INTELLIGIBILITY IMPROVEMENT WITH A TV STREAMER

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INTRODUCTION

The TV-DEX, a streamer by Widex, utilizes a new method of wireless transmission (WidexLink) to provide stereo, echo-free sound from an audio source. The direct transmission of the audio signal from the TV-DEX to the hearing aid has the potential to eliminate the negative influence of ambient noise in the environment resulting in a better Signal-to-Noise Ratio (SNR) than what may be achieved by an individual without hearing aids or with their hearing aids alone.

The direct transmission of the audio signal to the hearing aids in the TV-DEX can be accomplished in two ways called "Room-On" and "Room-Off". "Room-On" allows sound from the audio source to be heard by direct wireless transmission via the TV-DEX and through the microphones on the hearing aid. "Room-Off" allows sound from the audio source to be heard by direct transmission via the TV-DEX only and the microphones on the hearing aids are muted. This removes any interfering or annoying background noise in the environment that may be distracting to the user listening to the audio signal of interest. So thus, the "Room-Off" condition could provide additional comfort and ease of listening vs. the "Room-On" condition. Both of these methods of direct communication with the TV-DEX should result in better intelligibility and subjective sound quality than unaided or with hearing aids only.

It is our hypothesis that the TV-Dex will improve speech intelligibility in challenging listening situations and that users will prefer the sound quality of the audio signals using hearing aids with the TV-Dex over hearing aids alone and unaided. This study is designed to document this hypothesis.

METHODS

Subjects

- 10 hearing impaired subjects were recruited for participation.
- Adult subjects (>18 years).
- Good cognitive function and English (American-dialect) as their primary language
- At least had 6 months of HA experience.
- Their selection was contingent upon auditory thresholds ≥ 20 dB HL at 500Hz – 8000 Hz; their average audiograms can be seen in Figure 1.

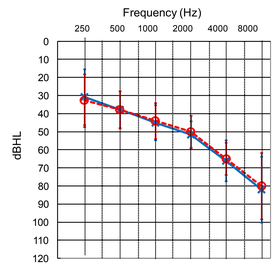

Figure 1: Average hearing loss of 10 test participants.

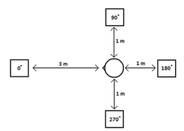

Figure 2: Arrangement of loudspeakers of test condition.

METHODS [cont.]

Procedures

- Participants were fitted binaurally with Clear 440 '9' model BTE hearing aids and with temporary instant fit foam tips (with size #13 tubing) for earmolds.
- In-situ (Sensogram) thresholds were measured at .25k .5k, 1k, 2k, & 4 kHz with gain and features set at their default settings and a feedback test was performed.
- The TV-DEX controller was placed around the neck of the test participant and the TV-DEX base station was placed on top of the 0° speaker 3 meters away from the participant.
- Evaluation of 32-Item ORCA Speech Test in quiet & in noise, was presented in a counter-balanced order for the following conditions:

i. Unaided
ii. Aided
iii. Aided with TV-Dex (Room-On)
iv. Aided with TV-Dex (Room-Off)

Evaluation was carried out in a classroom (40' 3" x 20' 11") space. Test signal originated from a 0° loudspeaker 3 meters away from the participant at 68 dB SPL. The noise source, when activated, originated from 3 loudspeakers at 90°, 180°, and 270°, 1 meter away from the participant (Figure 2). The noise stimulus, an 8-person babble uncorrelated noise, was presented at levels sufficient to obtain a 0 dB SNR.

RESULTS

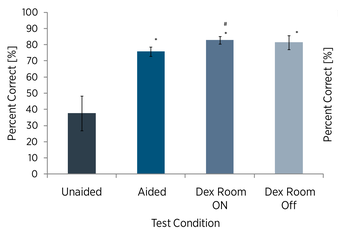

Figure 3: % correct for all phonemes
Quiet condition @ 68 dB SPL input
* = Significance vs. unaided (p<0.05)
# = Significance vs. aided (p<0.05)
^ = Significance vs. dex room on (p<0.05)
(Error bars = Standard error)

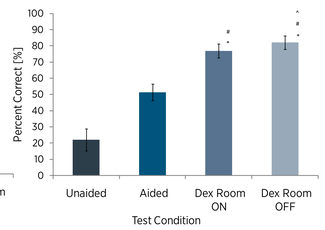

Figure 4: % correct for all phonemes
Noise condition @ 68 dB SPL input; (0 dB SNR)
* = Significance vs. unaided (p<0.05)
# = Significance vs. aided (p<0.05)
^ = Significance vs. dex room on (p<0.05)
(Error bars = Standard error)

Figure 3 shows the percent correct for all phonemes in quiet across the 4 test conditions. One-way repeated-measures ANOVA showed that the effect of test condition was significant, $F(3,27) = 20.37$, $p = 0.001$, $\eta^2 = 0.69$.

RESULTS [cont.]

Post hoc analysis with Bonferroni adjustment showed that the percent correct for the Unaided was significantly lower than those for Aided, Dex Room On, and Dex Room Off ($p < 0.05$). Additionally, Dex Room On had significant higher percent correct than Aided ($p < 0.05$).

Figure 4 represents the percent correct for all phonemes in noise (0 dB SNR) for the 4 test conditions. One-way repeated-measures ANOVA also showed that the effect of test condition was significant, $F(3,27) = 66.78$, $p < 0.001$, $\eta^2 = 0.88$. Post hoc analysis with Bonferroni adjustment indicated that Aided, Dex Room On, and Dex Room Off had significant improvement over Unaided ($p < 0.05$). Moreover, Dex Room On had percent correct significantly higher than Aided ($p<0.05$), while Dex Room Off had percent correct significantly higher than Dex Room On and Aided ($p<0.05$).

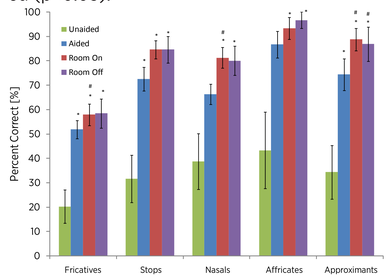

Figure 5: % correct by manner of articulation
Quiet condition @ 68 dB SPL input
* = Significance vs. unaided (p<0.05)
# = Significance vs. aided (p<0.05)
^ = Significance vs. dex room on (p<0.05)
(Error bars = Standard error)

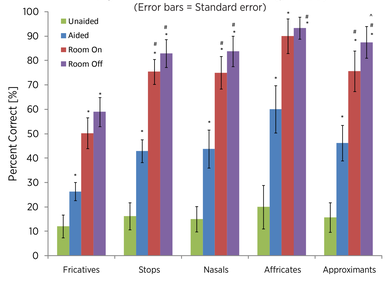

Figure 6: % correct by manner of articulation
Noise condition @ 68 dB SPL input; (0 dB SNR)
* = Significance vs. unaided (p<0.05)
# = Significance vs. aided (p<0.05)
^ = Significance vs. dex room on (p<0.05)
(Error bars = Standard error)

Figures 5 and 6 display the performance in manners of articulation across four test conditions for quiet and noise, respectively. Two-way repeated-measures ANOVA was performed for the effect of articulation manner (stops, fricatives, nasals, approximants, and affricates) and the effect of test condition (Unaided, Aided, Dex Room On, Dex Room Off). Results showed that for quiet, both the effect of articulation manner and the effect of test condition were significant, $F(4,36) = 16.67$, $p < 0.001$, $\eta^2 = 0.65$, and $F(3,27) = 28.09$, $p < 0.001$, $\eta^2 = 0.75$, respectively.

RESULTS [cont.]

In addition, the interaction between articulation manner and test condition was significant, $F(12,108) = 1.87$, $p = 0.04$, $\eta^2 = 0.17$. For noise, both the effect of articulation manner and the effect of test condition were also found significant, $F(4,36) = 17.92$, $p < 0.001$, $\eta^2 = 0.66$ and $F(3,27) = 109.54$, $p < 0.001$, $\eta^2 = 0.92$, respectively. The interaction between articulation manner and test condition was also significant, $F(12,108) = 2.50$, $p = 0.006$, $\eta^2 = 0.21$.

Figures 7 & 8 show performance on two of the highest frequency phonemes in the English language: /s/ & /Sh/ (Fricatives). These phonemes are typically the hardest to hear, particularly in challenging listening environments, and when removed or "unheard" could lead to negative intelligibility performance. One-way repeated-measures ANOVA showed that the effect of test condition was significant for /s/ and /sh/ in quiet, $F(3,27) = 12.20$, $p = 0.002$, $\eta^2 = 0.57$. and $F(3,27) = 12.23$, $p = 0.003$, $\eta^2 = 0.57$, respectively. The results for noise also showed significant effect of test condition for /s/ and /sh/, $F(3,27) = 125.70$, $p < 0.001$, $\eta^2 = 0.74$. and $F(3,27) = 20.92$, $p < 0.001$, $\eta^2 = 0.69$, respectively.

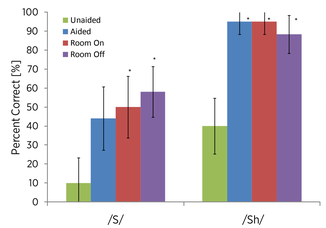

Figure 7: % correct /s/ and /Sh/
Quiet condition @ 68 dB SPL input
* = Significance vs. unaided (p<0.05)
# = Significance vs. aided (p<0.05)
^ = Significance vs. dex room on (p<0.05)
(Error bars = Standard error)

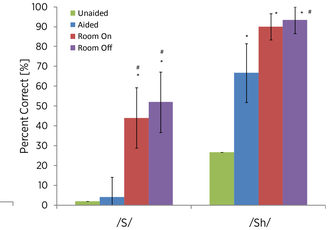

Figure 8: Percent correct /s/ and /Sh/
Noise condition @ 68 dB SPL input; (0 dB SNR)
* = Significance vs. unaided (p<0.05)
# = Significance vs. aided (p<0.05)
^ = Significance vs. dex room on (p<0.05)
(Error bars = Standard error)

CONCLUSIONS

The results of this study have demonstrated the improvement in intelligibility that is achieved when using a wireless streamer (TV-DEX), in both quiet and noise; with the greatest improvement seen when the streamer is used in noise. It is worthy to note that when in noise, the intelligibility of the /s/ phoneme was retained when using Dex Room-On & Dex Room-Off vs. both the Unaided & Aided conditions. The findings validate the intent of this study and show evidence of the value of using such a device (TV-DEX) to improve for intelligibility of users vs. unaided or with their hearing aids alone in both quiet and noise.