

Aged-related Differences in Neural and Perceptual Signatures of Temporal Fine Structure Processing Underlying Multi-talker Speech Intelligibility



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Background

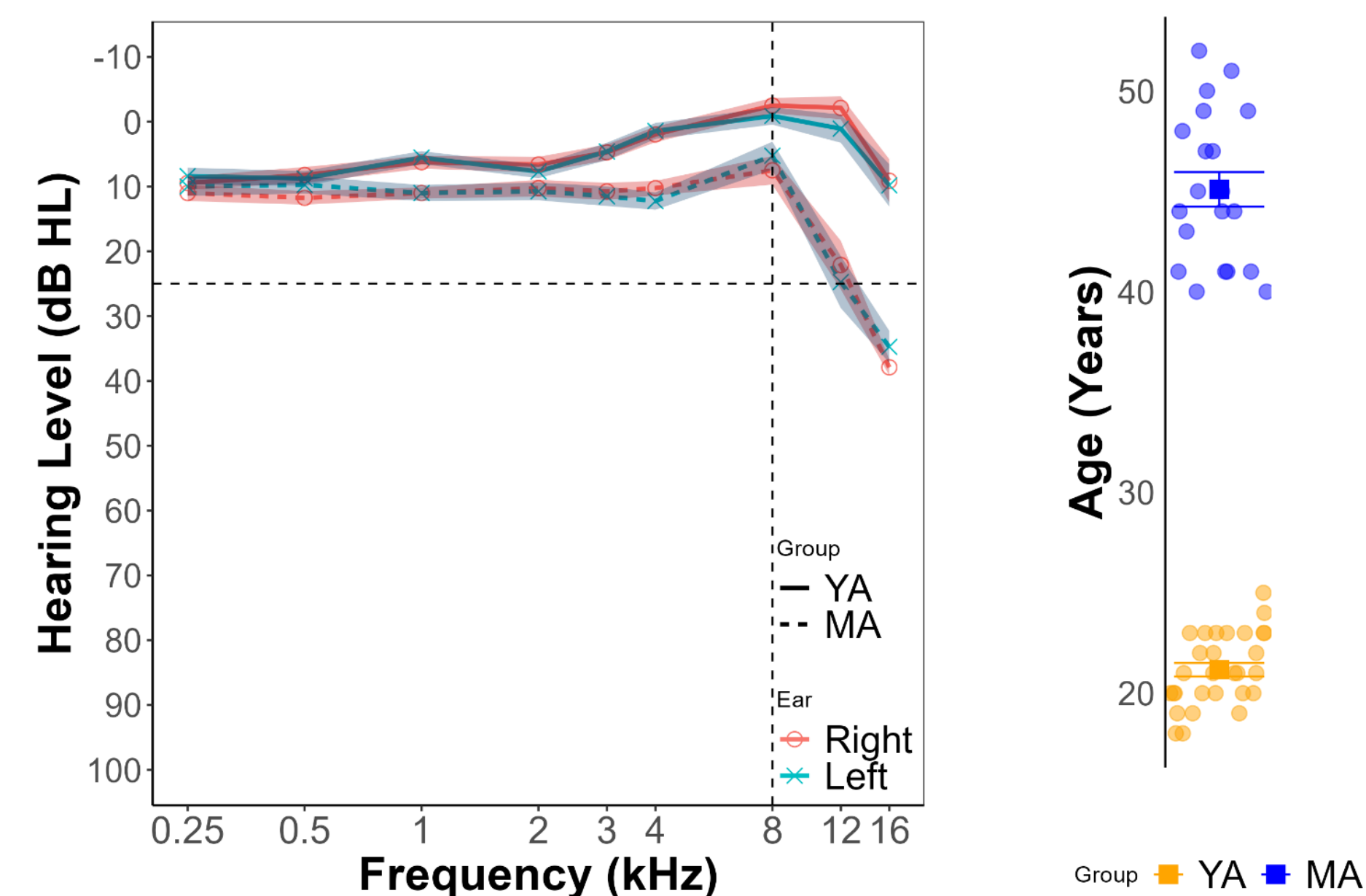
Aging is associated with declines in multi-talker speech intelligibility, which is thought to be mediated by degraded processing of stimulus temporal fine structure (sTFS) cues.^{1,2,3} We have previously developed an objective neurophysiological marker of sTFS processing using phase-locked neural responses to frequency modulated (FM) tones.⁴ We demonstrated that degraded sTFS processing is accompanied by an increased reliance on top-down listening effort in young adults performing a multi-talker speech intelligibility task. Here, we use the same biomarker of sTFS processing paired with pupil-indexed measures of listening effort to assess factors underlying variability in multi-talker speech intelligibility in middle-aged adults with normal audiometric thresholds. Specifically, we investigated the extent to which:

1. Neural coding of sTFS cues decrease with age
2. Middle-aged adults rely on top-down mediated listening effort
3. Bottom-up sTFS coding and top-down listening effort explain variability in multi-talker speech intelligibility

Participants

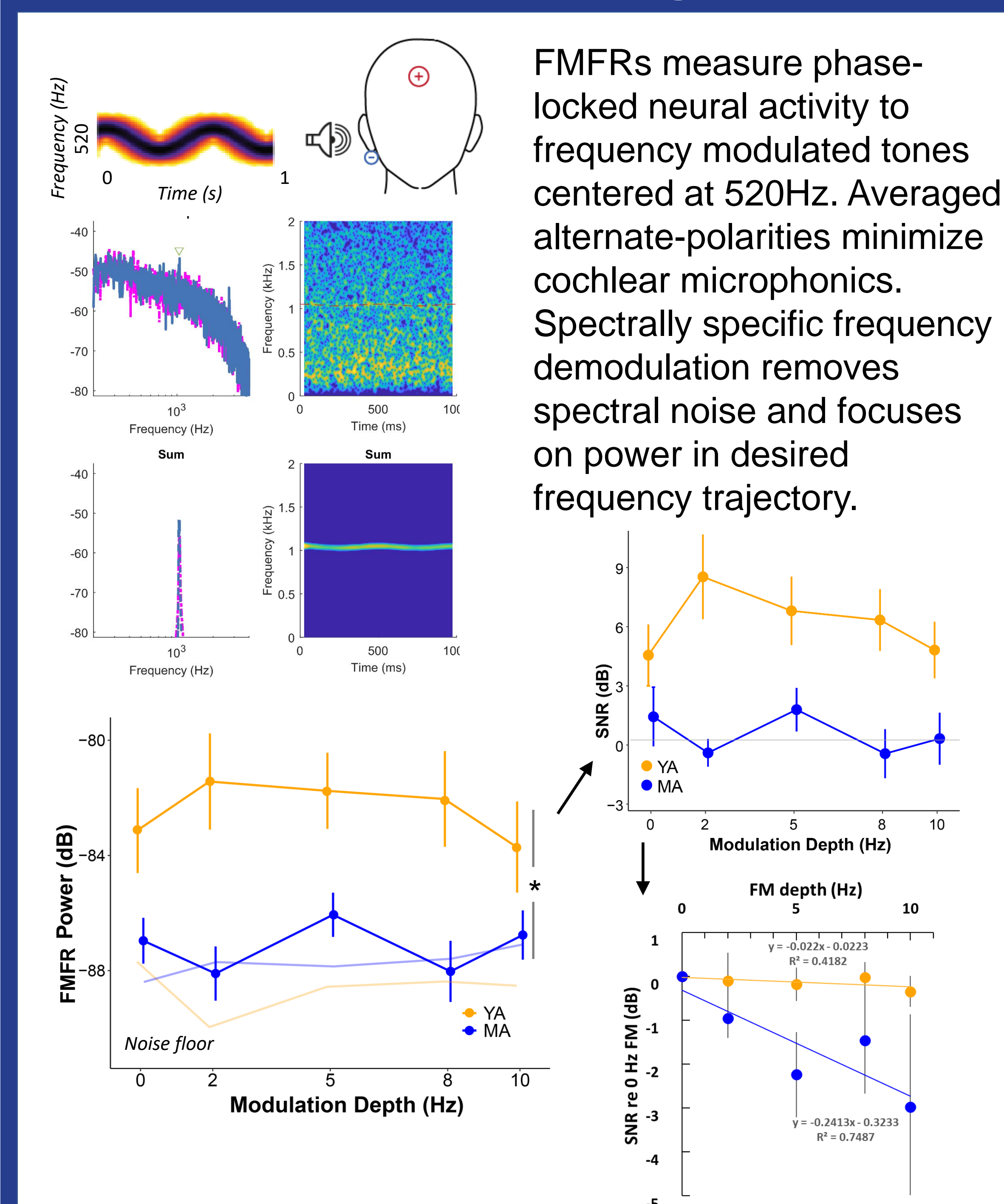
Inclusion Criteria

- Young adults (YA; n=29) aged 18-25 years or middle-aged adults (MA; n=20) aged 40-55 years
- Fluent in American English
- Normal otoscopy and normal hearing, defined as ≤ 25 dB HL for .25, .5, 1, 2, 4, 8 kHz
- Loudness discomfort levels ≥ 80 dB for .5, 1, 2, 3, 4 kHz
- Montreal Cognitive Assessment score ≥ 25
- No severe tinnitus



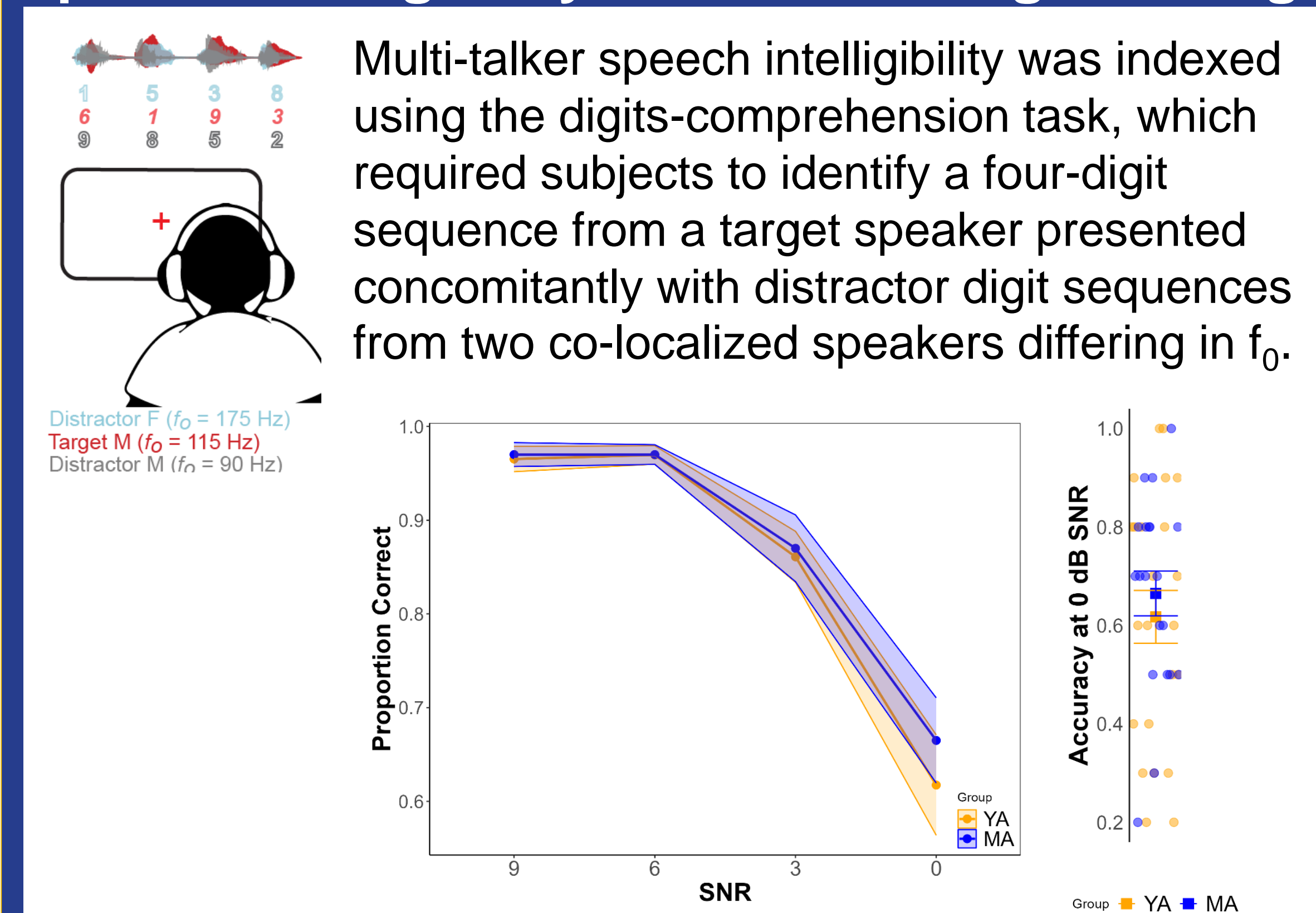
Middle-aged adults had normal audiometric thresholds up to 8 kHz and showed some evidence of hearing threshold losses at extended high frequencies.

Neural encoding of temporal fine structure cues decreases with middle-age



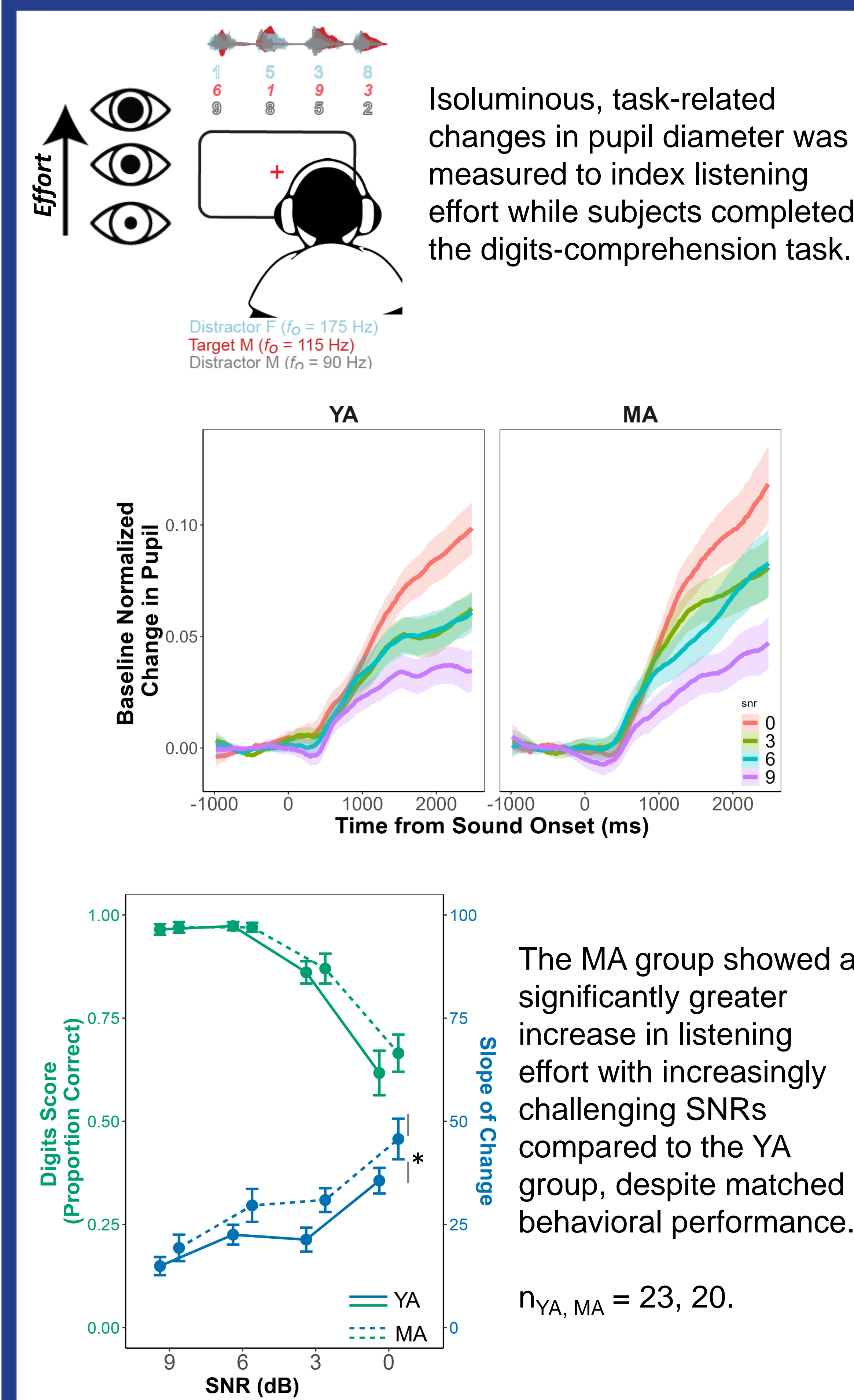
Middle-aged adults show significantly decreased pure-tone phase-locking at 520 Hz as well as decreased representation of frequency modulation, suggesting impaired neural representation of sTFS cues. $n_{YA, MA} = 13, 12$.

Behavioral performance on multi-talker speech intelligibility does not change with age

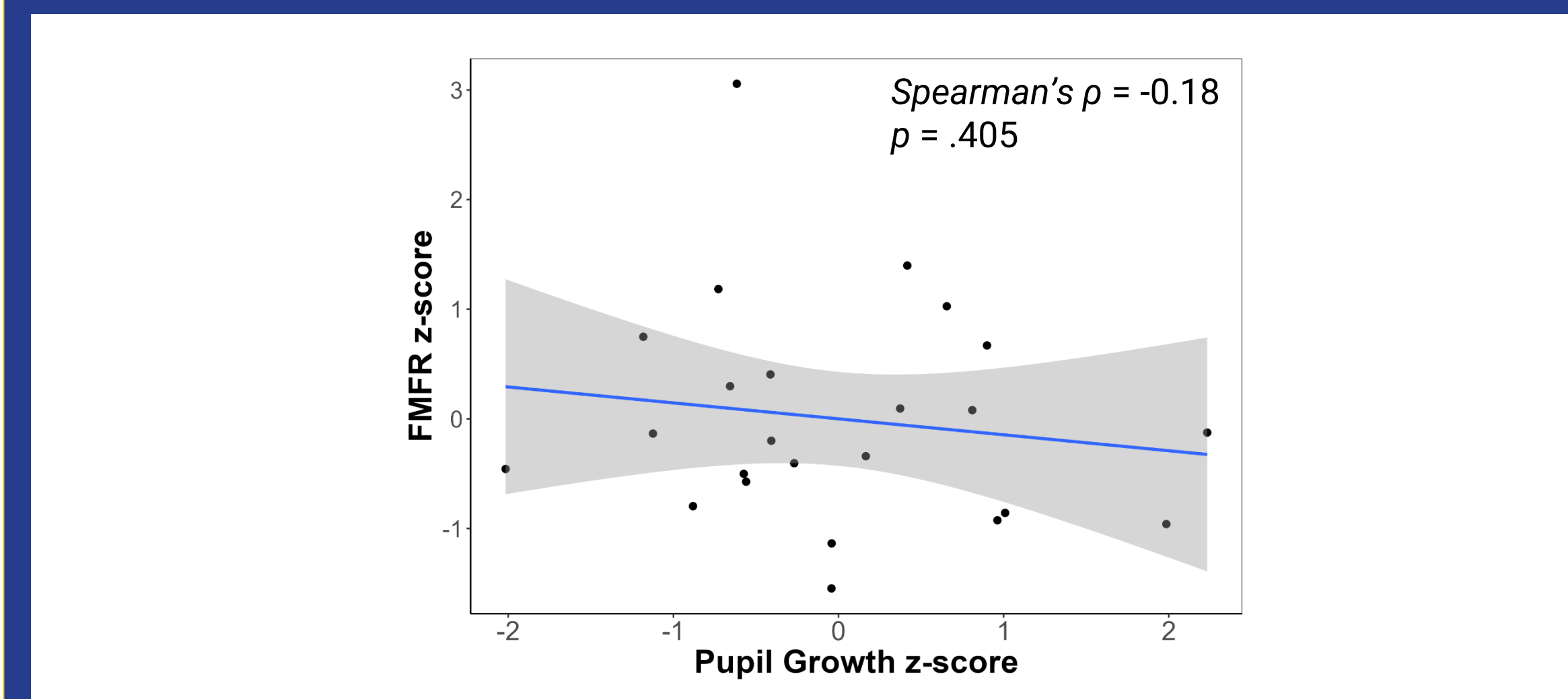


Behavioral performance on the multi-talker speech task was comparable across young and middle-aged participants. Shading and error bars represent \pm SEM. $n_{YA, MA} = 23, 20$.

Listening effort increases with age and worsening SNR, despite matched behavioral performance

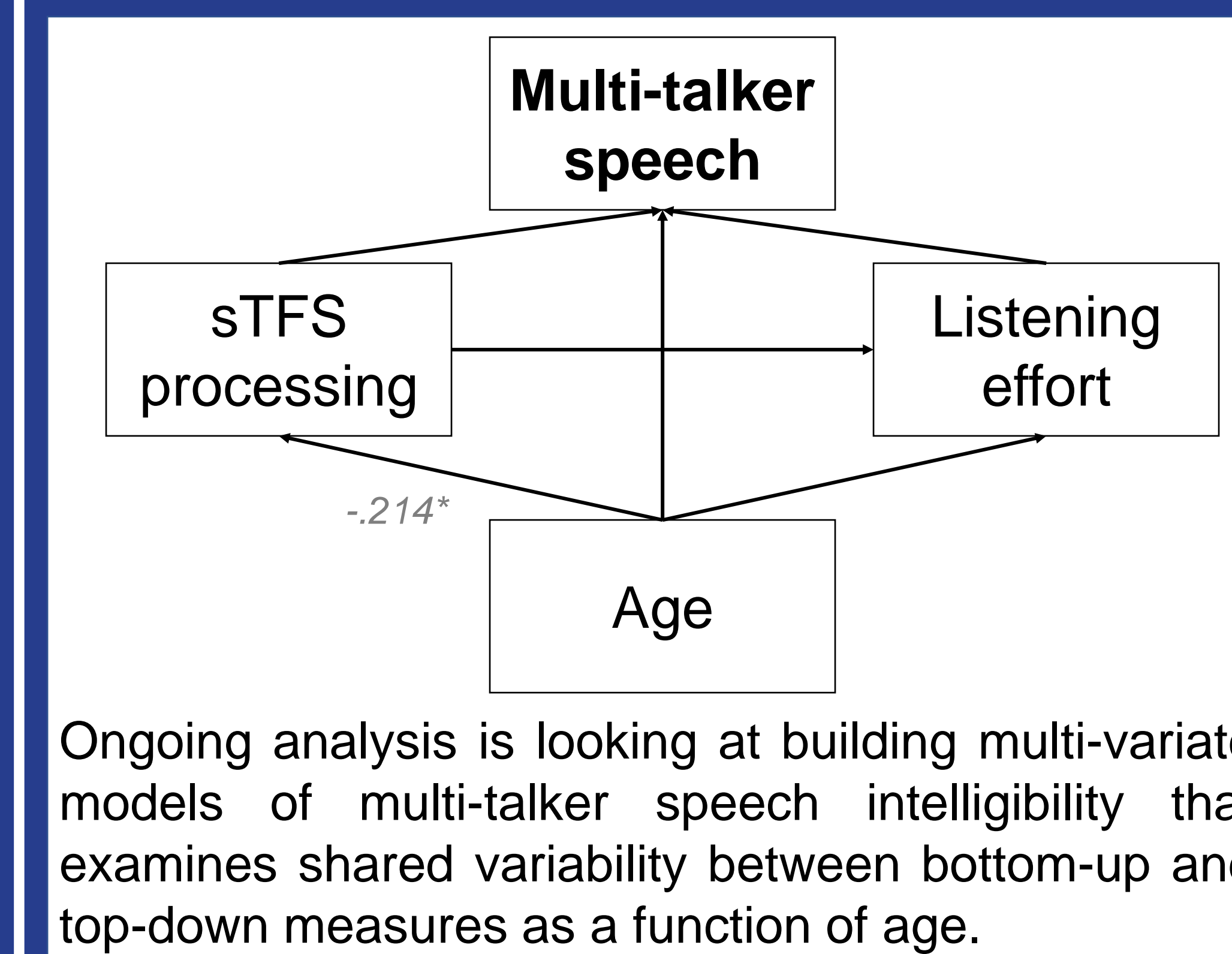


FMFRs and Pupil diameters are not linearly correlated



FMFRs and pupil diameters were not linearly correlated, suggesting they share a non-linear relationship or index independent neural processes. $n_{YA, MA} = 13, 11$.

Multivariate model of speech-in-noise examines relationships between bottom-up and top-down measures



Summary

- Middle-aged adults with normal audiometric thresholds show decreased neural representation of sTFS cues
- Behavioral performance in young and middle-aged adults are matched
- However, middle-aged adults exhibit increased listening effort despite matched behavioral performance
- Ongoing analysis is examining the interactions between decreased sTFS representation and increased listening effort in explaining performance on multi-talker speech intelligibility in middle-aged adults with normal audiograms
- Parallel experiments are investigating the neural mechanisms underlying decreased sTFS processing using animal models

References

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Acknowledgments

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