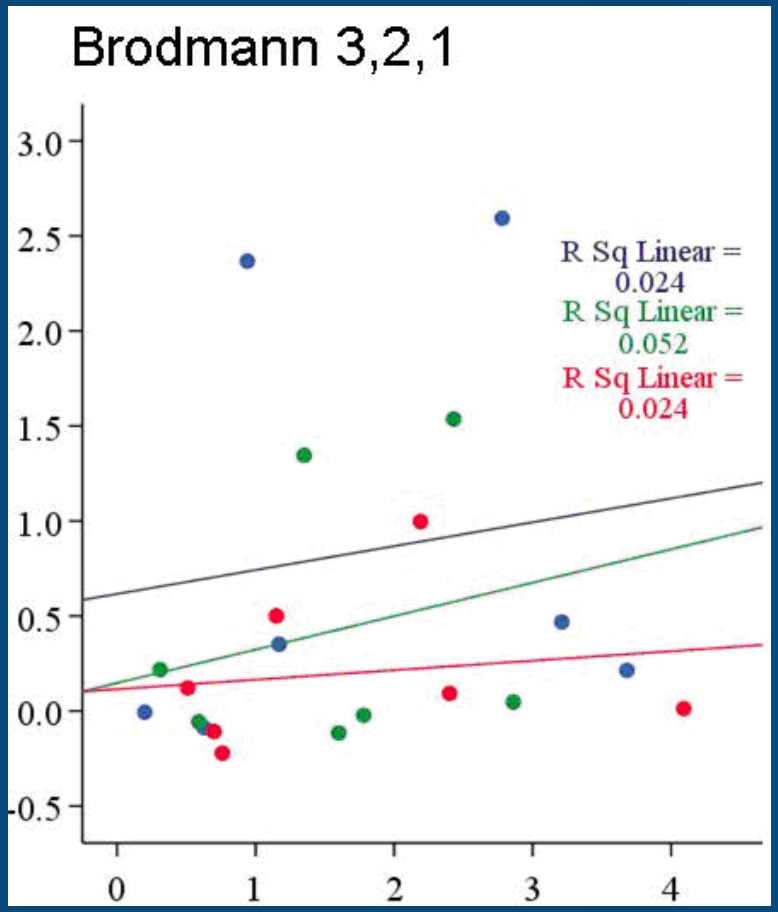
Results: sEMG- fMRI correlation



Non-affected arm

- Fast motor block (blue) coefficient 0.89 (p=0.008)
- Medium motor block (green) coefficient 0.76 (p=0.048)
- Slow motor block (red) coefficient 0.75 (p=0.055)

Results: sEMG fMRI correlation



Affected arm

- No significant correlations between the sEMG power and fMRI Z scores

Conclusions

- The sEMG - evident speed effect and difference between the affected and non-affected arm
- FMRI - did not show the similar pattern → due to haemodynamical changes?
- The relationship was observed between sEMG and the imaging data in the non-affected side, and not in the affected side → due to changes in haemodynamics and in properties of the muscles?

Conclusions

- The haemodynamics in stroke patients is important factor to be considered, as this may influence the BOLD fMRI
- Due to these changes, the electromyographic-imaging relationship can be skewed from what is expected, as indicated in this study
- The fMRI is not yet ready to be used as the quantitative measure for certain performance parameters