

Benefit of telephone solutions for children and adults

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Abstract

"Children are not just small adults": this is also true when using their hearing devices while listening to a phone as adults and children benefit from different approaches. Two novel approaches and their benefit especially when making use of binaural hearing skills have been investigated in two studies - one with children and one with adults. Three different coupling methods between the phone and the hearing aid have been used: acoustic coupling (adult study), inductive coupling (ped study) and a digitally coded inductive coupling system (adult study). Both studies used objective speech tests where the speech material was presented via a phone receiver.

For children ages 2-5 years the presentation of the phone signal to both ears compared to a monaural presentation significantly improved speech understanding by 19.5%. For the older children, 6-14 years, the improvement was 32% on average which was statistically significant.

The adult subjects with moderate to severe hearing loss had an improvement in speech intelligibility by about 3,5 dB using the acoustic coupling and both ears but it turned out that speech perception is highly dependent on the correct receiver positioning. This uncertainty could be overcome using a novel DECT phone where an inductive coupling method based on a digitally coded signal showed a more robust behaviour regarding the positioning of the phone receiver resulting in an additional improvement of the speech intelligibility and an easier handling.

Introduction

- Hearing on the telephone is a common challenge for hearing aid wearers.
- Several surveys report that many hearing aid wearers are dissatisfied when using the telephone with a hearing aid (Kochkin 2002; 2005; 2010).
- The difficulty which they face when using the phone is thought to be due to a number of factors: lack of visual clues, reduced frequency bandwidth, lack of binaural hearing abilities, presence of (loud) background noise and difficulties coupling the phone to the hearing aid.

- A number of modern approaches to overcome these problems are available and have been tested in recent studies (Latzel, 2001a, Kiessling et al. 2013, Picou & Ricketts, 2011; 2013).
- They all show significantly improved speech intelligibility especially when listening to a telephone speech signal with two ears using a streaming device to make use of binaural hearing abilities
- These studies
 - Use a streaming system that requires a body worn device to stream the phone signal to the hearing aids
 - Do not use speech tests especially designed for listening on phone
 - Do not look into the performance of modern devices for children when using the phone
- The studies described in this poster incorporate these important aspects

Young hearing aid user: Ped — study

- How does speech recognition on the phone in quiet and in noise compare when using a monaural versus binaural listening condition? Participants are a group of children with hearing loss using a wireless signal routing system?

Adult hearing aid user: Adult — study

- Does a special DECT phone solution provide improved speech intelligibility and user satisfaction in a realistic situation with background noise?
- How does the speech recognition and subjective perception on the phone in a situation with background noise compare when using a monaural versus binaural listening condition? Participants are a group of adults using a wireless signal routing system?

Participants & Methods

Ped - Study

Site: Hearts for Hearing foundation, Oklahoma City, USA

Subjects

- Age-group#1: 10 children: 2 – 5 years
- Age-group#2: 14 children: 6 – 14 years
- Bilateral symmetrical hearing loss (better-ear): HL4FA: 35-75 dB HL

Devices

- Phonak Bolero Q90-M13
- Fitting: DSL5.0 targets, microphone: omni mode, NR: OFF
- Verification: REM or simulated REM (with RECD)
- Gain equalization (output related) of acoustic and telecoil program (see figure 1)
- Microphone sensitivity: -10 dB

Test conditions

- Monaural phone condition (inductive telecoil)
- Binaural phone condition (inductive telecoil)
- Counter balanced presentation

Outcome measures

- Age-group#1: Northwestern Univ – Children's Perception of Speech ((NU-CHIPS - Elliott & Katz, 1980) in quiet and in noise (noise level: 55 dB)
- Age-group#2: CNC material, in quiet and in noise (noise level: 50 dB)
- Presentation of speech material via landline phone



Figure 1 Equalization of the gain settings for the acoustic program

Adult - Study

Site: Hearing Centre Oldenburg, Oldenburg, Germany

Subjects

- 15 hearing impaired adults (7 male, 8 female)
- Mean age 72 years (range 57-83 years)
- Bilateral symmetrical hearing loss: HL4FA: 56-74 dB HL

Devices

- Phonak Naída Q90-SP
- Fitting: Adaptive Phonak Digital, closed vent

Test conditions

- Monaural phone condition (acoustic coupling): STANDARD
- Binaural phone condition (acoustic coupling): DuoPhone
- DECT phone (binaural wireless coupling): DECT
- Microphone sensitivity: -6 dB (contra-lateral ear)
- Counter balanced presentation

Test conditions

- Monaural phone condition (acoustic coupling): STANDARD
- Binaural phone condition (acoustic coupling): DuoPhone
- DECT phone (binaural wireless coupling): DECT
- Microphone sensitivity: -6 dB (contra-lateral ear)
- Counter balanced presentation

Outcome measures

- Speech test:
 - Triple-Digit-Test (TDT) (Zokoll et al., 2012; 2013)
 - Speech: level 65 dB (KEMAR)
 - Noise: ISTS with adaptive level,
 - Setup: 4 loudspeaker: 45°, 135°, 225°, 315°
 - Presentation of speech material via DECT phone (for STANDARD and DuoPhone digitally inductive coupling of DECT phone was deactivated)
 - Measurement of SRT: 50% digit recognition
 - Use DEMO-sound of phone to find most effective phone position for each coupling method
- Subjective assessment:
 - Subjective perception of listening effort, sound quality, loudness and effort to find correct receiver position

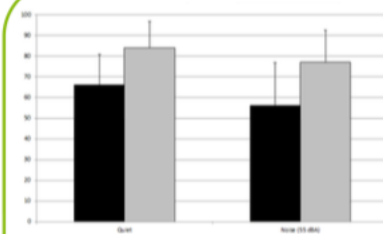


Figure 2 Comparison of mean word recognition scores for age-group#1 between a monaural and binaural phone condition

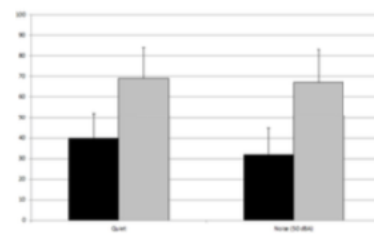


Figure 3 Comparison of mean word recognition scores for age-group#2 between a monaural and binaural phone condition

Results

- Ped-Study:** Speech intelligibility for younger children improved by 18% in quiet and by 21% in noise when using the binaural rather than the monaural phone condition (Fig.2).
- Ped-Study:** Speech intelligibility for older children improved by 29% in quiet and by 35% in noise when using the binaural rather than the monaural phone condition (Fig.3).
- Ped-Study:** A RANOVA analysis revealed a significant main effect of condition (Age-group#2: $F[1, 56] = 10.1$, $p < 0.05$; Age-group#1: $F[1, 40] = 8.3$, $p < 0.05$) and a significant main effect of telephone program condition (Age-group#2: $F[1, 56] = 13.1$, $p < 0.05$; Age-group#1: $F[1, 40] = 11.4$, $p < 0.05$) for both age groups.
- Adult-Study:** SRT for DECT is improved by 7,8 dB compared to STANDARD and by 4,3 dB compared to DuoPhone (Fig.4). Both results are statistically significant ($p < 0.005$). DuoPhone provides better speech intelligibility than STANDARD (SRT improvement of 3,5 dB) but without statistical significance
- Adult-Study:** Loudness, sound quality, listening effort and overall impression are rated statistically significant (up to 6 points on a 10 points scale) better when using the DECT condition compared to both acoustical coupling methods.
- Adult-Study:** Figure 5 demonstrates that finding the best receiver position for the best phone signal was rated as significantly less effort with the DECT condition than with both acoustical conditions. This possibly leads to the high overall satisfaction with the DECT condition as finding the correct position of the telephone receiver (easily) is crucial.
- Adult-Study:** TDT is a valuable test to determine speech understanding on the phone.

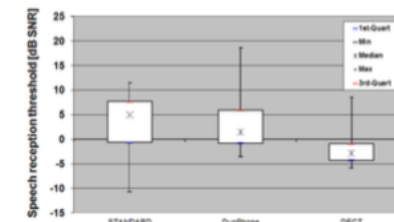


Figure 4 SRT for 50% correct digit recognition in adaptive noise for three different coupling conditions (STANDARD: monaural, DuoPhone & DECT: binaural)

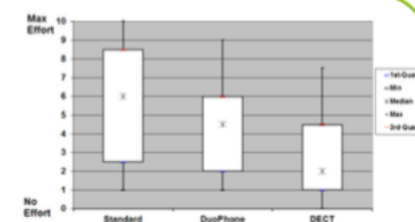


Figure 5 Subjects' ratings of the effort required to find a receiver position where they could hear well for all phone conditions on a scale of 0-10 for three different coupling conditions (STANDARD: monaural, DuoPhone & DECT: binaural)

Discussion and Conclusion

- In both studies participants showed substantial benefit when using a wireless routing of the telephone signal to the contra-lateral ear and so making use of the better ear effect.
- The **inductive coupling** method used for the child groups seems to be advantageous as these groups provide statistically significant improvements in speech intelligibility. Using **acoustical coupling** does not show such clear results as it is dependent on the correct position of the telephone receiver to the hearing aids. This observation confirms findings from Holmes and Chase (1985) who showed that holding the phone receiver only 2.5 cm away from the optimum location can potentially decrease the output of the telephone signal by 15 dB.
- Overall the improvements found in both studies are in line with findings from Picou & Ricketts (2011; 2013) and Kiessling et al. (2013). The difference in this study is that a wireless system was used that does not require a body worn streamer as the signal is directly routed from the telephone ear to the contralateral ear. This makes the handling much more comfortable.
- The use of a **special DECT phone** which couples the speech signal into the hearing aids by means of an inductive, digitally coded signal provides even better speech intelligibility and even less handling effort.

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