

I. Introduction

THE SPEECH PRODUCTION SYSTEM OVER TIME

- Age affects wide range of systems in the body
- Children and older adults differ from young adults in terms of laryngeal mechanisms, respiratory processes, peripheral and cognitive functions, etc.
- This affects speech in terms of speaking rate, voice quality, pitch, variance in intelligibility, etc.

SPEAKING STYLE ADAPTATIONS

- Talkers can improve the ease to which they are understood via systematic alterations in their speech patterns
- **Speech-in-noise**: modification in response to environmentally-sourced difficulties (environment-oriented)
 - E.g. boosting loudness when speaking in noisy restaurant
- **Clear speech**: modification in response to listener-sourced difficulties (listener-oriented)
 - E.g. slowing speech rate when speaking to a hard-of-hearing person
- Limited research suggests age-related differences across these speaking-style adaptations [1][2]

→ Important to examine speaking style adaptations in children and older adults

- Acoustic-phonetic modifications
- Impact on intelligibility, the degree to which spoken language can be comprehended

RESEARCH QUESTIONS

- **Speech Production**
What are the different strategies for environment-oriented vs. listener-oriented speech modifications used by each age group?
- **Speech Perception**
What is the perceptual impact of these speaking style enhancements as produced by talkers of different ages?

II. Methods

TALKERS

- Native speakers of American English
- Half M, half F in each group
- 10 children
 - Range: 11-13
- 10 young adults
 - Range: 18-29
- 10 older adults
 - Range: 60-84

STIMULI

- 60 target words embedded in meaningful sentences produced by talkers
 - *Mice like to eat cheese*

PROCEDURE

- 4 conditions:
 - Quiet vs. noise
 - Conversational vs. clear
- *Instructions to talkers:*

Conversational speech in quiet (QCO)	"Speak as if you are talking to a friend or family member."
Clear speech in quiet (QCL)	"Speak as if you are trying to communicate with someone who has low proficiency in English."
Conversational speech in noise (NCO)	"You will hear background noise. Speak normally and conversationally, as if you are talking to a friend or family member in a noisy place."
Clear speech in noise (NCL)	"You will hear some background noise. Speak as if you are trying to communicate with someone who has a low proficiency in English, in a noisy place."

ACOUSTIC ANALYSES

- 15 acoustic metrics shown to change with speaking style or with age, including measures of:
 - **Voice quality**: jitter, shimmer, harmonics-to-noise ratio (HNR)
 - **Pitch**: mean and range
 - **Vowels**: vowel duration
 - **Distribution of energy**: energy in different frequencies

LISTENERS

- 60 normal hearing young adult listeners
- Native speakers of American English
- Range: 17-33 years

PROCEDURE

- Recorded sentences were mixed with noise to increase difficulty
- Listeners heard these sentences and were asked to transcribe what they heard

INTELLIGIBILITY SCORING

- Each sentence has 1 target word
- Scoring is determined by recognition of target word

III. Results

SPEAKING STYLE CHANGES

SIMILARITIES

Across age groups, both speech-in-noise and clear speech differ from their baseline counterparts in terms of:

- Increase in pitch mean and range
- Greater distribution of energy (more energy increases intelligibility)
- Longer vowel duration
- Increase in HNR (voice quality measure that increases intelligibility)
- Greater intelligibility

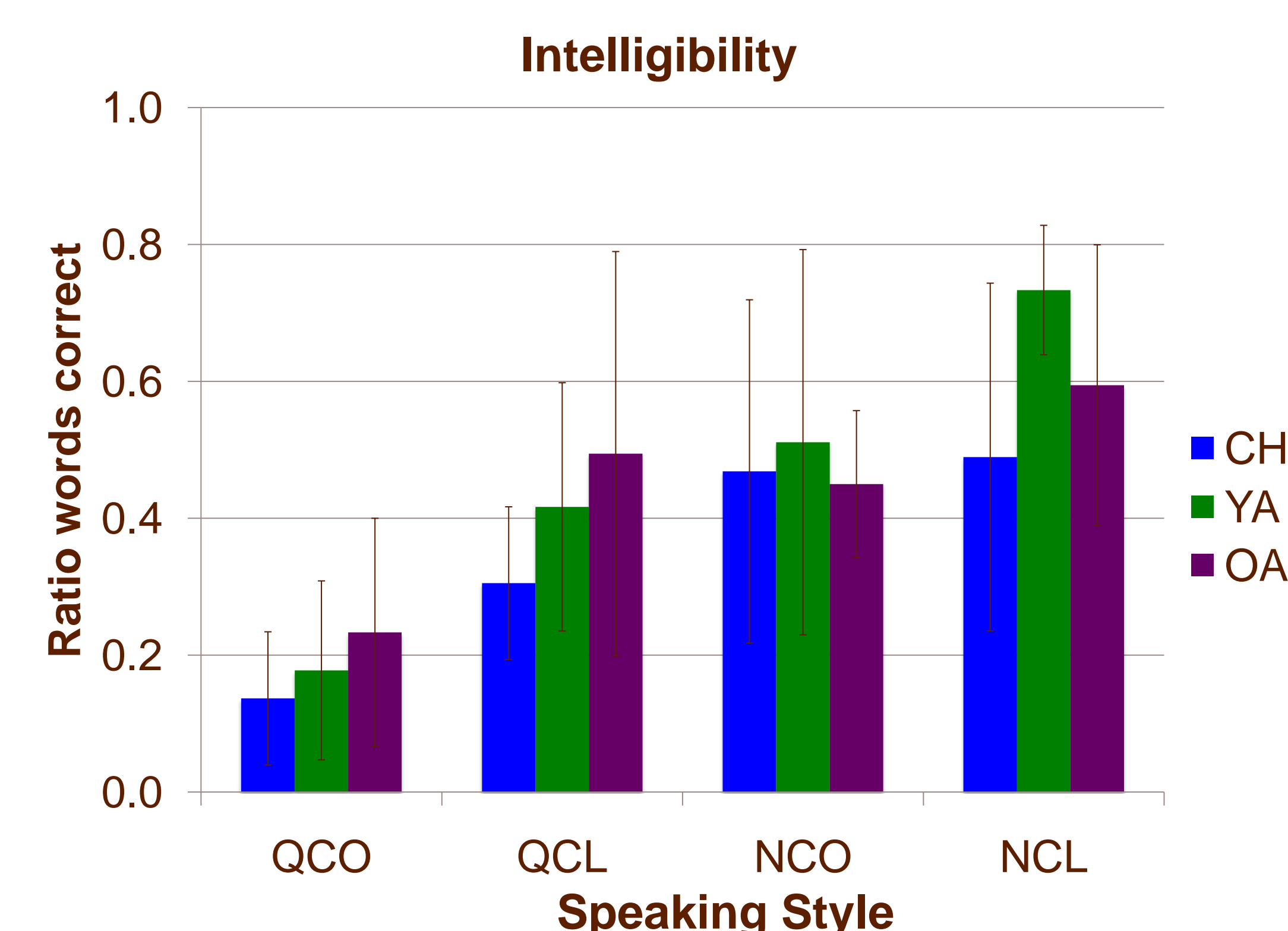
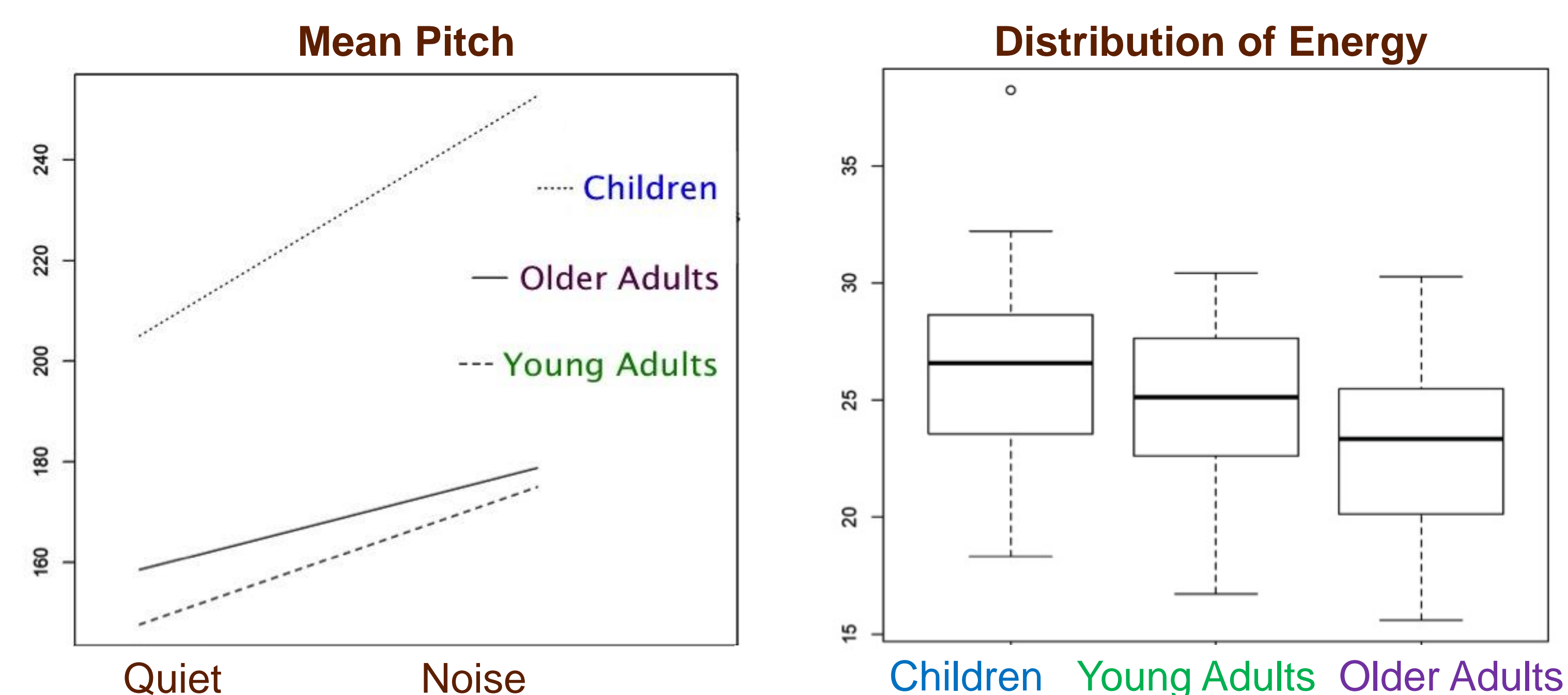
DIFFERENCES

Across age groups, only speech-in-noise exhibits:

- Significant decrease to jitter and shimmer (voice quality measures that decrease intelligibility)

AGE-RELATED CHANGES

- Production:
 - Aging involves significant increase to:
 - Pitch range (Older adults show larger range than younger groups)
 - Vowel Duration (Older adults show longer vowels than younger groups)
 - Jitter (Children show much lower jitter than adults)
 - Shimmer (Children show much lower shimmer than adults)
 - Aging differentially affects:
 - Pitch mean (Children > Older adults > Young adults)
 - Aging involves significant decrease to:
 - Distribution of energy (Children > Young adults > Older adults)
 - HNR (Children show much higher HNR than adults)
- Perception:
 - Children marginally less intelligible than adults



IV. Conclusion

SUMMARY

- Comparison of the two speaking style adaptations reveals a large overlap of modifications aimed to boost intelligibility
- Older adults and children implementing many of the same acoustic-phonetic modifications as young adults when producing speech-in-noise and clear speaking style adaptations
 - But older adults have greater pitch range, longer vowel duration
 - Children have less jitter, shimmer, higher HNR and increased distribution of energy
- Overall, for intelligibility
 - Children are less intelligible than adults across all speaking styles
 - Older adults are the most intelligible age group in quiet
 - Young adults are the most intelligible age group in noise
- Results contribute to a better understanding of how age-related changes relate to speech production mechanisms and intelligibility across a lifespan

DISCUSSION

- Talker groups significantly altered speech in response to both types of adverse communicative situations
- However, older adults more intelligible than expected
 - Self-selected population resulted in atypical sample
 - Perceived as younger than biological age
- However, talker intelligibility is not consistent across different speaking styles
 - Intelligibility boosted in quiet for older adult talkers who exhibit longer vowel duration
 - Intelligibility boosted in noise for younger adult talkers who better adapt speech in noisy environments

→ *Practical applications:*

- For educational and clinical uses (e.g. training ESL teachers or family members of patients with hearing loss)
- For speech technology (e.g. better talker selection for training automatic speech recognition algorithms)

THE NEXT STEPS

- Examining additional measures that may better capture aging differences in speech
- Additional speakers with greater physiological aging (more representative)
- Talker-listener pairs matched for age