Similarity in evoked responses does not imply similarity in macroscopic network states across tasks
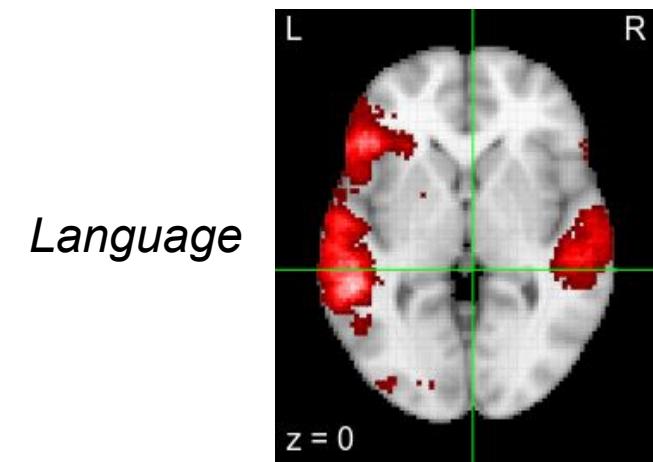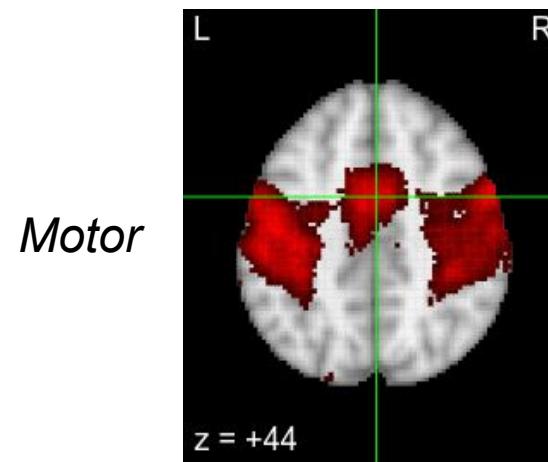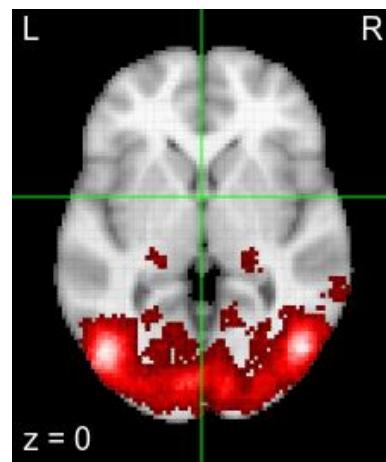
Javier Rasero

neuromatch conference

A modular view of the brain function

➢ Modularity in the brain: cognition emerges from the interplay between specialized and domain-specific units.

Visual

Motor

Language
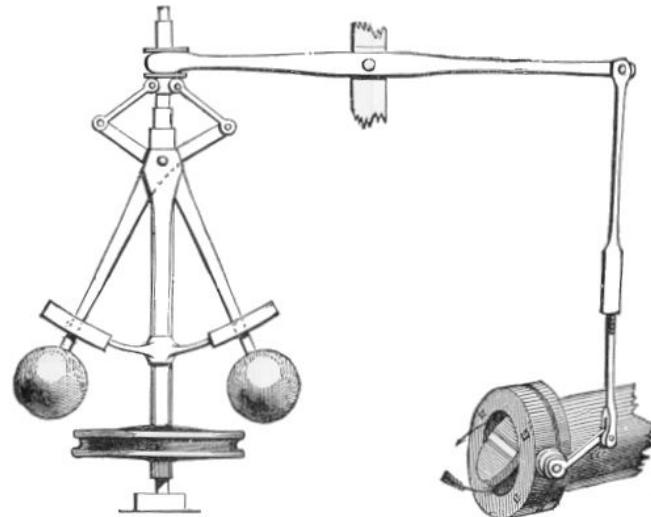
Neurosynth.org

A modular view of the brain function

➢ Modularity in the brain: cognition emerges from the interplay between specialized and domain-specific units.

➢ <u>A critical assumption</u>: Communication between modules is simply a matter of relaying information from one stage of processing to the next, so the same modules will also lead to similar connectivity between those modules.

Another view of the brain

➢ The brain is a **dynamical system**, so cognition emerges also from the interactions between its different units.


Tim Van Gelder, 1995

Another view of the brain
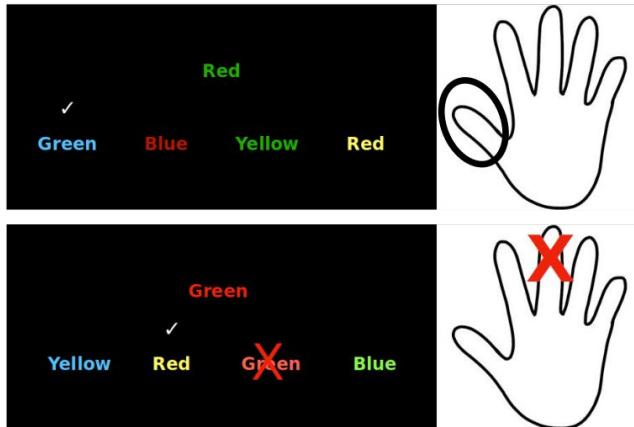
➢ The brain is a **dynamical system**, so cognition emerges also from the interactions between its different units.

➢ In this perspective, it is possible that two tasks activate the same pattern of nodes, but express different communication (connectivity) patterns (Prinz, 2004; Hooper, 2004).

Our goal
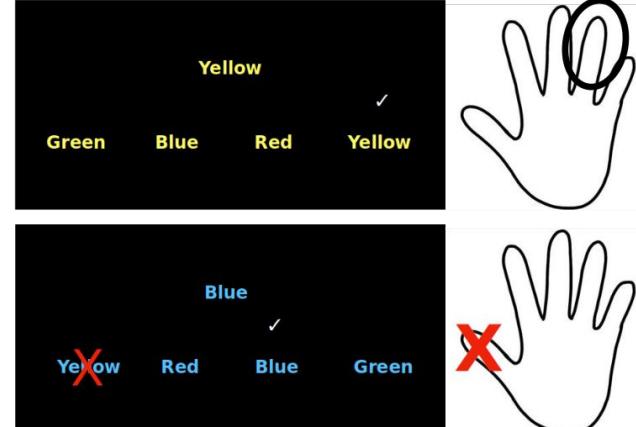
Test both views by evaluating whether two fmri tasks that evoke a similar brain response also exhibit similar connectivity patterns.

Our tasks: Color-Word Stroop


Incongruent (hard) trial
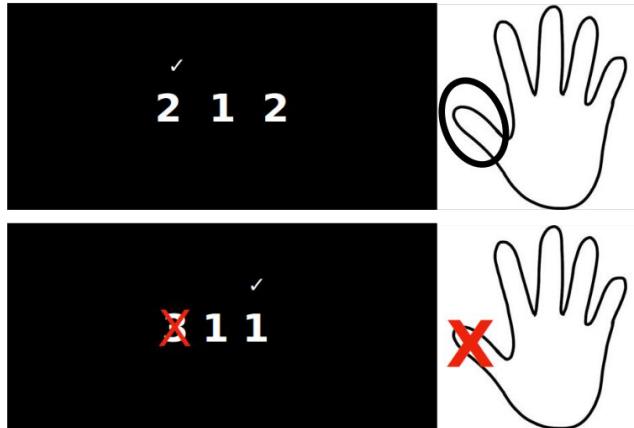
Congruent (easy) trial
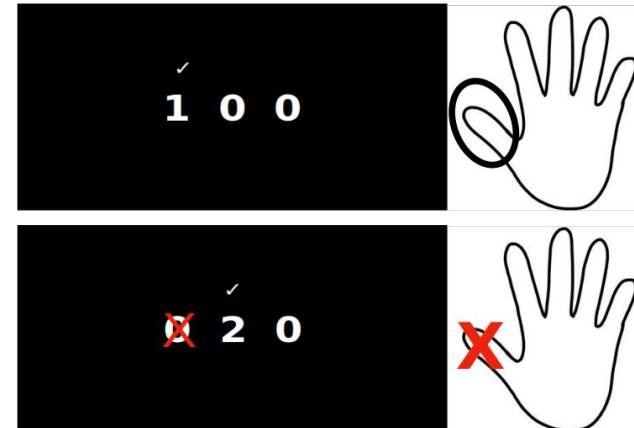
# Our tasks: Multi-source Interference Task (MSIT)

Incongruent (hard) trial
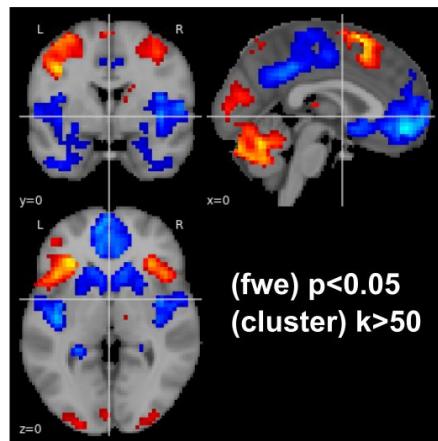
Congruent (easy) trial
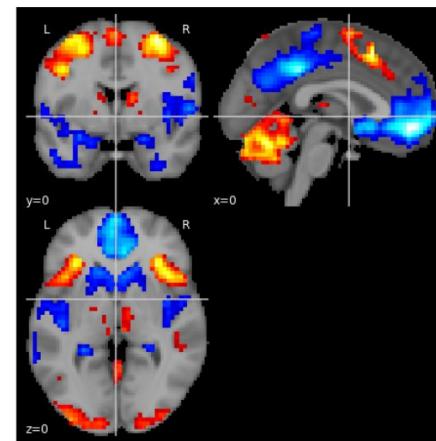
Our tasks: a similar brain response

STROOP

**MSIT**

(fwe) p<0.05
(cluster) k>50
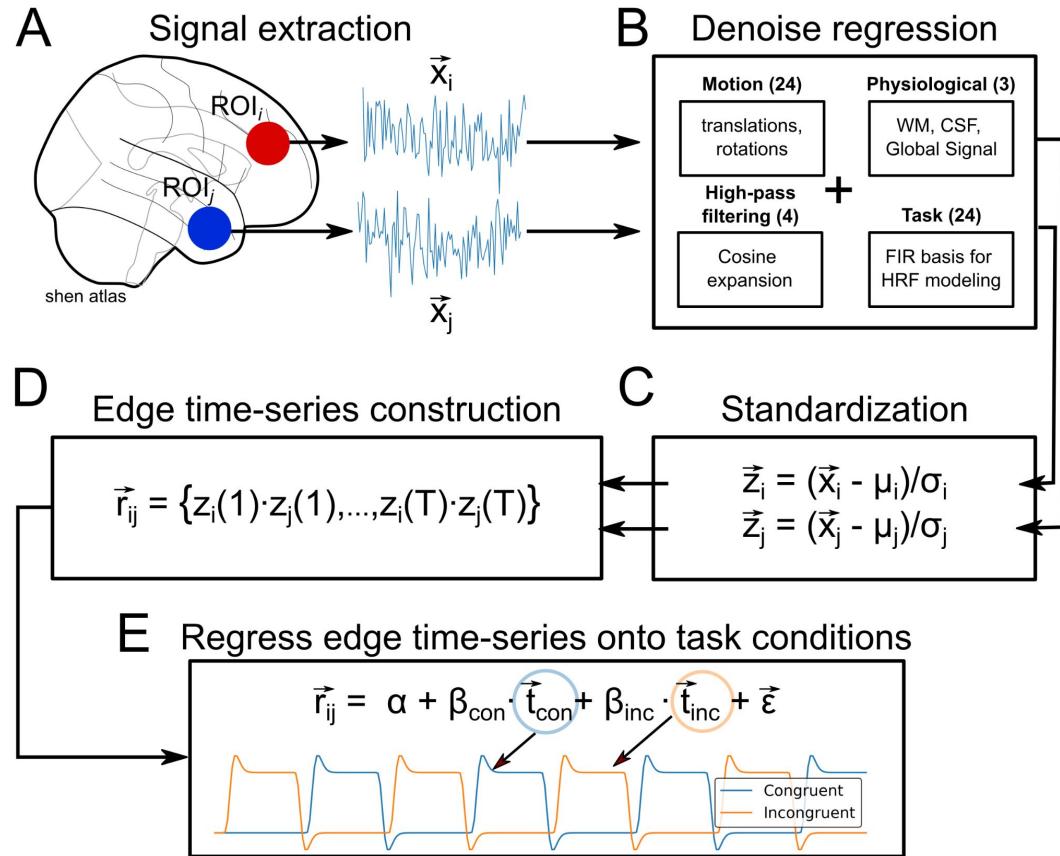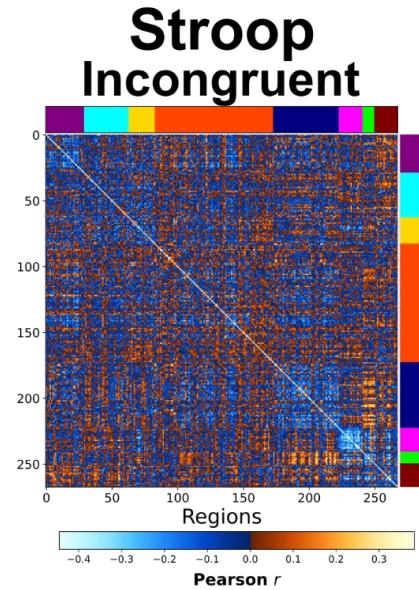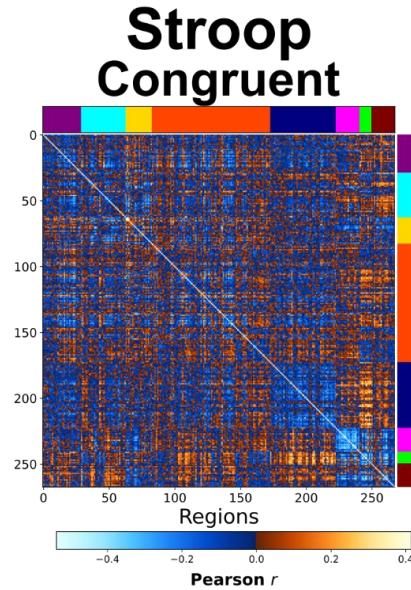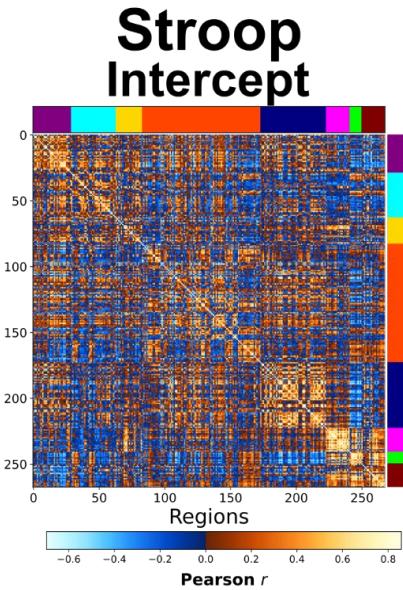
Methodology
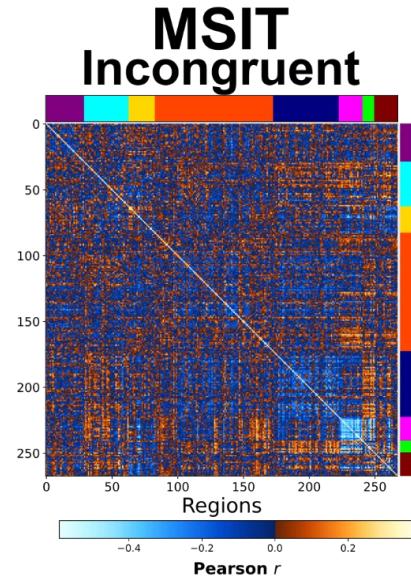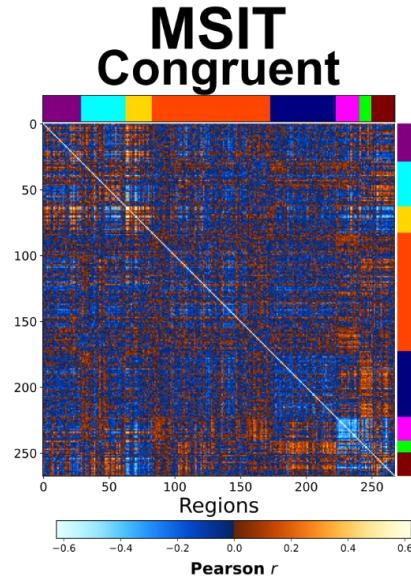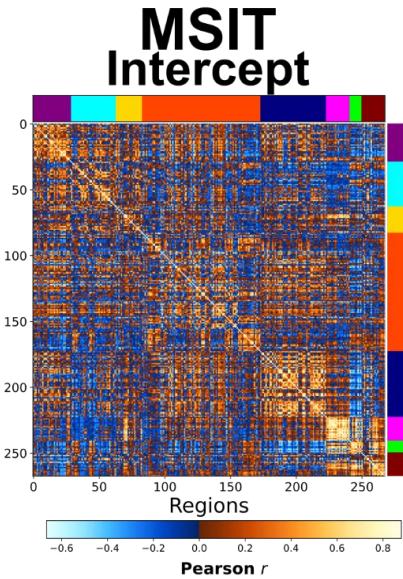
We assess connectivity changes between task conditions using a novel approach of instantaneous connectivity based on edge time series (Esfahlani, 2020) as outcome variables.

A Signal extraction

B Denoise regression

C Standardization

D Edge time-series construction

E Regress edge time-series onto task conditions
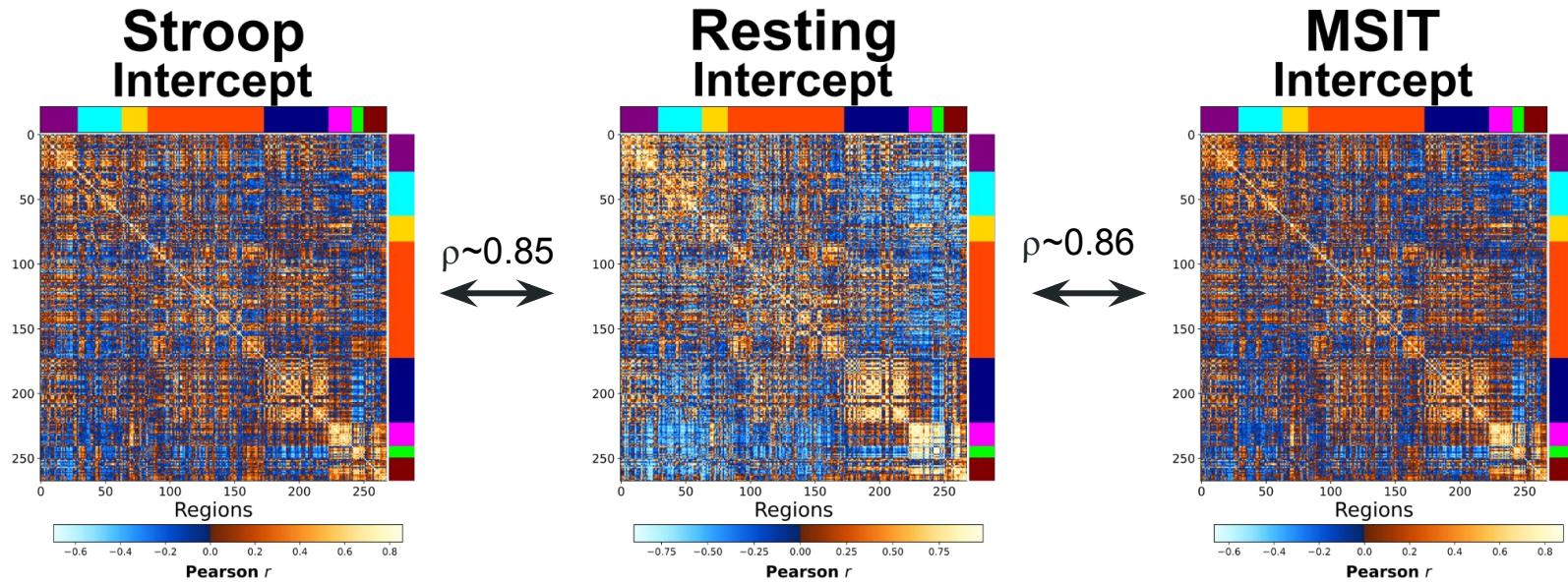
# Estimation of connectivity per task
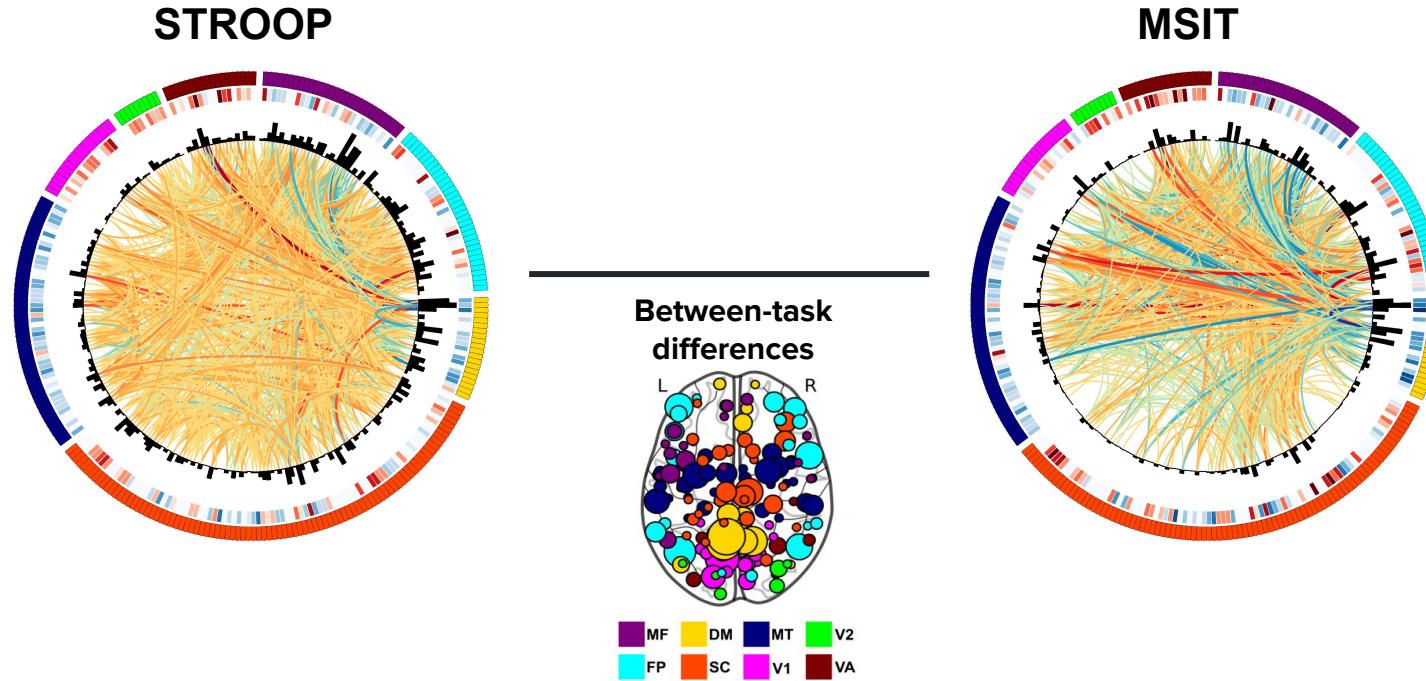
Estimation of connectivity per task

Recover of intrinsic connectivity

ρ~0.85

ρ~0.86
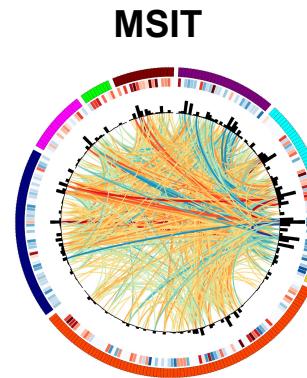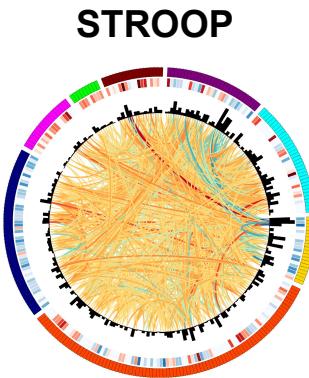
Patterns of connectivity **changes**
(Incongruent vs Congruent) **...**

STROOP

MSIT

Between-task differences

L R

🟪 MF	🟨 DM	🟦 MT	🟩 V2
🟦 FP	🟧 SC	🟪 V1	🟥 VA

...which are distinct between tasks...

STROOP
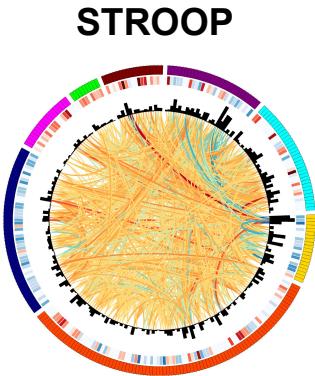
MSIT

Connectivity

…which are distinct between tasks…

STROOP

MSIT

Connectivity

ρ~0.64
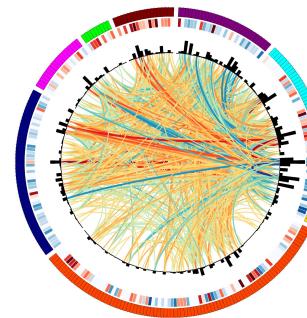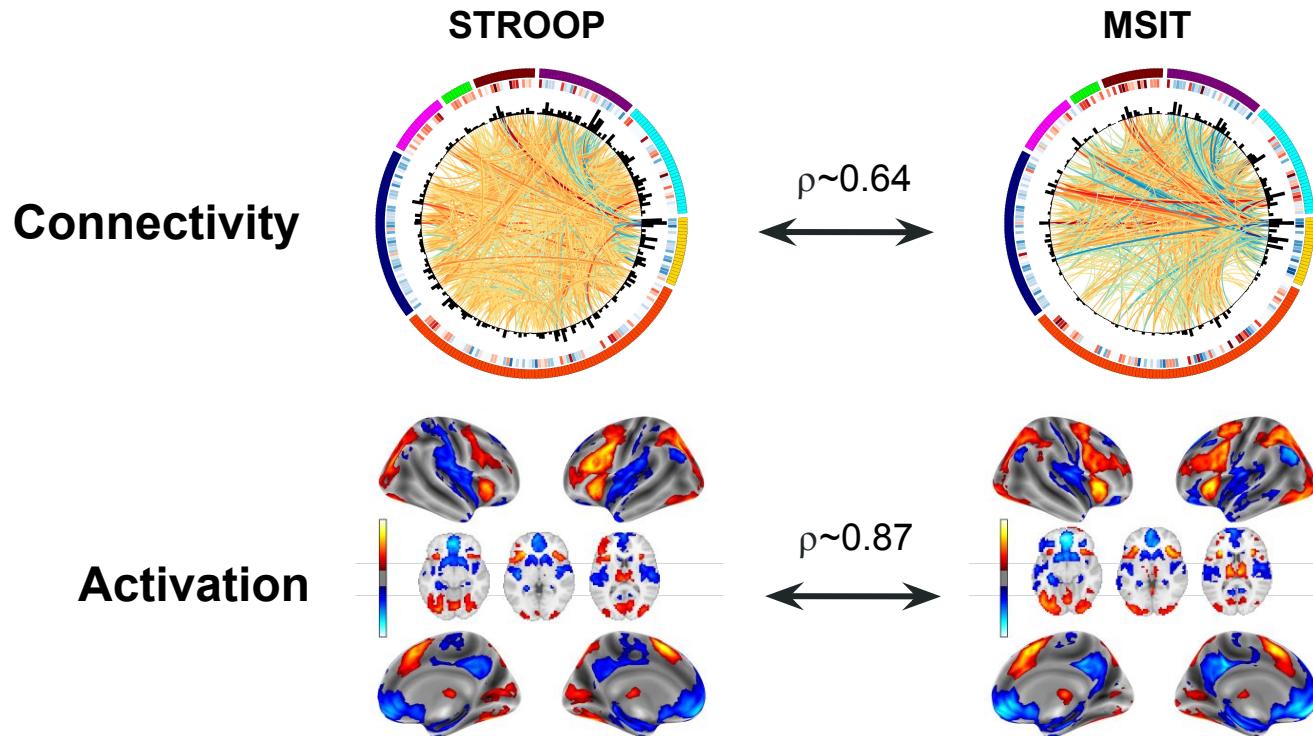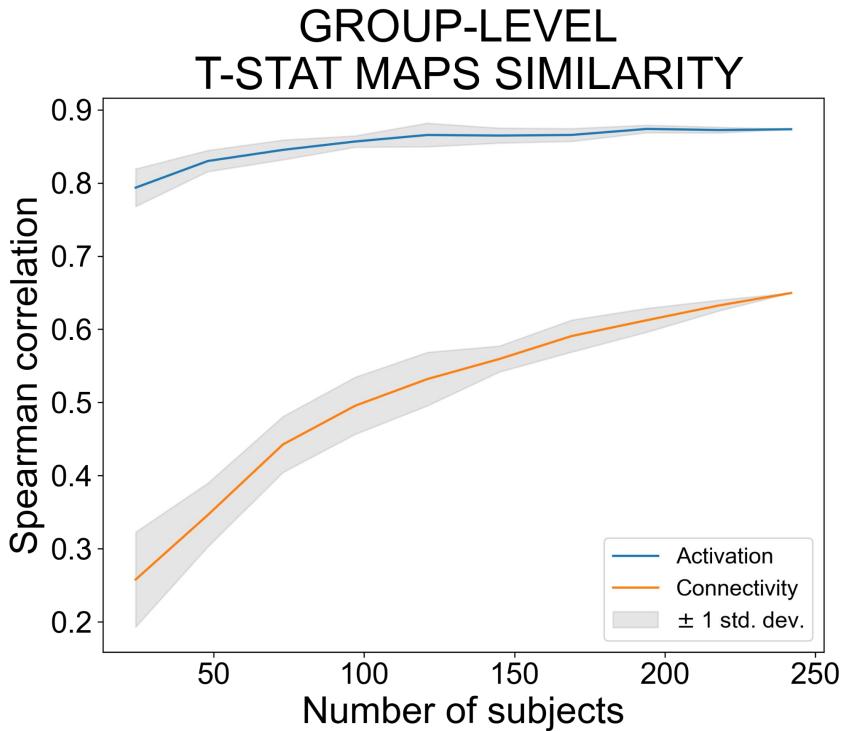
...in contrast to their larger similar activation patterns
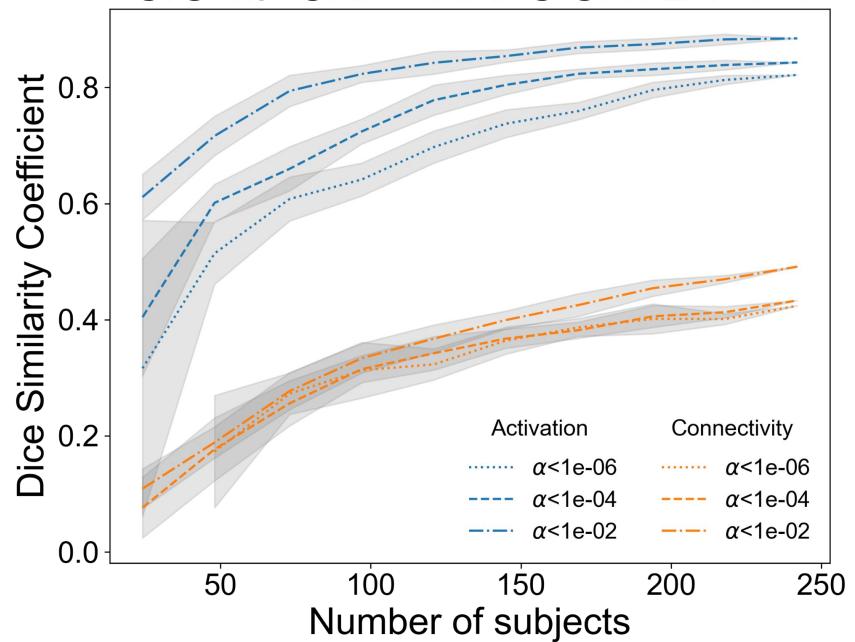
STROOP   MSIT

Connectivity   ρ~0.64

Activation   ρ~0.87
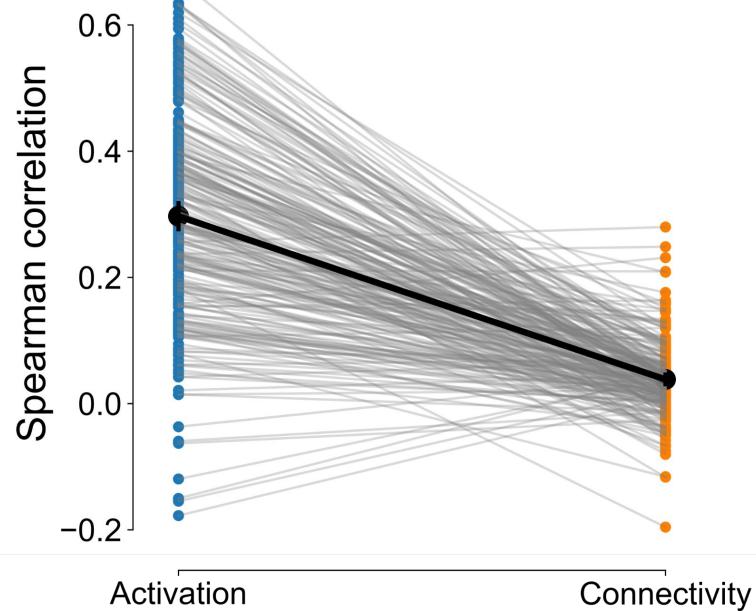
➤ Across different numbers of subjects.

GROUP-LEVEL
T-STAT MAPS SIMILARITY

GROUP-LEVEL
SIGNIFICANT MAPS SIMILARITY

➢ Across different numbers of subjects.

➢ Using a different measure of similarity.

SUBJECT-LEVEL
β-MAPS SIMILARITY

➢ Across different numbers of subjects.

➢ Using a different measure of similarity.

➢ Using instead subject-level estimations.

Take-home message

The brain is a dynamical system where its communication is important. As a consequence, the complete description and understanding of how it functions should rely on **both** node (activation) and edge (connectivity) level representations.

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THANK YOU FOR YOUR ATTENTION!!!

Any question, please do not hesitate to reach me:

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