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Preregistering an fMRI study

Helena Hartmann

29.06.2021

First experiences and lessons learned

When you preregister, you…

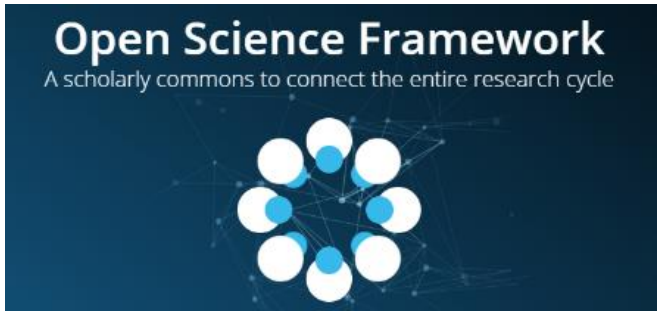
- … **openly declare the research** you are planning to conduct (public or with embargo)
- … **commit ahead of time** to hypotheses, methods, and analytic strategy
- … clearly **distinguish confirmatory from exploratory** research

Resources → multiple templates online (e.g. OSF or AsPredicted)

Claim early authorship for ideas/designs

No peer-review → faster start than with Registered Reports

Faster dissemination → a shift in time commitment from post- to pre-study



Why do we need preregistration of fMRI studies?

Article

Variability in the analysis of a single neuroimaging dataset by many teams

https://www.narps.info/

https://doi.org/10.1038/s41586-020-2314-9

Received: 14 November 2019

Accepted: 7 April 2020

Published online: 20 May 2020

Check for updates

A list of authors and affiliations appears

Data analysis workflows in many scie
complex and flexible. Here we assess
functional magnetic resonance imag
the same dataset, testing the same 9
approaches is exemplified by the fac
analyse the data. This flexibility resu
hypothesis tests, even for teams whc
intermediate stages of the analysis p
to several aspects of analysis methoc
aggregated information across team
regions. Furthermore, prediction ma

News & views

Reproducibility

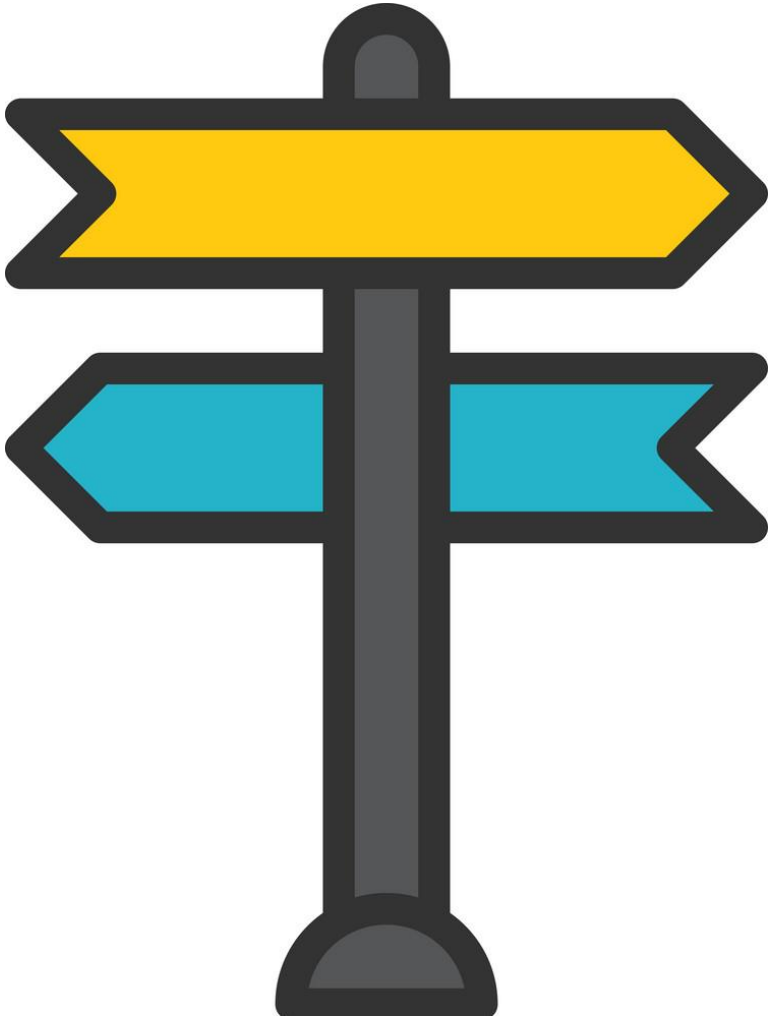
Pipeline choices alter neuroimaging findings

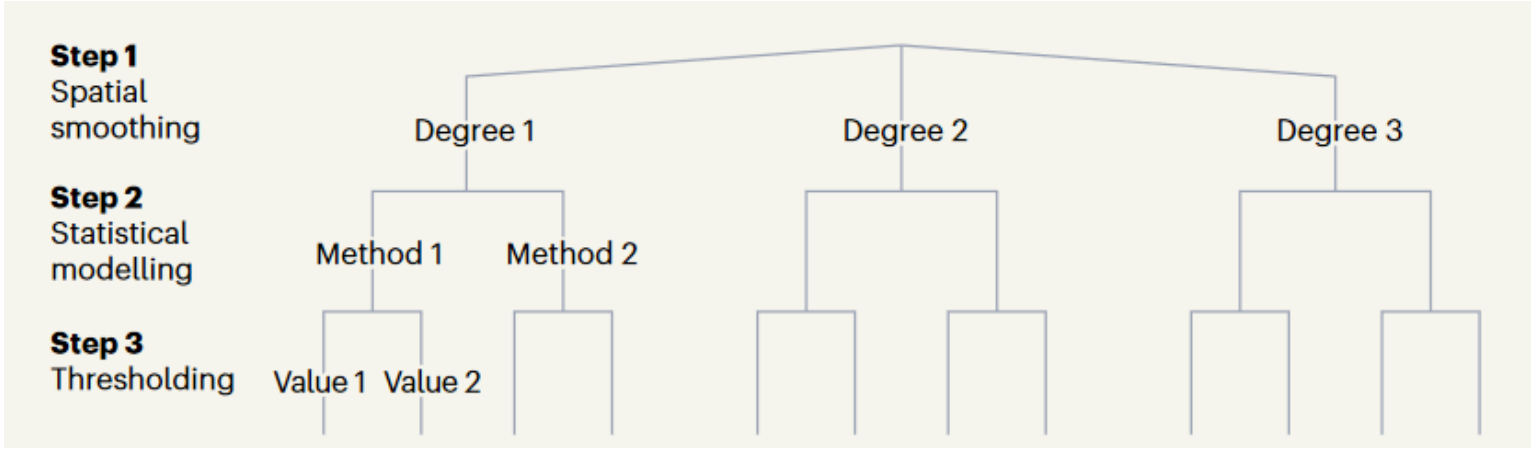
Martin Lindquist

Seventy laboratories that analy
data each produced different r
the potential consequences of
for processing complex data. S

"Notably, no two teams chose identical workflows to analyse the data, resulting in substantial variation in the results."

Because of decisions, decisions…

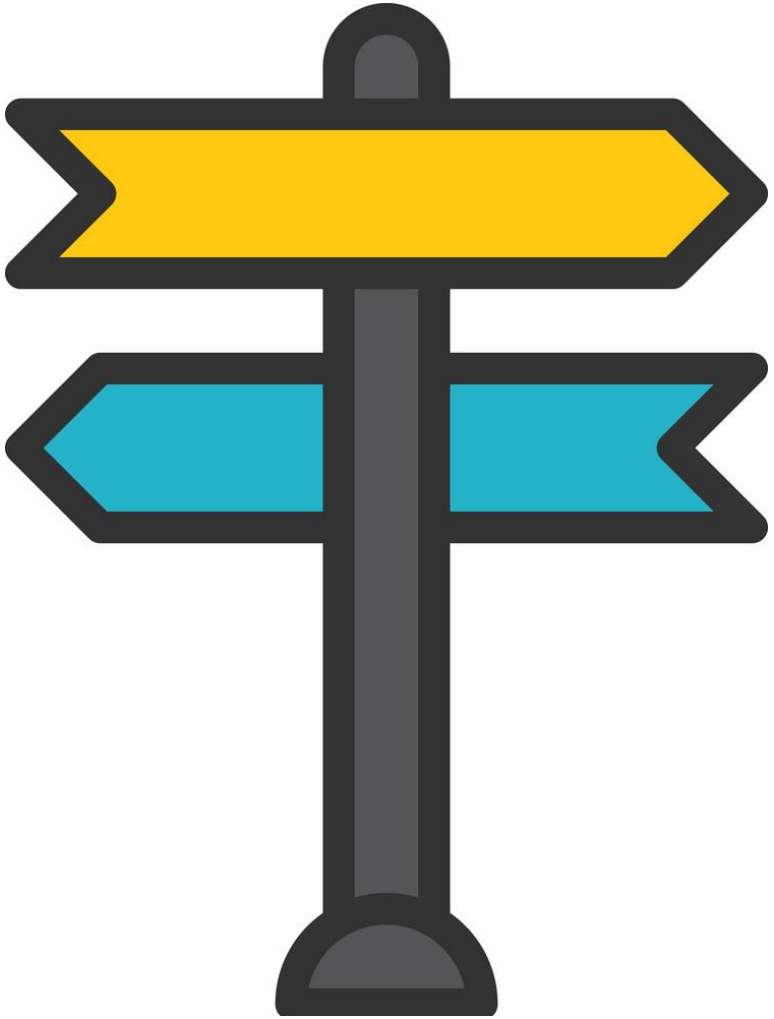




n possible combinations (where n = A LOT)

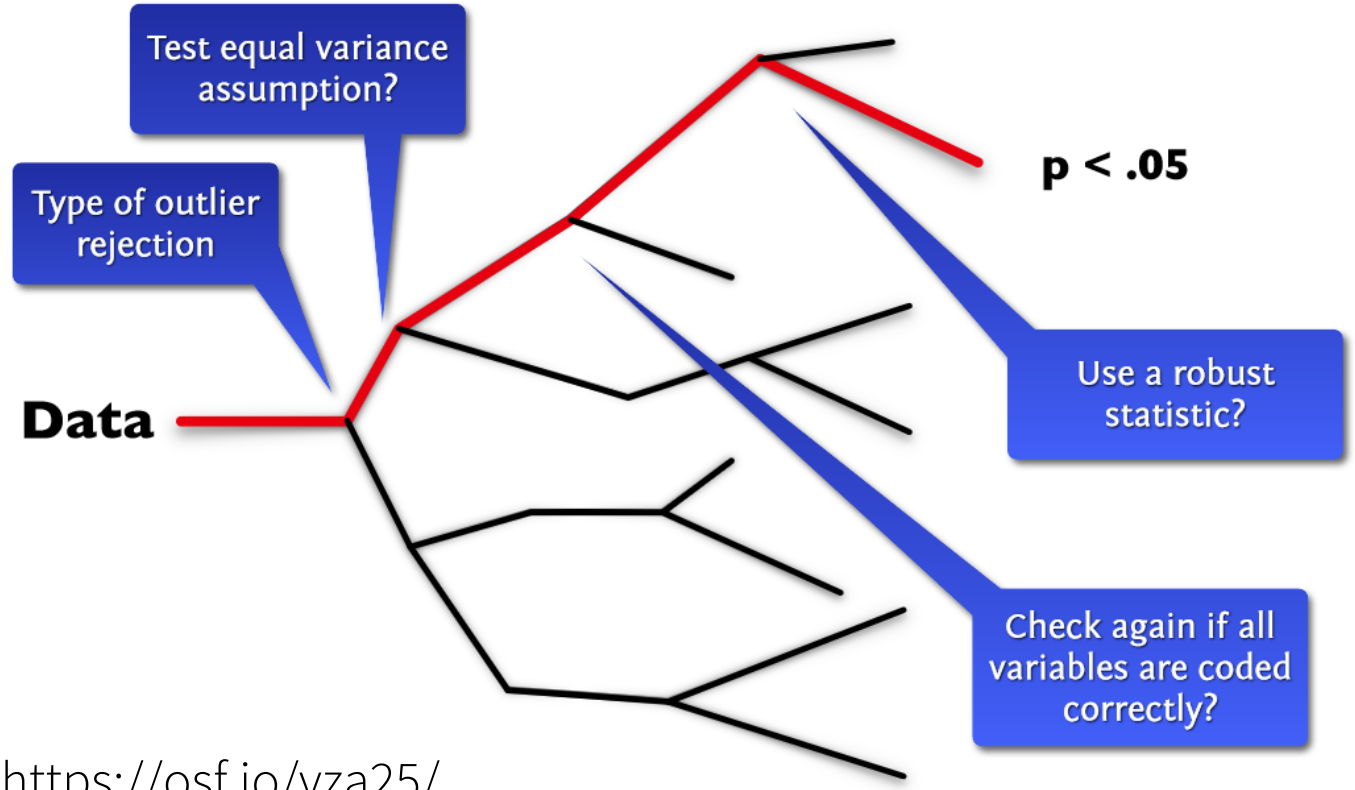
Lindquist et al. (2020)

Because of decisions, decisions…



The garden of forking paths

Andrew Gelman & Eric Loken, 2013

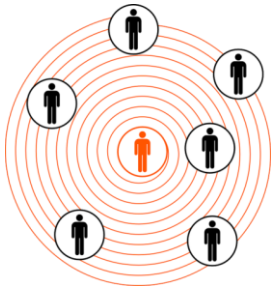


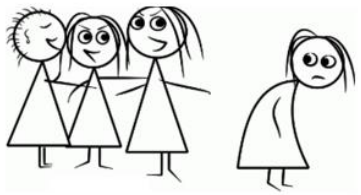
https://osf.io/vza25/

Inspired by Neurosceptic's blog: http://blogs.discovermagazine.com/neuroskeptic/2015/05/18/p-hacking-a-talk-and-further-thoughts/#.VV2TiOePKsN

17

MSc in Clinical & Biological Psychology → **PhD in Psychology**





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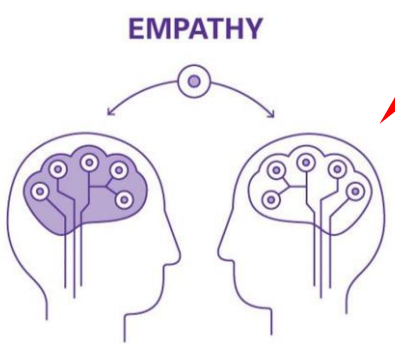
CLINICAL SOCIAL NEUROSCIENCE UNIT



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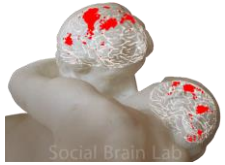
NETHERLANDS INSTITUTE FOR NEUROSCIENCE
Master the mind

SCAN Unit



Psychologist for MyMind

MyMind
EMBRACING NEURODIVERSITY

How it started

Study Information

https://osf.io/uwzb5

Title

Effects of placebo analgesia on somatosensory responses during first-hand and empathy for pain

Research Questions

Previous studies on placebo empathy analgesia (Rütgen et al., 2015, PNAS, J Neurosci) did not report any variation of somatosensory activation in the pain-processing network during empathy for pain, but only showed activation changes in the network related to the affective-motivational component. This is surprising given that placebo analgesia generally also affects the sensory-discriminative component of first-hand pain (Benedetti et al., 2005; Wager & Atlas, 2015). However, this mismatch might have resulted from the specifics of the experimental paradigm used in past studies, which did not seem ideally suited to observe activation of somatosensory areas (Keysers, Kaas, & Gazzola, 2010). In fact, it has been suggested that certain types of paradigms showing a specific body part in pain are required to observe modulation of somatosensory areas. Importantly, previous research on placebo empathy analgesia did not use such a setup (but used abstract cues and facial expressions of pain as a more indirect measure).

Furthermore, placebo empathy analgesia has only been investigated using first-hand painful and non-painful electrical stimulation and with a paradigm focusing on abstract cues ("cue-based" task). What is not clear yet, is whether also other types of empathic pain can be modulated by placebo analgesia, e.g. merely seeing pictures of

How it's going

Another's pain in my brain: No evidence that placebo analgesia affects the sensory-discriminative component in empathy for pain

Helena Hartmann, Markus Rütgen, Federica Riva, Claus Lamm*

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ARTICLE INFO

Keywords:
Empathy
Social
Electrical pain
Placebo analgesia
Somatosensation
fMRI

ABSTRACT

The shared representations account of empath… …ions relies on neural processes similar to those engaged wh… …ecent research corroborated this by showing that placebo an… …d in reduced pain empathy and decreased activation in shar… …ies did not report any placebo-related variation of somatos… …he experimental paradigms used in these studies did not direct attent… …pain, which may explain the absence of effects for somatosensation. The m… …egistered study was to implement a paradigm overcoming this limitation, and to investig… …lacebo analgesia may also modulate the sensory-discriminative component of empathy for pain. We …duced a localized, first-hand placebo analgesia effect in the right hand of 45 participants by means of a placebo gel and conditioning techniques, and compared this to the left hand as a control condition. Participants underwent a pain task in the MRI scanner, receiving painful or non-painful electrical stimulation on their left or right hand, or witnessing another person receiving such stimulation. In contrast to a robust localized placebo analgesia effect for self-exp… neither for behavioral nor r… while replicating previous … for first-hand and empathy … work, we again find no ca… refines the understanding o… investigating such models.

Free of HARKing or p-hacking!

1. Introduction

Empathy is a multifaceted psychological construct fundamental for human social interactions and relationships (e.g. Marsh, 2018 for recent review). While many definitions of empathy have been proposed, here we define empathy as an affective state isomorphic to the state

- Another's Pain in my Social Brain: The Effects of Placebo (Empathy) Analgesia on Social Behavior
  Hartmann & Lamm
- The Effects of Placebo Analgesia on Interoceptive Abilities
  Hartmann, Riva & Lamm

Experiences when writing up the papers

- **Open Science („21 word“) statement** at the beginning of the methods

2.2. Preregistration

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. This study was preregistered on the OSF prior to any creation of data (Hartmann et al., 2018; preregistration: osf.io/uwzb5; addendum: osf.io/h7v9p) and was designed to extend and specify the results of Rütgen et al. (2015b) in regard to somatosensory sharing. Methods reported below are therefore reproduced partly verbatim from the preregistration. Note that the preregistered plan contains a second research question that is not part of the present paper but will be reported elsewhere. In the following methods and results, we clearly distinguish preregistered procedures and analyses from those added post hoc.

- Clear **distinction between preregistered and post hoc** analyses in methods and results

2.7.1. Preregistered analyses

We implemented a within-subjects, full-factorial design with three factors of two levels each (*treatment*: placebo vs. control hand, *target*: self vs. other, *intensity*: pain vs. no pain). Two parametric repeated-measures analyses of variance (ANOVAs) were used to analyze the results. In the first ANOVA (analysis A1 in Fig. 2), the dependent variable was the self- and other-related pain ratings. A second ANOVA (analysis A2 in Fig. 2) included the unpleasantness ratings as the dependent variable (omitting the factor *target*, as unpleasantness ratings were only collected in the empathy condition). For each ANOVA, we then computed planned comparisons using paired *t*-tests.

2.7.2. Post hoc analyses

Due to the unexpected “null” finding of no transfer of the first-hand placebo effect to empathy, we aimed to gather further relative evidence for the null vs. the alternative hypothesis, using a Bayesian approach

Experiences when writing up the papers

- **Editor:** „(…) Reviewers **complimented the Authors on the decision to pre-register the study**.“
- **Reviewer 1:** „The fact that the **study was pre-registered** led to **high clarity in the description of the methods**, as well as to an **honest report of the planned analysis and of the additional investigations** - an aspect that is absolutely commendable.“
- **Reviewer 3:** „(…) interesting study design, combined with **rigorous, pre-registered analyses** that are compiled to a well-written manuscript.”
- **Reviewer 4:** “Overall, this study is a **carefully conducted, preregistered study**.”

Overall positive feedback

Learning by doing:
I preregistered one fMRI study so far!

aka

„The naive first-year PhD student approach“

Red Team excercise

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The 20% Statistician

A blog on statistics, methods, philosophy of science, and open science.
Understanding 20% of statistics will improve 80% of your inferences.

Monday, May 11, 2020

Red Team Challenge

by Nicholas A. Coles, Leo Tiokhin, Ruben Arslan, Patrick Forscher, Anne Scheel, & Daniël Lakens

Today we announce an initiative that we hope can incentivize critical feedback and error detection in science: the Red Team Challenge. Daniël Lakens and Leo Tiokhin are offering a total of $3,000 for five individuals to provide critical feedback on the materials, code, and ideas in the forthcoming preprint titled "Are facial feedback effects solely driven by demand characteristics? An experimental investigation". This preprint examines the role of demand characteristics in research on the controversial facial feedback hypothesis: the idea that an individual's facial expressions can influence their emotions. This is a project that Coles and colleagues will submit for publication in parallel with the Red Team Challenge. We hope that challenge will serve as a useful case study of the role Red Teams might play in science.

About Me

Blog by Daniel Lakens, experimental psychologist at the Human-Technology Interaction group at Eindhoven University of Technology, The Netherlands.

https://daniellakens.blogspot.com/2020/05/red-team-challenge.html

Red Team excercise (1/5)

In what fashion?

Hypotheses

1) The somatosensory component of the empathic reaction to pain is modulated in a similar fashion by placebo analgesia as the affective component, but only if the attention of participants is explicitly directed to the specific body part in pain. To this end, a new experimental paradigm will be used in which placebo analgesia is induced only for one of the two hands (placebo hand), while no analgesia is induced in the other (control hand). We predict reductions in empathy in the pain and unpleasantness ratings as well as in both pain matrix components. These reductions will be restricted to the hand in which placebo analgesia was induced (in comparison to the control hand).

What‘s the pain matrix? What brain regions do you expect?

https://osf.io/uwzb5

Red Team excercise (2/5)

What on earth constitutes extensive movement?

Data exclusion

If subjects show consistent extensive movement during the fMRI scans, and in particular, if this movement is stimulus-related, they will be excluded from further analysis.

Please explain further what this means!

https://osf.io/uwzb5

Red Team excercise (3/5)

Come on, standard algorithms and parameters? What does that even mean?

Transformations

Regarding the neuroimaging data, preprocessing will be carried out with the Statistical Parametric Mapping software package (SPM12; Wellcome Trust Centre for Neuroimaging, UCL, London, UK) using standard algorithms and parameters (slice timing correction, VDM calculation from field maps, realign & unwarp, coregistration, segmentation, functional and structural normalization and smoothing). Region of

Nice that you mention all the steps, but each of these have multiple parameters that can be changed flexibly…

https://osf.io/uwzb5

Red Team excercise (3/5)

Independent is great, but what are the exact coordinates? What‘s the sphere size? Or are they anatomical ROIs?

Statistical models

into the analysis as one single factor, with independent ROIs determined from recent findings on pain (e.g. Lamm et al., 2011; Corradi-Dell'Acqua et al., 2011; Rütgen et al., 2015, PNAS and JNeurosci). In addition to previously found areas related to placebo empathy analgesia, the focus will be on ROIs in the first and secondary somatosensory cortex. In the case of significant effects with the factor 'ROI' (pooled activation of all

What areas?

The somatosensory cortex is big, so where exactly?

https://osf.io/uwzb5

Red Team excercise (5/5)

Follow-up analyses

Significant interactions, if not sufficiently explained by the analysis plan and in particular by the planned comparisons, will be followed-up (and corrected for multiple comparisons).

That‘s nice, but what kind of correction? FDR, FWE, …?

https://osf.io/uwzb5


FROM J. K. ROWLING'S
WIZARDING WORLD
FANTASTIC
fMRI
prereg
DILEMMAS
AND
HOW
TO
SOLVE
THEM

Common dilemmas

- I used **OSF Prereg Challenge** and standard **OSF Prereg** templates (more templates can be found here: https://osf.io/zab38/wiki/home/)
- **PRP-QUANT Template**: https://www.psycharchives.org/handle/20.500.12034/4042.2
- Now there is an **fMRI-specific template** available:
  - **OSF**: https://osf.io/6juft/ (also provides guidance for common difficulties!)
  - Adapted within **MPI-CBS Hackathons**: https://docs.google.com/document/d/1GHkCCvu_io56mB8wWwWzuts1hTXyWOC9-DNOHlYSUTw/edit#heading=h.omxd3x3jr2d7 (for questions contact Frauke Beyer at fbeyer@cbs.mpg.de)
- **SIPS 2019 collection of neuroimaging/electrophysiology preregs**: https://docs.google.com/spreadsheets/d/1K-sBCobM1jmTbC3ctWdqaZpkt00RyPVpU1xk95njLU8/edit#gid=1351240212

„I have no idea where to start or which information to include!“

https://osf.io/mtdh2/

Common dilemmas

- Be **as detailed as possible**
- BUT very flexible/free in what you include → **It is up to you**, nobody will check it, except (hopefully) the reviewers!
- Who to add as **authors**? → be as sparingly as possible, it‘s always easier to add new people!
- Upload **additional** method-related **files**: Task/Analysis code, Stimuli, Randomizations, etc.
- Think about all **possible outcomes**, e.g. what analyses to do if the data are not normally distributed?

„I don‘t know how detailed the preregistration should be!“

https://osf.io/mtdh2/

Common dilemmas

- Best **before collection of any data** that you will use in the analysis
- **My approach**: After pilots, before first real participant
- Theoretically possible at all time points, but the closer you get to analysis, the **harder it is to disentangle biasing** by data/analysis/results

„I don‘t know WHEN to preregister!“

https://osf.io/mtdh2/

Common dilemmas

- Preregistration is "**a plan not a prison**"
- Keyword **transparency:** State prior knowledge of existing dataset
- **Amendments** always possible

„I cannot preregister before the start of the data collection!/Data collection is already ongoing!"

Summary

Provide a narrative summary of what is contained in this registration, or how it differs from prior registrations.

This is an addendum to the preregistration of this project, uploaded on August 3rd 2018. There, we wrote:

https://osf.io/mtdh2/

Common dilemmas

- **Link to all previous publications/preregistrations**, possibly all under an OSF project
- State **how prior information will influence hypotheses** or how you will not allow prior knowledge to influence your hypotheses
- Include **descriptions of measurements you plan to use**

„If my study is part of a larger project, how much information do I include in my preregistration?“

https://osf.io/mtdh2/

Common dilemmas

- It's crucial to **think through those decisions** prior to data analysis!
- Make use of **available data structures and pipelines**:
  - **BIDS** & BIDS apps which allow you to quickly share your exact analysis pipeline, with the specific software and correct software versions
  - **Many Labs** have standard operating procedures and pipelines
- If you don't know a decision yet, it's a good reminder to think about what you want to do!

„There are too many decisions, e.g. imaging parameters, preprocessing, …!“

https://osf.io/mtdh2/

Common dilemmas

- **NeuroPowerTools**: http://neuropowertools.org/ (You can use data that you upload or that's already on Neurovault)
- **fMRIpower**: http://fmripower.org/

„I cannot really calculate my power, which makes sample size calculations hard!“

https://osf.io/mtdh2/

Common dilemmas

- Definitely **needs to be specified**, this is where a lot of flexibility comes from!
  - Anatomical definition
  - Prior study cluster
  - Neurosynth definition (make sure to be specific here!)
  - Parcellation definition
- Use **previous studies/lab experience** as a guideline

„My region of interest is HUGE and I don‘t know which coordinate/approach to pick!“

https://osf.io/mtdh2/

Common dilemmas

- **Yes, it does!** Preregistration just clearly distinguishes confirmatory from exploratory research!
- See **“Exploratory Reports”** from Cortex: https://www.elsevier.com/__data/promis_misc/Exploratory_Reports_Guidelines.pdf

„I only have exploratory hypotheses, so it doesn‘t really make sense to preregister!“

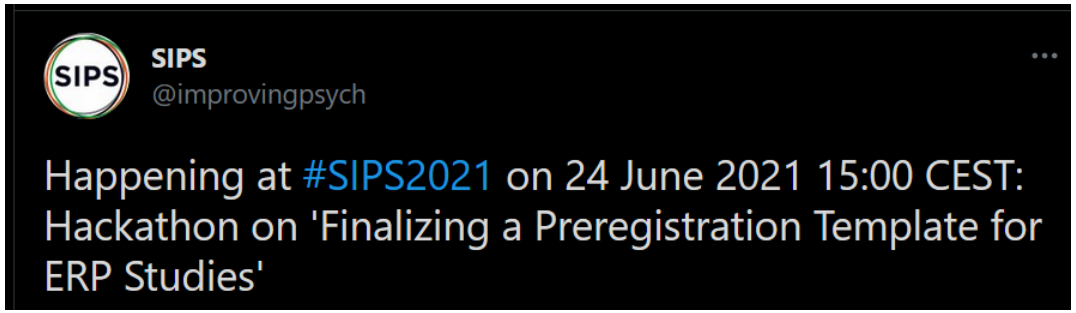
https://osf.io/mtdh2/

Personal lessons learned

- Choose a template that is detailed and gives you a good **framework/structure**
- Have a look at **other fMRI preregistrations**
- **Read Team:** Let colleagues **evaluate/review** it before submitting
- Don‘t be afraid to make mistakes/**amendments**
- **IMO:** Better to have an only 80% perfect preregistration than none!
- Key: **Transparency!**
- Ask yourself: Would somebody else be able to **replicate your study just using the preregistration?**
- **When in doubt**: Write to the COS, they are super helpful (contact@cos.io)!

More information

- **OHBM Open Science room** (fMRI prereg template): https://ohbm.github.io/osr2021/
- For **EEG**-interested people: Hackathon @ SIPS (https://www.improvingpsych.org/SIPS2021/)
- **Nichols et al. (2017)** – best practices in neuroimaging studies
- **Poldrack et al. (2007)** – what to report in an fMRI study
- **Gentili et al. (2020)** – Preregistering ROI analyses



Best practices in data analysis and sharing in neuroimaging using MRI

Thomas E Nichols, Samir Das, Simon B Eickhoff, Alan C Evans, Tristan Glatard, Michael Hanke, Nikolaus Kriegeskorte, Michael P Milham, Russell A Poldrack, Jean-Baptiste Poline, Erika Proal, Bertrand Thirion, David C Van Essen, Tonya White & B T Thomas Yeo

Guidelines for reporting an fMRI study

Russell A. Poldrack,[a,*] Paul C. Fletcher,[b] Richard N. Henson,[c] Keith J. Worsley,[d] Matthew Brett,[c] and Thomas E. Nichols[e]

[a]*Department of Psychology, Department of Psychiatry and Biobehavioral Sciences, and Brain Research Institute, University of California Los Angeles, Los Angeles, CA 90095, USA*

The case for preregistering all region of interest (ROI) analyses in neuroimaging research

Abstract

In neuroimaging studies, small sample sizes and the resultant reduced statistical power to detect effects that are not paired with voxel- or cluster-wise corrections for multiple comparisons. Though voxel-wise corrections are more reliable in terms of controlling the false-positive rate, they have

Any other questions?

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Thank you for your attention!