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

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## Smoothness & Modulation

EPSRC

GlaxoSmithKline

Supplementary material, including references:
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# Smoothness & Modulation

- Modulating for inter-subject volume changes in longitudinal VBM/VCM is optional
  - Intra-subject changes over time are the focus
- There appears to be no agreement in the literature regarding its use
  - Chetelat et al. do not [5]
  - Kipps et al. (includes John Ashburner) do [8]

# Smoothness & Modulation

- VCM gives smoother results than the other techniques, as it uses just the deformations
  - The segmentations are rougher, which leads to rougher residuals from the fitted model
- VCM with intersubject modulation is more like an analysis of just the intersubject warps, since these swamp the longitudinal changes
  - The intersubject deformations are much smoother than the longitudinal warps due to the models used
    - Lower dimensional DCT basis, ~$10^3$ Degrees of Freedom
    - High-dimensional, 3 DF for each of ~$10^6$ voxels

# Smoothness & Modulation

- The smoothness of standard VBM (ISN) results is affected by the use of modulation, but this seems not to be the case for longitudinal VBM
- Smoothness relates to the residuals from the fitted linear model; it may be that Modulated ISN is in some way better modelled than Unmodulated ISN
  - Arguably the converse would be expected
    - Unmodulated ISN could theoretically remove all scan differences
  - Perhaps for TSN and AVG the model is less affected
    - Further investigation is required…
- The following slide gives tables of the average of the x-, y- and z-axis FWHM smoothness (mm)

# Smoothness & Modulation

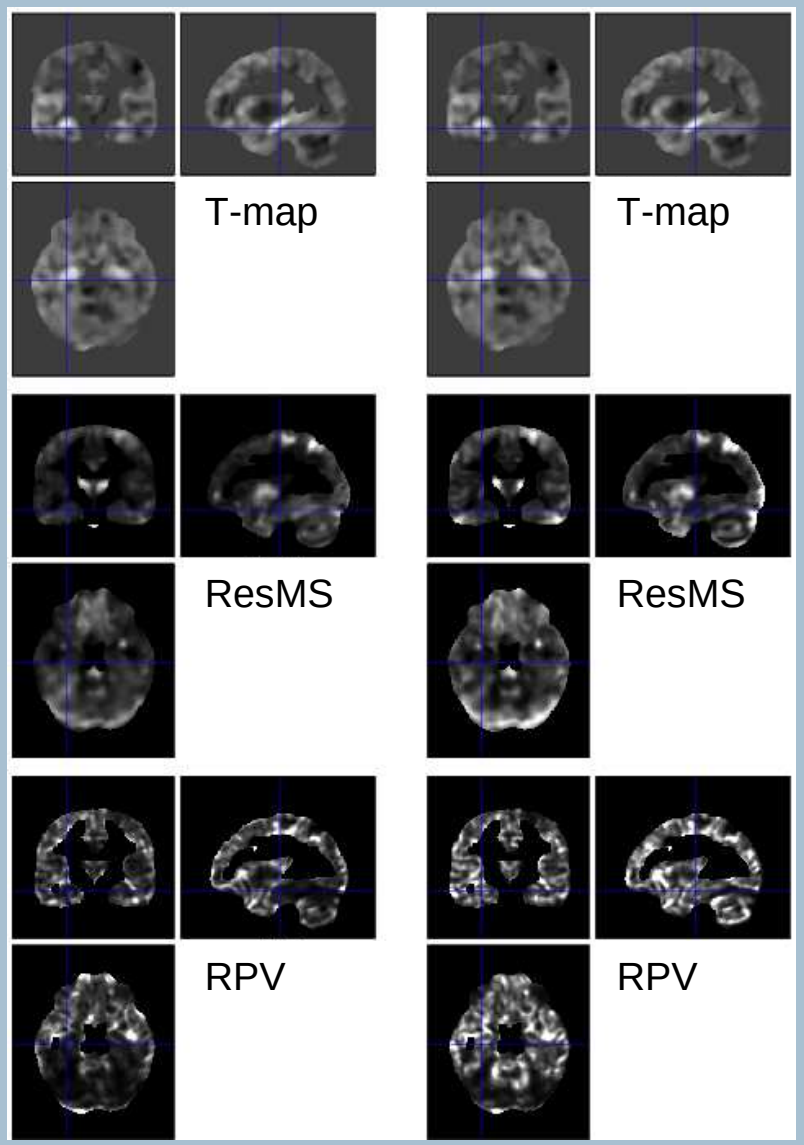
| Method<br>Results | VCM | ISN | TSN | AVG |
|---|---|---|---|---|
| 6 months M | 46.83 | 11.06 | 10.20 | 10.59 |
| 6 months U | 12.15 | 10.21 | 10.27 | 10.57 |
| 12 months M | 46.44 | 11.05 | 10.34 | 10.56 |
| 12 months U | 11.88 | 10.18 | 10.26 | 10.55 |

(Applied smoothing was 8mm FWHM)

# Smoothness & Modulation

- The following slide shows results at 12 months, comparing modulated and unmodulated, ISN and TSN, in terms of:
  - T-value images
  - ResMS: the mean squared residuals
    - Summarising the set of residuals, from which smoothness is derived
  - RPV: the Resels Per Voxel image
    - A local measure of roughness
    - Cf. FWHM – a global summary of smoothness
- All slices are at (-30,-20,-20) mm MNI
- Intensity display ranges are equal within image types

# Smoothness & Modulation

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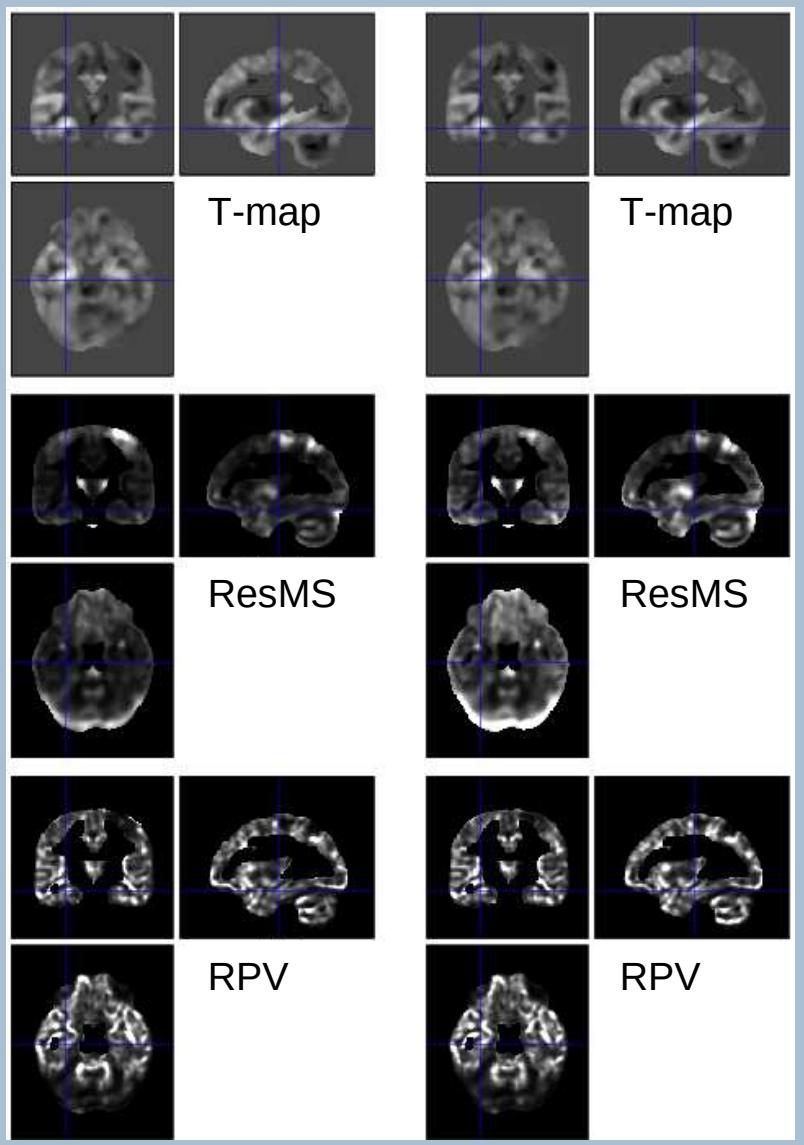
**Standard ISN VBM**

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**Longitudinal TSN VBM**