Effects of Defacing Whole Head MRI on Neuroanalysis

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Introduction

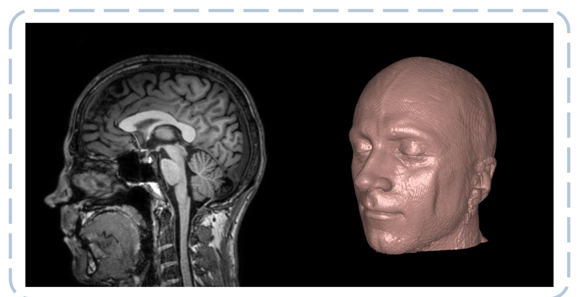
BACKGROUND

Recent advances in magnetic resonance (MR) scanner quality and the rapidly improving nature of facial recognition software have necessitated the introduction of MR defacing algorithms to protect patient privacy. As a result, there are a number of MR defacing algorithms available to the neuroimaging community, with several appearing in just the last five years. These various approaches have qualities that have been explored with respect to skull stripping masks or identifiability of the patient in previous works. However, to our knowledge there has been no evaluation of the subsequent impact of these defacing algorithms on a neuroimaging pipeline.

OUR WORK

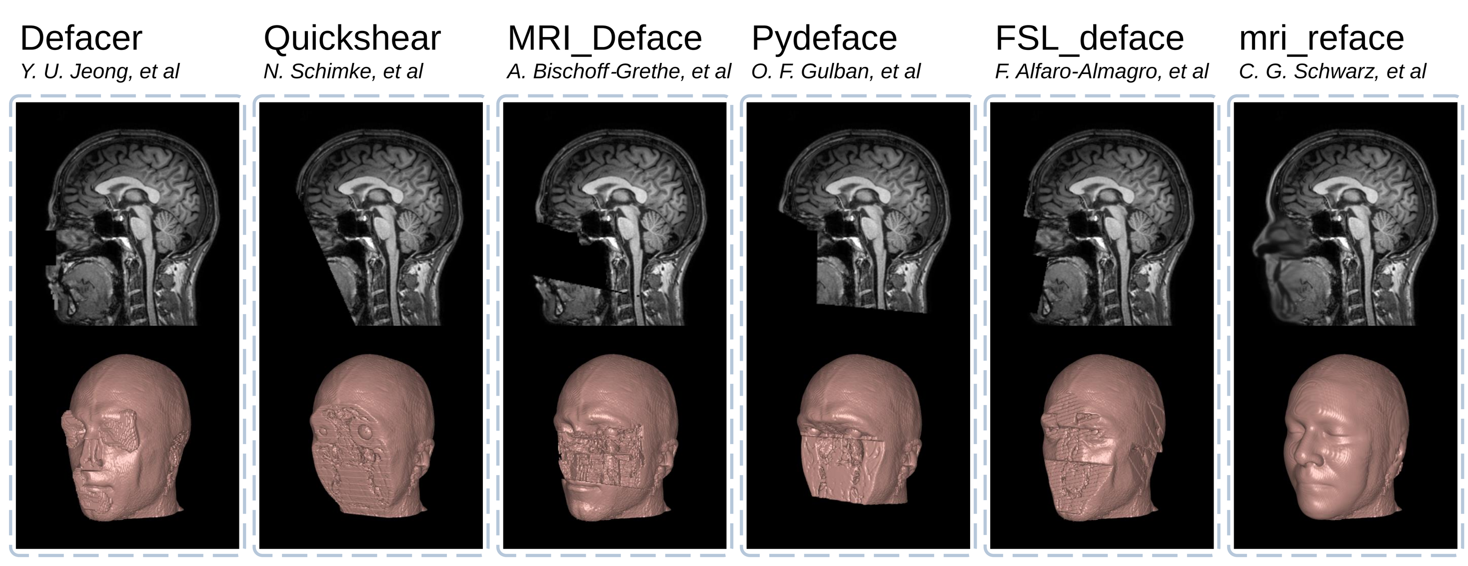
We use six MR defacing algorithms on 179 subjects from the OASIS-3 cohort and 21 subjects from the Kirby 21 dataset, then apply a neuroimaging pipeline to the resultant defaced images. We compare the consistency of the output from the pipeline using the defaced images with the output of the same pipeline without defacing the MR data.

Methods & Datasets



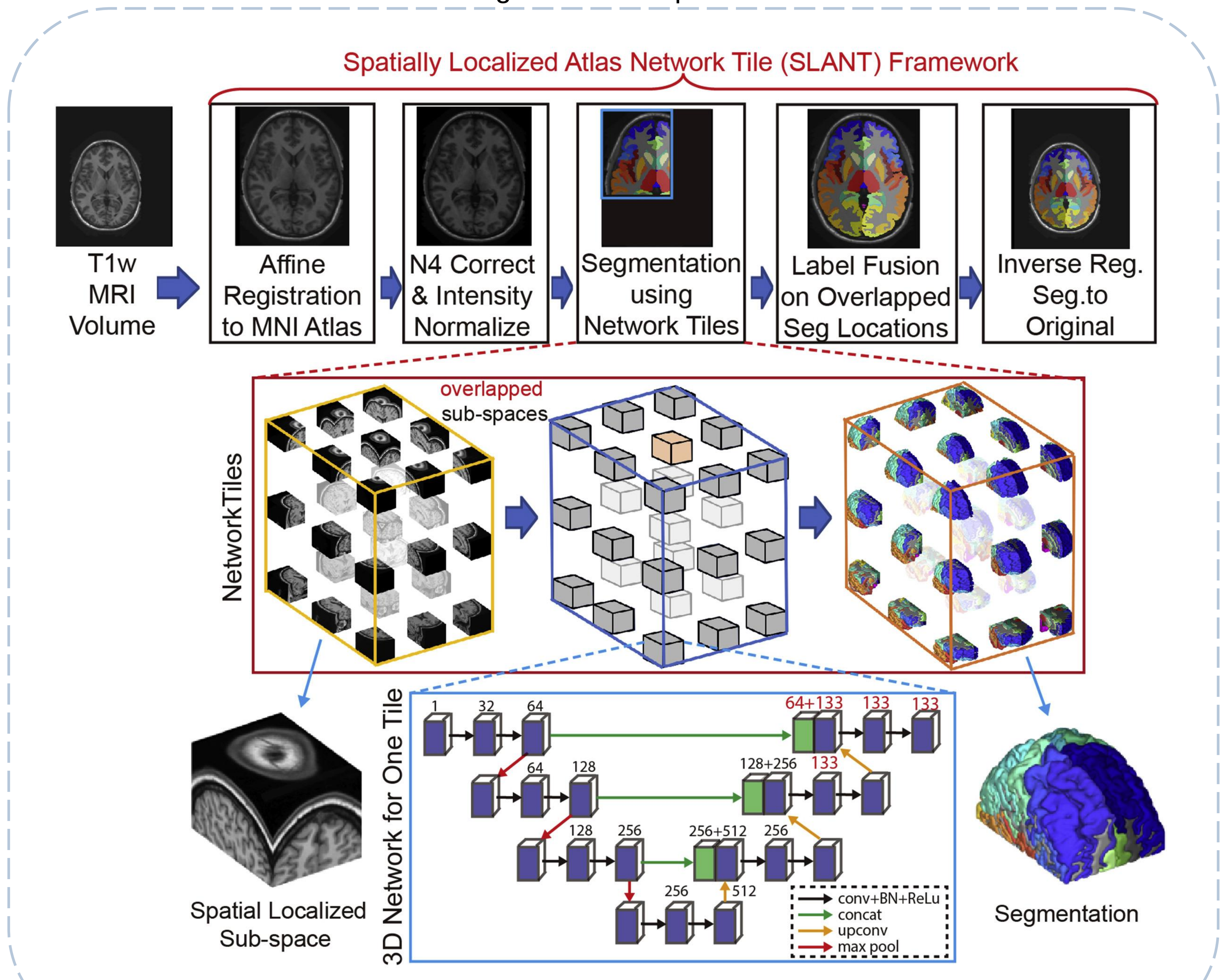
Original MRI
OASIS-3 or Kirby 21 Dataset

Defacing



Segmentation

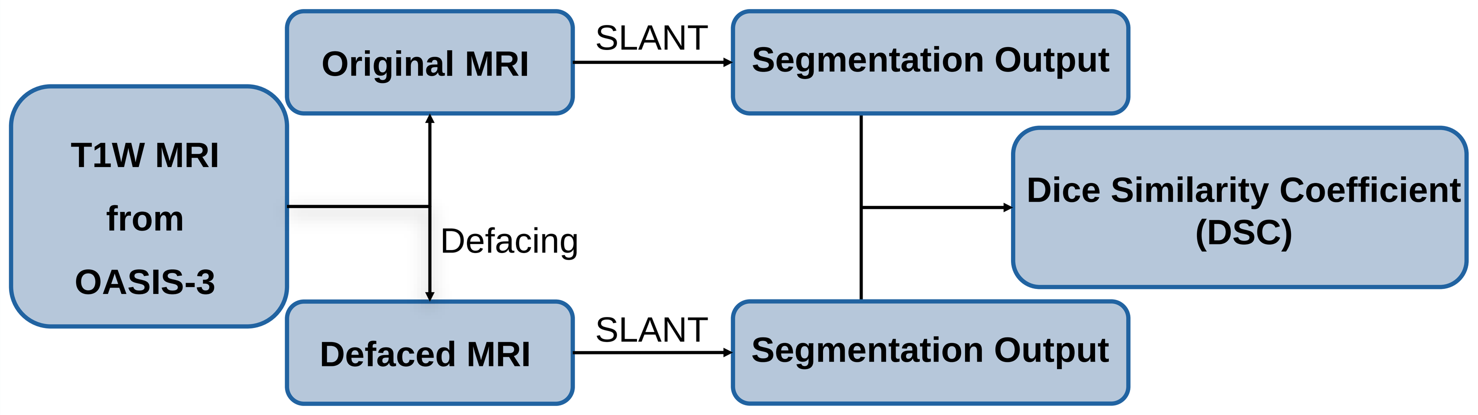
Brain Segmentation Pipeline: SLANT

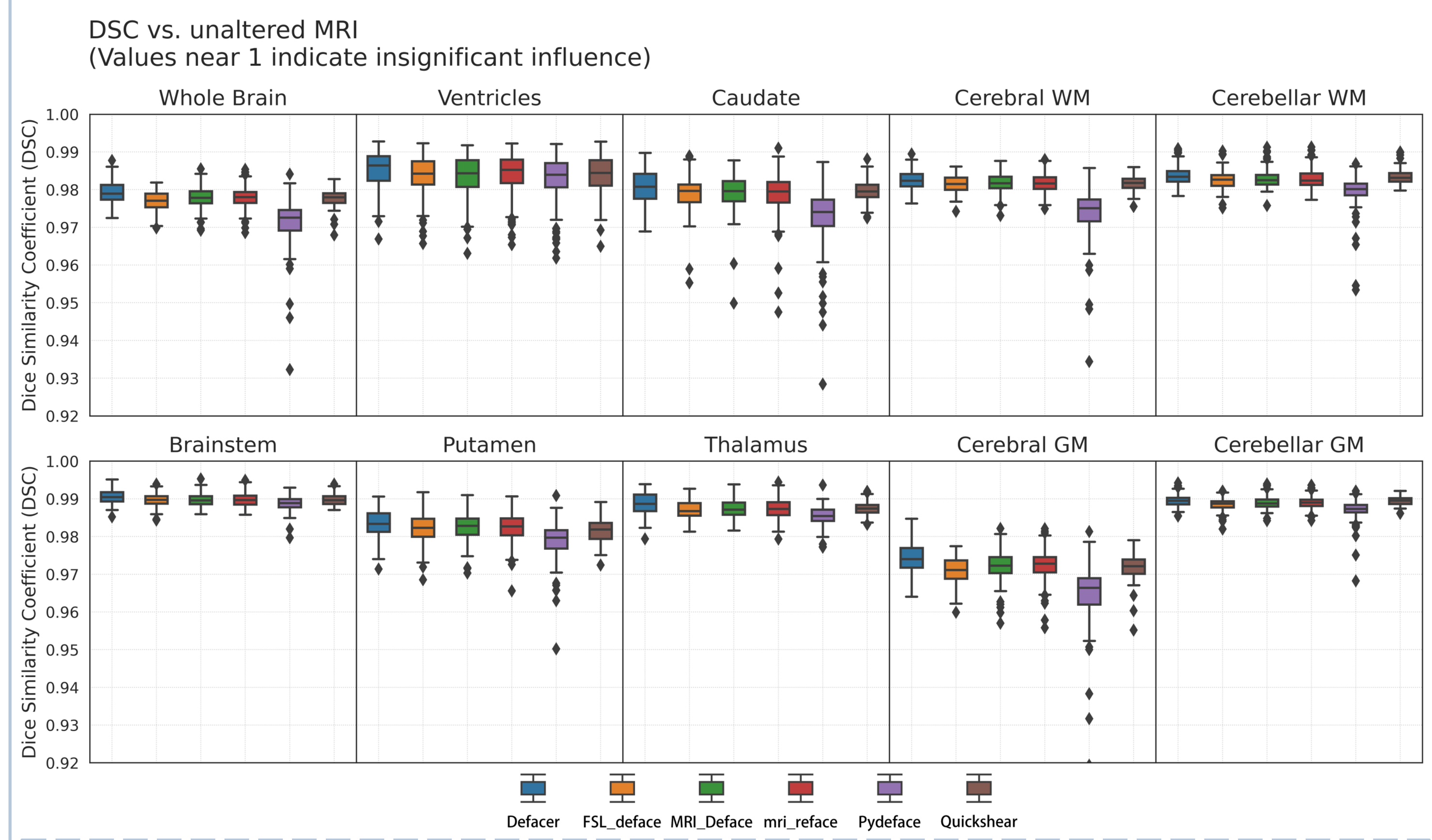


Huo, Yuankai, et al. "3D whole brain segmentation using spatially localized atlas network tiles." NeuroImage 194 (2019): 105-119.

Experiments & Results

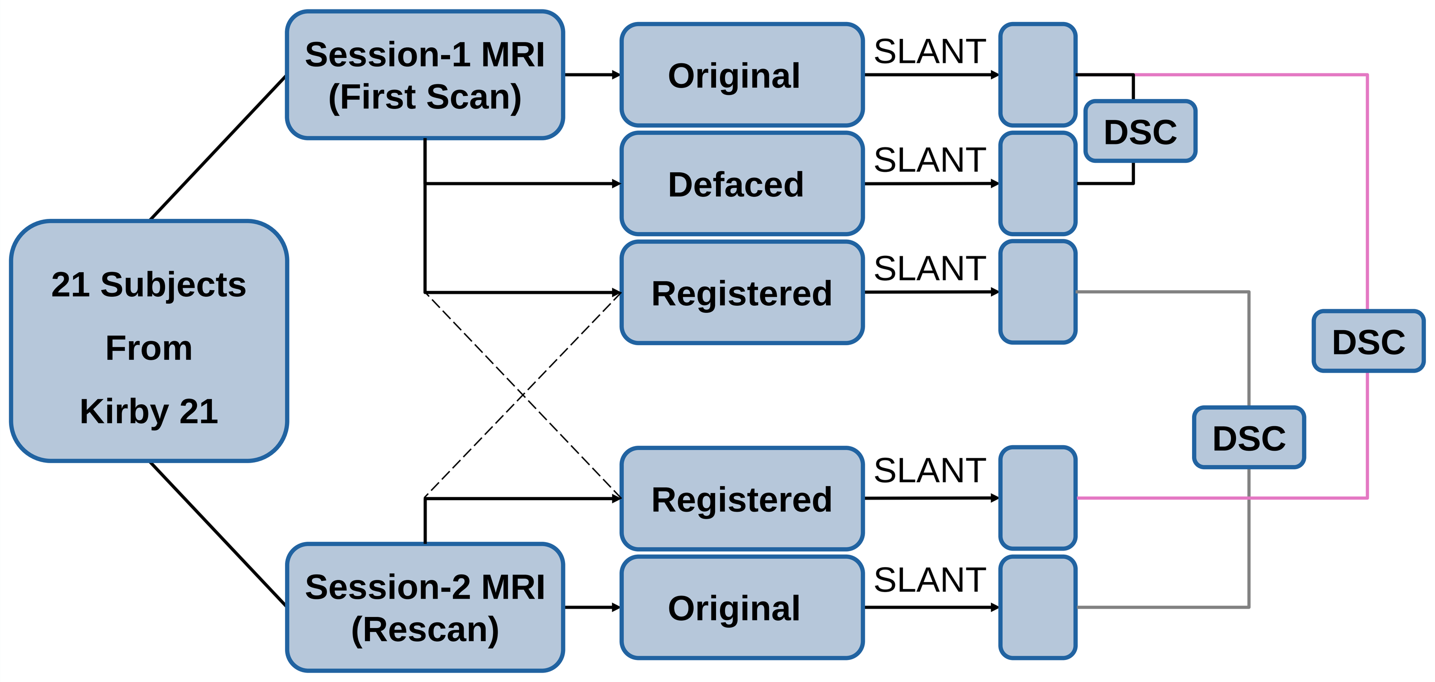
Experiment-1: Quantify the Effects of Defacing

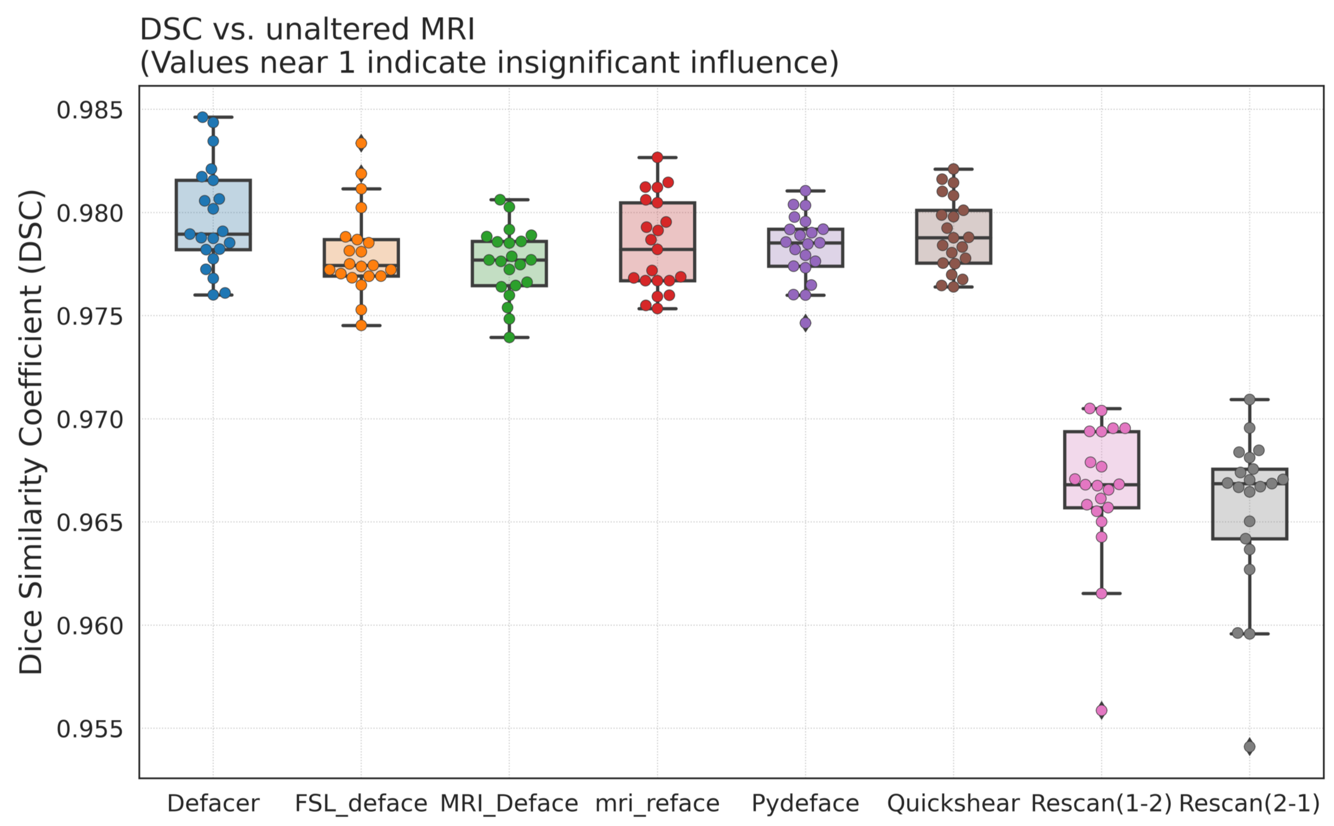




- For most of the regions of interest (ROIs), all six algorithms can achieve dice similarity coefficient (DSC) of over 0.96, but there are discernible differences among them, and such differences are fairly consistent in all ROIs.
- All defacing algorithms tend to influence the cerebral gray matter more than other regions

Experiment-2: Compare Defacing with Scan-Rescan

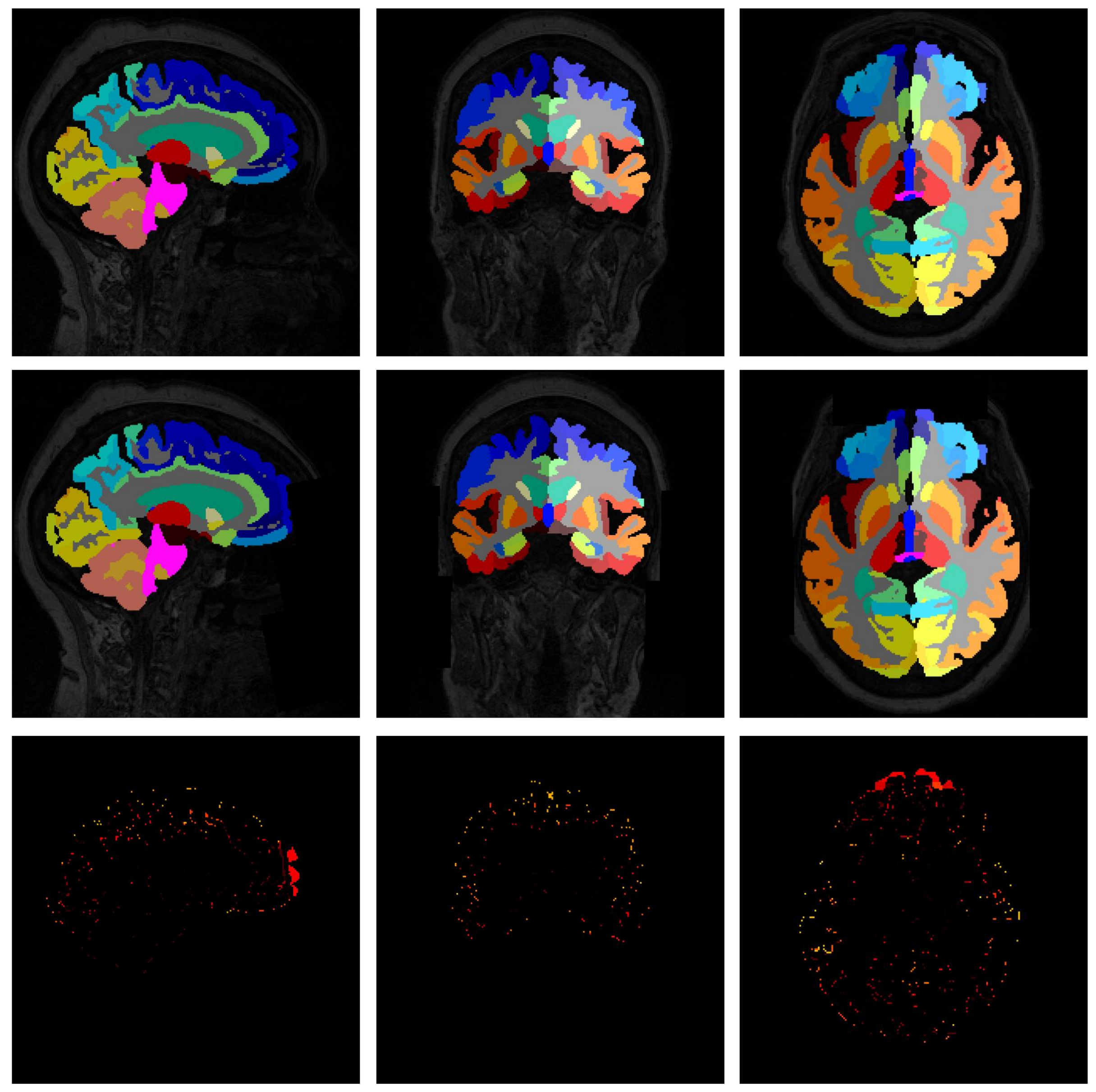




- The results seem to indicate that the effects of defacing are minor compared to the effects of rescanning a patient and then registering that scan to the previous scan.

Algorithm	Total	Success	Failure I	Failure II
Defacer	179	163	16	0
FSL_deface	179	142	0	37
MRI_Deface	179	136	7	36
mri_reface	179	179	0	0
Pydeface	179	179	0	0
Quickshear	179	78	0	101

Quality check of the outputs from each defacing algorithm



Example of Failure II: voxels of the frontal lobe are damaged due to excessive defacing

Discussion & Conclusion

- Many of the defacing algorithms have unstable performance, which is detrimental to the consistency of neuroanalysis. In extreme cases, part of the brain can be removed due to excessive defacing.
- Defacing has a detrimental influence on brain segmentation. This influence varies from subject to subject and from ROI to ROI.
- Despite the fact that such influence is minor compared to rescanning and registration, it still requires future work to determine whether the effects of defacing can be neglected.

References

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(See paper for complete references)

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