

Midway assessment

Characterizing the brain using deep neural networks

Esten H. Leonardsen

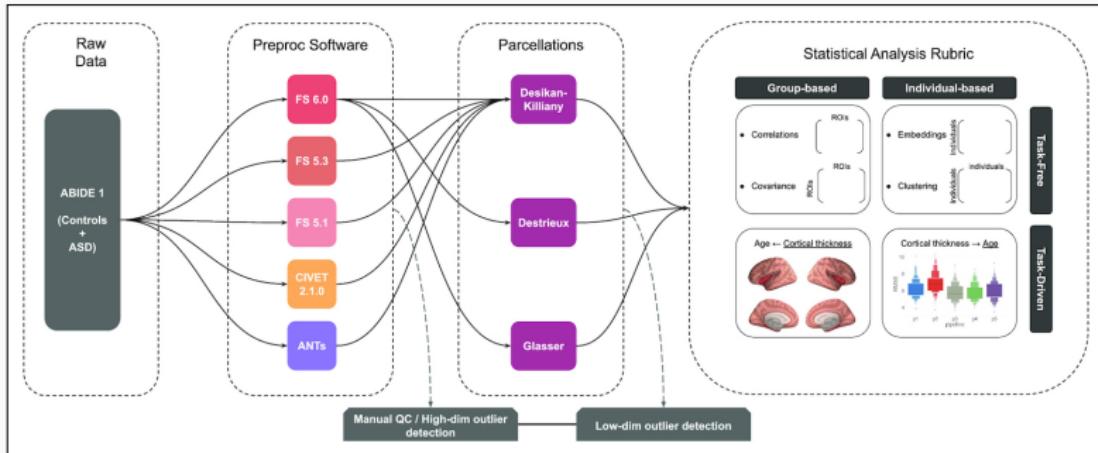
03.07.23



Overview of progress

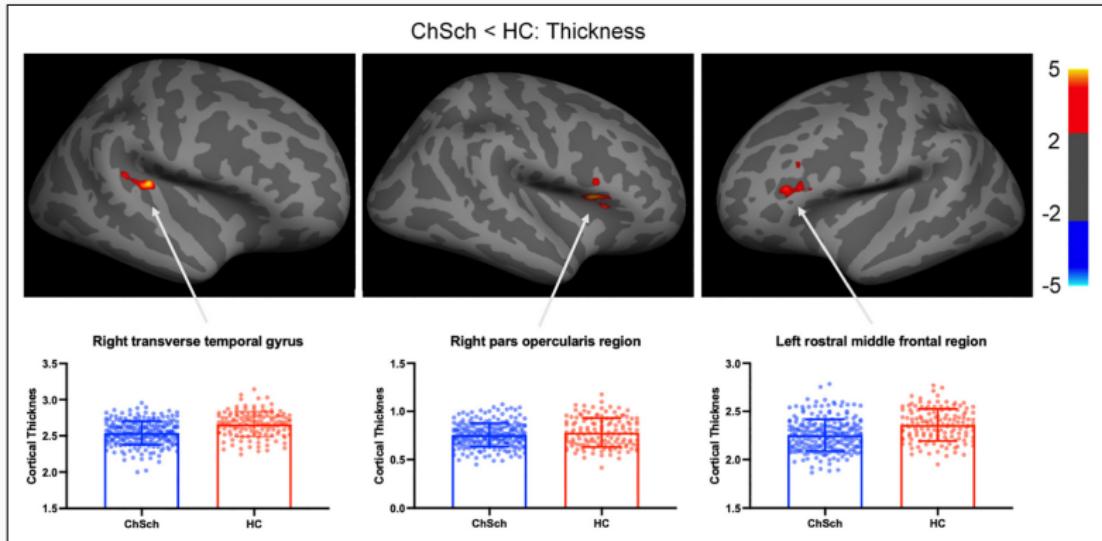
- Paper 1: Published Neuroimage 01.08.22
- Paper 2: Published Molecular Psychiatry 10.05.23
- Paper 3: Preprint medRxiv 27.06.23
- Paper 4 (pls don't tell Lars): Finishing modelling

Introduction



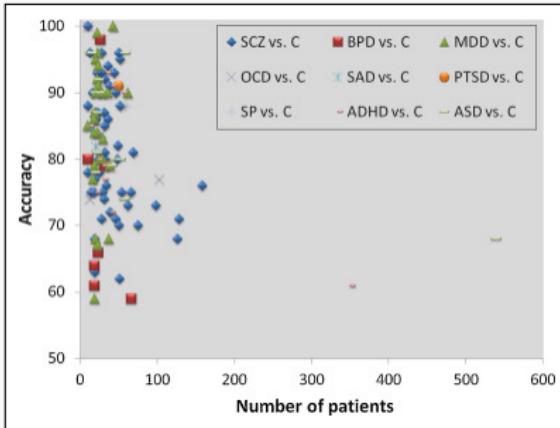
"Understanding the impact of preprocessing pipelines on neuroimaging cortical surface analyses.",
Bhagwat et al. 2021, *GigaScience*, <https://doi.org/10.1093/gigascience/giaa155>

Introduction



"Cortical surface abnormalities are different depending on the stage of schizophrenia: A cross-sectional vertexwise mega-analysis of thickness, area and gyration.",
Rosa et al. 2021, *Schizophrenia Research*, <https://doi.org/10.1016/j.schres.2021.08.011>

Introduction

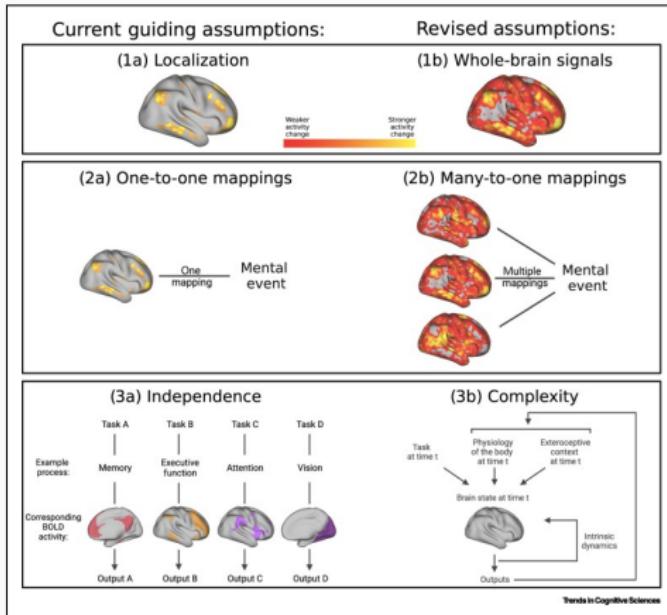


"From estimating activation locality to predicting

disorder: A review of pattern recognition for
neuroimaging-based psychiatric diagnostics."

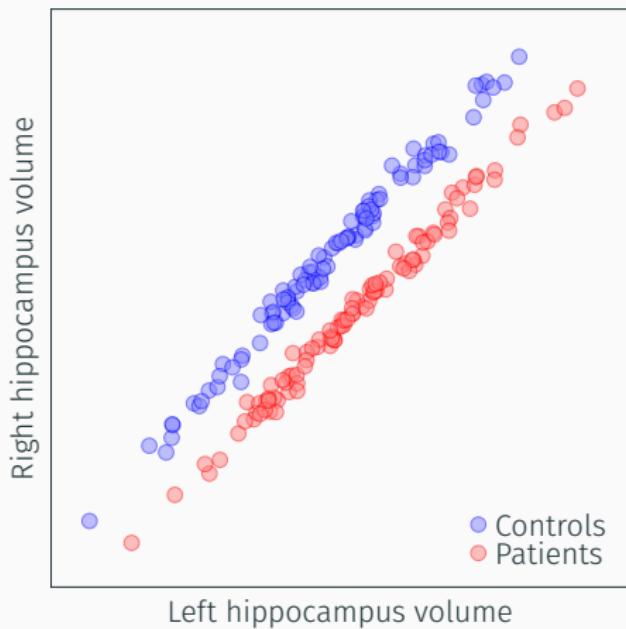
Wolfers et al. 2015, *Neuroscience & Biobehavioral Reviews*,
<https://doi.org/10.1016/j.neubiorev.2015.08.001>

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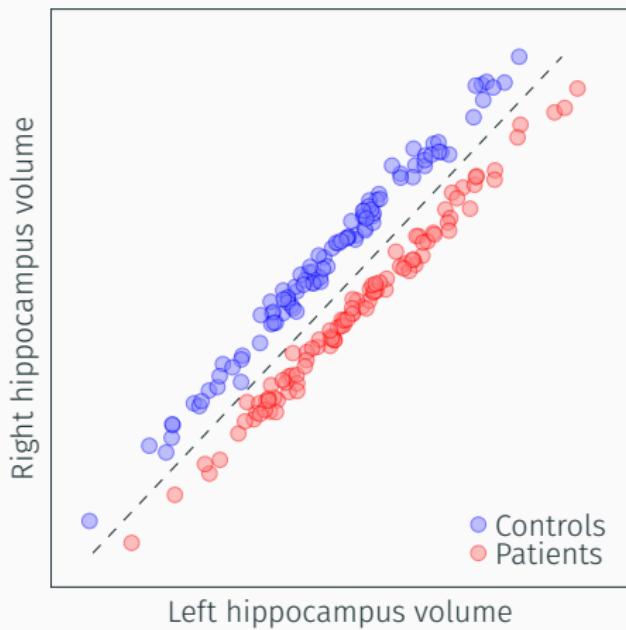


"Improving the study of brain-behavior relationships by revisiting basic assumptions.",
Westlin et al. 2023, *Trends in Cognitive Sciences*,
<https://doi.org/10.1016/j.tics.2022.12.015>

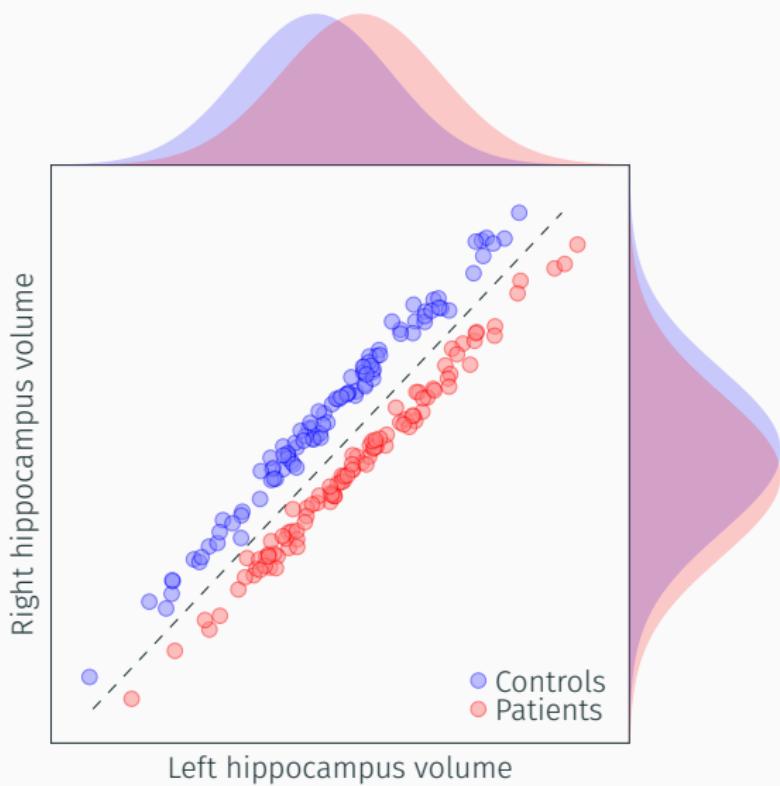
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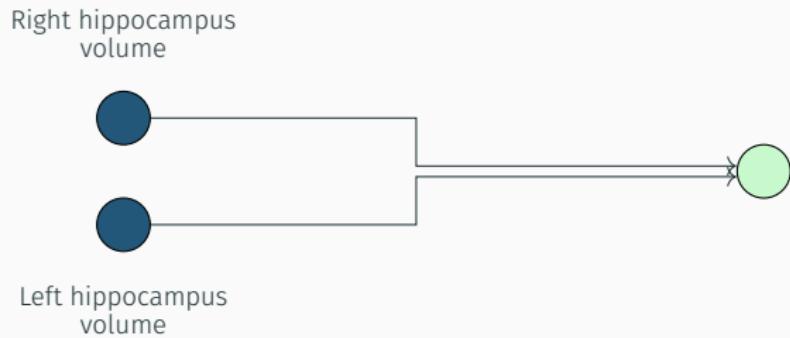
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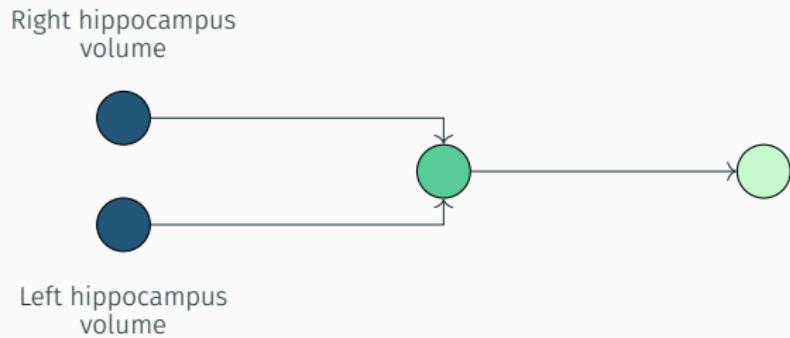
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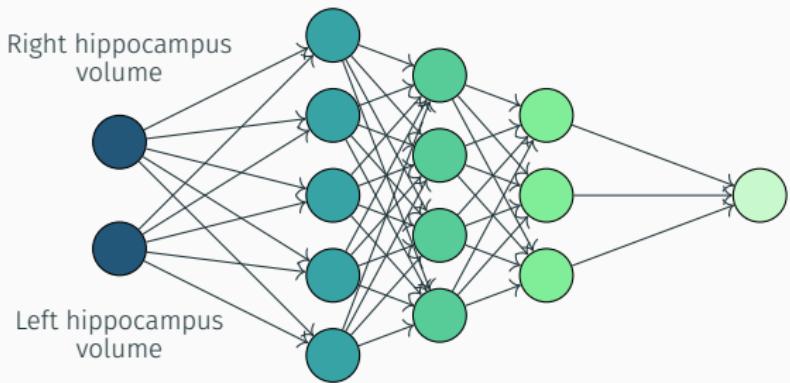
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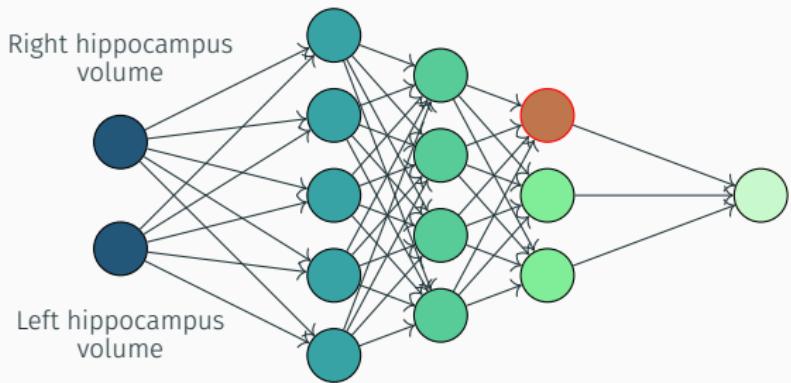
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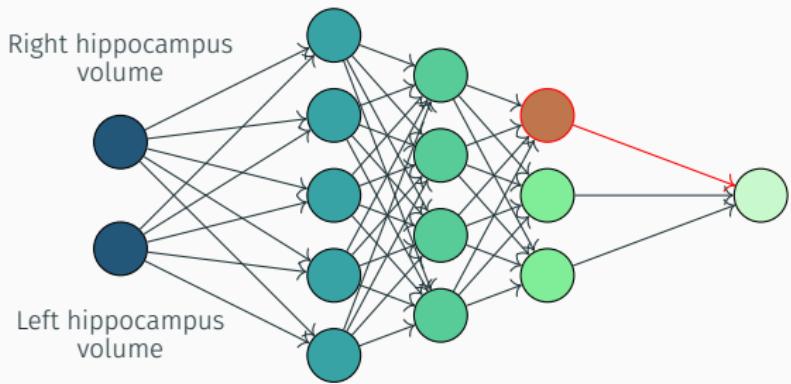
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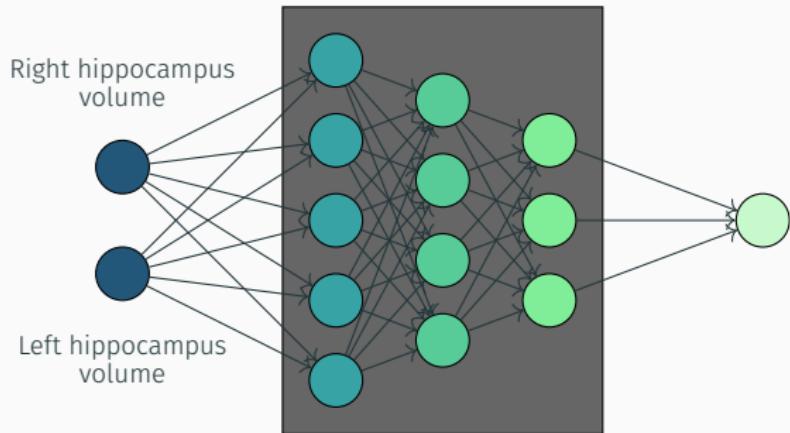
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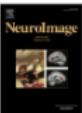


Introduction

- There are high level abstractions that could help delineate the relationship between the brain as represented in neuroimaging data and mental and neurological conditions.
- Deep neural networks epitomize the expressive capacity to learn and utilize these abstractions.
- Approaches need to allow for interpretations of the abstractions themselves.

 ELSEVIER

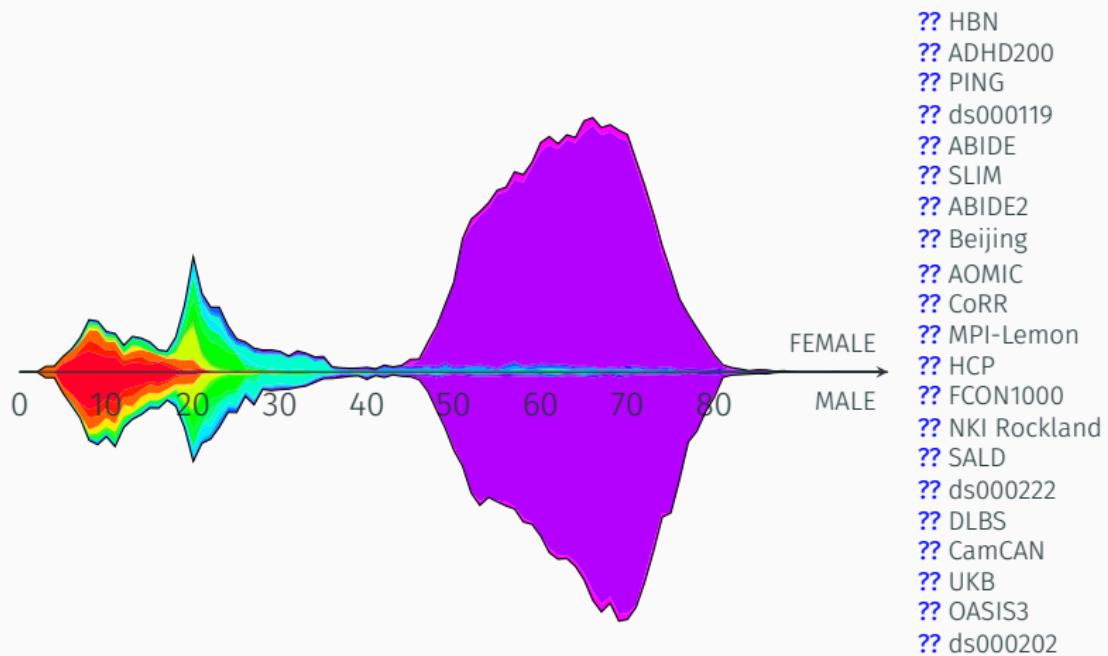
NeuroImage
Volume 256, 1 August 2022, 119210



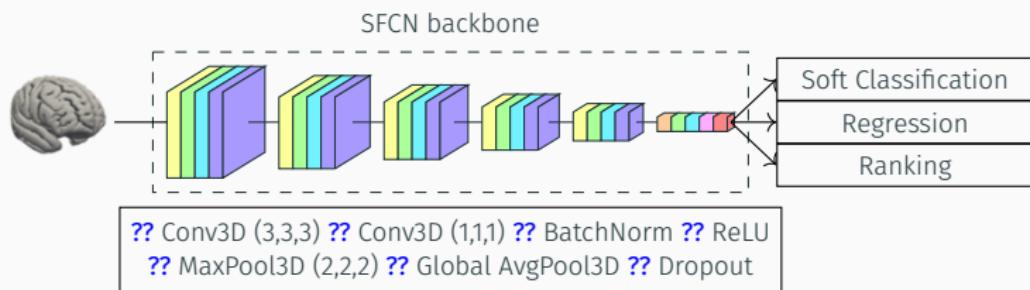
Deep neural networks learn general and clinically relevant representations of the ageing brain

Esten H. Leonardsen^{a b},  , Han Peng^c, Tobias Kaufmann^{b d}, Ingrid Agartz^{b e f}, Ole A. Andreassen^b, Elisabeth Gulowsen Celius^{g h}, Thomas Espeseth^{a i}, Hanne F. Harbo^{g h}, Einar A. Høgestøl^{a b g}, Ann-Marie de Lange^{a j k}, Andre F. Marquand^l, Didac Vidal-Piñeiro^a, James M. Roe^a, Geir Selbæk^{m n}, Øystein Sørensen^a, Stephen M. Smith^c, Lars T. Westlye^{1 a b o}, Thomas Wolfers^{1 a b}, Yunpeng Wang^{1 a}

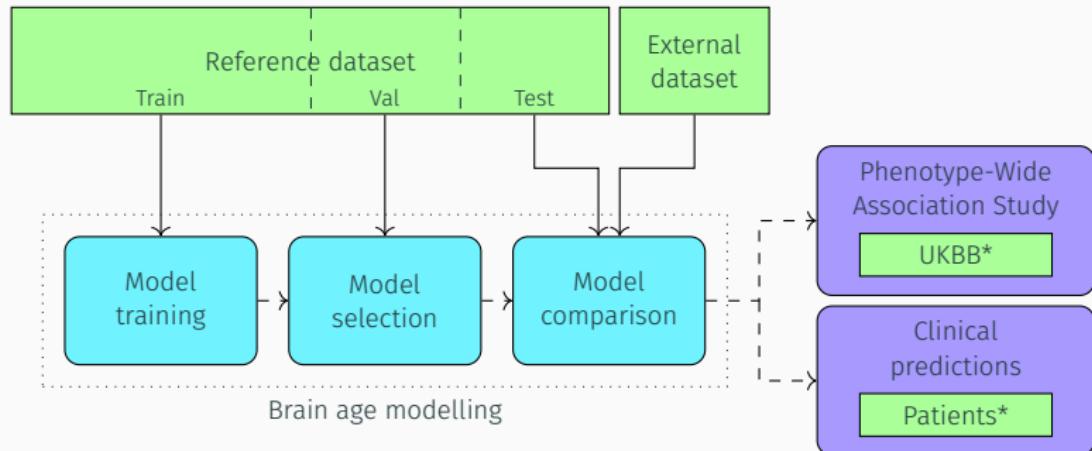
Paper 1: Brain age



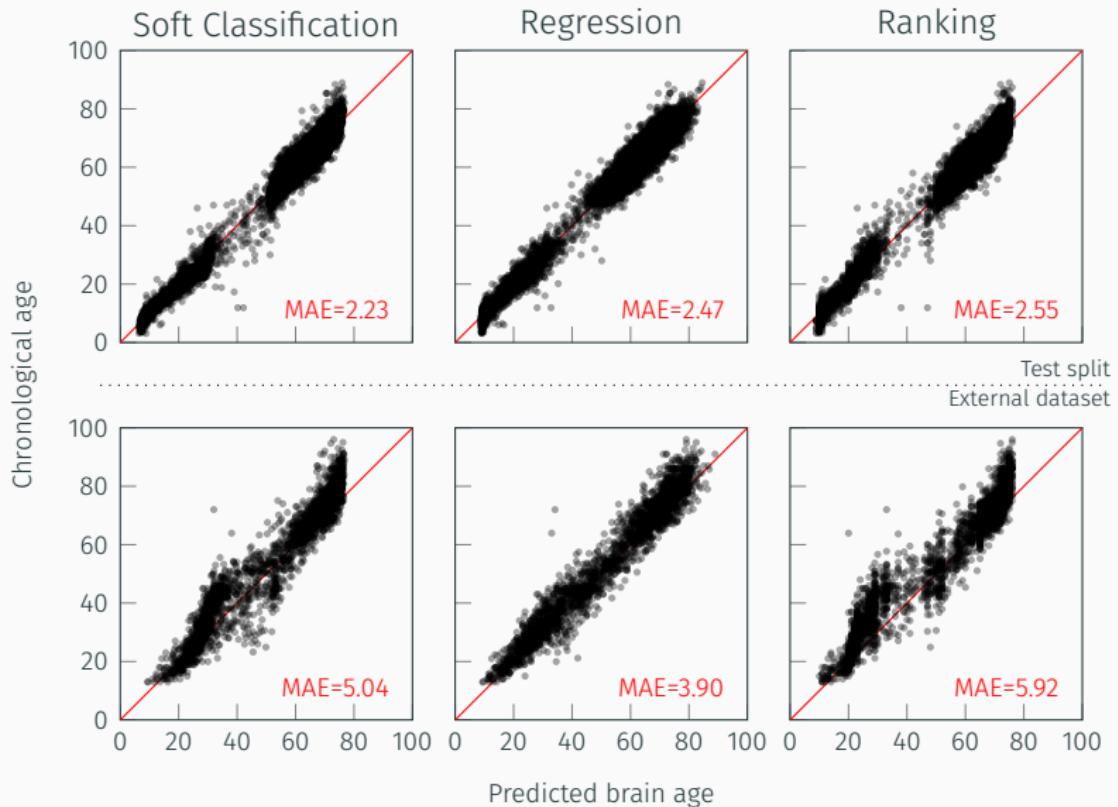
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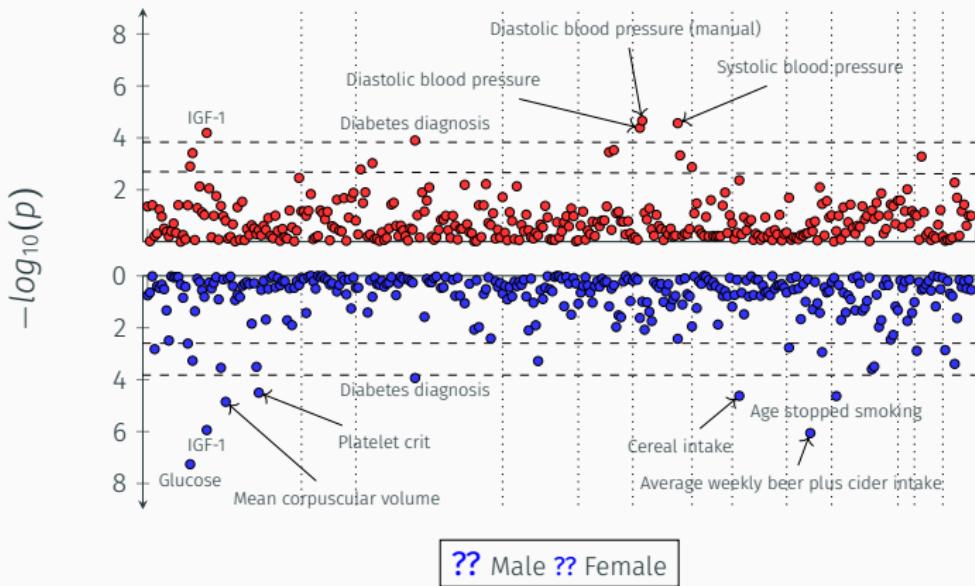
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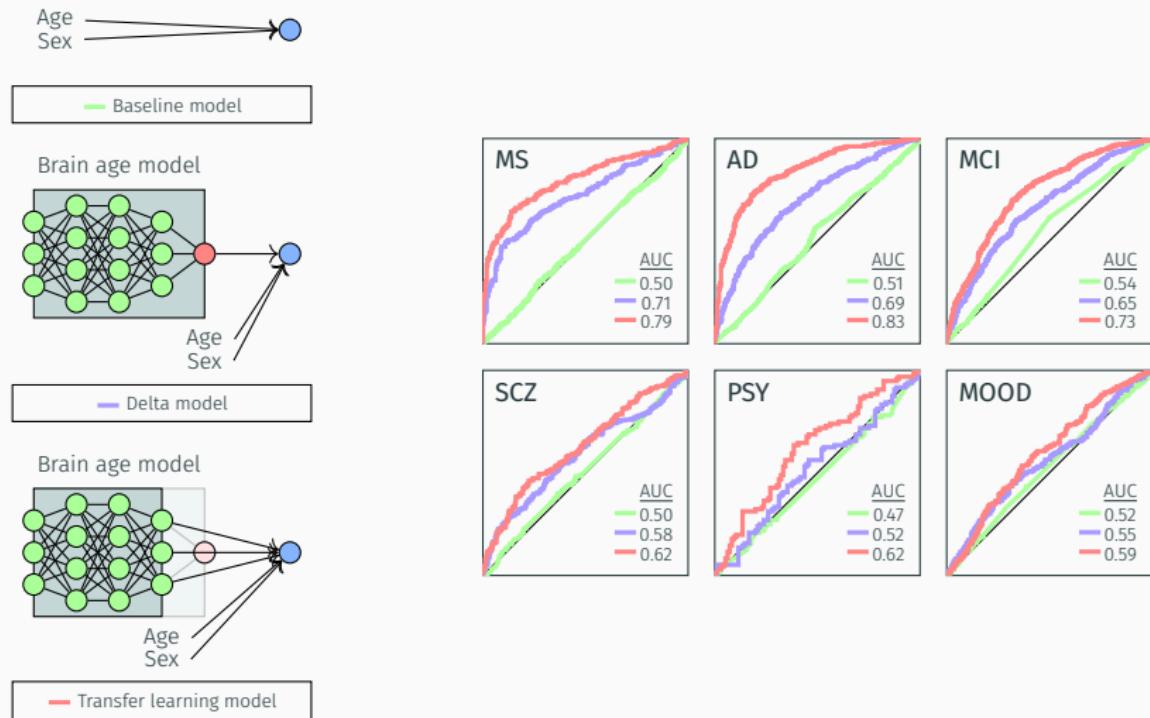
Paper 1: Brain age



Paper 1: Brain age



Paper 1: Brain age



Paper 2: Genetic architecture of brain age

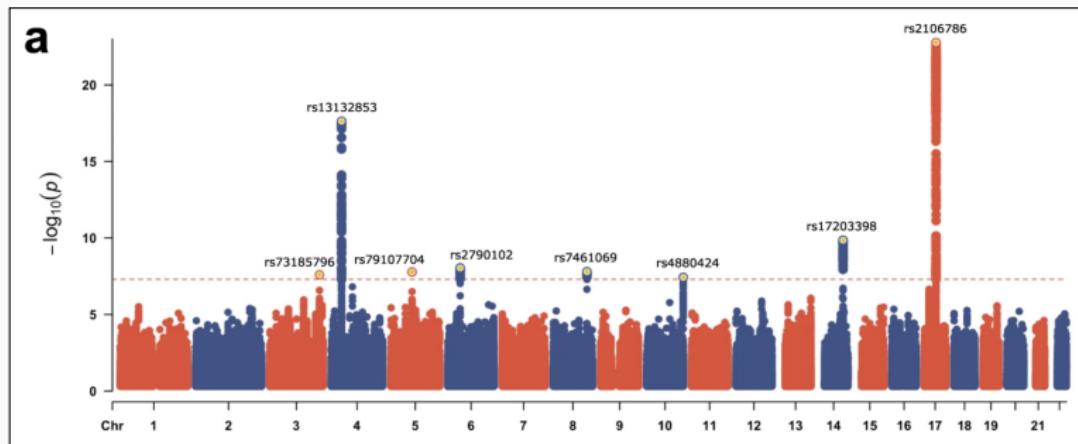
Article | [Open Access](#) | Published: 10 May 2023

Genetic architecture of brain age and its causal relations with brain and mental disorders

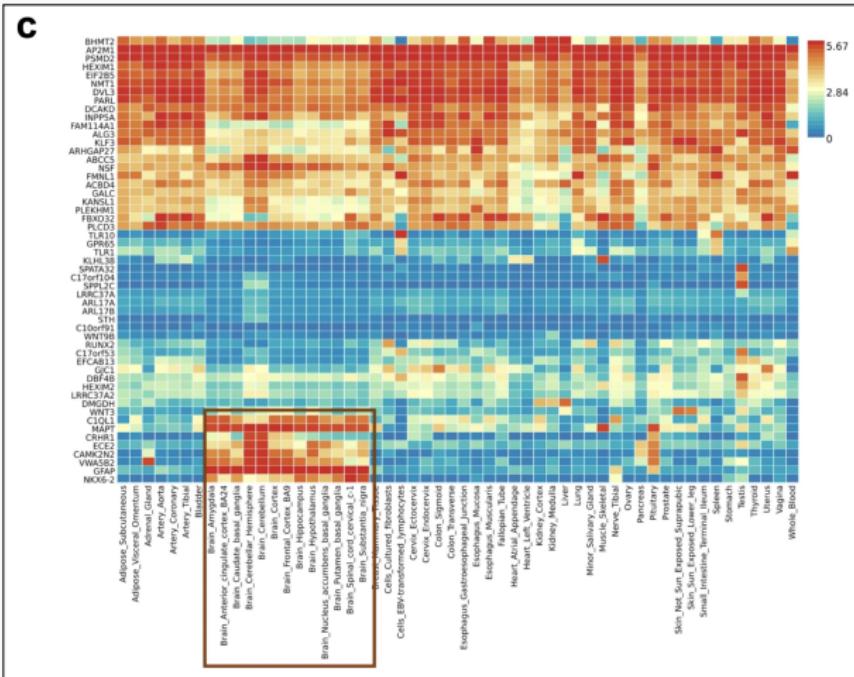
[Esten H. Leonardsen](#), [Didac Vidal-Piñeiro](#), [James M. Roe](#), [Oleksandr Frei](#), [Alexey A. Shadrin](#), [Olena Iakunchykova](#), [Ann-Marie G. de Lange](#), [Tobias Kaufmann](#), [Bernd Taschler](#), [Stephen M. Smith](#), [Ole A. Andreassen](#), [Thomas Wolfers](#), [Lars T. Westlye](#) & [Yunpeng Wang](#)✉

[Molecular Psychiatry](#) (2023) | [Cite this article](#)

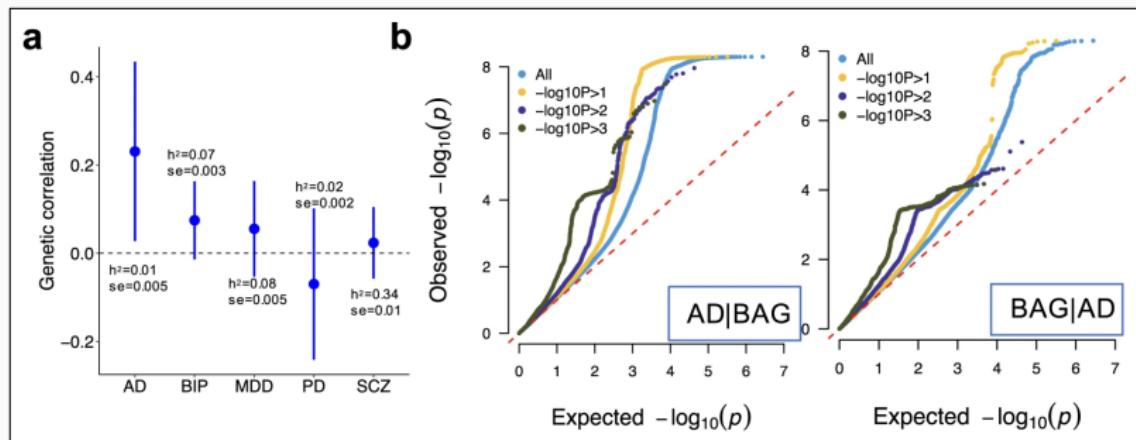
Paper 2: Genetic architecture of brain age



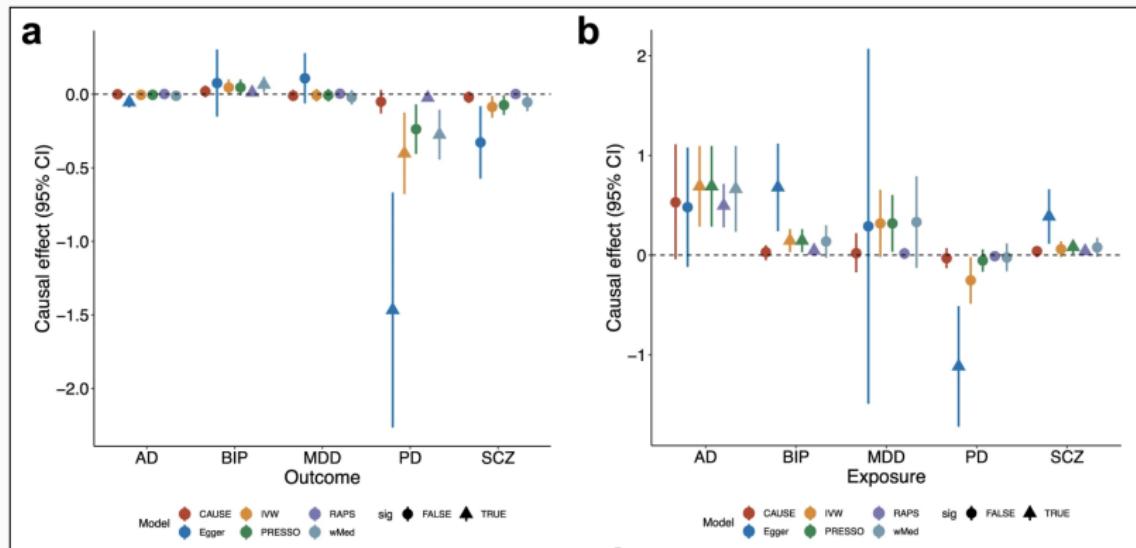
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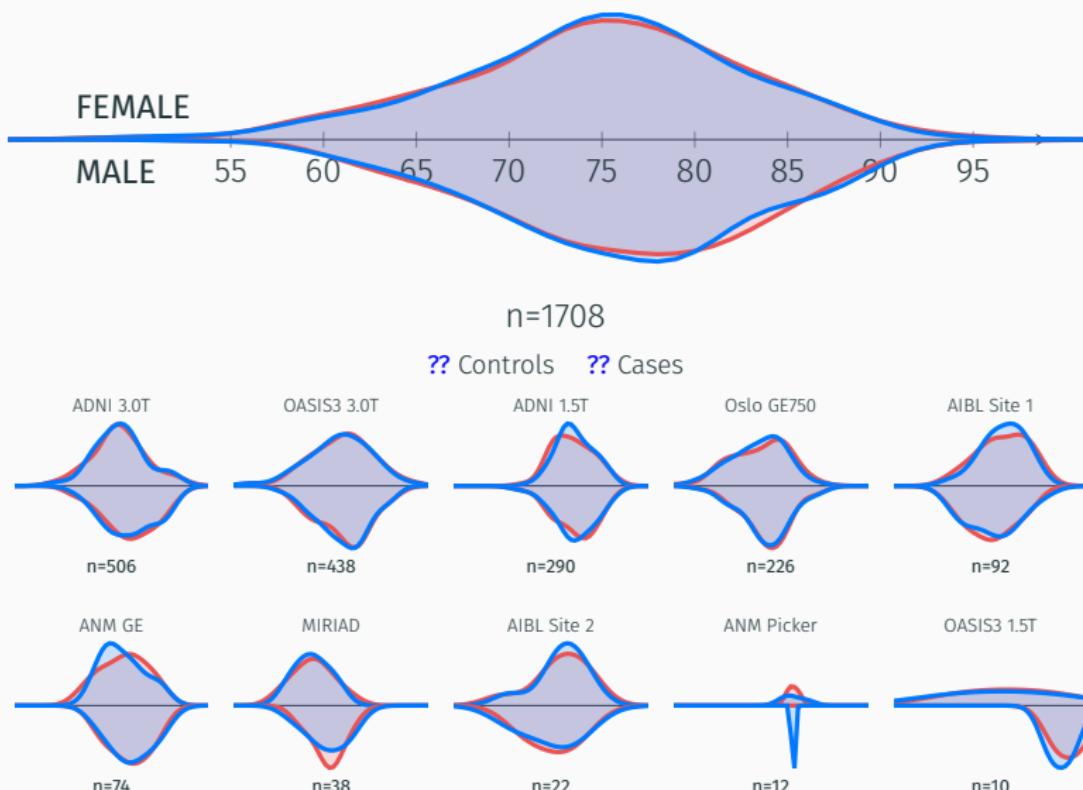
Characterizing personalized neuropathology in dementia and mild cognitive impairment with explainable artificial intelligence

✉ Esten H. Leonardsen, ✉ Karin Persson, ✉ Edvard Grødem, ✉ Nicola Dinsdale, ✉ Till Schellhorn,
✉ James M. Roe, ✉ Didac Vidal-Pineiro, ✉ Øystein Sørensen, ✉ Tobias Kaufmann, ✉ Andre Marquand,
✉ Geir Selbæk, ✉ Ole A. Andreassen, ✉ Thomas Wolfers, ✉ Lars T. Westlye, ✉ Yunpeng Wang,
the Alzheimer's Disease Neuroimaging Initiative,
the Australian Imaging Biomarkers and Lifestyle flagship study of ageing

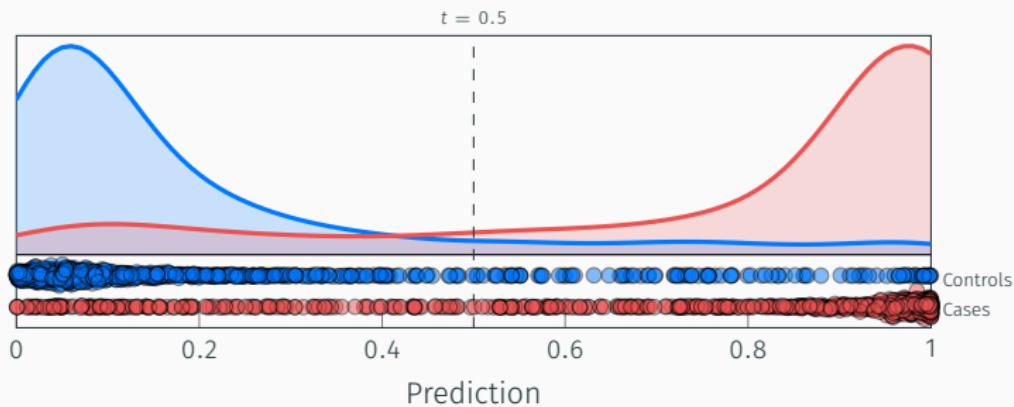
doi: <https://doi.org/10.1101/2023.06.22.23291592>

This article is a preprint and has not been certified by peer review [what does this mean?]. It reports new medical research that has yet to be evaluated and so should not be used to guide clinical practice.

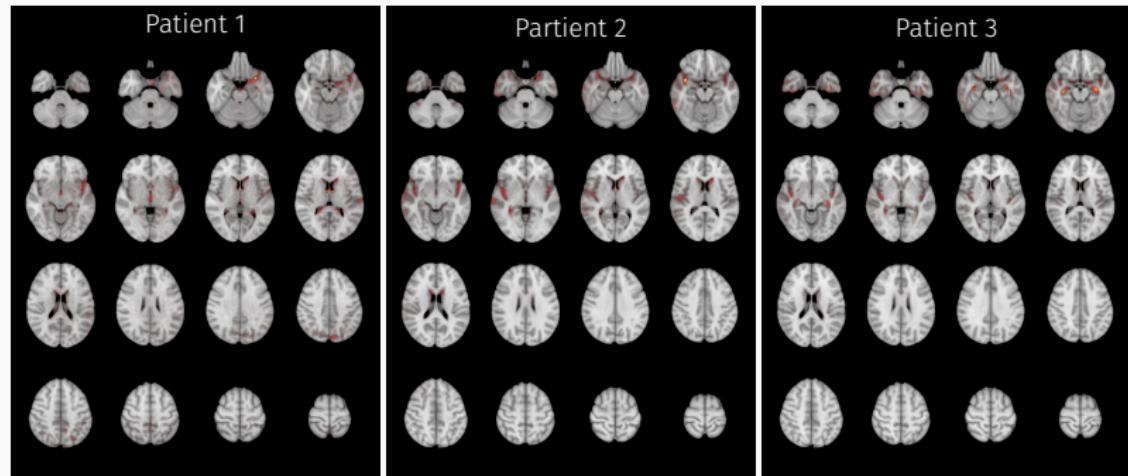
Paper 3: Explainable AI and dementia



Paper 3: Explainable AI and dementia

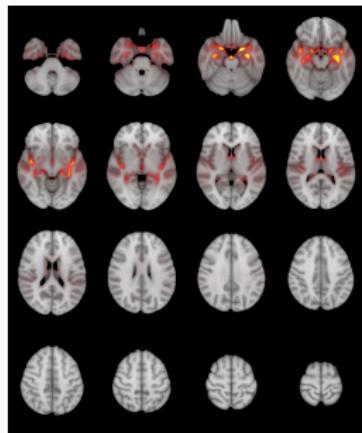


Paper 3: Explainable AI and dementia



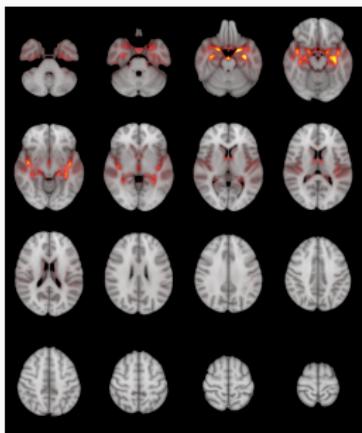
Paper 3: Explainable AI and dementia

LRP

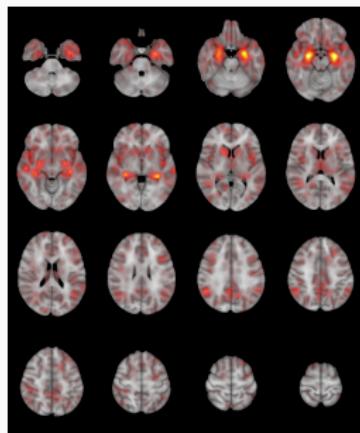


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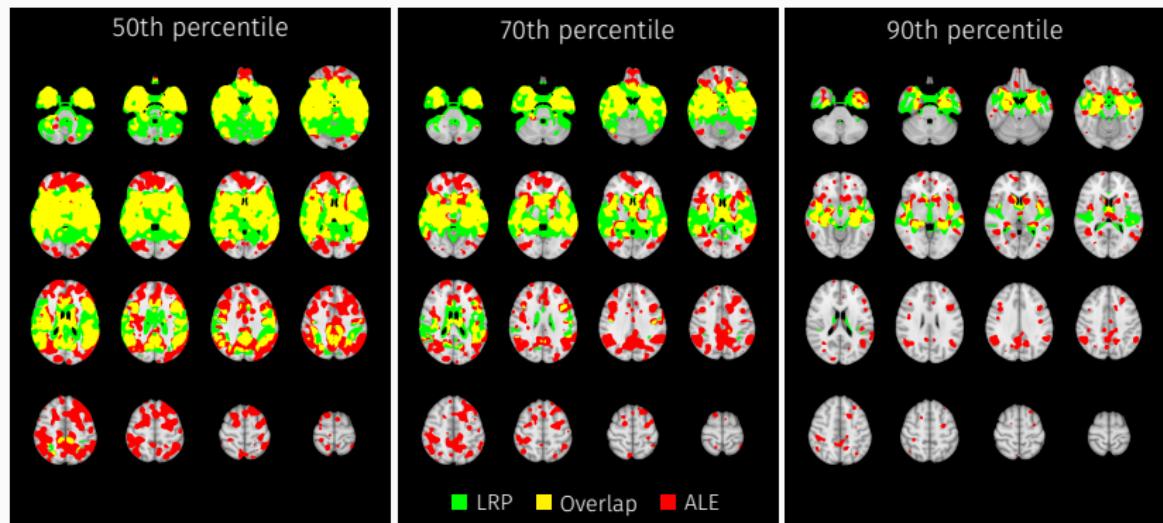
LRP



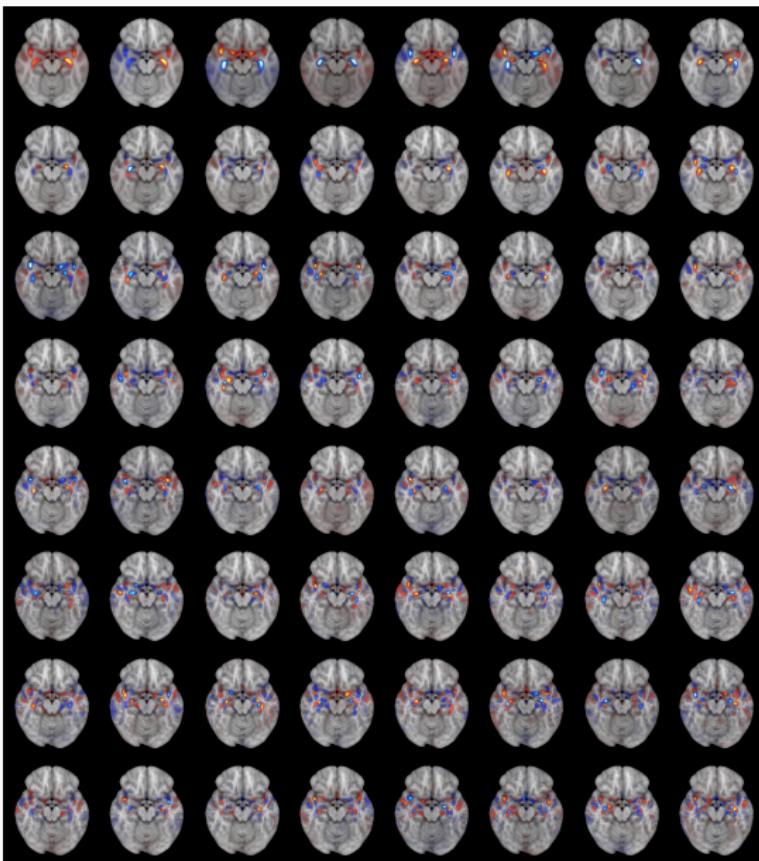
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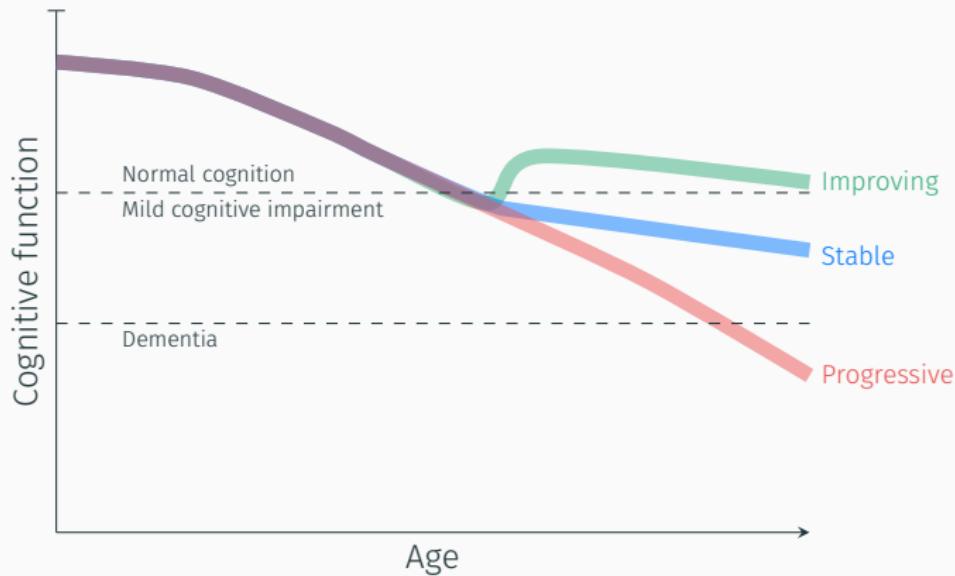
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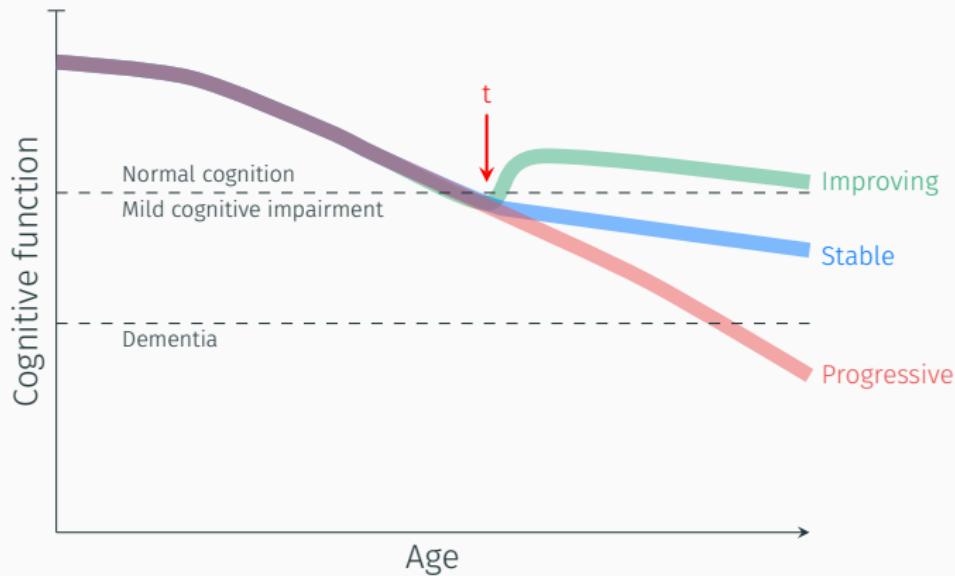
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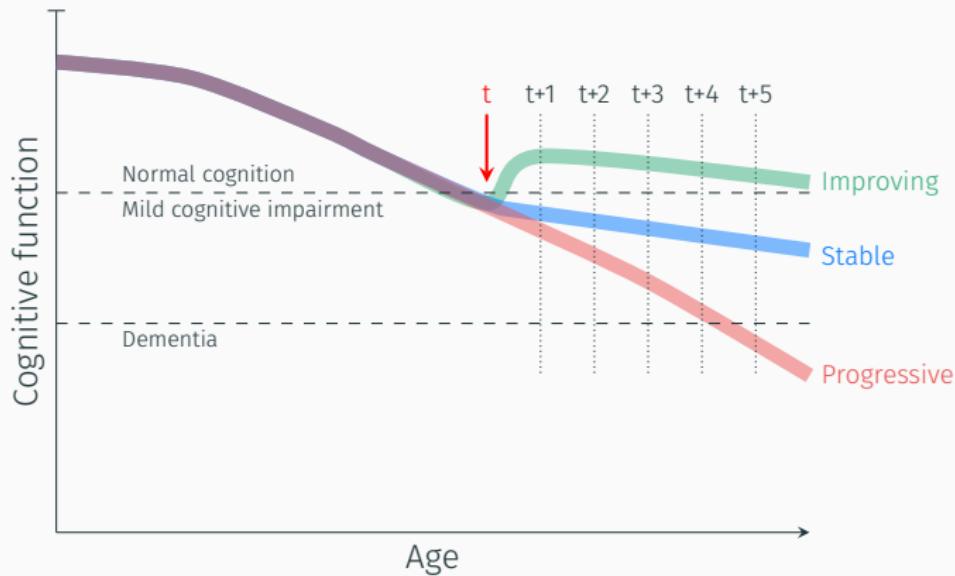
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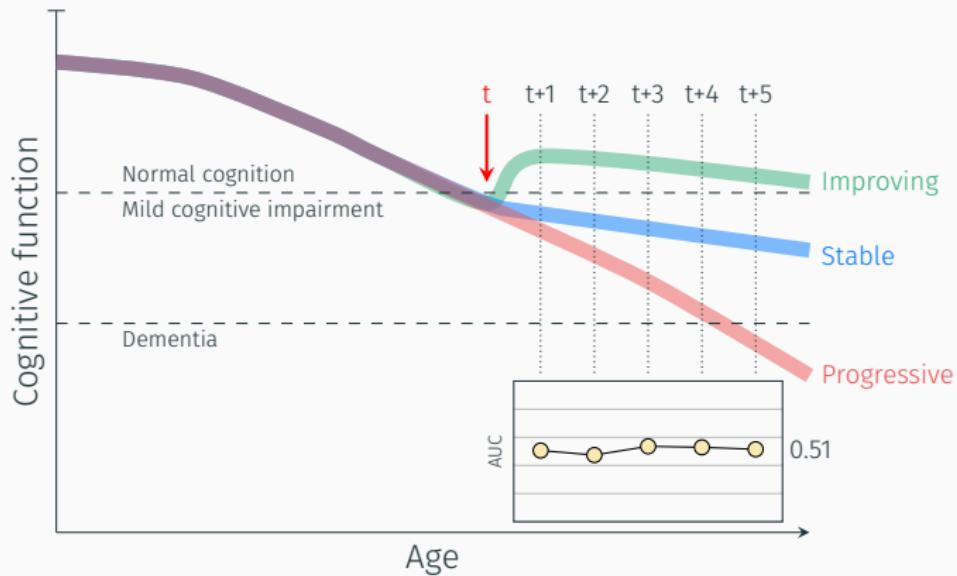
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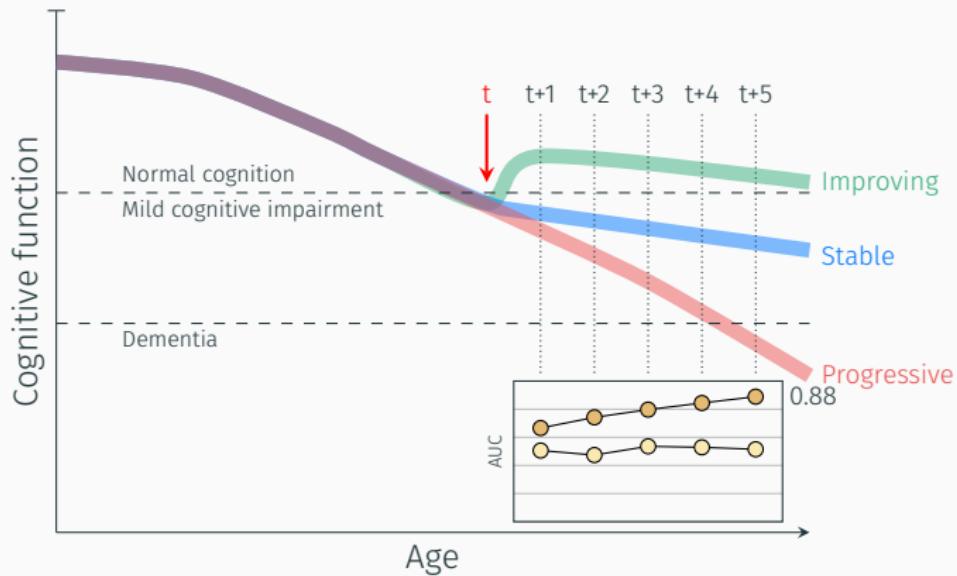
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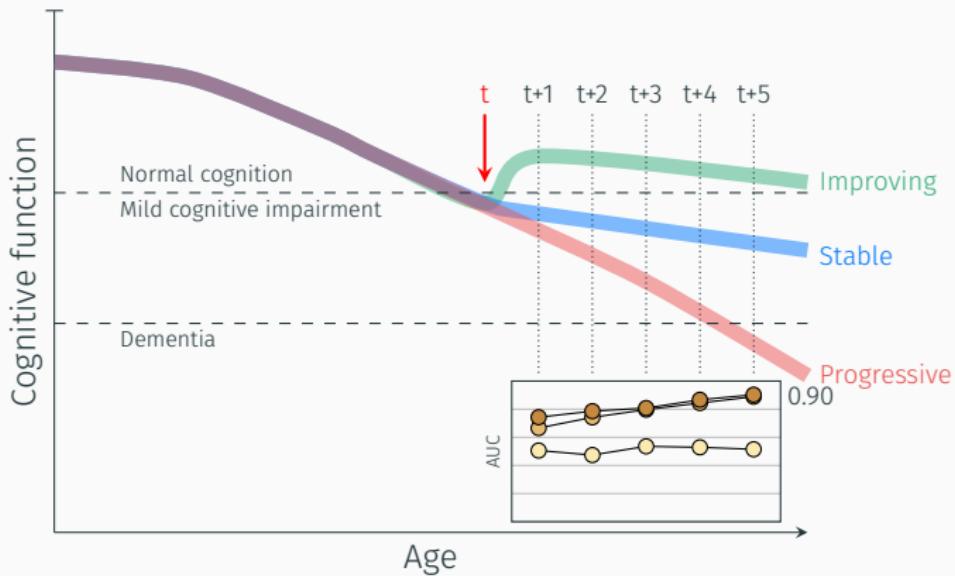
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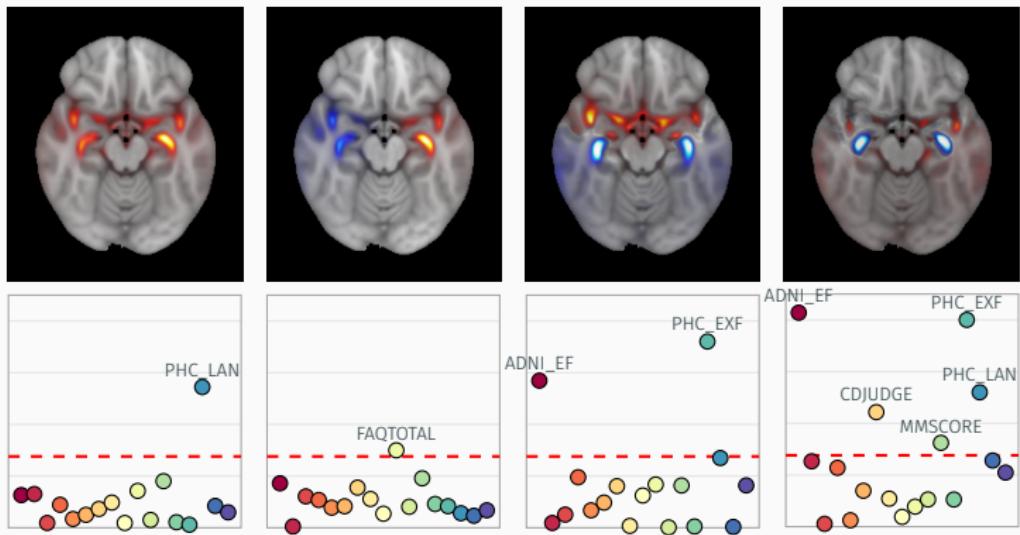
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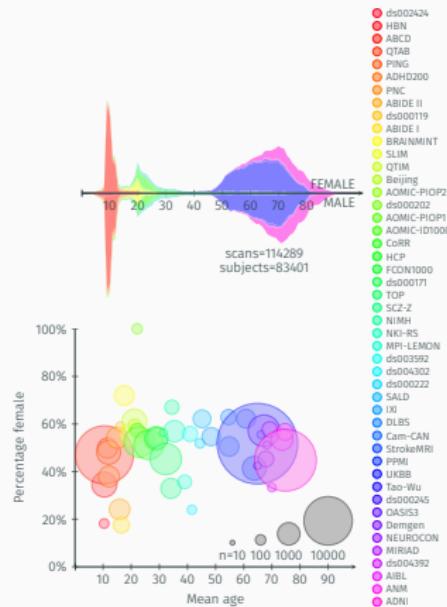
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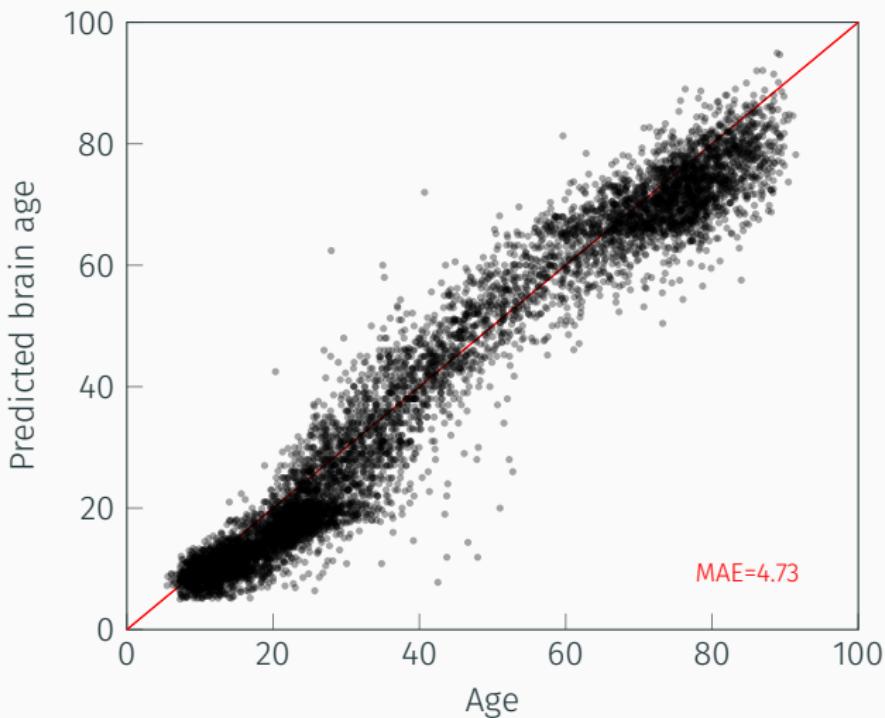
Paper 4: Explainable brain age

Explainable artificial intelligence reveals ??? patterns of brain aging in
???

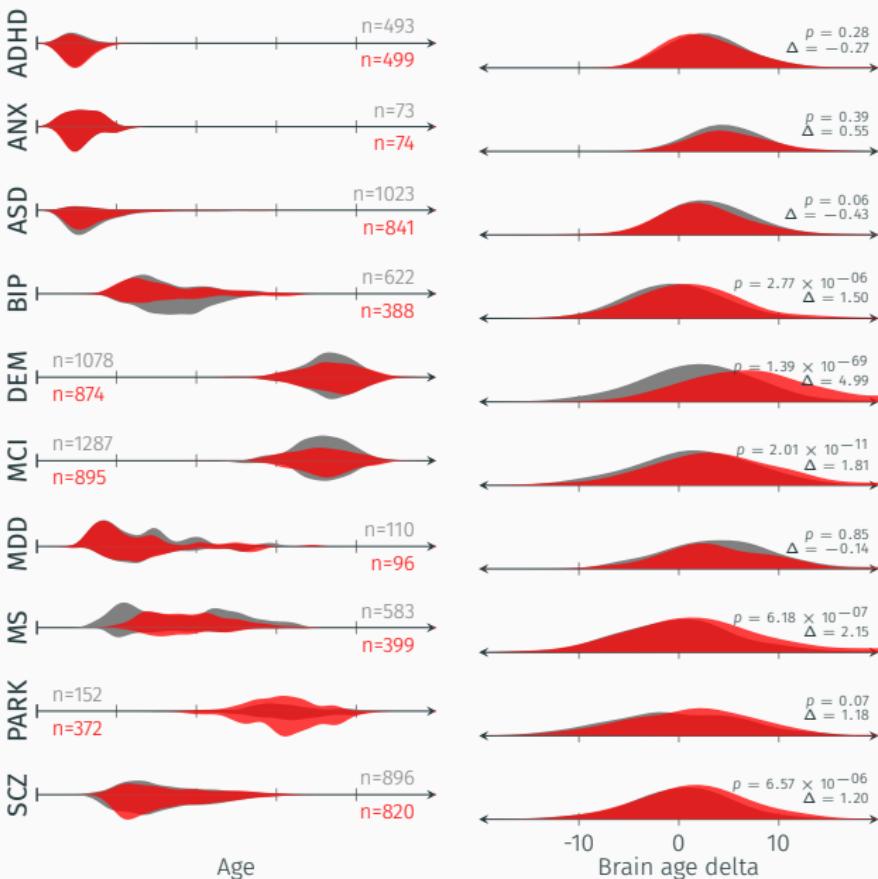
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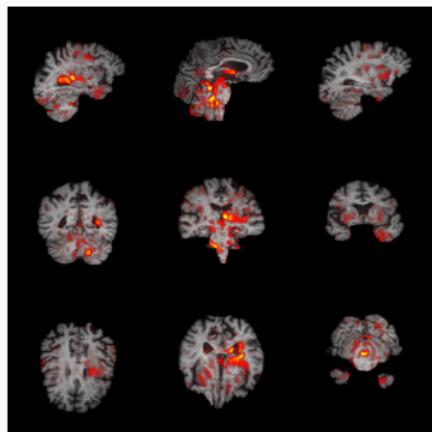
Paper 4: Explainable brain age



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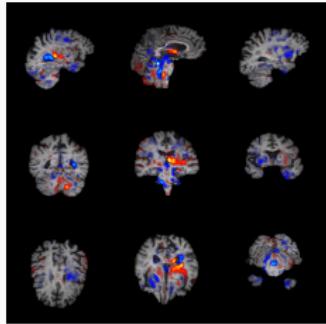


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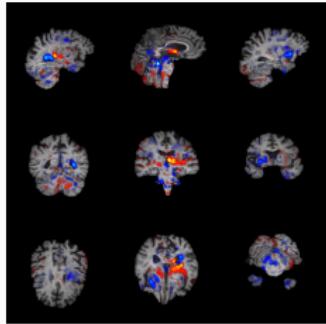


$\hat{age} = 79.6$

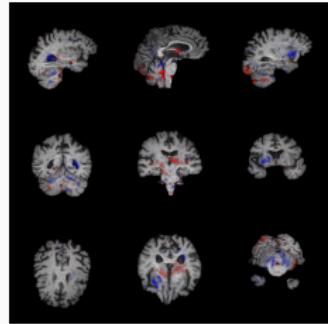
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$$\delta_{50} = 29.6$$



$$\delta_{70} = 9.6$$



$$\delta_{90} = -10.4$$

Practical stuff

- ✓ 35/30 credits
- ✓ Presented at conference
- ✗ ?/? teaching hours (PSY9511 this fall)
- ✓ Public dissemination
- ✓ Open source contributions