Edge Mode+: On-demand processing improves speech recognition and listening effort in hearing-aid users

Brittany N. Jaekel, M.S., Ph.D., Jingjing Xu, Ph.D., Ryan Schwantes, M.A.

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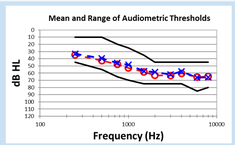
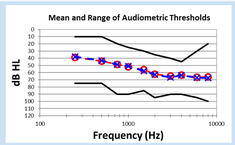
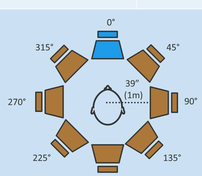
INTRODUCTION

Understanding speech in noise remains difficult for hearing aid users. One tool aiming to help users in these kinds of challenging listening environments is an AI-driven, on-demand processing feature called Edge Mode+.

Edge Mode+, when activated, prompts the hearing aid to classify the listening environment and then apply additional specialized setting changes specific to that environment and the listener's goal (Best Sound, Reduce Noise, Enhance Speech). These classification and adaptation schemes were derived via machine learning, which was performed based on a large number of real-life sound recordings.

One goal of **Edge Mode+** is to improve user outcomes – like speech understanding and listening effort – in a variety of challenging listening scenarios.

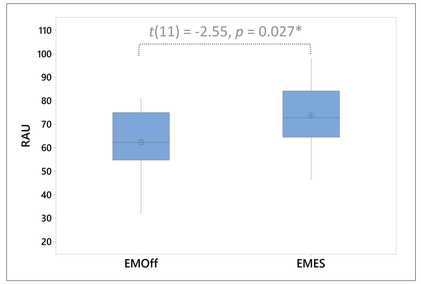
METHODS

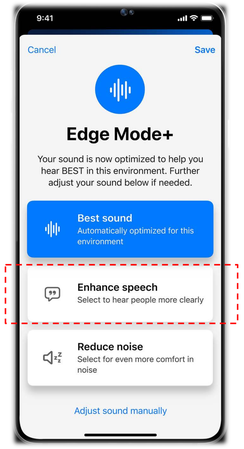
	Study 1: Speech recognition	Study 2: Listening effort
Participants	12 experienced users (5 females)	20 experienced users (5 females; 12 from study 1)
Age	42-84 years (Mean = 71.1, SD = 12.2)	42-84 years (Mean = 71.2, SD = 12.7)
Audiogram		
Hearing aid fitting	Starkey Genesis AI 24 receiver-in-the-canal (RIC RT) devices, programmed to e-STAT 2.0 and fit with occluded earbuds or earmolds	
Conditions for comparison	**Default settings (EMoff)** **Edge Mode+ Enhance Speech enabled (EMES)**	
Tasks	Repeat IEEE sentences presented in a restaurant noise. (Individualized speech level to achieve 70% speech recognition with EMoff)	Adaptive Categorical Listening Effort Scaling (ACALES): Listen to speech (English Matrix Test) in a modulated noise (ICRA250) and rate listening effort at various SNRs.
Lab setup		

RESULTS

Study 1: SPEECH RECOGNITION

- The speech recognition performance in percent correct was converted to rationalized arcsine units (RAU)[1] for analysis.
- With EMES, speech recognition significantly increased by 11.37 RAU (*about 12%*) over the default EMOff hearing aid condition.

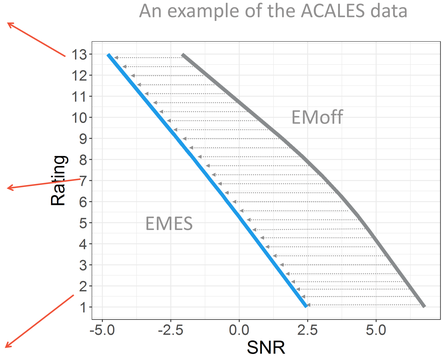




Study 2: LISTENING EFFORT

How much effort does it require for you to follow the speaker?
Only noise
Extreme effort
:
Very much effort
:
Considerable effort
:
Moderate effort
:
Little effort
:
Very little effort
:
No effort

An example of the ACALES data



- Performance measure with the ACALES data is mean SNR benefit:

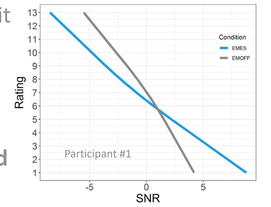
$$mean\ SNR\ benefit = \frac{\sum_{i=1}^{n}(SNR_{EMoff i} - SNR_{EMES i})}{n}$$

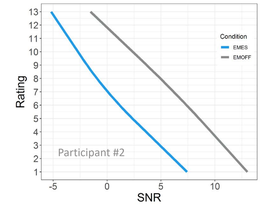
where *n* is the number of listening effort ratings for the fitted curve, $SNR_{EMoff i}$ and $SNR_{EMES i}$ are the SNR for effort rating score *i*. A positive mean SNR benefit value indicates the benefit of using EMES.

RESULTS (CONT.)

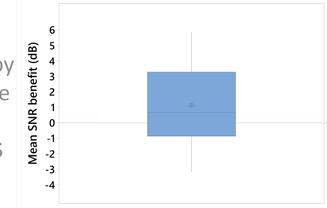
- The individual mean SNR benefit values varied greatly. Two participants' ACALES data are shown as an example. They had similar hearing loss but their benefit from Edge Mode+ differed. **Thus, as an on-demand feature, Edge Mode+ can provide significant benefit for those patients that need additional assistance in noisy situations.**

Participant	Left Threshold (Hz)				Right Threshold (Hz)				Word Recognition	
	0.5k	*1k*	*2k*	*4k*	*0.5k*	*1k*	*2k*	*4k*	*Left*	*Right*
#1	50	50	65	65	50	50	60	65	82	68
#2	55	60	70	75	55	70	60	55	84	78





- Compared to EMoff, the mean SNR benefit with EMES across all participants increased by 1.13 dB ($t(19) = 2.08$, $p = 0.05$. This difference was associated with approx. 13% increase in speech understanding[2], indicating that **EMES improved (reduced) listening effort**.



CONCLUSIONS

While the MarkeTrak 2022 survey data indicate that more than 80% of hearing aid owners are satisfied with their devices[3], hearing aid wearers still encounter difficulties understanding speech in certain noisy environments. Edge Mode+, as an AI-driven, on-demand feature, provides an option for hearing aid users to optimize their hearing aids in situations when they have trouble hearing with the default settings. More importantly, Edge Mode+ in Genesis AI 24 and 20 tier devices provides choices (Enhance speech and Reduce noise) that can take the wearer's listening intent into consideration, which can further tailor the signal processing to meet the wearer's needs.

Results from the present studies showed that compared to the default settings, the Edge Mode+ Enhance Speech feature improved speech understanding and listening effort in noisy conditions. These findings support the conclusion that Edge Mode+ can provide additional speech enhancement and noise reduction to help communication in these challenging situations.

REFERENCES

1. Studebaker, G. A. (1985). A" rationalized" arcsine transform. *J. Speech Lang. Hear. Res., 28*(3), 455-462.
2. Kreisman, B., Carroll, R., Zokoll, M., et al. (2013). Design, optimization and evaluation of an American English Matrix Sentence Test in Noise. Presented at the American Academy of Audiology Conference.
3. Picou, E. M. (2022, November). Hearing aid benefit and satisfaction results from the MarkeTrak 2022 survey: Importance of features and hearing care professionals. *Seminars in Hearing, 43*(4), 301-316.

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