Lessons from the FMRI Open QC Project: Improving and Sharing Data Assessment Tools

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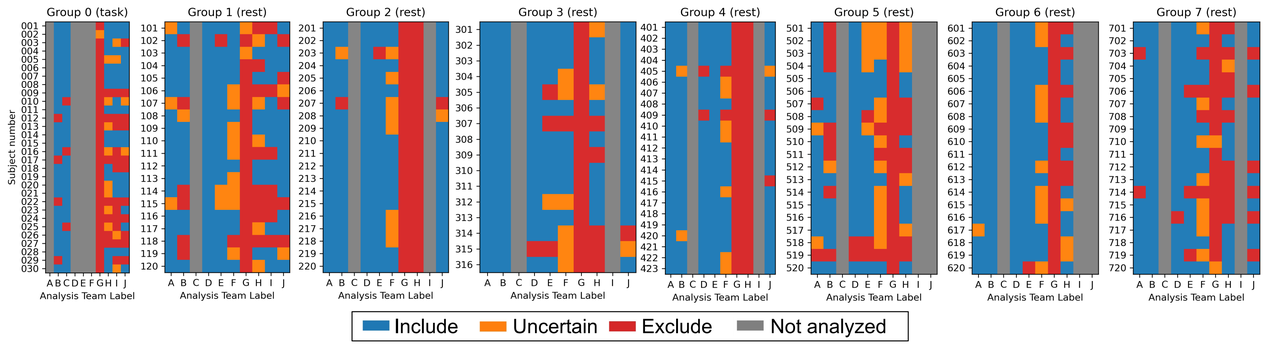
The Project: Demonstrating Quality Control (QC) Procedures in fMRI

Organized by Paul Taylor, Jo Etzel, Daniel Glen and Rick Reynolds

Quality control (QC) has long been an important part of FMRI processing, but it is typically underreported and too often underappreciated, whether for small or large, public or local datasets. This project aims to showcase examples of QC practices across institutions and to foster discussions within the field.

Everyone in the field was invited to participate and perform their own QC protocol on provided FMRI data from real, common repositories. Each would created QC tutorial papers, detailing their steps and criteria (with examples).

What Were the Teams' Evaluations? Many Excluded >=25%



Why Was the Project Setup?

1. **To promote the broader adoption of quality control practices in FMRI.** Many packages contain QC tools/protocols. Here, AFNI, CONN, DPARSF, fMRIprep, MRIQC, pyfMRIqc, SPM and more were used. Check 'em out!
2. **To facilitate the inclusion of more details in QC protocol descriptions.** Each Team contributed a detailed list of QC criteria, plus examples.
3. **To share QC criteria across researchers and developers.** Increase clarity and potentially broaden the homogeneity of QC methods.
4. **To promote QC as more than "just" vetting datasets; rather as deeply understanding the contents of the collection and analysis as a whole.** Have greater confidence in results. (Maybe even improve reproducibility?)

Common QC Themes Across the Teams

Each team found many subjects to exclude based on data quality (and many more "uncertain"). Many teams excluded >=25% of subjects the collections.

Nearly all protocols checked raw data consistency and metadata, and each team identified consistency, reliability or mismatch errors within datasets.

Each protocol used qualitative measures; most also used quantitative ones.

QC parameters were often tied with specific study goals and assumptions; purpose matters for evaluating data.

Each team made both their processing and QC pipelines publicly available, as well as their papers describing examples in detail.

Who Participated? 10 Teams from Across the Community

Quality control procedures and metrics for resting-state functional MRI
Rasmus M. Birn[1,2]*

Quality control in resting-state fMRI: the benefits of visual inspection
Rebecca J. Lepping[1,2]*, Hung-Wen Yeh[3,4], Brent C. McPherson[5], Morgan G. Brucks[2,6], Mohammad Sabati[2,7], Rainer T. Karcher[2], William M. Brooks[1,2], Joshua D. Habiger[8], Vlad B. Papa[2] and Laura E. Martin[2,6]

Quality control in functional MRI studies with MRIQC and fMRIPrep
Céline Provins[1]*, Eilidh MacNicol[2], Saren H. Seeley[3], Patric Hagmann[1] and Oscar Esteban[1]*

A functional MRI pre-processing and quality control protocol based on statistical parametric mapping (SPM) and MATLAB
Xin Di* and Bharat B. Biswal*

Efficient evaluation of the Open QC task fMRI dataset
Joset A. Etzel*

Demonstrating quality control procedures for fMRI in DPABI
Bin Lu[1,2]* and Chao-Gan Yan[1,2,3,4]*

Quality control practices in FMRI analysis: Philosophy, methods and examples using AFNI
Richard C. Reynolds*, Paul A. Taylor and Daniel R. Glen

Functional connectivity MRI quality control procedures in CONN
Francesca Morfini[1], Susan Whitfield-Gabrieli[1,2,3] and Alfonso Nieto-Castañón[4,5]*

The art and science of using quality control to understand and improve fMRI data
Joshua B. Teves[1], Javier Gonzalez-Castillo[1], Micah Holness[1], Megan Spurney[1], Peter A. Bandettini[1,2] and Daniel A. Handwerker[1]*

Inter-rater reliability of functional MRI data quality control assessments: A standardised protocol and practical guide using pyfMRIqc
Brendan Williams[1,2]*, Nicholas Hedger[1,2†], Carolyn B. McNabb[3†], Gabriella M. K. Rossetti[1,2†] and Anastasia Christakou[1,2]

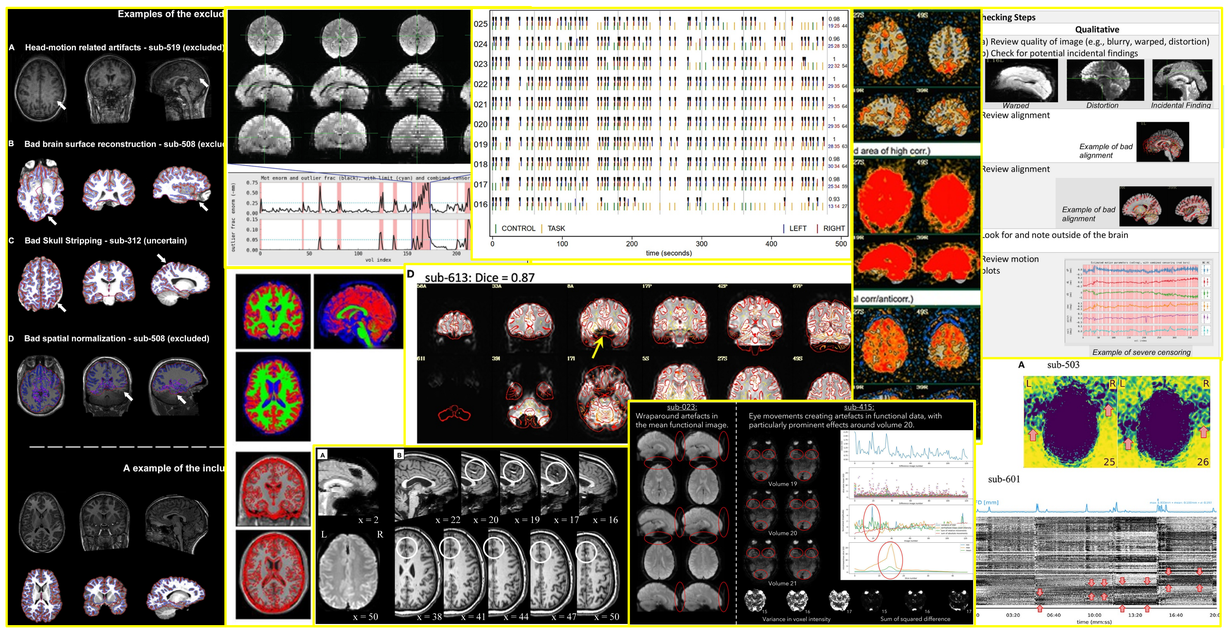
Lessons for FMRI, Low-field MRI and Other Areas of Neuroimaging

FMRI is over 30 years old, yet this Project showed how much the field's QC practice still needs to be improved. It also took a large step to aid in that.

Other areas of imaging, such as low-field MRI, can benefit from these lessons:

- **Have open data.** For example, not much low-field MRI is easily available.
- **Share expertise** and build educational resources with organized community participation. Include data visualization as a fundamental basis.
- **Focus on understanding data properties**, and use feedback to improve acquisition. This will reduce data waste, improve data quality and facilitate applications, helping researchers, clinicians and those scanned.

Participating Teams: QC Example Images



Conclusions

All MRI—in every continent, country and lab—benefits from increased awareness and practice of QC methods. Ignoring QC leads to information waste and reduced clinical outcomes. Developing open resources for QC evaluation and education should be a shared project among all stakeholders.

When designing new approaches for acquiring and analyzing MRI, such as to increase its accessibility with low-field strengths or other innovations, having a detailed understanding of the data and their properties is key. This is the ultimate goal for quality control practices.

Acknowledgment & Useful Links

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- the reviewers and guest editors, for their useful feedback for the work.
- the researchers who share the public data collections

Links for the FMRI Open QC Project
- Description and details
- Participating teams' article collection
- The data collections used
- Editorial (overview, summary and notes)