fmreli: a toolbox for the analysis of fMRI reliability

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Background

What is reliability?

- Consistency of a "biomarker": how trustworthy is the value-tracking signal in the ventral striatum?
- True score theory: scaling of measurement error (psychometric evaluation)
  - The smaller the measurement error, the more reliable is the measure

Why is it important?

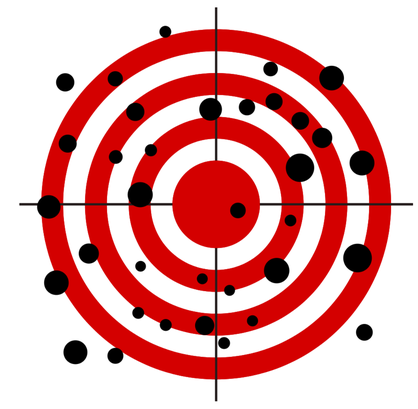
- Helps us to judge whether our measure captures inter- and intra-individual differences well

What do we already know about reliability in fMRI [1]?

- Reliability is dependent on tasks and the variability in their underlying cognitive functions [e.g. 2,3]
- Range from low to high reliability
- *Reliability is dependent on the level of analysis*: group vs. individual; global vs. local response [4,5]

How can we make reliability assessment more accessible to the brain mapping community?

- fmreli is a collection of key indices to facilitate reliability analyses as an integral part of task development
- Novel feature: split-half reliability for single runs/sessions



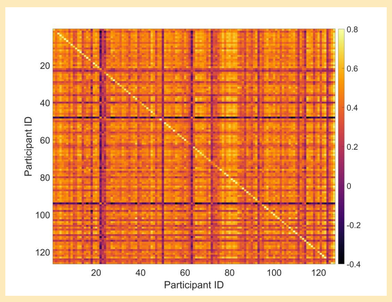
The toolbox

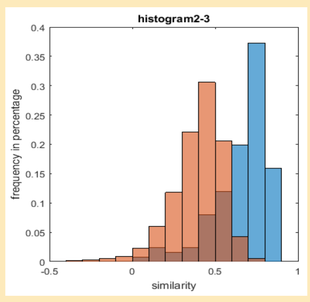
Study Characteristics

- ***Design:***
  - Where is the data?
  - Which subjects? Which session(s)?
- ***Contrast(s) of interest***
  - One or two contrasts?
  - Which one?

Global reliability

- Whole-brain/within region-of-interest
- ***Similarity***
  - Vectorize 3D-matrix for each subject → correlate within (diagonal/blue) and between (off-diagonal/red) subject

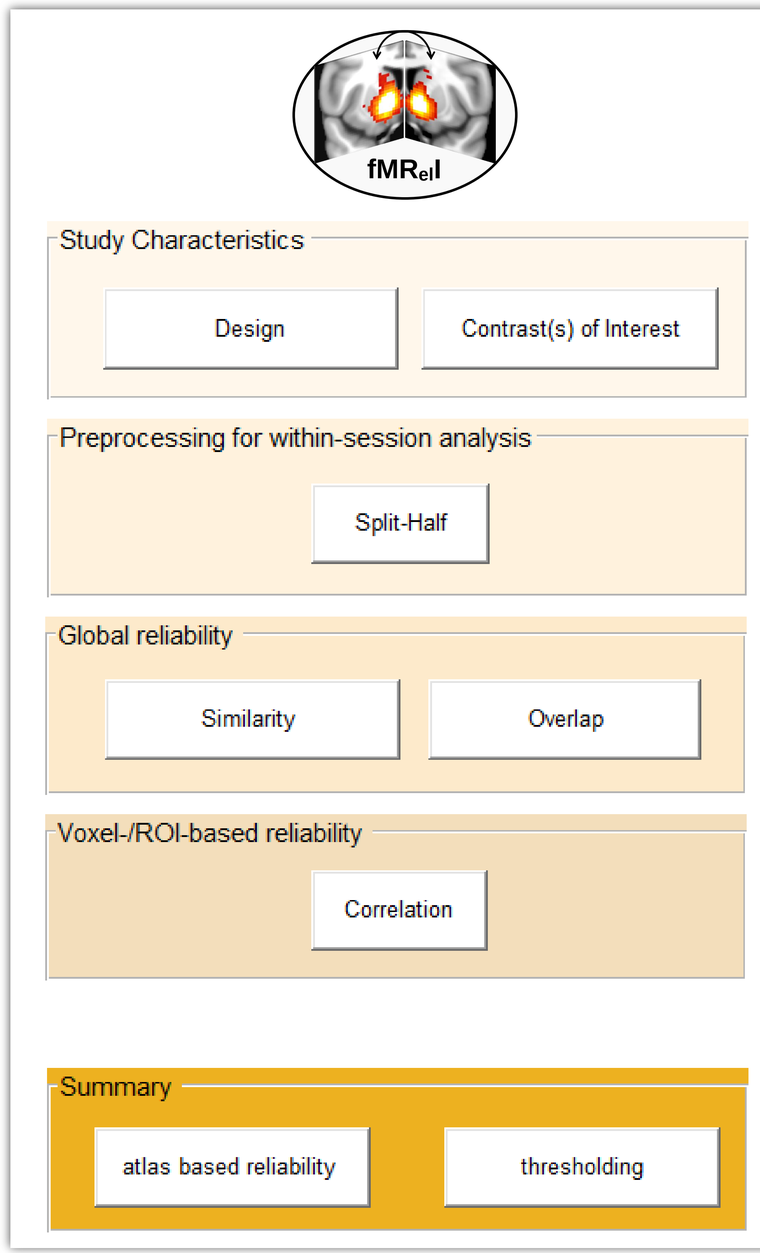




☺ easy comparison of between- and within-subject reliability

- ***Overlap***
  - Dice and Jaccard coefficient
  - Percentage of overlapping significant voxels

Toolbox is available on GitHub
https://github.com/nkroemer/reliability
see [6] for methodological details



Split-half for within-session analysis

- Definition of contrast/regressor to split
- Split events and corresponding parametric modulators randomly into two parts
- Re-estimation of first-level stats

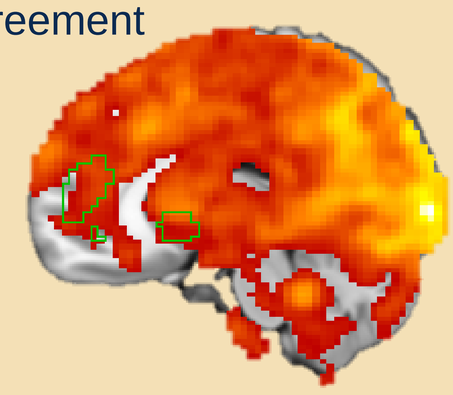
Local/voxel-based reliability

Correlation coefficients

- Pearson
- Spearman
- Intraclass Correlation Coefficient (ICC)
  - Absolute agreement
  → More conservative
  → Takes into account between-session variance
  - Consistency agreement
  → More liberal

***ICC* > 0.2** 0.7

$\emptyset ICC_{ROI} = 0.22$



Summary

- ***Atlas-based reliability***
  - Summarizes calculated reliability measures for all atlas regions
  - Default atlas: Harvard-Oxford brain atlas and the Automatic Anatomic Labeling (AAL) for the cerebellum (CONN atlas)
- ***Thresholding***
  - Set threshold (e.g. 0.5) and keep only voxels with reliability ≥0.5 in a mask

References

1 Bennett, C. M., & Miller, M. B. (2010) https://doi.org/10.1111/j.1749-6632.2010.05446.x
2 Gorgolewski, K. J., Storkey, A. J., Bastin, M. E., Whittle, I., & Pernet, C. (2013) https://doi.org/10.1016/j.neuroimage.2012.10.085
3 Plichta, M. M., et al. (2012) https://doi.org/10.1016/j.neuroimage.2012.01.129
4 van den Bulk, B. G. et al. (2013) https://doi.org/10.1016/j.dcn.2012.09.005
5 Vetter, N. C., Pilhatsch, M., Weigelt, S., Ripke, S., & Smolka, M. N. (2015) https://doi.org/10.1016/j.dcn.2015.05.001
6 Fröhner, J. H., Teckentrup, V., Smolka, M. N., & Kroemer, N. B. (2017) https://doi.org/10.1101/215053

Notes:

This research was supported by the Grant # BMBF 01EV0711

IMAGEN is funded by the European Community's Sixth Framework Programme (LSHM-CT-2007-037286).This poster reflects only the authors' views and the Community is not liable for any use that may be made of the information contained therein.

This research was supported by the fortüne grant NWG Kroemer #2453-0-0

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