Field Study News

September 2017

TV Connector – superior listening to television programs containing speech

This study conducted at DELTA SenseLab in Denmark reveals that the latest solution for television listening from Phonak, the TV Connector in combination with Audéo B-Direct hearing aids, outperforms its competitors in terms of preference, in particular for television broadcasts which contain speech. The sound quality of the TV Connector is very close to the ideal profile as defined by hearing aid wearers.

Introduction

Watching television has become an increasingly important activity among older adults. According to Nielsen ratings data, adults over 50 years of age watch an average of 48 hours of television per week. That amounts to almost seven hours per day spent watching television (Nielsen 2015). This phenomenon is not limited to one particular country. By the year 2021, it is projected that 1.68 billion households worldwide will own at least one television. For seniors, watching television has been shown to have positive benefit, offering "an active way to remain socially integrated, to structure daily life, and to satisfy needs for reflection and contemplation (Oestlund, Jönsson & Waller 2010)." Unfortunately for those with hearing loss, watching television can be a frustrating experience. Actors with foreign accents, loud background music, and a lack of visual cues can make understanding speech difficult.

Volume preference for different listeners within a household is another common challenge, which is often reported at audiology appointments. One solution for assisting with listening to television is the use of headphones. This has the disadvantage of isolating the headphone wearer from social conversation with other people in the room. Other possible solutions are devices which stream the audio signal from the television to the hearing aids. This often involves the use of a personally worn or intermediate streaming device which may not be cosmetically appealing and may be difficult to set up.

The latest television solution from Phonak, the TV Connector has been proven to be very easy to install and use (Magnenat & Smith, 2017). It allows users to effortlessly stream television audio directly into their hearing aids for a truly seamless, plug and play TV watching experience.

Recent studies (Froehlich et al. 2017 and Ramsgaard et al. 2016) have looked at sound quality of made for iPhone direct streaming hearing aids with normal hearing participants. The purpose of this study was to evaluate the sound quality of Audéo B-Direct in combination with the TV Connector, specifically with hearing impaired participants.

Methodology

Participants

15 participants (9 male, 6 female) took part, aged between 67 and 84 years (mean age was 75 years). They all had a moderate hearing loss. They were all experienced hearing aid users and used hearing aids on a daily basis. Before starting the study, participants received training and were familiarized with the listening tasks. This training qualified them as expert listeners
(Legarth et al. 2012).

Equipment

Participants tested three different sets of hearing aids (in combination with their respective TV streaming device): Phonak Audéo B90-Direct and premium hearing aids from two leading competitors. All hearing aids were fitted to the manufacturers' recommended fit using SlimTips and closed domes. Frequency lowering was turned off for all hearing aids, in order to equate settings across manufacturers to reduce variability. All hearing aids were set up so that the streaming program was activated manually. All hearing aids were configured to have both streamed and acoustic input in the manufacturers recommended balance.

All three hearing aid pairs were wirelessly connected to the television using a compatible TV streaming device that was physically attached, via Optical out, to a 49" Samsung TV. The TV was connected via HDMI to a stationary lab PC where the uncompressed original audio stream of the broadcast samples was played from Adobe Audition 3.0.

5 different TV broadcast samples were selected for testing the hearing aid TV streamers (Table 1). The samples represented different television programs which varied acoustically e.g. some contained more speech, some contained more music and some contained just applause to challenge the investigational devices in different psychoacoustic dimensions.

Broadcast sample description	L_{Aeq} Kemar position	L_{Aeq} Kemar position
DR news 2 News from national Danish television	56.3 dB	61.2 dB
Sport Champions League football match	55.6 dB	60.3 dB
Gladiator An ambient outdoor scene of an action movie with moving horses	61.9 dB	62.9 dB
Music Eric Clapton live concert from Royal Albert Hall "I shot the sheriff"	49.2 dB	57.1 dB
Applause Applause from Eric Clapton live concert at Albert Hall	56.2 dB	64.8 dB

Table 1. Description of the 5 different TV broadcast samples used for the recordings of the hearing aid streamers. Levels recorded at Kemar position 3 meters from the acoustic output.

The output of the hearing aids with a streamed signal was recorded on a KEMAR (Knowles Electronics Manikin for Acoustic Research) head and torso simulator for test of binaural hearing aids in a standardized listening room.

Recordings were generated for all three sets of hearing aids together with their corresponding TV streamer. During the evaluations, the recordings were played to participants via headphones whilst videos of the broadcast samples were also reproduced over the TV, time-aligned with the audio recordings. In order to avoid the influence of loudness, all samples were equalized individually.

Procedures

After recordings had been produced, the study was executed within three steps:

For the first step, 6 relevant attributes for the perceptual evaluation of the hearing aid media streamers were identified. The attributes were required to capture the key characteristics that differentiated the hearing aid streamers in the test. Therefore, six of the participants attended a preliminary appointment and were presented with all recordings of the streamers and took part afterwards in a consensus meeting, which led to the attributes, anchors and definitions (Table 2) that would be used for the evaluation of the hearing aid profiles. The attributes which were identified and their descriptions are as follows:

1. The deep tones of a sound were identified as an attribute and labelled as Bass. A sound perceived as thin and tenuous has little Bass. A sound perceived as dark and deep has a lot of Bass.
2. The bright tones were identified as an attribute and labelled as Treble. A little Treble can sound like 'listening under a quilt' where details disappear. A lot of Treble can sound like lisping and sometimes sharp and shrill.
3. The presence of an echo was identified and labelled as Reverberation. A lot of reverberation sounds as if the sound does not die out. If an echo is heard, this would be a lot of reverberation.
4. The naturalness of a sound was identified and labelled as Naturalness. Subjects were asked to judge whether the sound stream natural and realistic in relation to content shown on the TV?
5. How lively the sound is was identified, and labelled as Dynamics. Flat dynamics means the content sounds flattened and less intrusive. Varying Dynamics can sound alive and seem more realistic.
6. Whether details disappear and are blended and muddy was identified as an attribute and labelled as Details – do details disappear and are blended and muddy? Or are details distinct and clear with high separation? High separation can contribute to better speech intelligibility of the voice.

Attribute	Low anchor	High anchor
Bass	A little	A lot
Treble	A little	A lot
Reverberation	A little	A lot
Naturalness	Low	High
Dynamics	Flat	Varying
Details	Blurred	Separated

Table 2. The attributes and anchors which were identified, in order to evaluate the recordings.

The second step was a double-blind randomization test and involved all 15 participants. Study participants identified the preferred rating for a given attribute using SenseLabOnline™ (a proprietary software for facilitating listening tests). The software guided the participant through so that they would rate all products for each broadcast sample, for each given attribute. Following this, participants then determined the ideal point for each attribute based on their experience with the different sound samples. This created an ideal profile.

For the third step, an overall evaluation of preference was made for all three hearing aid streamers with the five broadcast samples. All 15 participants completed the preference test twice, in order to check for reliability. Participants rated their preference (double blind randomization) using SenseLabOnline™, on a scale ranging from 0 = dislike extremely to 15 = like extremely.

Results

Ideal profiling evaluation

The profile plot in figure 1 shows the ideal profile which the test participants defined. The ideal rating of the different attributes reflects the average rating which subjects would expect to be optimal.

The Ideal profile is characterized by

- Balanced timbre with a slight Bass tilt
- Medium level Reverberation
- A high level of Dynamics, Details and Naturalness

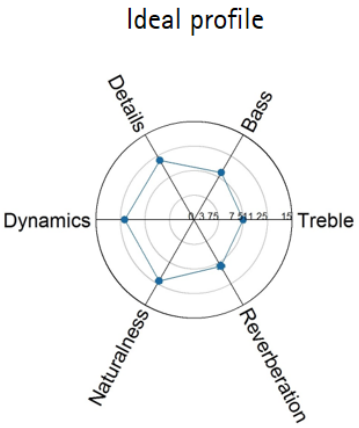

Figure 1. The ideal sound sample, defined by the test participants.

Figure 2 shows the profile plot which the participants defined for the Phonak Audéo B-Direct hearing aids with the TV Connector (Phonak TV solution). It is overlaid onto the ideal profile and looks very similar to the ideal profile. The Phonak TV solution was rated to have just a little bit less naturalness, dynamic, details and treble than the ideal profile. The bass and reverberation were considered identical.

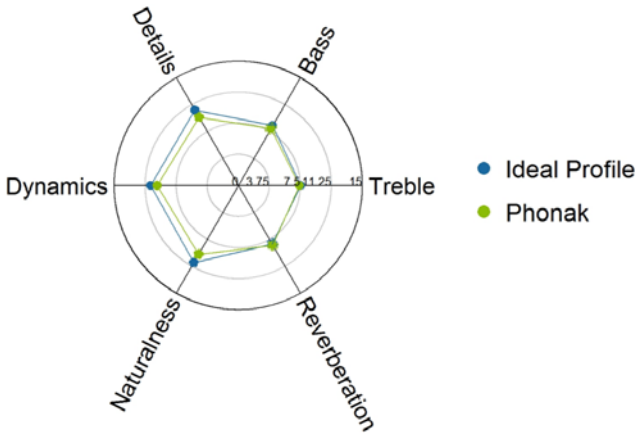

Figure 2. The profile plot from the Phonak TV streaming solution overlaid onto the ideal profile.

Figure 3 shows profile plots of the Phonak TV solution as well as those from the two competitors. Competitor 2 produces a profile plot which is quite similar to that of Phonak and hence is quite similar to the ideal profile. Competitor 1 produces a profile plot which looks quite different both from that of Phonak and the ideal profile. It has a lot less details, dynamics and naturalness and could be proven to be statistically significant different to Phonak and competitor 2.

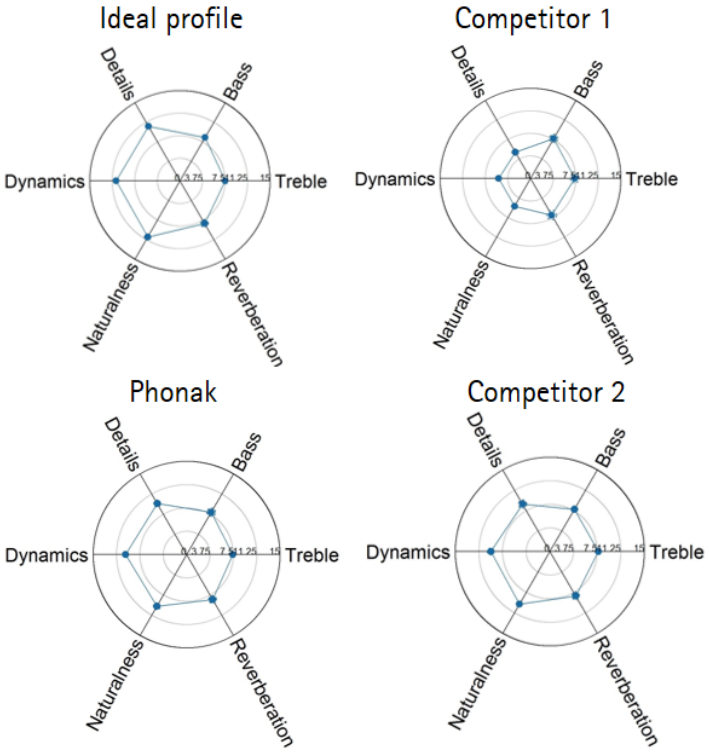

Figure 3. Profile plots of the 3 hearing aid streamers and also the ideal profile, average for the five broadcast samples.

Preference evaluation

An overall preference evaluation revealed a preference for Phonak, followed by competitor 2. The difference between Phonak and competitor 2 was not significant. In order to differentiate between the two, a cluster analysis was performed.

The cluster analysis was performed on the five broadcasting samples in order to identify any sub-groups of samples that shared similar characteristics and preference patterns. The following three clusters were found:

News and Sport (speech)
Gladiator and concert (entertainment)
Applause (noise)

Figure 4 shows the preference rating for News and Sport which are dominated by speech.

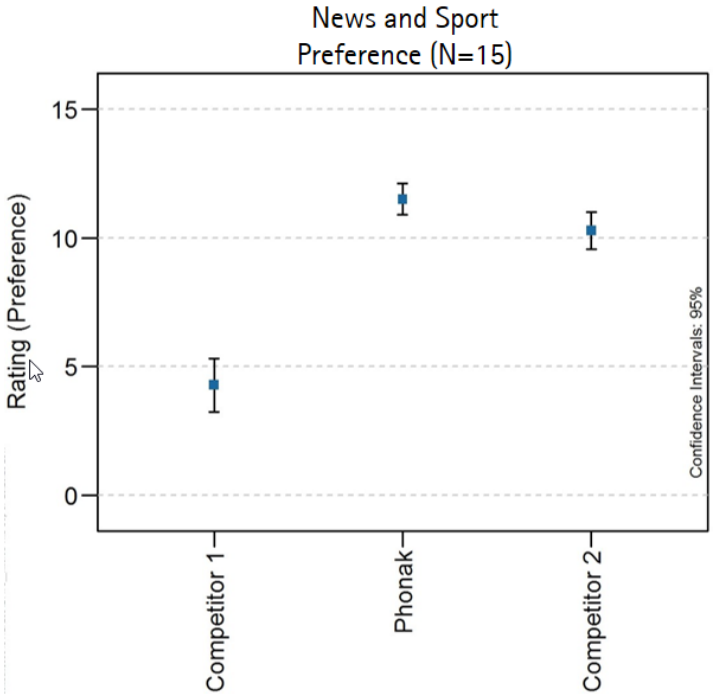

Figure 4. Preference ratings for News and Sport. Mean and 95% confidence intervals are shown.

A Tukey HSD significance test on the results in figure 4 reveal a significant difference between all 3 hearing aid streamers. This means that Phonak is preferred over the competitors for the broadcast samples News and Sports which are dominated by speech.

Preference evaluation for the other two clusters revealed a very similar pattern, but ratings for Phonak and competitor 2 were not statistically significant.

A further statistical analysis for the cluster News and Sport showed that for the attribute 'Details', only Phonak is not significantly different from the ideal profile. The preliminary appointment where the attributes were defined, described 'Details' as being associated with speech intelligibility. This suggests that the Phonak solution provides higher speech intelligibility than the other investigational devices.

Conclusion

Market research shows that watching television is an important leisure activity in many countries. Hearing aid users may face some challenges when watching television, including streaming devices which are complicated to set up.

The Phonak TV Connector, together with Audéo B90-Direct hearing aids is a plug and play solution which has been proven in other studies to have very good usability (Magnenat & Smith, 2017). Alongside good usability, this

study has shown its streamed signal to not only be very close to the ideal profile, but also to be preferred over its competitors for television programs dominated by speech.

This excellent sound quality of the latest television streaming solution from Phonak, together with its ease of use, gives hearing aid wearers more enjoyment when watching television.

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Authors and investigators

External principle investigator

Søren Vase Legarth graduated from the Technical University of Denmark in 2004 as M.Sc.E.E. with key interest and attention towards Acoustics. He was after graduation employed at the acoustics department in DELTA and in 2007 when SenseLab was started he had the responsibility of setting up a trained test panel, lab facilities and develop test software. In 2011 he became Head of Department.

Internal principle investigator

Matthias Latzel studied electrical engineering in Bochum and Vienna in 1995. After completing his PhD in 2001, he carried out his PostDoc from 2002 to 2004 in the Department of Audiology at Giessen University. He was the head of the Audiology department at Phonak Germany from 2011. Since 2012 he is the Clinical Research Manager for Phonak AG, Switzerland.

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Jennifer Appleton-Huber received her MSc in Audiology from the University of Manchester in 2004. Until 2013, she worked as an Audiological Scientist mainly in the UK and Switzerland, where she worked with adults and pediatrics, in the areas of hearing aids and cochlear implants. Her current role is Technical Editorial Manager at Phonak Headquarters.