



# R26: IMPACT ANALYSIS OF NATURALISTIC ENVIRONMENTAL NOISE TYPE ON SPEECH PRODUCTION FOR COCHLEAR IMPLANT USERS VERSUS NORMAL HEARING LISTENERS



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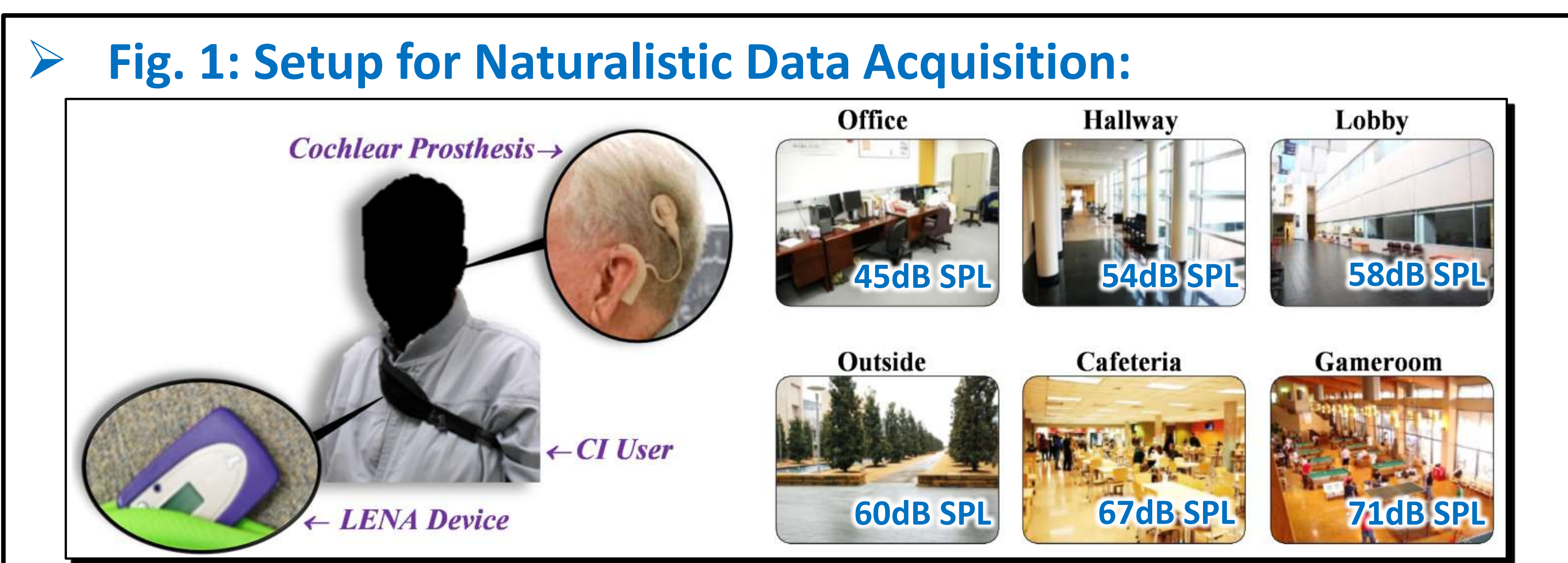
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## 1. Introduction

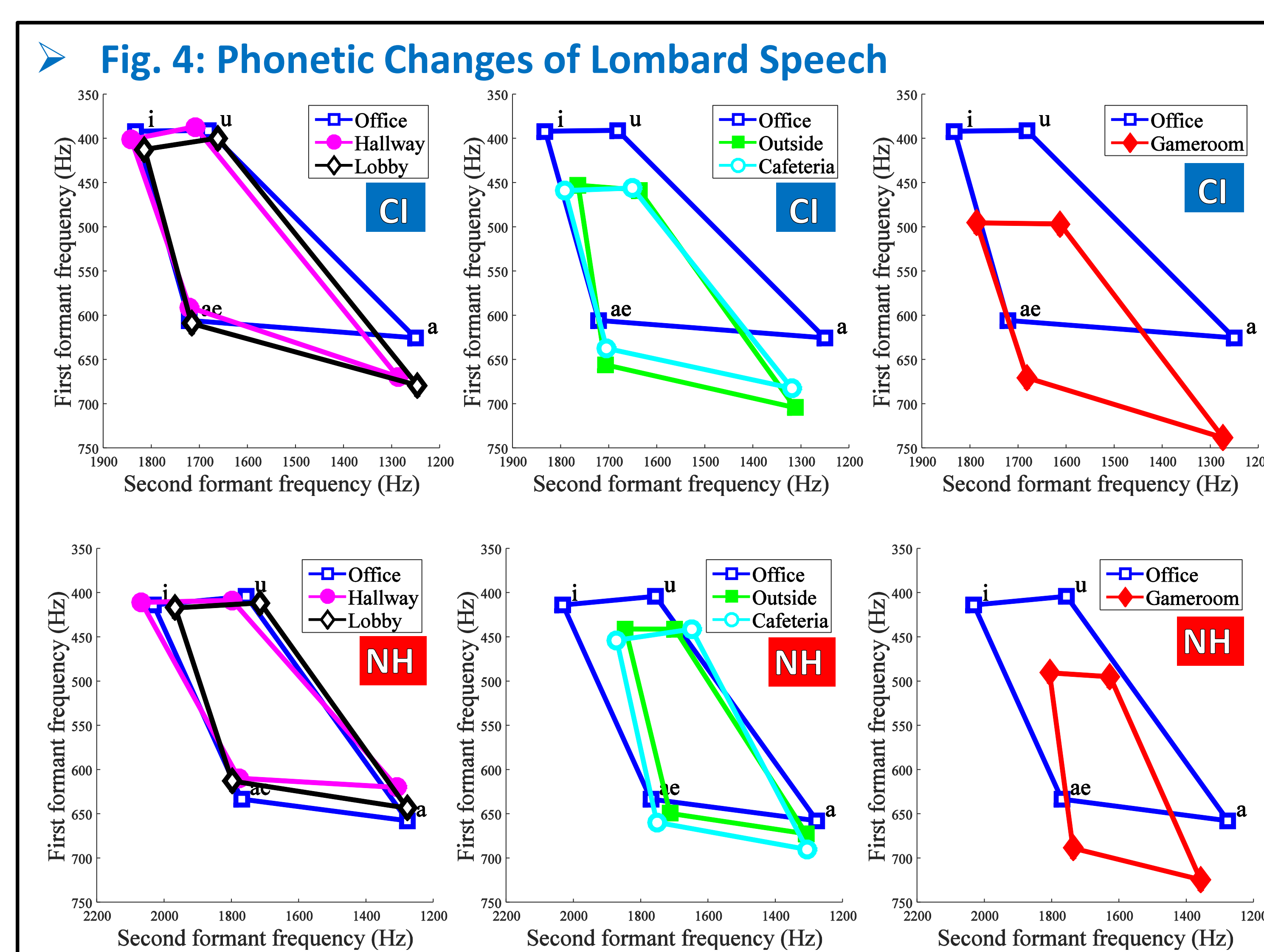
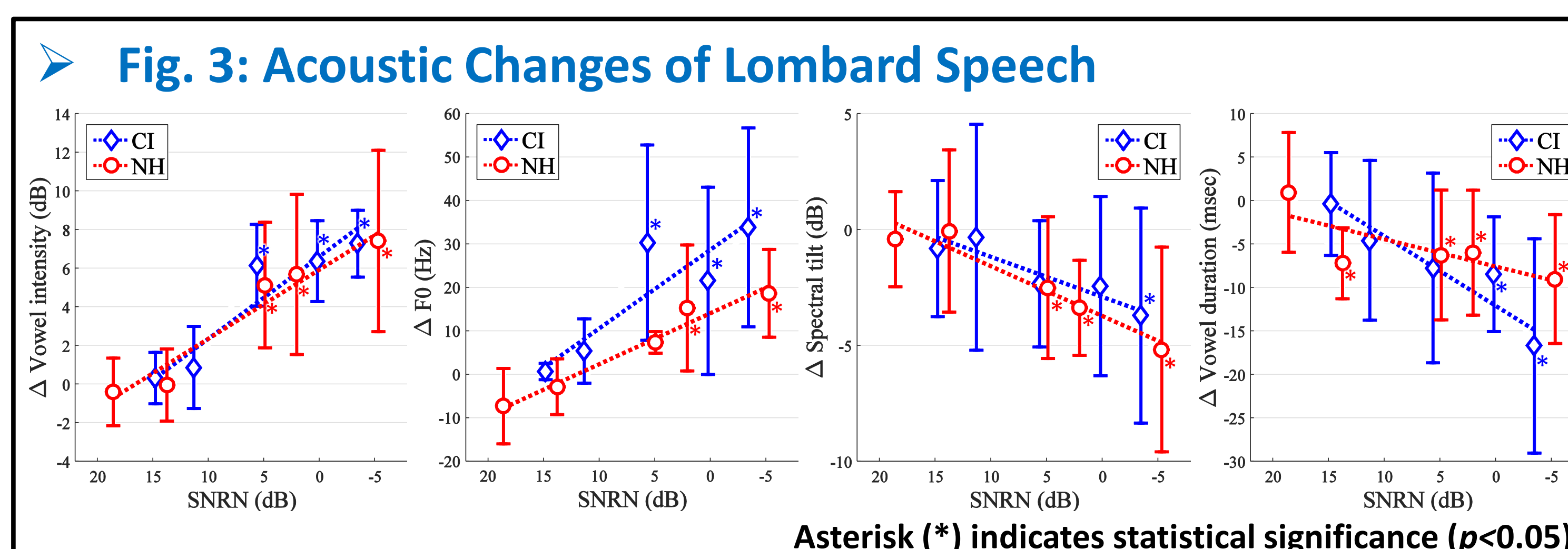
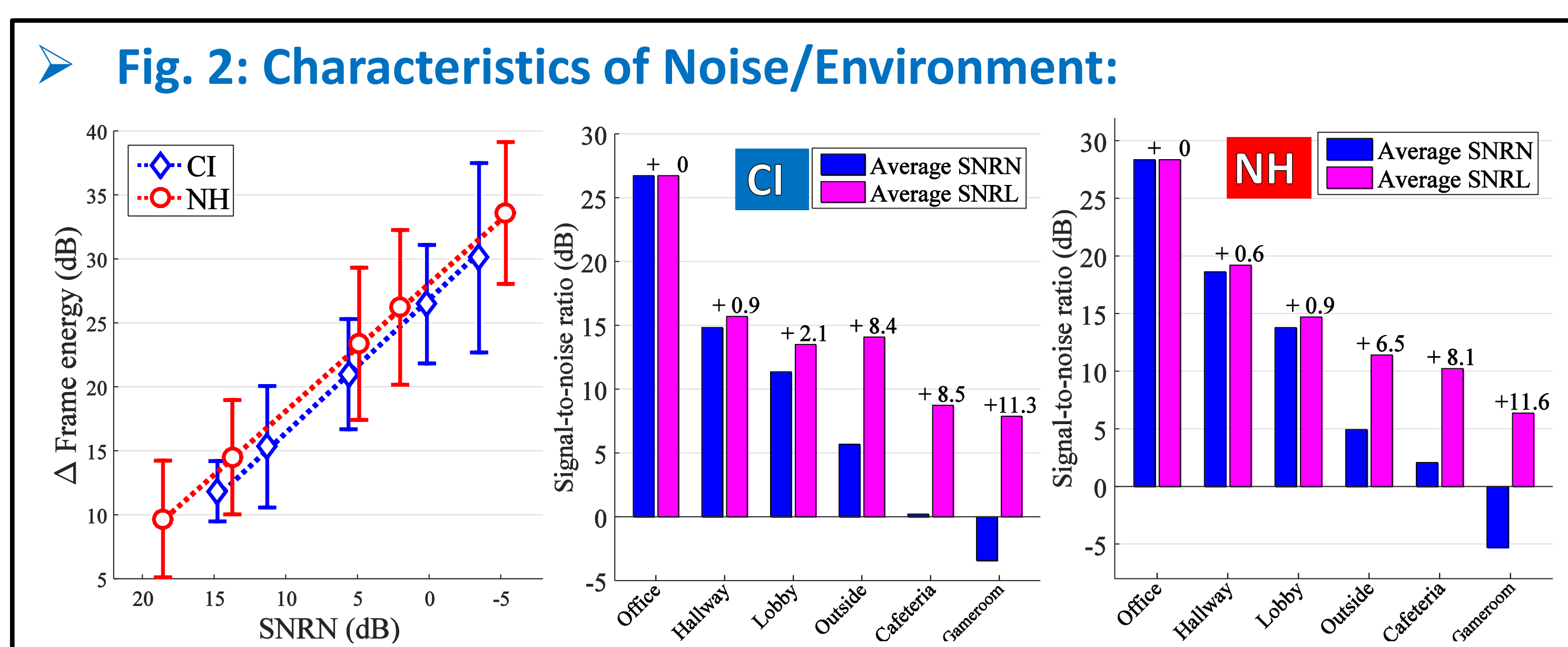
- ◆ Lombard Effect is involuntary response a speaker experiences speaking in the presence of noise (E. Lombard, 1911; Hansen, 1996).
- ◆ This phenomenon is known to impact change in vocal effort including increased voice intensity, pitch period structure, formant characteristics, glottal spectral slope, speech rate, etc.
- ◆ While well studied for normal hearing (NH) listeners, little is known about Lombard effect on speech production for cochlear implant (CI) users (Svirsky and Tobey, 1991).
- ◆ The objective of this study is to analyze the speech production of CI users with respect to environmental noise structure.
- ◆ In addition, the study aims to investigate the degree to which CI user's speech production is affected as compared to NH listeners for Lombard Effect.

## 2. Methods

- ◆ A total of 12 speakers (6 CI and 6 NH) participated by producing conversational speech in various everyday environments.
- ◆ Mobile personal audio recording devices from continuous single-session audio streams were collected and analyzed.
- ◆ Prior advancements in this domain include the "Prof-Life-Log" longitudinal study at UT-Dallas (Ziaei et al., 2013).
- ◆ A number of parameters that are sensitive to Lombard speech were measured from speech via PRAAT software.



## 3. Results



➤ Table 1: Pairwise Comparison of CI and NH

Vowel	Acou. Param. ANOVA		Phon. Param. ANOVA		Phon. Param. ANOVA	
	Intensity	F0	/a/	/æ/	/i/	/u/
		**↑				
					**↑	
		**↑				

Significance levels: \*\*\*<0.001, \*\*<0.01, and \*<0.05.

## 4. Conclusions

- ◆ Result suggest that the presence of Lombard effect is shown in speech of CI users who are post-lingual deaf adults.
- ◆ Speakers increased their vocal effort, vowel intensity, fundamental frequency, glottal spectral slope, and vowel duration significantly in challenging noisy environments.
- ◆ Auditory feedback appears to interact with the control of some suprasegmental and segmental properties of the speech production in noise for CI users.
- ◆ There is speech production changes which are similar patterns between CI and NH individuals during 2-way conversations.
- ◆ We observed results for CI users that are different from that of NH listeners (e.g., F0, F1, and some segmental features).

## 5. References

- ◆ Lombard, E. (1911). "Le signe de l'elevation de la voix [the sign of voice raising]", *Annals des Maladies de l'Oreille et du Larynx* 101–119.
- ◆ Hansen, J. H. (1996). "Analysis and compensation of speech under stress and noise for environmental robustness in speech recognition", *Speech Communication* 20, 151–173.
- ◆ Svirsky, M. A. and Tobey, E. A. (1991). "Effect of different types of auditory stimulation on vowel formant frequencies in multichannel cochlear implant users", *J. Acoust. Soc. Am.* 89, 2895–2904.
- ◆ Ziaei, A., Sangwan, A., and Hansen, J. H. (2013). "Prof-life-log: Personal interaction analysis for naturalistic audio streams", in *Proc. IEEE Int. Conf. Acoustics, Speech, and Signal Process. (ICASSP)*, 7770–7774.