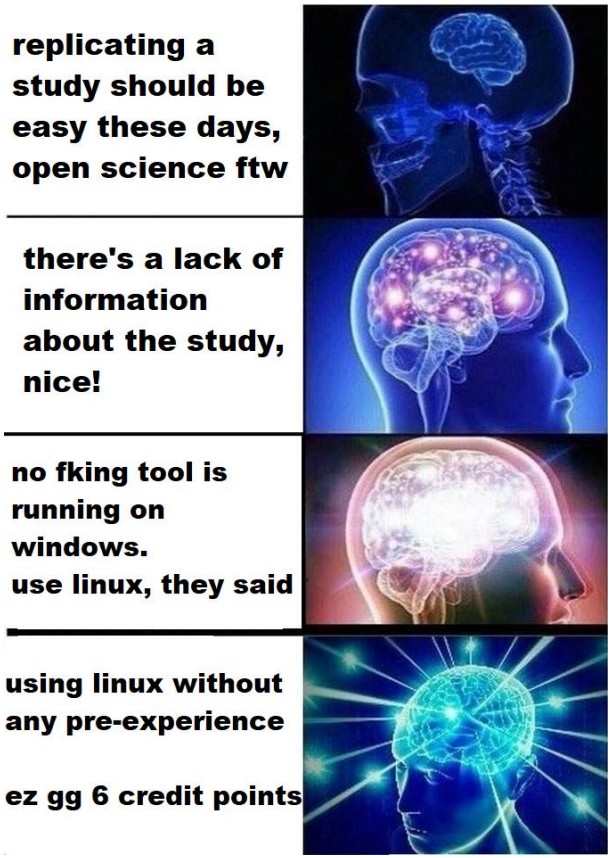
Our experiences and expectations



Philipps Universität Marburg

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Module: Methodological work in the neurosciences

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Overview

1. Study by Bezmaternykh et al. (2021)
2. Our replication approach
3. Results
4. Discussion
5. Conclusion

Study by Bezmaternykh et al. (2021)

Brain Networks Connectivity in Mild to Moderate Depression: Resting State fMRI Study with Implications to Nonpharmacological Treatment

Dmitry D. Bezmaternykh [1], Mikhail Ye. Melnikov [1], Andrey A. Savelov [2], Lyudmila I. Kozlova [1], Evgeniy D. Petrovskiy [2], Kira A. Natarova [3], and Mark B. Shtark [1]

- 72 Participants
- 51 patients with mild depression
- 21 healthy participants
- resting state fMRI study

Methods

- Preprocessing with Matlab and SPM12
  - 2 participants excluded (1 because of movement, 1 because of artefacts)
- GIFT 3.0.a software was used to perform spatial independent components analysis (ICA)
- FNC toolbox was used to calculate temporal correlations between the dynamics of the selected components.

Results

Table 3: Results of depressed vs. controls comparison in all cases (left part) and in cases correlated with 6 solid body motion parameters less than $r = 0.4$ on individual level (right part).

Pair	All cases				$r < 0.4$ with motion parameters			
	HC, Mean ± SD	DEP-51, Mean ± SD	t	p	HC, Mean ± SD	DEP-51, Mean ± SD	t	p
1-9 (DMN-LFr)	−0.09 ± 0.27	0.14 ± 0.32	−2.93	0.005	−0.11 ± 0.27	0.13 ± 0.33	−2.88	0.005
1-16 (DMN-DMN)	0.52 ± 0.19	0.35 ± 0.38	2.59	0.012	0.54 ± 0.19	0.38 ± 0.34	2.34	0.023
2-20 (RFr-Cer)	0.04 ± 0.32	0.21 ± 0.30	−2.13	0.037	0.02 ± 0.33	0.19 ± 0.31	−1.99	0.051 (n/s)
5-8 (mVis-AN)	0.15 ± 0.36	0.37 ± 0.38	−2.32	0.023	0.15 ± 0.36	0.39 ± 0.36	−2.50	0.015
5-17 (mVis-LN)	0.13 ± 0.29	−0.02 ± 0.35	1.89	0.066 (n/s)	0.15 ± 0.28	−0.10 ± 0.32	2.96	0.005
9-16 (LFr-DMN)	−0.12 ± 0.21	0.07 ± 0.29	−2.97	0.004	−0.13 ± 0.21	0.08 ± 0.29	−3.31	0.002
11-13 (DMN-ECN)	0.03 ± 0.37	0.23 ± 0.30	−2.34	0.022	0.02 ± 0.38	0.23 ± 0.31	−2.27	0.027
11-17 (DMN-LN)	0.04 ± 0.30	0.18 ± 0.34	−2.13	0.037	−0.16 ± 0.30	0.01 ± 0.32	−1.97	0.055 (n/s)

SD: standard deviation; DMN: default mode network; LFr: left fronto-parietal network; RFr: right fronto-parietal network; Cer: cerebellar network; mVis: medial visual network; AN: audial network; LN: language network; ECN: executive control network; t: t test value; p: 2-tailed significance level; n/s: nonsignificant.

In the depressed group:

- decreased functional connectivity within the DMN
- global increase of functional connectivity between the DMN and the ECN.
- Overconnectivity of the medial visual cortex (mVis) with the audial cortex (AN) in the depressive group.

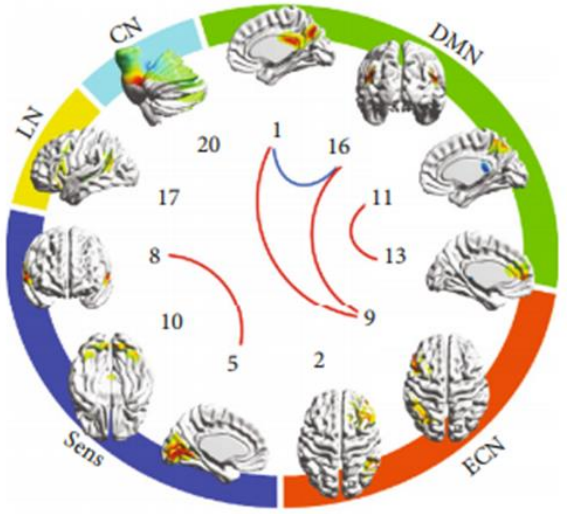


Figure 1: Results of depressed vs. controls comparison. IC numbers match ones of Tables 2 and 3. IC spatial distribution on the most representative cerebral (cerebellar for #20) surface is given. These surface maps were prepared using BrainNet Viewer software. ICs are grouped by relation to functional specialization to DMN, ECN, sensor, language, and cerebellar. Blue lines show pairs with more connectivity in controls, red lines show pairs with more connectivity in depressed patients ($p < 0.05$ uncorrected).

Hypothesis

- **Hypothesis 1**
  - Functional connectivity differs between depressed patients and healthy controls.
- **Hypothesis 2**
  - Replicating the methods that were made in the original study but using different analysis and preprocessing tools would lead to different results regarding the differences in functional connectivity between depressed patients and healthy controls.

Our methods

- Quality control with mriqc and mriqception
  - 3 subjects excluded because of too much movement or artefacts
- Preprocessing with Nipype
- Independent Component Analysis (ICA) with Nilearn

Our results – Areas with biggest difference

Brain Areas	Correlation Coefficient Healthy	Correlation Coefficient Depressed	Difference Both groups
Broca - Motor	0,60	-0,26	0,86
Broca - L Ant IPS	0,40	-0,38	0,78
V ACC - Motor	-0,30	0,61	0,91
R Par – Cing	-0,33	0,53	0,86

- Motor categorized as sensorimotor network.
- L Ant IPS categorized as dorsal attention network.
- Cing categorized as default mode network.
- V ACC categorized as salience network.
- R Par categorized as default mode network.
- Broca categorized as language network.

Our results

Brain Areas	Correlation Coefficient Healthy	Correlation Coefficient Depressed	Difference Both groups
L DMN - Med DMN	0,47	0,40	0,07
L DMN - Front DMN	0,24	-0,05	0,29
L DMN - R DMN	0,73	0,16	0,57
Med DMN - Front DMN	0,36	0,11	0,24
Med DMN – R DMN	0,27	0,29	0,02
Front DMN – R DMN	0,02	0,03	0,01

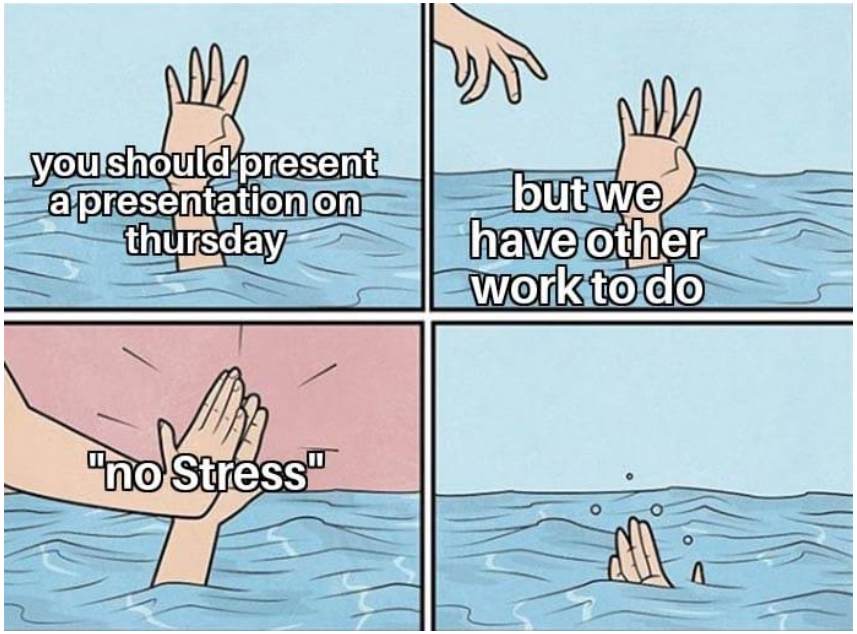
Discussion

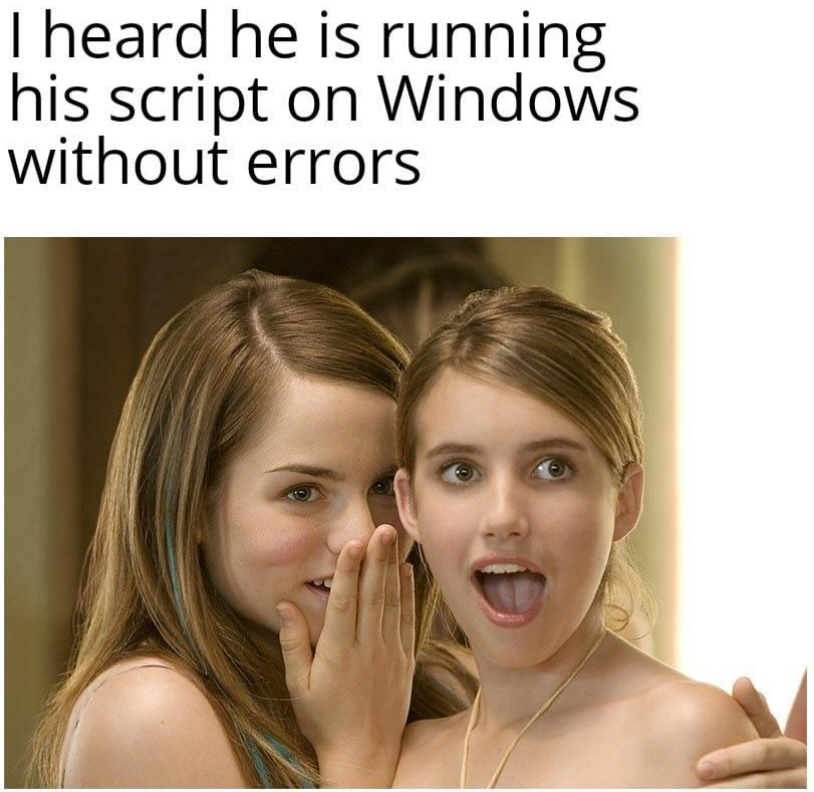
- Hypothesis 1 : confirmed
  - Differences between the two groups in connectivity
- Hypothesis 2 : confirmed
  - Bezmaternykh et al. (2021): decreased connectivity for the depressed group within the DMN.
  - Our analysis: DMN connectivity (R Par – Cing) was increased in the depressed group.
  - Broader areas: DMN connectivity in depressed group decreased
  - Findings not in line with further literature (Dai et al., 2019).
  - Further connectivity differences were found

Conclusion

- Functional brain connectivity differs between healthy and depressed subjects.
  - Can be found in this study as well as in the study by Bezmaternykh et al. (2021).
- The try replicate the concrete differences with different tools, was unsuccessful.
  - Further connectivity differences were found
  - The trend that connectivity within the DMN is not increased in depressed patients as further literature would suggest (Dai et al., 2019) is confirmed.

Memes





For more memes check out https://jakob236.github.io/notreadyyet/Memes.html

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Notreadyyet

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Introduction

Ioannidis (2005) claimed that most findings in the behavioral sciences are false and therefore, cannot be replicated. This project aims at investigating if the results of the following study Bezmaternykh et al. (2021) are reproducible. This is relevant because the study was done in a clinical setting where results might affect the well-being of patients.

Study & Methods

In this study they recorded 72 subjects with a resting state fMRI. 21 of the subjects were healthy (control) and 51 of the subjects had mild depression. They found functional connectivity differences between the two groups.

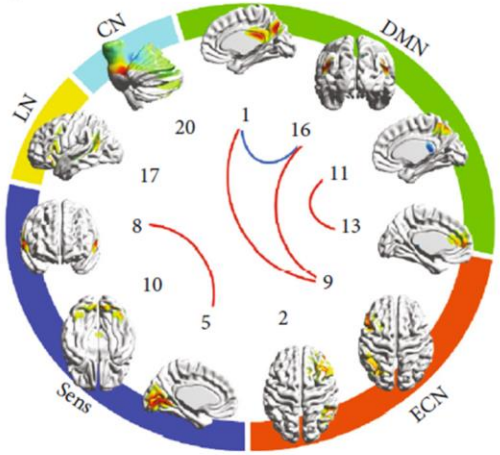

Figure 1: Results of depressed vs. controls comparison (Bezmaternykh et al. 2021, p. 6).
Blue lines show pairs with more connectivity in controls, red lines show pairs with more connectivity in depressed patients ($p < 0.05$ uncorrected)

Lit.: https://jakob236.github.io/notreadyyet/Literature.html

Analyses

We analyzed our data with different tools but all implemented in jupyter notebook and based python. First step was the preprocessing with nipype with implemented SPM. For the quality control we used mriqc and mriqception. With this results we excluded 3 subjects due to artifacts or to much movement. Further, we made an ICA (independent component analysis) that shows us areas with the same activation pattern. We created correlation matrices to compare the results with each other. In the last step we checked the discrepancies of the correlation in healthy vs. depressive. We extracted the most significant areas.

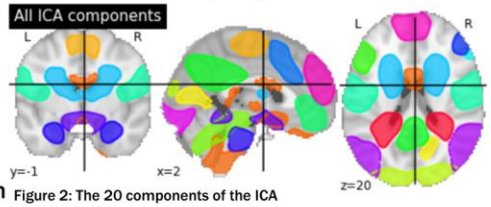

Figure 2: The 20 components of the ICA

Results

Our results show a similar pattern with slight differences. Here you can see the correlation matrices that compared 36 areas with each other. To compare the results with the paper we allocated our areas to the according network. We found higher correlation coefficients in depressive subjects between the saliency network and the sensorimotor network (V ACC – Motor), within the DMN for R Par – Cing. Higher correlation coefficients for the healthy group were between the language network and the sensorimotor network (Broca - Motor) and between the language network and the dorsal attention network (Broca - L Ant IPS). When looking at broader areas rather than specific regions in the DMN, a higher correlation coefficient in the healthy group could be found for L DMN - Front DMN, L DMN - R DMN and Med DMN - Front DMN. For the other areas the correlation coefficient difference was too small to be considered as a difference in connectivity between the two groups.

Table 1: connectivity – most significant results

Brain Areas	Correlation Coefficient Healthy	Correlation Coefficient Depressed
Broca - Motor	0,60	-0,26
Broca - L Ant IPS	0,40	-0,38
V ACC - Motor	-0,30	0,61
R Par – Cing	-0,33	0,53

Table 2: connectivity – Default mode network (DMN)

Brain Areas	Correlation Coefficient Healthy	Correlation Coefficient Depressed
L DMN - Med DMN	0,47	0,40
L DMN - Front DMN	0,24	-0,05
L DMN - R DMN	0,73	0,16
Med DMN - Front DMN	0,36	0,11
Med DMN – R DMN	0,27	0,29
Front DMN – R DMN	0,02	0,03

Conclusions

Our first hypothesis regarding the difference in connectivity between the groups is seen as confirmed because differences in correlation were found for multiple brain areas (Table 1). The second hypothesis, that different processing and analysis tools would lead to different results was confirmed too. Bezmaternykh et al. (2021) found decreased connectivity for the depressed group within the DMN. We, on the other hand found increased DMN connectivity. In broader areas in the DMN, a higher correlation in the healthy group was found for several areas (Table 2). This finding is not in line with further studies (Dai et al., 2019). Furthermore, big connectivity differences were found for the language network with the sensorimotor network but also several others. These results were not found in the original study.
In conclusion, functional brain connectivity differs between healthy and depressed subjects. This can be found in both studies. However, the try replicate the concrete differences with different tools was unsuccessful.