

Quality Control in fMRI Studies with MRIQC and fMRIPrep

Céline Provins

22/07/2023

DO YOU KNOW THAT ...

Ducharme et al. 2016, NeuroImage
Power et al. 2012, NeuroImage
Zalesky et al. 2016, NeuroImage
Alexander-Bloch et al. 2016, Hum. Brain Mapp.

Quality control (QC)

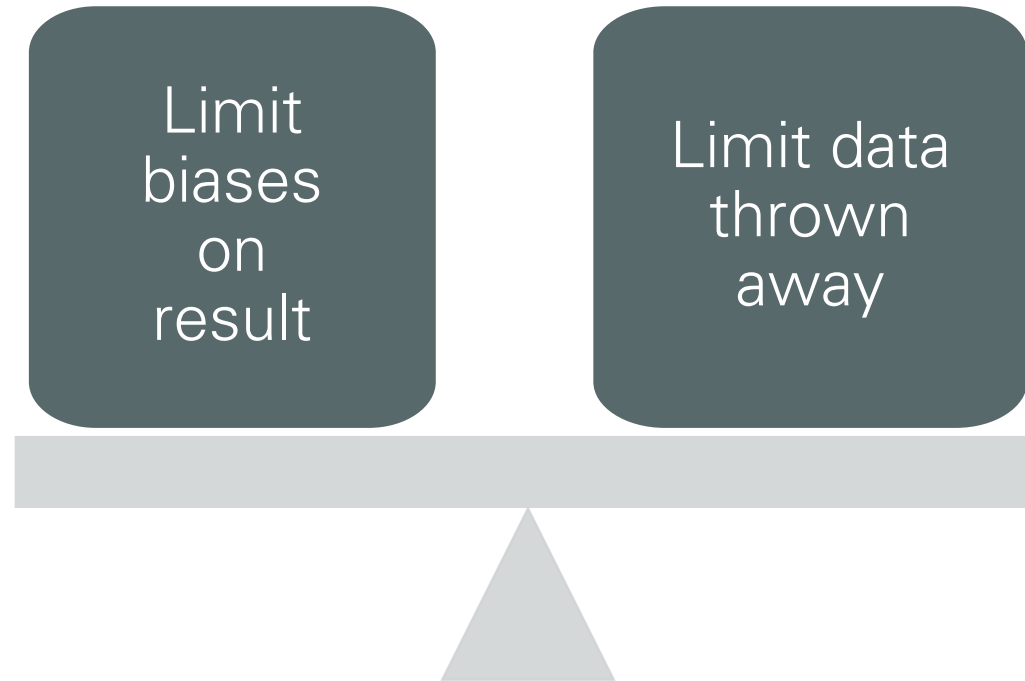
- Crucial

BUT

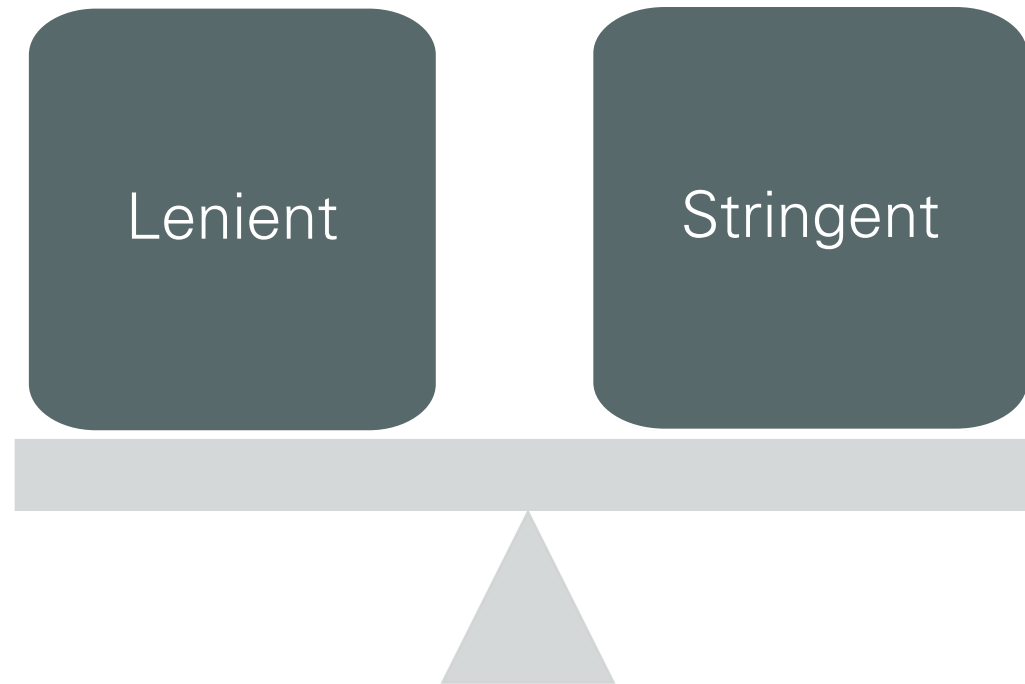
- Time-consuming
- Highly variable

→ need appropriate QC tools and protocols

Vetting the data quality



Vetting the data quality

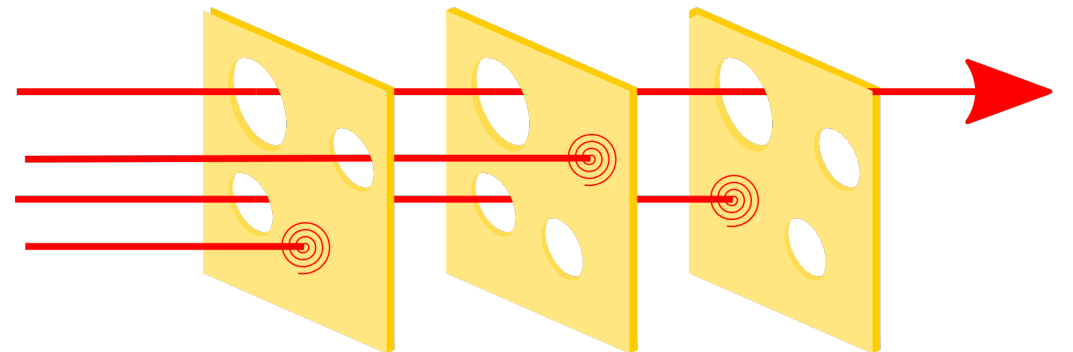


Guidelines

- Predefine exclusion criteria tailored to the particularities of the project
 - Research questions
 - Planned analysis
 - Types of data available

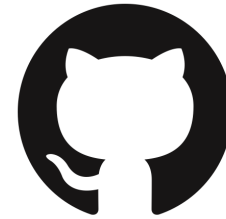
Guidelines

- Predefine exclusion criteria tailored to the particularities of the project
- Set up several checkpoints
 - To assess quality of preprocessing steps
 - But also offers different perspectives
 - Ensure robustness of the whole protocol





**Standard Operating
Procedures (SOPs)**



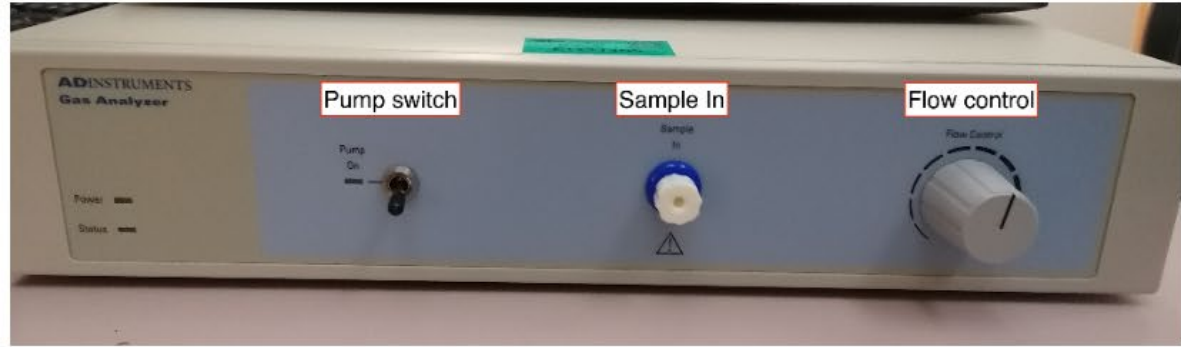
SOPs-cookiecutter

Standard Operating Procedures of the HCPH project

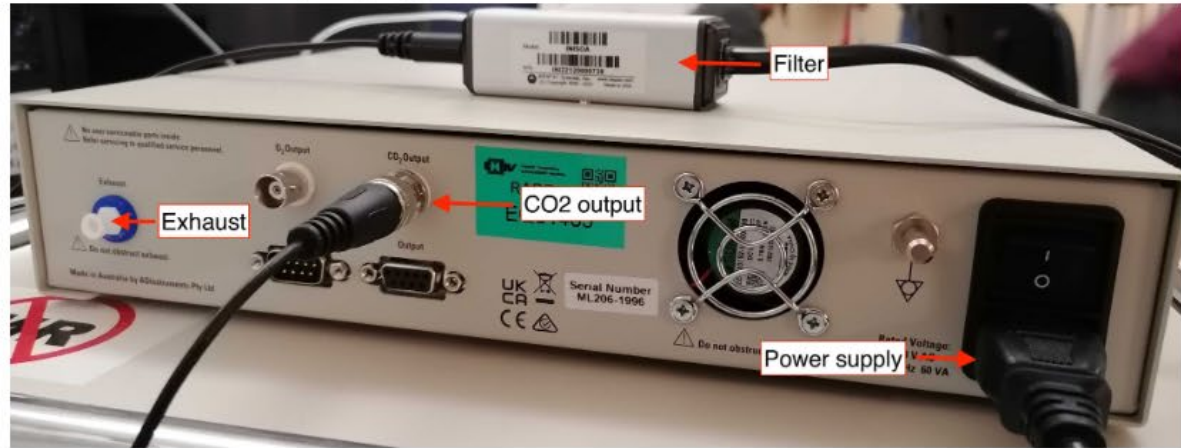
- Home
- Change History
- Recruitment, Scheduling, and Screening >
- Data collection >
 - Preliminary work
 - Before each session**
 - Preparing the participant
 - Notes on the scanner's console and recording devices
 - Running the scanning session
 - Session tear-down
 - Emergency procedures
- Data management >
- Preprocessing
- Release of data

⚠ If the color of the drying tube changes, it should be replaced.

- Remove the cap of the gas input (Sample In, front panel of the GA) and connect the MLA0110 inline filter to it. The inline filter **MUST** be replaced after some ten sessions.



- Connect the coaxial end of the BNC-BNC cable to the CO₂ output in the back of the GA and connect the other end (jack plug) into the input end of the INISO/A filter.



- Connect one end (RJ-11 to RJ-11) to the output of the INISO/A filter, and the other into

Table of contents

- Documentation and other non-experimental devices
- Boot the scanner up if it is shut down
- Basic preparations in the scanning room
- [Setting up the BIOPAC system and physiological recording sensors](#)
- Setting up the eye-tracker
- INSIDE the scanner room
- Back OUTSIDE THE SCANNER ROOM (control room)
- Final checks inside the scanning room



Standard Operating Procedures of the HCPH project

- Home
- Change History
- Recruitment, Scheduling, and Screening >
- Data collection ▾
 - Preliminary work
 - Before each session
 - Preparing the participant
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 - [Running the scanning session](#)
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- Data management >
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- Release of data

Positive-control task (PCT)

- ✓ Verify that the task's program is awaiting the scanner's trigger to start.
- ✓ Inform the participant that we will proceed with the positive control task (PCT). Repeat task instructions.
 - Hey [NAME], thanks for your collaboration with the eye tracking calibration.
 - The following block will collect some behavioral data and requires your collaboration. You will be exposed to several activities.
 - Whenever you see a red circle, please fix your gaze on it, wherever it is shown on the screen. If the red circle moves, we ask you to follow it with your eyes.
 - Some other times, you'll see either "RIGHT" or "LEFT" written on the screen. During those times, please tap your thumb and the other fingers of your right or left hand as indicated on the screen.
 - Before we start, please leave the alarm button on your tummy to free your hand for finger tapping. Please do not hesitate to grab it in case you need to squeeze it.
- ✓ Launch the `func-bold_task-pct_dir-{RL, LR, PA, AP}__cmrr_me4_sms4` protocol by pressing *Continue* (▶).
- ✓ Wait for the calibration scans to be finished (the process is reported on the bottom left corner of the console) and verify that the first volume's trigger signal was received by `hos68752` (meaning **CHECK that the task program was initiated**).
- ✓ While it is running:
 - ✓ [Adjust the FoV](#) for the following sequence,

Table of contents

- During the session
 - Check experimental setup
 - Acquire a localizer (AAhead_scout)
 - If the localizer presents very low quality
 - Acquire a high-resolution, anatomical image
 - Acquire the diffusion MRI run
 - Once the main diffusion MRI run is done, proceed with fieldmaps
 - [Acquire the functional MRI block](#)
 - Positive-control task (PCT)
 - Resting state fMRI
 - Breath-holding task (BHT)
- Concluding the session

[MRIQC :: SOPs](#)[Home](#)[Change History](#)[Quality Assessment and Control](#)[Exclusion Criteria](#)[Release of data](#)

Research topic

Exclusion criteria for unprocessed BOLD data based on the individual MRIQC visual report

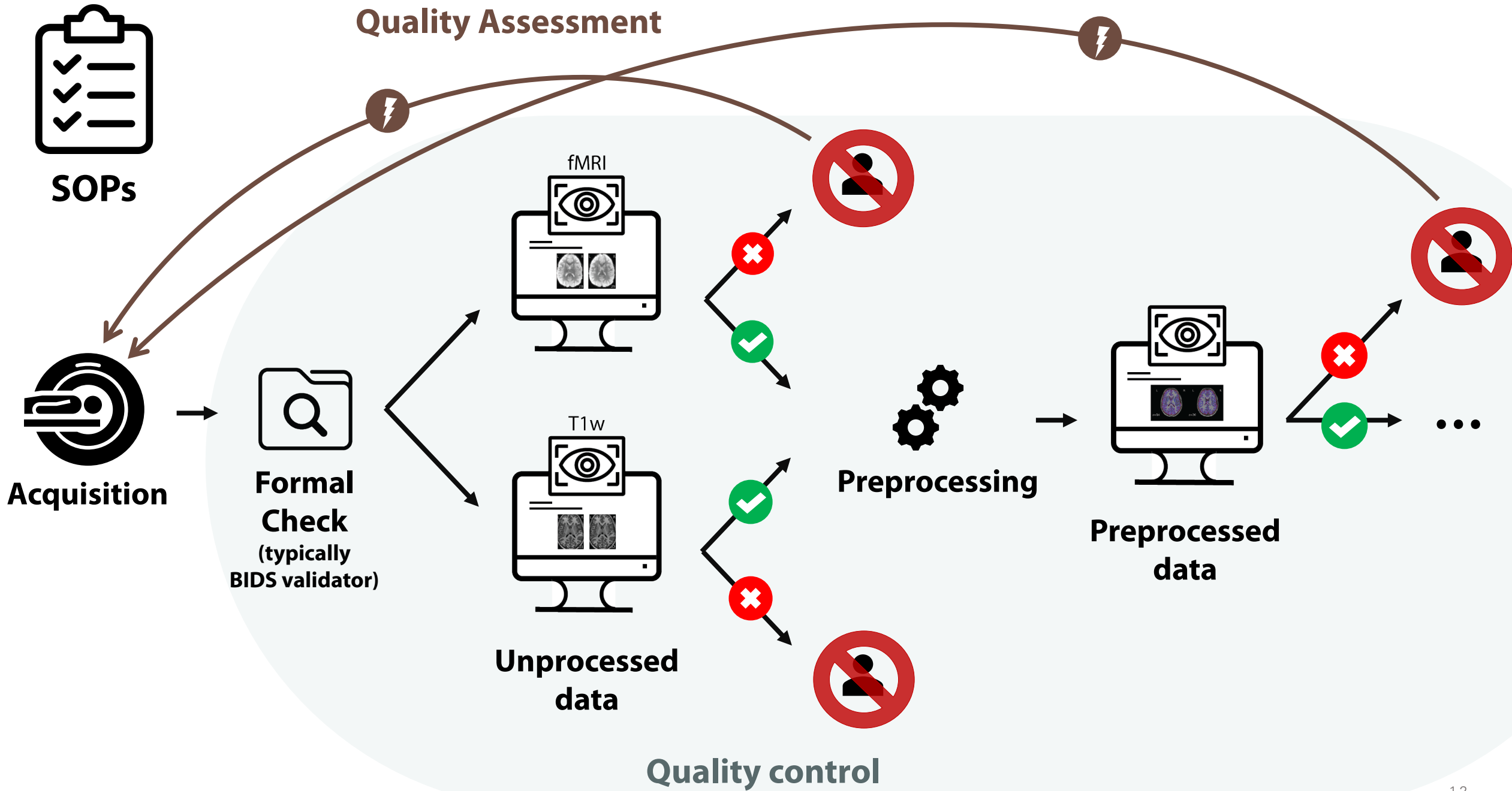
Summary

1. Artfactual structures in the background
2. Susceptibility distortion artifacts
 - a. Signal drop-out
 - b. Brain distortion
3. Aliasing ghosts
4. Wrap-around that overlaps with the brain
5. Structured crown region in the carpet plot
 - a. due to motion peaks
 - b. due to periodic motion
 - c. due to coil failure
 - d. drift of unknown source
6. Artifacts detected with independent components analysis
7. Hyperintensities of single slice
8. Vertical strikes in the sagittal plane of the standard deviation map
9. Data formatting issues

Details

1. **Artfactual structures in the background (A)**

Because no BOLD signal originates from the air surrounding the head, the background should not contain visible structures. However, signals sourcing from the object of interest can spill into the background through a number of imaging processes, e.g., aliasing ghosts, spill-over originating from moving and blinking eyes, or bulk head motion. Structures in the background are most clearly noticeable in MRIQC's "background noise panel" view, but they frequently are also detectable in the standard deviation map view. Structure in the background is not a problem in itself as it is situated outside of the brain: the issue is that the

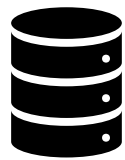




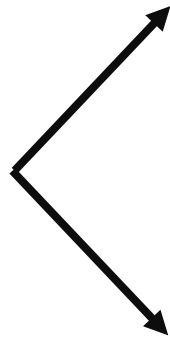
SOPs



Whole-brain,
voxel-wise analysis
of spatially standardized
resting-state BOLD fMRI



Data

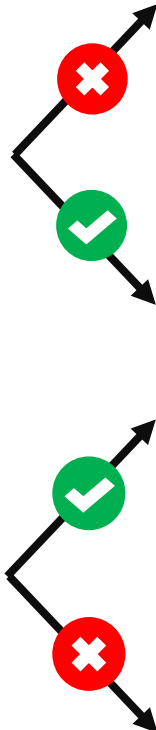


fMRI



T1w

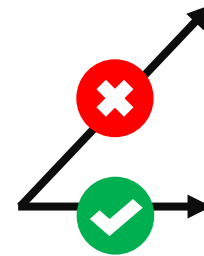
**Unprocessed
data**



Preprocessing



**Preprocessed
data**



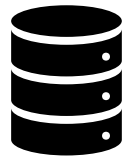
...



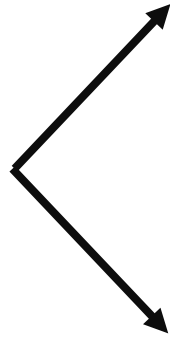
SOPs



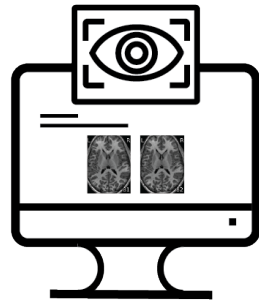
Whole-brain,
voxel-wise analysis
of spatially standardized
resting-state BOLD fMRI



Data

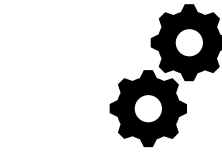
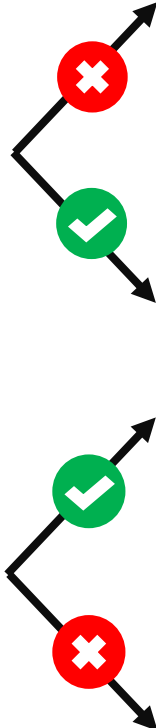


fMRI

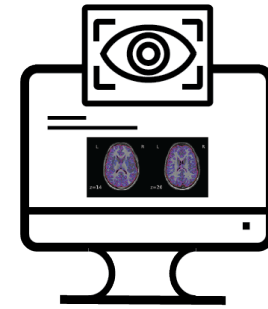


T1w

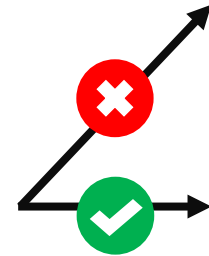
**Unprocessed
data**



Preprocessing



**Preprocessed
data**



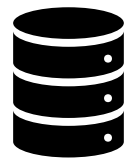
**Include
subject in
analysis**



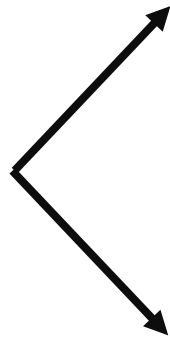
SOPs



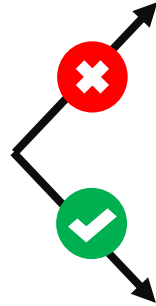
Whole-brain,
voxel-wise analysis
of spatially standardized
resting-state BOLD fMRI



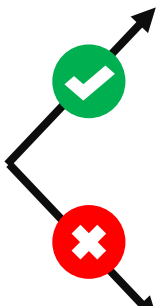
Data



fMRI



T1w



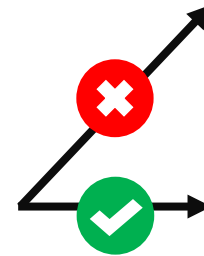
MRIQC



fMRIPrep



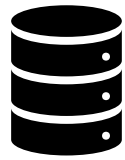
**Preprocessed
data**



**Include
subject in
analysis**



SOPs



Data

New!
MRIQC
supports
dMRI

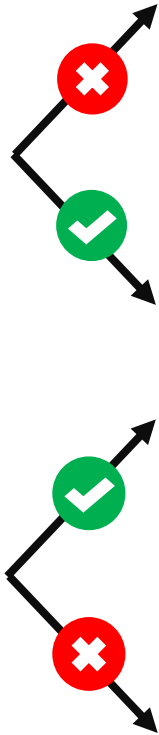


fMRI

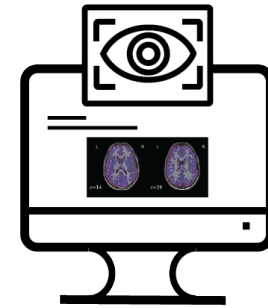


T1w

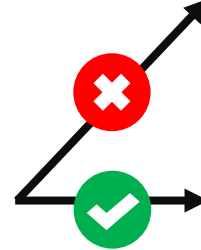
MRIQC



fMRIPrep



Preprocessed
data

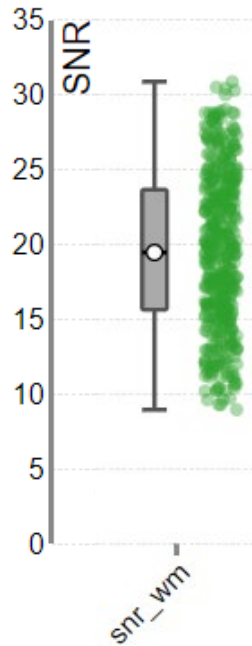


Include
subject in
analysis

MRIQC

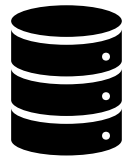


**Image quality
metrics (IQMs)**

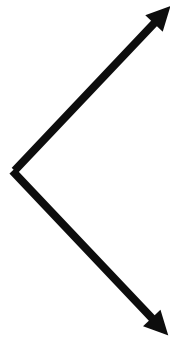




SOPs



Data



fMRI



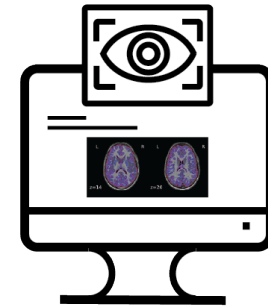
T1w



MRIQC



fMRIPrep



Preprocessed data

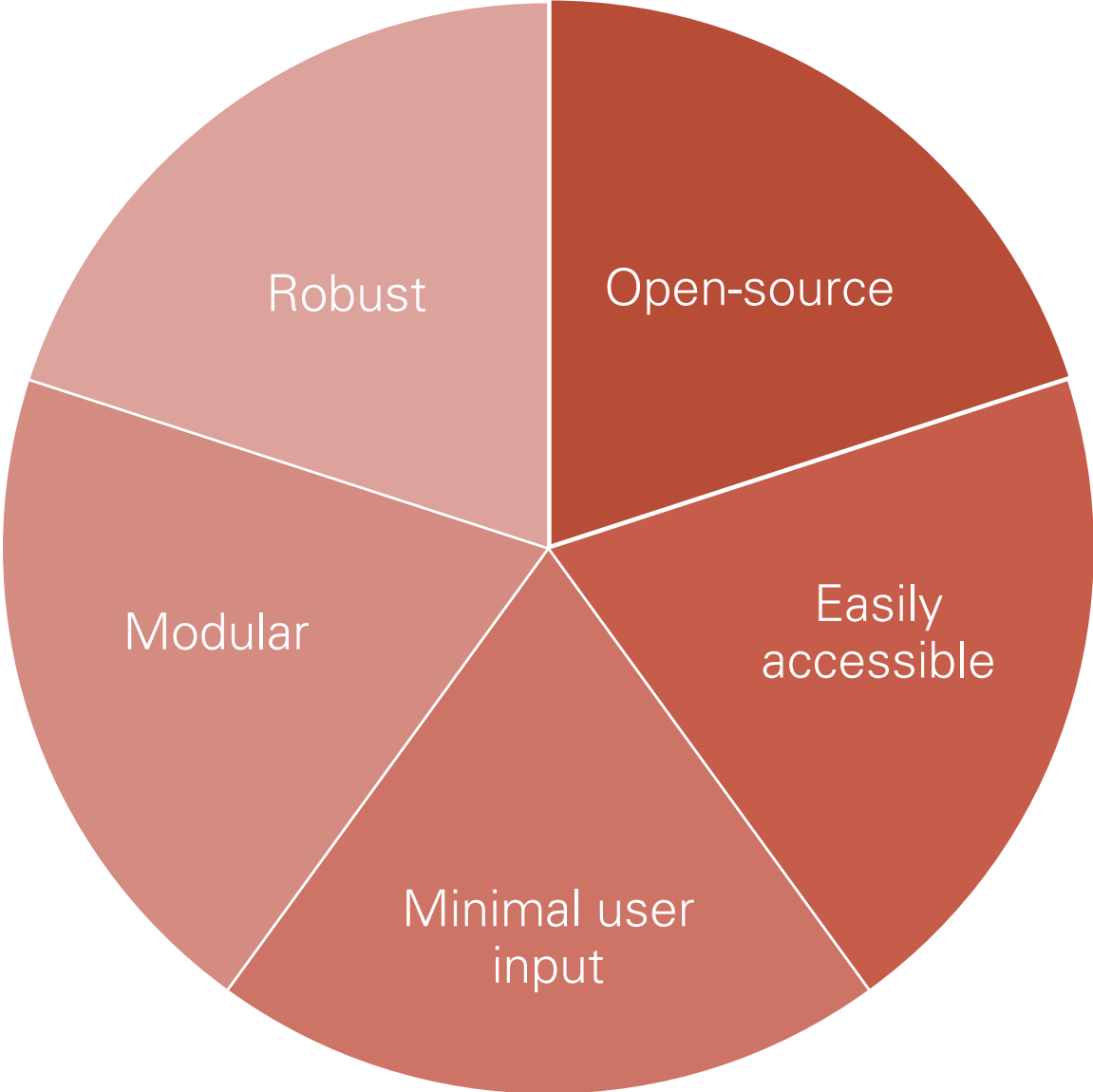


Include subject in analysis

MRIQC & fMRIPrep

Combination of tools from well-known software (AFNI, ANTs, ...)

MRIQC & fMRIPrep



Executing MRIQC and fMRIPrep

Thoroughly documented

- <https://www.nipreps.org/apps/framework/>
- Tools documentation

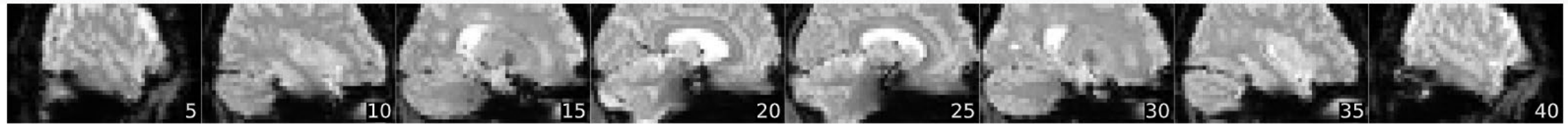


Examples

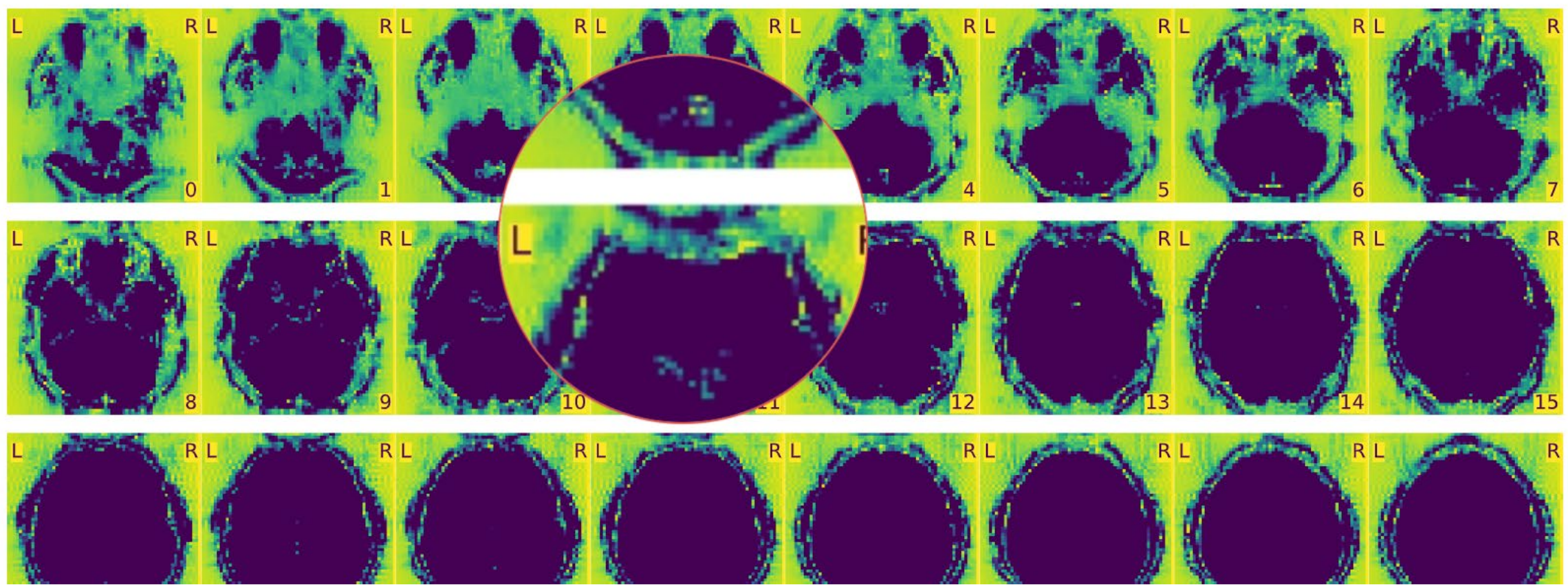
Research question

Summary Visual reports Other

Rating widget



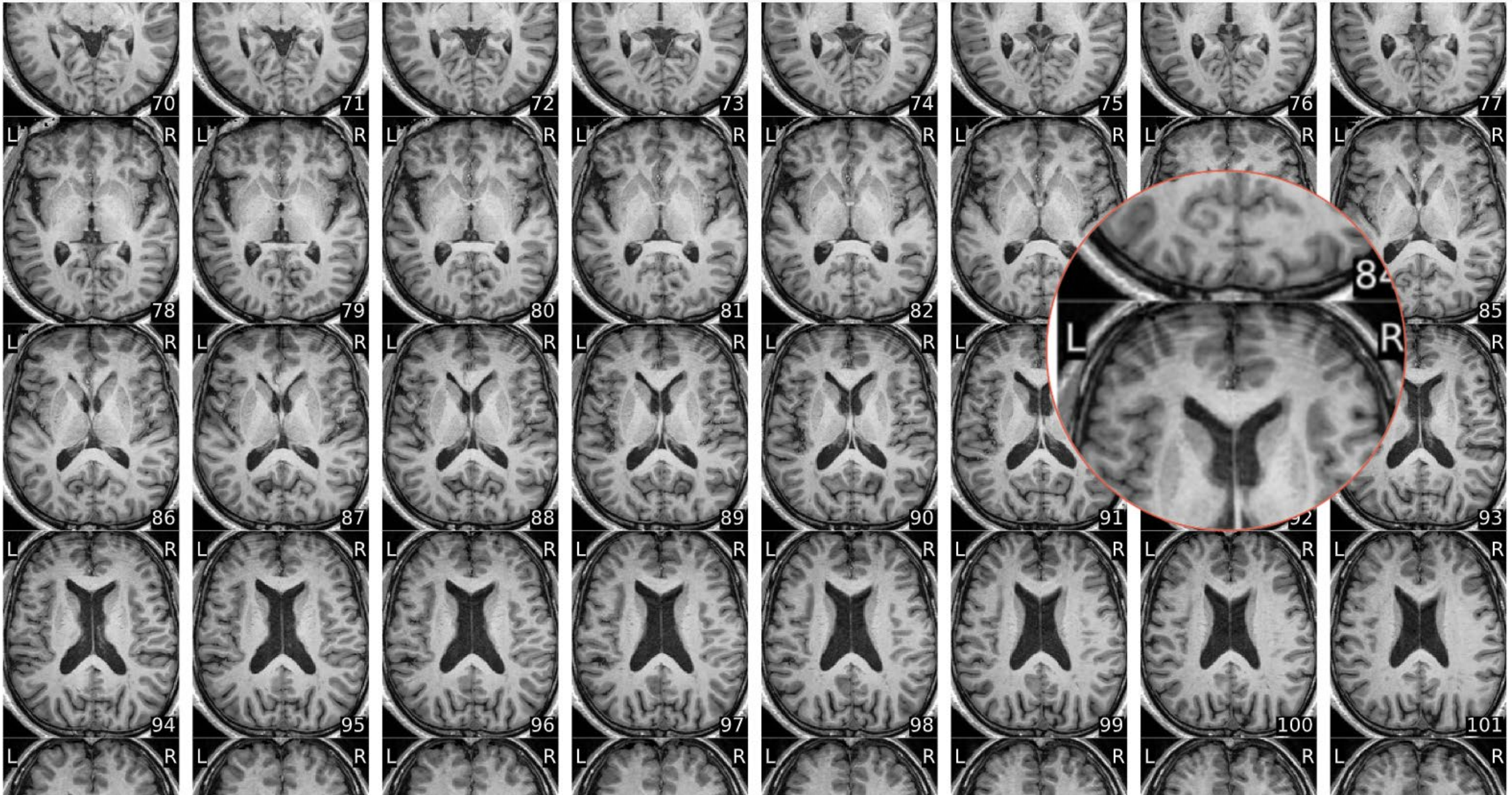
Background noise



Planned analysis

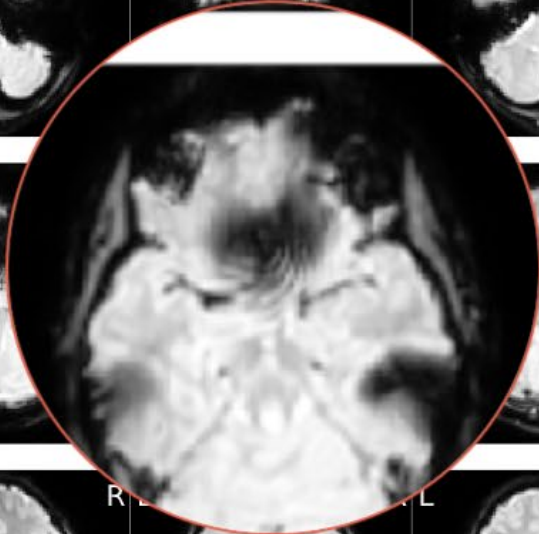
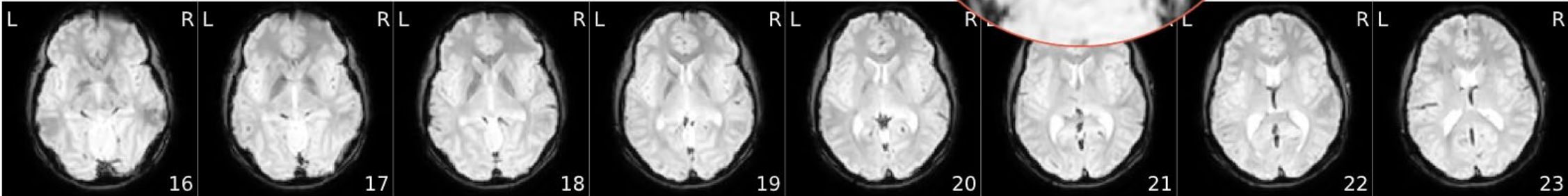
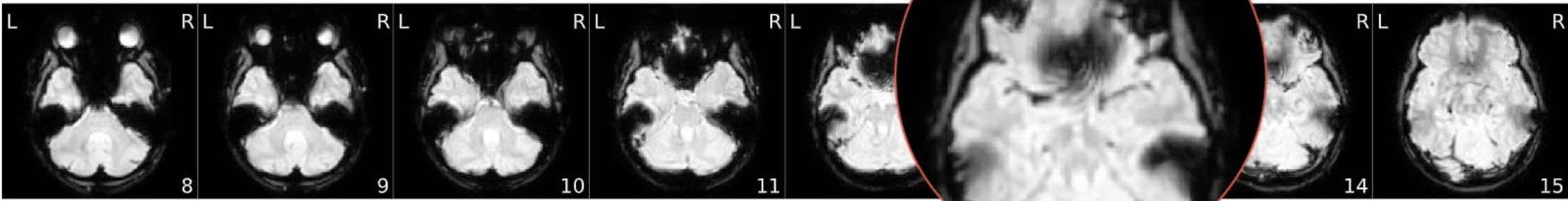
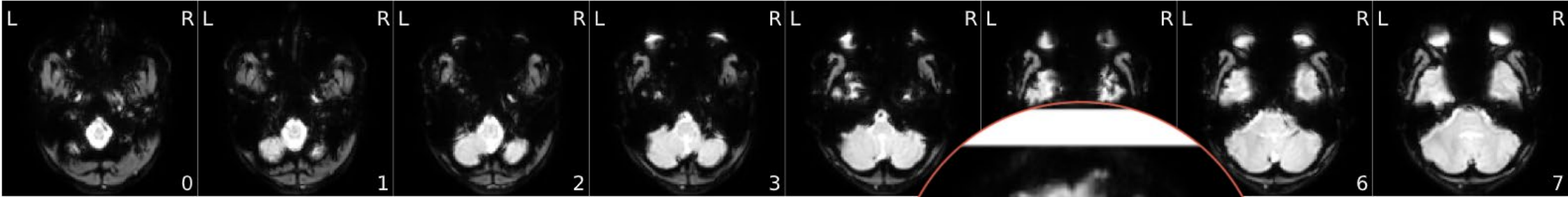
Summary Visual reports Other

Rating widget



Data available

BOLD average



Set up several QC checkpoints

More in our paper

METHODS article

Front. Neuroimaging, 12 January 2023

Sec. Brain Imaging Methods

Volume 1 - 2022 | <https://doi.org/10.3389/fnimg.2022.1073734>

This article is part of the Research Topic

Demonstrating Quality Control (QC) Procedures in fMR

[View all 11 Articles >](#)

Quality control in functional MRI studies with MRIQC and fMRIPrep



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Patric Hagmann¹ and

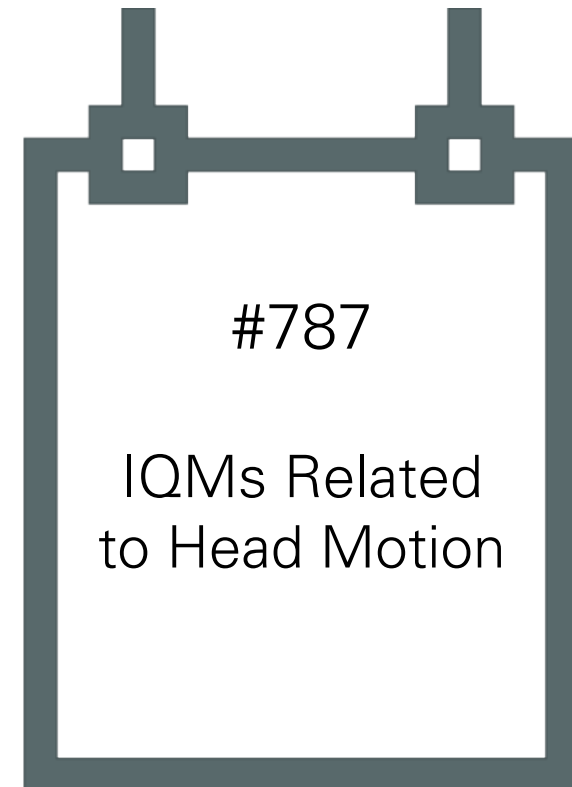


Oscar Esteban^{1*}

Tuesday, July 25 | 12:45 PM – 2:45 PM
Wednesday, July 26 | 12:45 PM – 2:45 PM

Sunday, July 23 | 12:15 PM – 2:15 PM
Monday, July 24 | 1:00 PM – 3:00 PM

Posters



Thank you for your attention!

Questions?



Our paper



MRIQC-SOPs



QC book



Poster #2467
Q'kay
Manual ratings
manager



Poster #834
Wavelet
transform
for QC



Poster #787
IQMs
interpretation

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