**BACKGROUND**

Hearing aids and visual speech (lip reading) are two strategies recommended by audiologists to enhance speech understanding in noise. [1]

**Auditory Speech**

Auditory and visual speech streams are correlated in multiple ways. [2-3] Neurophysiological evidence indicates that mouth movements help the auditory cortex to track the temporal amplitude envelope of auditory speech (the slow time-varying changes in signal energy). [4-7] This helps listeners predict the timing of peaks in the auditory signal and direct auditory analyses to the speech signal of interest, rather than surrounding background noise. [8, 9]

**Visual Speech**

Distortions of the auditory speech understanding in individuals with hearing loss. [10, 11] WDRC is a key feature in hearing aids and a primary means of improving envelope and the mean (long-term) correlation over the duration of the auditory sentence.

**Wide dynamic range compression (WDRC)**

WDRC is a key feature in hearing aids and a primary means of improving auditory speech understanding in individuals with hearing loss. [10, 11] Hearing aids with WDRC amplify low intensity parts of auditory signals more than the higher-intensity parts. WDRC distorts the amplitude envelope of auditory speech. [12] Distortions of the auditory amplitude envelope likely disrupt the natural temporal correspondence between auditory and visual speech. Therefore, WDRC may affect the benefit derived from visual speech.

**PURPOSE**

Long-term goal: Understand the impact of wide dynamic range compression (WDRC), a key feature in hearing aids, on AV speech perception in individuals with hearing loss.

Questions addressed in this proposal:

1. How does WDRC affect the AV temporal correspondences?
   - How does WDRC affect AV speech perception benefits in individuals with normal hearing?

2. Determine the effect of WDRC on auditory-visual temporal correspondences and AV speech perception benefit in listeners with normal hearing.
   - What is the effect of test order, t = 8.852, p < 0.0001, and an effect of mean AV correlation, t = 3.122, p = 0.0026.
   - Consistent with practice effects, benefit was greater for participants tested in the auditory condition first.
   - Consistent with our hypothesis, benefit was greater for sentences with a higher auditory-visual correlation.

**AIMS AND HYPOTHESES**

1. Determine which AV temporal correlations are related to speech perception benefit.
   - Hypothesis: Correlations at the auditory peak are important for detecting speech in noise and correlations over the whole sentence are important for speech recognition.

2. Determine the effect of WDRC on auditory-visual temporal correspondences and AV speech perception benefit in listeners with normal hearing.
   - Hypothesis: WDRC decreases AV temporal correlations, which decreases AV detection benefit.

**Competing hypotheses:**

a) Decreased correspondence between the auditory and visual envelopes may decrease AV recognition benefit

b) Visual envelopes in the WDRC condition may serve as a complementary cue that helps to restore the original information about the degraded acoustic amplitude envelope.

**THREE EXPERIMENTAL TASKS**

**Participants:** Young adults with normal hearing and normal or corrected-to-normal vision

**Stimuli:** 74 AV sentences spoken by 4 talkers

**Stimulus analysis:**

- Calculated the instantaneous correlation between the area of the mouth opening and the auditory envelope at each video frame over the duration of the auditory sentence, using a flat 334 ms moving window and 0-2 frames of visual lead.

- Calculated the short-term correlation over the 334 ms centered on the peak of the auditory envelope and the mean (long-term) correlation over the duration of the auditory sentence.

**Wide Dynamic Range Compression:**

- Apply WDRC to the auditory stimuli and experiment to the speech signal of interest. Use FaceScanner software. [12]

**Experimental Tasks:**

- Conducted with unprocessed and WDRC compressed signals.

**Adaptive Detection Threshold Measurement:**

- Participants select the interval that contains auditory speech.

**Sentence Recognition:**

- 72 auditory and AV sentences presented in noise.

**RESULTS**

- 20 adults completed the sentence recognition task with unprocessed stimuli. Test order was counterbalanced across participants.

- Calculated mean benefit (AV accuracy – auditory accuracy) across subjects, for each sentence and test order.

- Mixed linear modeling was conducted on the benefit data with a fixed effect of test order, a random effect of mean (long-term) AV correlation, and a random intercept for sentence.

- Results showed an effect of test order, t = 8.852, p < 0.0001, and an effect of mean AV correlation, t = 3.122, p = 0.0026. Consistent with practice effects, benefit was greater for participants tested in the auditory condition first.

- Consistent with our hypothesis, benefit was greater for sentences with a higher auditory-visual correlation.

**ACKNOWLEDGEMENTS**

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**REFERENCES**


2. Ch distributions and effects of hearing aids. [10, 11] Hearing aids with WDRC amplify low intensity parts of auditory signals more than the higher-intensity parts. WDRC distorts the amplitude envelope of auditory speech. [12] Distortions of the auditory amplitude envelope likely disrupt the natural temporal correspondence between auditory and visual speech. Therefore, WDRC may affect the benefit derived from visual speech.

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