Influence of network size on individual identifiability by functional brain connectivity in movies vs rest

Jean-Philippe Kröll[1,2*], Chenyue Wan[1,2], Xuan Li [1,2], Patrick Friedrich[1,2], Lisa Mochalski[1,2],Kaustubh R. Patil[1,2],Xing Qian[3], Ken Wong[3], Yng Min Loke[3], Michael W.L. Chee[3], Juan Helen Zhou[3], Simon B. Eickhoff [1,2], Susanne Weis[1,2]

[1]Institute of Systems Neuroscience, Heinrich Heine University Düsseldorf, Düsseldorf, Germany
[2]Institute of Neuroscience and Medicine (INM-7: Brain and Behaviour), Research Centre Jülich, Jülich, Germany, j.kroell@fz-juelich.de
[3]Center for Sleep and Cognition & Center for Translational MR Research, Yong Loo Lin School of Medicine, National University of Singapore

WTh420

Introduction

- Since the interest in individual differences and their relation to individual behaviour has grown exponentially, researchers are in a constant search for paradigms which can evoke a brain state that brings out individual differences best. Individual identifiability is commonly used to evaluate paradigms in their ability to emphasize those differences.

- Previous studies have shown that Naturalistic Viewing (NV) of movie clips in the scanner might facilitate individual difference research over the use of resting-state (RS) paradigms[1,2]

- Our current study aims to investigate the influence of networks size on individual identifiability during NV and RS. This will be done by comparing identifiability in artificially created networks with different sizes and meta-analytical networks.

Methods

Sample

- 35 healthy participants (19 female, mean age 26.9) completed three testing sessions within one week. Each session consisted of of a RS scan, followed by three different movie scans (Inscapes, Circus & Indiana Jones) and then a second RS scan.

Functional Imaging Data

- Siemens PrismaFIT3-Tesla, voxel size = 2.96 x 2.96 x 3 mm, TR = 719ms, TE = 30ms, slices = 44 , flip angle = 52,
- Scans lasted 10 min (847 volumes)
- Standard data preprocessing was performed with the fMRIPrep toolbox[3].
- For each network, the mean time series of all ROIs was extracted and Pearson's correlation coefficients (PCC) for every ROI pair were computed to produce an n-times n connectivity matrix.

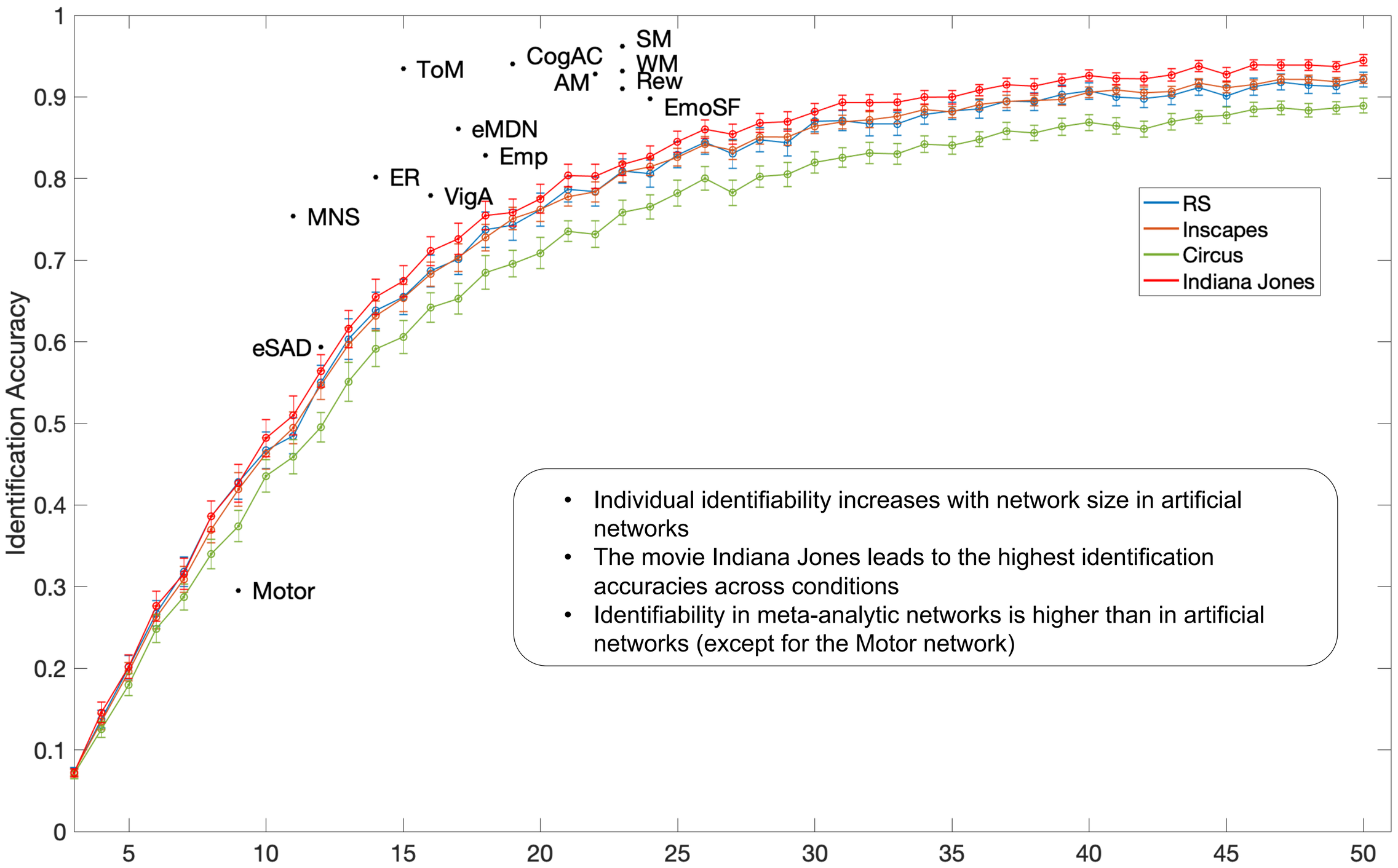
Artificial networks

- Artificial networks were created by randomly choosing n coordinates from the MNI152 grey matter mask. This process was repeated 100 times for each network size, ranging from 3 to 50 nodes. To preserve comparability, the mean minimal Euclidean distance between the nodes of the original networks was applied for the artificial networks as well.

Identification accuracies

- Identifiability was assessed by running an identification algorithm across sessions (but within conditions), for each network. The identification algorithm computed the PCC between the FC matrix of one subject and every other FC matrix from the other session and predicted those with the highest correlation to be from the same individual.

Results



- Individual identifiability increases with network size in artificial networks
- The movie Indiana Jones leads to the highest identification accuracies across conditions
- Identifiability in meta-analytic networks is higher than in artificial networks (except for the Motor network)

Identification accuracies in artificial and meta-analytical networks. Accuracies for the 14 meta-analytically defined networks are averaged across conditions and placed at their respective number of nodes for comparison. (AM =Autobiographic Memory, CogAC = Cognitive Attention Control,eMDN=extended Multiple Demand Network, EmoSF= Emotional Scene and Face Perception, ER = Emotion Regulation, eSAD=Extended Social-affective Default, MNS = Mirror Neuron System, Rew = Reward, SM = Semantic Memory, ToM = Theory of Mind, VigA= Vigilant Attention, WM = Working memory)

Discussion

- The size of artificial networks leads to a steep increase of identification accuracy until approximately 25 nodes where the increase rate stabilizes
- Our results suggest that the size of a network should be taken into account when comparing identifiability between networks
- The Indiana Jones movie led to the highest identification accuracy across conditions, regardless of network size
- These results imply that NV could potentially enhance the detection of individual differences
- Additionally, our results indicate that identifiability during NV is also dependent on the content of a given movie
- Meta-analytical defined networks generally led to higher accuracy which confirms their ecological validity
- Our results show that networks respond differently to the same type of stimuli

References:

1. Vanderwal T, Eilbott J, Finn ES, Craddock RC, Turnbull A, Castellanos FX. Individual differences in functional connectivity during naturalistic viewing conditions. *NeuroImage*. 2017;157:521-530.doi:10.1016/j.neuroimage.2017.06.027
2. Finn ES, Bandettini PA. Movie-Watching Outperforms Rest for Functional Connectivity-Based Prediction of Behavior. Neuroscience; 2020. doi:10.1101/2020.08.23.263723
3. Esteban O, Markiewicz CJ, Blair RW, et al. fMRIPrep: a robust preprocessing pipeline for functional MRI. *Nat Methods*. 2019;16(1):111-116. doi:10.1038/s41592-018-0235-4