Confound-free hand grip strength prediction:
Synergy of advanced machine learning and neuroimaging
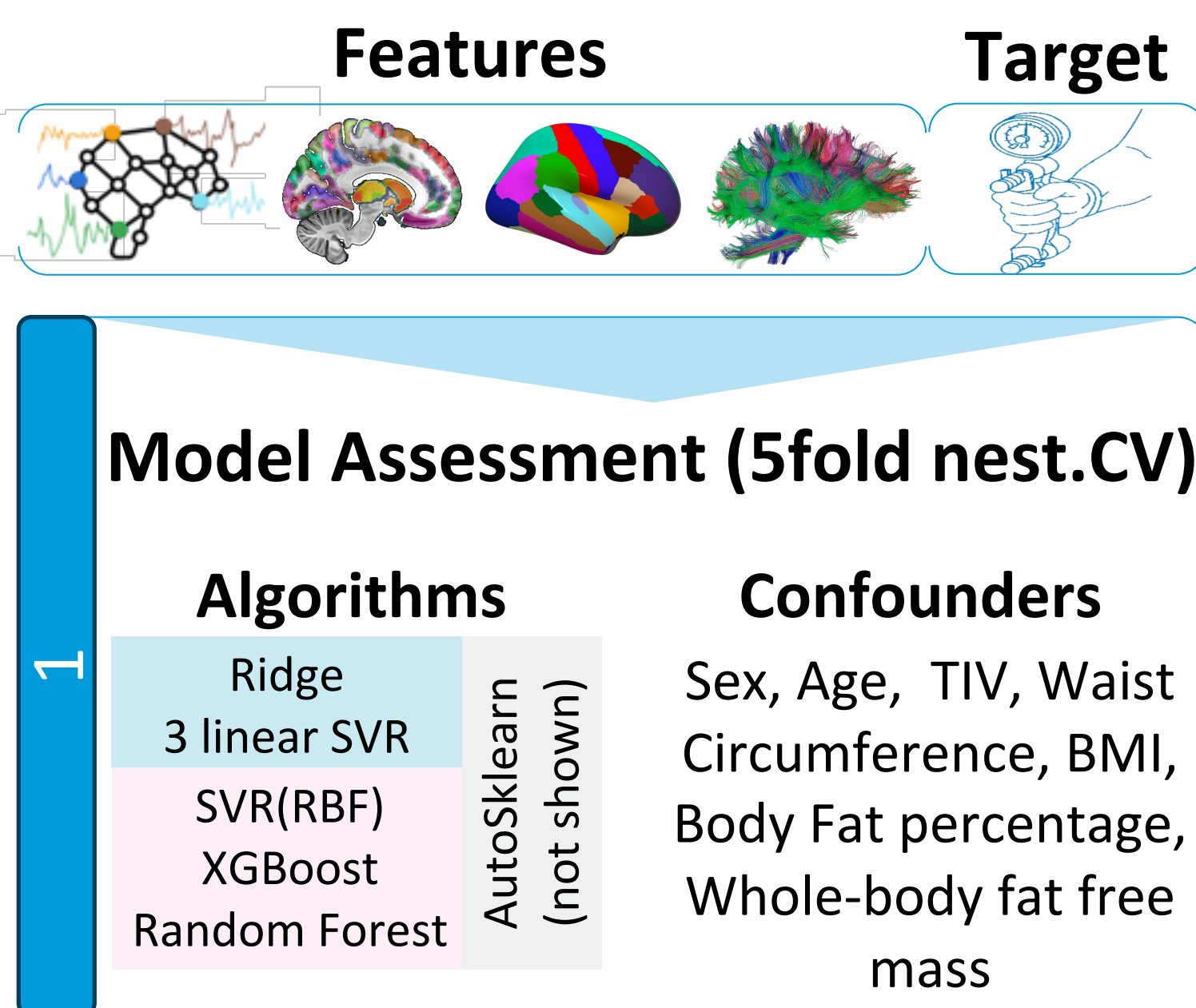
Vera A. Komeyer[1,2,3], Simon B. Eickhoff[1,2], Jan Kasper[1,2], Christian Grefkes[4,5,6], Kaustubh R. Patil[1,2], Federico Raimondo[1,2]

[1]Institute of Systems Neuroscience, HHU | [2]Institute of Neuroscience and Medicine (INM-7), FZJ | [3]Department of Biology, Faculty of Mathematics and Natural Sciences, HHU | [4]Department of Neurology, University Hospital Cologne and Medical Faculty, University of Cologne | [5]Cognitive Neuroscience, Institute of Neuroscience and Medicine (INM-3), FZJ | [6]Centre for Neurology and Neurosurgery, University Hospital Frankfurt, Germany

Motivation & Impact

- Hand grip strength (HGS) is…
  - a marker of overall strength, physical disability, cognitive decline, vitality and mortality[1-4]
  - a cost-efficient and reliable measure in clinical practice
  - strongly confounded by sex, age and body composition measures[5]

- This work…
  1) evaluates if neuroimaging-derived features allow for Out Of Sample (OOS) prediction of HGS → precision medicine
  2) provides insights into non-confounded underlined neuronal correlates of HGS

Workflow

Features   Target

Model Assessment (5fold nest.CV)

Algorithms

Ridge
3 linear SVR
SVR(RBF)
XGBoost
Random Forest

AutoSklearn (not shown)

Confounders

Sex, Age, TIV, Waist Circumference, BMI, Body Fat percentage, Whole-body fat free mass

Model Comparison

Find the best CONFOUND-FREE model

→ Friedmann test (R^2 CV) + Nemenyi post-hoc

Out Of Sample evaluation

Predict HGS in previously UNSEEN subjects

Driving Brain Factors

SHAP

Examples: White Matter Tracts & GMV

Feature Collinearities?

Example GMV - Correlation Network Analysis

Example WM - Cluster Analysis

Analyses & Results

sex regressed

sex-split

Female

Male

White Matter

Gray Matter

Resting State (fALFF)

15 most important GMV-features

GMV - Male

GMV - Female

WM - Male

WM - Female

Take away

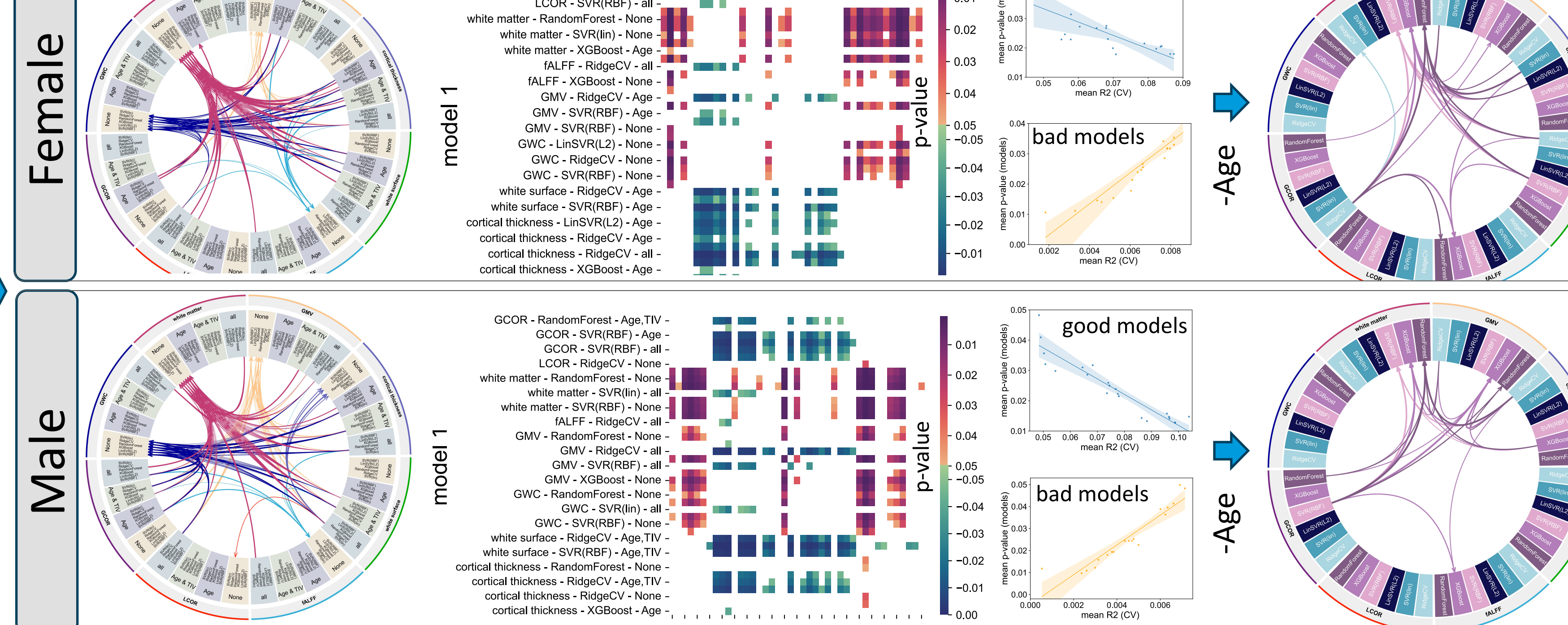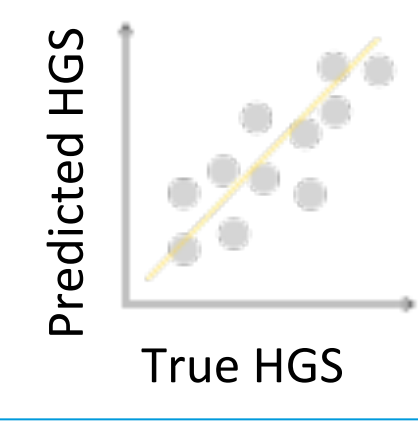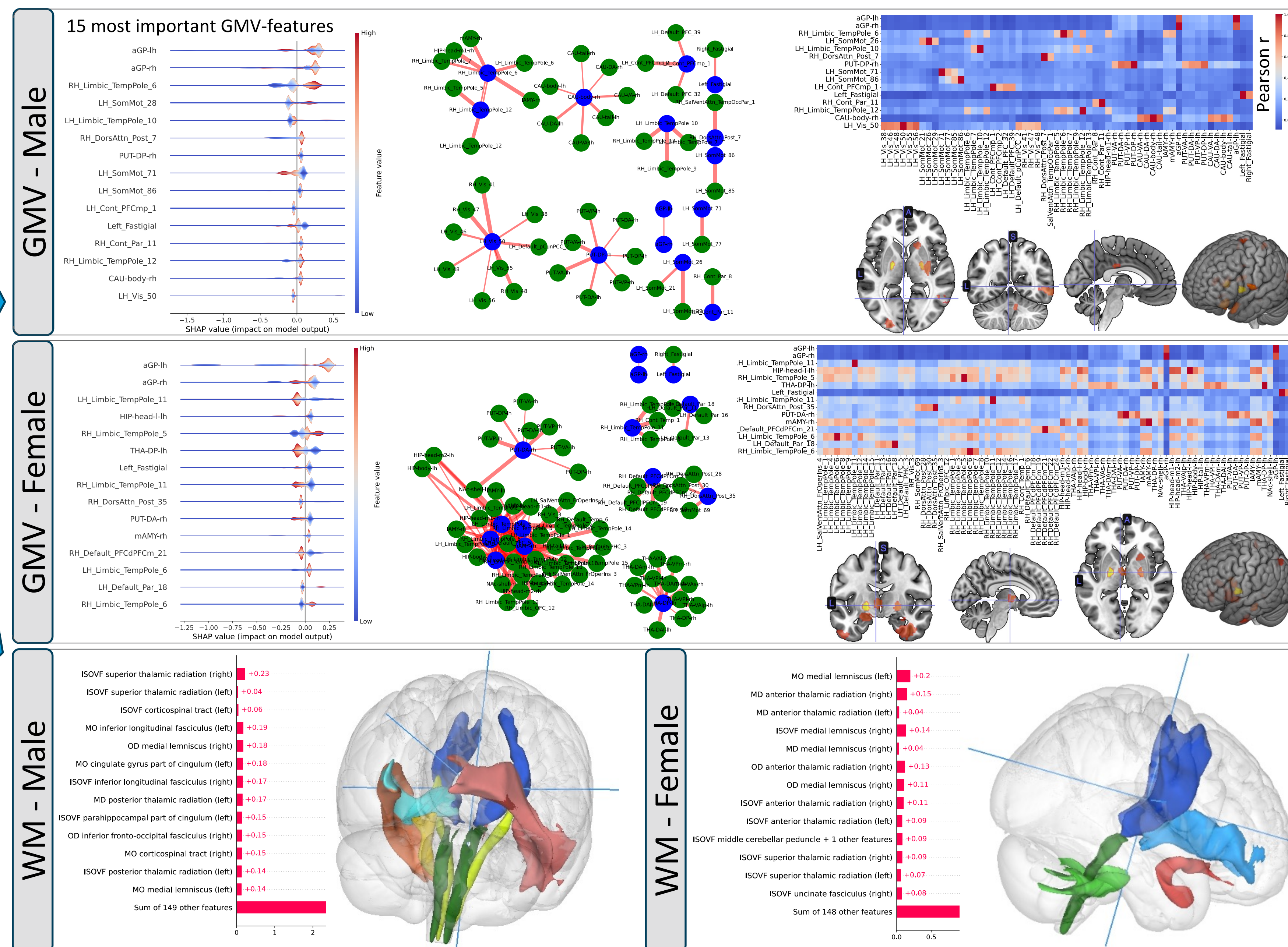**Confounders** heavily **impact performance**

→ sex-split models needed to rule out non-linear sex effects

"None"-models perform significantly best

p-value & R^2 value correlated → **model ranking**

Sign. best CONFOUND-FREE models:
- Non-linear
- White Matter, GMV, fALFF

Predictive GMV

- bilateral anterior globus pallidus
- left fastigial

→ carry robust unique information

Predictive White Matter Tracts
- ISOVF: thalamic radiations (m&f)
- tubular water diffusion: medial lemniscus (f)

References
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