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Dysarthria: Best Practices for Assessing Intelligibility

Kimberly L. Dahl, MS, CCC-SLP

Kimberly L. Dahl, MS, CCC-SLP

- Kimberly Dahl (she/her) is a speech-language pathologist with clinical expertise in voice, swallowing, and motor speech disorders. She is a doctoral candidate at Boston University where she researches speech motor control in people with Parkinson's disease and voice perceptions of transgender and nonbinary people.
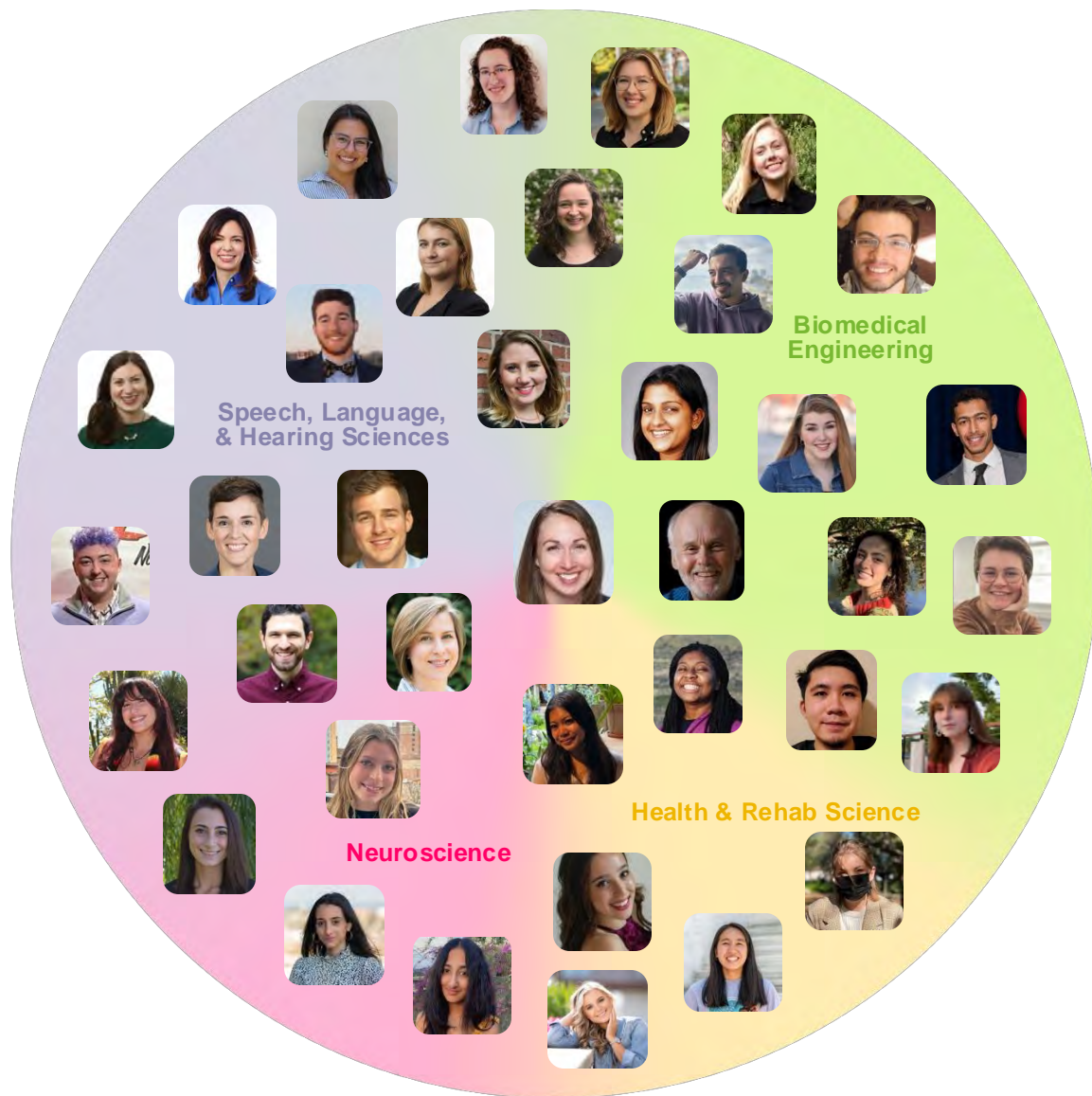
Disclosures

- **Presenter Disclosure:** *Financial:* Kimberly Dahl was paid an honorarium for this presentation. They receive a stipend from Boston University and grant funding from the National Institute on Deafness and Other Communication Disorders. *Non-financial:* Kimberly Dahl has no relevant non-financial relationships to disclose.

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Learning Outcomes

After this course, participants will be able to:

- List two valid methods of assessing intelligibility.

- Describe common methods of assessing intelligibility.

- Identify three factors that may bias intelligibility estimates.

Speech, Language, & Hearing Sciences

Biomedical Engineering

Neuroscience

Health & Rehab Science

What is dysarthria?

A class of motor speech disorders characterized by "abnormalities in the strength, speed, range, steadiness, tone, or accuracy of movements required for… speech production"[1]

- Flaccid
- Spastic
- Ataxic
- Unilateral upper motor neuron

- Hypokinetic
- Hyperkinetic
- Mixed
- Undetermined

[1]Duffy, 2020, p. 3

What is intelligibility?

- The degree to which a speaker's message is understood by a listener[1]

- A *perceptual* outcome

- Core functional deficit of the dysarthrias

- Important outcome in both clinic & research[1-3]

- Not predictive of etiology, dysarthria subtype, or speech subsystem(s) impaired

[1]Kent et al., 1989; [2]Gurevich & Scamihorn, 2017 [3]Hirsch et al., 2022

Assessing intelligibility
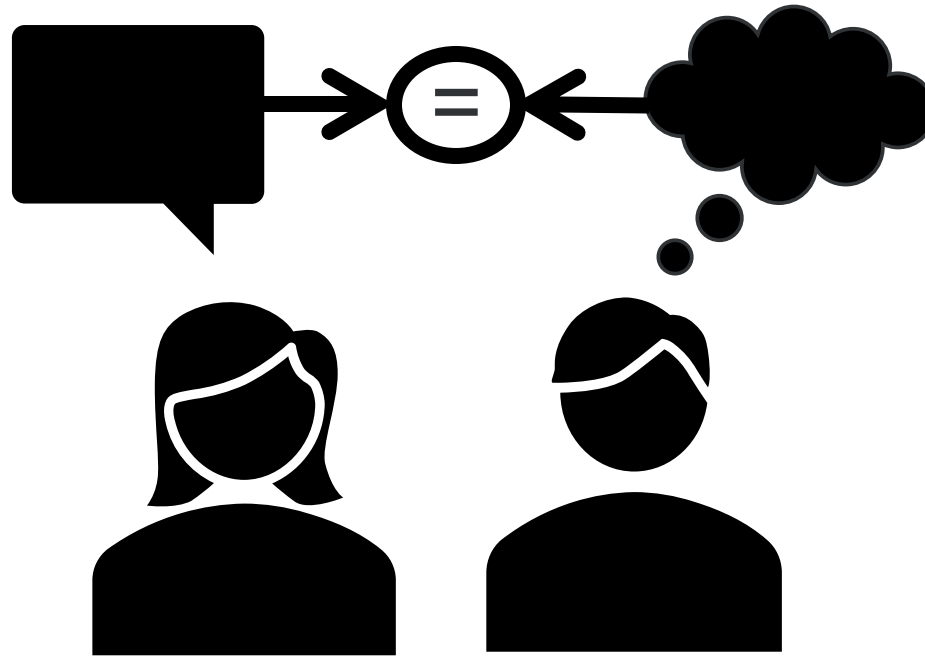
Assessing intelligibility
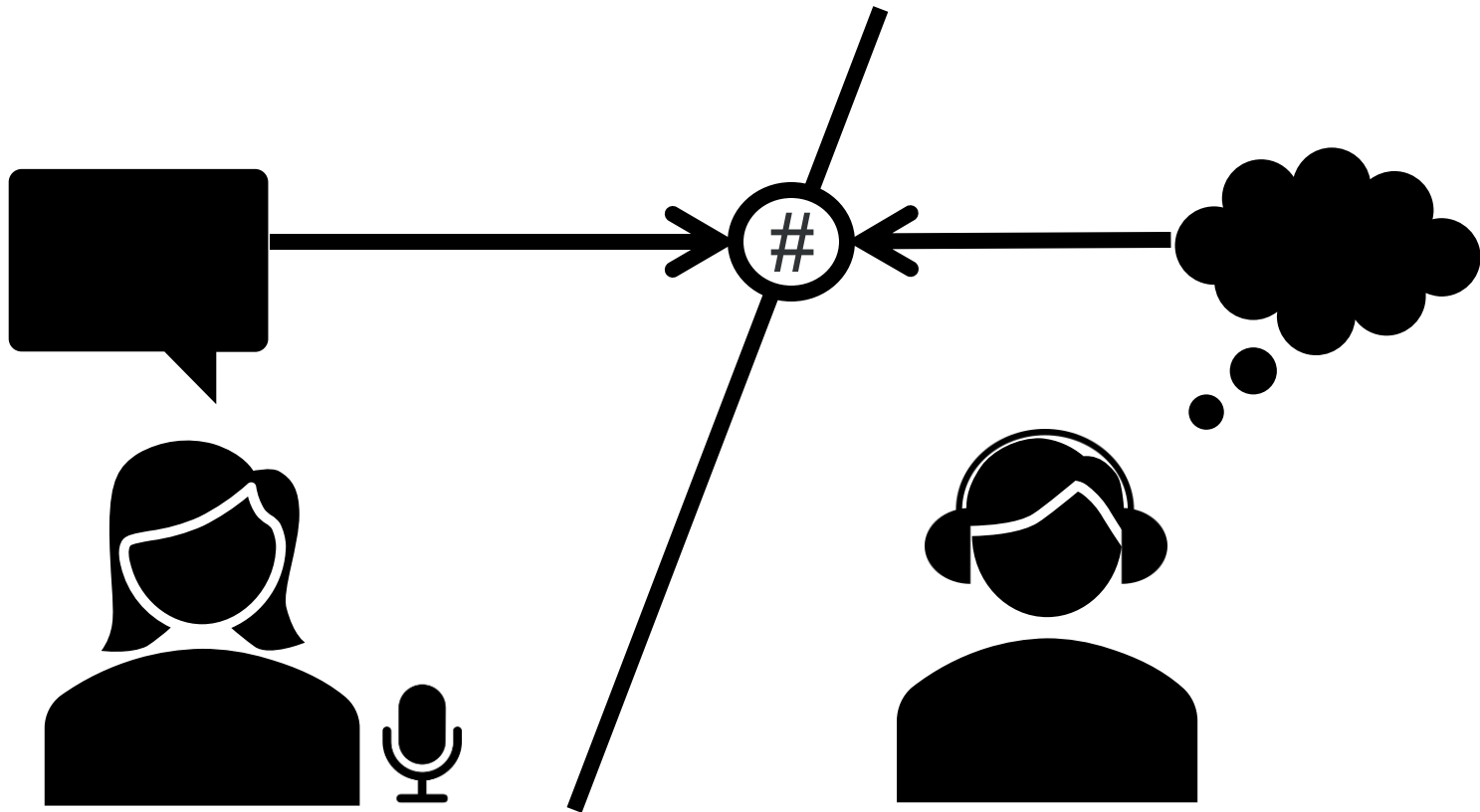
Big decisions

1 Method

2 Speech sample

3 Listeners

The questions   The evidence   The takeaways

① Method

How do I assess intelligibility?

- Formal assessment

- Informal assessment

  - ⚠ Oral mechanism exam
  - ⚠ Diadochokinesis (e.g., /pataka/)
  - ⚠ Cranial nerve exam

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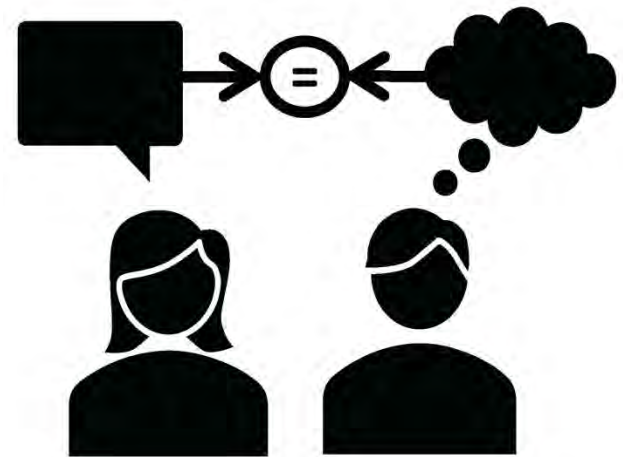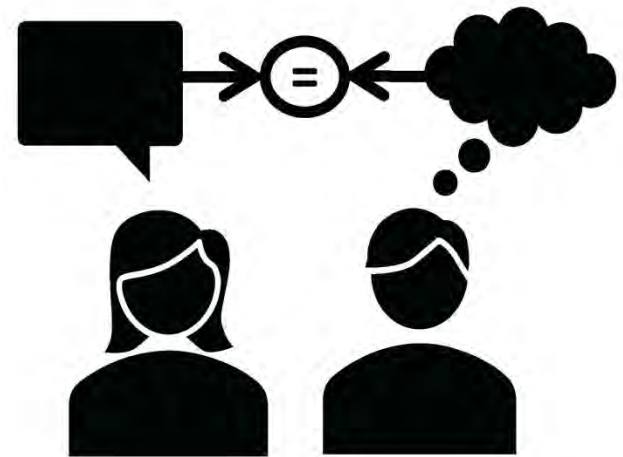
Method

How do I assess intelligibility?

- Formal assessment

- Informal assessment

  - ~~Oral mechanism exam~~
  - ~~Diadochokinesis (e.g., /pataka/)~~
  - ~~Cranial nerve exam~~

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Gurevich & Scamihorn, 2017

① Method

How do I assess intelligibility?

Formal assessments

- AIDS: Assessment of Intelligibility of Dysarthric Speech[1]

- SIT: Speech Intelligibility Test[2]

- FDA: Frenchay Dysarthria Assessment[3]

- DEB: Dysarthria Examination Battery[4]

$ Reliable? Valid? Applicable?

- Dysarthria Profile[5]

[1]Yorkston & Beukelman, 1984; [2]Yorkston et al., 1996; [3]Enderby, 1980; [4]Drummond, 1993; [5]Robertson, 1987

① Method

The evidence

Instrument	Reliable	Valid
AIDS/SIT	✔ ✔	✔
Frenchay Dysarthria Assessment	✔ ✔	✔ ✔
Dysarthria Examination Battery	✔ ✔	✔ ✔
Dysarthria Profile	-	-

Gurevich & Scamihorn, 2017

1 Method

How do I assess intelligibility?

Informal assessments

• Orthographic transcription	**More objective**	**Time-consuming**
• Visual analog scale (VAS)	**More variable**	**Efficient**
• Percent estimation		
• Interval scale		

1 Method

Orthographic transcription vs VAS

- Strong[1] / moderate[2] relationships
- Inexperienced listeners

[1]Abur et al., 2019; [2]Stipancic et al., 2016

① Method

Hirsch et al., 2022
Percent estimation vs VAS
Speech-language pathologists (SLPs)
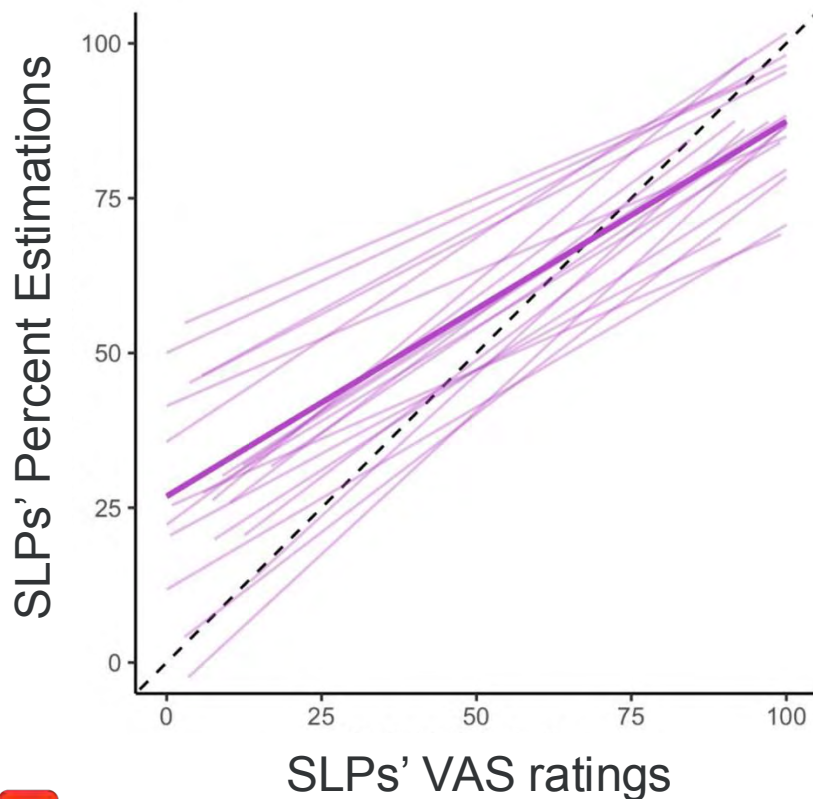
Dahl et al., in prep
Transcription vs VAS
SLPs & inexperienced listeners

SLPs' Percent Estimations vs SLPs' VAS ratings

Visual analog scale — Estimates of intelligibility (%) vs Orthographic transcription — Estimates of intelligibility (%)
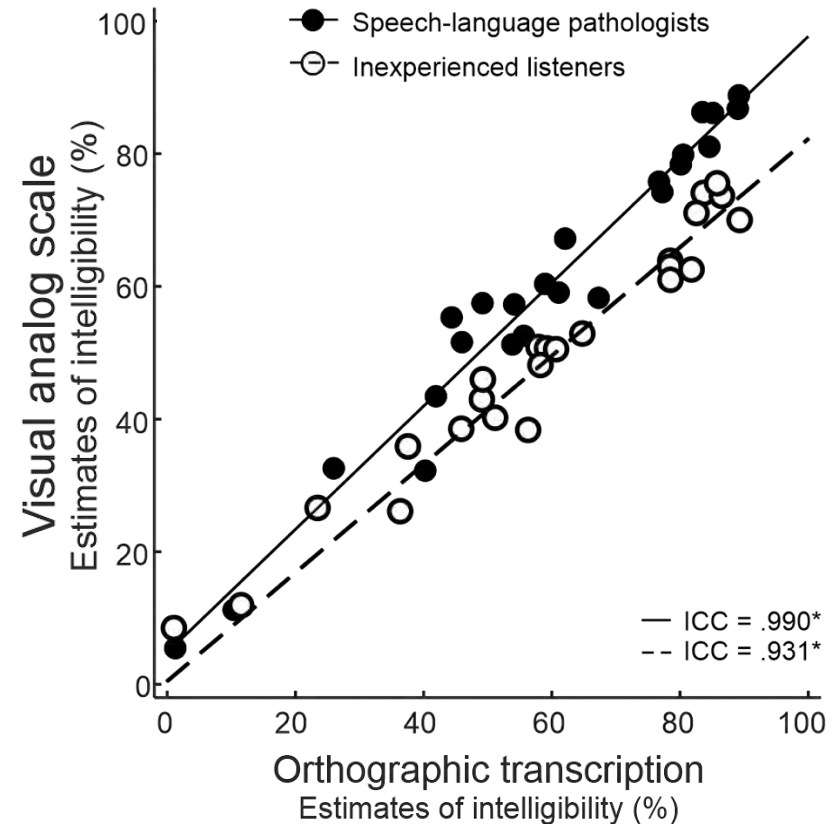
Legend:
- ● Speech-language pathologists
- ○ Inexperienced listeners
- — ICC = .990*
- -- ICC = .931*

Method

The takeaways

- Formal assessments are useful if *available, reliable, valid, and appropriate* for your client/participant

- Informal assessments
  - Prioritize **objectivity** with orthographic transcription
  - Prioritize **efficiency** with visual analog scale

② Speech sample

What kind of speech sample should I collect?
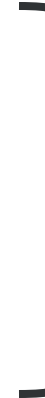
Words

Phrases

Sentences

Passages

Conversation

More ecologically valid

More challenging

- **Known target**
- **Requires reading**

② Speech sample

What kind of speech sample should I collect?

Words

Phrases

Sentences

Passages

Conversation

Formal assessments **$**

TIMIT Sentences[1]   **$**

Harvard Sentences[2]

Personalized sentences

[1]Garofolo et al., 1993; [2]IEEE, 1969

2 Speech sample

What kind of speech sample should I collect?

Key considerations

- Repeatability

- Reading ability

- Phonetic characteristics

  - Phonetic coverage: Every speech sound is included

  - Phonetic balance: Speech sounds are included in proportion to how common they are in the language

- Lexical characteristics

  - Word frequency: How common the words are in the language

  - Neighborhood density: Number of similar-sounding words in the language

② Speech sample

Source	Repeatable	Reading required	Phonetic coverage	Phonetic balance	Lexical features
AIDS/SIT Sentences	✔	✔	?	?	~ [5]
TIMIT Sentences	✔	✔	?	✔ [6]	?
Harvard Sentences	✔	✔	?	~*	?
Personalized sentences	~	✔	?	?	?
Rainbow Passage[1]	✕	✔	✔ [6]	✔ [6]	?
Grandfather Passage[2]	✕	✔	✕ [6]	✔ [6]	?
Caterpillar Passage[3]	✕	✔	✔ [6]	✔ [6]	?
Northwind Passage[4]	✕	✔	✕ [6]	✔ [6]	?
Conversation	~	✕	?	?	?

[1]Fairbanks, 1960; [2]Darley et al., 1975; [3]Patel et al., 2013; [4]See appendix of 6; [5]Stipancic et al., 2023 [6]Lammert et al., 2020

② Speech sample

How long should the speech sample be?

11 AIDS/SIT Sentences

10 Harvard Sentences

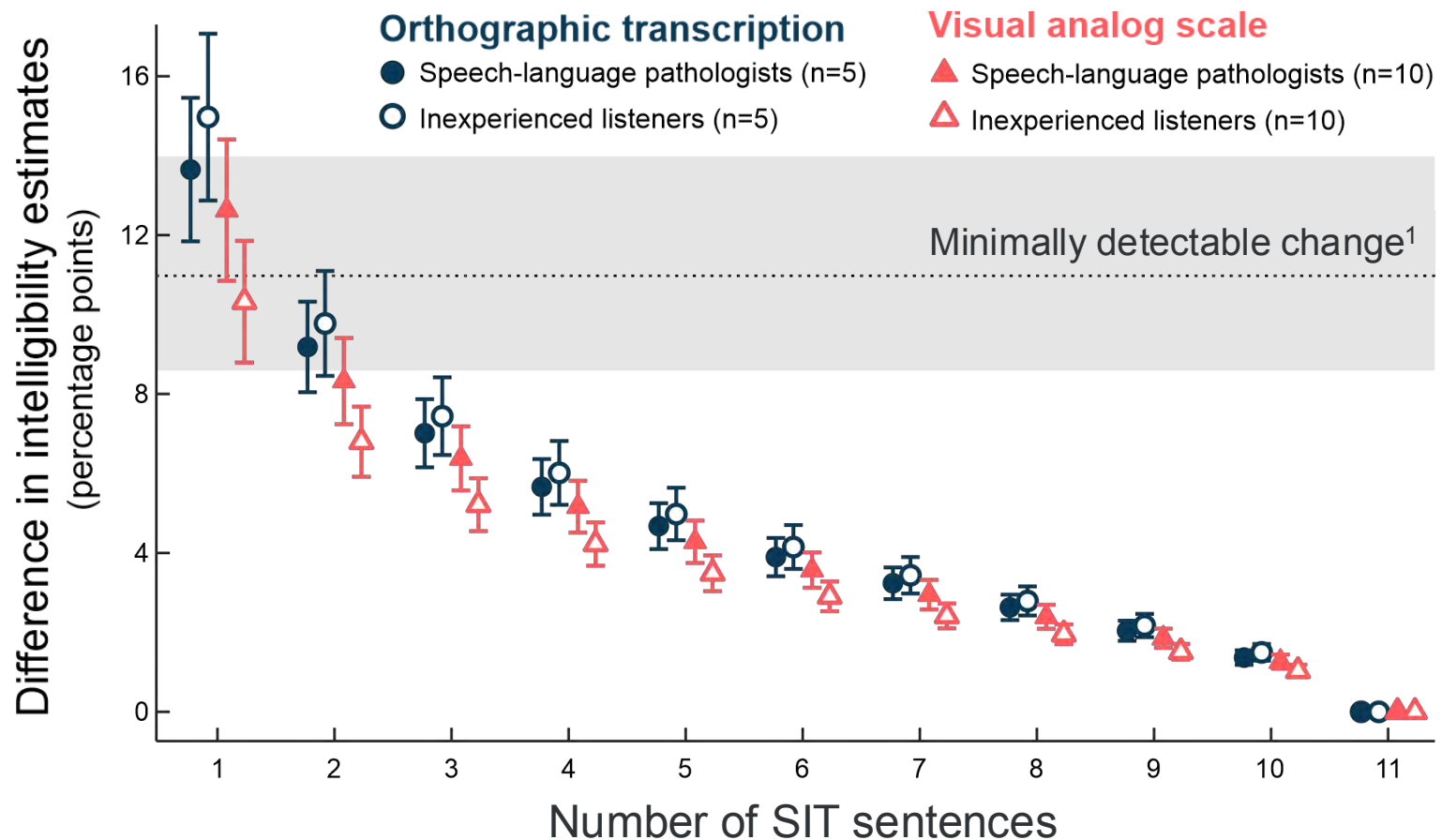# TIMIT Sentences determined by user

Personalized sentences, passages, and conversational samples vary

② Speech sample

Dahl et al., in prep: Number of sentences

[1]Stipancic et al., 2022

② Speech sample

The takeaways

- Repeatable stimuli can track treatment progress or disease progression

- Standardized stimuli may control phonetic & lexical confounds

- Conversation samples eliminate reading burden

- Prioritize efficiency by reducing number of sentences…?

3 Listeners

Can I be the listener?

- Access to other listeners differs by setting

- Familiarity with a speaker may affect the listener's comprehension

The evidence

(3) Listeners

Familiar vs unfamiliar listeners

- Familiar listeners understood more words than unfamiliar[1,2]

- Familiarity boosted comprehension by **20%**[1,2]

[1]Borrie et al., 2012; [2]D'Innocenzo et al., 2006

③ Listeners

Can Siri be the listener?

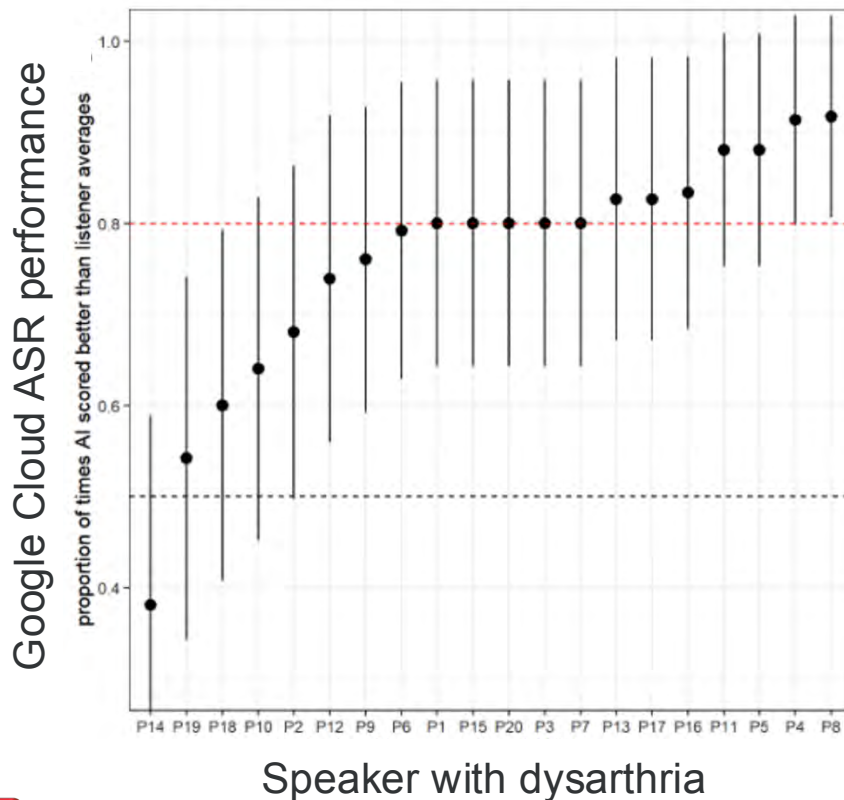Automated speech recognition (ASR)

- Fast

- Free

- Easy to access

- May address familiarity concern

- Ecologically valid, for some speakers

Listeners

The evidence

Moya-Galé et al., 2022
Google Cloud ASR vs human transcription

Gutz et al., 2022
Google Cloud ASR vs human transcription

Speaker with dysarthria

- Strong, nonlinear relationship between automated and human transcriptions

- Poorest performance for mildly dysarthric speech

③ Listeners

Who should I recruit as the listener?

Listeners **inexperienced** with dysarthric speech

- Capture daily interactions outside of the clinic/lab
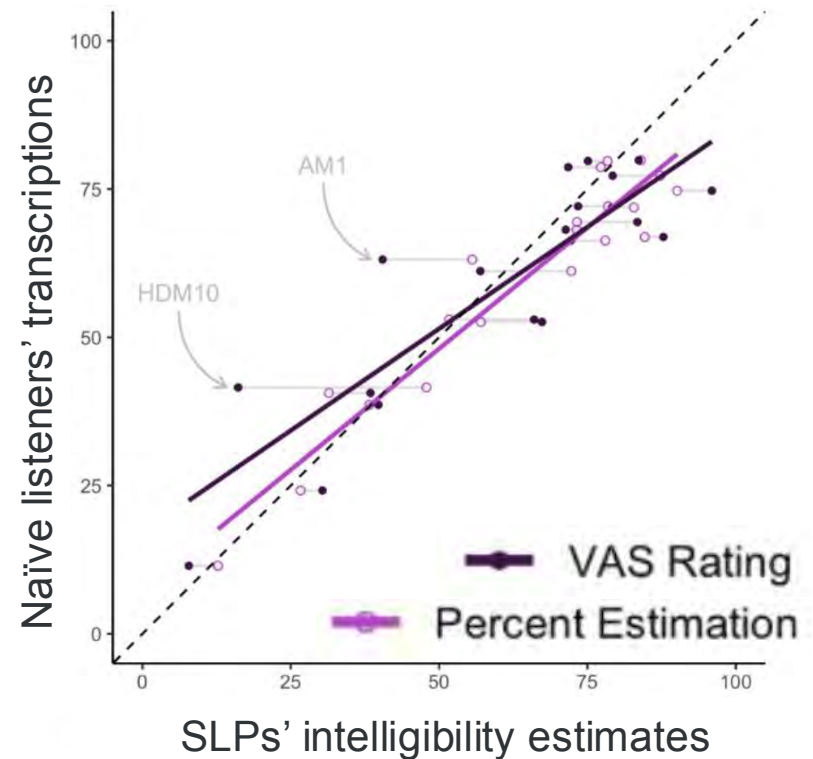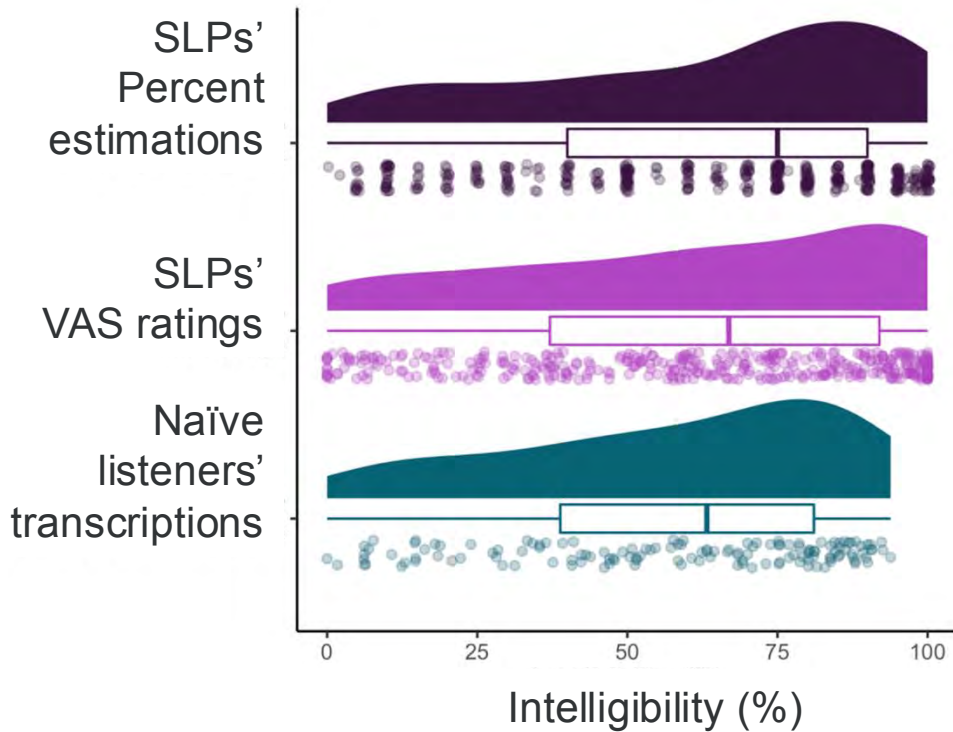- Harder to recruit in clinical settings

Listeners **experienced** with dysarthric speech

- Allow comparison across clinical settings
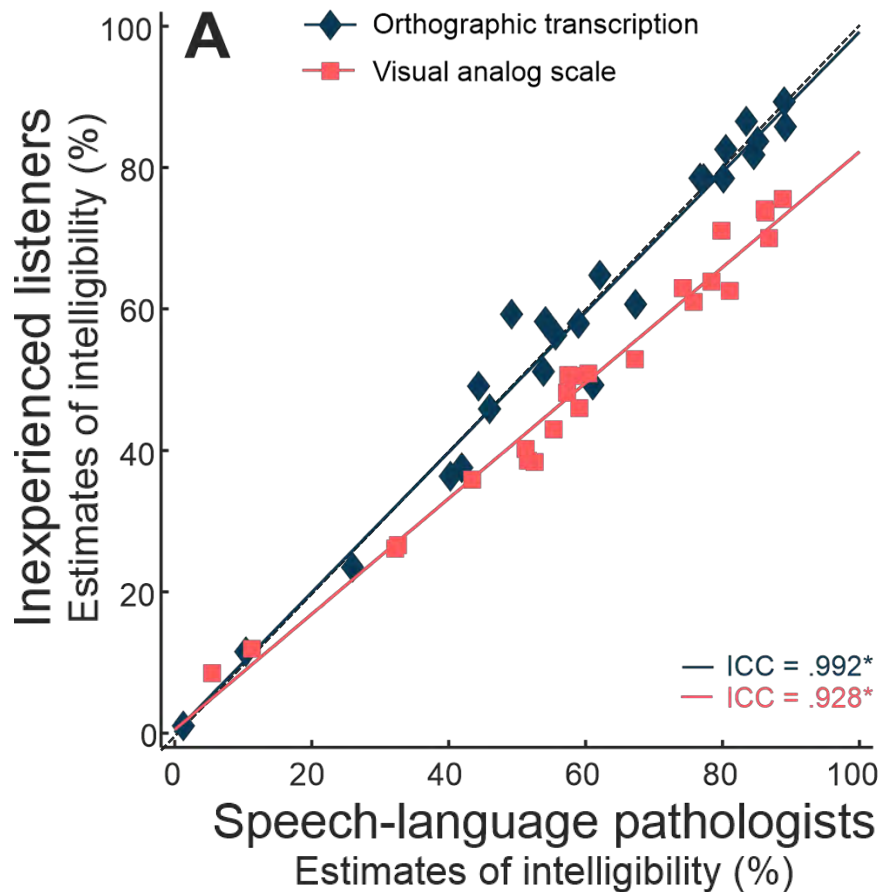- Harder to recruit in research settings

continu**eD**

3 Listeners

Hirsch et al., 2022: SLPs vs inexperienced listeners

③ Listeners

Dahl et al., in prep: SLPs vs inexperienced listeners

3 Listeners

How many listeners do I need?

- Variability in intelligibility measures
- Multiple listeners reduce measurement error

③ Listeners

- More listeners = more stable and accurate intelligibility estimates

- As few as two listeners for accurate measurement[1]

  - Inexperienced listeners
  - SIT sentences
  - 7% change as accuracy benchmark

[1]Abur et al., 2019

3 Listeners

The takeaways

- Familiar listeners may not capture overall intelligibility

- Automated assessment—promising but preliminary

- Experienced listeners may overestimate intelligibility with some assessment methods

- As few as two listeners needed…?

Tying it together

Do method, speech sample, and listeners interact?

1 Method
Multiple valid options that prioritize objectivity or efficiency

2 Speech sample
As few as three SIT sentences… *if you have 5-10 listeners*[1]
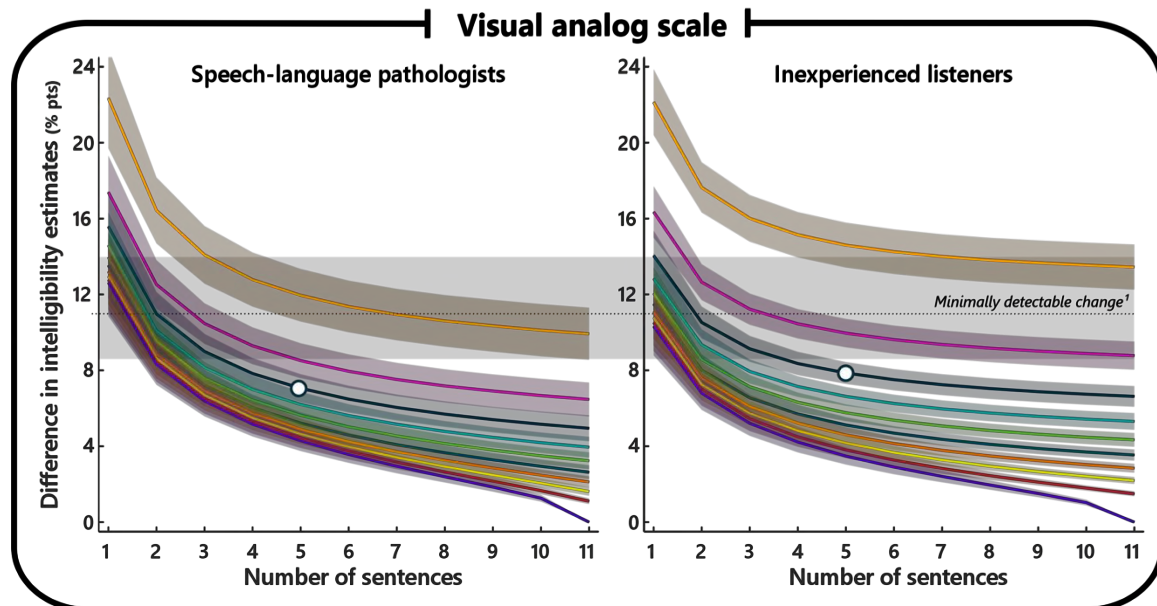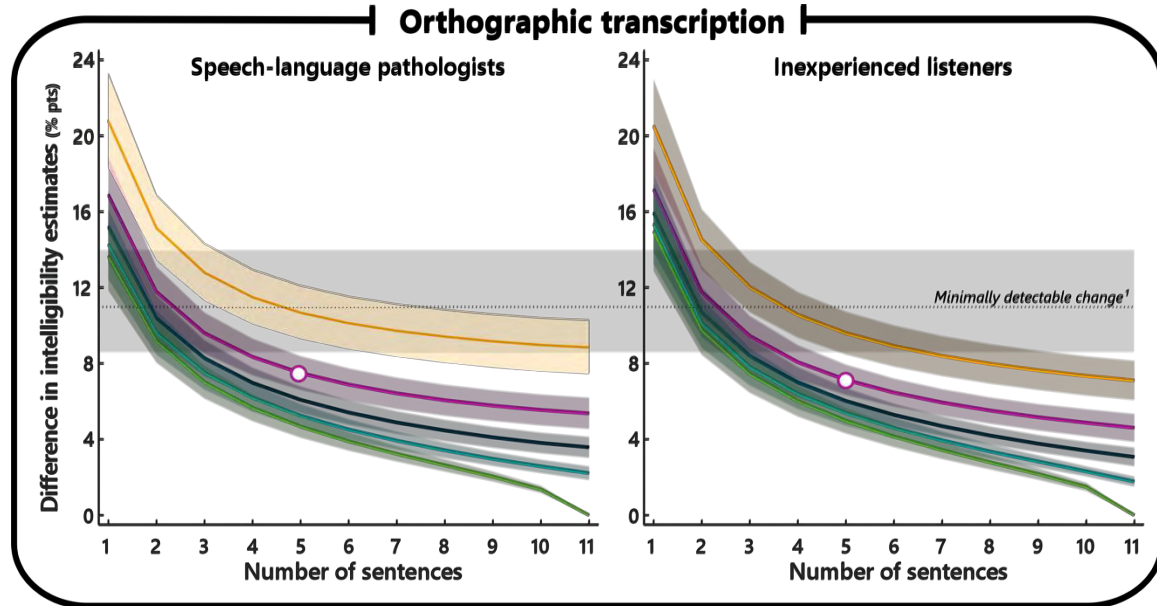
3 Listeners
As few as two listeners… *if they transcribe 11 SIT sentences*[2]

[1]Dahl et al., in prep; [2]Abur et al., 2019

Tying it together

The evidence

Dahl et al., in prep

[1]Stipancic et al., 2022

Tying it together

The evidence

Dahl et al., in prep

Orthographic transcription

Speech-language pathologists

Inexperienced listeners

Visual analog scale

Speech-language pathologists

Inexperienced listeners

Differences in intelligibility estimates below minimally detectable change[1] (%)

Number of sentences

- 1 listener
- 2 listeners
- 3 listeners
- 4 listeners
- 5 listeners
- 6 listeners
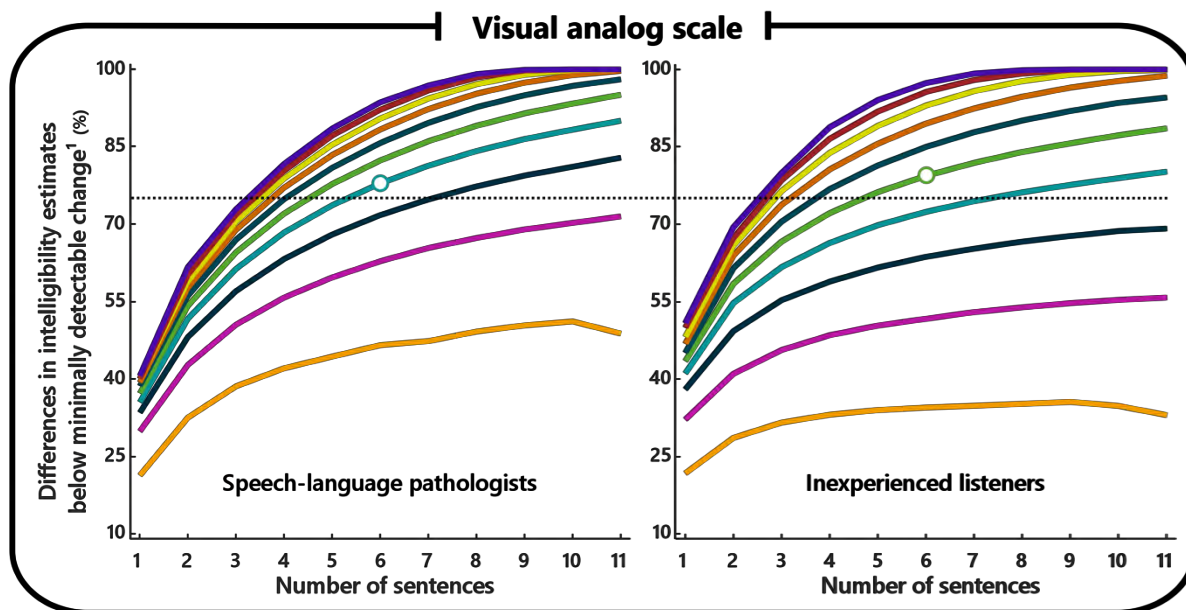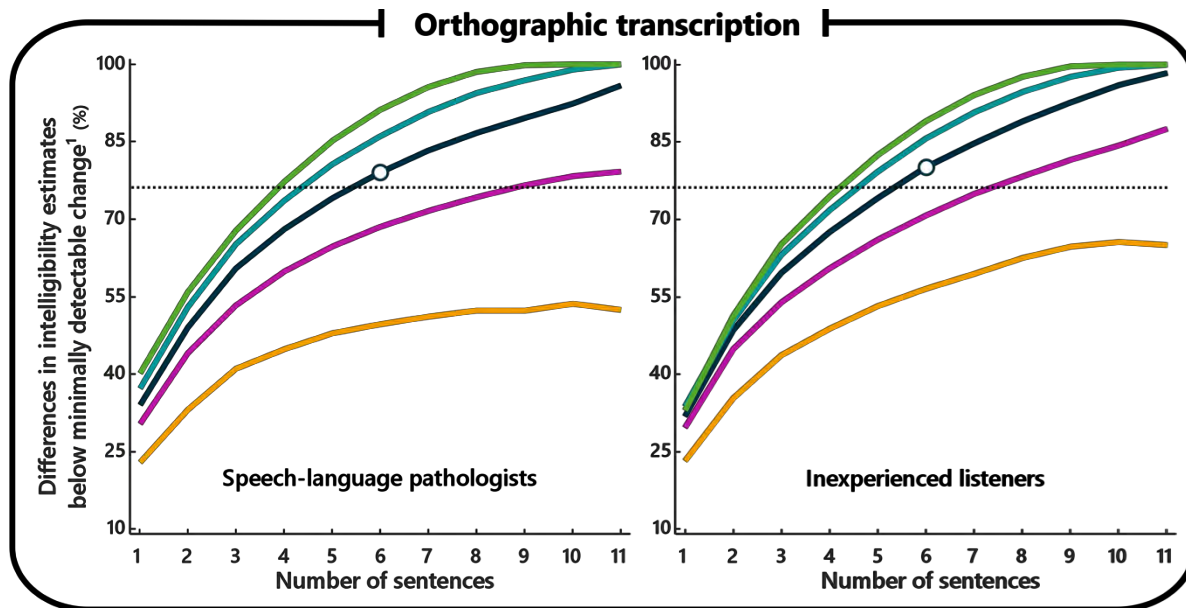- 7 listeners
- 8 listeners
- 9 listeners
- 10 listeners

[1]Stipancic et al., 2022

Summary

1 Method   2 Speech sample   3 Listeners

- What type of assessments do I have access to?
- How much time do I have to assess intelligibility?
- What speech samples do I have or can I collect?
- What type of listener can I easily recruit?
- How many listeners can I recruit?

Questions?

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