A Comparison of Voxel Compression Mapping & Longitudinal Voxel-Based Morphometry

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Clinical Motivation

Serial brain imaging can reveal patterns of change over time with important clinical implications for neurodegenerative disease [1]. We investigate the performance of four analysis methods, in terms of a comparison of 20 patients with probable AD to 20 age- and sex-matched controls, characterising differences in change from baseline to later scans.

Analysis Techniques

VCM [2] and VBM [3] are computational neuro-anatomy methods. We compare VCM to standard VBM (with ISN), longitudinal VBM with TSN [4], and a method that averages warped images (AVG) based on [5]; all re-implemented for SPM5.

Fig.1: VCM, AD vs Control, 6-month vs baseline, pFDR < 0.01
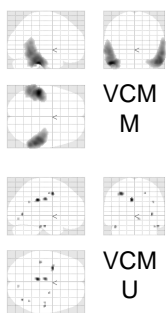
Glossary:
AD – Alzheimer's Disease. AC – Anterior Commissure
SPM – Statistical Parametric Mapping
FDR – False Discovery Rate.
HDW – High-Dimensional Warping
VCM – Voxel Compression Mapping (here denoting the technique of applying SPM to compression maps)
VBM – Voxel-Based Morphometry
ISN – Independent Spatial Normalisation
TSN – longitudinally-Tied Spatial Normalisation
AVG – Average of HDW aligned images
M/U – Modulated/Unmodulated for spatial normalisation
**SM – Supplementary material gives more information**

Statistical Parametric Mapping Results

Fig.1 presents maximum intensity projections of the significant voxels for VCM at 6 months (no other methods pass correction for multiple tests). Fig.2 shows similar results at 12 months for all methods. Unthresholded t-maps for all methods at 6 months are given in Fig.3.

VCM is more sensitive, but less able to localise change; its results are smoother, especially when modulated (SM). TSN and AVG produced similar results to standard ISN; with minor differences in t-values, peak locations, and "reverse contrast" – regions where controls change more than AD.

No methods found significant (corrected) reverse contrast voxels. Specificity was further shown by absence of findings in comparing two mixed groups of balanced AD and control subjects (SM).

Fig.2: AD vs Control, 12-month vs baseline, pFDR < 0.01
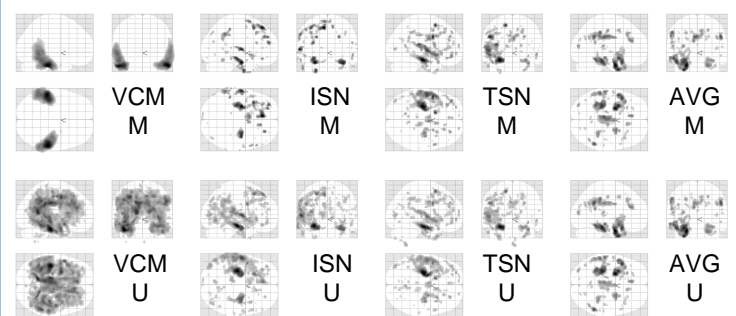
Intersubject modulation strongly affects VCM, longitudinal change is swamped and the result is similar to a between-group comparison of repeat images alone. Other methods seem less sensitive to modulation, although ISN U appears better.

Fig.3: 6-month vs baseline. Unthresholded T = -6 to 6
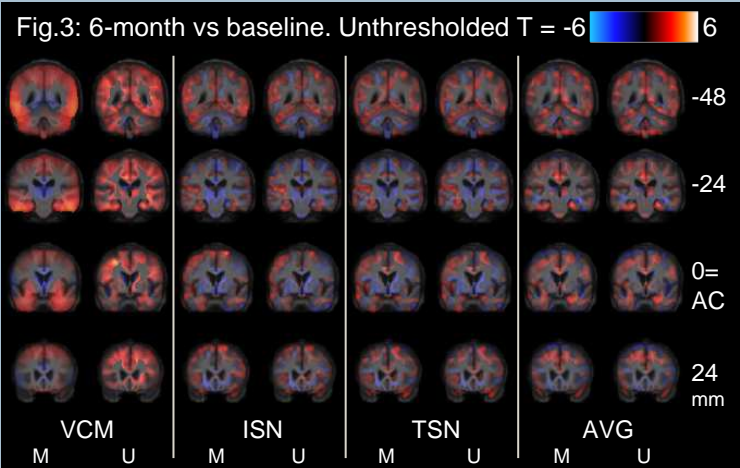
Conclusions

There are major differences between VCM and VBM results, and less pronounced (though still potentially important) differences between VBM genres. Further investigation is required, ideally a quantitative comparison to known ground truth.