Comparison of Normalisation Techniques for fMRI Preprocessing: *SPM, DARTEL, and CAT12*

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INTRODUCTION

Normalisation is one of the most important preprocessing steps to complete during fMRI analysis. In this stage the objective is to transform data to a standardised anatomical reference space template (Brett et al., 2002).

The current study aimed to examine preprocessing normalisation techniques:

- ➔ **SPM** - Statistical Parametric Mapping
- ➔ **DARTEL** - Diffeomorphic Anatomical Registration using Exponentiated Lie algebra
- ➔ **CAT12** - Computational Anatomy Toolbox

They were assessed via comparative analysis techniques and rated according to their: **efficiency, optimisation**, and **usability.**

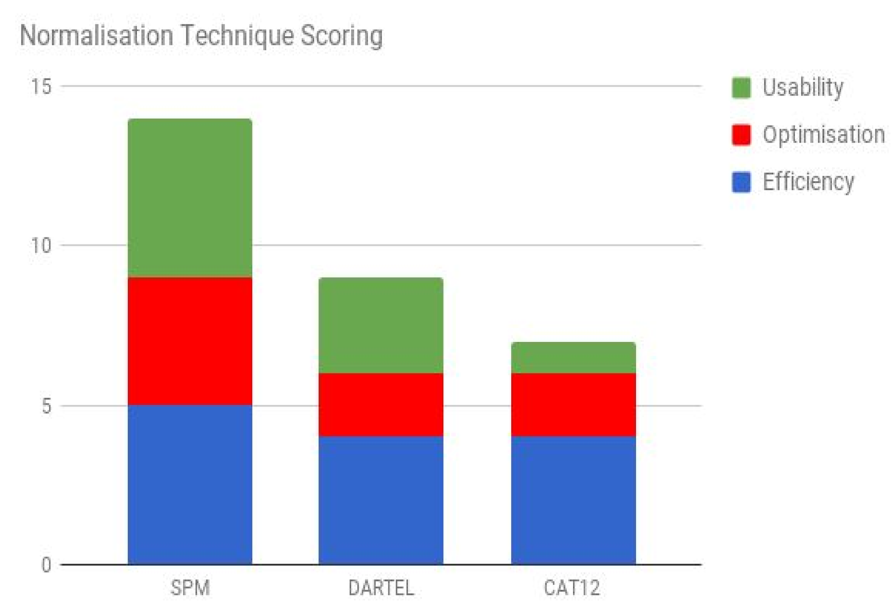
METHODS

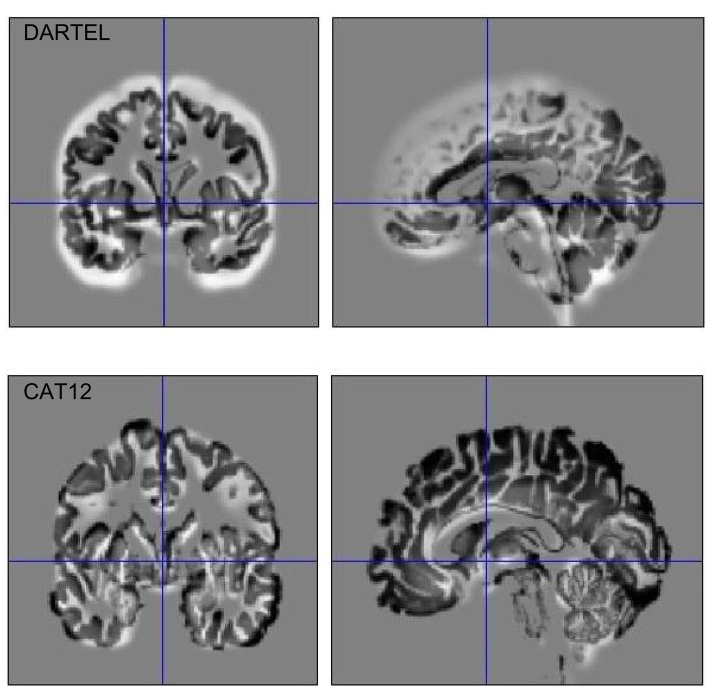
Image Acquisition: Collected from a study of time & distance estimation.
Procedure: 3 identical copies of data were generated and each had the different predefined pipelines applied to them.
Set Origin: A script was incorporated into MATLAB to automatically set the origin of each image to the Anterior Commissure to a high precision this was one of the most successful elements of the experiment.

Toolboxes: For **SPM, DARTEL,** and **CAT12**, MATLAB required additional toolboxes to be installed, Furthermore, a fMRI quality assurance toolbox was installed with various scripts for analysis.

RESULTS

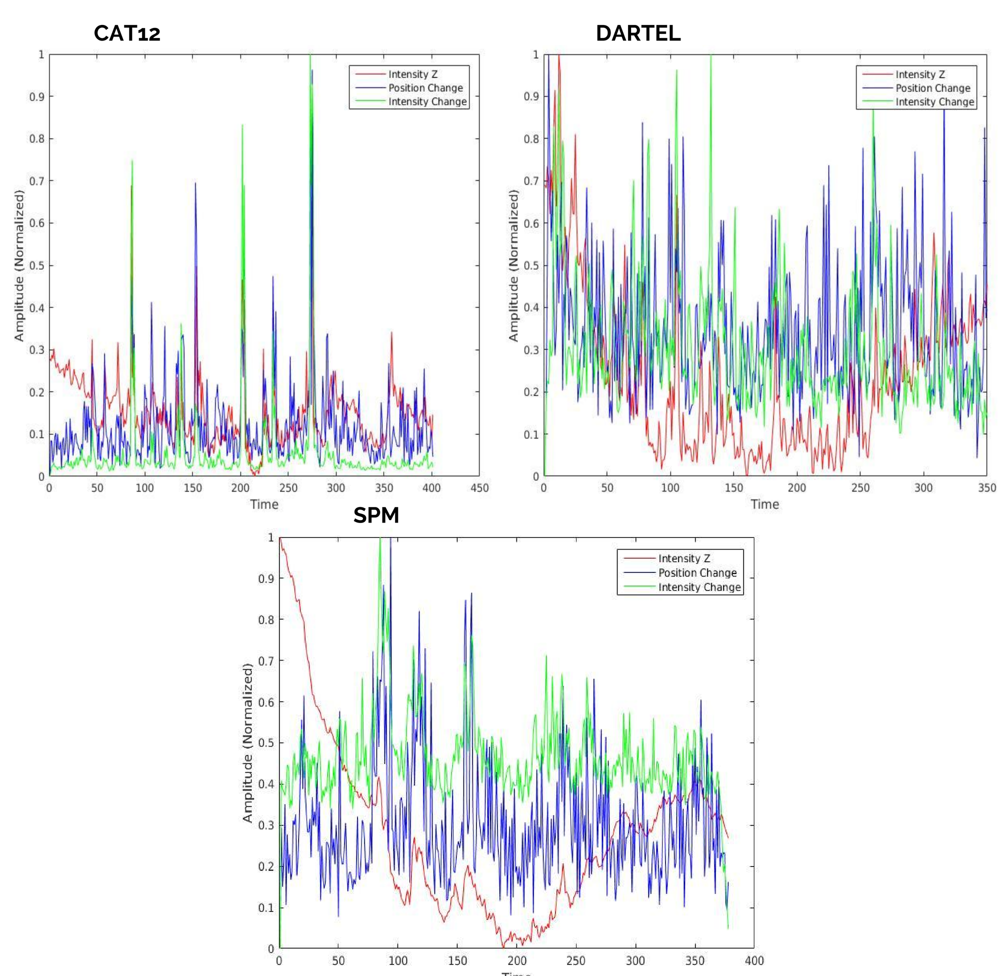
Results of the scoring demonstrated that **SPM** had the most consistent ease of use out of the 3 techniques. **DARTEL** was found as the moderate approach and **CAT12** the least usable.





Images demonstrate the computed differences in mean grey-matter for **DARTEL** & **CAT12** after being subtracted from template. Notably there are clearer brightness intensities in **DARTEL** extremities. SPM creates incompatible images and thus was excluded.

The 4D representation of intensity Z scores of the 3 techniques in an average run. It is clear that **CAT12** has significantly reduced variance (green line). No significant differences were found of mean intensity (red line) across the 3 runs.



CONCLUSIONS

- ➔ CAT12 was the most effective normalisation technique of the 3 tested.
- ➔ Conversely, CAT12 was the weakest technique in terms of qualitative measures (efficiency, optimisation, and usability).
- ➔ DARTEL was determined to be the most well-rounded and useful normalisation technique out of the three tested.
- ➔ The origin setting tool was very effective and strongly recommended.
- ➔ Logistical inconsistencies need to be addressed in the future.

FUTURE DIRECTIONS

Some of the biggest hurdles of this experiment were the time constraints and issues with cropping functions. Future research could focus on reexamining data with more consistent usage of cropping and brain stripping tools.
Furthermore, future research should be attributed to the **set-origin** function. It showed substantial benefits for not only minimising preprocessing step tedium, but worked to retain a level of consistency across participants not usually seen.

REFERENCES

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Computational Anatomy Toolbox. (2016). Retrieved May 04, 2017, from http://www.neuro.uni-jena.de/cat