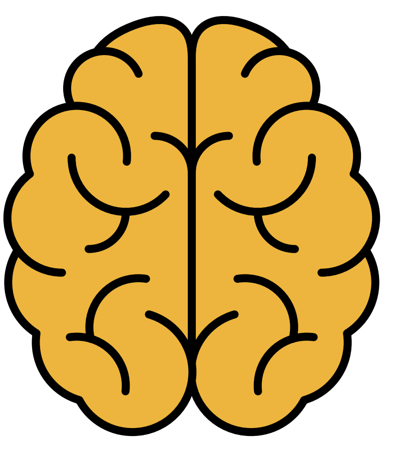
Effective connectivity differences in motor network during passive movement of paretic and non-paretic ankles in subacute stroke patients

BACKGROUND

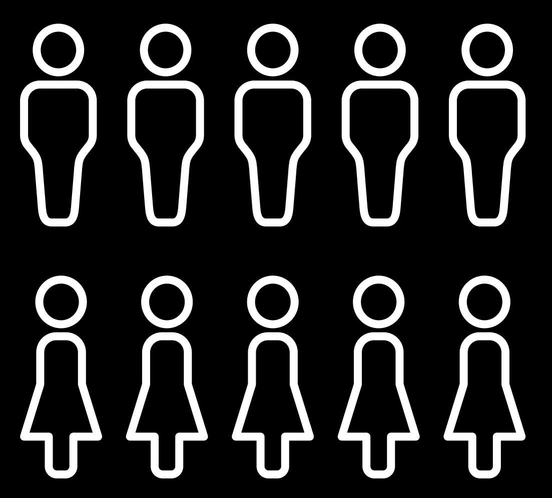
A better understanding of the neural changes associated with paresis in stroke patients can have important implications for therapeutic approaches. Dynamic Causal Modeling (DCM) for functional magnetic resonance imaging (fMRI) is commonly used for analyzing the effective connectivity patterns of brain networks due to its ability to model neural states behind fMRI signals. We applied this technique to analyze the differences between motor networks (MNW) activated by the continuous passive movement (CPM) of paretic and non-paretic ankles in subacute stroke patients.



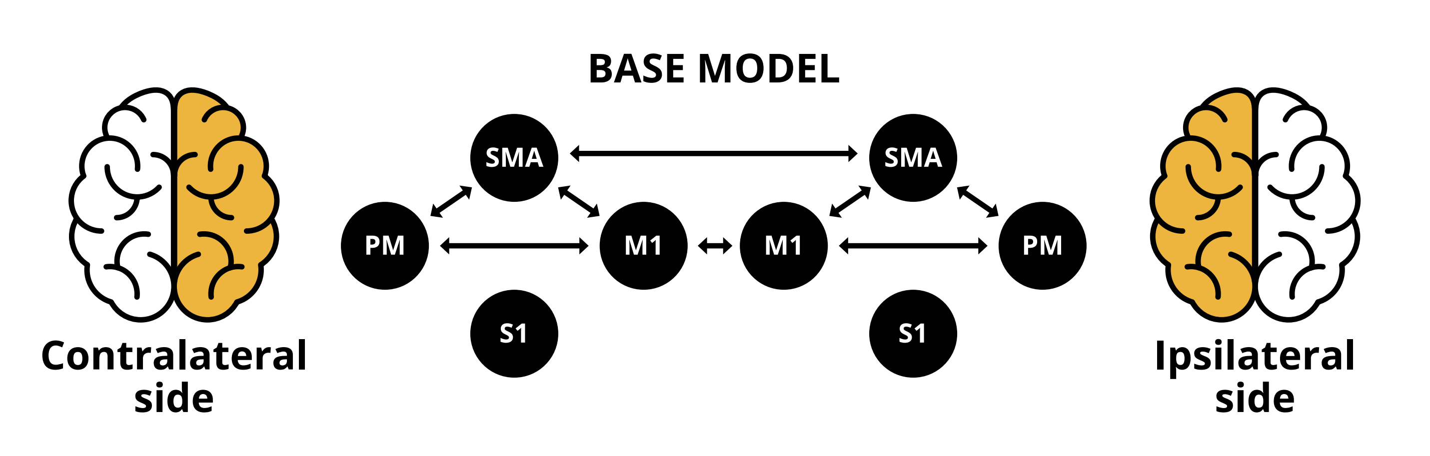
This study aimed to identify CPM-induced connectivity characteristics of the primary sensory area (S1) and the differences in extrinsic directed connections of the MNW and to explain the hemodynamic differences between brain regions in the MNW.

METHODS

In our network analysis we used **ten stroke patients' task fMRI data collected under both ankle's CPMs**.



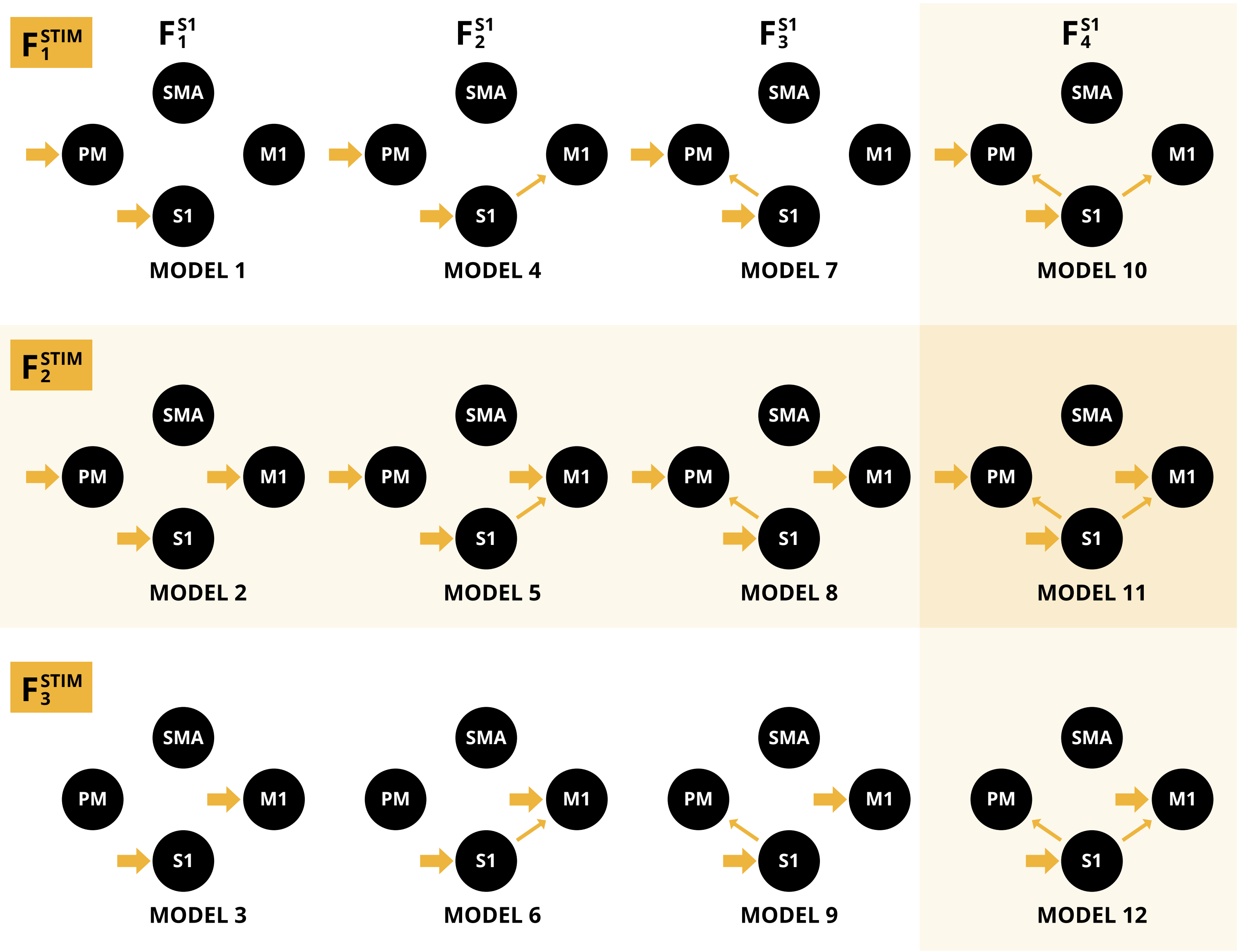
Using independent component analysis, we defined regions for the MNW, the primary motor cortex (M1), the premotor cortex (PM), the supplementary motor area (SMA) and the S1 in a data-driven way. For the network analysis of both CPMs, we compared twelve models organized into two model-families, depending on the S1 connections and input stimulus modelling. Using DCM, we evaluated the extrinsic connectivity strengths and hemodynamic parameters of both stimulations in all patients.



RESULTS

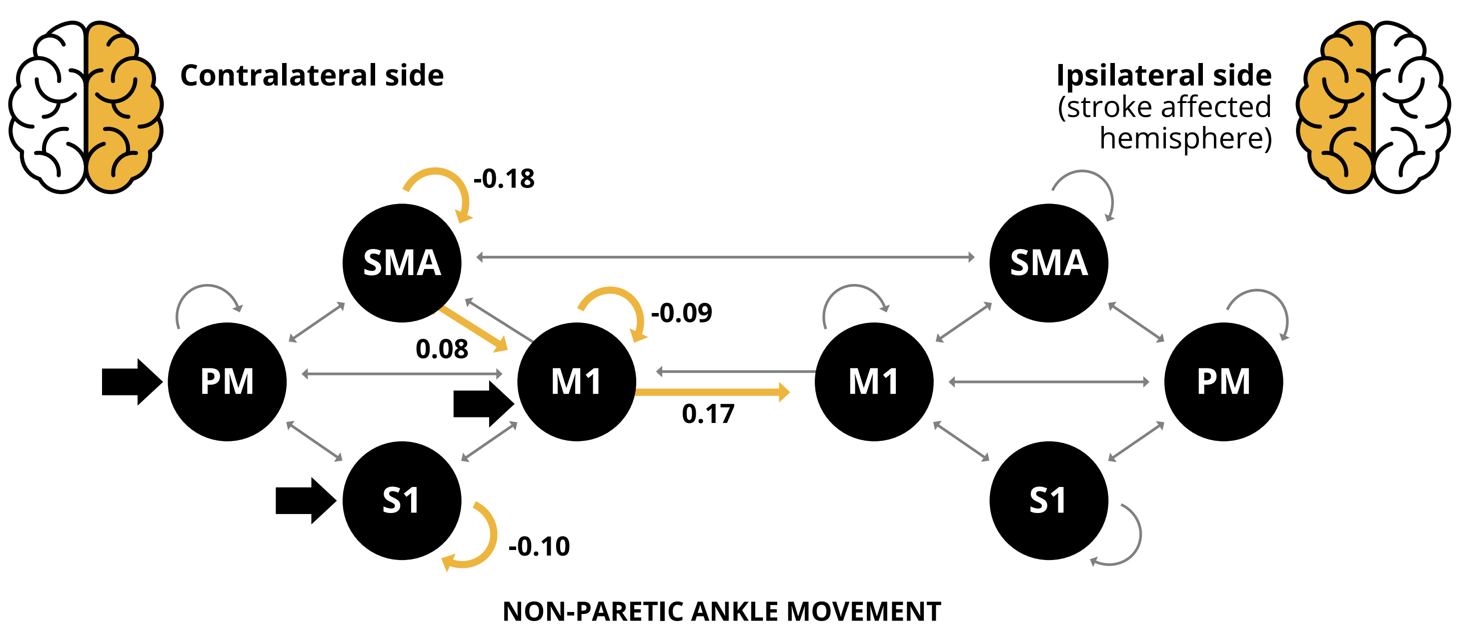
After a statistical comparison of the extrinsic connections and their modulations of the "best model", we concluded that **three contralateral self-inhibitions (cM1, cS1, and cSMA), one contralateral inter-regional connection (cSMA ▸ cM1), and one interhemispheric connection (cM1 ▸ iM1) were significantly different.** Our research shows that hemodynamic parameters can be estimated with the Balloon model using DCM but that the parameters do not change with stroke.

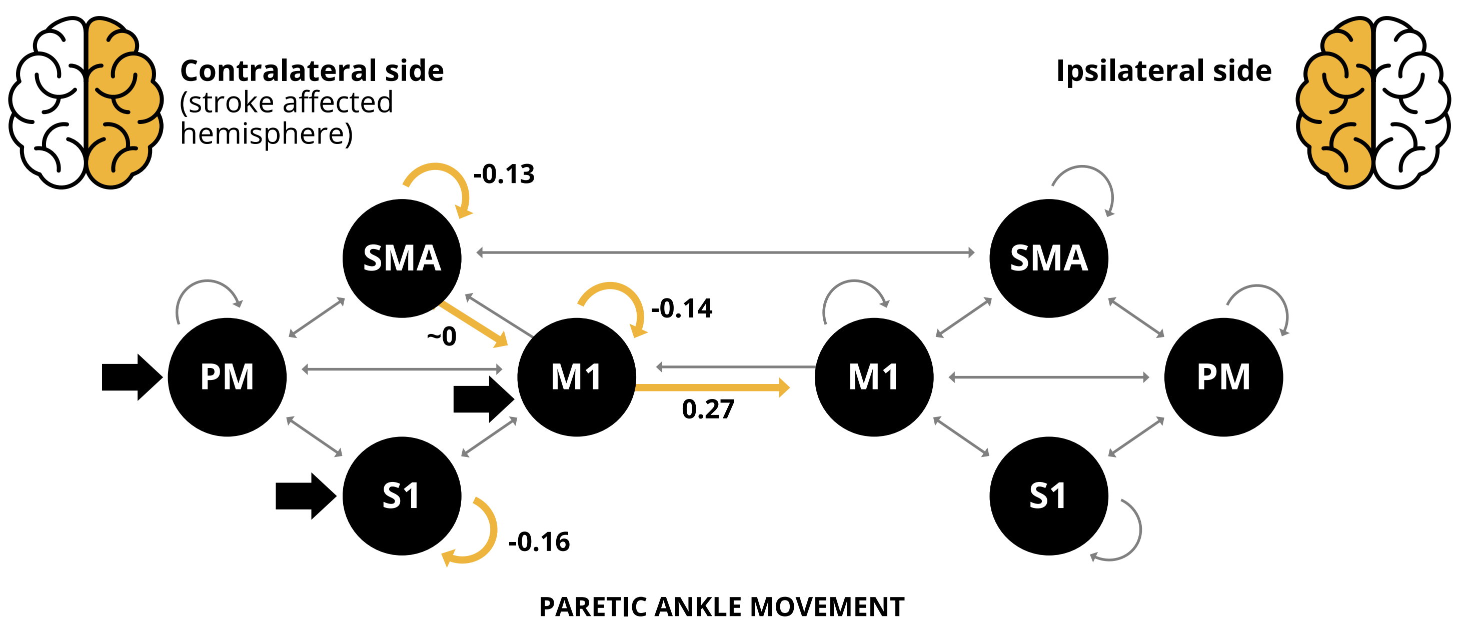
COMPARISON OF MODEL FAMILIES



The highlighted model (11) illustrates the best model.

MEAN VALUES OF SIGNIFICANTLY DIFFERENT ENDOGENOUS CONNECTION STRENGTHS OF THE BEST MODEL (MODEL 11)





CONCLUSION

Our results confirm that the DCM-based connectivity analyses combined with Bayesian model selection may be a useful technique for quantifying changes in the motor network characteristics of subacute stage stroke patients and in determining the degree of MNW changes.

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