**INTRODUCTION**

Speech communication is more than correctly identifying words. As we perceive stimuli, we predict what comes next [1-3]. In Speech Perception, prediction can be driven by:

- Acoustics
- Knowledge of a talker
- Words are easier to recognize when presented by relevant context [4-6].

Context helps us predict and understand what we are about to hear.

“Sweep the floor with a broom”

“Nicole thought about a broom.”

High-context sentences are more intelligible than low-context sentences. Context facilitates better and faster word recognition.

**WHY MEASURE PUPIL DILATION?**

Poor spectral resolution increases overall listening effort [10, below]. This approach lets us observe the growth of effort during the perceptual process.

**METHODS**

**PARTICIPANTS:** 21 young listeners with normal hearing (ages 19 – 32 yrs)

12 listeners with cochlear implants (ages 40 – 67 yrs)

**STIMULUS:** Revised speech-in-noise (R-SPIN) sentence lists [6,7]

Each list contains 25 high-context and 25 low-context sentences.

**SPECTRAL RESOLUTION:**

Four testing blocks alternated in sound quality between normal (clean) speech and degraded (2-channel vocoder) speech.

**PROCEDURE:**

Listen tr & repeat sentences while fixating on a monitor

(-3 s silence) Stimulus (2 s silence) Response

“Your coffee with a spoon”

**MEASUREMENT OF LISTENING EFFORT:**

High-speed eye tracking was used to measure pupil dilation during each trial. Greater pupil dilation indicates increased listening effort [8, 9].

**RESULTS:** Semantic context reduces listening effort rapidly...

but only if signal quality is clear

**CONCLUSIONS**

- Semantic context reduces listening effort (Fig 1)
- Effort reduction from context is rapid for NH listeners, and delayed (by ~ 1 second) for CI listeners (Fig 2) & NH listeners hearing vocoded speech (Figs 2, 3)
- Delays in effort release are observed even when intelligibility is perfect (Fig 4)
- **Implications:** Benefit of context might occur only after a sentence has been heard, but still lead to good intelligibility in the clinic/lab, but in conversational speech, we don’t have lengthy silent pauses after sentences for listeners to catch up and recover context; a brief delay in processing might cause interference between the last sentence and the next sentence
- **Methods:** Time-varying physiological measures (such as pupillometry) can capture the temporal dynamics of listening effort as it unfolds during the perceptual process.

**Philosophy of outcome measures:** Speech perception is more than just recognition of isolated units like syllables and words: Poor signal quality can cause disruption in the ongoing process of prediction and restoration of words.

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**Fig. 1:** Growth of pupil dilation in response to low- and high-context sentences. How do we quantify benefit of context on listening effort?

**Effect Release:**

The difference between

- Response to Low-context
- Response to Low-context
- Response to High-context

**Fig. 2:** Reduction of pupil dilation when sentences were spoken contextually. A significant parameter sigmoid function:

Percent

1 - e^(-x / (Time + a) + b) - C

* Significant shallower slope (slower effort release) for CI listeners
* Significantly longer latency (slower onset of effort release) for CI listeners
* Stronger effects of the same direction were observed for the NH vocoder condition

**INTELLIGIBILITY:**

(Second task during testing)

- % of sentences with errors on non-targeted (“context”) words
- % of sentences that continued as “target” words
- % of targeted word errors produced by “non-context” errors

**Fig. 3:** Slope of pupil size change over time in two time windows labeled in Fig 1. Results persist even if intelligibility is perfect

**Fig. 4:** Growth of pupil dilation is observed in the high-context condition but not in the low-context condition. "Control" error is the regression of any word before the final word

**Fig. 5:** Reduction of pupil dilation when sentences were spoken contextually. A significant parameter sigmoid function:

Percent

1 - e^(-x / (Time + a) + b) - C

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* Stronger effects of the same direction were observed for the NH vocoder condition

**RESULTS:** Semantic context reduces listening effort rapidly...

but only if signal quality is clear

**Fig. 6:** Slope of pupil size change over time in two time windows labeled in Fig 1. Results persist even if intelligibility is perfect

**Fig. 7:** Reduction of pupil dilation when sentences were spoken contextually. A significant parameter sigmoid function:

Percent

1 - e^(-x / (Time + a) + b) - C

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