Adapting the MRIQC structural workflow for estimation of FLAIR scan quality

We have developed a modified version of the MRIQC workflow for FLAIR scans and validated it across multiple sites and head-motion degraded scans

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Background

MRIQC is a widely used tool to generate **automated assessments of MRI scan quality**; however its structural workflow does not include FLAIR scans

FLAIR-specific challenges:

- Low signal-to-noise (SNR) due to CSF suppression
- White-matter (WM) hyperintensities

This work **adapted the MRIQC tool** for assessment of 3D isotropic **FLAIR** scans

Methods

Iteratively modified the MRIQC workflow to process FLAIR scans from the Australia Epilepsy Project (AEP) and OpenNeuro ds004332 dataset.

Dataset	N	Age	Multi-site
AEP	272	37y (18-67y)	Yes (235/25/7/3/2)
ds004332	29	23.5y (19-36y)	No

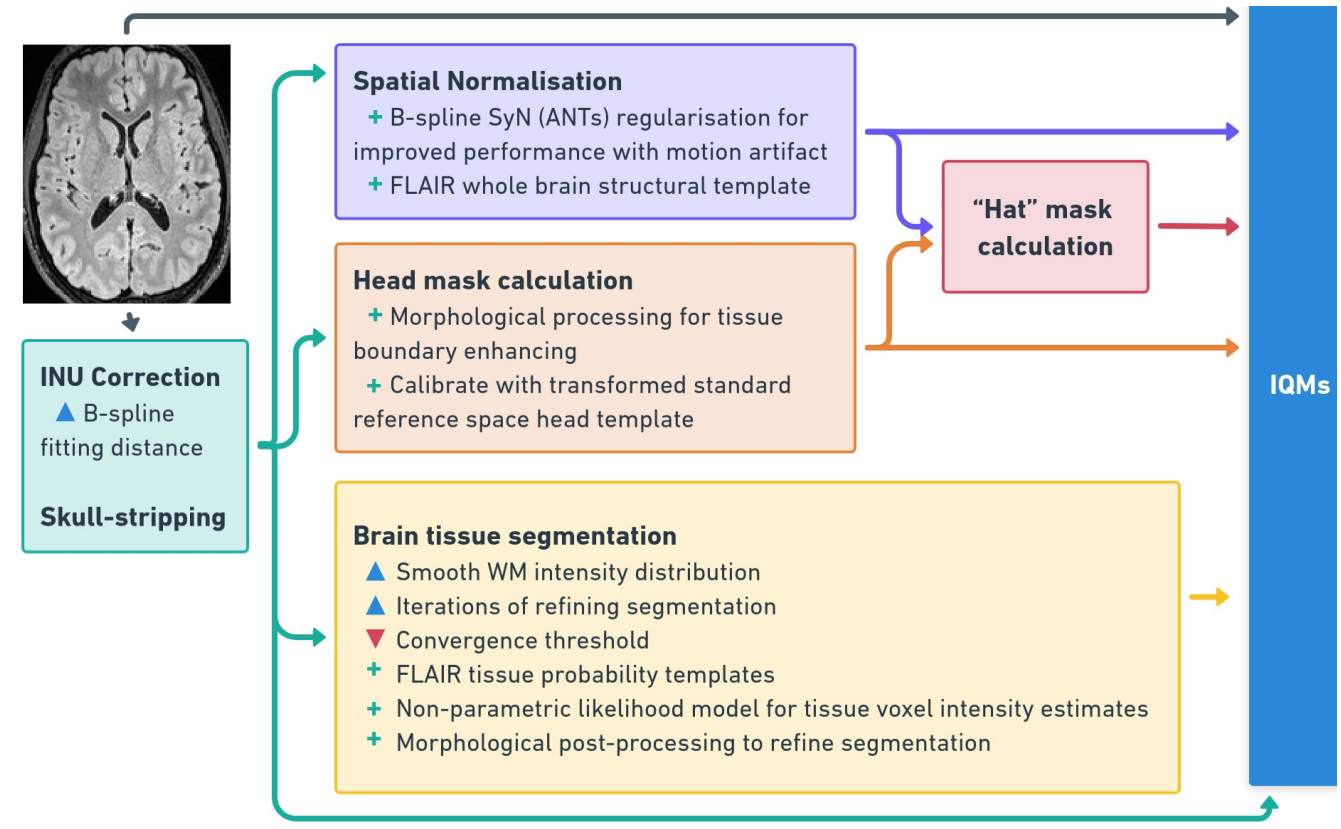
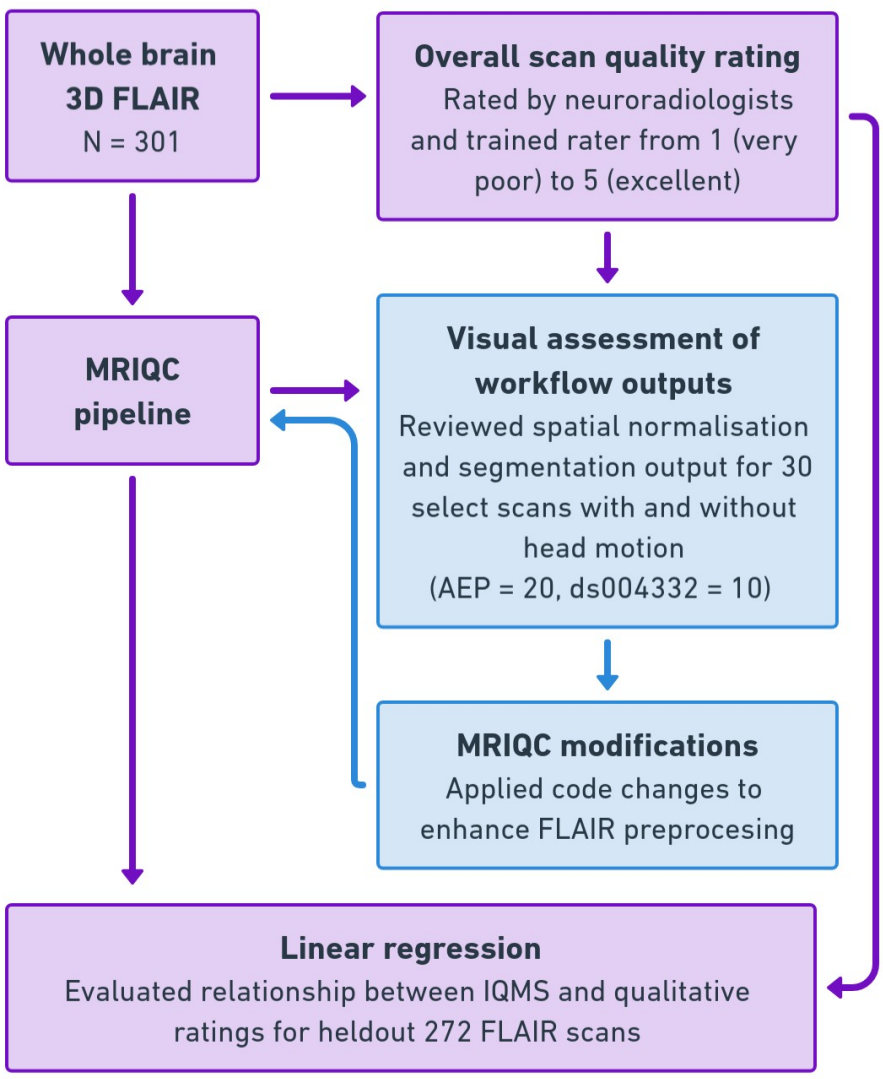


Figure 1: Adapted MRIQC structural workflow for FLAIR scans. Modifications to the workflow are embedded within preexisting processing modules. Changes: ▲= increase, ▼ = decrease, + = addition.



To evaluate our FLAIR pipeline, the relationship between expert neuroradiological ratings and output image quality metrics (IQMs) was assessed with linear regression.

Finally, we compared these relationships with the same analyses applied to output from T1w scans from the unmodified MRIQC pipeline.

Results

Three changes significantly improved overall preprocessing for FLAIR:

1. Spatial transforms using FLAIR templates in MNI space
2. Registration with ANTs B-spline symmetric normalisation (SyN) algorithm showed significant improvements for motion-affected FLAIR scans relative to default SyN
3. Tissue segmentation with a nonparametric likelihood model

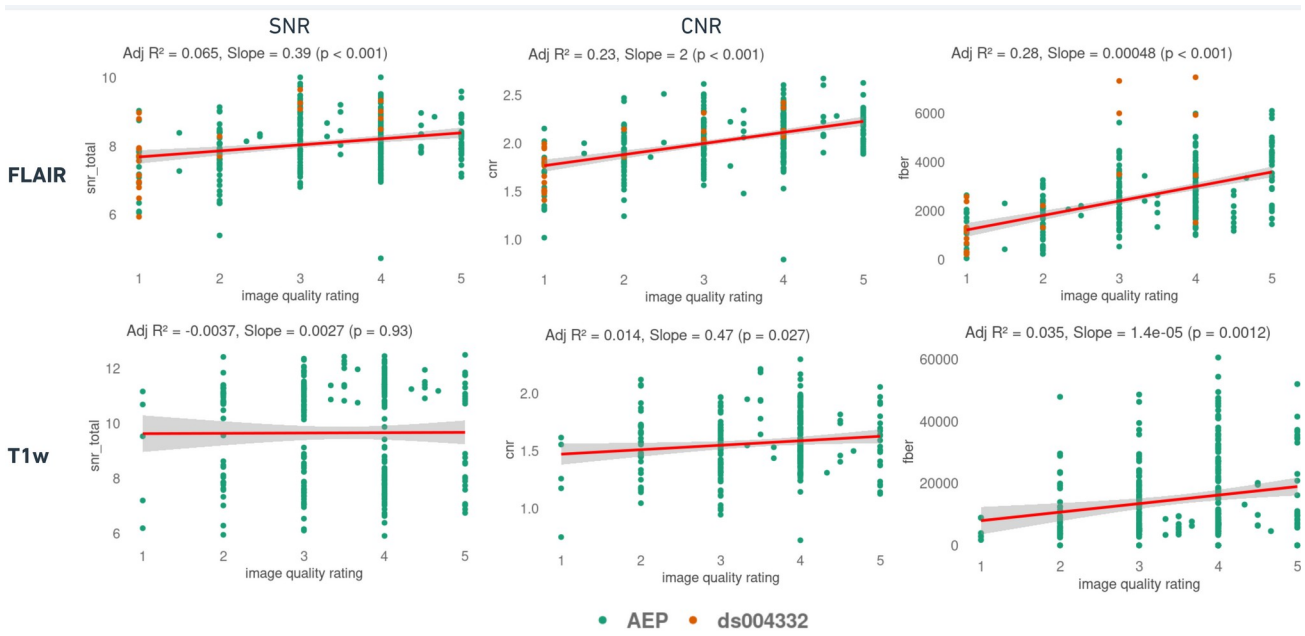


Figure 2: Comparisons of overall scan quality ratings against selected IQMs (snr_total, cnr and fber) for T1w and FLAIR scans.

- Many more IQMs correlated with visual ratings for FLAIR (N = 44) compared to T1 (N = 18)
- FLAIR and T1w IQMs were consistent with each other. Same direction for 13/15 IQMs with statistically significant associations for both modalities
- Mean adjusted R^2 higher for FLAIR (0.2) than T1w (0.04)

Conclusions

- Modified MRIQC workflow to estimate image quality metrics for 3D isotropic FLAIR
- Validated relationship between FLAIR IQMS from multisite, motion-affected and motion-free scans against neuroradiologist visual image quality ratings
- Predominantly developed with standardised Australian Epilepsy Project data meaning more multisite data required to validate performance

References

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