

Types of Scaling

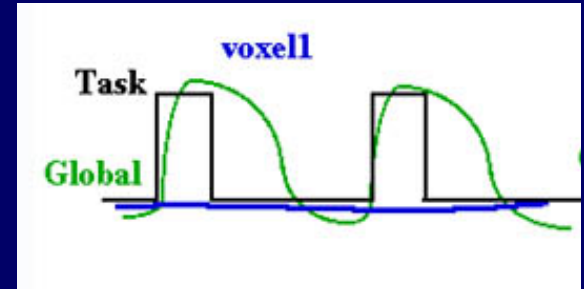
- **Session scaling; global mean scaling; block effect; mean intensity scaling**
 - Purpose – remove intensity differences between runs (i.e., the mean of the whole time series).
 - whole time series may have different mean value
 - must compensate for between run variance
 - Usually scaled to mean of 100 (or 50 or similar).

Types of Scaling

- **Global scaling; proportional scaling; scaling**
 - i.e. dividing the intensity values for each scan by the mean value for all voxels (or the global brain mean intensity) for this scan.
 - Purpose: remove global drifts and improve sensitivity.
- Danger to applying global scaling. The global brain mean must be independent of the task activity (i.e., does not correlate with it).
 - If violated, applying global scaling can dramatically the outcome of the statistical analysis, and can be the cause of multiple Type I and Type II errors.

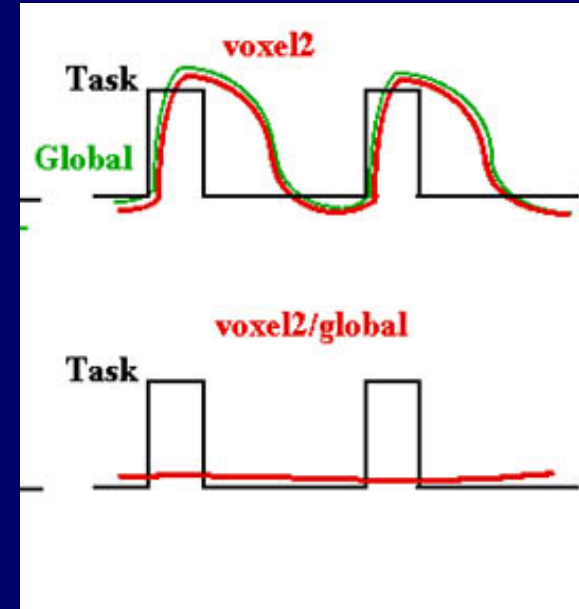
Proportional Scaling

- Consider **voxel1**: a voxel of no interest that is not influenced by the task.
- If the **global** brain mean correlates with the task and **voxel1** is divided by it, then **voxel1/global**, the transformed voxel's timecourse, would appear to negatively correlate with the task and its significant deactivation may lead us to identify it as a voxel of interest (Type I error).



Proportional Scaling

- Consider **voxel2**, a voxel of interest that correlates with the **task**, and that we would like to identify.
- If the **global** brain mean correlates with the task and **voxel2** is divided by it, then **voxel2/global**, the transformed voxel's timecourse, would no longer correlate with the task (in fact, it would look more like a flat line) and we would therefore fail to identify it (Type II error).



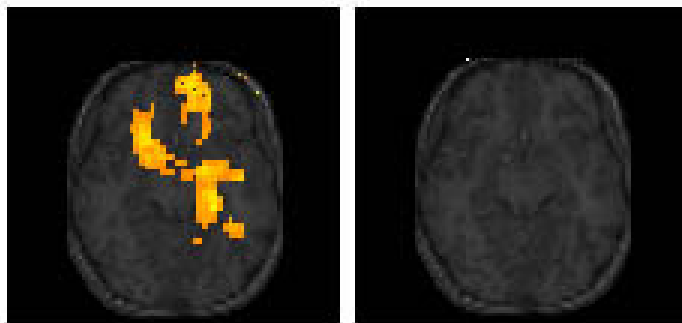
Proportional Scaling Example

<u>Condition</u>	<u>Pearson's R</u>	<u>p value</u>
rhyme	-.54	.00
letter	.49	.00
line	.20	.23

Proportional Scaling Example

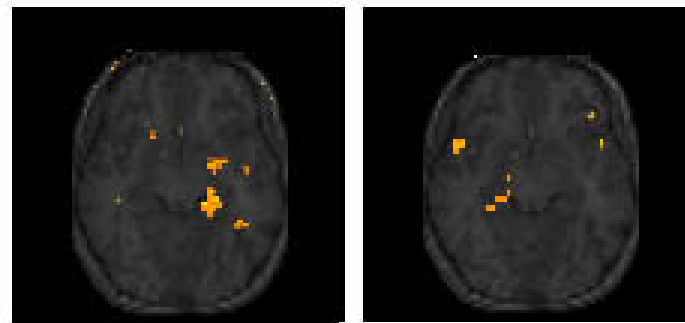
with global scaling

rhyme > letter letter > rhyme



without global scaling

rhyme > letter letter > rhyme



T = 3.30 k = 0 voxels

Proportional Scaling

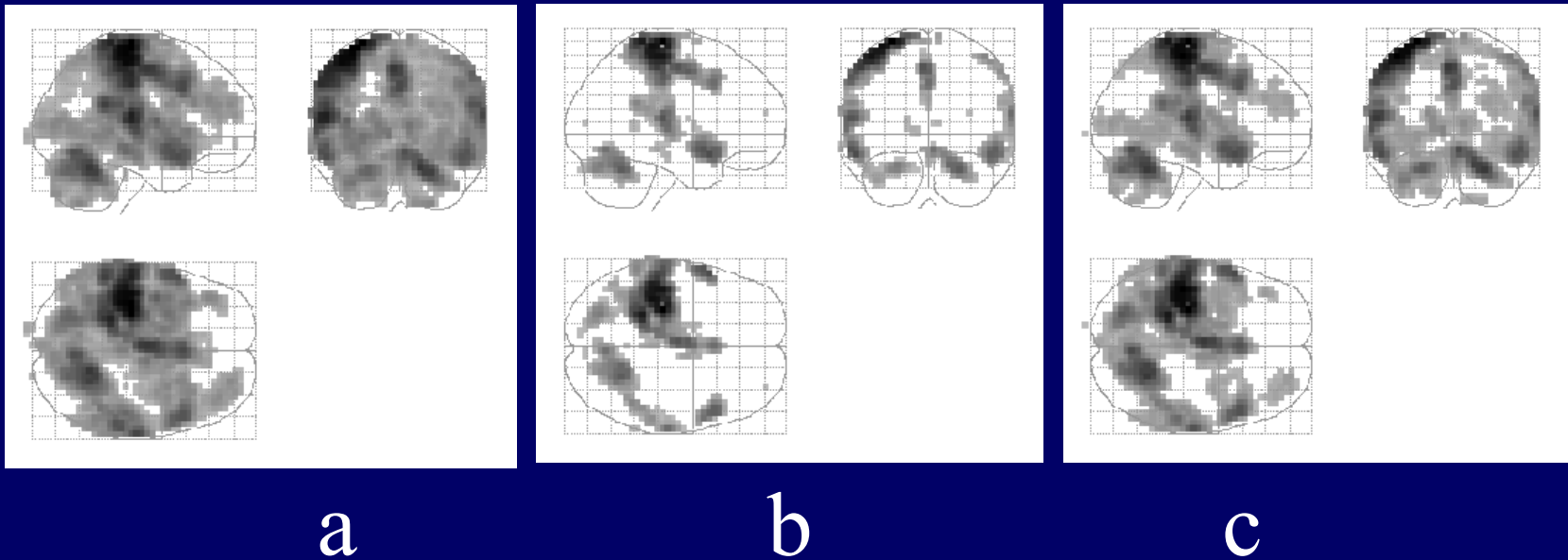


FIG. 1. SPM{t}'s for target responses a) no scaling, b) proportional scaling, and c) adjusted proportional scaling. SPM{t}'s are set at a corrected voxel-level threshold of $p < 0.05$.

Proportional Scaling

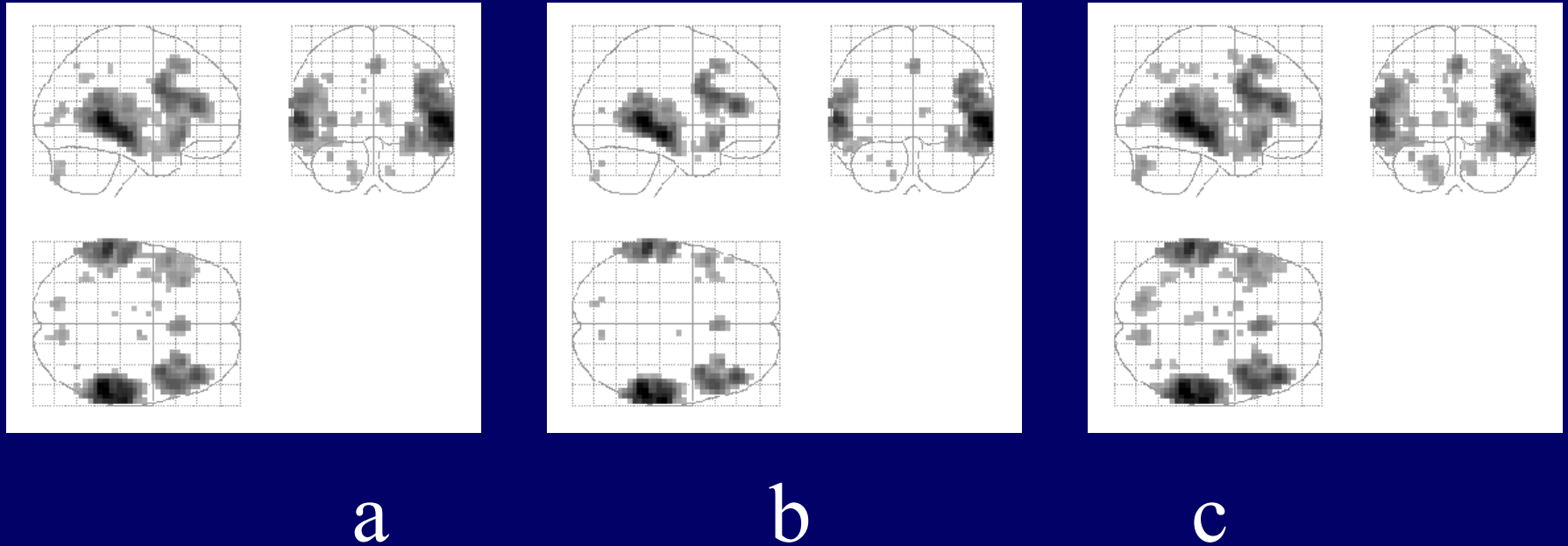


FIG. 2. SPM{t}'s for novel activations with a) no scaling, b) proportional scaling, and c) adjusted proportional scaling.

Proportional Scaling

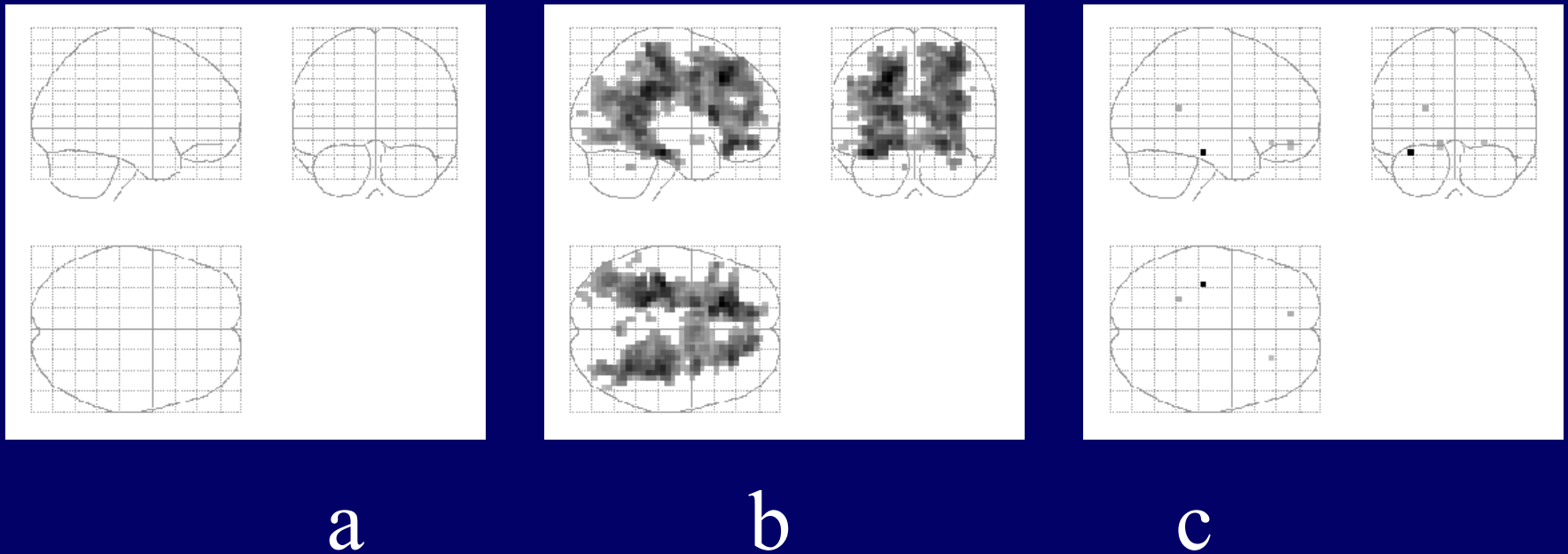


FIG. 4. SPM{t}'s for target deactivations obtained from analyses with a) no scaling, b) proportional scaling, and c) adjusted proportional scaling.

Proportional Scaling

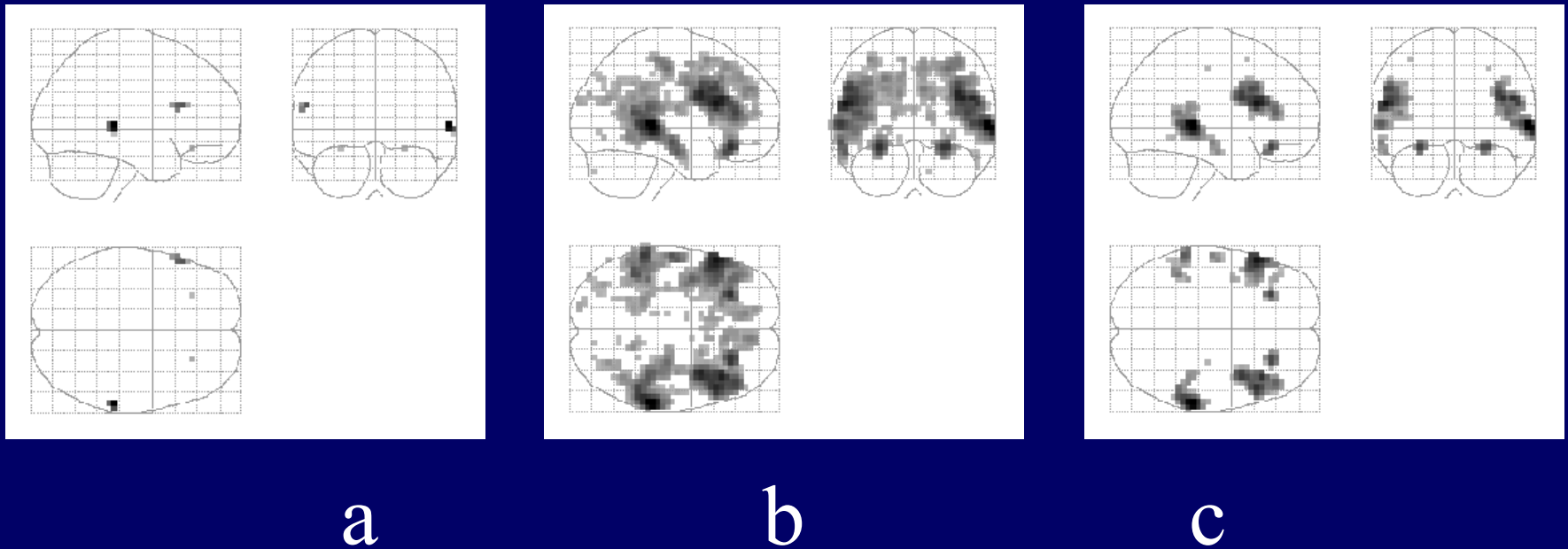


FIG. 5. SPM{t}'s for novel responses relative to target responses with a) no scaling, b) proportional scaling, and c) adjusted proportional scaling.

Proportional Scaling

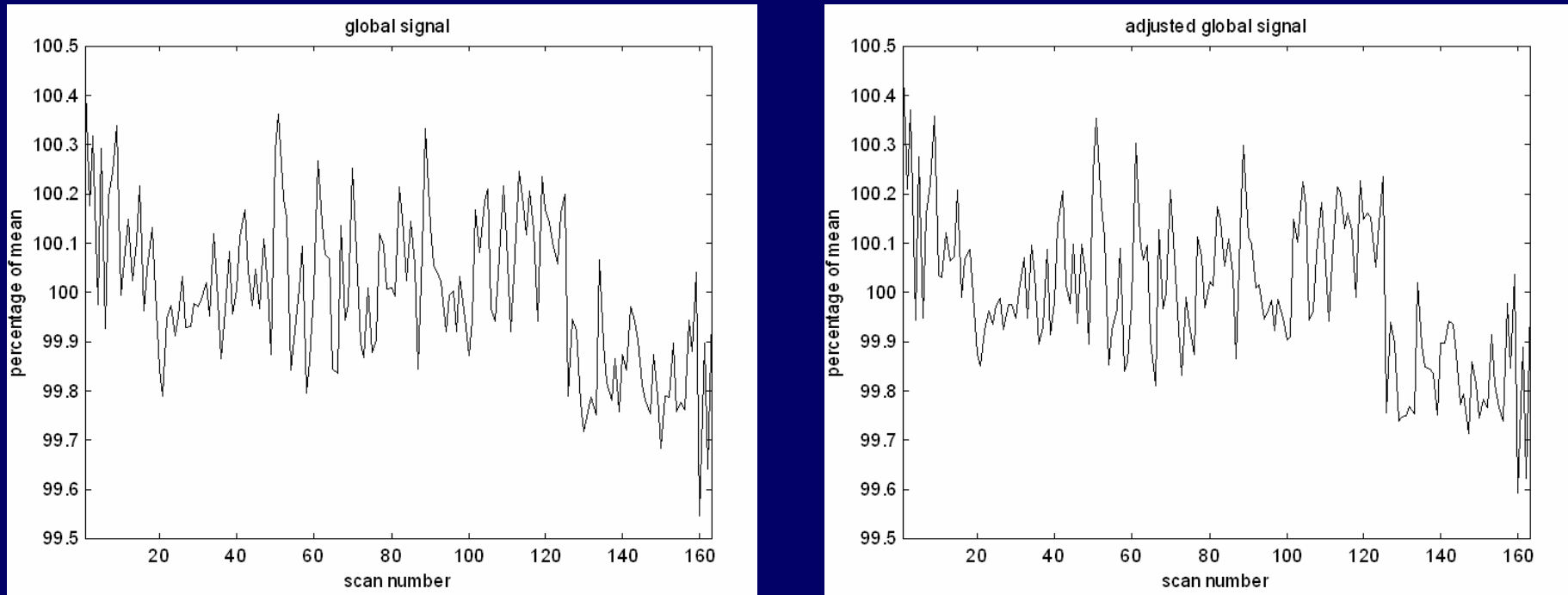


FIG. 3. Global signal and adjusted global signal of a representative session from Experiment 1. The standard deviation of the global signal is 0.157% of the mean. These figures illustrate that the component of the global signal that was removed by orthogonalization with respect to the non-constant covariates of interest was small relative to the variations about the mean: the standard deviation of the difference between the global signal and the adjusted global signal is only 0.0328%

Table 1. Representative Z-scores from Experiment 1.

Z-scores from analyses of target responses relative to baseline:

Location [x y z]	no scaling	proportional scaling	adjusted proportional scaling
Right Anterior Temporal Lobe [48 16 -16]	10.98	9.87	11.42
Left Anterior Temporal Lobe [-56 12 -16]	11.59	10.90	12.28
Supplementary Motor Area [-4 -12 52]	12.79	10.39	13.17
Right Cerebellum [16 -56 -24]	12.60	9.26	12.62

References

- Macey, P.M., et al (2004) A method for removal of global effects from fMRI time series. *NeuroImage* 22. 360-366.
- Aguirre, G. K., Zarahn, E., & D'Esposito, M. (1998). The inferential impact of global signal covariates in functional neuroimaging analyses. *Neuroimage*, 8(3), 302-306.
- Andersson, J. L. (1997). How to estimate global activity independent of changes in local activity. *Neuroimage*, 6(4), 237-244.
- Andersson, J. L., Ashburner, J., & Friston, K. (2001). A global estimator unbiased by local changes. *Neuroimage*, 13(6 Pt 1), 1193-1206.
- Desjardins, A. E., Kiehl, K. A., & Liddle, P. F. (2001). Removal of confounding effects of global signal in functional magnetic resonance imaging analyses. *Neuroimage*, 13, 751-758.