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Performance measures of the Nuance Audio™ Glasses: behavioral outcomes and real ear measures

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Introduction: Over-the-Counter (OTC) hearing devices were introduced for adults with perceived mild to moderate hearing loss, and can be purchased without a hearing assessment or device prescription from a hearing health care provider. The Nuance Audio™ Glasses are approved as software as a medical device OTC hearing aids in the United States, but come in a novel form factor, with the components of digital hearing aids embedded in the frames of eyeglasses, without any components entering the ears themselves. This in-lab study applied an outcome test battery, typically used for traditional hearing aid studies, to evaluate the device with a group of OTC candidates.

Method: A total of 21 adult participants with mild to moderate sensorineural hearing loss completed the test battery. Speech recognition in noise was assessed in steady-state noise using the American English Matrix test and in multi-talker babble at two signal-to-babble ratios (0 dB and −3 dB) using the Connected Speech Test. Participants provided ratings of subjective listening effort in multi-talker babble using a 7-point scale. Real ear measures of the device were completed as a means to evaluate the aided response and speech-intelligibility-index value for the participants.

Results: Speech recognition, measured by the Matrix and the CST, was significantly better with the Nuance device than in the unaided condition. Listening effort in noise was significantly reduced with the device on compared to the unaided condition. Real ear measures showed the device provided gain from 750-6,000 Hz and the measured Speech Intelligibility Index scores were significantly better in the aided conditions compared to the unaided condition.

Discussion: The findings suggest that Nuance Audio Glasses provide improved access to speech, leading to significantly better speech recognition and reduced listening effort in noise. These outcomes suggest this device may be an effective strategy for adults with perceived bilateral mild to moderate sensorineural hearing loss.

KEYWORDS
hearing aids, listening effort, OTC, over-the-counter, probe microphone verification, speech recognition, verification

1 Introduction

According to the Global Burden of Disease (GBD) study, almost 1.6 billion people worldwide live with hearing loss (GBD 2019 Hearing Loss Collaborators, 2021). This equates to one in five people globally, and the GBD predicts that number will grow to 2.5 billion by 2050. Age-related hearing loss is the most common type of hearing loss, affecting 65% of older adults (Feder et al., 2015; Lin et al., 2011). By the 2060s, older adults, among whom mild to moderate sensorineural hearing loss is highly prevalent, are projected to account for one quarter of the population in Canada and the United States (Government of Canada. Statistics Canada, 2023; Ramage-Morin et al., 2019; Vespa et al., 2020).

For years, the primary treatment options for mild to moderate sensorineural hearing loss have been air conduction hearing aids prescribed by a hearing health care professional (Carr and Kihm, 2022). In October 2022, the United States Food and Drug Administration (FDA) established the new category of over-the-counter (OTC) hearing aids for adults 18 years of age and older with perceived mild to moderate hearing loss (Food and Drug Administration, 2022). This category of hearing device has become a popular choice for those who have never purchased hearing devices before, as reflected in the most recent Marketrak 2025 report that found 70% of OTC owners are first-time buyers (Sobek Dobyan and Powers, 2025). Previous studies indicate that OTCs, and other self-fitted hearing devices, can provide improved speech access and are effective interventions for adults with mild to moderate hearing loss (De Sousa et al., 2023; Humes et al., 2017; Knoetze et al., 2025; Turnbull et al., 2026; Urbanski et al., 2021).

The components of most prescription hearing aids and many OTCs are typically encased in a small device that fits behind or in the ear. One drawback of this design is the restricted space available to incorporate multiple microphones to help reduce background noise. Another disadvantage to the conventional style of hearing aids that sit behind the ear is that, for those who also wear eyeglasses, there is limited room behind the ear to fit both devices. A new device (Nuance Audio Glasses) that has the components of hearing aids, such as microphones and speakers, within an eyeglasses frame (Figure 1) has been developed. Harel-Arbeli and Beck (2025) outlined the benefits of this novel design and discuss an in-house series of three pilot studies examining the benefits of the Nuance device for speech in noise. More recently, Turnbull et al. (2026) evaluated the device's performance on aided speech reception thresholds in multi-talker babble measured with the BKB-SIN (Bench et al., 1979), aided preference during aided and unaided guided walks, and self-reported communication outcomes using the Client-Oriented Scale of Improvement. Both papers report significant benefit in noisy environments with the device on compared to unaided.

In the current study, we aimed to further examine hearing aid wearers' speech recognition using different noise types, as well as their subjective listening effort ratings in these challenging environments. Additionally, we wanted to define the real ear aided output and associated speech intelligibility index (SII: American National Standards Institute, 2020) for each user at their preferred setting to characterize their electroacoustic output. This was of interest because, although Humes et al. (2017) and Urbanski et al. (2021) reported unaided to aided benefit in speech recognition and SII for OTCs with preset frequency gain configurations, both those studies used behind-the-ear devices with slim-tubes. The Nuance Audio Glasses, however, use a non-traditional acoustic pathway that does not deliver sound into the ear using an in-the-canal component. Previous work has emphasized the need for clinical evaluation of novel hearing devices (Manchaiah et al., 2017).

The primary objective of this in-lab study was to evaluate whether the Nuance Audio Glasses improve speech recognition in noise compared to the comparison condition of no treatment (unaided) for adults with mild to moderate hearing loss. This was measured using the American English version of the Matrix test (Kollmeier et al., 2015). This test uses adaptive bracketing of signal-to-noise ratio (SNR) to maximize test sensitivity. The secondary objective of this study was to evaluate the benefit for speech-in-noise recognition using a measure with higher ecological validity. This secondary objective used a version of the Connected Speech Test (Cox et al., 1987, 1988) in a general North American accent (Saleh et al., 2020; Sung et al., 2025), tested at fixed signal-to-babble ratios (SBR). Tertiary outcomes examined participants' ratings of listening effort in noise with and without the device. Real ear measures were completed to describe the frequency responses of the unaided and aided output at the User-Preferred Settings (UPS), which were determined by their choice of volume setting and device frequency response, as well as the associated speech intelligibility index scores.

FIGURE 1
Nuance audio glasses components from essilorluxottica.

2 Materials and methods

Investigational Testing Authorization Approval was obtained from Health Canada (Class II: 384015). This study was approved by the Western University Research Ethics Board (HREB 125687). Participants were compensated for their in-lab time. Participants were not permitted to keep the device at the end of the study. All data collection and statistical analysis were conducted independently by the authors from the university team.

2.1 Test device description

The Nuance Audio Glasses tested in this study were an open ear air conduction hearing aid, intended to amplify sound for users with hearing loss, within a form factor that could also allow use of prescription spectacle lenses for the correction of visual impairments. As an OTC device, the glasses are intended only for use by individuals 18 years old and older with perceived mild to moderate hearing impairment. These rechargeable glasses integrate six microphones and two directional loudspeakers (left, right) along with tap and push controls for volume, directional mode change and ON/OFF (Figure 1). Sound is transmitted from the directional loudspeakers without placing an eartip in the ears.

Beamforming algorithms use the data from the microphone array to provide directivity for sounds from the front. The device manufacturer indicates that proper use of the product does not require pre-programming or pre-hearing test. The device provides amplification by offering four preconfigured gain settings, called Presets (A, B, C, D), created based on NAL-NL2 prescriptions (Keidser et al., 2012) for the four Urbanski hearing loss configurations (Urbanski et al., 2021).

Device wearers can also choose between two different audio modes: *Frontal*, amplifying sounds mainly from the front, and *All-around*, amplifying sounds arriving from all directions. User-controlled background noise settings include: *Standard*, *Lowered*, and *Heightened,* and there is also a volume control. For this project, the device options were controlled via the mobile app on an in-lab iPhone, with the device set to Frontal Audio Mode and Lowered Background noise for all testing.

2.2 Participants

An *a priori* power analysis using GPower (Faul et al., 2007) suggested a minimum sample size of 19 participants. Twenty-one (21) participants were recruited into the study (12 females and 9 males, ages 60–89 years, mean 75.3 years). The majority of participants had no experience with hearing aids (15). The other six (6) participants had some type of hearing aid use in the past 5 years (range: 3 months to 5 years, mean 2 years).

Audiometric assessment and tympanometry were completed to confirm that each participant had symmetrical mild to moderate sensorineural hearing loss, as classified by the World Health Organization (Olusanya et al., 2019). Symmetry was defined as a between-ear difference of ≤ 15dB at the four-frequency puretone average calculated using 0.5, 1, 2, 4 kHz (Suen et al., 2021). Four-frequency puretone averages ranged from 25 to 55 dB HL with a mean of 36.45 dB HL. The participants' audiometric thresholds and the mean audiogram for each ear are presented in Figure 2.

2.3 Device calibration

Participants were provided with a new, charged set of Nuance Square 56 Black eyeglasses that were paired via Bluetooth connection to an in-lab Apple iPhone with an installed Nuance App [version 1.3.1 (3)]. The app's feedback and own voice calibration procedures were completed for each participant to configure the device's parameters according to the manufacturer's recommendations.

2.4 Test environment

For all speech-in-noise and listening effort evaluations, participants were seated in a double-walled sound booth surrounded by speakers at 0^0, 90^0, 180^0, 270^0 at a distance of 115 cm from the center of the head.

2.5 User-preference setting determination

A continuous presentation of babble stimuli from the General North American Accent version of the CST (Saleh et al., 2020;

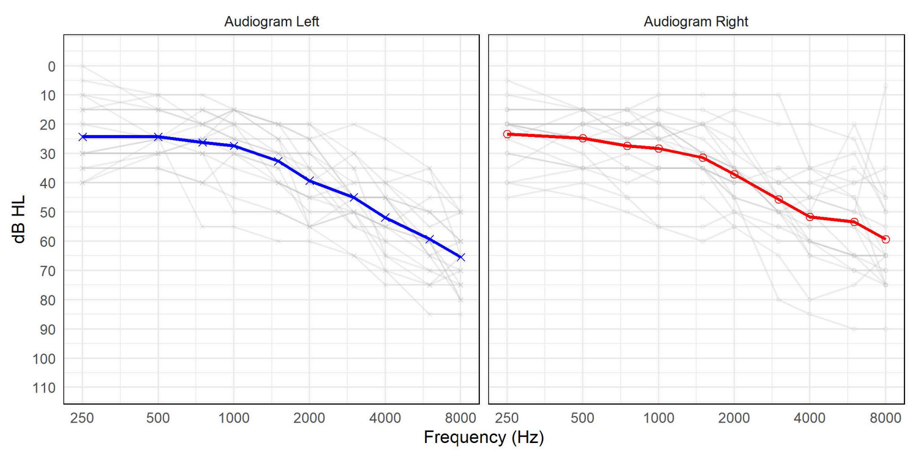

FIGURE 2
Participant thresholds in dB HL across the audiometric frequencies in Hz. Individual audiograms are in gray and the mean audiogram is in bolded blue **(left)** and bolded red **(right)**.

Sung et al., 2025) was played at 60 dB SPL from 90^0, 180^0, 270^0. In this 2x2x2 version, there were six unique talkers (three males and three females). One male and one female talker are played from one of the three masking locations so that there were three unique male/female pairs surrounding the participant. A concatenated stream of CST practice lists was then played from the 0^0 speaker at −3 dB SBR. Participants were asked to listen to the CST talker, and were given the following instructions: *"Imagine you are in a restaurant and trying to listen to this woman while there are other tables around you, talking. Listen to her on all of the four presets as many times as you need to, and adjust the volume until you find the preset and volume combination you would choose to use in this situation."* Participants were able to listen to this running babble for several minutes if needed to make their choice. Their preferred Preset + volume control combination was then used for all subsequent aided testing.

2.6 Electroacoustic characterization

2.6.1. Real ear measures

Measurements of the participant's real ear unaided (REUR) and real ear aided response (REAR) in the UPS setting were completed using SpeechMap on a calibrated Audioscan VF2. All measurements were completed with the participant wearing the Nuance Audio Glasses to ensure the aided gain was assessed accurately and to control for any potential differences caused by acoustic reflections of the frames. The participant's REUR and REAR were measured at 60 dB SPL with the International Speech Test Signal (ISTS: Holube et al., 2010), with the participant's audiometric thresholds and measured real ear to coupler differences entered into the system.

2.6.2 Measured REAR to OTC fitting range comparisons

The VF2 session files were saved, and the aided output at 60 dB SPL was extracted and plotted against the OTC fitting ranges from Urbanski et al. (2021), which were created to fit most older adults with mild to moderate hearing loss within a ± 5 dB fit criterion. NAL-NL2 targets were generated at 60 dB SPL for the four Urbanski preset audiograms using the following settings in the Audioscan VF2: NAL-NL2 targets, adult, insert + foam hearing level transducer, with an NL2 average RECD, and a binaural fitting for a non-tonal language. The measured REAR for each participant was plotted against the range spanning a ± 5 dB allowance around the targets from the four different audiograms.

2.6.3 Speech intelligibility index: unaided/aided

The unaided and aided SII values, displayed in percentage form in the Audioscan VF2, were recorded for analysis.

2.7 Speech-in-noise testing

Two different speech-in-noise tests were completed with and without the Nuance Audio Glasses on: the Matrix test and the Connected Speech Test (CST). The test order of the Matrix and CST was counterbalanced across participants. For both speech tests, the lists presented were randomized across the conditions. Practice lists were always presented before the test lists, but the list numbers for the practice trials were randomized using the sequence generator in random.org. The order of the unaided and aided conditions, including the SBR levels, were also randomized. The tester turned the glasses on or off and ensured the settings on the iPhone app were set to the UPS for the aided test conditions.

2.7.1 Matrix test

The American English version of the Matrix test consists of 36 lists with 20 sentences per list. Each five-word sentence has the same format "Name/verb/number/adjective/object e.g. Nina got three green chairs". This is an adaptive test where the noise is held constant at 65 dB SPL and the speech levels vary to determine the 50% correct speech reception threshold (SRT50). The target sentences were presented from the 0^0 speaker, and the speech-shaped Matrix noise was presented from the surrounding speakers located at 90^0, 180^0, and $270^{0.}$ Two lists were completed initially with the device turned on to familiarize the participant with the task before running the test conditions. The Matrix noise was played for 15 seconds before the first target sentence was presented, and was played continuously throughout the presentation of the 20 sentences. The participant completed 2 lists per condition. Two conditions were tested: (1) unaided, where the device was worn but turned off; and (2) aided in the UPS.

2.7.2 Connected speech test

The CST presents passages containing 9 or 10 sentences on familiar topics. Each passage has 25 key words, scored as correct or incorrect. Target passages were recorded by a female talker and are presented in multi-talker babble, consisting of male-female dyads presented from each of three sounding speakers (Sung et al., 2025). The target speech was varied to create the test signal-to-babble ratios at 0 and −3 dB, selected to sample a performance range away from ceiling and floor scores (Saleh et al., 2020; Sung et al., 2025). The babble was played for 15 seconds before the first sentence was presented in order to engage the noise reduction system of the hearing devices, and was held at a constant level of 60 dB SPL throughout the passage. The participant was asked to repeat each sentence back to the best of their ability, even if only a word or two was heard. The topic of the passage was made known to the participant before the start of the babble. One aided practice list was completed initially to familiarize the participant with the task. Two lists were completed for each condition (unaided, aided).

2.8 Subjective listening effort ratings

For each CST-speech recognition condition tested above, a Listening Effort Rating was collected. At the end of the final sentence of the topic, the babble was turned off, and the participant was asked to provide a rating of listening effort using a scale based on the categories described in Johnson et al. (2015) (Figure 3).

3 Results

All data analysis was completed using SPSS version 30.0.0.0 (IBM Corp, 2024).

3.1 User-preferred setting choices

Preset preferences were distributed across all four presets, with eight (8) participants selecting Preset D, eight (8) selecting Preset C, three (3) selecting Preset B, and two (2) selecting Preset A. Participants' 3-frequency (0.5 1, 2 kHz) and 4-frequency (0.5, 1, 2, 4 kHz) puretone averages were calculated. The slope of the hearing loss in each ear was determined by calculating the mean threshold at 3, 4, and 6 kHz minus the mean threshold at 0.25, 0.5, and 1 kHz (Hornsby and Dundas, 2009). Multinomial regression analyses indicated that none of the examined variables (previous hearing aid experience, sex, degree of hearing loss, or slope of hearing loss) significantly predicted Preset choice. A summary of Preset Choice grouped by experience level, along with mean aided CST scores, listening effort ratings, and SII values, as well as 4fPTA, is presented at the end of the results section is presented at the end of the results section.

3.2 Electroacoustic and real ear measures

3.2.1. Presets

To examine the frequency-gain changes across the presets, real ear measures of all four Presets were completed at mid volume on the mobile app with one representative participant (Figure 4). These results show small differences in the frequency-gain characteristics across the presets between 750 and 6,000 Hz.

3.2.2. Real ear aided response

Results of the mean real ear response at 60 dB SPL for the 21 participants' unaided (device worn, but turned off), and the device worn and in the UPS are presented in Figure 5. In addition, the mean REAR at UPS for each individual Preset Group is shown (i.e., the REARs of all those who chose Preset A, all who chose Preset B, etc.). Results show the device provided gain that exceeded the real ear unaided response from 750 to 6,000 Hz for the participant groups regardless of UPS.

3.2.3. Evaluation of device against OTC fitting ranges

NAL-NL2 targets were generated at 60 dB SPL for the four Urbanski preset audiograms (Urbanski et al., 2021) using the following settings in the Audioscan VF2: NAL-NL2 targets, adult, insert + foam hearing level transducer, with an NL2 average RECD, and a binaural fitting for a non-tonal language. The measured REAR for each participant was plotted against the range spanning a ± 5 dB allowance around the targets from the four different audiograms. The REAR of 20 of the 21 participants (95%) were within the Urbanski ranges for at least one ear. Because the REAR was completed at the UPS, one participant had chosen a lower volume setting than what could have been achieved by the device. Of the remaining 20 participants, two additional participants had at least one frequency out of the range for one ear only (Figure 6).

3.2.4 Speech intelligibility index (SII)

Measured aided and unaided Speech Intelligibility Index values, reported in percentages on the Audioscan VF2, were recorded for analysis. Normality of the difference scores was assessed using the Shapiro-Wilk test and was not violated ($p > 0.50$). A paired-samples t-test showed that the aided SII scores from the aided UPS Preset (M = 70.02, SD 17.63) were significantly higher than the unaided SII scores ($M = 52.45$, $SD = 17.86$), $t(41) = 16.34$, $p < 0.001$, Cohen's $d = 6.97$

3.3 Speech recognition outcomes

3.3.1. Matrix

The adaptive speech reception threshold (SRT50) for each participant was obtained by averaging the results of the two trials for each condition.

On average, there was a 2.21 dB benefit (SD 1.60) in the aided UPS compared to the unaided condition as measured by the SRT50 of the Matrix (Table 1). A Shapiro-Wilk test of normality indicated that the unaided Matrix scores did not appear to follow a normal distribution ($p = 0.03$). Therefore, the non-parametric Wilcoxon

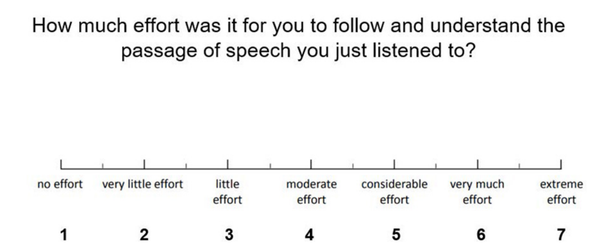

FIGURE 3
Listening effort scale. Participants used this scale where higher ratings indicated more effortful listening to rate the CST passages in noise.

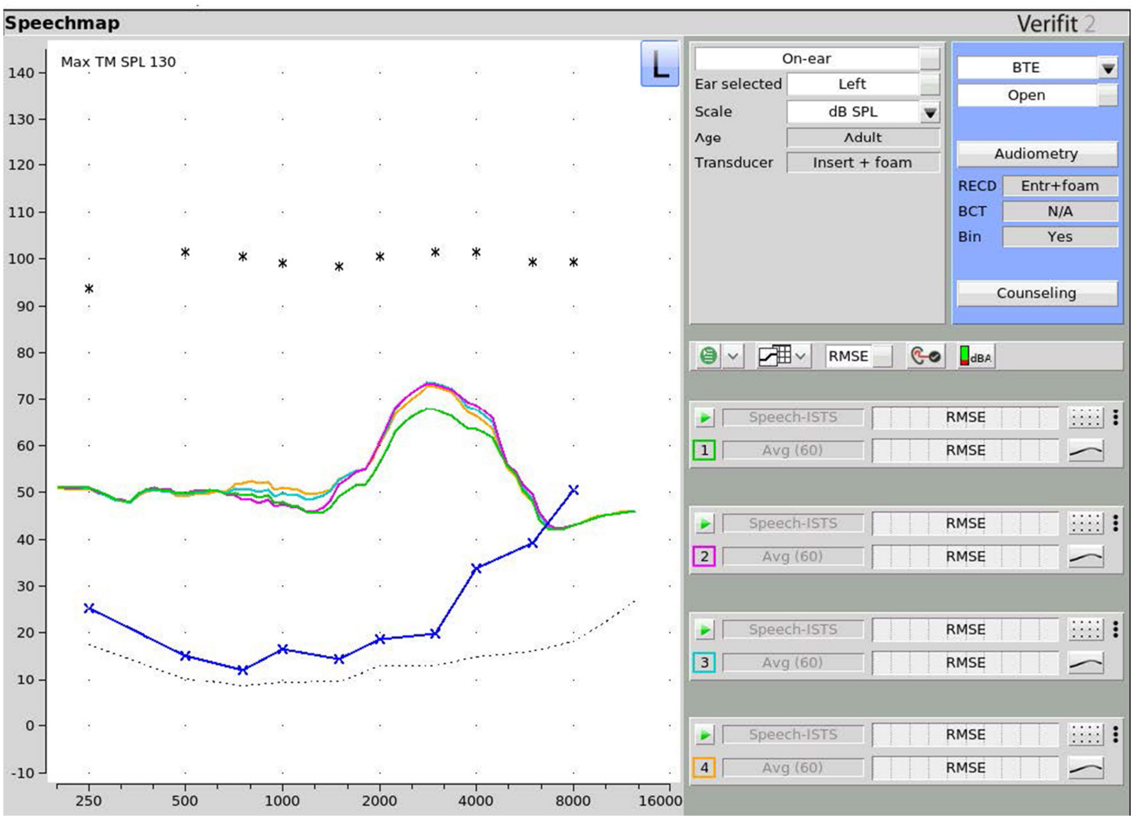

FIGURE 4
Frequency-gain characteristics at mid volume for all four presets for one representative participant. Tests 1–4 display Presets A-D, in ascending order.

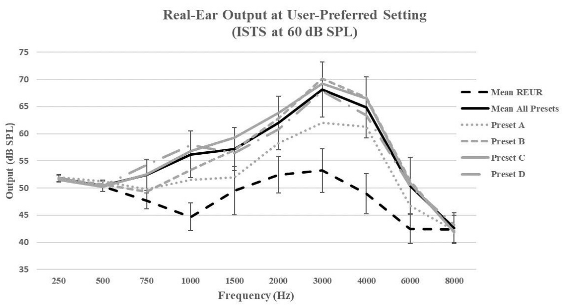

FIGURE 5
Real ear output measured using the international speech test signal at 60 Db spl. Vertical lines around the means indicate 1 standard deviation. Mean all presets is the averaged output per frequency for all participants when the device was worn and turned on to the user-preferred setting. The mean REUR (real ear unaided responses) were measured with the device worn, but turned off. Preset measures are averaged for the participants who chose that Preset for their User-Preferred Setting. Preset A (2 participants), Preset B (3 participants), Preset C (8 participants), Preset D (8 participants).

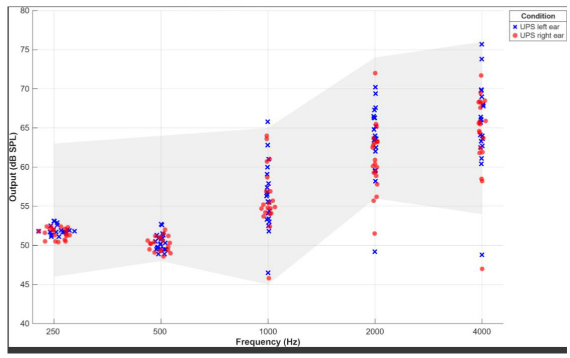

FIGURE 6
Real ear aided response of the participants' user preferred setting at 60 dB SPL plotted against the REAR output range ± 5 dB of the four presets described by Urbanski et al. (2021).

Signed-Rank Test was conducted to assess differences between unaided and aided performance (Wilcoxon, 1945). Effect size was calculated using $r = z/\sqrt{N}$, where N represents the number of non-zero difference pairs (Rosenthal, 1994). Results indicated that the Matrix scores were significantly better when using the Nuance device compared to the unaided condition ($z = -3.911$, $p < 0.001$) with a large effect size ($r = 0.85$; Cohen, 1988).

3.3.2 CST

Percent correct scores for the keywords on the CST ranged between 0 and 96% across conditions and participants. In the −3 dB

TABLE 1 Mean scores for speech recognition in noise for the Matrix test (expressed as SRT50, dB SNR), for adult participants tested with and without the Nuance eyeglass hearing aid.

Condition	Unaided	Aided UPS
Mean SRT50 (SNR dB)	−8.34	−10.55
SD	2.78	1.77
Confidence interval	−9.61 to −7.07	−11.36 to −9.75

Standard deviations (SD and confidence intervals (CI) in the unaided and aided conditions are also shown.

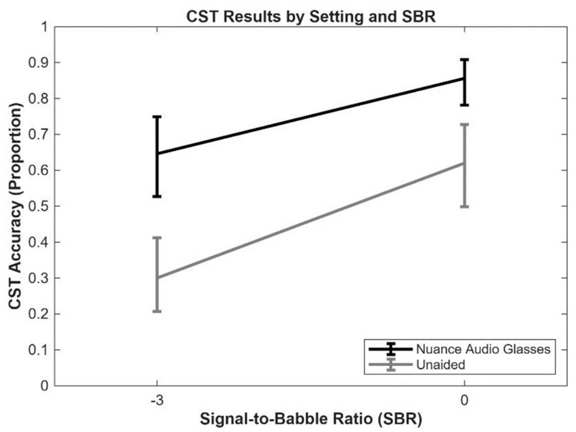

FIGURE 7
Estimated marginal means for keyword correct scores (expressed as proportions) for the Connected Speech Test (CST) at −3dB and 0 dB Signal-to-Babble Ratios (SBR) for the unaided (gray) and aided (black) conditions. Vertical lines represent the 95% confidence intervals around the mean.

SBR condition, mean values were 34.2% in the unaided condition and 63.2% in the aided condition. In the 0 dB SBR condition, mean scores were 61.1% in the unaided condition and 81.2% in the aided condition.

The percent correct scores for each CST list were transformed to rationalized arcsine units (RAU; Studebaker (1985). A Linear Mixed Model analysis was initially conducted using the CST RAU score as the dependent variable. Signal-to-babble ratios (-3 and 0) and device settings (unaided and aided) were set as fixed effects. Results of a Shapiro-Wilk test of normality using generated residuals were significant (p <0.001), indicating that the data did not follow a normal distribution.

Therefore, a Generalized Linear Mixed Model with a binomial distribution and logit link function was used to model the number of correct responses out of 50 as a function of condition. The fixed effects were SBR (-3 dB and 0 dB) and Device Setting (unaided and aided UPS). Participant was included as a random effect. The analysis revealed significant main effects of SBR, $F_{(1,80)} = 260.93$, p <0.001, and of Device Setting, [$F_{(1,80)} = 306.55$, p <0.001]. Results are presented in Figure 7.

As expected, a pairwise comparison with Bonferroni corrections revealed speech recognition scores in the poorer SBR of−3 dB were significantly worse than those obtained in the 0 dB SBR condition (t (80) = −12.66, p <0. 001). Pairwise comparisons with Bonferroni corrections for the main effect of device setting indicated the aided UPS had significantly better scores than unaided (t (80) = 13.39, p<0.001). The paired contrasts within each SBR were also significant at −3dB SBR, t (80) = −15.20, p <0.001, and at 0dB SBR, t (80) = −7.06, p <0.001.

3.4 Listening effort

Listening effort ratings ranged from 1.5 to 7, with a median value of 5.5 across conditions and participants. Mean values with the range of ratings per condition are shown in Table 2.

TABLE 2 Mean listening effort ratings for speech in babble presented at two signal to babble ratios (SBR) from the connected speech test for unaided and aided in UPS conditions.

Condition	3dB SBR	0dB SBR
Unaided	6.7 [6.0–7.0]	5.5 [4.0–7.0]
Aided in UPS	5.3 [2.5–7.0]	3.7 [1.5–5.5]
Mean aided improvement for listening effort	**1.4**	**1.8**

The range of ratings are indicated within brackets. The mean aided improvement for listening effort scores are bolded.

A linear mixed-effects model analysis was completed with SBR and Condition entered as fixed effects. Results revealed significant main effects of SBR, F (1, 80) = 41.01, p <0.001), and Condition, [F (1, 80) = 56.15, p <0.001]. Bonferroni corrected pairwise comparisons revealed significantly higher listening effort in the −3 dB SBR condition compared to the 0 dB SBR (mean difference = 1.40, df = 80, p <0.001). Listening effort ratings were also significantly higher in the unaided compared to aided conditions in both the −3 dB SBR (mean difference = 1.43, df = 80, p <0.001), and the 0 dB SBR condition (mean difference = 1.85, df = 80, p <0.001).

Overall, participants reported greater listening effort in the −3 dB SBR condition than in the 0 dB SBR condition, and rated the unaided condition as more effortful than the aided condition across both SBRs.

4 Discussion

The purpose of this study was to conduct an in-lab evaluation of an eyeglass-embedded OTC hearing aid that provides frequency-shaped gain, directionality, and noise reduction signal processing. The evaluation was conducted with a group of OTC candidates, adults with mild to moderate sensorineural hearing loss. Nuance Audio Glasses provide four Preset frequency responses, all of which are available to the device-wearer through the app. Real ear measures indicated that all Presets provided gain from 750–6,000 Hz. Aided fittings with the device resulted in an average improvement of 18 points in the SII compared to unaided. This unaided-to-aided improvement in SII is consistent with results from previous studies that have used behind-the-ear style devices with preconfigured frequency-gain responses (Humes et al., 2017; Urbanski et al., 2021) and indicates that the Nuance Audio Glasses improve access to the speech signal for those with mild to moderate hearing loss.

When participants were asked to choose their Preset in a speech-in-babble-listening environment, no consistent pattern was observed. Multinomial regression analysis indicated that the choice was not related to sex, hearing aid experience, or hearing loss. Since OTC devices are recommended for adults with perceived mild to moderate hearing loss without limitations of experience level or age within the adult range, the study was powered at the group level rather than allowing for subgroup analysis in order to represent the range of those who may decide to try this novel form factor. Targeting of specific groups for further investigation into Preset choice and outcome measurement is addressed in the future directions section. As was seen in previous studies (Humes et al., 2017; Urbanski et al., 2021), participants were able to self-select a Preset that resulted in positive aided outcomes. Real ear measures of the UPS, which was determined by the participants' choice of Preset plus volume control setting, showed a range of frequency gain responses (Figure 5) and captures individual listening preferences in noisy conditions, highlighting the role of access to user-driven fine-tuning.

Because the majority of OTC buyers are first-time users (Sobek Dobyan and Powers, 2025), and because OTC and direct-to-consumer devices are increasingly recognized as viable options for this group, aided speech recognition performance was compared to unaided performance. Two different measures of speech recognition in noise (one adaptive and one non-adaptive), were included, along with subjective ratings of listening effort on the non-adaptive test. The non-adaptive test used background noise types and signal-to-noise ratios with higher ecological validity (Keidser et al., 2020) than the adaptive outcome measure. Across both noise types, significant aided benefit was observed for all objective outcome measures when listeners wore the Nuance Audio Glasses compared to the unaided condition. This pattern of aided benefit aligns with previous work that demonstrated OTC-style devices can provide improved speech-in-noise benefit for adults with mild to moderate hearing loss (De Sousa et al., 2023; Humes et al., 2017; Urbanski et al., 2021).

Consistent with previous in-lab evaluations of the Nuance Audio Glasses (Harel-Arbeli and Beck, 2025; Turnbull et al., 2026), significant aided benefit for speech recognition in noise was found. In these studies, aided benefit of 2.2 to 4.4 dB was reported. The range may be related to differences in the test setup (Harel-Arbeli and Beck, 2025) and the speech-in-noise test used (Turnbull et al., 2026). While there is limited research evaluating speech intelligibility in noise with the emerging study of OTC devices, the observed aided benefit of 2.2 dB from the current study may be compared with that found by (Klemp and Dhar, 2008) for directional open-canal hearing aids (2.6 dB), and with the directional benefit results from (Harianawala, 2019) using the Matrix test (2.9 dB). The clinically meaningful difference for the Matrix test is approximately 1 dB SNR (Kollmeier et al., 2015), and the mean improvement in the current study of more than double that, demonstrates a perceptual benefit and improvement in speech reception thresholds consistent with traditional directional hearing aid studies.

Significant aided benefit was also demonstrated with a non-adaptive test in a background of multi-talker babble at realistic but challenging SBRs. This is consistent with results from Humes et al. (2017), who measured unaided and aided CST benefit in older adults fitted with hearing aids using OTC delivery models. Findings from the present study show improvements in both speech recognition scores and patient-reported listening effort; however, these two outcome domains do not reflect the same aspect of listening performance (Pichora-Fuller et al., 2016). Aided improvement in keyword correct scores using the CST exceeded 20%, and increased to 29% as the SBR decreased, indicating that the device provided greater speech recognition benefit as listening conditions became more challenging. Listening in background babble was significantly less effortful with the Nuance Audio Glasses compared to the unaided condition in both 0 and −3 dB SBR. Notably, in the easier 0 dB condition, the device reduced listening effort even though the demand for speech recognition support was lower. In contrast, in the more challenging −3 dB condition, although the same degree of reduction in listening effort was not achieved, the speech recognition benefit was larger, suggesting that the device improved recognition despite the task remaining effortful. The benefits found in these more challenging SBRs from surrounding pairs of talkers support findings in Turnbull et al. (2026), where there was a significant preference for use of the Nuance Audio Glasses in more challenging environments.

Overall, the findings of this in-lab study indicated that Nuance Audio Glasses provide improved access to speech, leading to significantly better speech recognition and reduced listening effort in noise. These outcomes suggest this device may be an effective strategy for adults with perceived bilateral mild to moderate hearing loss.

4.1 Limitations and future directions

The devices in this study were used only in-lab. Future research with a field trial and home use is recommended to assess real-world benefit. Additionally, comparisons of in-lab and real-world performance across acoustically variable conditions would allow for better interpretation of in-lab-real-world differences. With respect to future in-lab assessment, the use of parameters that maximize realism could be considered to better simulate real-world conditions (Goverts et al., 2025). In-lab measurements of frame-shadow effects could also be considered to determine whether high-frequency attenuation is produced by the frames, and whether this varies across the frame types offered. While, the audiograms of the participants fell across the full mild to moderate range specified for OTC devices, suggesting a good representation of the audiometric profile of the population that these devices are for, the participants in this study had a mean age of 75 years, and therefore, the results of this study may not fully translate to other age groups who might use this device. In addition, the current study was not powered to complete formal analysis within the subsets of degree of hearing loss, slope of hearing loss, or hearing aid experience. Targeted recruitment in future studies would allow for the evaluation of these possible groups of interest.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: OSF https://osf.io/q95ug/overview?view_only=436d5a2e821749ad88f8cb47f5ec92a0.

Ethics statement

The studies involving humans were approved by Western University Research Ethics Board Health Canada. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

PF: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. Y-YS: Formal analysis, Software, Visualization, Writing – review & editing. TH-A: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. GC: Conceptualization, Writing – review & editing. SS: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing, Investigation.

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Conflict of interest

TH-A and GC are employees of EssilorLuxottica. The funder and manufacturer-affiliated authors were not involved with the data collection, data analysis, interpretation of the data, or the decision to submit it for publication.

The remaining author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fauot.2026.1822238/full#supplementary-material

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