Edge Mode: Unmasking Benefits for Hearing Aid Users in Difficult Listening Environments

Dave Fabry, Ph.D. | Thomas Burns, Ph.D.

Introduction

When it was introduced in 2018, Starkey's Livio AI was the industry's first device that incorporated embedded motion sensors and Artificial Intelligence (AI), which enabled hearing aid users to hear better and live better by enabling them to track physical activity and social engagement[1]. This "reinvention" of the hearing aid provided outstanding hearing performance, as well as a gateway to health and wellness, effectively transforming it from a single-purpose device into a multi-purpose, multi-function one. For example, in addition to the traditional capabilities of modern hearing aids, Livio AI was the first hearing aid capable of automatic fall detection and text alerts to trusted contacts[2]. In 2020, Livio Edge AI pushes that platform further with the introduction of Edge Mode, which puts the power of AI at the patients' fingertips.

During daily operation, Livio Edge AI continuously monitors and characterizes the acoustic environment with onboard machine-learning technology, dynamically applying appropriate levels of gain, noise management, directionality and other features only when necessary.

When Edge Mode is activated by the hearing aid user via a double tap or user-controlled button press, the operating parameters in place for "all around" listening are expanded, allowing end-users to automatically access alternative settings that optimize comfort and clarity for uniquely challenging listening environments.

Previous investigations have demonstrated that most patients found Edge Mode easy to use and preferred it over "Normal" hearing aid settings in restaurant noise, when communicating in an automobile, and in reverberant listening environments [3].

During the current novel coronavirus disease (COVID-19) pandemic, health and government officials are encouraging, even mandating, community-wide face mask wearing (i.e., universal masking) to reduce potential pre-symptomatic or asymptomatic transmission of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) to others. This practice, in combination with social distancing (> six feet apart) has helped "flatten the curve" for those most vulnerable to the disease, but it has also provided a barrier to clear communication, particularly for those with hearing loss[4,5].

The impact of face masks and social distancing on speech audibility

Figures 1–3 demonstrate the impact on speech audibility measured for conditions when a face mask is worn, and physical distancing is used between talkers and listeners. In Figure 1, the green curve represents levels recorded from the ear simulator of a Knowles Electronics Manikin

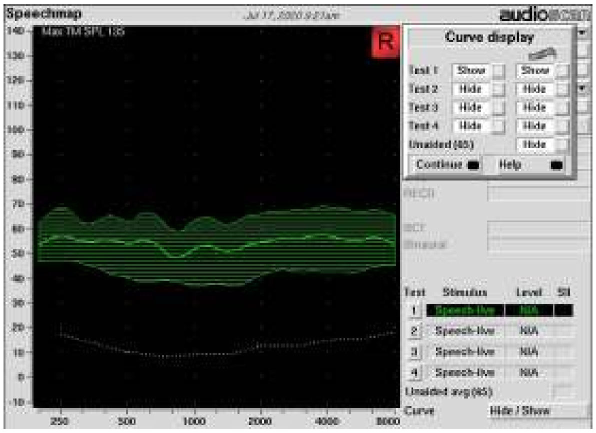

Figure 1. Long-term speech levels (green curve) measured at the listener's eardrum for conversational-level speech measured at a talker-listener distance of three feet when no face mask is worn.

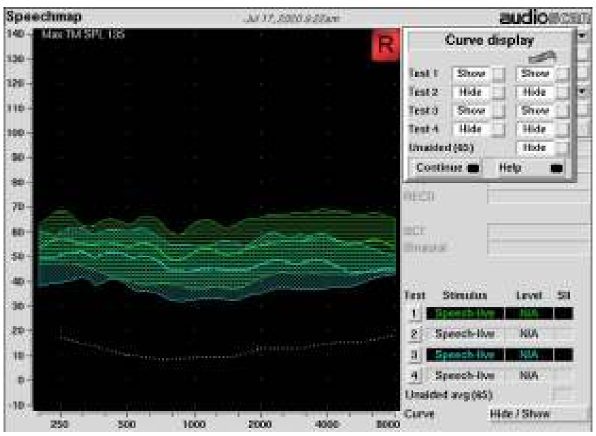

Figure 2. Long-term speech levels measured at the listener's eardrum for conversational-level speech measured at a talker-listener distance of three feet when no face mask is worn (green curve) versus when an N95 face mask is worn (teal curve).

for Acoustic Research (KEMAR) for recorded conversational speech (The Rainbow passage) presented at 65 dB SPL measured at a "typical" conversational distance of three feet between the talker and the listener.

Figure 2 shows the impact of social distancing to six feet between talker and listener, which reduces sound pressure levels by approximately 6 dB.

Figure 3 demonstrates the additional reduction in audibility when an N95 face mask (3M 8210 Plus) is worn with social distancing of six feet between talker and listener. Clearly, the use

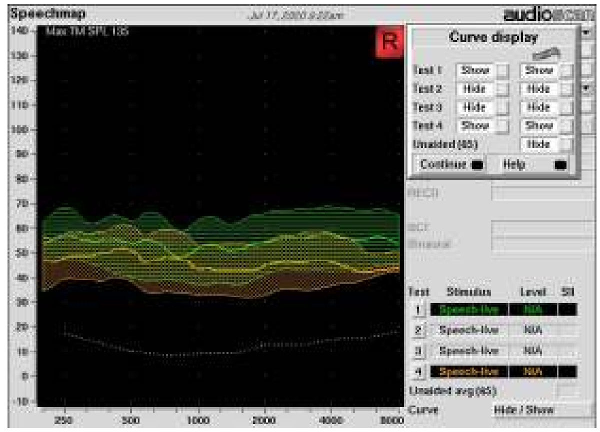

Figure 3. Long-term speech levels measured at the listener's eardrum for conversational-level speech measured at a talker-listener distance of three feet when no face mask is worn (green curve) versus when an N95 face mask is worn for a six feet talker-listener distance (orange curve).

of face masks and physical distancing reduce audibility for speech, even for individuals with normal hearing, as speech levels recorded at the listener's eardrum audibility are decreased by up to 15 dB relative to the condition when no mask is worn for "typical" physical distancing[6].

Hearing loss complicates the issue further

This situation is compounded for persons with hearing loss. Figure 4 illustrates the impact on

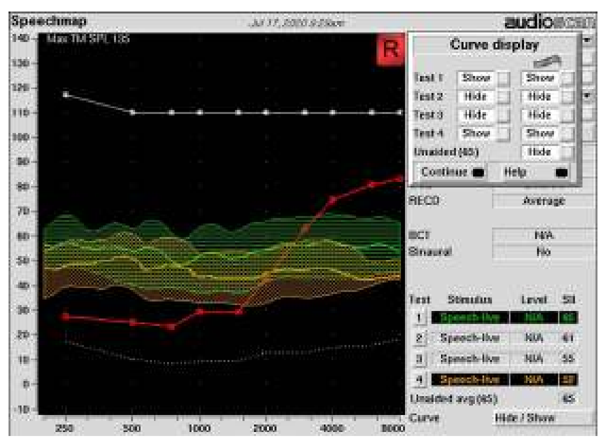

Figure 4. Unaided long-term speech levels measured at the listener's eardrum for conversational-level speech measured at a talker-listener distance of three feet when no face mask is worn (green curve) versus when an N95 face mask is worn for a six feet talker-listener distance (orange curve) for a person with a mild, sloping, high-frequency hearing loss (red curve). Area above the red curve is audible, below is inaudible.

unaided speech audibility for an individual with a gradually sloping high-frequency hearing loss for the same conditions as represented in Figure 3. For this individual, critical high-frequency information is reduced when the combination of face masks and increased social distancing are used, which reduces the computed Speech Intelligibility Index (SII) from 0.65 to 0.52 and predicts a reduction of up to 25% in speech intelligibility. When background noise is added, critical speech information may be rendered nearly inaudible.

Hearing aids can help

Figure 5 demonstrates how well-fit hearing aids help offset that loss of audibility by amplifying speech and restoring audibility matched to NAL-NL2 prescribed gain, when no face mask is worn. Figure 6 illustrates, however, how the combination of use of an N95 mask and social distancing of six feet may reduce audibility for the "Normal" memory. Therein lies the face-masking dilemma; while protecting against the spread of COVID-19, the use of face masks, social distancing and loss of lipreading cues make communication difficult, even with properly fitted hearing instruments.

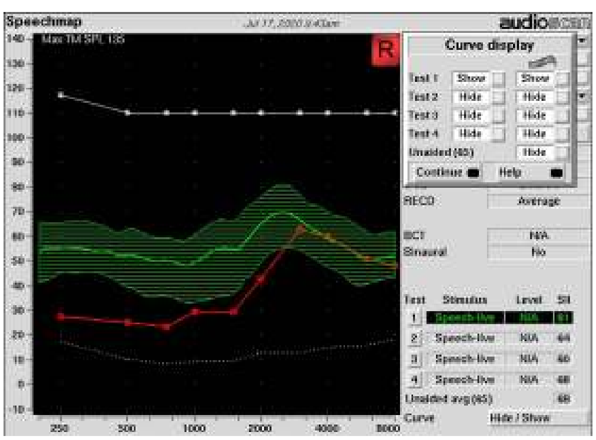

Figure 5. Amplified speech levels (green curve) for the "Normal" program for a person with mild sloping high-frequency hearing loss, measured at the listener's eardrum for conversational-level speech measured at a talker-listener distance of three feet when no face mask is worn.

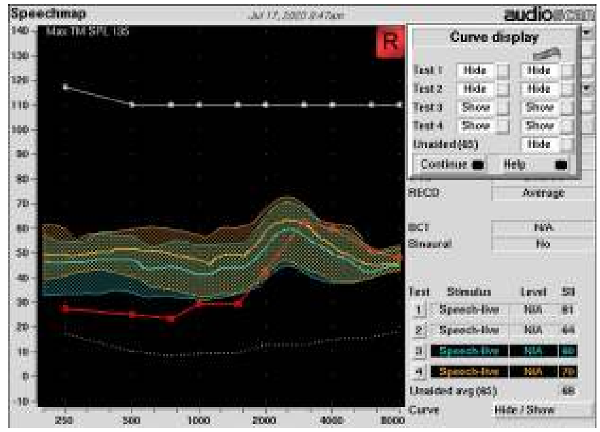

Figure 6. Long-term speech levels measured at the listener's eardrum for conversational-level speech measured at a talker-listener distance of six feet when an N95 face mask is worn for the Normal program (teal curve) versus when Edge Mode is activated (orange curve).

All masks are *not* created equal

Six months into the pandemic, individuals now have an array of face mask choices available to them, including disposable medical face masks, washable cloth masks, and masks with a clear window for lipreading restoration. For many, the solution reflects the best combination of protection, comfort, convenience, and proper fit. Another factor, particularly for those with hearing loss, is increasingly focused on acoustic performance and preservation of visual cues.

To assess differences in sound attenuation across face masks, acoustic measurements were made of many of the latest commercially available styles. Figure 7 illustrates the differences for a small sample. The data are normalized relative to when no mask is worn, which is depicted by "zero" line on the x-axis. While all of the masks reduce important high-frequency sound information, there is significant variation across fabric, medical, and paper masks, especially those equipped with a plastic "window". One unexpected finding was that face masks and face shields that used clear plastic indicated an enhancement of several dB in the low/mid frequencies, combined with a reduction in the high frequencies[7]. These data illustrate the challenge of using a predetermined compensation scheme, with fixed high-frequency gain adjustment, to adapt for the impact of social distancing and face mask use.

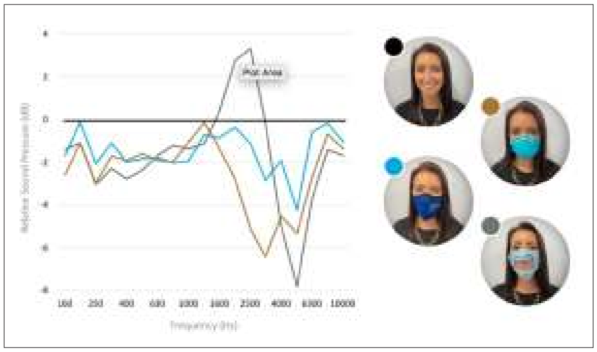

Figure 7. The acoustic impact of different face masks, relative to when no face mask is worn (black curve).

Edge Mode as the optimal mask mode for restoration of speech audibility

User-activated Edge Mode in Starkey Livio Edge AI hearing aids optimizes speech audibility and sound quality in all listening environments by assessing the levels of speech and noise that are present with an onboard AI model trained with machine-learning technology, and then dynamically applying gain, output, noise management, directional microphones, and other features to ensure that sounds are optimized for each person in each environment. In effect, Edge Mode is "agnostic" to which mask is worn, talker-listener social distancing, or presence of background noise—its sole focus is on providing optimal speech audibility in every listening situation. While improved audibility does not guarantee improved intelligibility, it can certainly be said that it is an essential ingredient for speech intelligibility and sound quality!

Figure 8 illustrates the relative difference in speech audibility, with six-foot social distancing and +5 signal-to-noise ratio for conditions when the talker is not wearing a mask, in the "Normal" program, and when Edge Mode has been activated. In this example, speech levels are greater than when no mask is used, which helps provide additional benefits to offset the loss of visual cues (e.g, lipreading) when a mask is worn.

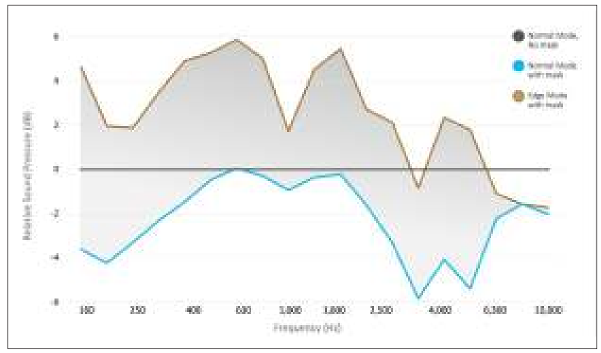

Figure 8. Relative sound pressure level (dB) for aided conditions when no mask is worn (black curve) and when an N95 face mask is worn in "Normal" Mode (blue) and for user-activated Edge Mode (gold).

Conclusion

Livio Edge AI puts the power of AI at your patients' fingertips to optimize speech audibility in challenging listening environments—both noisy *and* quiet. Edge Mode uses AI to instantaneously optimize speech audibility to offset communication challenges presented by face masks, social distancing and background noise. By focusing on optimizing speech comfort, clarity, and ease of use, Starkey has provided a simplified user experience that allows patients to simply "tap" to hear—whenever and wherever they want to hear better — without the need to access manual volume controls or programs.

References

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