Intelligence at the Edge

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Introduction

Patients experience a broad and dynamic range of listening situations in their daily lives. Typically, fine-tuning the hearing aid for these specific listening situations requires constant back and forth between the patient and the professional. The patient is expected to recount their listening experiences from the field or the provider must make inferences based on patient reactions to sounds in the clinical environment. Using this information, the professional either makes adjustments to the current hearing aid settings or provides a manual program to be used in a specific listening situation.

This manner of fine-tuning is complex and time-consuming. It is often difficult for the patients to describe the necessary details of problematic listening environments as well as the actual listening difficulty in a way that is helpful or meaningful for the professional. Even after the tuning, patients must change the program themselves as they move through different environments and may continue to encounter new situations for which they may not have a manual program. Further, repeat visits to the professional's office are time consuming for both the hearing aid wearer and the professional. Worse yet, if too much time passes before a professional can address their concern, the patient may be more likely to return the hearing aid.

New strategies like remote programming and customization via an application on the smartphone conveniently provide the hearing aid wearer the customization they seek in difficult situations. Remote programming essentially allows the hearing aid wearer to solicit the help of the professional at any time and from anywhere. However, this approach is still constrained by the availability of the professional and at best can only be used for distinct difficult environments.

Edge Mode

Starkey's new Edge Mode puts the power of artificial intelligence (AI) at patients' fingertips, allowing them to access alternative settings for difficult listening environments. Edge Mode can be assigned as a double tap or short press through Starkey's Inspire X fitting software. The user control screen seen in Figure 1 allows for assignment of Edge Mode to the desired control. It is also possible to assign Edge Mode to double tap through the Thrive Hearing Control app. Once enabled, the patient can receive an un-obtrusive, professional-quality adjustment to the hearing aid settings instantly and on demand. Starkey's research database includes over 2,000 active participants, providing a wealth of detailed environmental data, enabling the classification of difficult

listening environments including such things as the frequency of occurrence of a myriad of different acoustic conditions. Using a combination of this powerful proprietary data and insights derived from a review of published research and literature (such as Wolters, Smeds, Schmidt, Christensen & Norup, 2016), we are able to match hearing aid parameters with environmental conditions and predicted listening intent.
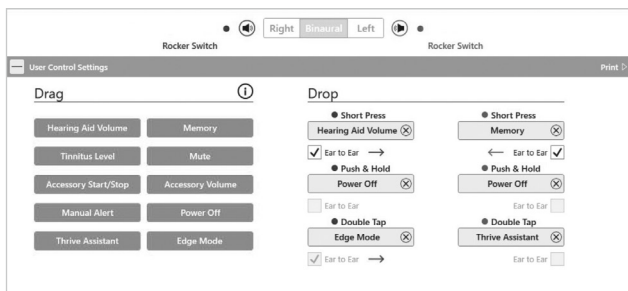

Figure 1. Inspire X user control screen. Edge Mode assigned to double tap on the right.

During daily operation, the hearing aid continuously characterizes the acoustic environment. When Edge Mode is activated, the current acoustic characterization is interpreted, and appropriate adjustments are calculated. The adjustments are based not only on the acoustic environment but also on the expected listening intent. The adjustments are based on recommendations from hearing aid fitting experts, on data related to successful hearing aid adjustments under difficult listening situations, and on research related to hearing aid troubleshooting (Jenstad, Van Tasell & Ewert, 2003). Parameter adaptations include various combinations of hearing aid gain, noise management and microphone mode.

Automatic acoustic classification and adaptation in hearing aids are not new phenomena and are available in most modern hearing aids. Typically, the acoustic environment is analyzed continuously, and the hearing aid parameters are adjusted in real-time. Because these algorithms adapt continuously without active patient interaction, only slow and relatively small adjustments can be made without disturbing the hearing aid wearer with unexpected parameter changes. Edge Mode, on the other hand, is activated by the patient when more significant adjustments are desired and expected. Researchers at Starkey conducted several studies to assess noticeable and meaningful parameter adjustments in hearing-impaired listeners while listening through hearing aids to simulated acoustic environments. The outcomes of these investigations were used to design the parameter adjustments in Edge Mode to ensure they were noticeable and effective in challenging acoustic situations.

Edge Mode Investigations

Laboratory studies were conducted to assess the performance of Edge Mode, compared to Normal (universal) memory. The Normal memory is the setting generally used by most people to hear well in the majority of their daily listening situations. With traditional environment adaptation features activated, the Normal memory is an adaptive memory that automatically adjusts hearing aid's gain, frequency response, and microphone mode (directionality) in response to different environments.

Edge Mode was investigated in the lab in terms of overall preference in three commonly occurring situations involving speech—single talker in restaurant noise, single talker in car, single talker in a large reverberant room. Real-world recordings of the aforementioned

listening situations were rendered in the laboratory using ambisonic processing, which presents a full 360-degree spatial representation of sound.

Participants completed paired comparisons of Normal and Edge Mode settings and selected their preferred setting for each listening situation. Fifteen individuals with mild to moderately severe sensorineural hearing loss participated in this study. The mean age of all participants was 67 years with a range of 33 to 87 years. All participants were experienced hearing aid wearers. A Wilcoxon Signed-Ranks test was conducted by collapsing the data across all three listening situations. The results indicated that Edge Mode was significantly preferred over the Normal settings (Z statistic = 2.587, p = 0.008) by hearing-impaired participants (Figure 2). In a restaurant, preferences varied with some participants wanting more clarity and some others preferring comfort.
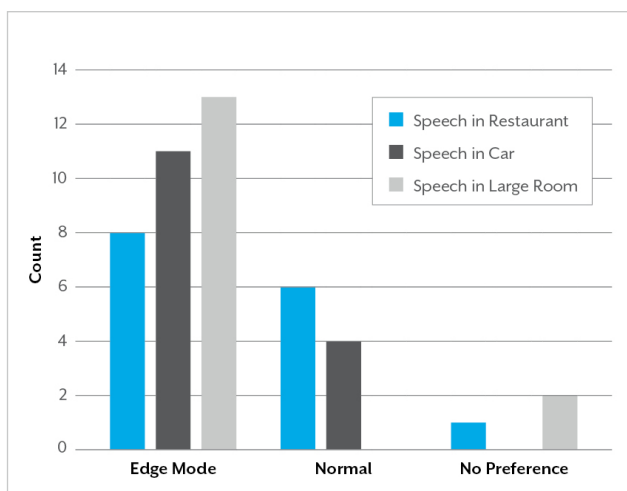
In-field usability was evaluated using the System Usability Scale (SUS; Brooke, 1996). The SUS is a 10-item scale that is commonly used to measure the quality of the patient's experience when interacting with a product. SUS scores of 68 or above generally mean that a product or feature is easy to learn or use. In our study, participants scored an average of 78, which indicates that subjects found Edge Mode easy to use (p = 0.003).

Another group of 19 experienced hearing aid wearers with mild to severe sensorineural hearing loss evaluated Edge Mode in their daily lives over 4 weeks. The mean age of these participants was 67 years with a range of 49 to 79 years. Participants were best-fit to eSTAT (Starkey's proprietary fitting formula) in the Normal memory. Additional manual programs were provided. Adjustment to the hearing aid fitting were made at the initial and follow-up sessions.

Most participants found Edge Mode provided additional speech clarity or comfort in difficult listening situations; 68% reported that Edge Mode provided additional speech clarity over the other settings available on their hearing aids. Edge Mode also provided additional comfort in necessary situations for 60% of the participants. Eighty-three percent of the participants also found that Edge Mode provided additional convenience in their daily operation of the hearing aids.

Across the laboratory and field investigations, Edge Mode was generally reported to be well accepted by all participants in its performance, convenience and ease of use.

Figure 2. Preference count of Edge Mode vs Normal settings from 15 hearing impaired participants. Legend identifies the accoustic environment.

Conclusion

With Edge Mode, patients now have an intuitive, non-intrusive option for difficult listening situations or for improving their hearing aid settings in general. Edge Mode is the only onboard system in hearing aids that does just that.

There is simply no way to predict and fit patients for each and every unique and unpredictable listening environment they will encounter. Edge Mode puts the power of AI at the patients' fingertips for more control in these challenging listening environments. When activated, Edge Mode instantly captures an "acoustic snapshot" of the environment and adjusts gain, noise management, and directionality to optimize clarity and comfort for every listening situation.

References

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