B05 - Single-case predictions of motor abilities in health and disease

Handgrip strength prediction using behavioural and anthropometric features in 179K individuals from the UK Biobank

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Introduction

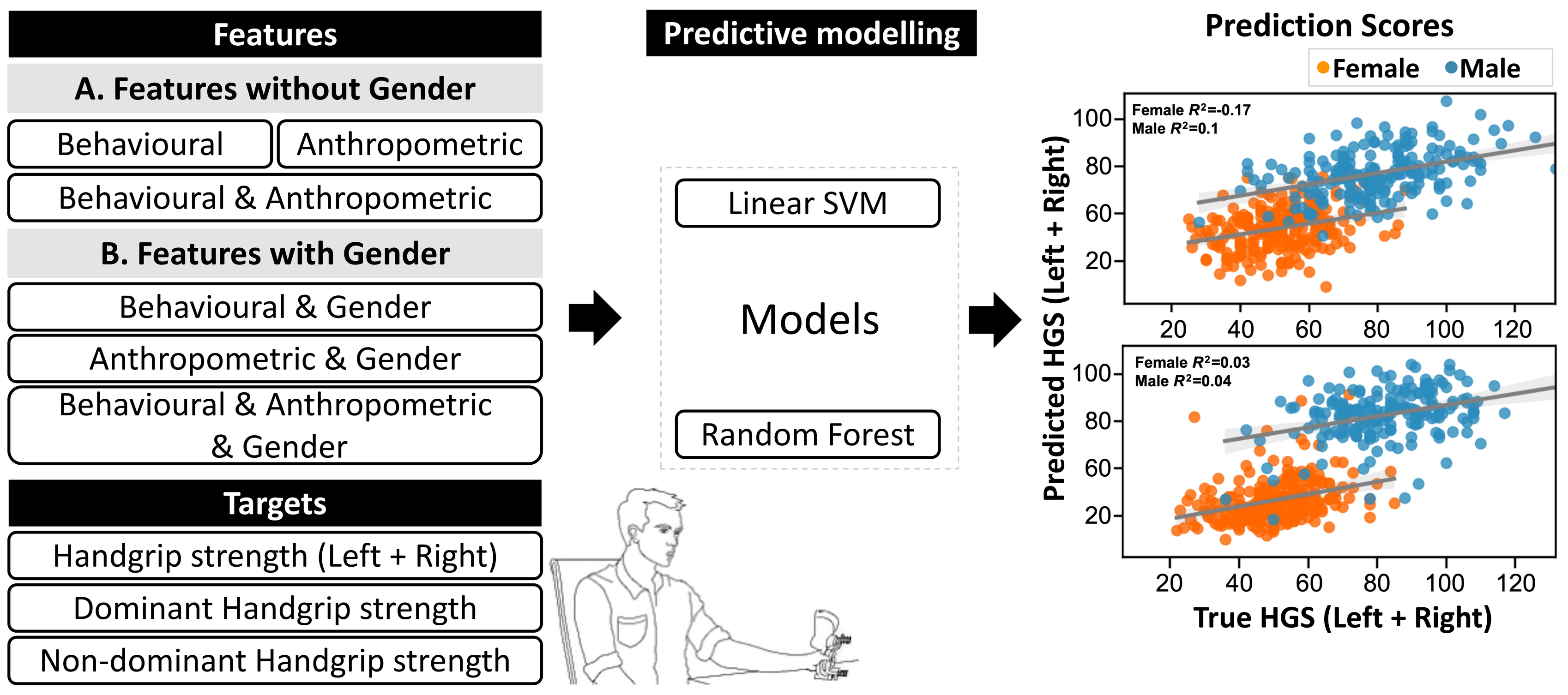
- Handgrip strength (HGS) is a valid biomarker for motor performance [1].
  - is an inexpensive, non-invasive, and commonly available measure in clinics.
  - is a powerful health condition predictor [2].
  - can diagnose and prognosticate acute stroke patients [2].
- Normative models can identify abnormality and in turn brain changes that affect HGS and other motor functions
  - Using a wide range of behavioural phenotypes and anthropometric measures.

Aim: Use anthropometric and behavioural features to build machine learning-based models to predict HGS.

Data and Methods

- Data from non-MRI healthy controls in the UK Biobank
- Participants with dominant handgrip strength < 4 kg excluded [2]
- 30 behavioural phenotypes, e.g. cognitive functions, anxiety, depression, neuroticism [2-5]
- Anthropometric measures; BMI, Height and waist-to-hip circumference ratio [2]
- Features with or without the inclusion of gender (which confounds HGS)
- Models were also built for the genders separately
- Predictive models: **Linear Support Vector Machine (SVM)** and **Random Forest**
  - CV scheme with 10 repeats and 5 folds
  - R^2 score (coefficient of determination) for evaluation
  - Sample size effects were analysed

Block Diagram of Study



Results: Prediction of HGS (Left + Right)

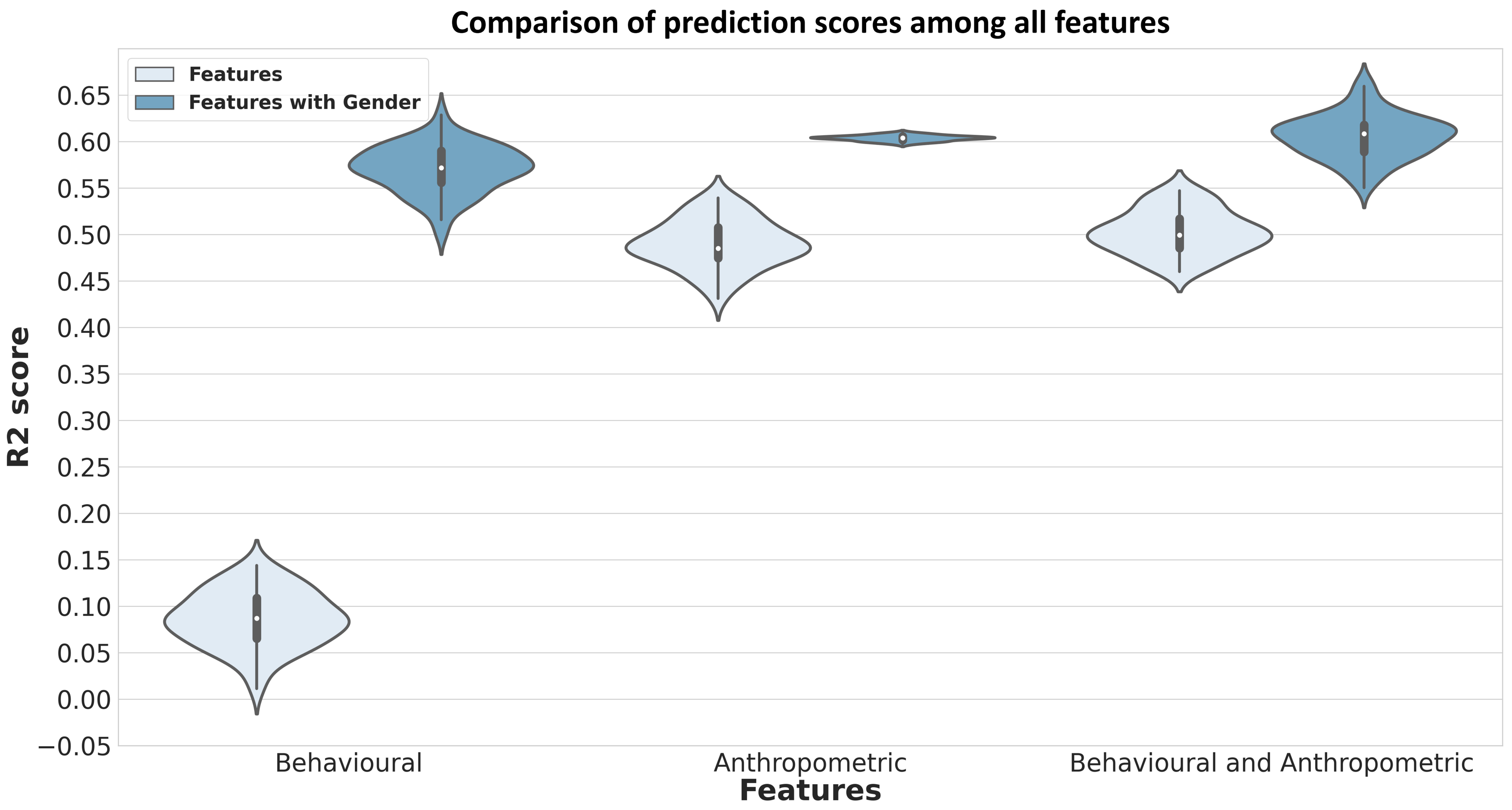


Figure 1:

- 2,143 subjects with completed assessments of all behavioural phenotypes
- Behavioural features have the lowest R^2 (median=.087)
- Anthropometric features showed high R^2 (median=.485)
- Adding gender as a feature significantly increased the prediction scores.

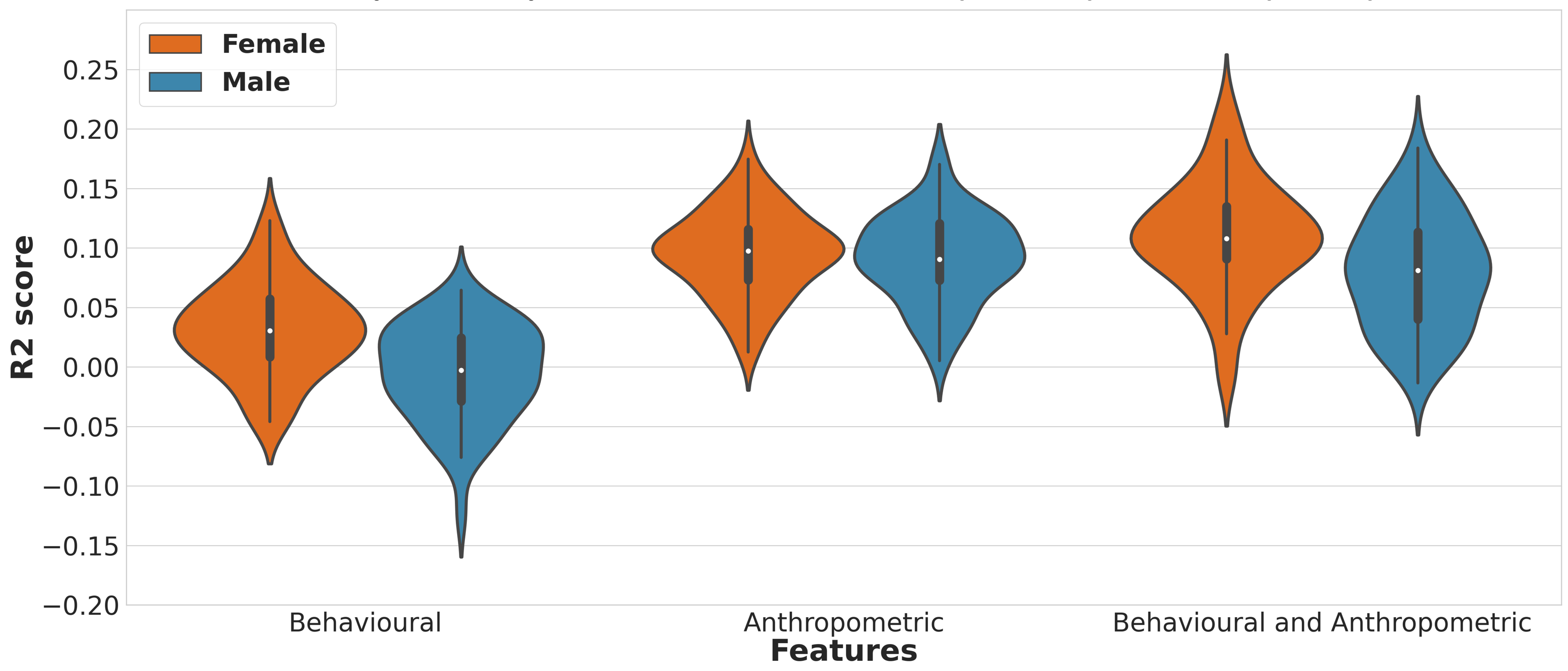


Figure 2:

- Building the model separately decreased accuracy significantly
- The difference between females and males was not pronounced within each feature type.
- Anthropometric features were still better than behavioural features
- The drop in accuracy (Fig. 1) indicates HGS information encoded in gender

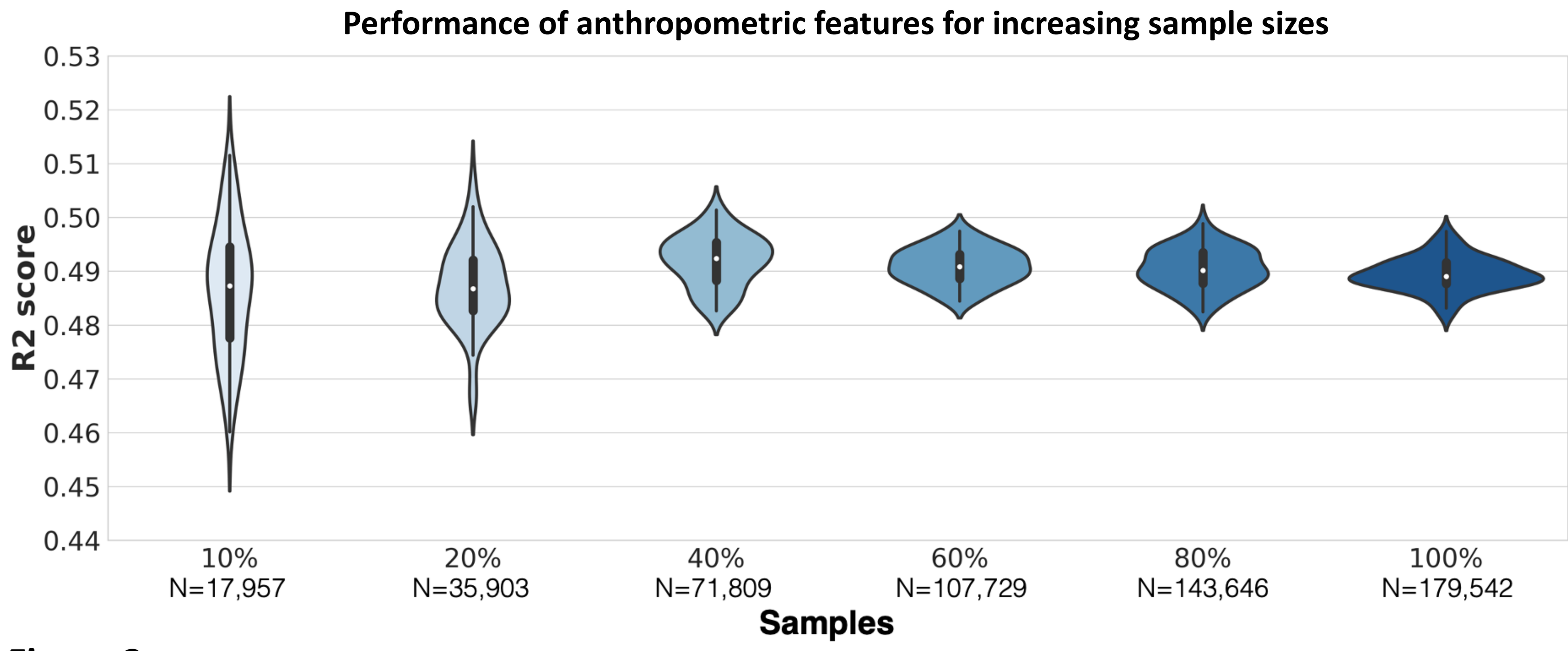


Figure 3:

- The lower sample size of anthropometric features shows a high variance [6].
- Median accuracy first increased and then slightly decreased.
- The performance saturates around N=71k

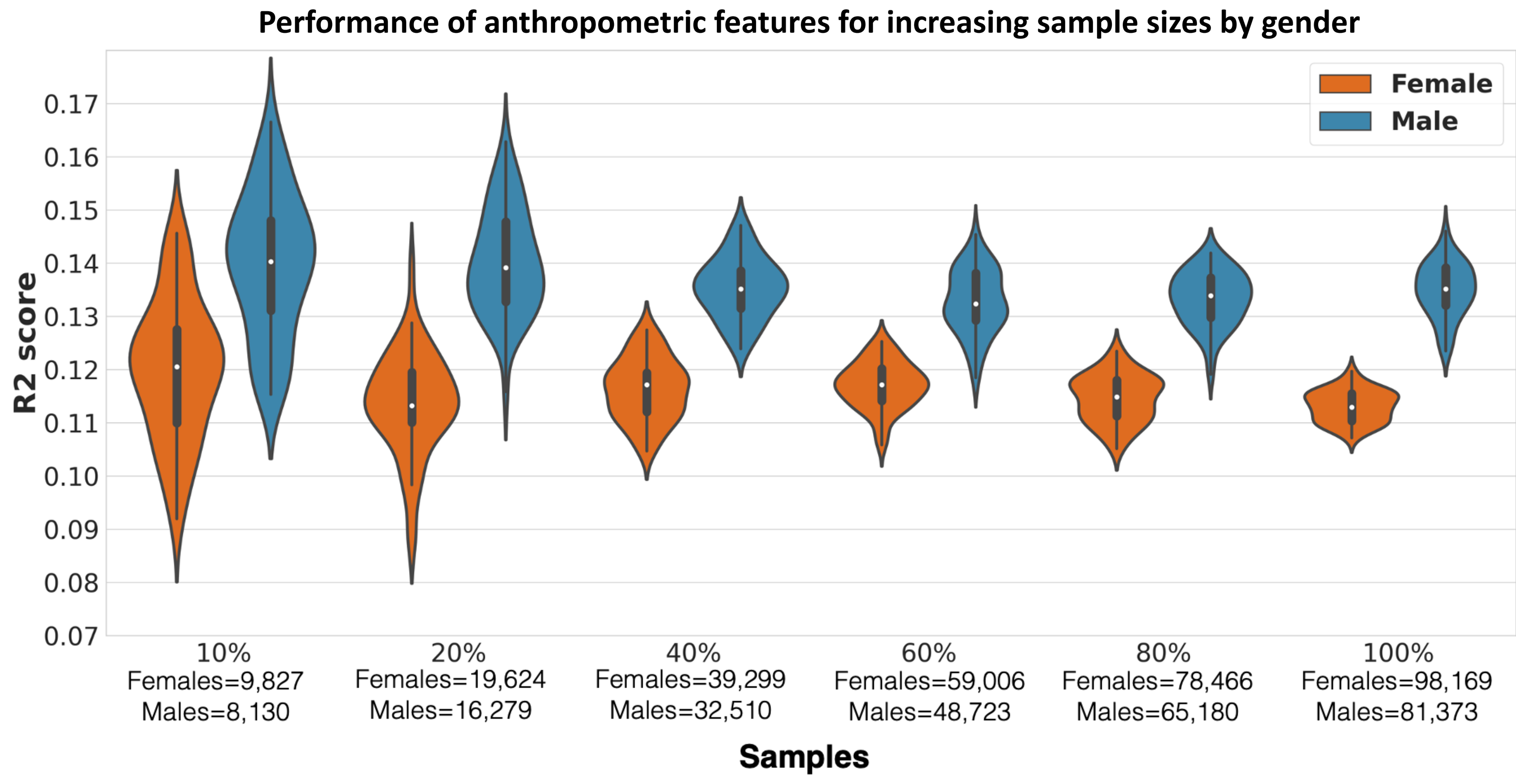


Figure 4:

- The prediction accuracy dropped when males and females were analysed separately
- Predictions in males were better than in females at all sample sizes.
- The difference became pronounced and more significant with increasing sample size.

Conclusion

- Linear SVM outperformed Random Forest.
- Using gender as an additional feature considerably increased prediction accuracy.
  - Gender is a strong confound when modelling HGS.
- Males predicted HGS better than females with anthropometric features.
- (Non-)dominant HGS could be predicted but the HGS (Left + Right) predictions were more accurate.

Next steps

- Deploy the models to predict individuals with MRI data
- Identify brain correlates (e.g. WM intensity)
- Apply the pipeline to stroke patients

References

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