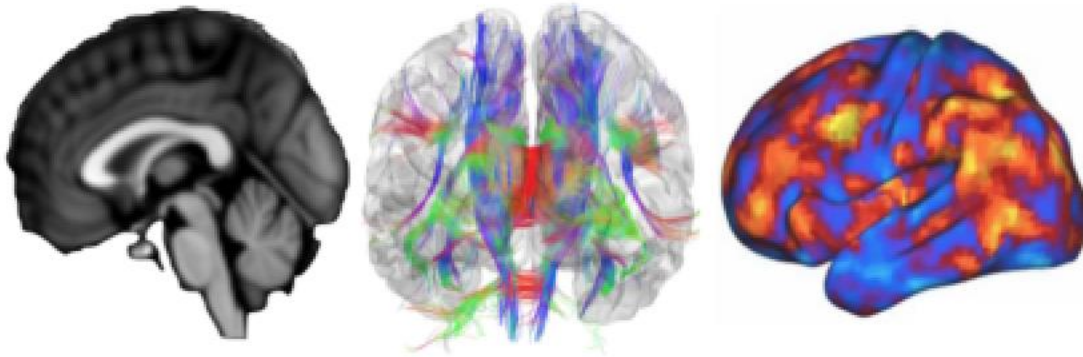




Welcome!

1. course overview & ressources
2. facility, informed consent, accidents, security training, artifacts
3. Structural MRI, volume, surface, cortical thickness
4. Neuro-Query, big data, Pilot studies, Individual subjects|
5. Pipelines, transparency, Open Science

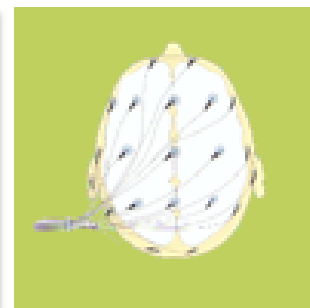
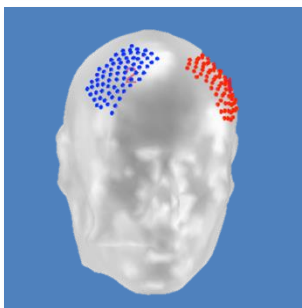
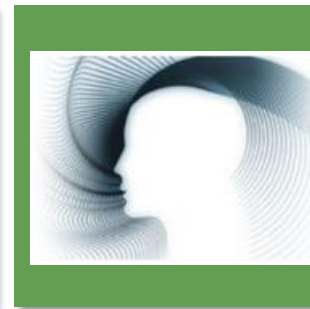
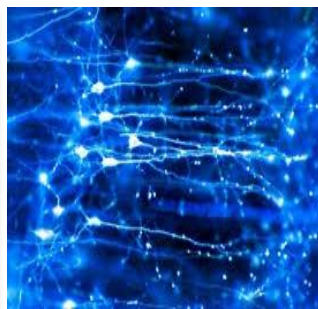
From Scans to Brain: MRI Basics and Safety Issues

Daniel Keeser

Research group “Neuromodulation and Multimodal NeuroImaging”

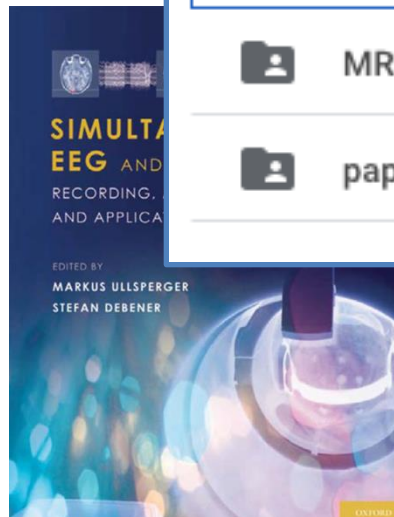
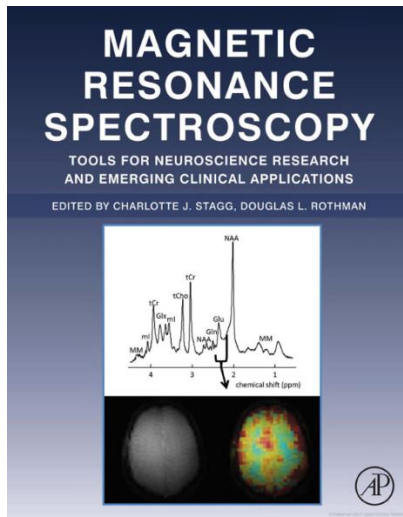
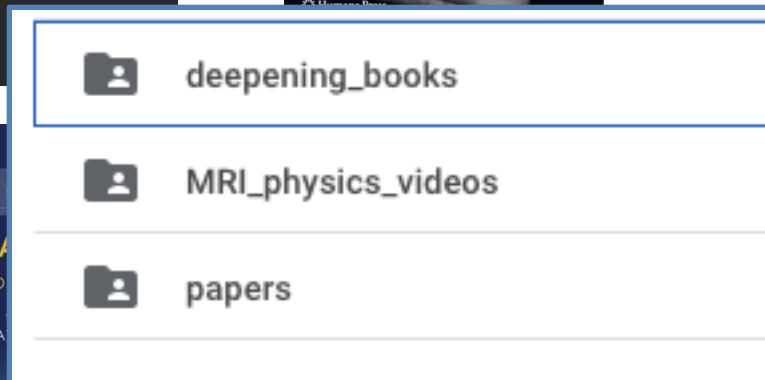
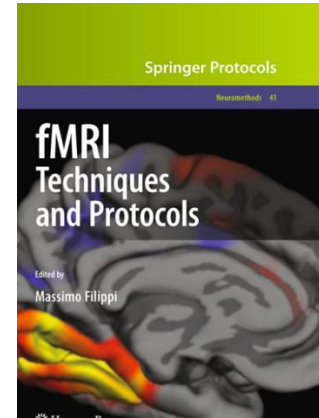
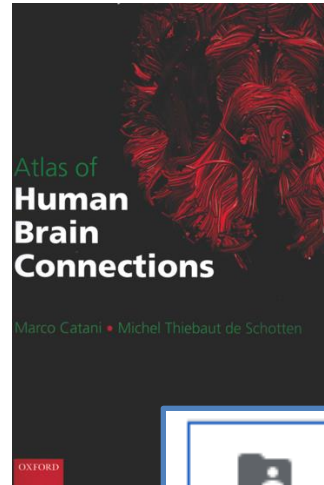
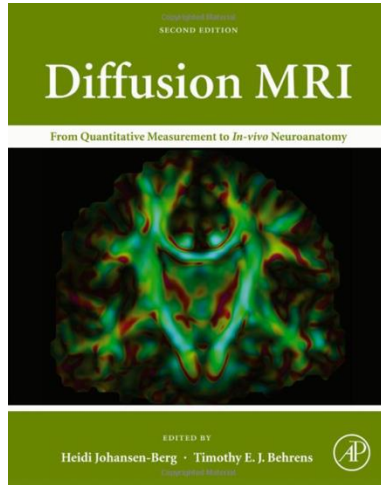
Dept. of Psychiatry and Psychotherapy, University Hospital (LMU), Munich, Germany

NeuroImaging Core Unit Munich (NICUM), University LMU, Munich, Germany



Resources provided (subsequent deepening)

https://drive.google.com/drive/folders/1uSG6F7pJ6EFNODxoUtUSgzsfY_IHwd9q?usp=drive_link

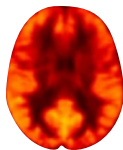


Online version downloaded from
<http://www.practicereproducibleresearch.org>

Cite as

Kitzes, J., Turek, D., & Deniz, F. (Eds.). (2018). *The Practice of Reproducible Research: Case Studies and Lessons from the Data-Intensive Sciences*. Oakland, CA: University of California Press.

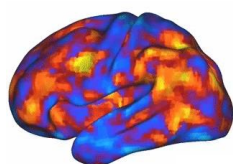
ASL



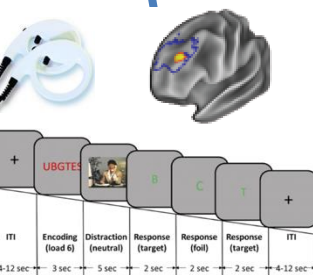
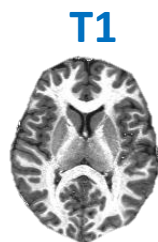
GM volumes



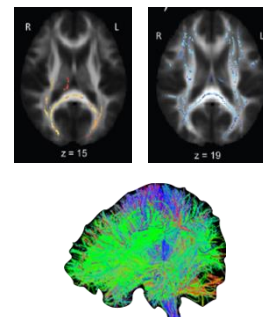
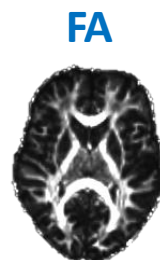
GM surfaces



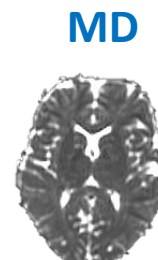
rsfMRI



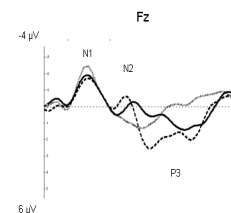
task-fMRI



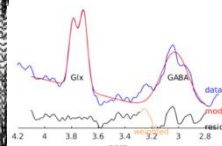
Tractography



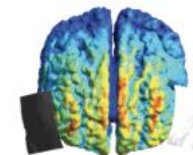
EEG



ERP, Phase



Simulation



1

Keeser et al., *J Neuroscience* 2011
 Keeser et al., *NeuroImage* 2011
 Palm*, Keeser* et al., *Schizophrenia Bulletin* 2016
 Chang et al., *NeuroImage* 2024

Wörsching et al., *NeuroImage* 2017
 Wörsching et al., *Brain Stimulation* 2018
 Bulubas et al., *Brain Stimulation* 2019, 2022
 Mizutani-Tiebel et al., *NeuroImage Clinical* 2022

Physics of MRI

 1_Intro_to_MR_physics.mp4 

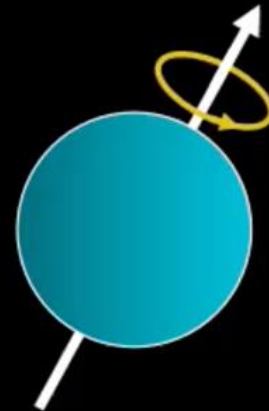
 2_ImageFormation.mp4 

 2a_Basic_Maths_Week2Lecture2.mp4 

 3_Pulse_Sequences.mp4 

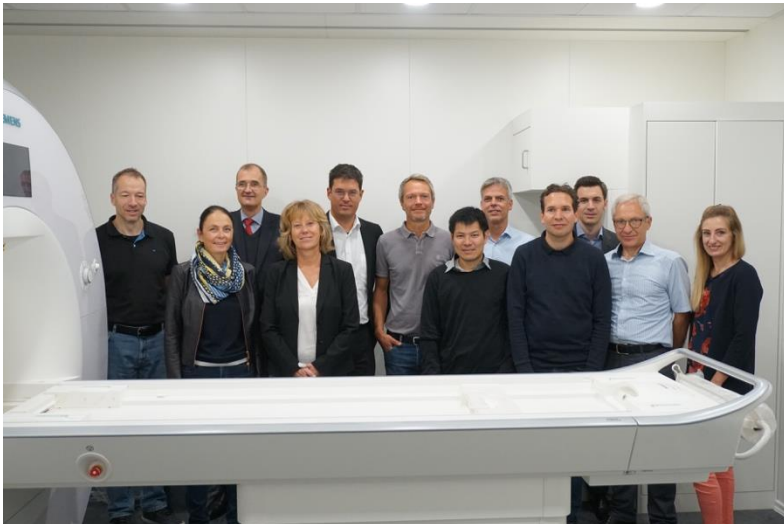
 4_Contrast_Manipulation_2014.mp4 

Introduction to MRI Physics



Karla Miller (karla@fmrib.ox.ac.uk)

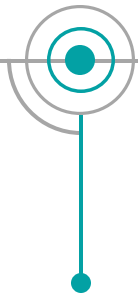
MRI facility – arrival of the scanner 2019



HISTORY

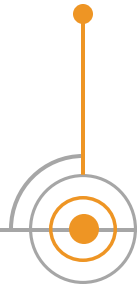


2015

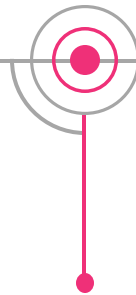


- Proposal for research scanner submitted to DFG
- grant awarded by DFG/Bavarian state (2,45 Mio. €)

2016

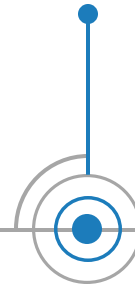


2017

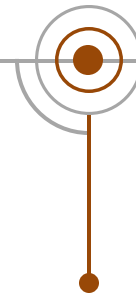


- 2018: Construction planning and construction work
- end of 2019: scanner transferred to KUM/LMU

2018/
2019



2020



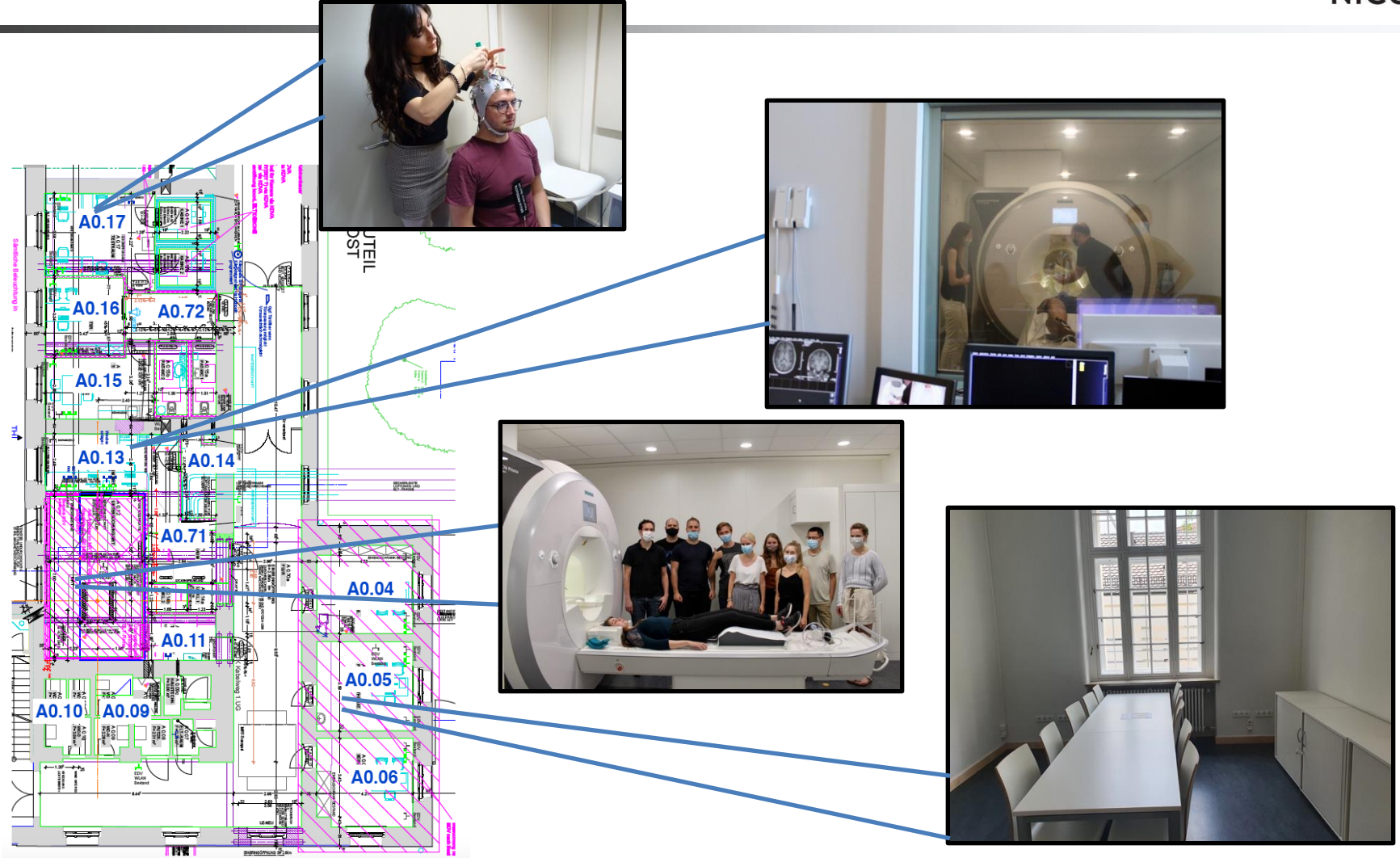
Roadmap NIMG Research at LMU:

- 2 x 3T scanners (2017)
- Animal MRI (2018)
- 7T scanner (2022)

- Sharing responsibilities LMU/KUM
- construction costs: 660,000€ KUM,
1 Mio. € LMU

8/2020: Release of the
NICUM research scanner
Real start 1/2021

MRI facility – rooms/location



Current Research Topics

Biological Psychiatry
Available online 27 April 2024
In Press, Journal Pre-proof [What's this?](#)

Archival Report

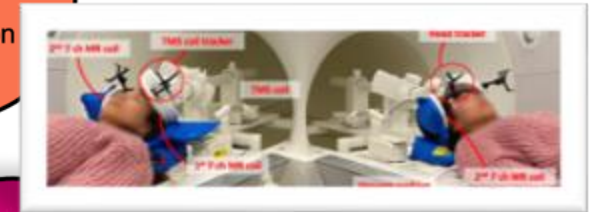
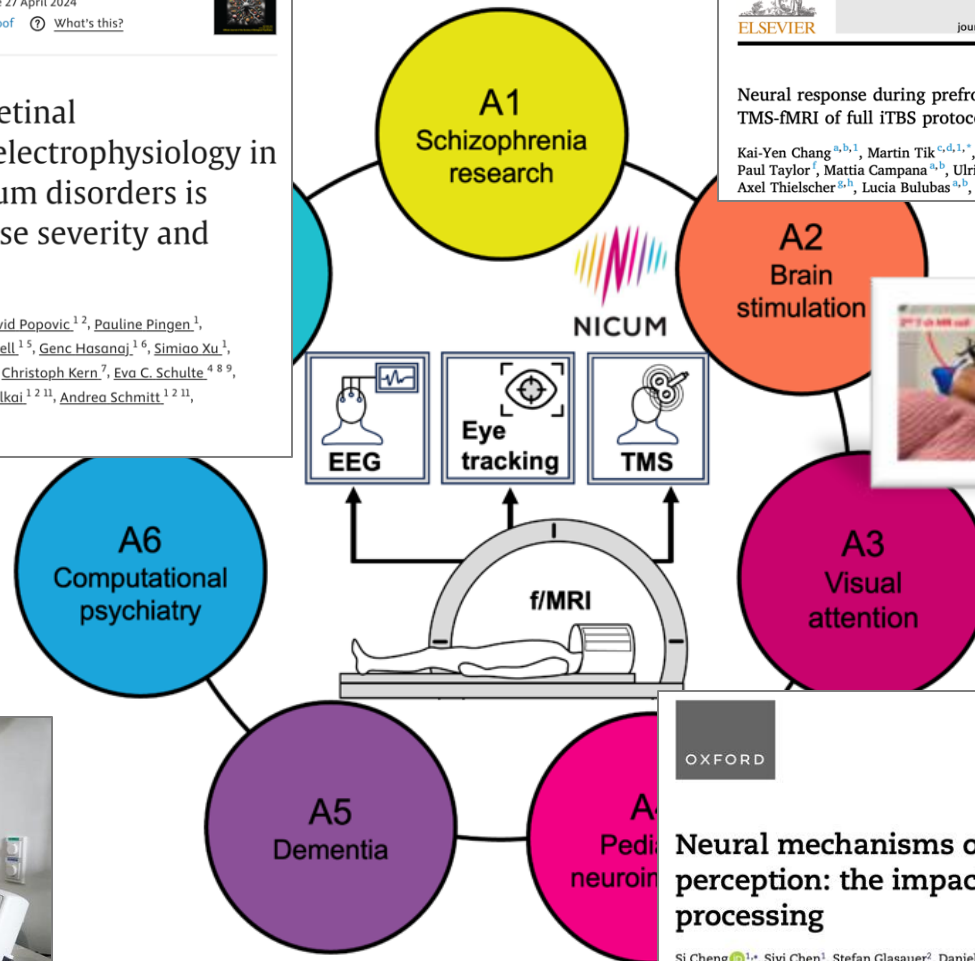
Signature of altered retinal microstructures and electrophysiology in schizophrenia spectrum disorders is associated with disease severity and polygenic risk

Emanuel Boudriot^{1,2,*}, Vanessa Gabriel^{1,*}, David Popovic^{1,2}, Pauline Pinget¹, Vladislav Yakimov^{1,3}, Sergi Papiol^{2,4}, Lukas Roell^{1,5}, Genc Hasanaj^{1,6}, Simiao Xu¹, Joanna Moussiopoulou¹, Siegfried Priglinger⁷, Christoph Kern⁷, Eva C. Schulte^{4,8,9}, Alkomiet Hasan^{10,11}, Oliver Pogarell¹, Peter Falkai^{1,2,11}, Andrea Schmitt^{1,2,11}, Benedikt Schworm⁷
CDP Working Group^{12,610}

NeuroImage 291 (2024) 120596
Contents lists available at ScienceDirect
NeuroImage
journal homepage: www.elsevier.com/locate/ynimg

Neural response during prefrontal theta burst stimulation: Interleaved TMS-fMRI of full iTBS protocols

Kai-Yen Chang^{a,b,1}, Martin Tik^{c,d,1,*}, Yuki Mizutani-Tiebel^{a,b}, Anna-Lisa Schuler^c, Paul Taylor^f, Mattia Campana^{a,b}, Ulrike Vogelmann^a, Barbara Huber^a, Esther Dechantsreiter^a, Axel Thielscher^{a,h}, Lucia Bulubas^{a,b}, Frank Padberg^{a,b,1}, Daniel Keiser^{a,b,1,*}



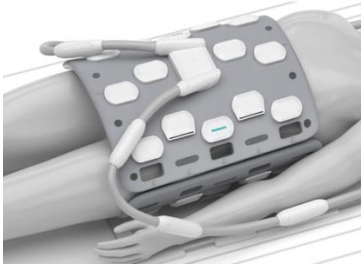
Cerebral Cortex, 2023, 1–14
<https://doi.org/10.1093/cercor/bhad453>
Original Article

Neural mechanisms of sequential dependence in time perception: the impact of prior task and memory processing

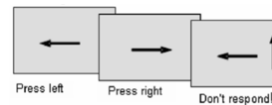
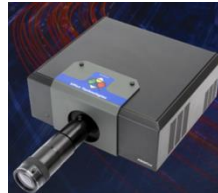
Si Cheng^{1,*}, Siyi Chen¹, Stefan Glasauer², Daniel Keiser³, Zhuanghua Shi^{1,3}

MRI facility - Equipment

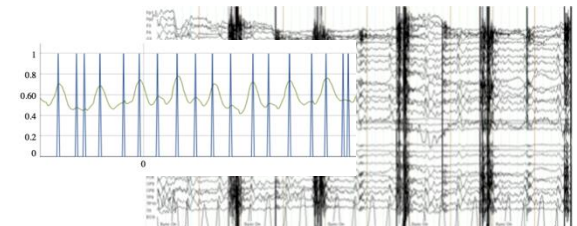
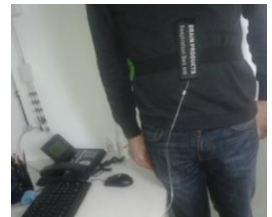
Head and body coils



Video projector fMRI

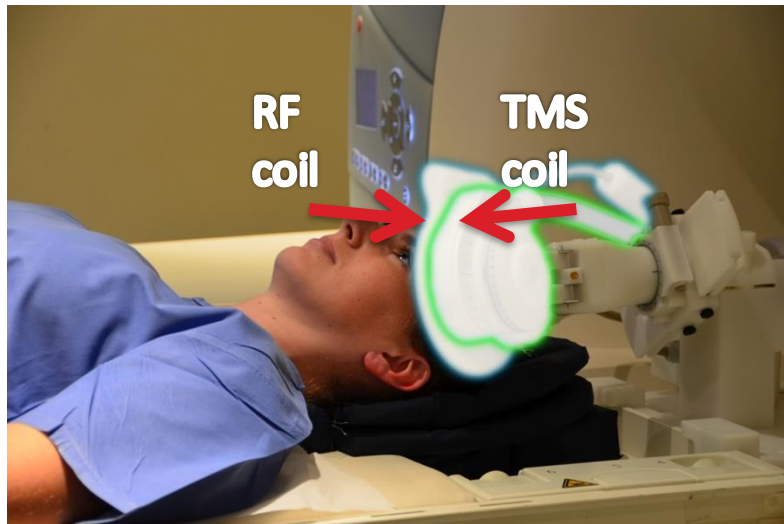


Simultaneous EEG/ECG/respiration

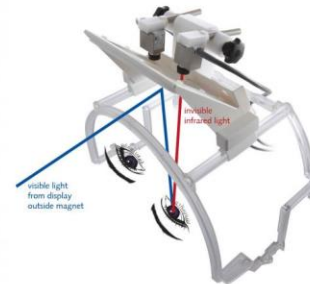


MRI facility - Equipment

Neuronavigated
TMS inside MRI



Eye Tracking



TMS



Contrast agent
pump



MR safety

1. Do you have an electronic implant or device (e.g. cardiac pacemaker, implanted defibrillator, neurostimulator, insulin pump)?

The form consists of a series of blue horizontal bars for text entry. There are 15 bars in total. The first 8 bars are of a standard height, followed by a single bar that is significantly taller than the others, and then 6 more bars of the standard height. All bars are currently empty.

MR safety – Informed consent

Basisinformation zum Aufklärungsgespräch

Seite 1/4

R 20 DE

Kernspintomographie

Kernspintomographie (MRT/MRS/MRA)

Seite 4/4

R 20 DE

18.01.2012 08:56:22

Lfd.Nr 206229

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Radiologie

Hospital Data Imprint/Stamp



KLINIK
DER UNIVERSITÄT

Patient identification sticker

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Juristische Bes
verboten.
Bestell-Adresse

Dear Patient, Dear Parents,

The purpose of this informed consent is to prepare for the patient-doctor discussion carefully before the discussion and to ensure that you understand the examination and its risks. We will always address you directly, and treatment is to be performed on your

Which examination is proposed

Magnetic resonance imaging (MRI) is a non-invasive examination of the body. In this imaging examination, body regions to be examined are taken with waves and magnetic fields. This way, (e.g. a prolapsed disc, a breast tumour, vascular diseases, diseases in the spine) can be accurately identified or excluded without the need to use X-rays.

Additional measurement technologies provide important information. Magnetic resonance spectroscopy (MRS) facilitates a non-invasive measurement of metabolic processes in the tissue. Magnetic resonance perfusion (MRP) or a specific examination of the tissue perfusion (diffusion-weighted imaging, DWI/DTI) are possible with magnetic resonance imaging. Your doctor will inform you which examination is proposed for your particular case.

How is the examination performed

Generally, you will be lying on a table in a closed cylinder (the scanner). The position instructed, breathe regularly and relax your arms and legs. Otherwise, local

Informierte Consent Documentation - Publisher: T
Authors: Prof. Dr. med. V. Rahn, Prof. Dr. med. M.
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www.thieme-compliance.de

Page 3/6

R 20/GR Magnetic Resonance Imaging (MRI/MRS/MRA)

able administration of a contrast medium containing gadolinium in any case and bring the result with you to the examination.

A magnetic resonance examination of the mammary gland (MRM) must be performed between the 7th and 12th day of the menstrual cycle (1st day of the menstrual cycle = 1st day of monthly bleeding) for women of childbearing age in order to avoid incorrect examination results if possible.

If an examination of the small intestine is planned in your case, your doctor will provide you with further instructions if applicable.

Please follow the doctor's instructions carefully, in particular with regard to taking medication and hormones (e.g. hormone substitutes in the menopause).

If general anaesthesia is planned for you, you will be informed about preparation for this, how it is performed and the associated risks during a separate patient-doctor discussion.

Please be sure to inform the doctor or the medical staff if you have permanent make-up, tattoos or a transdermal plaster or have a magnetically fixed dental prosthesis or other metal or magnetic implants.

For the examination

Injury can occur if metal objects enter the magnetic field, and this may also lead to image distortion (artefacts). Therefore, please remove all metal or magnetic items before entering the examination room:

- Watches, eyeglasses, keys, piercings/jewellery, hairpins/hairclips, ballpoint pens, purses, loose coins, wallet including bank or credit cards (magnetic strips will be erased!), etc.
- Clothing with metal parts (e.g. belt buckles), clothing with zippers (zips), functional underwear, metal buttons or similar items (metal catches or fasteners on bras) but also make-up may not be worn.
- Removable dental prostheses, braces.
- Acupuncture needles, hearing aids; cochlea implants in the inner ear could be damaged during magnetic resonance imaging.

After the examination

If you have received a sedative, please note that your reactions will be slowed temporarily. Therefore, you have to be picked up by an adult. Due to the lingering effects of the medication, you may not actively participate in road traffic, may not perform any dangerous activities, may neither drink any alcohol nor smoke within the first 24 hours or the length of time stipulated by your doctor. You should also refrain from making any important decisions.

If you received Buscopan®, your vision can be temporarily impaired. Therefore, you have to be picked up by an adult, or you are monitored for some time after the examination. The doctor will inform you about how long your ability to participate in road traffic and operate machines will be impaired.

The safety of MRI examination for patients having medical implants or metallic foreign bodies in place is the higher, the lower the field strength of the scanner. For modern MRI scanners with higher field strengths, some implants, e.g. IUD ("coil", contraceptive copper T), are not approved by the manufacturer in general. The doctor will discuss with you whether the IUD could dislocate (slip) as a consequence of the MRI, impairing the contraceptive effect and necessitating a check of the IUD's correct positioning; if necessary, ask him/her about it.

A shunt in the head (ventricular shunt) does not cause any issues for the MRI examination. However, we recommend

having its correct function checked after the examination, if applicable.

Important questions

In order for the doctor to decide whether you should undergo this examination for you, we need to ask you some questions carefully and

Age: _____ years • Height: _____

Gender: _____

1. Do you have any implants (e.g. pacemaker, cardiac valve, stent, cone, hydrogel, teeth, metal)?

If yes, please indicate! _____

2. Please be aware: an MRI examination has certain types of contrast agents to inform your doctor if you will decide whether you

Are there any additional parts/implants in the your surgical clips, vessel prods, skin chips, dental br metal fragments, coil (int puncture needles, insul neurostimulator, hearing implant), intraport, perma

If yes, please indicate! _____

If yes, in which part of the _____

3. Do you have tattoos?

If yes, please indicate the _____

4. Do you have a plaster or cast on your body?

If yes, please indicate the _____

5. Have you ever undergone surgery with contrast media?

If yes, did any complications occur (e.g. allergic reaction, circulatory reaction)?

If yes, please indicate! _____

6. Do you have or have you ever had a disease (e.g. hepatitis, HIV, tuberculosis)?

If yes, please indicate! _____

7. Do you have any allergies (e.g. to antibiotics, Novalgin, paracetamol, X-ray contrast agents, iodine, plaster, syringes, etc.)?

If yes, please indicate! _____

8. Do you have or have you ever had a disease (e.g. high blood pressure, heart attack, angina pectoris, heart valve defect)?

If yes, please indicate! _____

R 20/GR Magnetic Resonance Imaging (MRI/MRS/MRA)

Page 4/6

9. Do you have or have you ever had atrial fibrillation? ☐ Yes ☐ No

10. Have you ever had an operation of the heart, the head or of the body region to be examined? ☐ Yes ☐ No

If yes, please indicate! _____

11. Did you have any diseases of the upper abdominal organs (e.g. liver inflammation/hepatitis, fatty liver, cirrhosis, biliary colic/bile stones, jaundice, pancreatitis)? ☐ Yes ☐ No

If yes, please indicate! _____

12. Do you have or have you ever had any diseases or malformation of the kidneys/urinary organs (e.g. dysfunction of the kidneys, kidney stones, chronic urinary tract infection, nephritis/inflammation of the kidneys, congenital malformation [e.g. duplex kidney], bladder emptying disorder/delayed bladder emptying)? ☐ Yes ☐ No

If yes, please indicate! _____

13. Have you had a kidney or liver transplant? ☐ Yes ☐ No

If yes, please indicate! _____

14. Do you suffer from noises in the ears (tinnitus)? ☐ Yes ☐ No

If yes, please indicate! _____

15. Do you have any eye diseases (e.g. cataract, glaucoma)? ☐ Yes ☐ No

If yes, please indicate! _____

16. Do you have a tendency to have claustrophobia (fear of narrow or enclosed spaces) or panic attacks? ☐ Yes ☐ No

If yes, please indicate! _____

Additional questions for women

1. Could you possibly be pregnant? ☐ Yes ☐ No

2. Are you breastfeeding? ☐ Yes ☐ No

Additional questions for men

1. Do you have or have you ever had any diseases of the prostate (e.g. prostatic enlargement, prostatitis [inflammation of the prostate], prostate cancer)? ☐ Yes ☐ No

If yes, please indicate! _____

Doctor's notes on the patient-doctor discussion

(e.g. the type and importance of the examination; alternative examination methods; risk and possible complications; instructions for before and after the examination; individual risks and possible associated complications; specific side-effects of the contrast medium; explanations on questions of the patient; possible consequences if the patient/parents refuse(s) to undergo(s) the examination; reasons for refusal; determination of a minor's ability to comprehend; patient has a legal surrogate decision-maker/a legal guardian; patient has appointed a legal representative/provided a medical power of attorney, duration of the discussion)

The following examination is proposed:

Magnetic resonance imaging

☐ With contrast medium

☐ Without contrast medium

Body region to be examined: _____

In case of refusal to consent

I/we do not consent to the proposed examination. I/we have read the informed consent form, and I/we understand it. I/we have been explicitly informed of the possible consequences involved in my/our refusal (e.g. failure to detect diseases and determine their level of severity and progression, no exact localisation of the focus of a disease).

Place, date, time

Patient

Patient's guardian*

Witness (if applicable)

Doctor

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Fälle einer
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Neuroradiolog

Kurzbefund für Studien-MRT

Bitte an sek.neurorad@med.lmu.de schicken.

Von verantwortlichem*r Mitarbeiter*in auszufüllen:

Probanden ID/Name Studienpatient*in: NIMG_course_20

MRT vom (Datum der Untersuchung):

Studie: multimodal Neuroimaging Course 2021

Verantwortliche*r Wissenschaftler*in: Daniel Keiser

E-Mail verantwortliche*r Wissenschaftler*in:

Vom*n N Applications Transfer Edit View Settings Orientation Type Image Tools System Options Help

Vorliegen

Befunde:

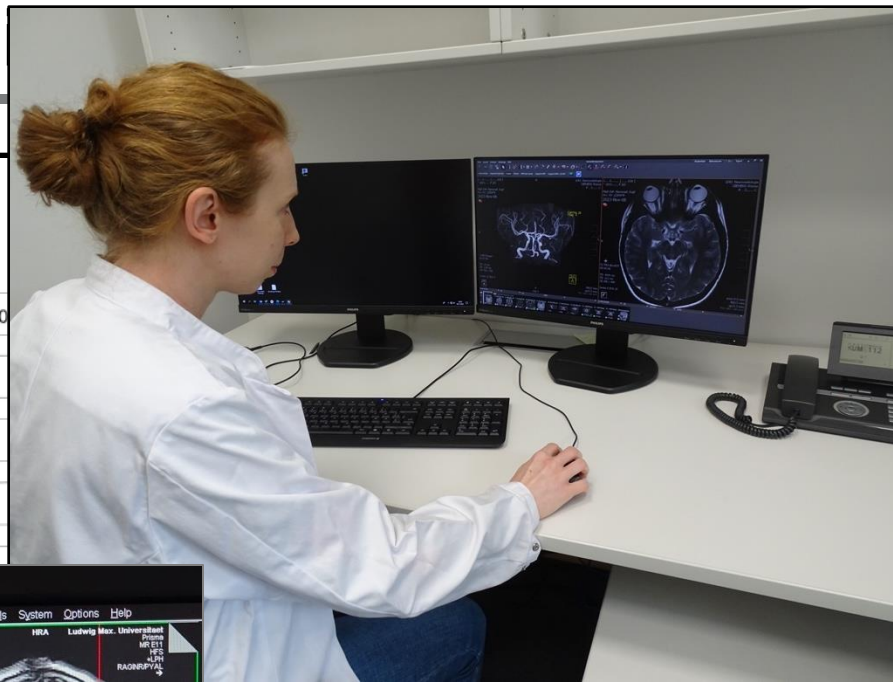
☒ Keine Pathologien oder Auffälligkeiten nachweisbar.

☒ Zufallsbefund ohne medizinische Relevanz.

☐ Zufallsbefund, weitere diagnostische Abklärung wird empfohlen.

Datum: 11.07.21

Stimulus SAR-NM 8 World Item(s) received.



e_2021_004

beser@med.uni-muenchen.de

Befunde:

☐ Keine Pathologien oder Auffälligkeiten nachweisbar.

☒ Zufallsbefund ohne medizinische Relevanz.

Befund: Vaskuläre - Zellen - Keine

☐ Zufallsbefund, weitere diagnostische Abklärung wird empfohlen.

Datum: 11.07.21, Name/Unterschrift Neuroradiologe*in:

[Handwritten signature]

MR safety – dangers



Risk through magnetic fields:

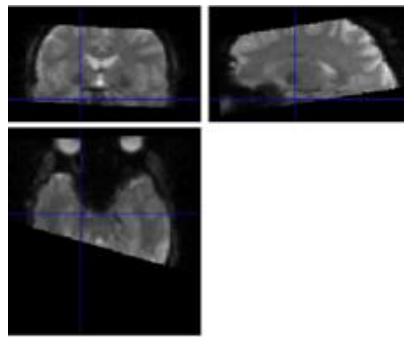
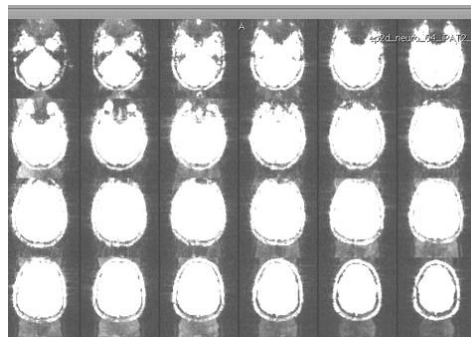
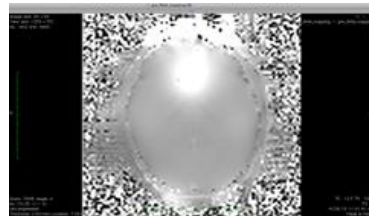
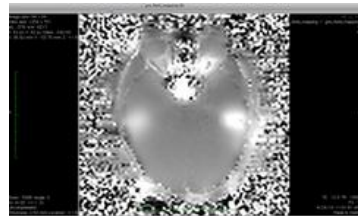
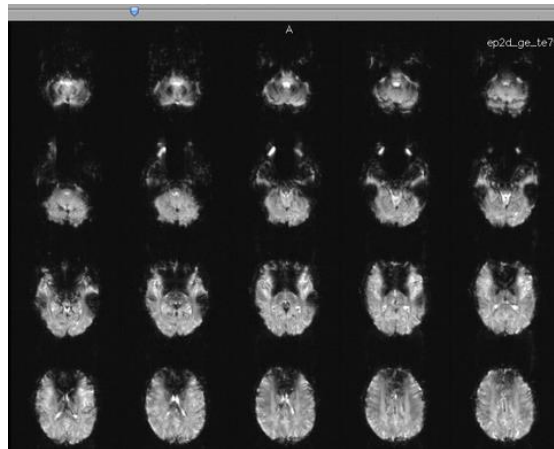
- Static magnetic fields (metal objects pulled)
- Moving objects in static field (induction, heat)
- HF-fields, gradients (heat, induction, nerve stim)



MRI safety training

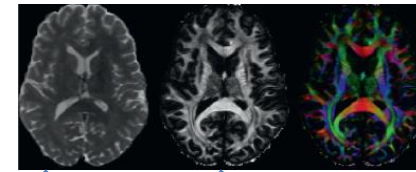
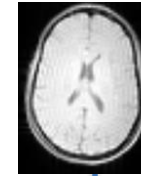
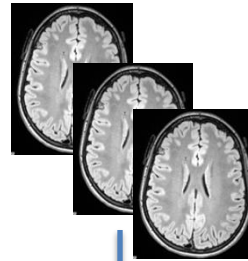
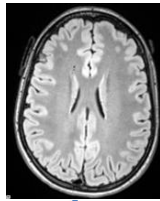
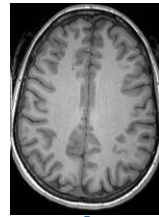
This lecture must be attended at least once a year (signature required).

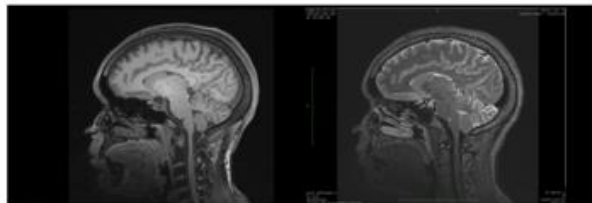
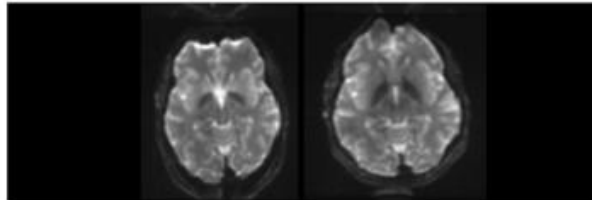
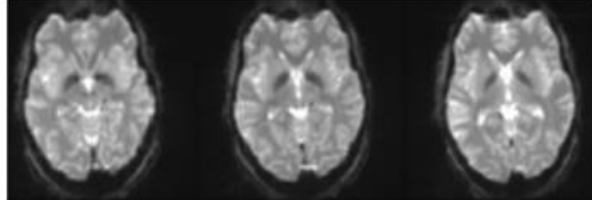
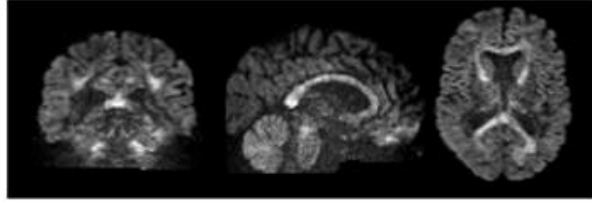
MR artifacts



Artifacts:	Variables:
Type of Artifact:	
No Artifacts	0
CSF Pulsation Artifacts	1
Wrapping/Aliasing Artifacts	2
Shading Artifact	3
Zebra Stripes	4
Motion Artifacts	5
Magnetic Susceptibility Artifacts	6
Insufficient FOV	7
Failed Image Transfer	8
Zippering Artifact	9
Severity:	
No Artifacts	0
Minimal (non-significant)	1
Significant (but probably usable for most research questions)	2
Severe (probably non-usable)	3
Location:	
No Artifacts	0
Whole Brain	1
Frontobasal	2
Frontal	3
Temporomesial	4
Occipital	5
Diencephalon	6
Mesencephalon	7
Pons	8
Cerebellum	9
Frontal and Occipital	25

MR Sequences



	T1-weighted	T2-weighted	EPI 1(Resting State)	EPI 2(Resting State)	Field maps	Diffusion weighted			
Sequence	MP-RAGE	T1 / T2 weighted 'structural' scans				• Motion			
TR (ms)	1900								
TE (ms)	2.22	EchoPlanar SpinEcho Images				• Motion (less so)			
flip angle	9								
B value (s/mm2)	-	T2* weighted images sensitive to BOLD				• Motion • Breathing • Cardiac pulsation • Fatigue • Performance • Other			
Diffusion directions	-								
Resolution (mm3)	0.7 x 0.7 x 0.7	EPI Diffusion Weighted Images (DWI)				• Motion			
Thickness	0.7								
Accelerator/Multiband factor	2/-								
Field of View	225 x 176								
Number of slices	176								
Imaging direction	Sagittal								

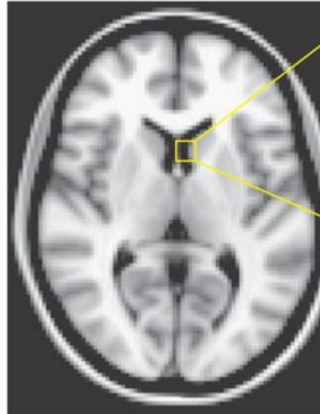
MP-RAGE = magnetization prepared-rapid gradient echo

mm=milimeter; . <https://www.cmrr.umn.edu>

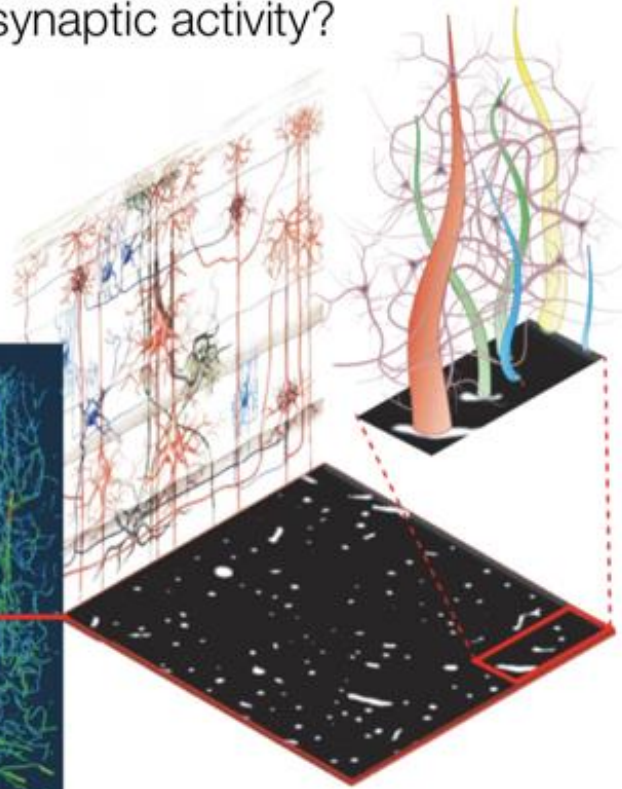
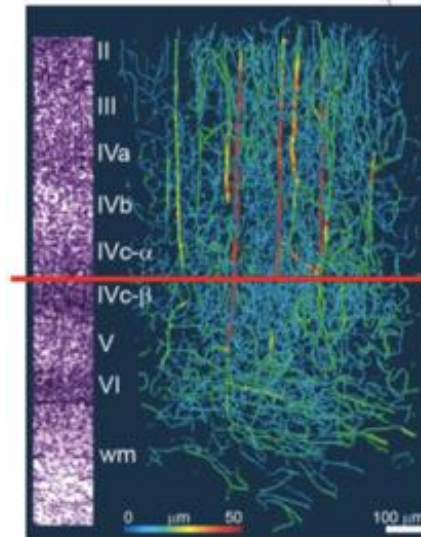
MP-RAGE = magnetization prepared-rapid
mm=millimeter; . <https://www.cmrr.umn.edu>

Volumetr

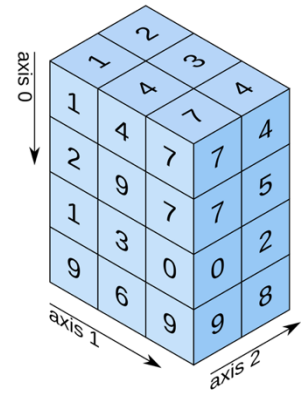
Aggregate measure
of total synaptic activity?



Logotheitis (2008). Nature.



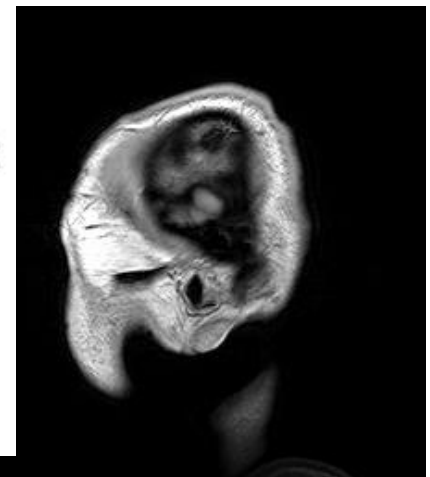
3D array



shape: (4, 3, 2)

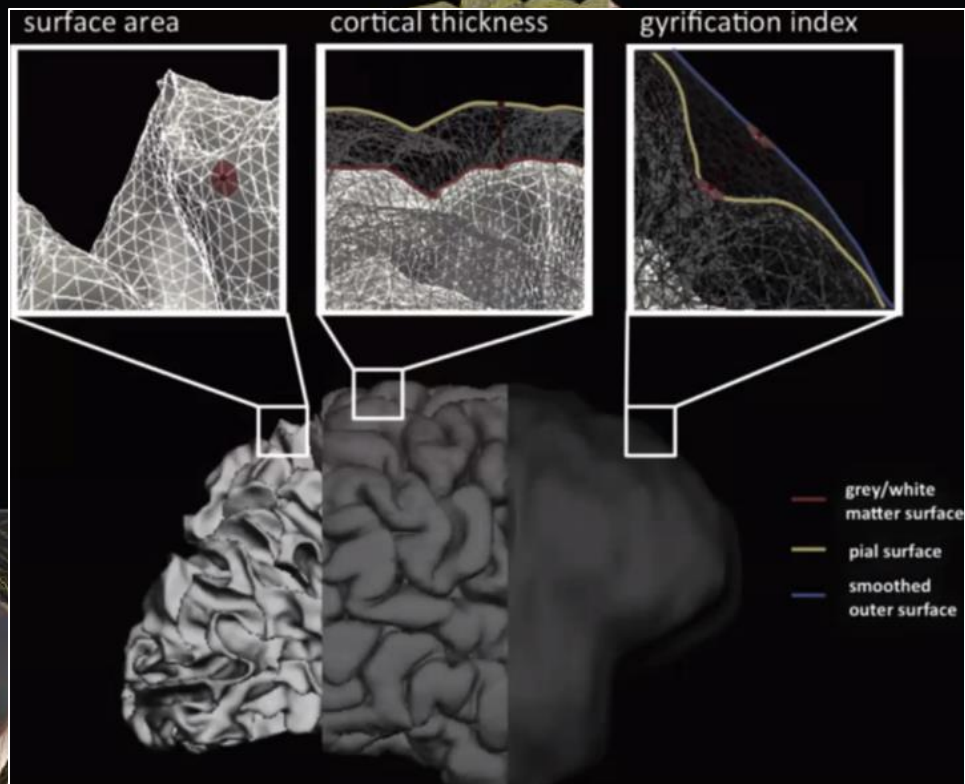
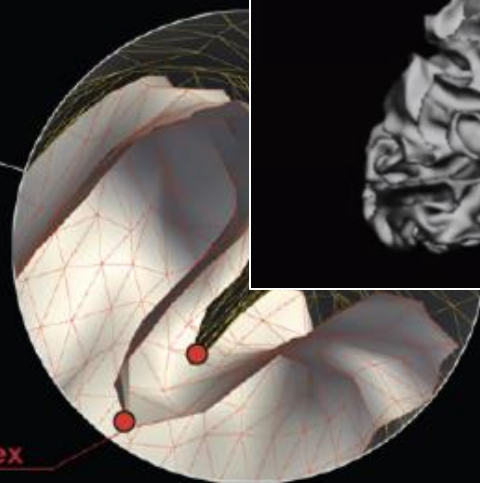
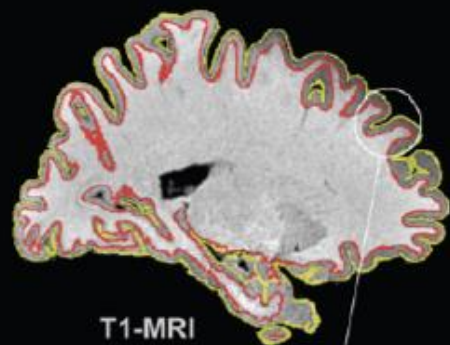
A typical fMRI voxel of 55 ml in size contains:

- 5.5 million neurons
- $2.2-5.5 \times 10^{10}$ synapses
- 22 km of dendrites
- 220 km of axons



Structural MRI

CORTICAL THICKNESS MEASUREMENT



Source: Bernhardt & Misic

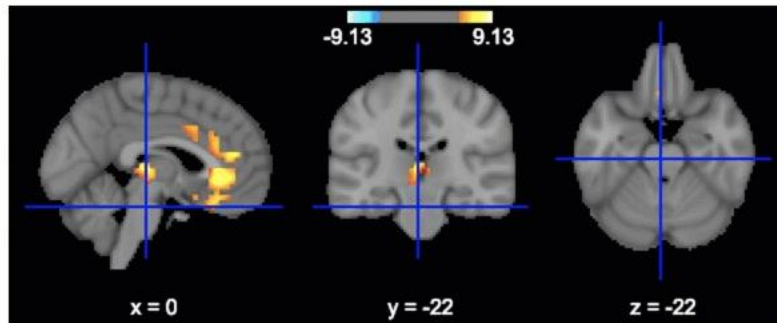
MDD meta-analysis using Neuroquery

11/2019: Encode major depression into a statistical map of the brain

```
[1] from neuroquery import fetch_neuroquery_model, NeuroQueryModel
    from nilearn.plotting import view_img

    encoder = NeuroQueryModel.from_data_dir(fetch_neuroquery_model())
```

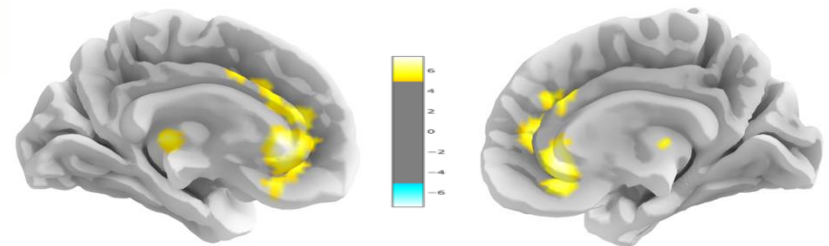
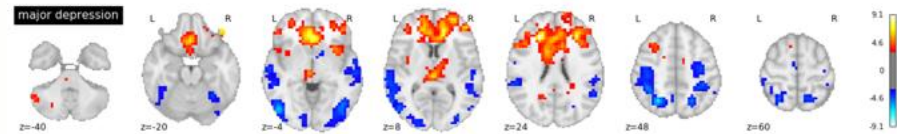
```
[8] query = """major depression"""
    result = encoder(query)
    view_img(result["z_map"], threshold=5.1)
```



```
[16] print("\nTerms recognized in the query:\n")
    print(
        response["similar_words"]
        .query("weight_in_query != 0")
        .sort_values(by="weight_in_query", ascending=False)
        .head()
    )
```

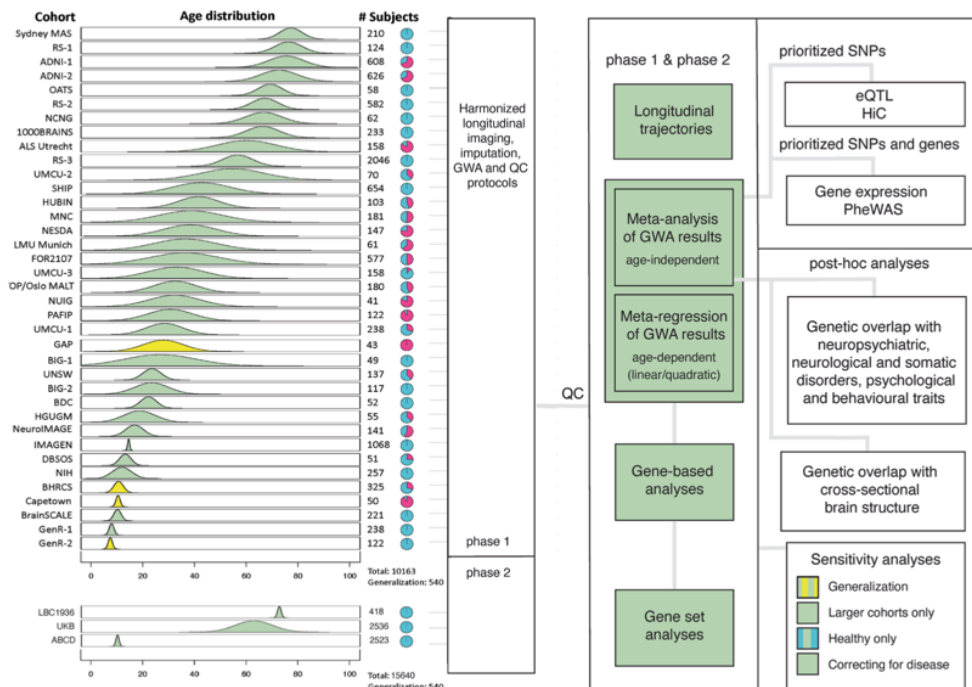
Terms recognized in the query:

	similarity	weight_in_brain_map	weight_in_query	\
major depression	0.994231	0.0	1.0	
major depression		n_documents	896	

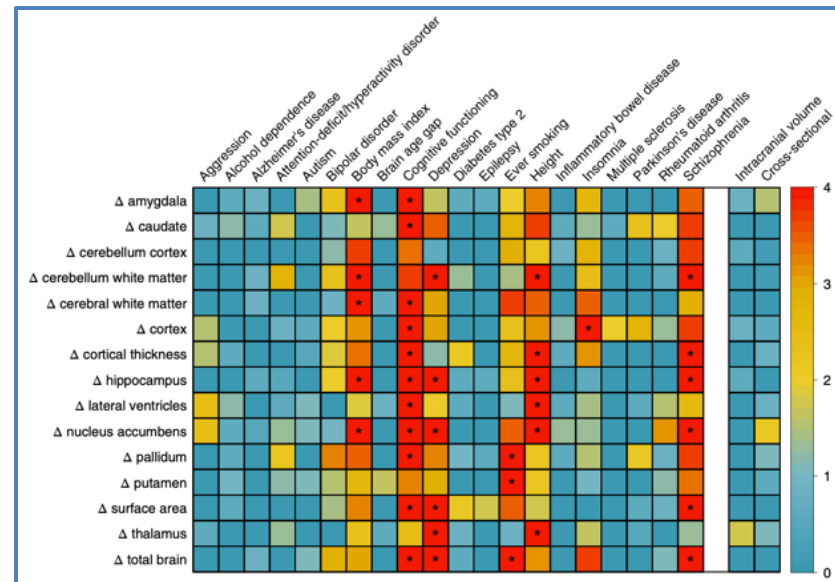


N=15640

Genetic variants associated with longitudinal changes in brain structure across the lifespan



GPR139, DACH1 und APOE



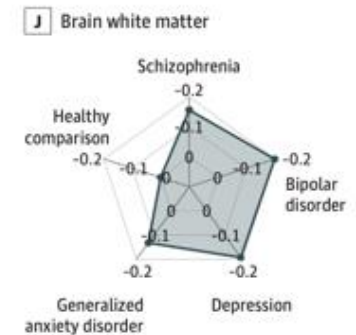
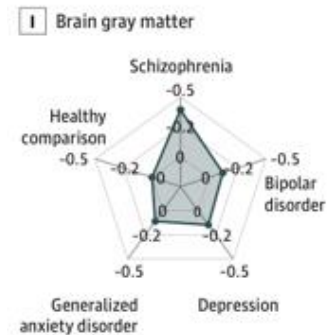
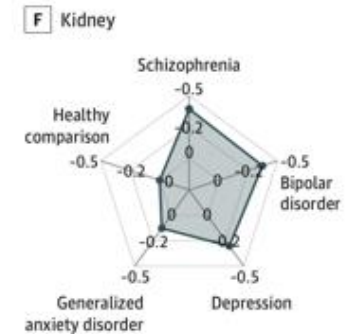
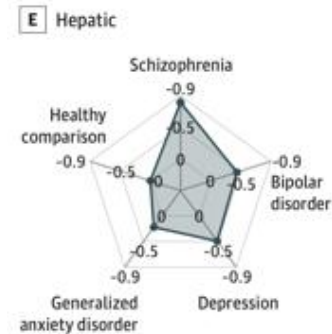
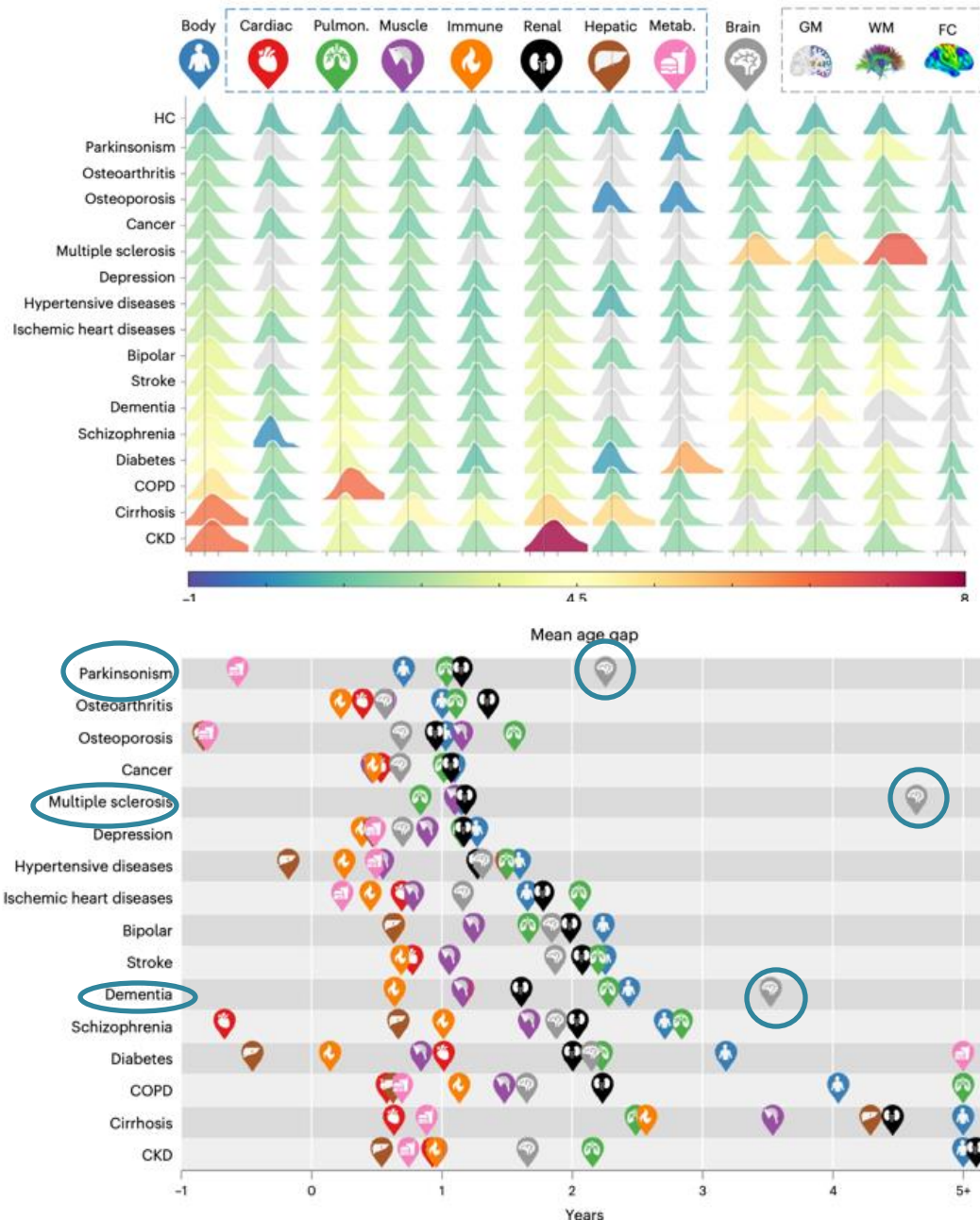
The ENIGMA Plasticity working group
presents



Genetic overlap

global genetic overlap with depression,
schizophrenia, cognitive functioning,
#insomnia, height, BMI, and smoking

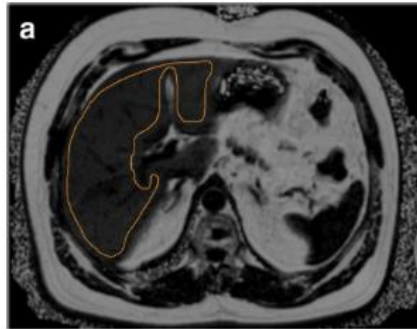
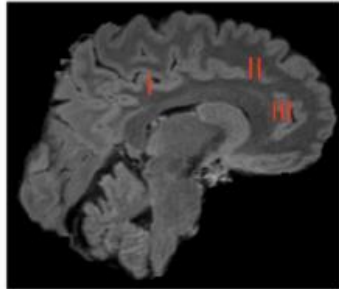
Brain Age gap across organs



Hepatic fat is superior to BMI, visceral and pancreatic fat as a potential risk biomarker for neurodegenerative disease

European
Radiology 2019

Ebba Beller^{1,2}  • Roberto Lorbeer² • Daniel Keeser² • Franziska Schoeppe² • Sabine Sellner² • Holger Hetterich² • Fabian Bamberg^{3,4} • Christopher L. Schlett^{3,4} • Annette Peters⁵ • Birgit Ertl-Wagner^{2,6} • Sophia Stoecklein²



MRI-based Hepatic fat

$R=-0.34, p<0.01$

Corrected for:

- age
- sex
- hypertension
- smoking
- BMI
- LDL
- total cholesterol
- alcohol

- n=361
(152 women, 199 men)

- ICV-corrected GM
brain volume

Reproducible brain-wide association studies require thousands of individuals

<https://doi.org/10.1038/s41586-022-04492-9>

Received: 19 May 2021

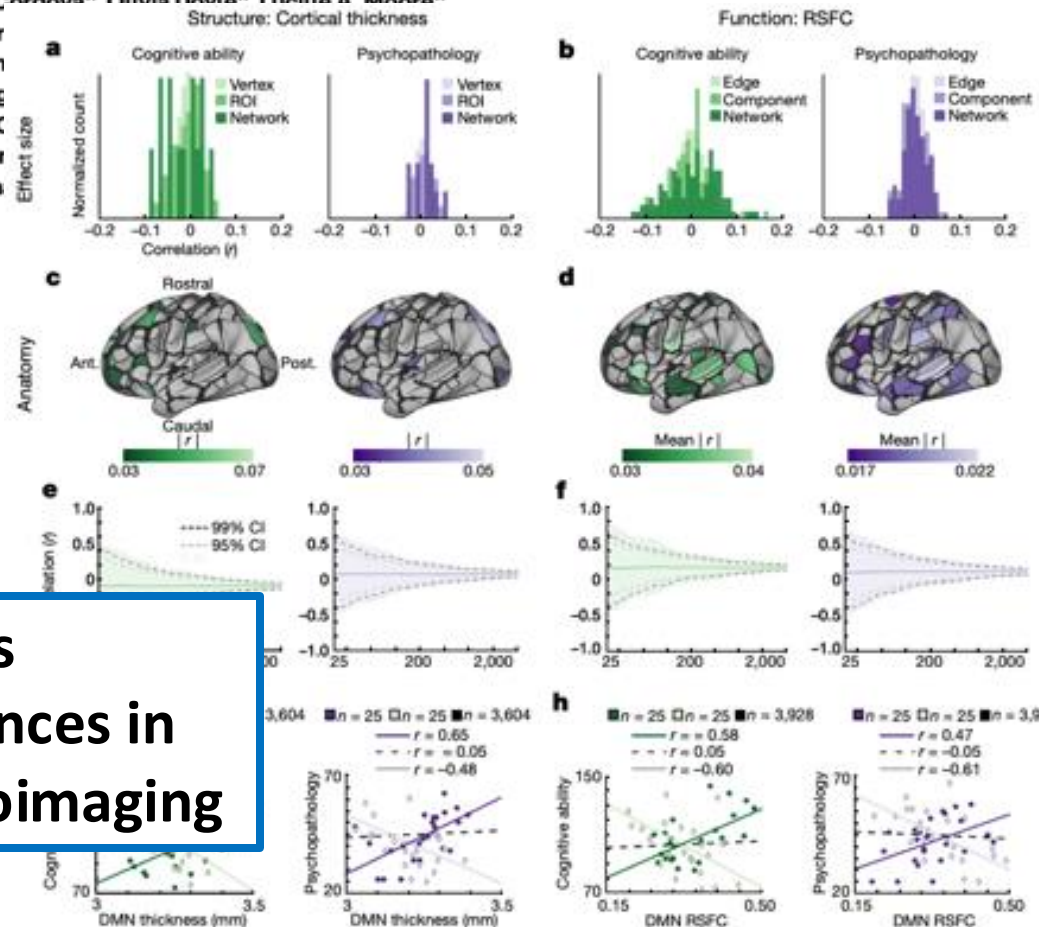
Accepted: 31 January 2022

Published online: 16 March 2022

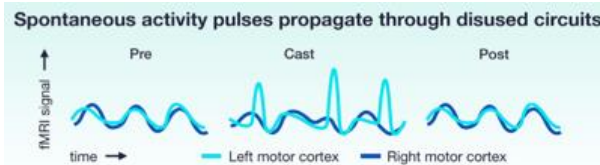
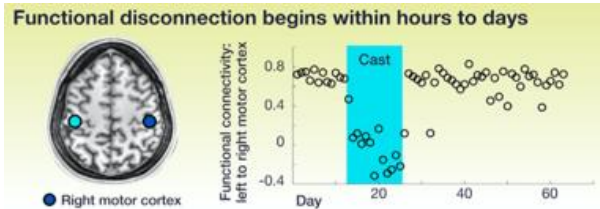
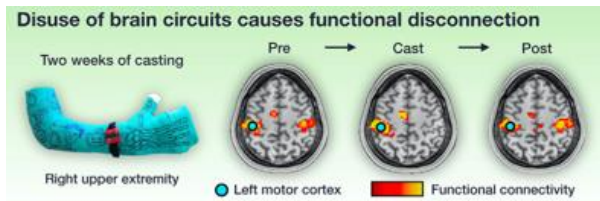
Open access

 Check for updates

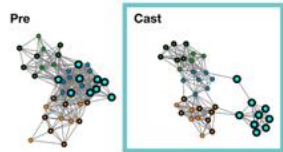
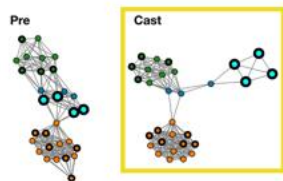
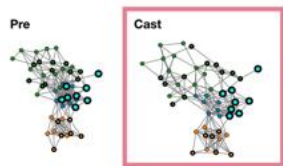
Scott Marek^{1,30}, Brenden Tervo-Clemmens^{2,3,30}, Finnegan J. Calabro^{4,5}, David F. Montez⁶, Benjamin P. Kay⁶, Alexander S. Hatoum¹, Meghan Rose Donohue¹, William Foran⁴, Ryland L. Miller^{1,6}, Timothy J. Hendrickson⁷, Stephen M. Malone⁸, Sridhar Kandala¹, Eric Feczko^{9,10}, Oscar Miranda-Dominguez^{9,10}, Alice M. Graham¹¹, Eric A. Earl^{9,11}, Anders J. Perrone^{9,11}, Michaela Cordova¹¹, Olivia Doula¹¹, Lucille A. Moore¹¹, Gregory M. Conan^{9,11}, Johnny Ur James C. Wilgenbusch^{9,12}, Thom Dillan J. Newbold⁶, Annie Zheng Roselyne J. Chauvin⁶, Timothy C Hugh Garavan²², Wesley K. Thori Deanna M. Barch^{1,21}, Beatriz Lun



cross-sectional correlations
between individual differences in
functional/structural neuroimaging

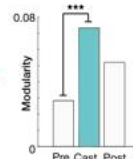
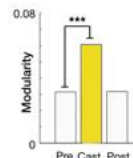
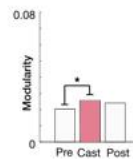


B Spring-embedded graphs

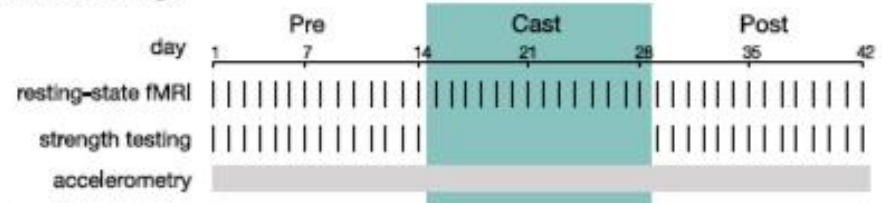


● L-SM1_{low} ● R-SM1_{low} ● L-SM1_{high} ● R-SM1_{high} ● L-SM1_{face} ● R-SM1_{face}

C Graph analysis



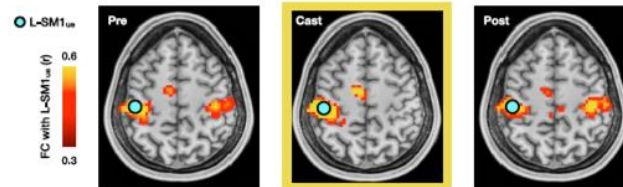
A Experimental design



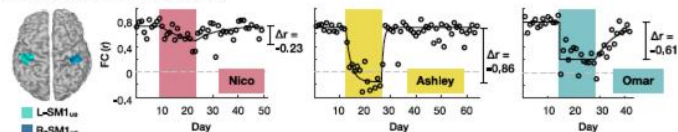
B Casts



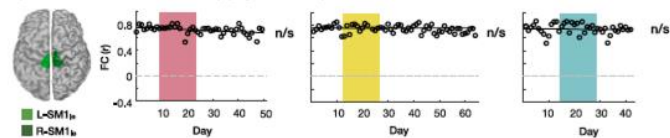
A Functional connectivity (FC) seed maps



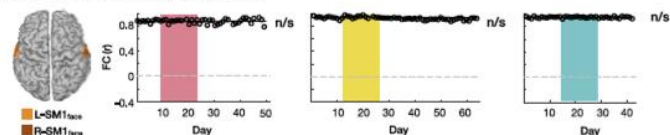
B Daily time course of FC: upper extremity



C Daily time course of FC: lower extremity (negative control)



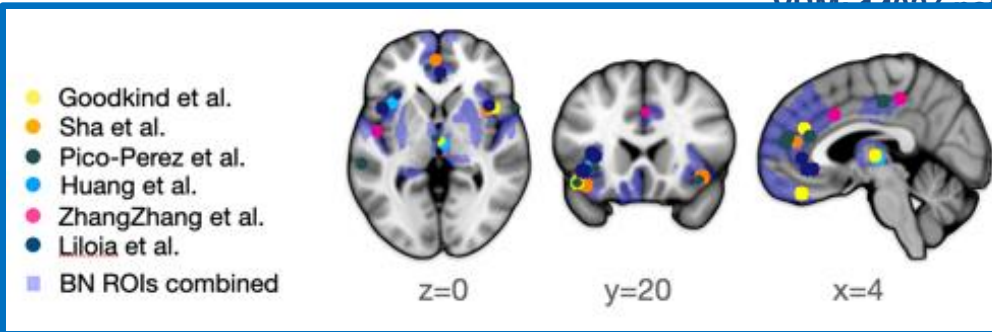
D Daily time course of FC: face (negative control)



Transdiagnostic network changes in psychiatric diseases 3

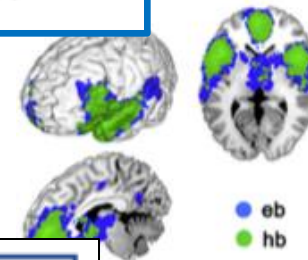
- 7381 patients, 8511 m
- SCZ, BPD, MDD, ANX

Overlap of struct
(based on meta-analy

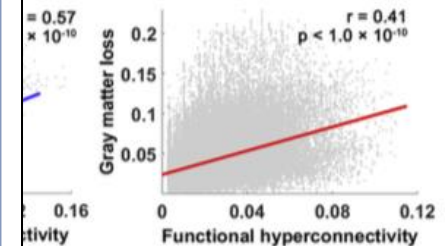


VBM, 14507 patients, 14504 HC
analysis of 363 VBM studies)
MRI: 8298 patients, 8165 HC
analysis of 242 rsfMRI studies)
orders

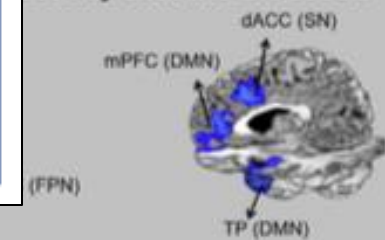
gray matter loss
psychiatric disorders



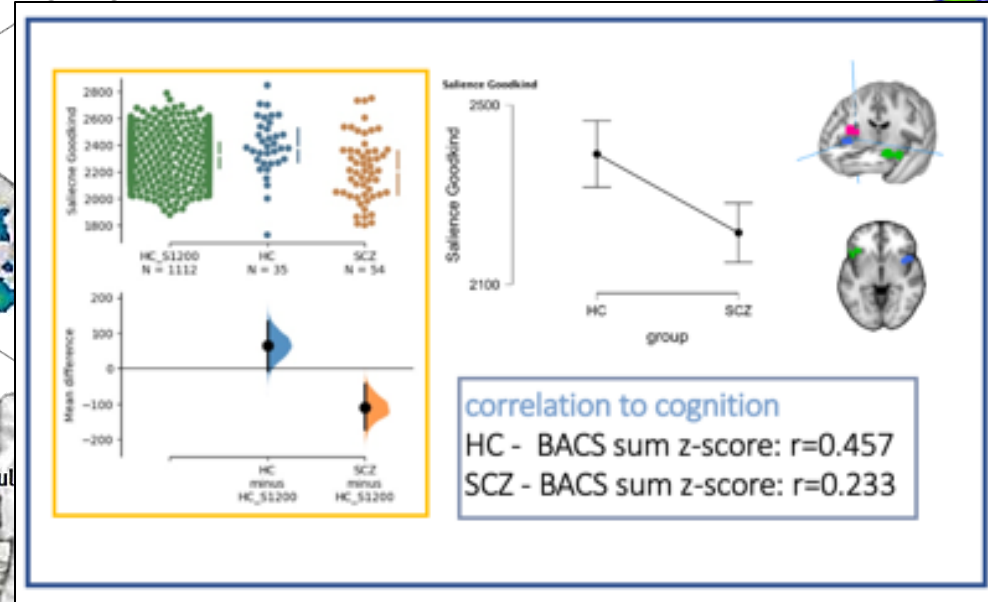
red network connectivity and gray matter loss



activity with the SN seeds



coactivated regions during
tasks
Overlap (MACM)
Psychotic only



Neuroimaging modalities

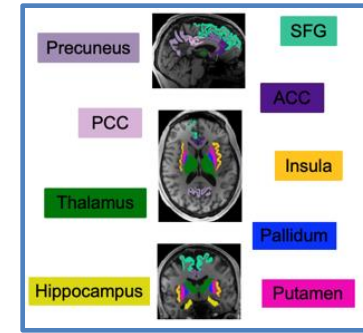
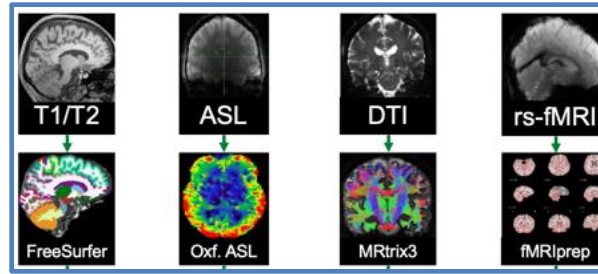
2

Sample characteristics

Data set	N	Age range	Sex
HCP-Ageing	725	36 – 100 years	406 ♀, 319 ♂
MPI Leipzig	227	20 – 85 years	82 ♀, 145 ♂

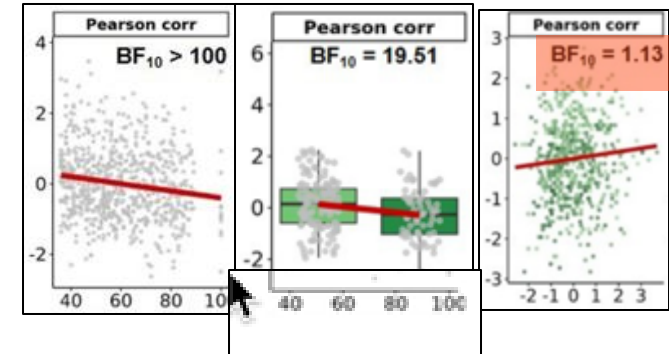
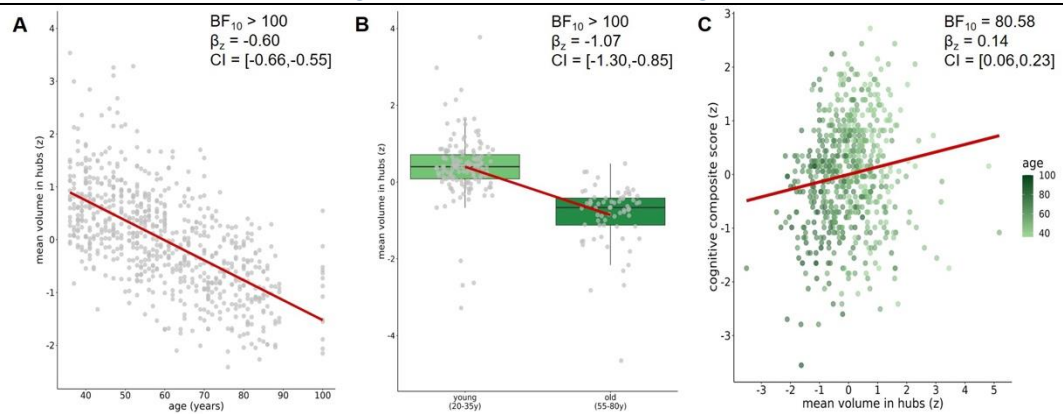


N=952



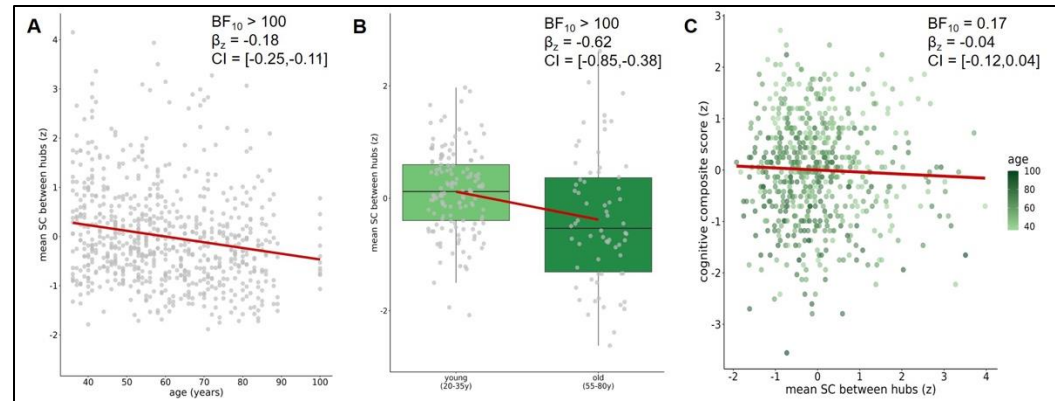
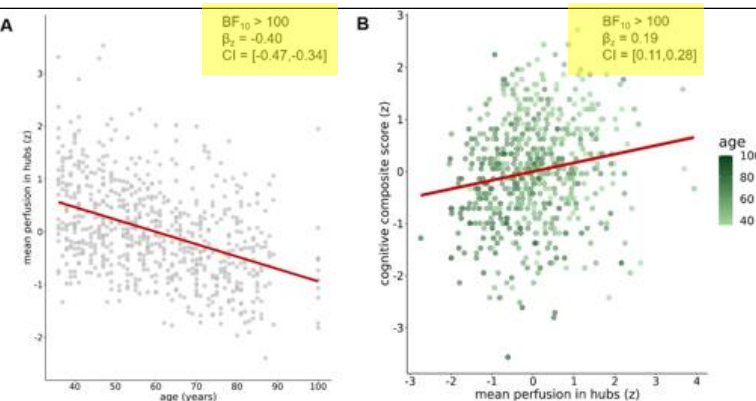
Structural MRI: Age - Brain Volumes - Cognition

rs-fMRI: Age – Functional Connectivity – Cognition

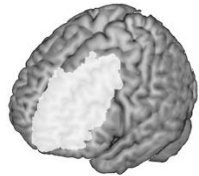
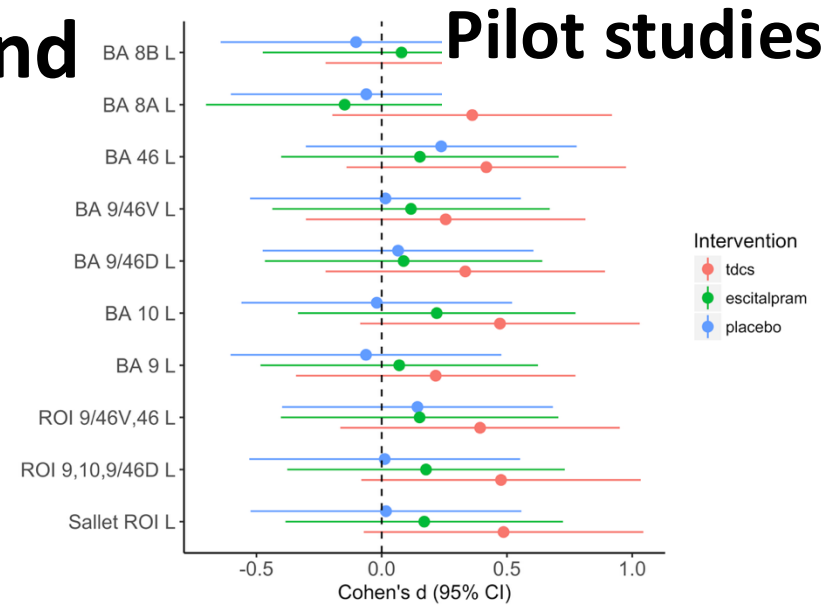
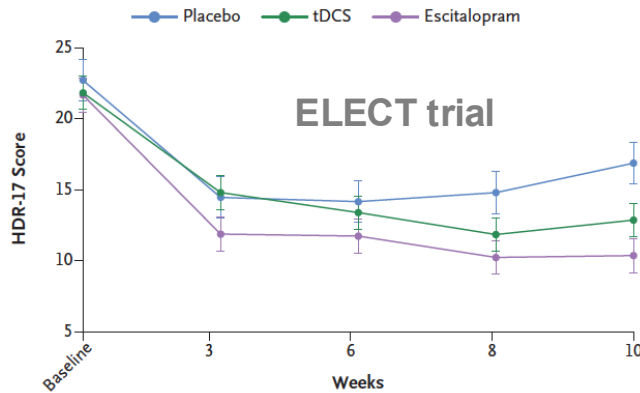


ASL: Age – Brain Perfusion – Cognition

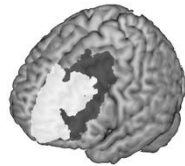
DTI: Age – Structural Connectivity – Cognition



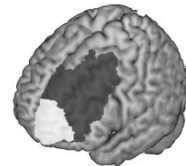
Association of GM volume and antidepressive response



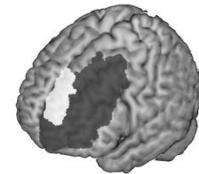
Sallet ROI (7 regions)



ROI 9,10,9/46D



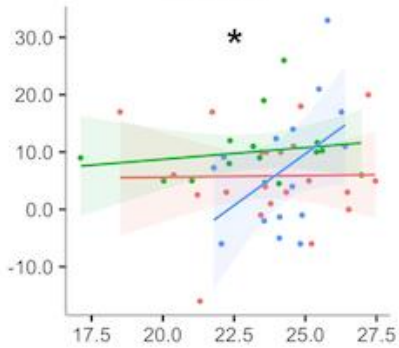
BA 10



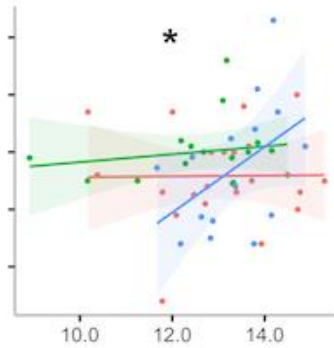
BA 9

LH

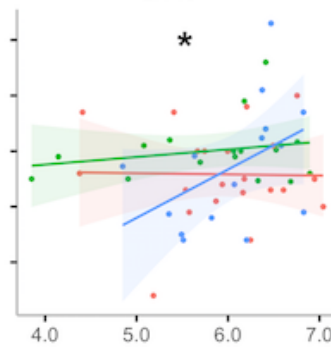
Sallet ROI



ROI 9,10,9/46D

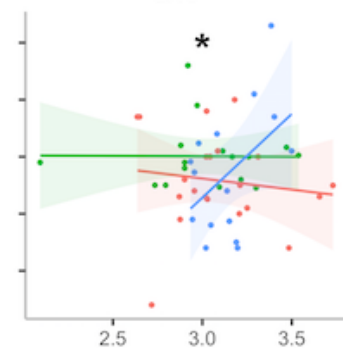


BA 10



RH

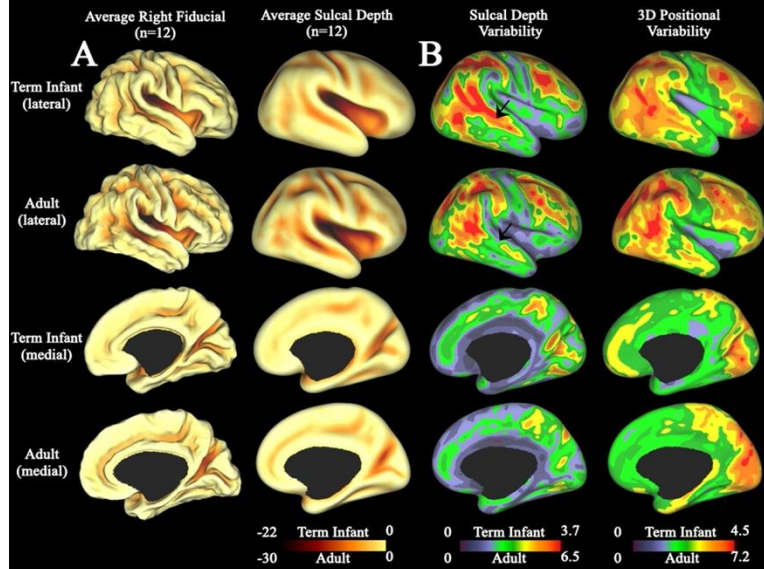
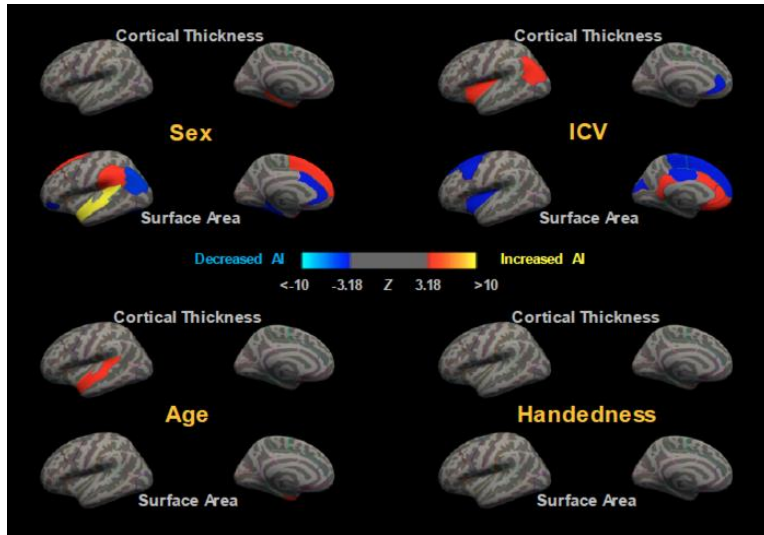
BA 9



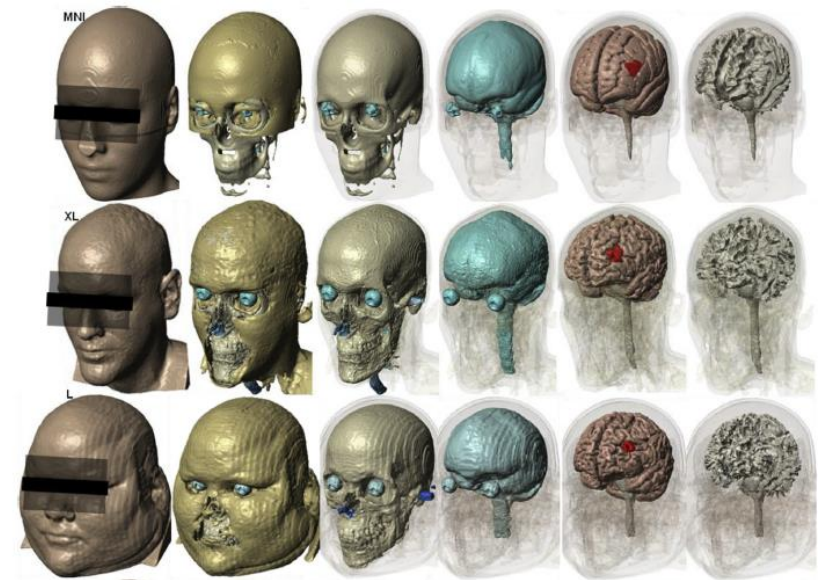
Brunoni et al., New England Journal of Medicine 2017

Bulubas et al., Brain Stimulation 2019

+ 17141 subjects
99 datasets worldwide



Anatomical variability



Seibt, *Brain Stimulation*, 2015

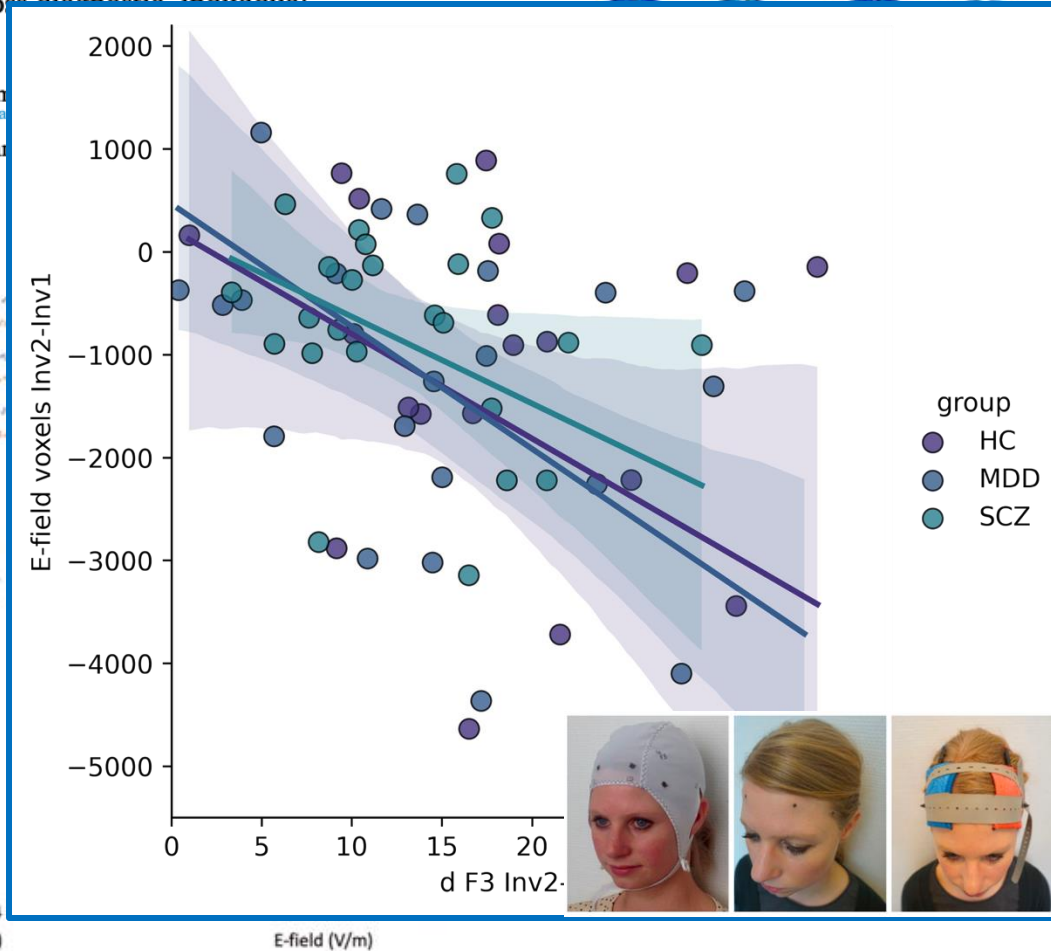
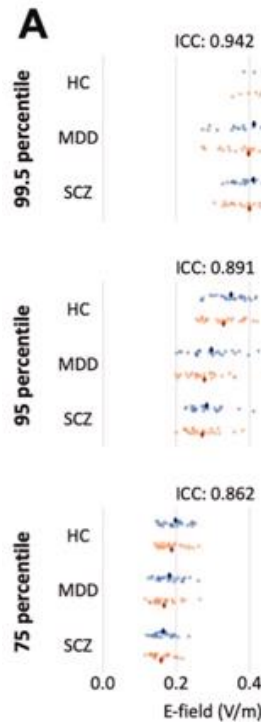
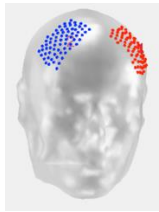
Kong et al., *PNAS* 2018

J. Hill, *Journal of Neuroscience*, 2010

Differences in electric field strength between clinical and non-clinical populations induced by prefrontal tDCS: A cross-diagnostic, individual MRI-based modeling study

Yuki Mizutani-Tiebel^{a,b,1,*}, Shun Takahashi^{a,c,d,e,f,1}, Temn Lucia Bulubas^{a,h}, Irina Papazova^{a,i}, Esther Dechantsreiter^a, Boris Papazov^{b,g}, Axel Thielscher^{j,k}, Frank Padberg^{a,1}, Dan

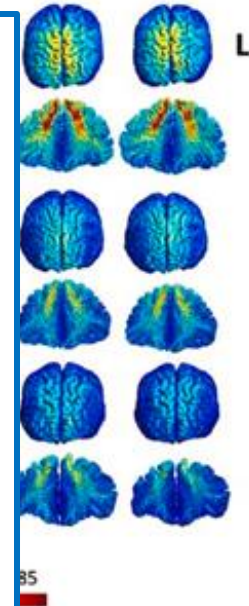
HC, n=25
MDD, n=25
SCZ, n=24



HC Investigator 1 2

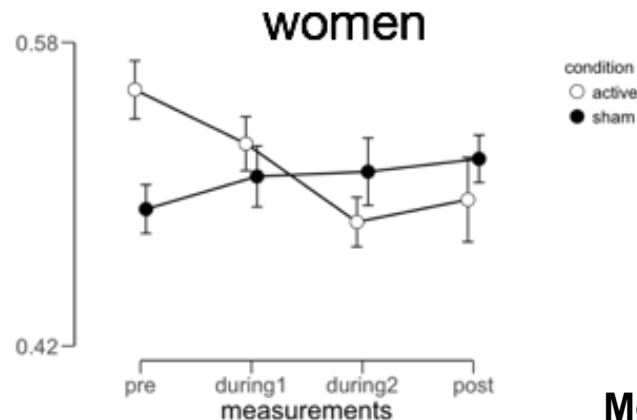
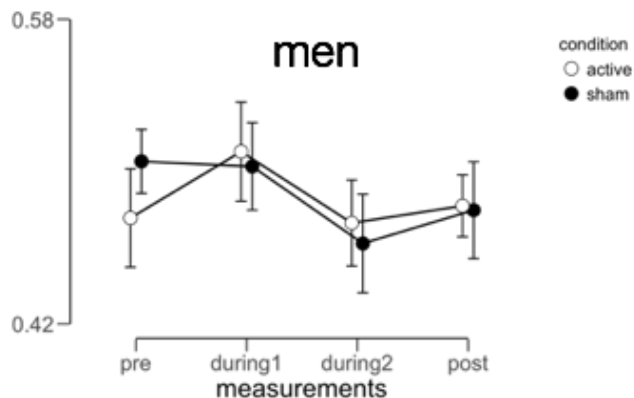
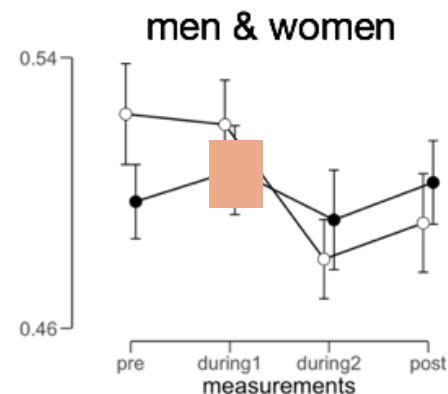
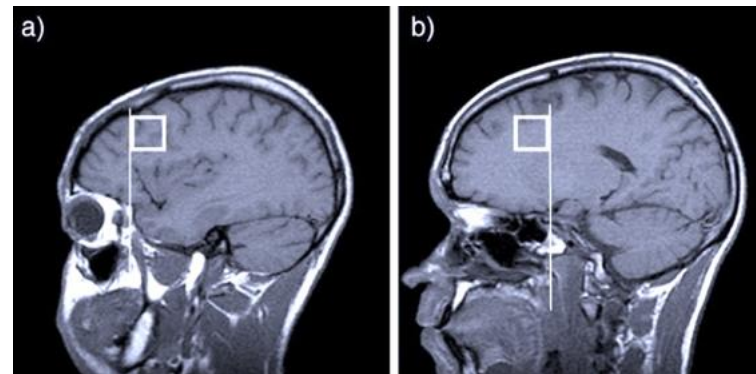
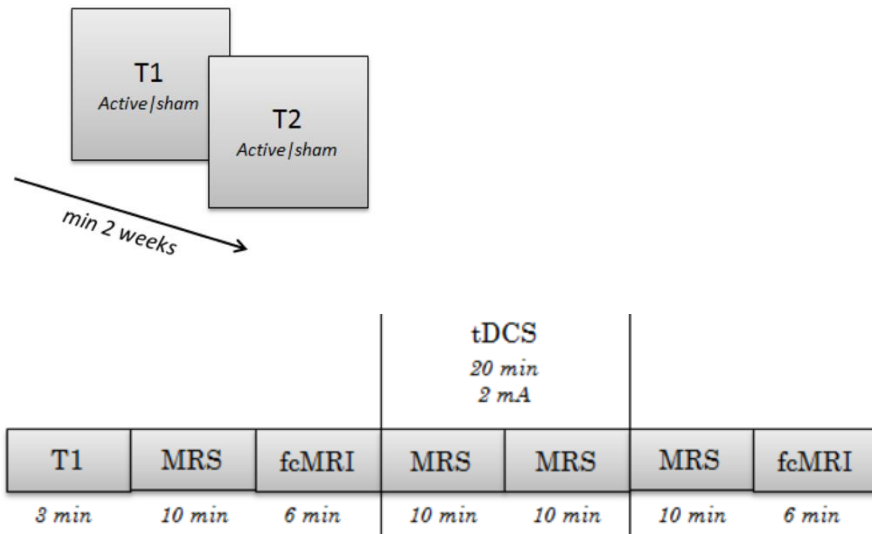
MDD Investigator 1 2

SCZ Investigator 1 2

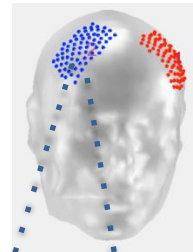


Magnetic Resonance Spectroscopy – MRSDC0

- cross-over design, healthy subjects, gender-mixed sample, n=19, MRSDC0
- **translational**: study on major depressive patients and schizophrenic patients (MRSDC1)



MRSDC0

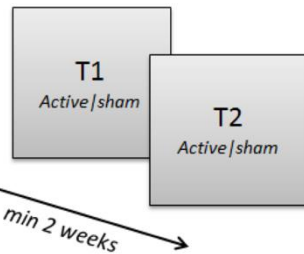
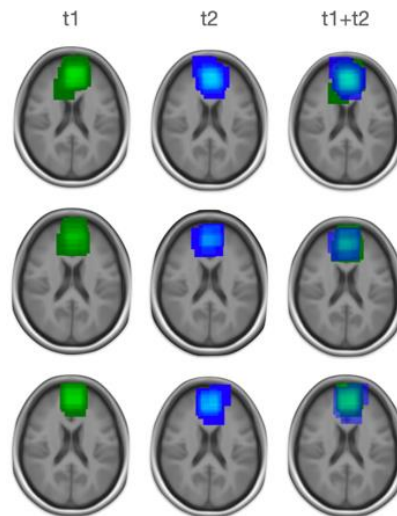
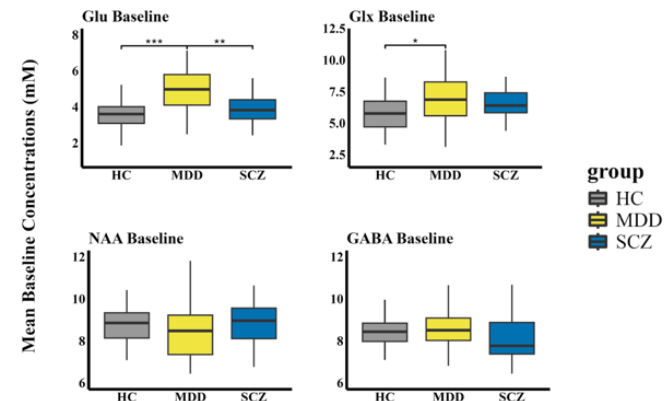


Magnetic Resonance Spectroscopy – MRSDC1

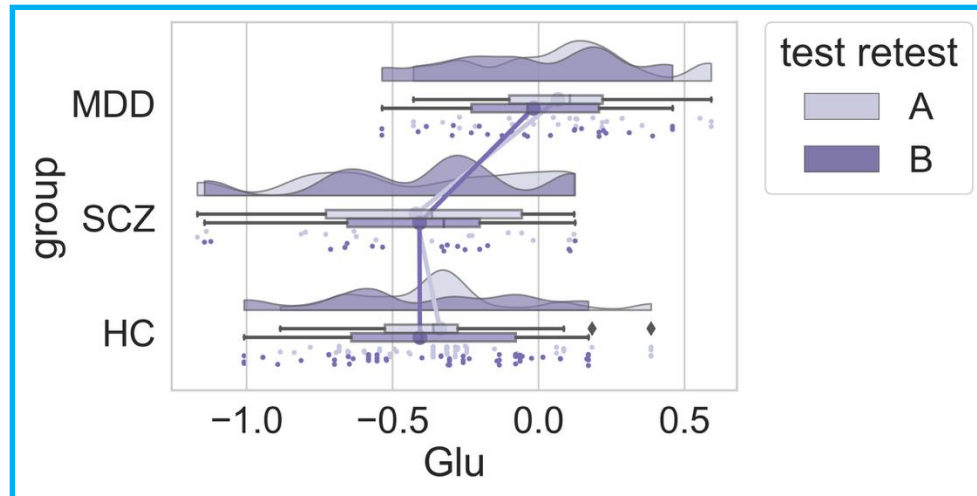
MRSDC1



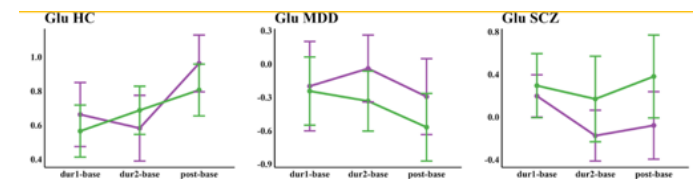
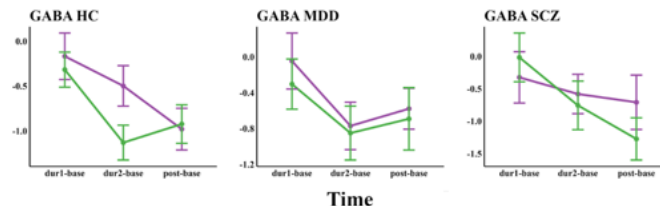
HC, N=38
MDD, N=24 (un-medicated)
SCZ, N=17
Total N=79



tDCS
20 min
2 mA



T1	MRS	fcMRI	MRS	MRS	MRS	fcMRI
3 min	10 min	6 min	10 min	10 min	10 min	6 min

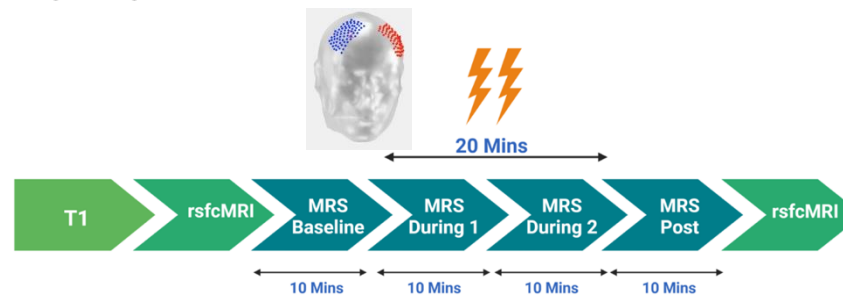
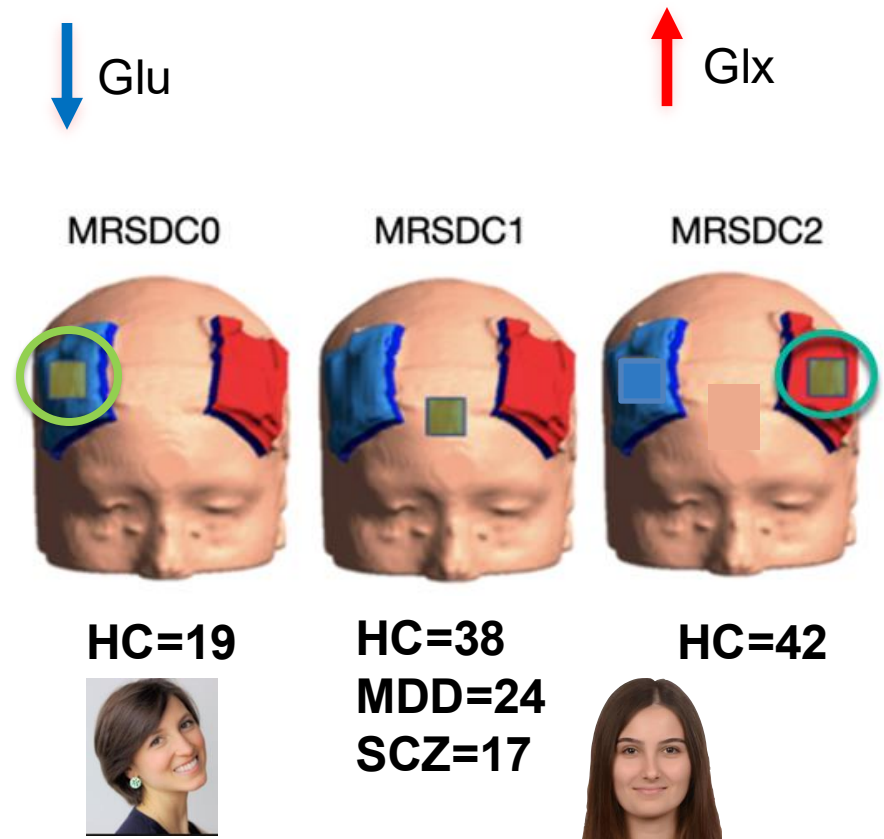
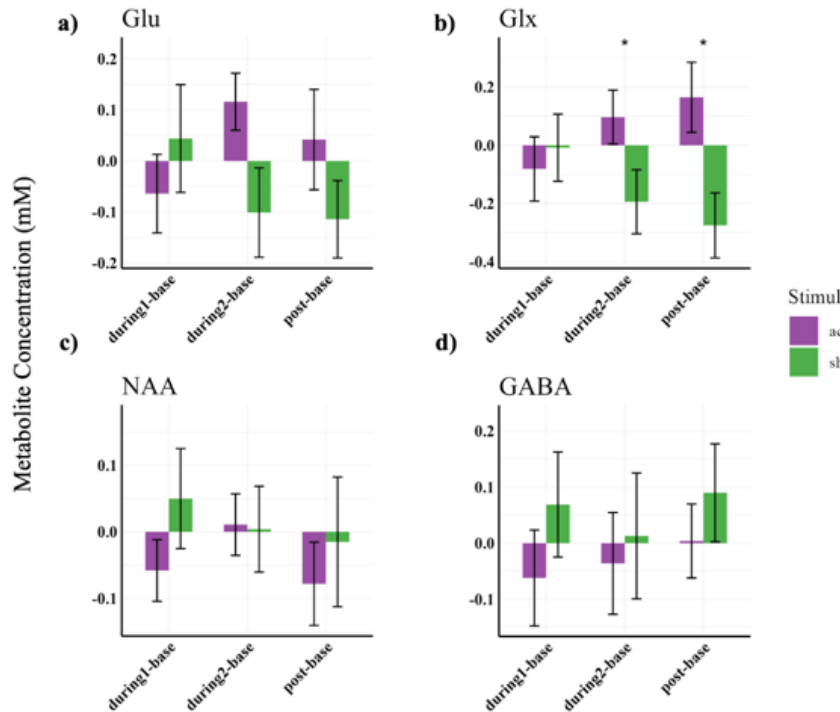


Vural et al. in prep.

Magnetic Resonance Spectroscopy – MRSDC2



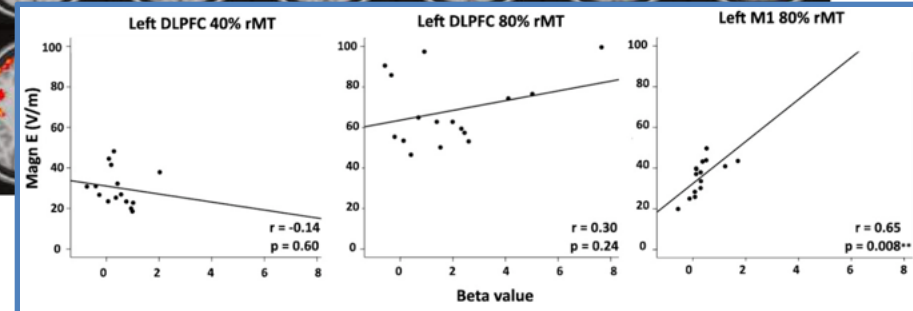
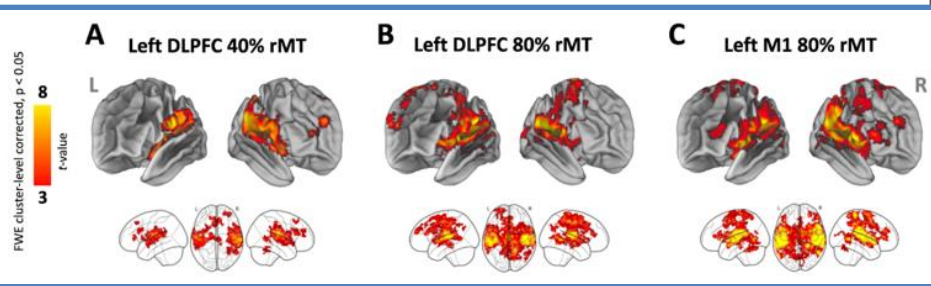
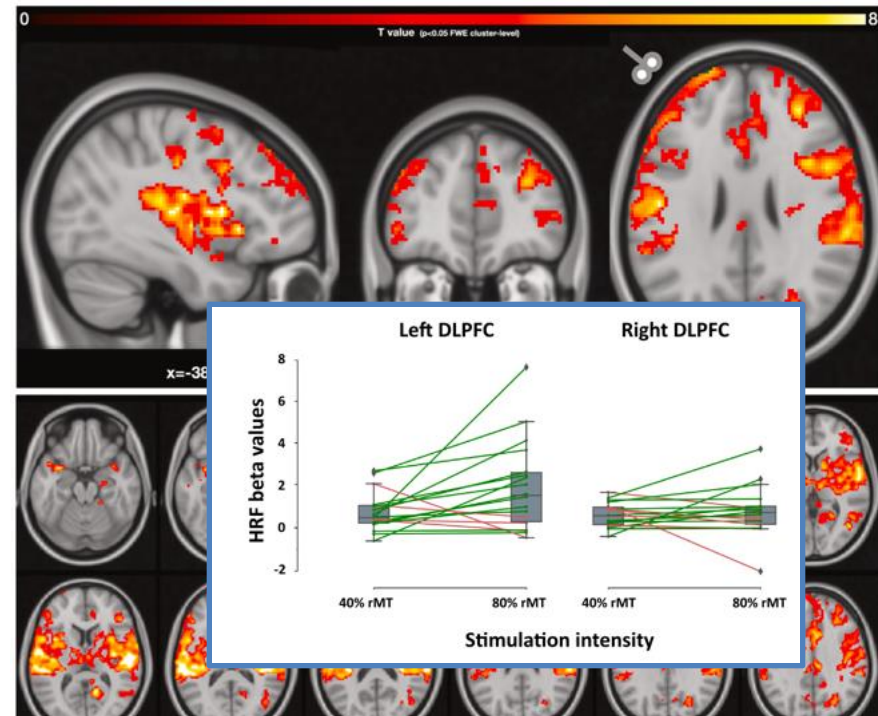
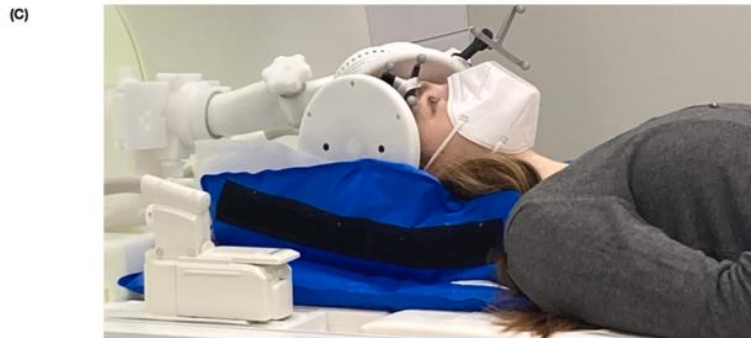
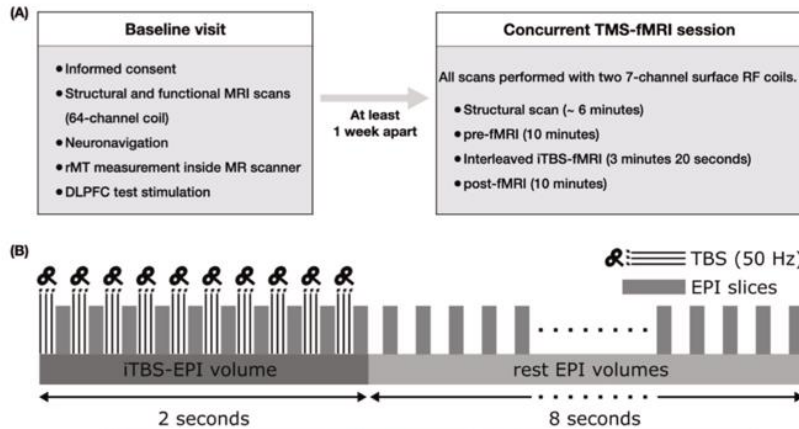
Design: Double Blind Placebo-Controlled, cross
Sample: 41 healthy participants (21 males, $\pm$ 24
Scanner: Siemens Prisma 3-Tesla MRI scanner
tDCS Device: NeuroConn DC-Stimulator Plus



Online TBS-fMRI



5



Mizutani-Tiebel et al., *Frontiers in Psychiatry* 2022

Chang et al., *NeuroImage* 2024

Chang et., *Biological Psychiatry:CNNI* 2024

Ongoing CDP research



Biological Psychiatry

Available online 27 April 2024

In Press, Journal Pre-proof ? What's this?

Archival Report

Signature of altered retinal microstructures and electrophysiology in schizophrenia spectrum disorders associated with disease severity and polygenic risk

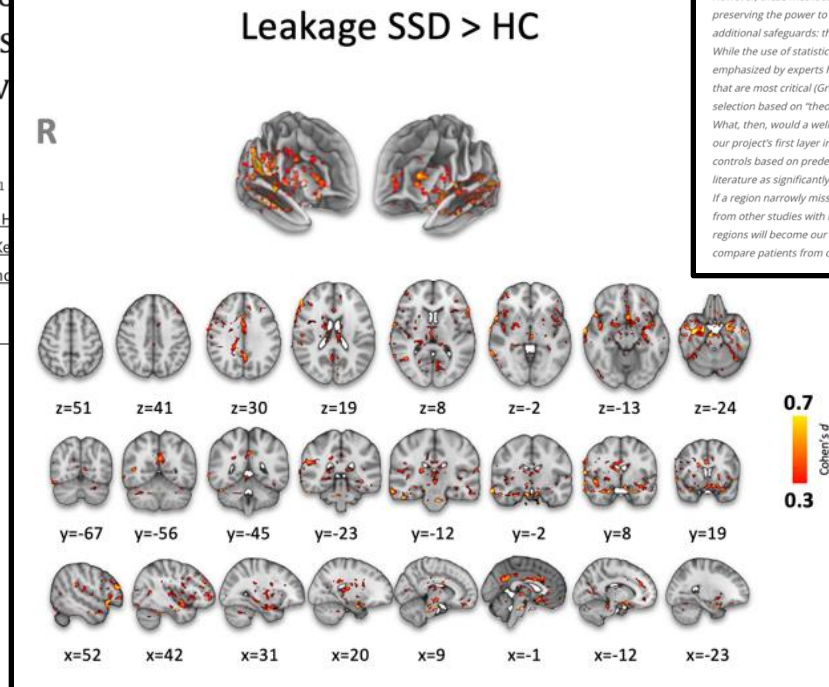
Emanuel Boudriot^{1,2,*}, Vanessa Gabriel^{1,*}, David Popovic¹, Vladislav Yakimov^{1,3}, Sergi Papiol^{2,4}, Lukas Roell^{1,5}, Genc Hasanaj¹, Joanna Moussiopoulou¹, Siegfried Priglinger⁷, Christoph K Alkomiet Hasan^{10,11}, Oliver Pogarell¹, Peter Falkai^{1,2,11}, And Benedikt Schworm⁷

CDP Working Group¹²⁶¹⁰

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Investigation of choroid plexus variability in schizophrenia-spectrum disorders – insights from a multimodal study

 Vladislav Yakimov,
  Joanna Moussiopoulou,
  Lukas Roell,
  Martin Mortazavi,
  Iris Jäger,
  Emanuel Boudriot,
  Genc Hasanaj,
  Mattia Campana,
  Lenka Krčmář,
  Marcel S. Kallweit,
  Sean Halstead,
  Nicola Warren,
  Dan Siskind,
  Sergi Papiol,
  Isabel Maurus,
  Alkomiet Hasan,
  Peter Falkai,
  Andrea Schmitt,
  Florian Raabe,
  Daniel Keeser,
  Elias Wagner





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Multimodal Clustering Analysis... Metadata Files Wiki Analytics Registrations

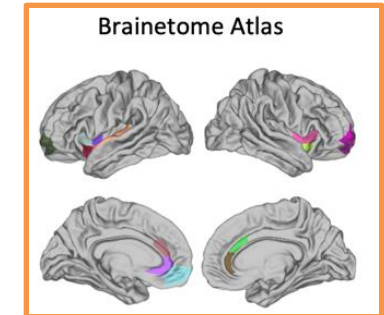
Multimodal Clustering Analysis of meta-analytically derived brain regions in Schizophrenia Spectrum Disorder

Contributors: Maxim Korman, Daniel Keeser

Date created: 2024-03-18 05:29 PM | Last Updated: 2024-06-11 02:51 AM

Category: Analysis

Description: Schizophrenia Spectrum Disorders (SSD) represent a broad spectrum of psychotic disorders. Their prevalence and severity highlight the urgent need for a deeper understanding of these heterogeneous diseases, which is crucial for developing tailored treatment strategies. A key determinant of progress in any scientific field is the discovery of associations that, over time, demonstrate replicability. Given our inability to completely eliminate the chance of finding false positives (i.e., to reject the null hypothesis definitively), an error threshold of 5% (p-value of 0.05) has been widely accepted. As we enter the era of big data, and hence an era of being able to test for an almost unlimited number of hypotheses, established thresholding becomes problematic, leading to a significant number of false positives (up to 1 in every 20 tests). To address this, multiple testing correction methods such as the Bonferroni correction and the False Discovery Rate (FDR) have been used. However, these methods are never a perfect solution, but rather represent trade-offs between minimizing the risk of false positives while preserving the power to detect true associations. To further increase the likelihood that the associations we detect are valid, we implement two additional safeguards: the pre-selection of our hypotheses and the pre-registration of our analyses. While the use of statistical corrections for multiple testing has become standard practice, other methodological aspects that are frequently emphasized by experts have received less attention. Groenwold et al. suggest reducing the number of hypotheses tested by prioritizing those that are most critical (Groenwold et al., 2021). Similarly, a recent article on replicability in brain imaging supports this by recommending a pre-selection based on "theoretical considerations" (Kelly et al., 2022). What, then, would a well-considered hypothesis in the area of brain imaging be based upon? A variety of methods are conceivable. To this end, our project's first layer involves finding all meta-analyses that address gray matter volume differences between SSD patients and healthy controls based on predefined criteria (see Analysis Plan for the specific criteria). We will then identify brain regions that have been reported in literature as significantly different more than once. We commit to including regions reported in at least half of the meta-analyses in our analysis. If a region narrowly misses this threshold in meta-analyses but is supported by strong theoretical arguments—evidenced by consistent results from other studies with large sample sizes and rigorous methodological designs—we will consider including it in our study. Collectively, these regions will become our regions of interest (ROIs), which we will examine in our cohort for patients vs. healthy controls (HC). Additionally, we will compare patients from our cohort with an age and sex matched group of HC from the Human Connectome Project (HCP).

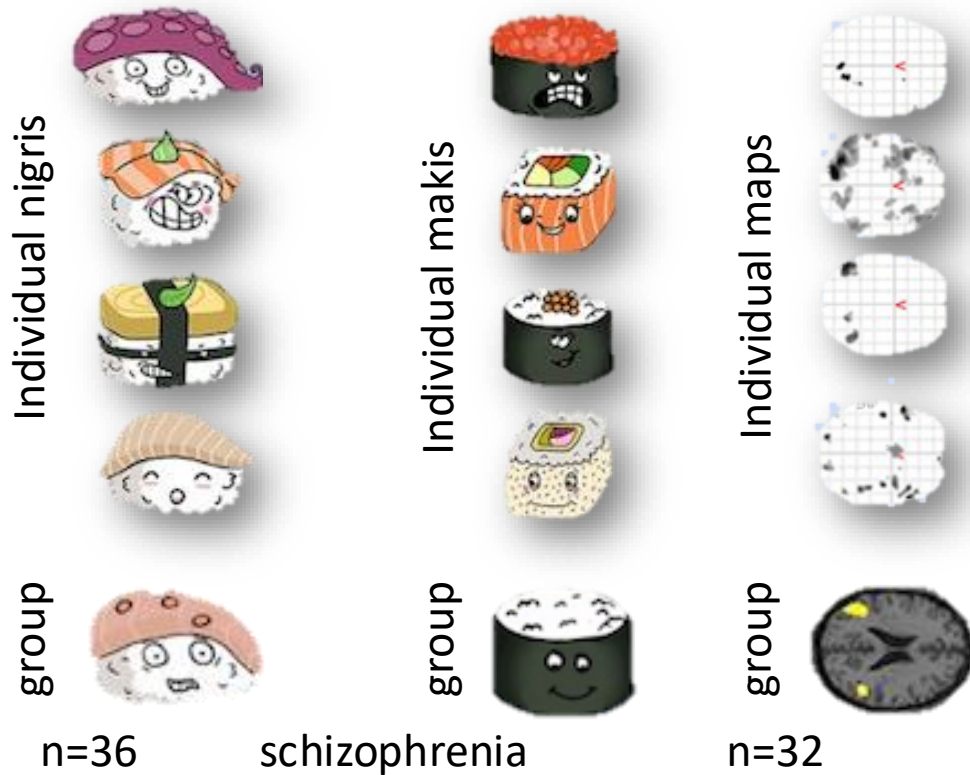


Boudriot et al., *Biological Psychiatry* 2024
Moussiopoulou et al., *under review*
Korman et al., *in preparation*
Yakimov et al., *under review*

Lack of group-to-individual generalizability is a threat to human subjects research

Aaron J. Fisher^{a,1}, John D. Medaglia^{b,c}, and Bertus F. Jeronimus^d

^aDepartment of Psychology, University of California, Berkeley, CA 94720; ^bDepartment of Psychology, Drexel University, Philadelphia, PA 19104; ^cDepartment of Neurology, University of Pennsylvania, Philadelphia, PA 19104; and ^dDepartment of Developmental Psychology, Faculty of Behavioural and Social Sciences, Groningen University, 9712 TS Groningen, The Netherlands



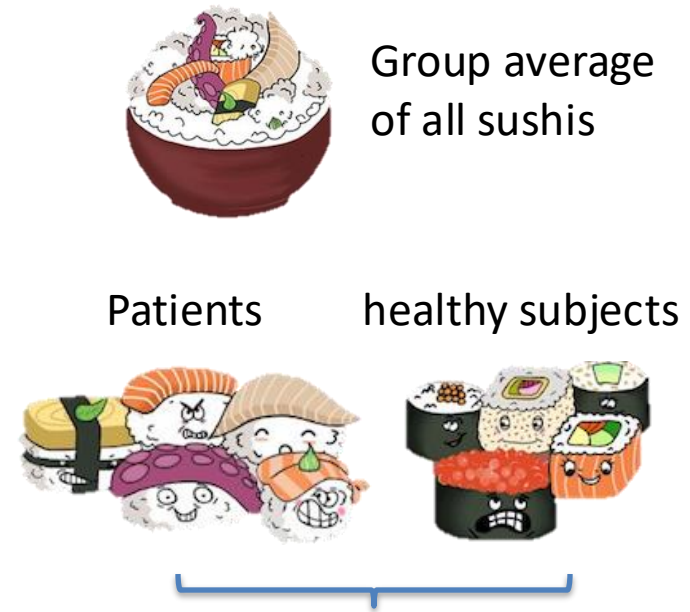
Feature Review

Building a Science of Individual Differences from fMRI

CellPress

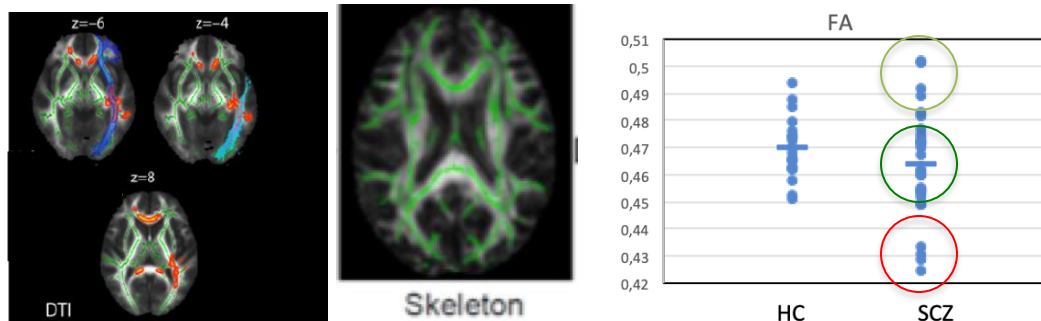
Julien Dubois^{1,*} and Ralph Adolphs¹

Trends in Cognitive Sciences



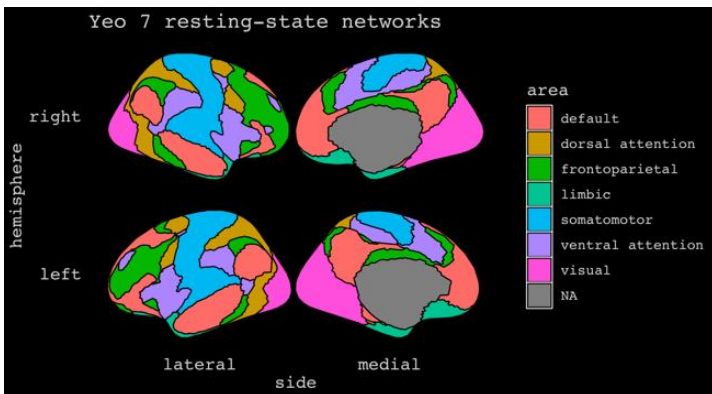
Even within group no two subjects are alike

Sushis adapted from *Nora Maria Raschle*
Takahashi et al., in preparation



(Individual) Brain parcellation

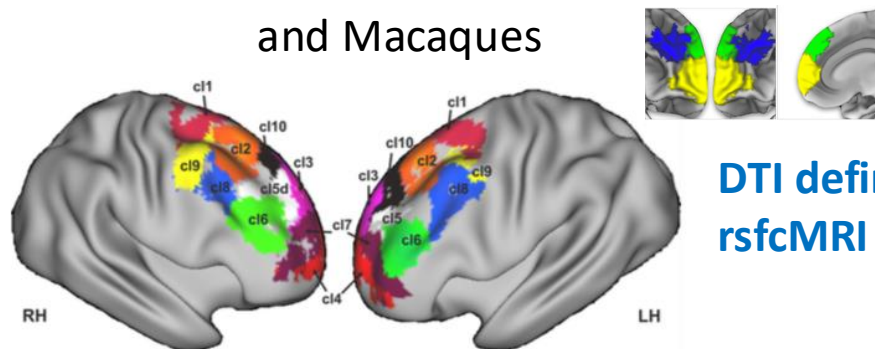
„Classical“ RSN atlas



rsfMRI

Yeo et al., J Neurophysiol 2011

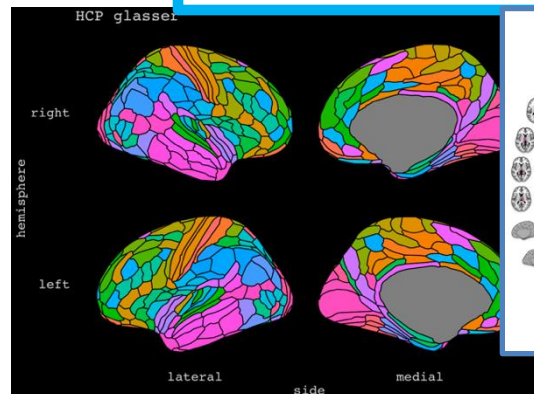
Dorsal frontal Cortex Atlas in Humans and Macaques



Sallet et al., J Neuroscience 2013

DTI defined
rsfMRI

Glasser - **Multimodal atlas1**

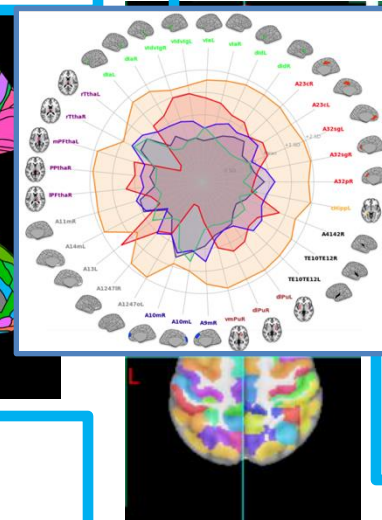


rsfMRI
task-fMRI
Myelin maps (T1/T2)

Glasser et al., Nature 2015

Brainetome –

Multimodal atlas2

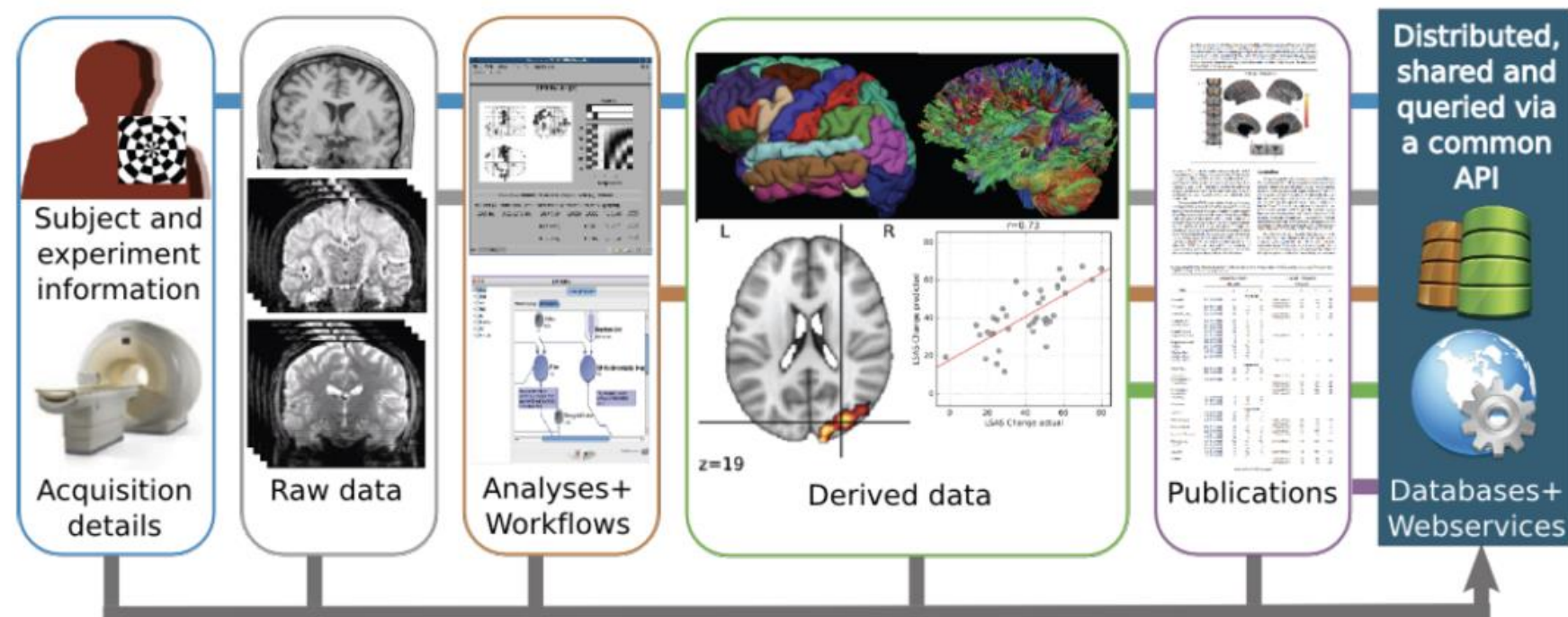


rsfMRI
task-fMRI
DTI

Fan et al., Cerebral Cortex 2016

Wörsching et al., *NeuroImage* 2017
Wörsching et al., *Brain Stimulation* 2018
Bulubas et al., *Brain Stimulation* 2019
Mizutani et al., *NeuroImage Clinical* 2022
Chang et al., *NeuroImage* 2024

Dataflow in Brain Imaging



Demographics
Stimuli
Scanner
Sequence

MRI
- T1
- T2
dMRI
fMRI
- Task
- Resting
EEG, MEG,
PET, MRS

SPM
FSL
FreeSurfer
AFNI
...
Nipype
LONI
...
QA/QC

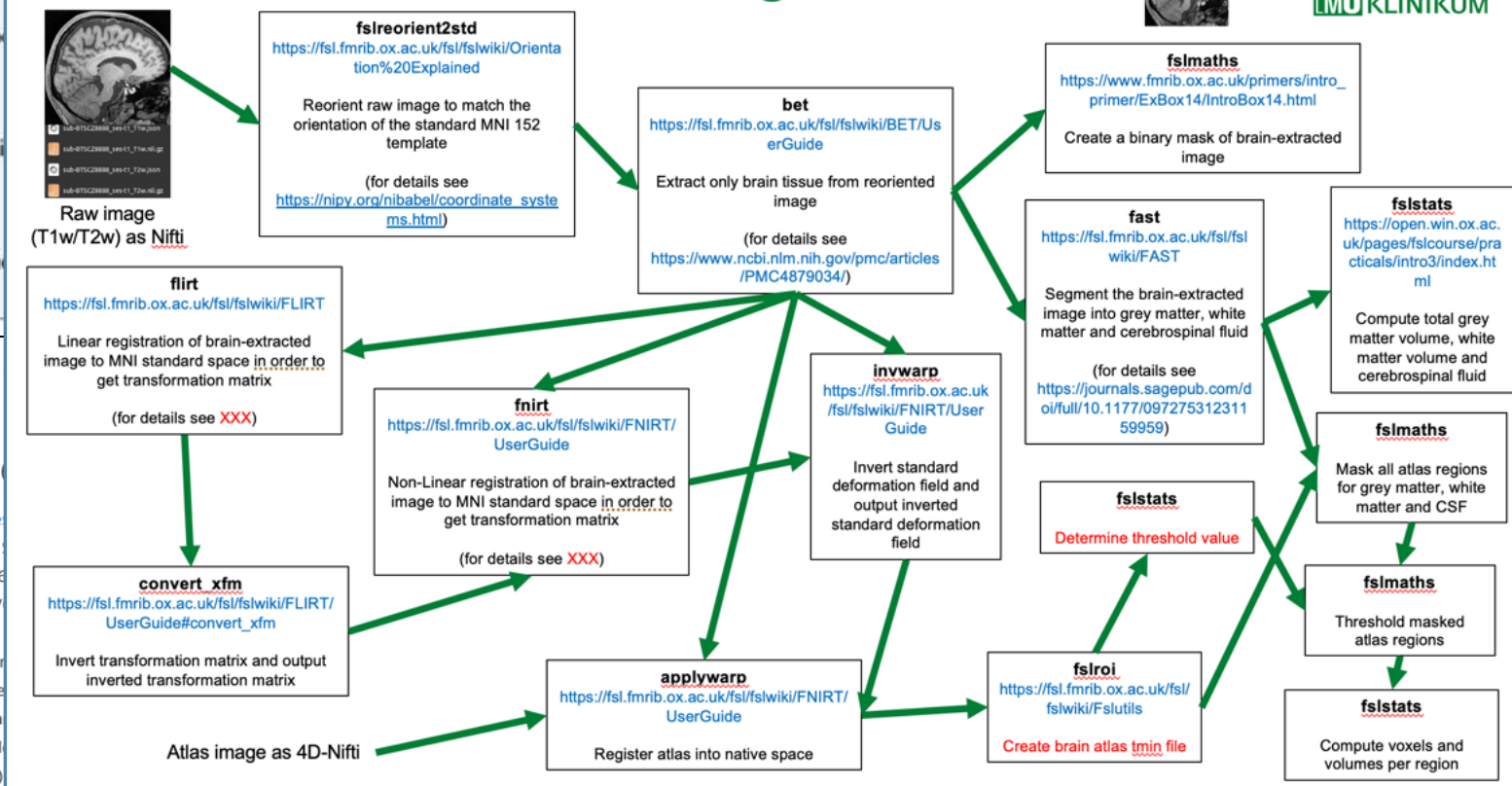
Contrasts
Correlation
Prediction

Journals
Preprint
archives
Websites
Blogs

XNAT
IDA
LORIS
COINS
Amazon S3
DropBox
Globus
Neurovault
Neurosynth

Neuromodulation And Multimodal NeuroImaging scripts

Structural MRI: Data Processing with NAMNIS



Effect of a
cortical th
schizophre

Contributors: [Daniel Kee](#)
Alkomiet Hasan, Andrea
Date created: 2020-02-06
Identifier: DOI 10.17605/
Category:  Project
Description: Aerobic exer
the disease remain uncle
relationship of these cha
patients who played tabl
resonance imaging (MRI)

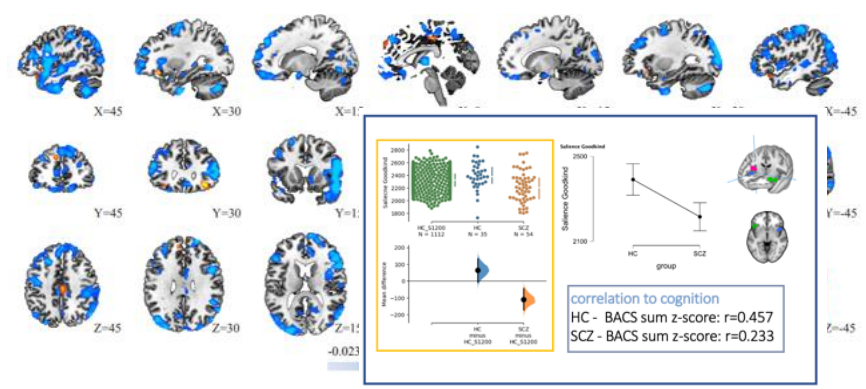
was assessed with FreeSurfer 6.0. The schizophrenia aerobic exercise group showed a significant correlation between the cortical thickness of the right lateral prefrontal cortex and the change in the number of correct responses. In the schizophrenia table soccer and healthy control groups, we found no significant longitudinal correlation of cortical thickness at baseline with clinical measures. Our results suggest that the right lateral prefrontal cortex is a structure adjacent to the hippocampus. Greater cortical thickness of the right lateral prefrontal cortex may be a marker of a protective factor against schizophrenia. Further intervention in patients with schizophrenia.

Effect of aerobic exercise combined with cognitive remediation on cortical thickness and prediction of social adaptation in patients with schizophrenia

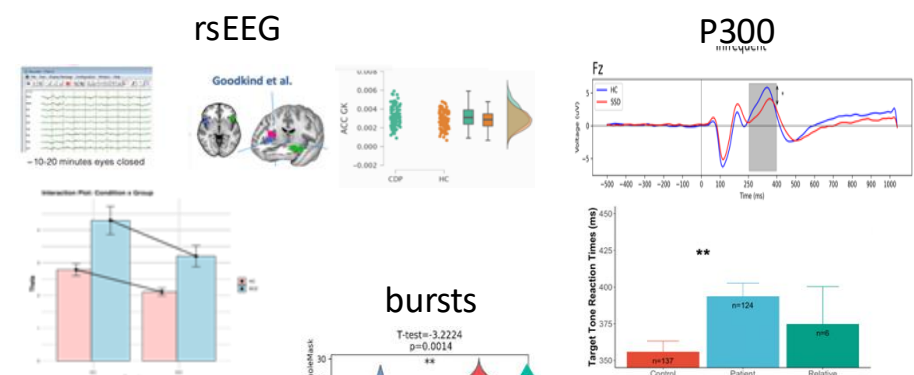
Shun Takahashi ^{a, b, *, 1}, Daniel Keeser ^{a, c, 1}, Boris-Stephan Rauchmann ^{a, c},
Thomas Schneider-Axmann ^a, Katriona Keller-Varady ^a, Isabel Maurus ^a, Peter Dechent ^d,
Thomas Wobrock ^{e, f}, Alkomiet Hasan ^a, Andrea Schmitt ^{a, g}, Birgit Ertl-Wagner ^{c, h},
Berend Malchow ^{a, i, 1}, Peter Falkai ^{a, 1}

mMRI reduces variability outcome? CDP study as an example...

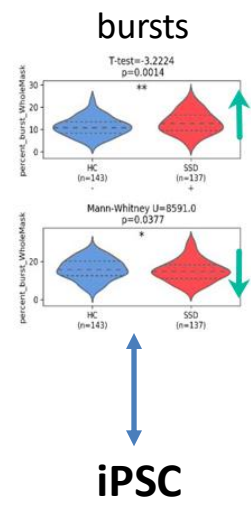
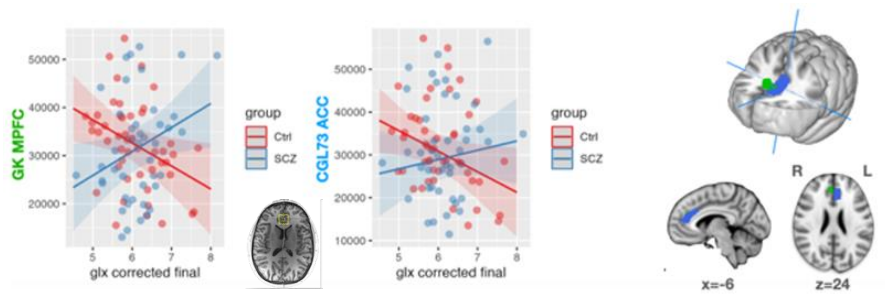
sMRI



EEG

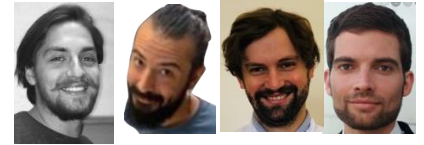


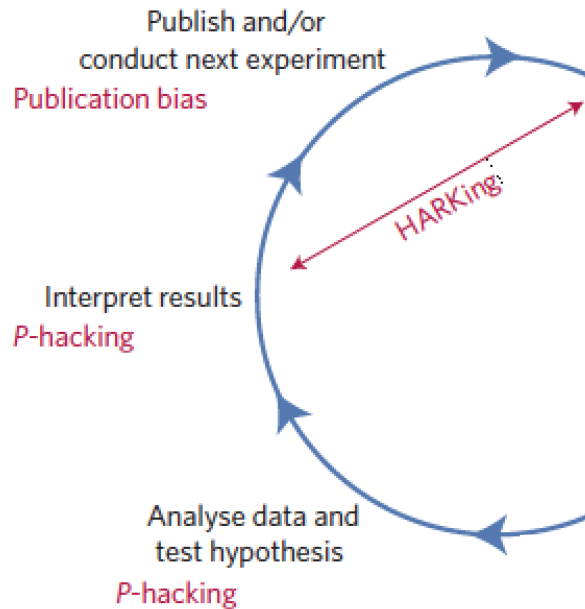
rsfMRI/MRS (subsample)



HC, N=287
SCZ, N=272

CDP: Krcmar et al., Frontiers in Psychiatry 2023
Raabe*, Hasanaj*, Karsli* et al, in Präparation





Generate and specify hypothesis

Prefrontal transcranial direct current stimulation changes connectivity of resting-state networks during fMRI.

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Schizophrenia Research xxx (xxxx) xxx

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journal homepage: www.elsevier.com/locate/schres

Effect of aerobic exercise combined with cognitive remediation on cortical thickness and prediction of social adaptation in patients with schizophrenia

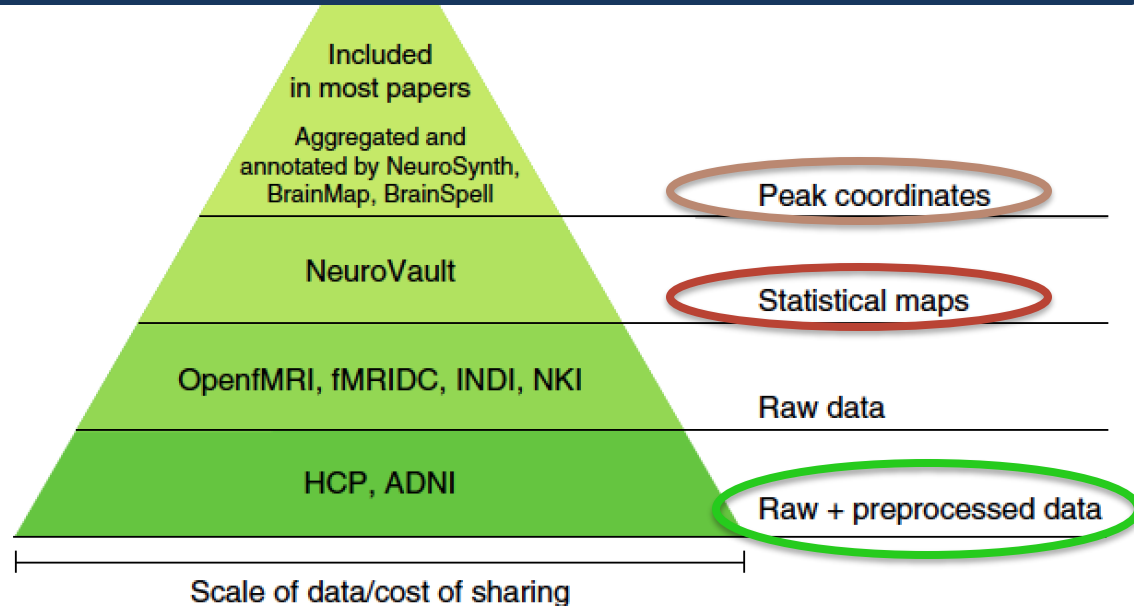
Shun Takahashi ^{a, b, *, 1}, Daniel Keeser ^{a, c, 1}, Boris-Stephan Rauchmann ^{a, c}, Thomas Schneider-Axmann ^a, Katriona Keller-Varady ^a, Isabel Maurus ^a, Peter Dechent ^d, Thomas Wobrock ^{e, f}, Alkomiet Hasan ^a, Andrea Schmitt ^{a, g}, Birgit Ertl-Wagner ^{c, h}, Berend Malchow ^{a, i, 1}, Peter Falkai ^{a, 1}

Munafo et al., Nature Hu



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More



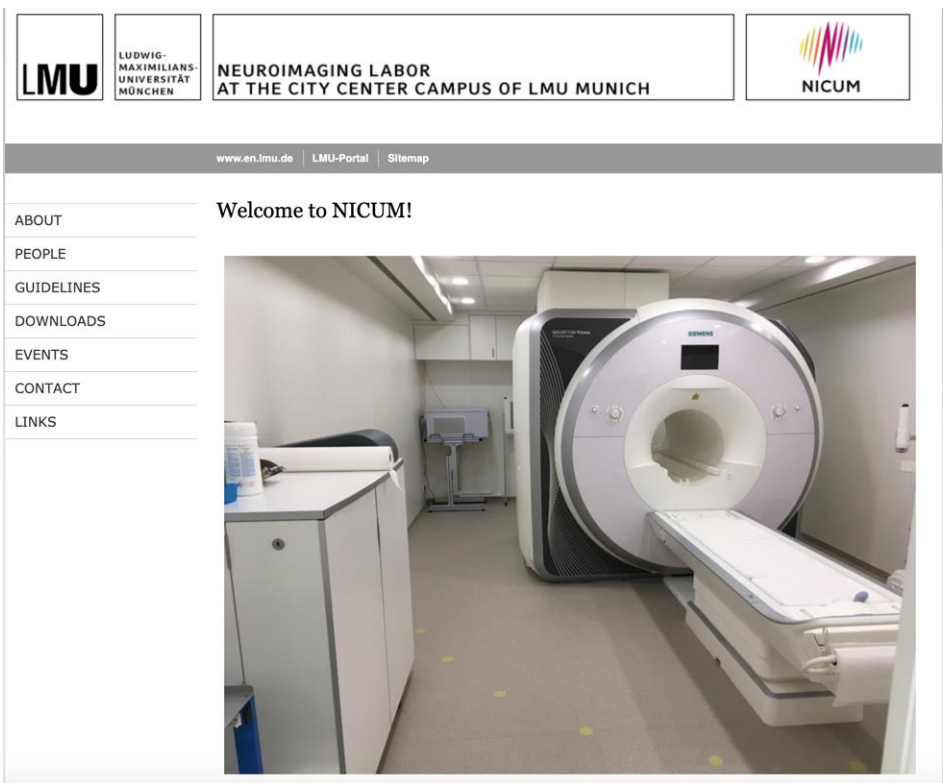
Poldrack & Gorgolewski, Nature Neuroscience 2014

NeuroImaging Core Unit Munich





<https://www.en.nicum.uni-muenchen.de/>



www.neuroimaging-munich.de

Dept. of Psychiatry and Psychotherapy, University Hospital LMU, Head: Prof. Dr. Peter Falkai