On the relationship between gray matter and behavioral data: lessons learned.

Submission Number:

7129

Submission Type:

Abstract Submission

Authors:

Sarah Genon[1], Tobias Wensing[2], Felix Hoffstaedter[2], Andrew Reid[3], Svenja Caspers[4], Christian Grefkes[5], Thomas Nickl-Jockschat[6], Simon Eickhoff[7]

Institutions:

[1]Forshungzentrum Juelich, Juelich, Germany, [2]Research Centre Jülich, Jülich, Germany, [3]Forshungzentrum Juelich, Juelich, [Select a State], [4]Institute of Neuroscience and Medicine, INM-1, Research Center Julich, Julich, Germany, [5]Department of Neurology, Cologne, Germany, [6]RWTH Aachen University, Aachen, Germany, [7]Institute of Clinical Neuroscience and Medical Psychology, Heinrich Heine University, Duesseldorf, Germany

Introduction:

Recently, we functionally characterized five right dorsal premotor (PMdr) subregions (identified by coactivation based parcellation) by quantitative forward and reverse inference based on a wide range of task-based activation studies [1]. We found that the rostral subregion was associated to high-level cognitive tasks, the caudal one to motor functions, the dorsal one to hand-movements, the ventral one to visual functions while the central one showed a heterogeneous profile. Here, we aimed to reinforce and complement this characterization by using correlations between brain morphology and standard cognitive scores in two independent large datasets.

Methods:

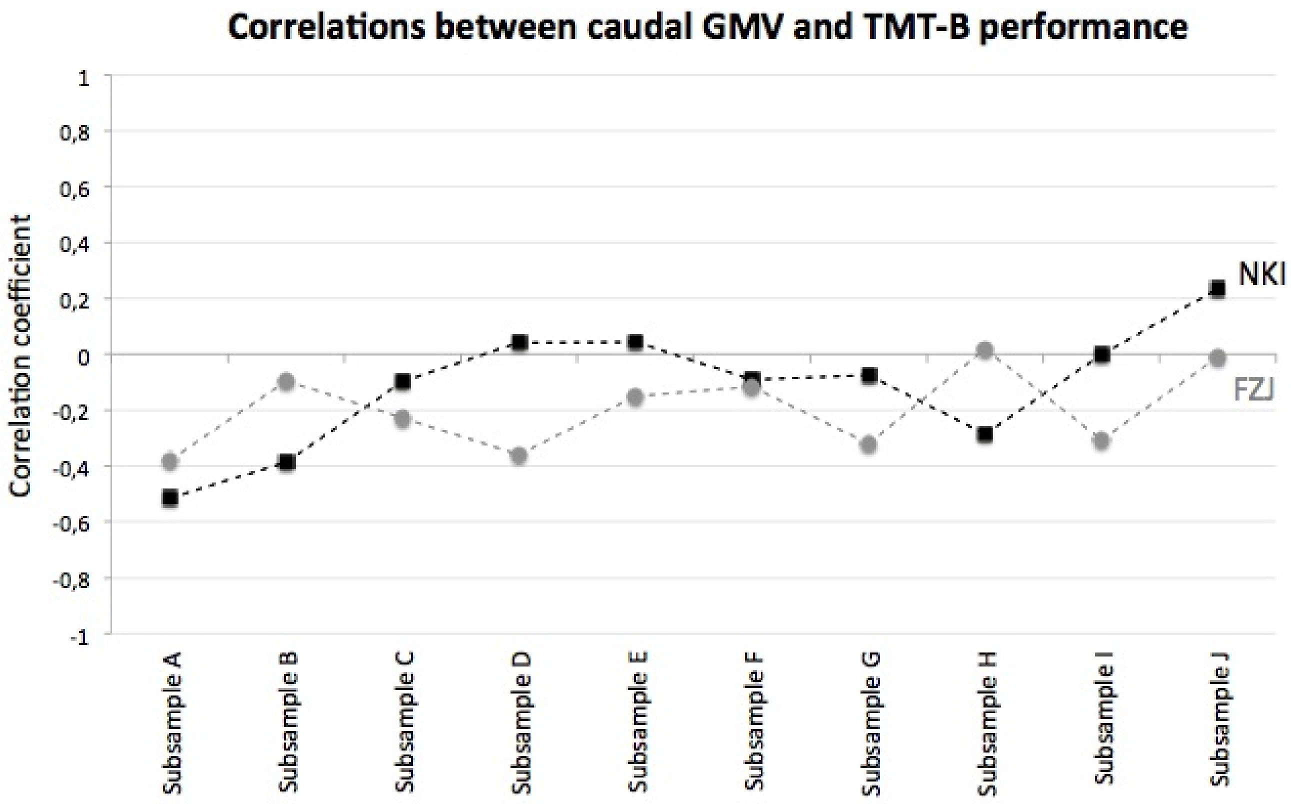
Two healthy adult cohorts matched for age, gender, education, depression and handedness were used: Forschungszentrum Jülich (FZJ, n = 87, age range: 21-71) and NKI (126: 18-81). Both datasets contained T1 images (1 mm3 voxels) and performance at standard neuropsychological tests. FZJ additionally included basic motor performance. T1 images were processed with the VBM8 toolbox [2] (using linear and non-linear modulation). The five PMdr subregions were used as regions of interest (ROIs), from which regional gray matter volume (GMV) was extracted after adjusting for tissues (GMV and white matter) total volume. In addition to full Pearson correlations, we performed partial correlations to examine correlation between each ROI GMV and performance when controlling for confounding effect of age, gender, education, depression, handedness and GMV of the four remaining ROIs. To further examine the reliability of correlation, we also performed the analyses in 10 subsamples of 30 randomly selected subjects within each sample.

Results:

As illustrated in Fig. 1, these analyses yielded generally low correlation coefficients, with the highest coefficient being $r = -.34$ for correlation between caudal GMV and right arm movement performance (10x30-R). Furthermore, out of 380 correlational analyses, only 25 (= 6.6 %) were statistically significant at $P < .05$, uncorrected for multiple testing. Notably, most of these correlations (16/25) were negative, i.e., higher performance was associated with lower GMV. In addition, the pattern of correlations varied across samples in magnitude, significance and direction. For example, with the partial correlation approach, whereas in FZJ, TMT-B performance (generally thought to reflect executive control abilities, [3]) correlated negatively with caudal GMV, it correlated positively with ventral GMV in NKI. Finally, subsampling revealed that the pattern of correlations varied across the different subsamples in both FZJ and NKI. For example, the coefficients of partial correlation between caudal GMV and TMT-B performance ranged from -.4 to 0 in FZJ subsamples and it ranged from -.5 to .2 in NKI (Fig. 2).

	Full correlation					Partial correlation				
	Rostral	Caudal	Central	Ventral	Dorsal	Rostral	Caudal	Central	Ventral	Dorsal
FZJ sample										
10s-R			.10		-.17	-.09	-.20		-.10	-.10
10s-L	-.08		.13	.13	-.14	-.11	-.14			
10s-Median			.16	.12	-.17	-.11	-.20			-.10
10x30-R	-.18	-.26		.12		-.23	-.34	-.13		
10x30-L	-.11	-.10		.18		-.14	-.16		.13	
10x30-Median	-.12	-.13		.17		-.17	-.20	-.10	.11	
TMT-A		.10	.13	.14		-.12				
TMT-B		-.14				-.14	-.24	-.10	-.11	
DST		.09			-.09				-.09	
DS-F Span			.12	.13			-.08			
DS-B Span	-.11	-.15	-.17		-.16	-.20	-.25	-.24		-.12
Benton f	.10	-.12			.09	.17		.11	.14	
Benton w	-.09	.16			-.08	-.15	.08	-.08	-.11	
Stroop Read	.15	.11	.13	.14		.09		.11		
Stroop Name						-.10				
Stroop CW		.14	.16	.23	-.12		.11	.15	.18	-.09
Block Tap-F	.16	.14	.17	.15	-.08	.08		.15		
Block Tap-B	.12		.09	.15	-.11				.11	-.09
COWAT	.09	.07		0,10	-.12					-0,10
NKI sample										
TMT_A	.11			-.09		.12			-.10	-.07
TMT_B	.14		.15	.22	.08	.16	-.09	.07	.22	.10
CardSorting_F		-.22			-.15		-.21			-.14
CardSorting_R	.11	-.14	.11			.12	-.14			
VF_Letters	-.17	-.11	-.15	-.10	-.11	-.16	-.11	-.15	-.09	-.10
VF_Categories							-.10			
VF_Switching		.10	.07				.09			
DF_FilledDots	-.07	-.08	-.20		-.10	-.07	-.09	-.22		-.11
DF_EmptyDots	-.09	-.12	-.20		-.18	-.09	-.14	-.23		-.18
DF_Switching		-.13	-.12	-.15	-.08		-.12	-.12	-.15	-.07
Stroop Read	.08		.10	.09	-.08	.09		.07	.07	-.08
Stroop Name					-.11					-.12
Stroop CW				.10	-.17			-.09	.08	-.16
20 Questions	-.16			-.15	-.19	-.17	-.09	-.10	-.19	-.22
WordContext	-.17	-.19	-.22	-.13	-.20	-.17	-.17	-.24	-.14	-.19
Tower Test	.26	.22	.19	.10	.16	.26	.21	.24	.11	.14
ANT_Alert		-.14					-0,13			
ANT_Orient			.10							
ANT_Conflict	-.07	-.24		-.15		-.07	-.24	-.10	-.19	

·TMT, Trail Making Test; DST, digit symbol test, DS; digit span; COWAT, Controlled Oral Word Association Test; VF/DF, verbal fluency/design fluency; ANT, Attentional Network Task.



·Partial correlations between caudal grey matter volume and performance at Trail Making Test Part B in 10 subsamples of 30 randomly selected subjects

Conclusions:

Our correlational approach, relating GMV and performance across a wide range of standard neuropsychological tests, did not corroborate or extend the profiles previously revealed using functional decoding based on fMRI-activations. Importantly, in two different large datasets we found mostly correlations whose magnitudes were opposite to those expected (i.e., more GMV is related to better test performance). Furthermore, the correlations were highly unstable across samples and subsamples. On the one hand, these findings may suggest that the current approach has several limitations. Namely, the results may not be replicable across similar distinct samples. On the other hand, these findings suggest that the functional specialization of some cortical regions, as highlighted by fMRI studies, does not necessarily imply a significant covariance of their actual structure with related standard task performance in the healthy population. In other words, a cognitive-morphologic approach based on healthy interindividual differences may not mirror functional characterization revealed by activations studies in some brain regions.

Imaging Methods:

Anatomical MRI [2]

Neuroanatomy:

Cortical Anatomy and Brain Mapping [1]

Keywords:

MRI

Other

[1|2] *Indicates the priority used for review*

Would you accept an oral presentation if your abstract is selected for an oral session?

Yes

Please indicate below if your study was a "resting state" or "task-activation" study.

Other

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Healthy subjects

Internal Review Board (IRB) or Animal Use and Care Committee (AUCC) Approval. Please indicate approval below. Please note: Failure to have IRB or AUCC approval, if applicable will lead to automatic rejection of abstract.

Not applicable

Please indicate which methods were used in your research:

Structural MRI

Neuropsychological testing

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

SPM

Provide references in author date format

[1] Genon, S., Müller, V.I., Cieslik, E., Hoffstaedter, F., Langner, R., Fox, P.T., Eickhoff, S.B. (2014). 'Examining the right dorsal premotor mosaic: a connectivity-based parcellation approach'. OHBM Annual Meeting.
[2] Friston, K.J., Ashburner, J. (2000). 'Voxel-Based Morphometry-The methods'. NeuroImage, vol. 11, pp. 805-821.
[3] Arbuthnott, K., Frank, J. (2000). 'Trail Making Test, Part B as a measure of executive control: validation using a set-switching paradigm. Journal of Clinical and Experimental Neuropsychology, vol. 22, n°4, pp. 518-528.