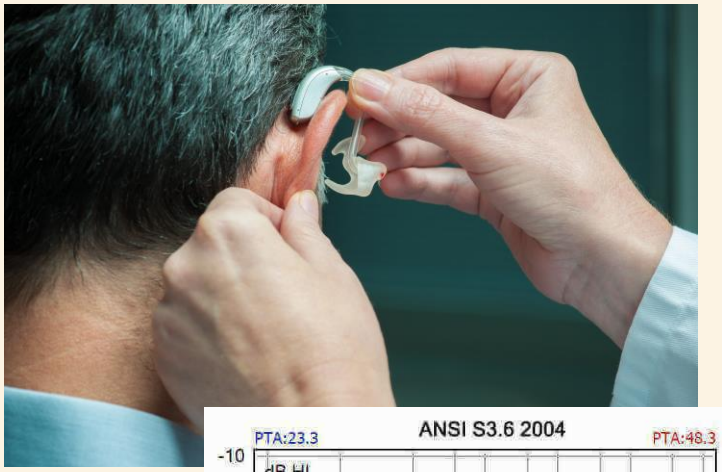
Predicting spatial release of masking for hearing impaired listeners: a statistical learning approach

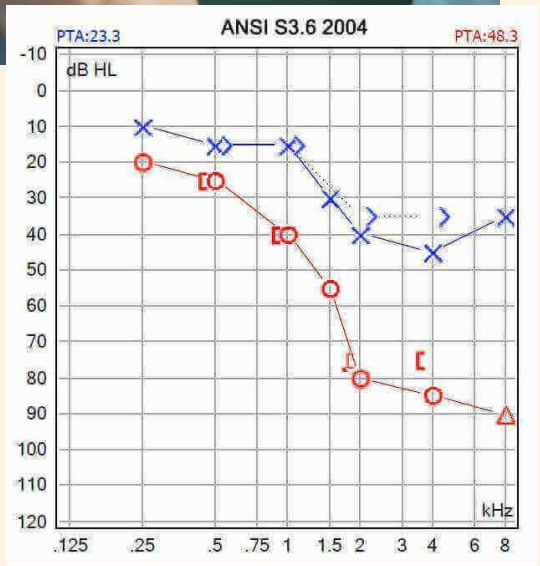
Mark Huckvale & Tim Green

Speech, Hearing and Phonetic Sciences

University College London

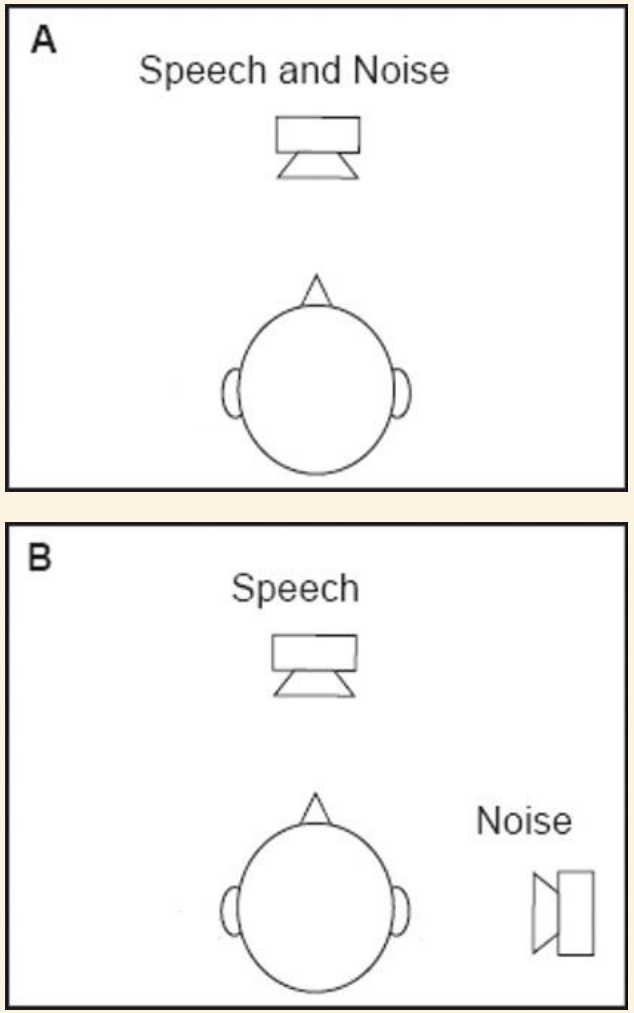
Objective





Predict change in intelligibility

from audiometric data

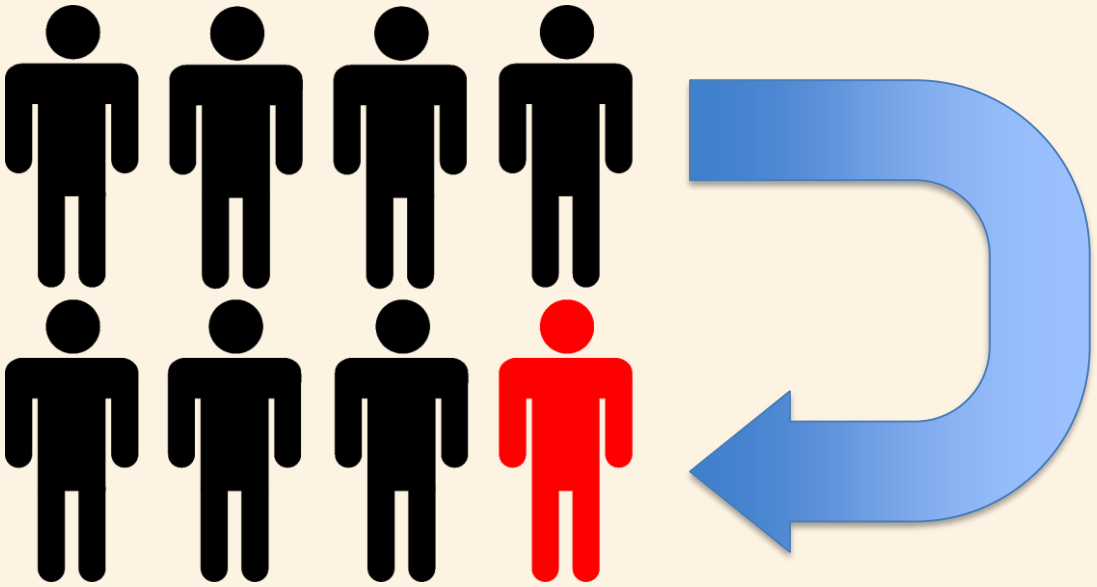


Prediction not explanation

- Speech Reception Thresholds are significantly affected by: *
  - raised pure tone thresholds
  - increased auditory filter bandwidths
  - degree of amplitude compression
  - raised FM detection threshold
- But:
  - these measures highly correlated
  - and errorful to collect

*Huckvale & Hilkhuysen, On the Predictability of the Intelligibility of Speech to Hearing Impaired Listeners, CHAT Workshop, 2017

Statistical learning

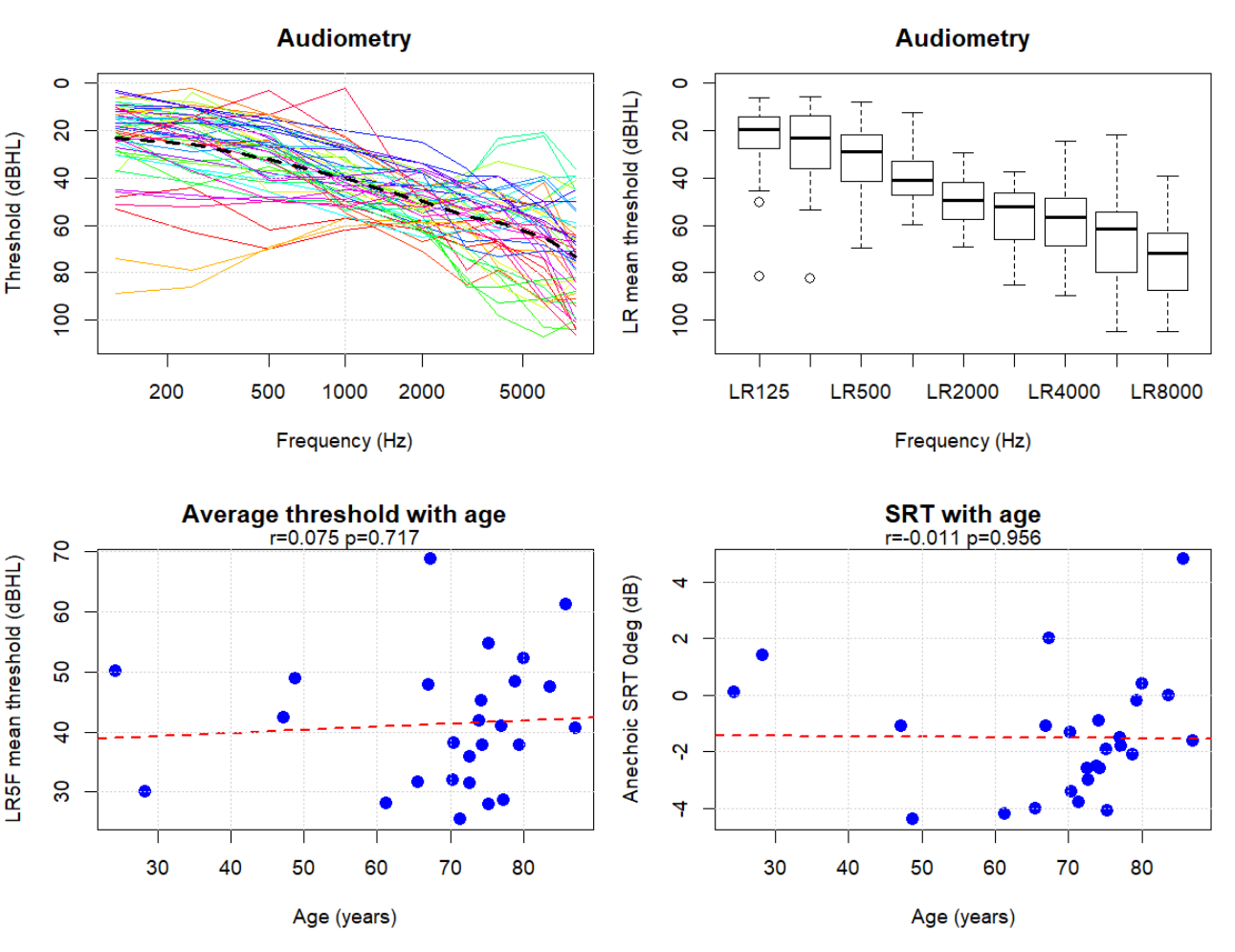


Build regression model from population of listeners, then use to predict performance of listener left out

Which psychoacoustic measures most useful in practice?

Support Vector Regression: defines regression hyperplane from those training data values that minimise the margin of error

Hearing Impaired Listeners



Listeners:

26 Hearing Impaired adults

L1 English

Average Pure Tone loss 250-2000Hz
< 70dBHL

Bilateral difference < ~10dB

Tested with NAL equalisation

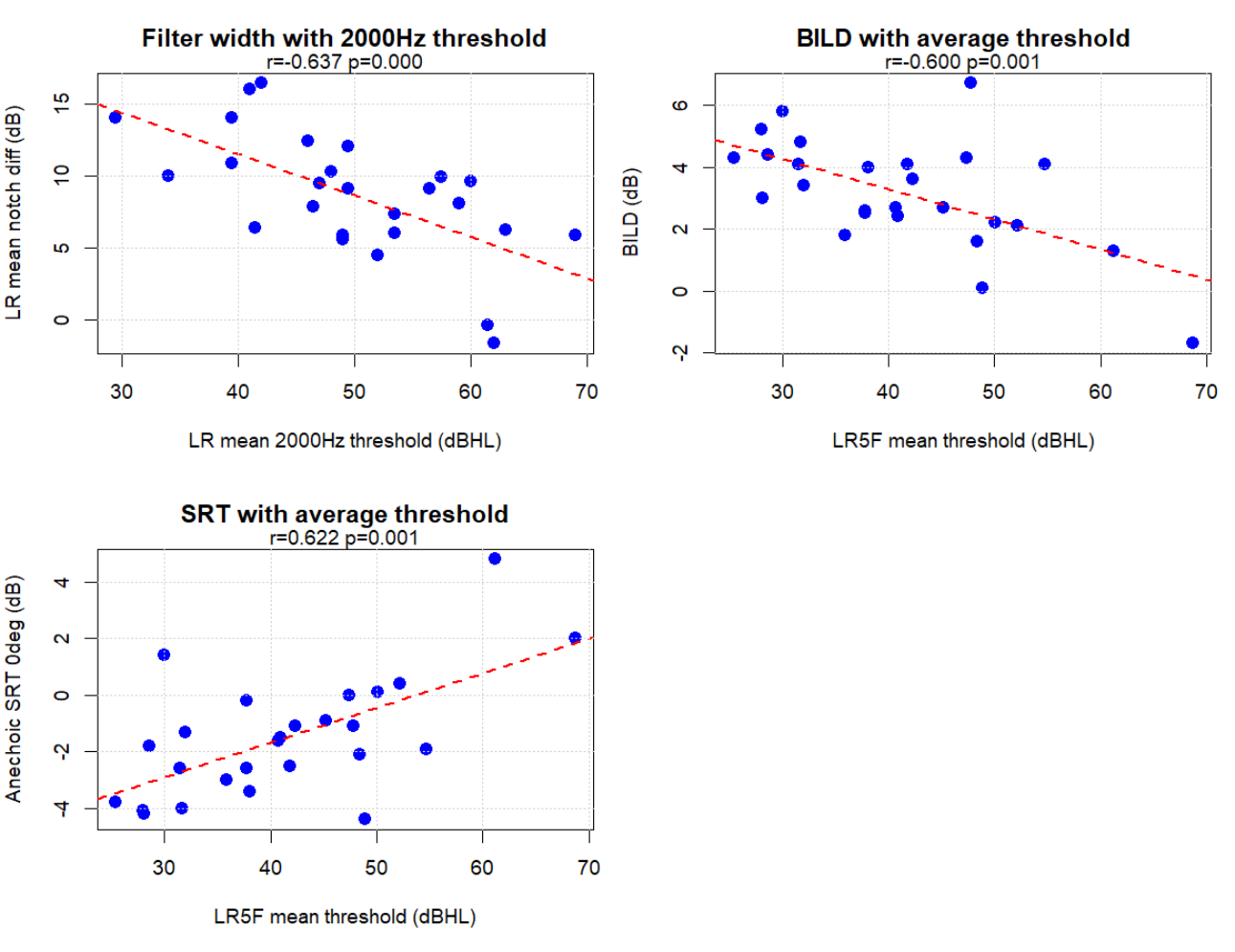
Psychoacoustic Measures

- Pure-tone thresholds
  - Adaptive, Bayesian estimation,
  - Measures: `L125,L250,…,L8000, R125,R250,…,R8000`
- Auditory filter bandwidth @2000Hz
  - Tone threshold in broadband and notched noise
  - Measures: `LNOTCHDIFF,RNOTCHDIFF`
- Binaural Intelligibility Level Difference
  - SRT difference for S0N0 and SπN0
  - Measures: `BILD`

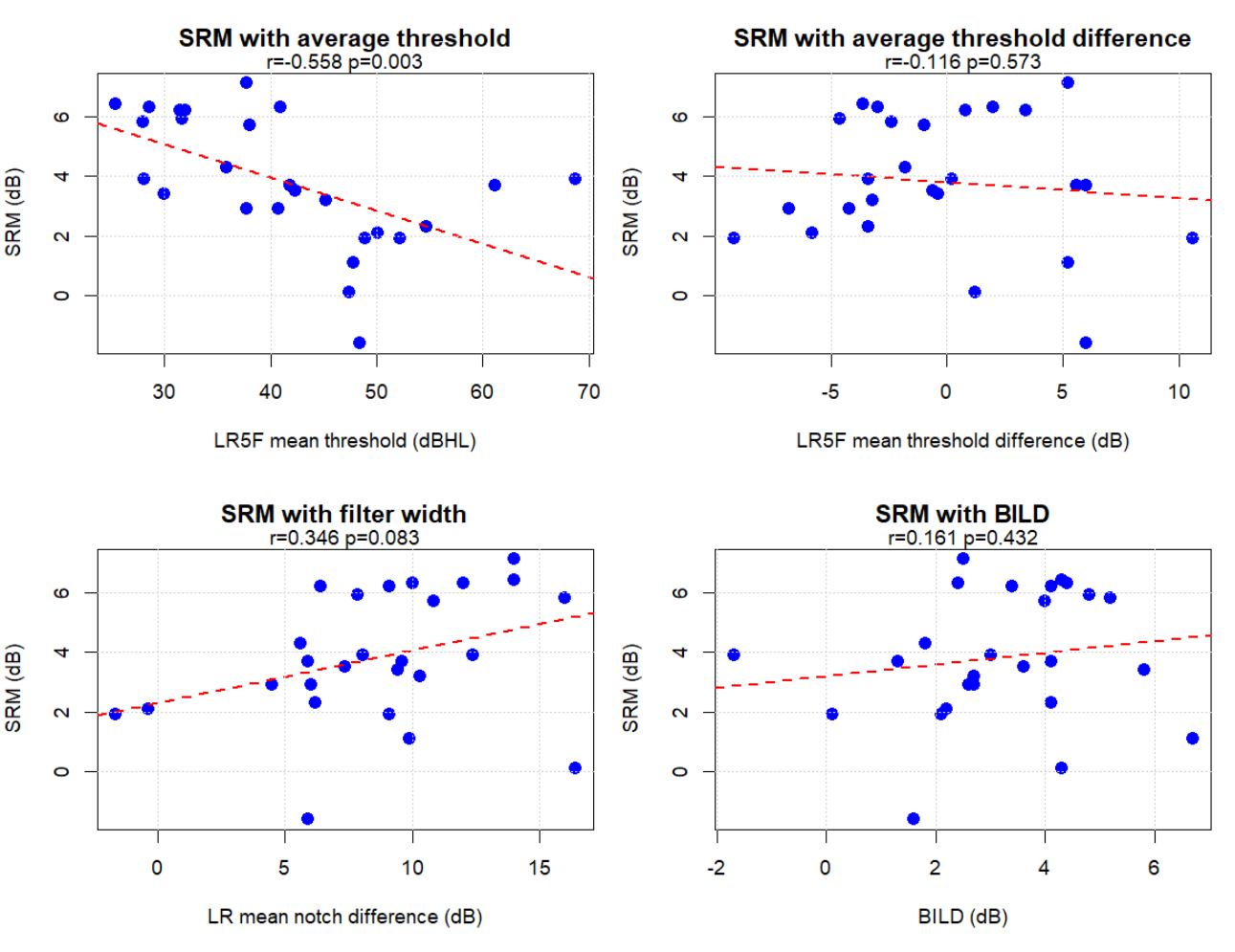
Intelligibility Testing

- IEEE sentences at 0°
- LTASS noise at 0° or 60° right
- Adaptive procedure to find Speech Reception Threshold
- Virtualised audio
  - Anechoic simulation
  - Office simulation

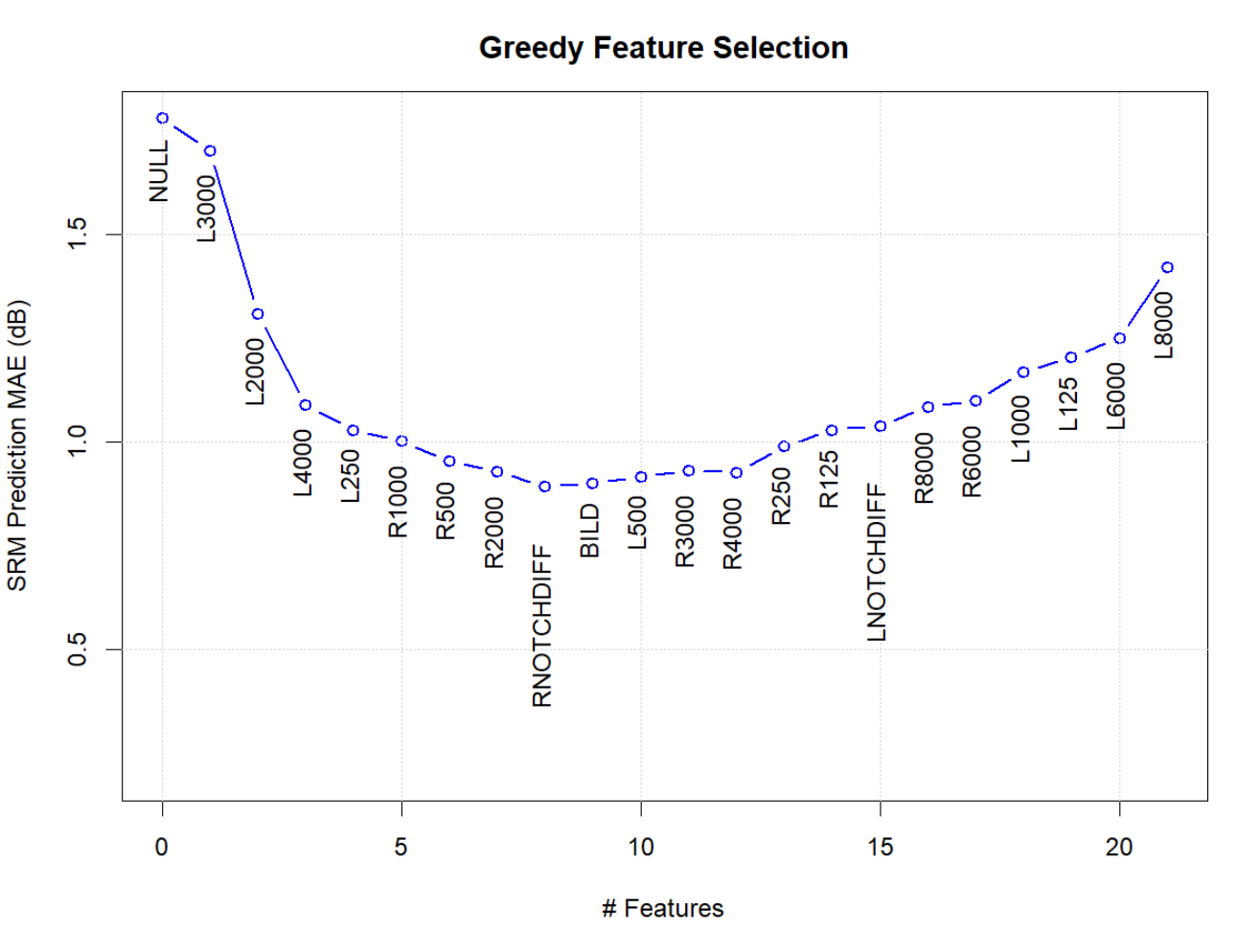
Psychoacoustics correlation



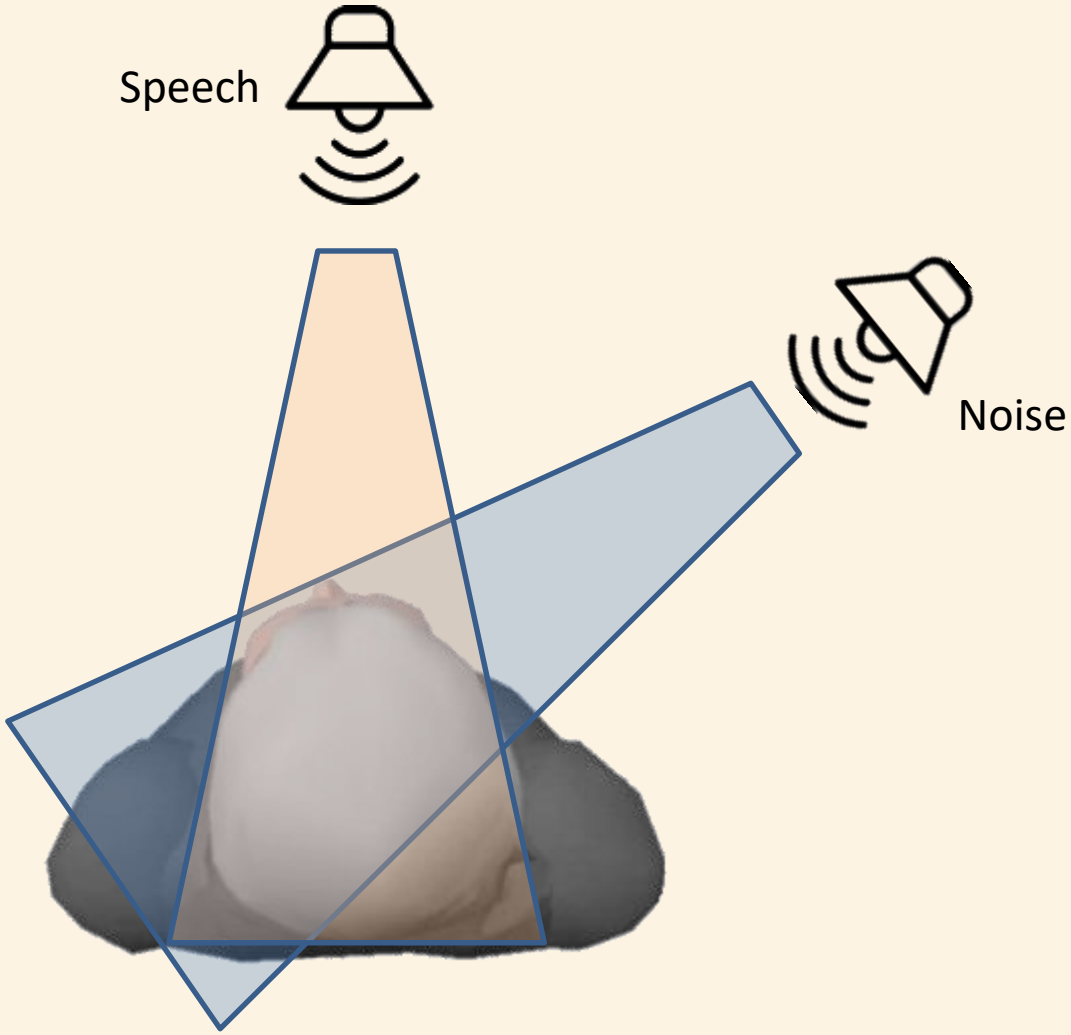
SRM with Psychoacoustics



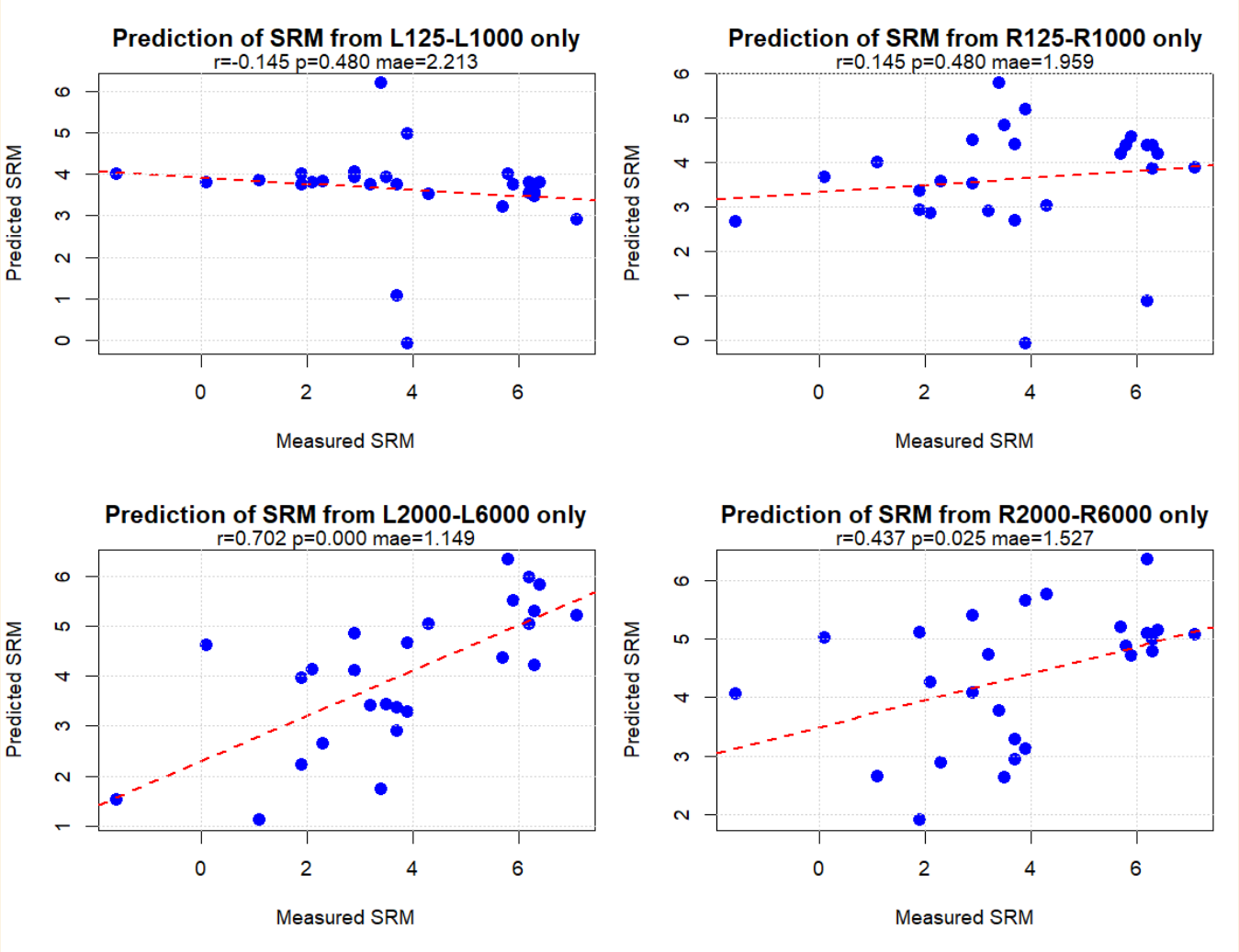
SRM Prediction (Anechoic)



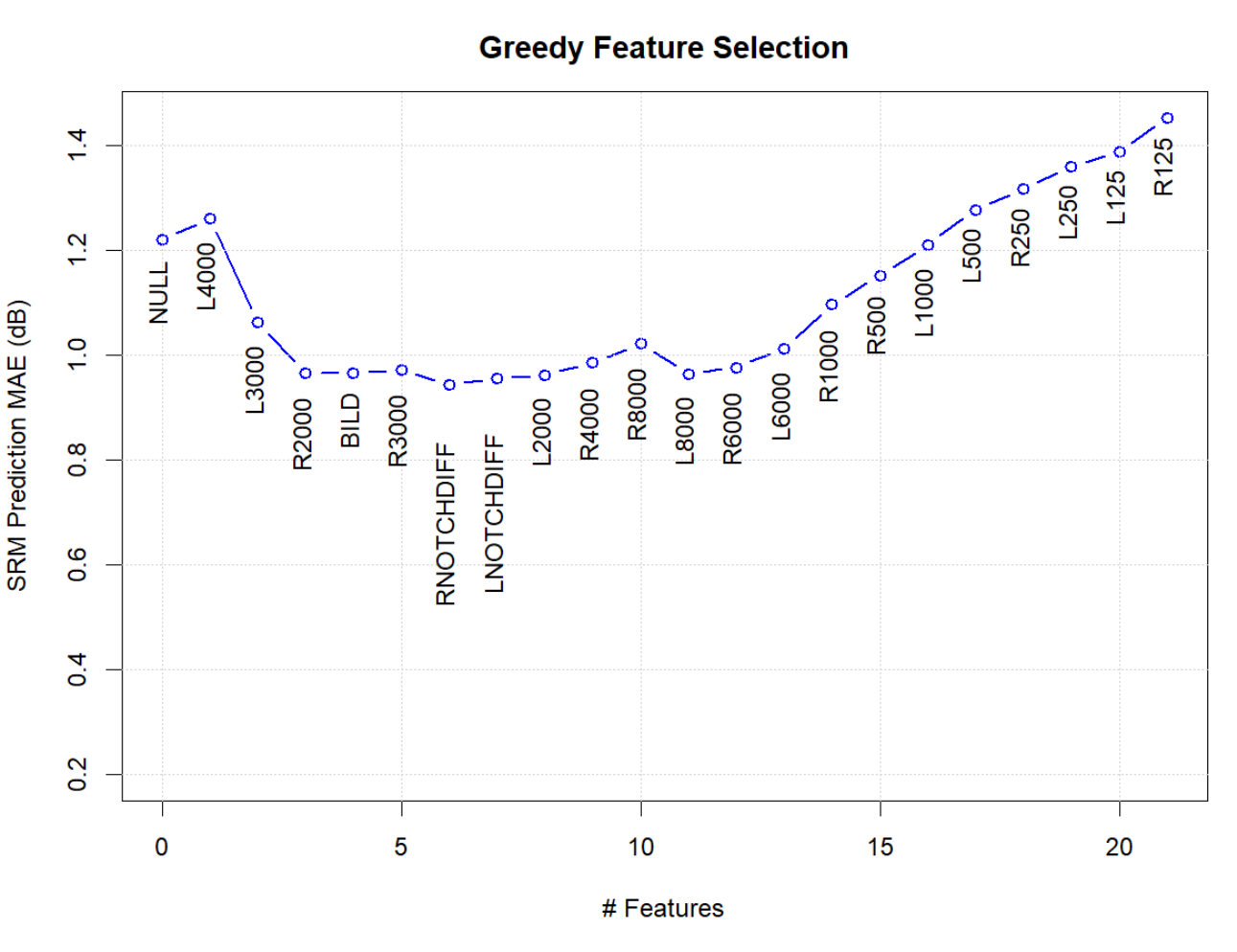
Head Shadow



Predictions from Thresholds



SRM Prediction (Office)



Summary

- Built predictive model of SRM from audiometric measures of a group of HI listeners
- Used Support Vector Regression and Leave-one-out cross validation to build the best model
- Greedy feature selection to find practically useful measures taking into account correlations between features and measurement error
- Best prediction came from high-frequency thresholds in ear with best SNR
- Prediction error 1.1dB MAE, 1.5dB RMSE