UNAIDED AND AIDED LOCALIZATION PERFORMANCE

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INTRODUCTION

The pinna attenuates sounds that originate from the rear by approximately 5 dB in the 2000-6000 Hz range. By positioning the microphone of a hearing aid outside the concha area, such as a behind the ear [BTE] instrument, this directional advantage from the pinna is lost. A new algorithm was developed to mimic the directional advantage of the pinna for BTE instruments [the Digital Pyinna]. This algorithm would assist with front/back localization. This case study poster will examine the front/back localization abilities of four individuals tested in the unaided and aided conditions with and without the new algorithm.

METHODS

Hearing instrument

- Widex Clear 440 Passion, Receiver in Canal
  - 15 channel
  - Fully adaptive directional microphone
  - Speech intelligibility based noise reduction
  - Multi directional active feedback cancellation
  - Inter ear communication [compression, noise reduction, volume, program, zen tones...]
- Custom CAMISHA shells made for each participant
- Venting based on hearing loss at 500 Hz
- <20 dB = open fit; 20-29 dB = 1.5-2mm; 30-39 dB = 1-1.5mm; 40-49 dB = 0.5-1mm; 50-60 dB = 0-0.5mm

- For testing purposes
  - Digital Pinna feature turned on and off for test comparison
  - Hear aid set in omni directional mode
  - Noise reduction off
  - Feedback cancellation set to default
  - Inter ear communication off

Set up

- Participants were seated in a 10'x10'x6'6"double wall sound treated booth.
- Participants faced a 0^0 speaker in a 12 speaker array [Figure 1].
  - Each speaker separated by 30^0
  - Each speaker one meter from center
- A 17" Planar PT 1700 MU touch screen was placed in front of listener for responses.
- A foam headrest was used to remind the participant to keep head position straight.

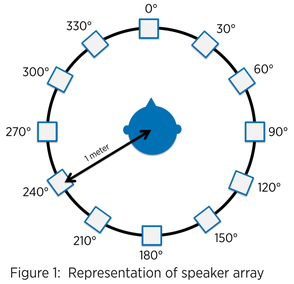

Figure 1: Representation of speaker array

- A 300 ms high pass filtered noise [above 2000 Hz] was presented at 30 dB sensation level [SL] in sound field.
- The test signal was presented randomly from one of the twelve speakers. The test ended when the signal had been presented a total of three times from each of the twelve speakers [36 total test signals].

METHODS [cont.]

Procedures

Visit 1:
- Participant seen for unaided testing and insert earphone puretone audiometric check.
- Ear impressions were taken and custom CAMISHA earmolds ordered.

Visit 2:
- Instruments programmed with in-situ threshold measurements [Sensogram] and feedback test.
- Default gain settings were used. Fine tuning permitted if participant reported issue with loudness.
- Localization testing conducted.
- For home use, hearing aid settings included: Locator [automatic adaptive directional microphone] with Digital Pinna algorithm, Speech Enhancer [SII based noise reduction], feedback cancellation set to default, and inter-ear communication was active [noise reduction, compression, feedback cancellation ...].

Visit 3:
One month after fitting. Localization testing repeated.

Visit 4:
Two months after hearing aid fitting. Localization testing repeated.

RESULTS

Even though the participants were evaluated at 12 different angles for each test, for reporting purposes of front and back localization, the front score was comprised of 330^0, 0^0, and 30^0; and the back score was comprised of 150^0, 180^0, and 210^0.

Participant 1

Participant 1: a 73 year old female
- Presented with a mild to moderate sensorineural hearing loss [Figure 2].
- She had 2 years of hearing aid experience with a BTE instrument.
- Her own hearing aid had automatic adaptive directional microphones.

Results shown in Figure 3:
- Unaided testing indicated that she had better localization to the front than to the back [by 44%].
- With no Digital Pinna algorithm, she was unable to identify sounds to the back [which did not improve over time].
- With the Digital Pinna algorithm, she was able to identify sounds to the front and sounds to the back equally [89% correct].
- The results of this participant with the Digital Pinna were very similar to results obtained for those with normal hearing on this test.

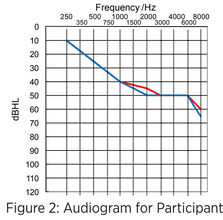

Figure 2: Audiogram for Participant 1

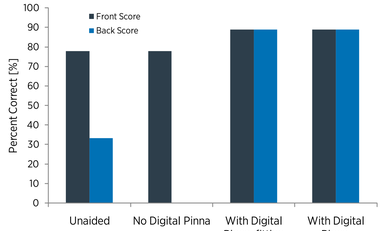

Figure 3: Front/Back results for Participant 1

RESULTS [cont.]

Participant 2

Participant 2: a 69 year old male
- Presented with a precipitous high frequency hearing loss [Figure 4].
- He had 7 years of hearing aid experience with an ITE instrument.
- His hearing aid only had an omni directional microphone.

Results shown in Figure 5:
- Unaided testing indicated that he had better localization to the front than to the back [by 44%].
- With no Digital Pinna algorithm, he localized more to the back than to the front [by 55%]; this did not improve over time.
- With the Digital Pinna algorithm, identification to the back [89%] as well as to the front [22%] improved over no Digital Pinna.
- Front localization improved over time.
- Localization ability to the back was considerably better with the Digital Pinna algorithm than unaided. After experience, localization to the front was similar to unaided.

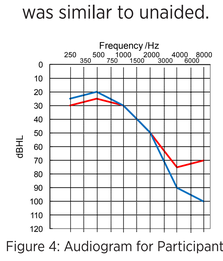

Figure 4: Audiogram for Participant 2

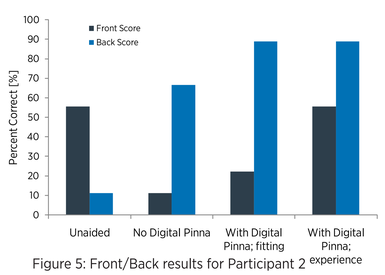

Figure 5: Front/Back results for Participant 2

Participant 3

Participant 3: a 76 year old male
- Presented with a mild to moderate snesorineural hearing loss [Figure 6].
- He had no hearing aid experience.

Results shown in Figure 7:
- Unaided testing indicated that he had better localization to the front than to the back.
- With no Digital Pinna algorithm, he was unable to localize in either direction [which did not improve over time].
- With the Digital Pinna algorithm, he began to localize some sounds to the back.
- With experience, localization to the back improved considerably and he began to localize sounds in the front as well.
- If given more time to acclimatize to amplification, it would be interesting to see if this participant would continue to improve localization ability.

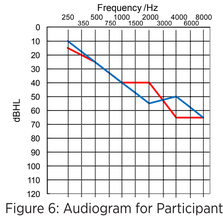

Figure 6: Audiogram for Participant 3

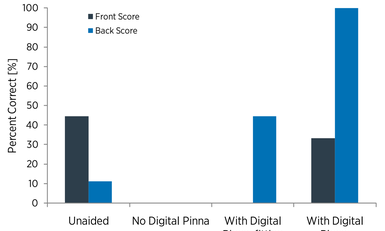

Figure 7: Front/Back results for Participant 3

RESULTS [cont.]

Participant 4

Participant 4: a 65 year old male.
- Presented with a precipitous high frequency hearing loss [Figure 8].
- He had no hearing aid experience.

Results shown in Figure 9:
- Unaided testing indicated that he had minimal localization to the front and no localization to the back.
- With no Digital Pinna algorithm, he was not able to localize sounds to the front and was able to localize some of the sounds to the back [33%]. This did not improve over time.
- With the Digital Pinna algorithm, he was able to localize sounds to the back [67%] and began to localize sounds to the front [22%].
- With experience, localization to the front started to improve and localization to the back decreased slightly by 10%.
- As with Participant 3 with no hearing aid experience, it would be interesting to see if his localzation skills continued to improve with time.

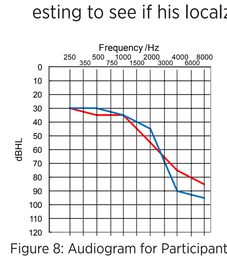

Figure 8: Audiogram for Participant 4

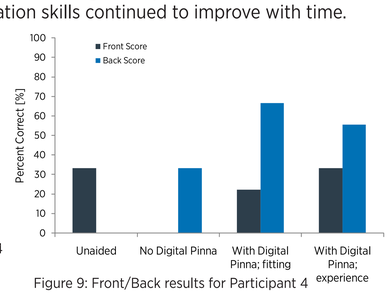

Figure 9: Front/Back results for Participant 4

OBSERVATIONS

- Participants 1 and 3, although having similar hearing losses, had very different localization ability.
- Participants 2 and 4, also having similar hearing losses, had very different localization ability.
- The participants with hearing aid experience, Participants 1 and 2, had better localization ability with amplification than did those without experience, Partcipants 3 and 4.
- The participants without hearing aid experience did improve over time. It would be interesting to see if this improvement continued with more hearing aid experience.
- These participants had better localization ability with the use of amplification than their unaided localization.
- All four participants demonstrated better localization ability with the use of the Digital Pinna than without the use of the Digital Pinna algorithm.

CONCLUSIONS

- Localization ability was not determined by auditory thresholds alone.
- Localization ability was influenced by hearing aid experience for these listeners.
- Further investigation will be needed to examine if localization ability continues to improve over time.
- Further investigation will be needed to examine why there are differences in localization ability for the hearing impaired besides auditory thresholds; such as damage to inner hair cells.