THE UNIVERSITY OF MELBOURNE

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REDENLAB

Challenges and possibilities of automated speech monitoring in ataxia

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Disclosures

How should we use speech in clinical trials?

Tool for differential diagnosis?	→	Not needed in genetic conditions?
Proxy of overall disease severity?	→	In isolation or combined with other domains
Means of tracking treatment response	→	Stability over time, influenced by ++ factors
Measure of something important or meaningful for patient / family / clinician?	→	Ability to talk, sound dysarthric, quality of life

Clinical Outcome Assessments: where does speech fit?

Patient-reported outcome (PRO)

E.g., Dysarthria Impact Scale

Observer-reported outcome (ObsRO)

Communication Effectiveness Survey (completed by communication partners)

Clinician-reported outcome (ClinRO)

'Speech' item in disease severity scale, e.g., SARA speech item

Performance outcome (PerfO)

Acoustic outcomes from set tasks

Challenges / opportunities in communication testing for neurodegenerative disease

What aspects of communication?	→	Speech subsystems, intelligibility, naturalness, SARAspeech?
How can we get that information?	→	PROs, ObsROs, ClinROs, set tasks, semi-structured tasks, naturalistic settings
Do we test in the clinic or at home?	→	Remote capture, decentralized, in clinic, mixed approach
How often (and long) should we test?	→	Once a day, month, six-month, year, bursts

Considerations for communication testing in ataxia

Speech features in ataxia vary based on age of onset and disease duration

Home data collection requires equipped / informed testers

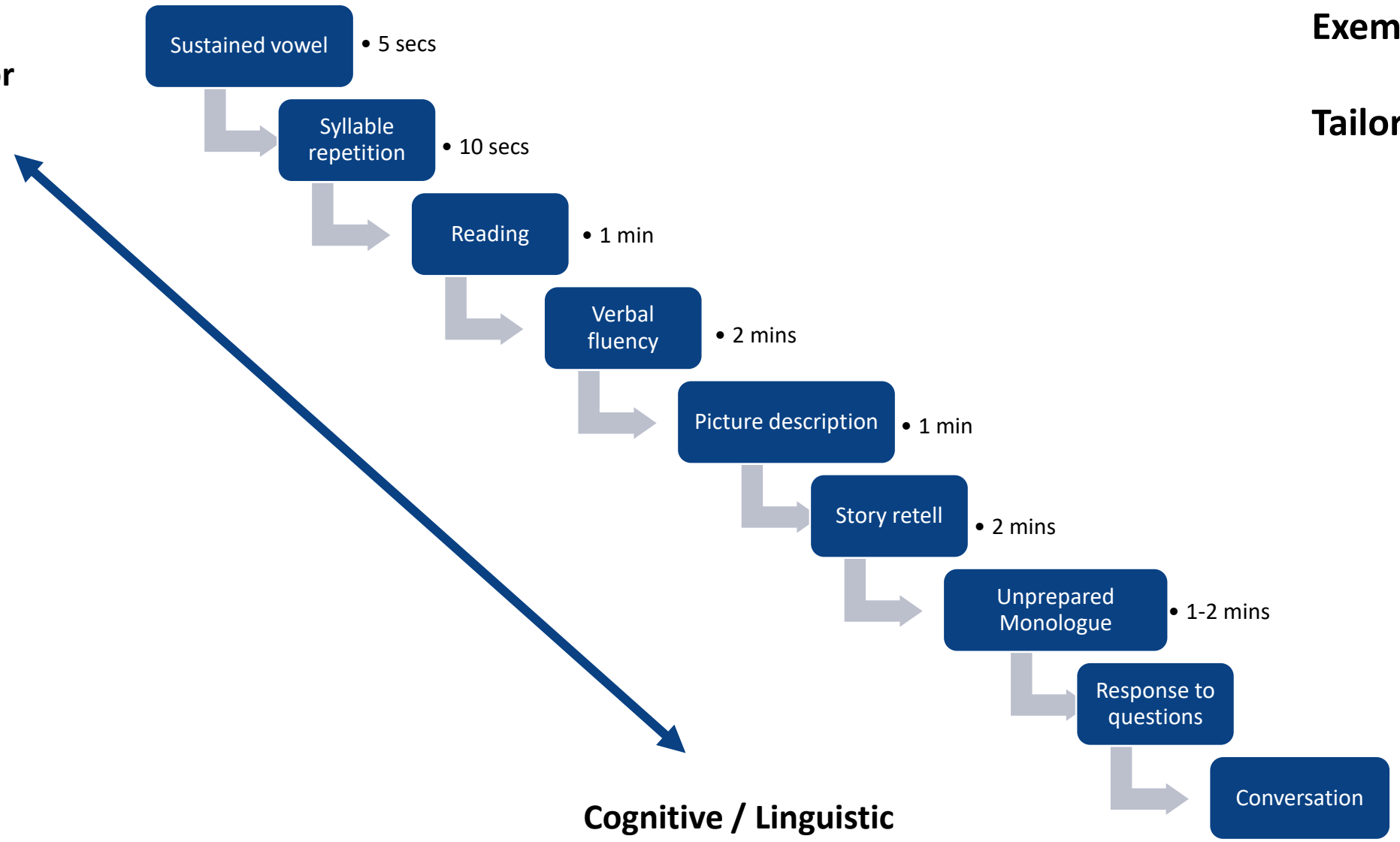
Naturalistic protocols require extended recording periods to capture adequate coverage

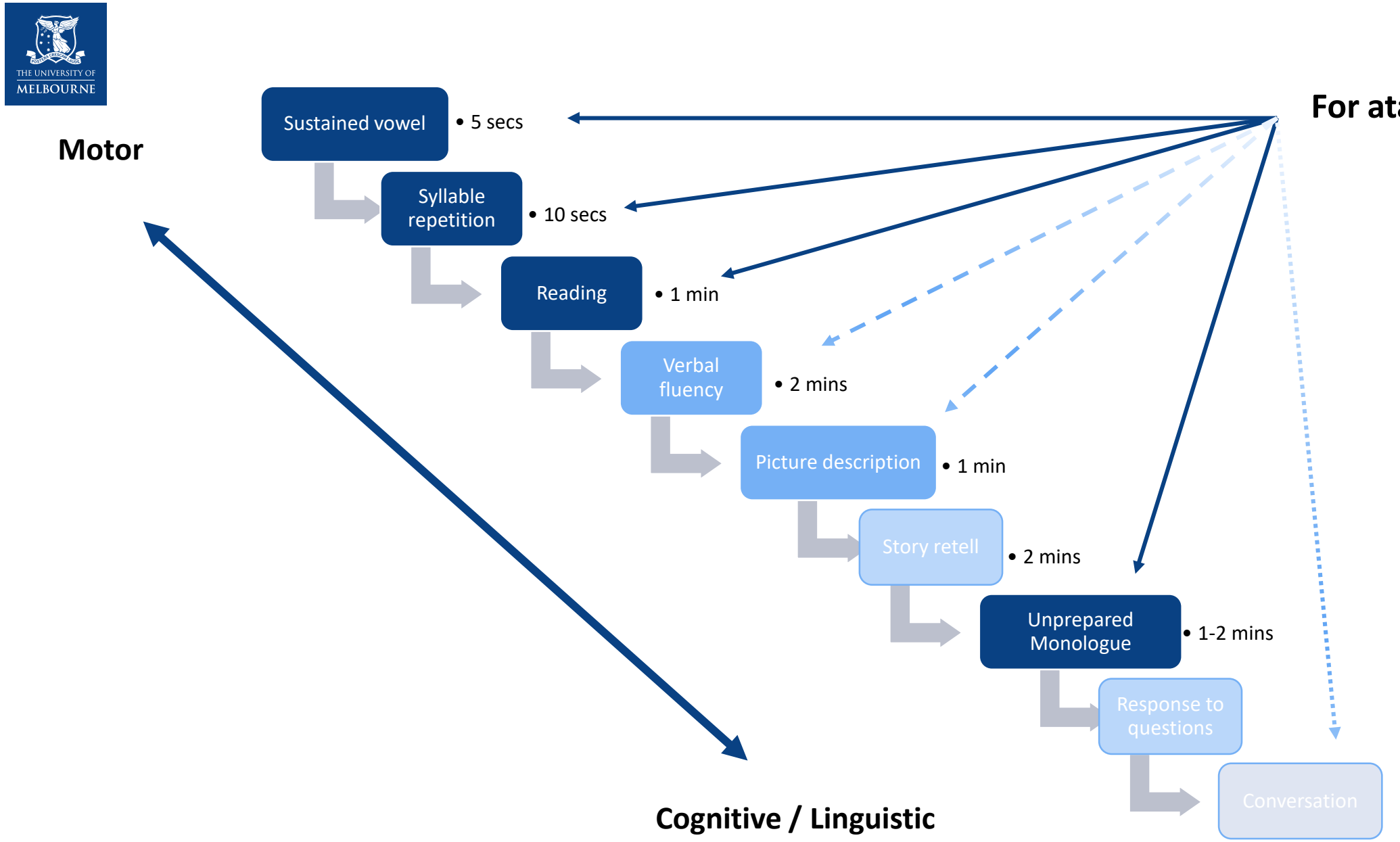
Analysis uses clinician derived measures and signal processing/NLP features

QA/QC is important in any collection settings, but particularly in remote assays

Exemplar tasks

Tailored to indication




Motor
Sustained vowel
• 5 secs
Syllable repetition
• 10 secs
Reading
• 1 min
Verbal fluency
• 2 mins
Picture description
• 1 min
Story retell
• 2 mins
Unprepared Monologue
• 1-2 mins
Response to questions
Conversation
For ataxia?
Cognitive / Linguistic

Multiple sclerosis (with ataxia)

Cohort: 118 people

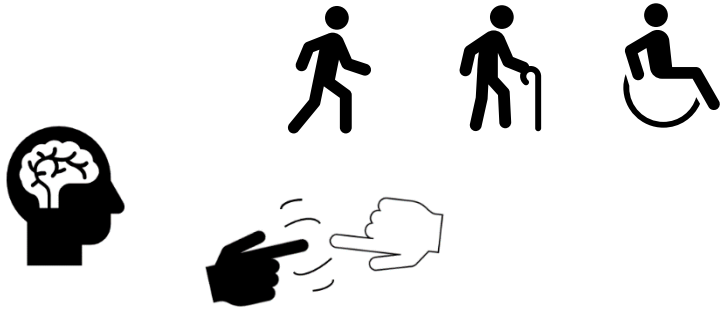
MSIS-29 (quality of life)

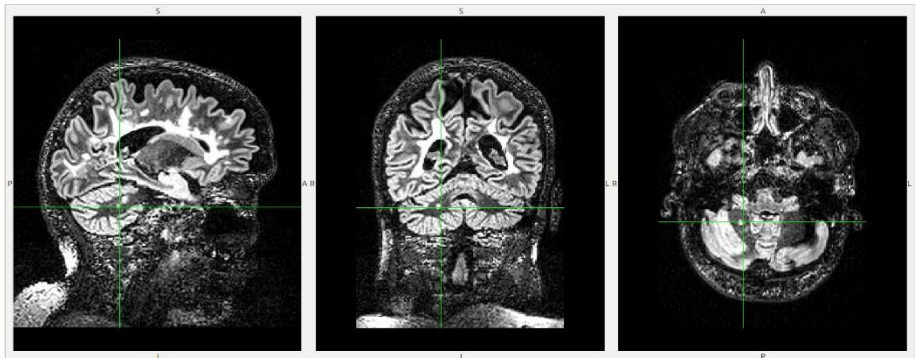
VHI (voice-related quality of life)

EDSS (overall disability)

SARA (ataxia)

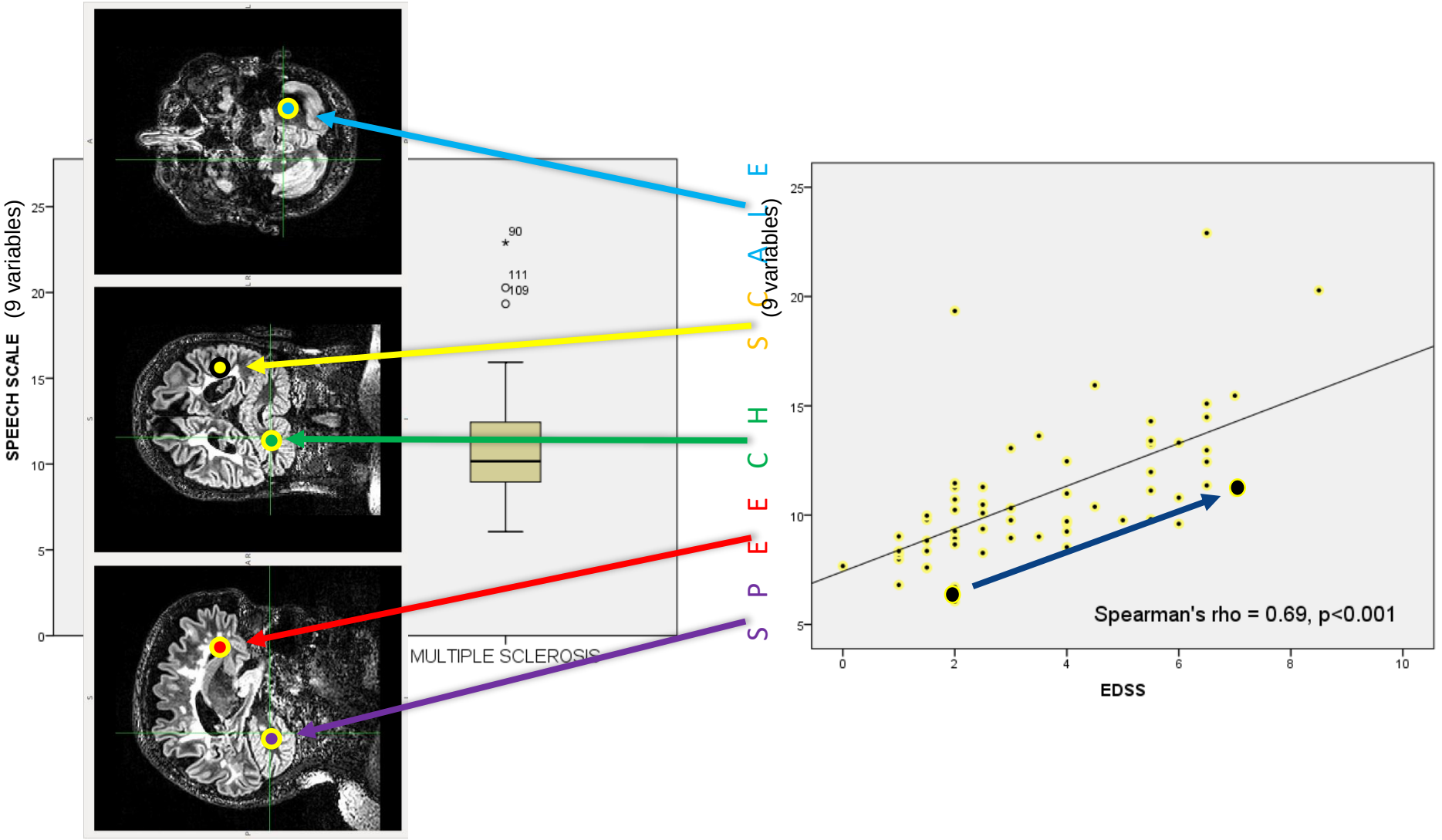
MRI: volumes, lesions,
tracts, fMRI





Noffs et al. Eur J Neurol 2021; Noffs et al. Cerebellum 2020

Speech & MRI correlates in MS



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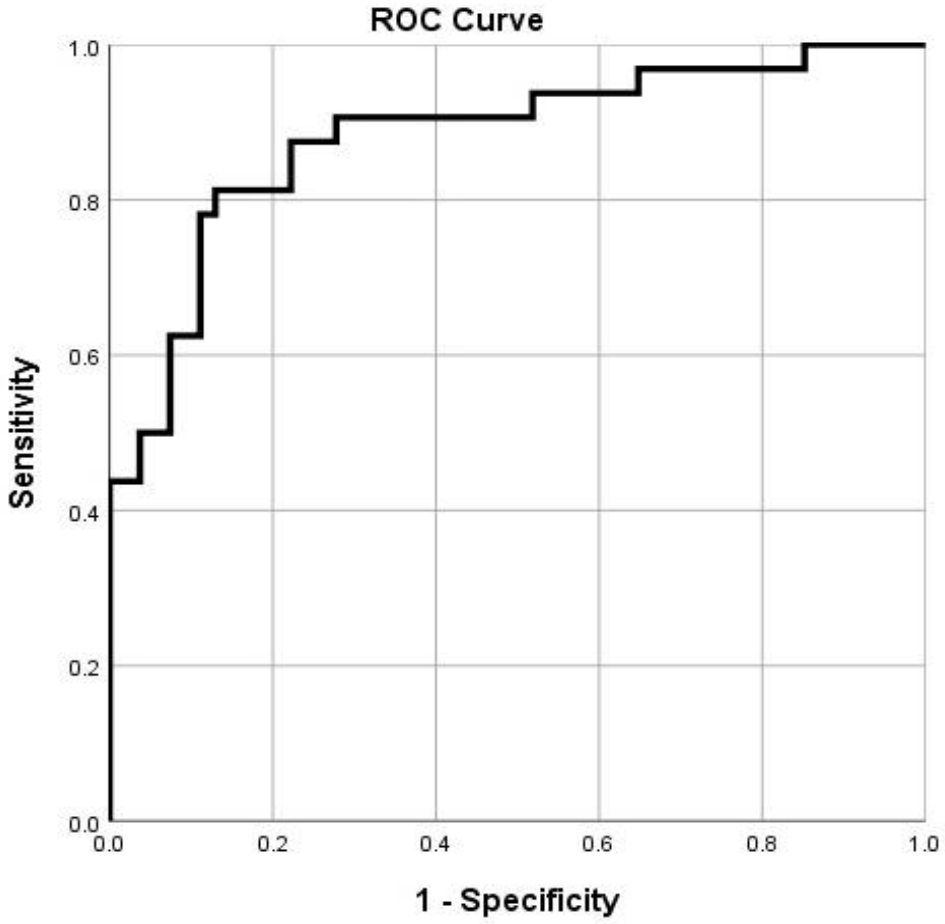
Accuracy for predicting an abnormal 9HPT in MS

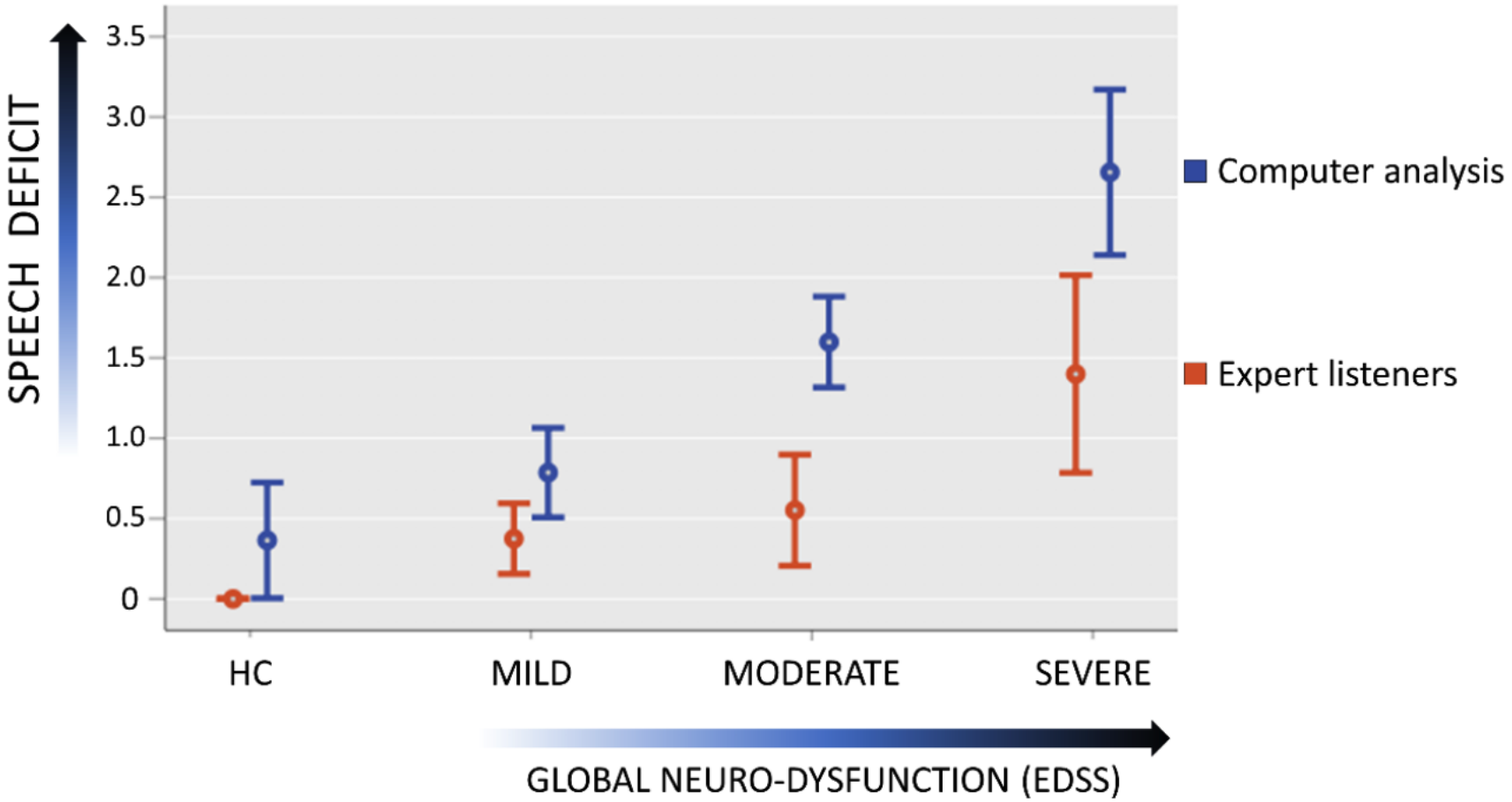


ROC curve for acoustic composite score as predictor. AUC 0.87, 95% CI = 0.78 to 0.96.

Syllable repetition, timing during monologue & phonatory instability monologue were the strongest predictors of cerebellar impairment

Noffs et al. Eur J Neurol 2021; Noffs et al. Cerebellum 2020

Digital vs listener accuracy



Acoustic composite score differentiated mild vs moderate ($p<0.001$) moderate vs severe subgroups ($p=0.003$)

Correlated with:

- overall neurological disability ($r = 0.6$, $p<0.001$),
- quality of life ($r = 0.5$, $p <0.001$),
- white matter volume ($r = 0.3$, $p=0.007$),
- lesion load ($r = 0.3$, $p=0.008$).

Acoustic metrics also correlated with disability scores in people with no perceivable (listener determined) dysarthria

Noffs et al. Eur J Neurol 2021; Noffs et al. Cerebellum 2020

Speech recognition in dysarthria

International Journal of Speech Technology (2021) 24:771–779
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Automatic speech recognition in neurodegenerative disease

Benjamin G. Schultz[1,6] · Venkata S. Aditya Tarigoppula[2,3] · Gustavo Noffs[1] · Sandra Rojas[1] · Anneke van der Walt[4] · David B. Grayden[2,3] · Adam P. Vogel[1,5]

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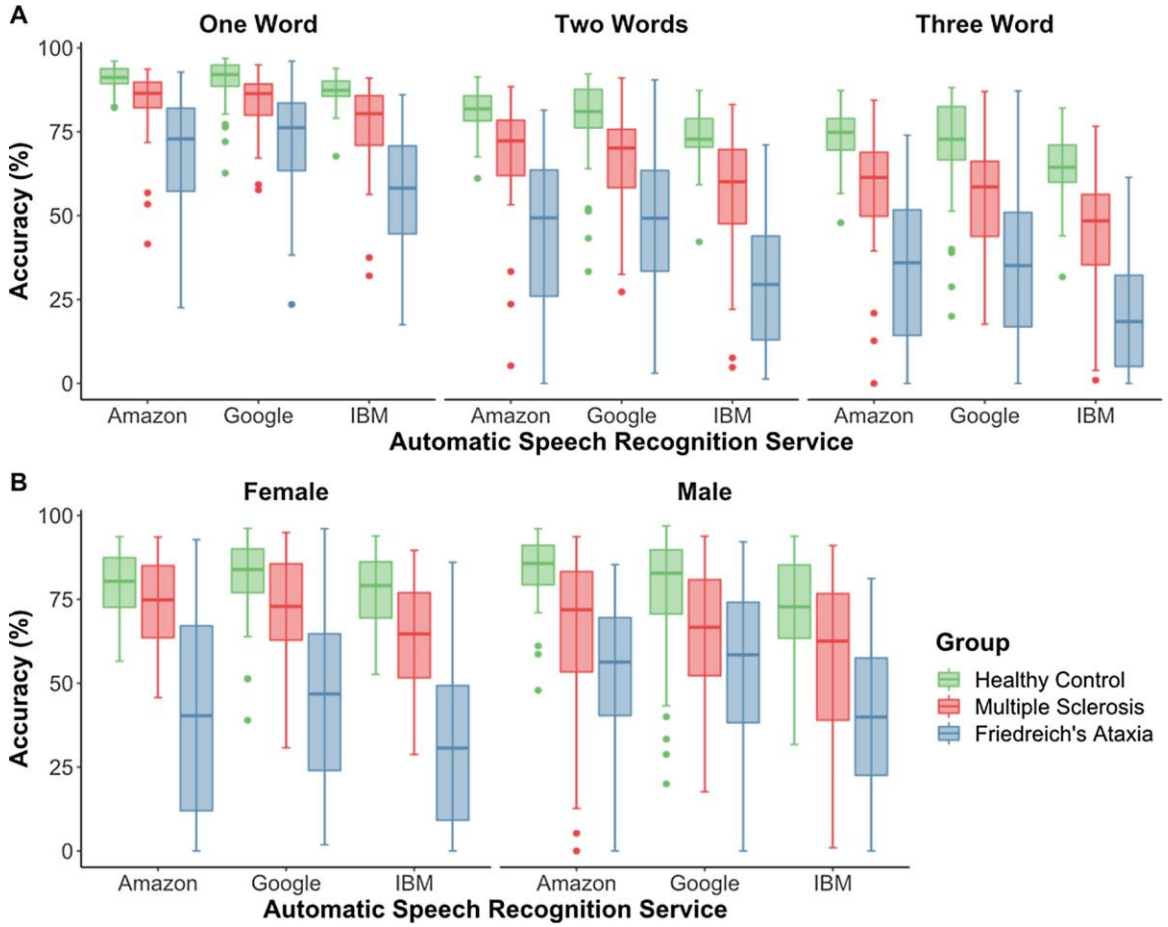
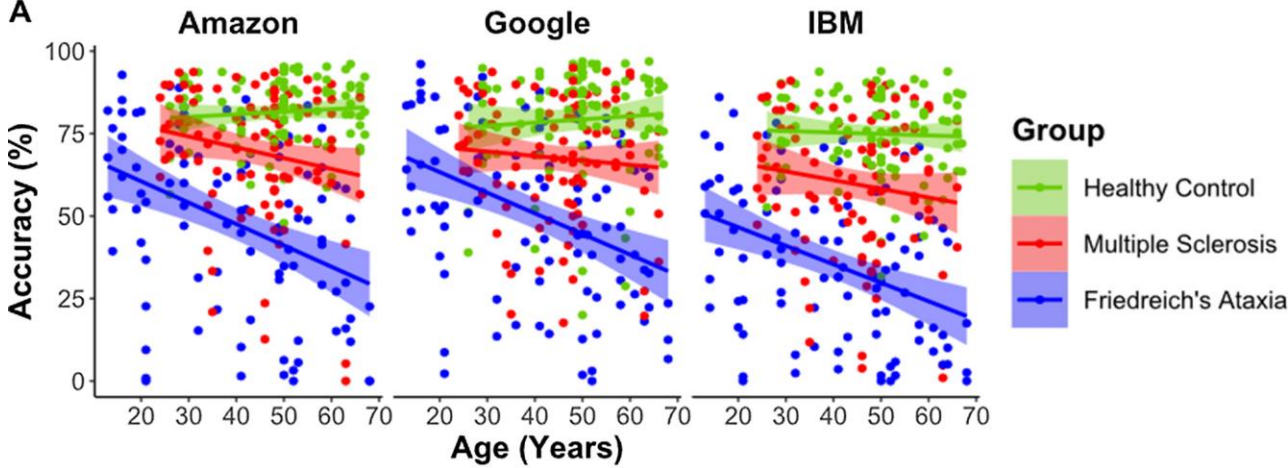
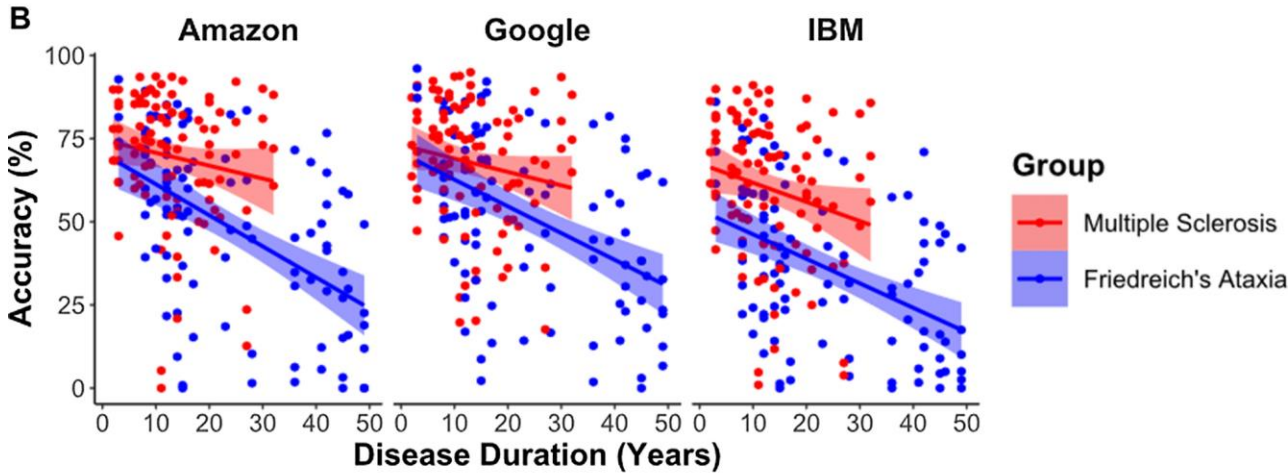


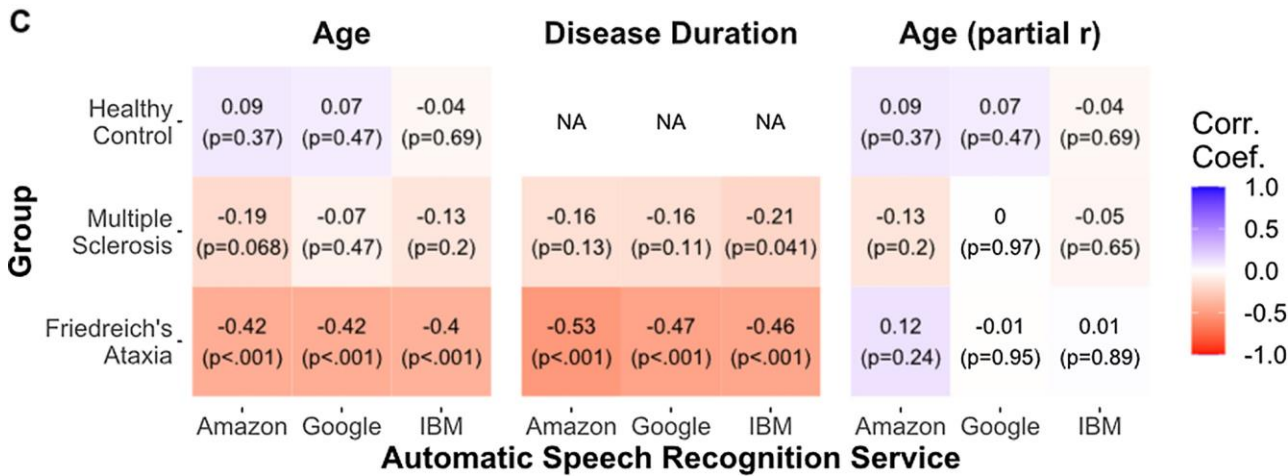
Mean accuracy for automatic speech recognition methods for groups for **a** nGrams consisting of one, two, and three consecutive words, and **b** between females and males

Speech recognition in dysarthria

a between accuracy & age, **b** between accuracy & disease duration, & **c** correlation coefficients between ASR accuracy & age, ASR accuracy & disease duration, & partial correlations between accuracy & age controlling for disease duration







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Thank you

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