The influence of study characteristics on coordinate-based fMRI meta-analyses.

Han Bossier^a, Ruth Seurinck^a, Simone Kühn^b & Beatrijs Moerkerke^a

^aDepartment of data analysis, Ghent University ^bMax Planck Institute for Human Development, Germany
Han.Bossier@Ugent.be

1. Coordinated-based meta-analyses

Coordinate based meta-analysis (CBMA) is a popular tool to integrate data across studies and labs. In this study we evaluate the **influence** of a study characteristic, i.e. the **group level analysis** model, on the **validity** and **test-retest reliability** of CBMA using a large data-set from the IMAGEN project [3].

2. Methods and outcome measures

Group level analyses (FSL):

- fixed effects model
- ordinary least squares (OLS)
- mixed effects model

CBMA methods:

- ALE** meta-analysis [1]: combines studies using only peak locations. Correction for multiple testing: *uncorrected*, *false discovery rate (FDR) -pID* (assumes independence or positivity in the joint distribution between voxels) and *FDR -pN* (no assumption on joint distribution).
- seed based d-mapping** [2]: a random effects meta-analysis using not only peak locations but also peak height.
- a fixed effects** analogue of seed based d-mapping.

(1) Validity through ROC curves:

(2) Test-retest reliability (image i and j) using overlap of activation [4]:

$$\frac{V_{i,j}}{V_i + V_j - V_{i,j}}$$

With $V_i (V_j)$ = # voxels that are declared significant in image i (image j) and $V_{i,j}$ = # voxels declared significant in both images.

3. Design

4. Results: validity and test-retest reliability

5. Conclusion

Results show:

- highest AUC and test-retest reliability using random effects meta-analysis (MA) based on mixed effects pooling.
- lowest AUC using ALE on all pooling methods.
- lowest test-retest reliability using ALE after conservative multiple testing corrections (FDR -pN).

Hence we conclude that:

- there is positive evidence in favor of **mixed effects pooling** methods at group level for all MA methods.
- random effects MA** using peak height outperforms other MA methods.

When between study heterogeneity would be larger, differences between fixed and random effects MA could be more apparent.

6. References

- Eickhoff S, et al. Coordinate-based activation likelihood estimation meta-analysis of neuroimaging data: a random-effects approach based on empirical estimates of spatial uncertainty. *Human brain mapping*, 30(9):2907–26, 2009.
- Radua J, et al. A new meta-analytic method for neuroimaging studies that combines reported peak coordinates and statistical parametric maps. *European psychiatry : the journal of the Association of European Psychiatrists*, 27(8):605–11, 2012.
- Schumann G, et al. The imagen study: reinforcement-related behaviour in normal brain function and psychopathology. *Mol Psychiatry*, 15(12):1128–1139, 2010.
- R Maitra. A re-defined and generalized percent-overlap-of-activation measure for studies of fMRI reproducibility and its use in identifying outlier activation maps. *NeuroImage*, 50(1):124–35, 2010.