Inter rater reliability

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## Short version

Agreement is acceptable for all but atrophy. See calculations in the end.

My suggestion will be to re-plan. Instead of retraining, I will assign two assessors to each subject. On disagreement, consensus will be sought.

With 8 assessors helping out, each will get to perform a mean of ~250 assessments

Pros and cons to the new approach

| *Pros* | *Cons* |
| --- | --- |
| Increased accuracy | Increased workload |
| Improved data quality | Possibly increased time use |
| Improved chance of using the data for further projects | Decreased chance of finishing on time |

**Alternative**: exclude atrophy as a biomarker. The HARNESS initiative as well as the FINESSE framework recommends exactly WMH, lacunes, microbleeds and atrophy as biomarkers.(Smith et al. 2019; Markus et al. 2022)

## Litterature

Staals et al. (2014) reports Intraclass Correlation Coefficient of 0.68-0.92 depending on the biomarker. They use different aids to maximise the likelihood of agreement (reference pictures etc.).

Depending on sources, Fleiss-Kappa or Intraclass Correlation Coefficient (ICC) are argued as the best meassure. Hallgren (2012) recommends using the ICC with multiple assessors and when scores are ordinal. Multiple performance measures are included.

Here are a few discussions on the topic:

* [researchgate](https://www.researchgate.net/post/Calculating-a-weighted-kappa-for-multiple-raters)
* [cookbook-for-r](http://www.cookbook-r.com/Statistical_analysis/Inter-rater_reliability/)

## Data

| svd\_user | n |
| --- | --- |
| ABF | 52 |
| AGD | 52 |
| AMG | 1 |
| GA | 18 |
| JKM | 52 |
| KMØ | 52 |
| MFH | 52 |
| NLP | 52 |
| RAB | 52 |
| SBV | 52 |

### Inter-rater-disagreement examples

Example of overall score differences

| svd\_user | svd\_quality | svd\_microbleed | svd\_microbleed\_location\_\_\_1 | svd\_microbleed\_location\_\_\_2 | svd\_microbleed\_location\_\_\_3 | svd\_siderose | svd\_lacunes | svd\_wmh | svd\_atrophy |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SBV | 2 | 1 | 0 | 1 | 0 | 0 | 2 | 1 | 0 |
| JKM | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 |
| KMØ | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 2 | 0 |
| NLP | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 |
| RAB | 2 | 1 | 1 | 0 | 0 | 0 | 3 | 1 | 0 |
| MFH | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 |
| AGD | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 |
| ABF | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 |

| svd\_user | microbleed | lacunes | wmh | atrophy | score |
| --- | --- | --- | --- | --- | --- |
| SBV | 1 | 1 | 0 | 0 | 2 |
| JKM | 0 | 1 | 0 | 0 | 1 |
| KMØ | 1 | 1 | 1 | 0 | 3 |
| NLP | 0 | 1 | 0 | 0 | 1 |
| RAB | 1 | 1 | 0 | 0 | 2 |
| MFH | 0 | 1 | 0 | 0 | 1 |
| AGD | 0 | 1 | 0 | 0 | 1 |
| ABF | 0 | 1 | 0 | 0 | 1 |

## Calculations

Overall reliability measures on all variables

Warning: Using an external vector in selections was deprecated in tidyselect 1.1.0.  
ℹ Please use `all\_of()` or `any\_of()` instead.  
 # Was:  
 data %>% select(.x)  
  
 # Now:  
 data %>% select(all\_of(.x))  
  
See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.

| Variable | Agreement | Krippendorffs\_Alpha | Fleiss\_Kappa | Brennan\_Predigers\_Kappa | IntraclCorrCoef |
| --- | --- | --- | --- | --- | --- |
| svd\_quality | 0.7884615 | 0.3909154 | 0.389447748 | 0.7867959 | 3.971007e-01 |
| svd\_microbleed | 0.6923077 | 0.5344182 | 0.533296331 | 0.6923038 | 8.384529e-01 |
| svd\_microbleed\_location\_\_\_1 | 0.7884615 | 0.6058272 | 0.604877423 | 0.7867959 | 6.102045e-01 |
| svd\_microbleed\_location\_\_\_2 | 0.8269231 | 0.5509859 | 0.549903896 | 0.8255603 | 5.551565e-01 |
| svd\_microbleed\_location\_\_\_3 | 0.9230769 | 0.4543851 | 0.453070386 | 0.9224712 | 4.581498e-01 |
| svd\_siderose | 0.9795918 | 0.0000000 | -0.002557545 | 0.9794311 | -1.275022e-15 |
| svd\_lacunes | 0.4375000 | 0.4987262 | 0.497417440 | 0.4374928 | 7.205385e-01 |
| svd\_wmh | 0.1730769 | 0.5336626 | 0.532538933 | 0.1730264 | 7.904484e-01 |
| svd\_atrophy | 0.1960784 | 0.2637533 | 0.261944363 | 0.1960294 | 4.579298e-01 |

Reliability on simplified 0-4 scale.

| Variable | Agreement | Krippendorffs\_Alpha | Fleiss\_Kappa | Brennan\_Predigers\_Kappa | IntraclCorrCoef |
| --- | --- | --- | --- | --- | --- |
| microbleed | 0.7307692 | 0.6595911 | 0.6587709 | 0.7286493 | 0.6635782 |
| lacunes | 0.6041667 | 0.7007082 | 0.6999267 | 0.6010499 | 0.7050209 |
| wmh | 0.6538462 | 0.7193592 | 0.7186830 | 0.6511205 | 0.7231512 |
| atrophy | 0.7058824 | 0.3095880 | 0.3078916 | 0.7035665 | 0.3192449 |
| score | 0.2553191 | 0.5176905 | 0.5164044 | 0.2553096 | 0.8003456 |

## Conclusion

For the simplified score, the Intraclass Correlations Coefficients for microbleed, lacunes, wmh, atrophy and score is 0.66, 0.71, 0.72, 0.32 and 0.8 respectively.

Hallgren, Kevin A. 2012. “Computing Inter-Rater Reliability for Observational Data: An Overview and Tutorial.” *Tutorials in Quantitative Methods for Psychology* 8 (1): 23. <https://doi.org/10.20982/tqmp.08.1.p023>.

Markus, Hugh S., Wiesje M. van Der Flier, Eric E. Smith, Philip Bath, Geert Jan Biessels, Emily Briceno, Amy Brodtman, et al. 2022. “Framework for Clinical Trials in Cerebral Small Vessel Disease (FINESSE).” *JAMA Neurology* 79 (11): 1187. <https://doi.org/10.1001/jamaneurol.2022.2262>.

Smith, Eric E., Geert Jan Biessels, François De Guio, Frank Erik De Leeuw, Simon Duchesne, Marco Düring, Richard Frayne, et al. 2019. “Harmonizing Brain Magnetic Resonance Imaging Methods for Vascular Contributions to Neurodegeneration.” Edited by Jorge Jovicich and Giovanni B. Frisoni. *Alzheimer’s & Dementia: Diagnosis, Assessment & Disease Monitoring* 11 (1): 191–204. <https://doi.org/10.1016/j.dadm.2019.01.002>.

Staals, Julie, Stephen D. J. Makin, Fergus N. Doubal, Martin S. Dennis, and Joanna M. Wardlaw. 2014. “Stroke subtype, vascular risk factors, and total MRI brain small-vessel disease burden.” *Neurology* 83 (14): 1228–34. <https://doi.org/10.1212/WNL.0000000000000837>.