Individuelle Verifikation und Evaluation von drahtlosen akustischen Übertragungsanlagen

Individual Verification and Evaluation of Wireless Remote Microphone Systems

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Many thanks to all having participated (random order) …

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Guideline by the Europäische Union der Hörakustiker e.V. (EUHA)

Wireless remote microphone systems – configuration, verification and measurement of individual benefit (Guideline 04-06)
1. Introduction

Wireless remote microphone systems (WRMS) [1-2]

- **Source:** Speaker with remote microphone
- **Coupling to the hearing impaired,** e.g. by the hearing aids

Wireless (nonacoustic) transmission of the audio signal
1. Introduction

- Wireless remote microphone systems (WRMS) [3-6]
  - can increase the signal-to-noise ratio (SNR)
  - and can reduce effects of the room acoustics (reducing reverberation).
1. Introduction

- Consequently, wireless remote microphone systems (WRMS) [1-4]
  - can not only improve speech intelligibility
  - but can also reduce listening effort
- People with and without hearing impairment can benefit from a WRMS [13]
- For hearing impaired children, it can be a great support in school [14]

- However, to this end, it is required that the transfer characteristic is correctly adjusted. [14]
1. Introduction

2. Configuration and verification of the transfer characteristic

3. Evaluation of the individual benefit

4. Summary and outlook
2. Configuration and verification of the transfer characteristic

a) What is an appropriate transfer characteristic?
b) How can we verify the transfer characteristic?
2. Configuration and verification of the transfer characteristic

- Using a WRMS means for the user that two signals are mixed together

  - What is a good ratio between the signal of the remote microphone and signals in the environment of the user (i.e. for hearing aids the signal of the hearing aid microphone)?

![Diagram showing transmitter and receiver with signal levels 80 dB and 65 dB]
2. Configuration and verification of the transfer characteristic

Ratio between the signal of the remote microphone and environmental signals:

- Too soft
  - The remote microphone signal is masked by environmental sounds and background noise
  - The positive effect of the WRMS is lost

- Too loud
  - No awareness of environmental sounds (e.g. speech from the audience or a neighbor)
  - Total isolation so that no communication with other people than the speaker is possible

- Goal
  - The voice of the speaker should be dominant whereas environmental sounds are still noticeable
2. Configuration and verification of the transfer characteristic

- Suggestion by the ASHA – 10 dB FM advantage [7]
  - The signal of the speaker should be experienced 10 dB louder than environmental sounds, which are assumed to be at 65 dB SPL (before amplification)
2. Configuration and verification of the transfer characteristic

a) What is an appropriate transfer characteristic?

b) How can we verify the transfer characteristic?
2. Configuration and verification of the transfer characteristic

For the verification, e.g. speech signals are presented at the remote microphone and at the hearing aid.
2. Configuration and verification of the transfer characteristic

- For the verification, e.g. speech signals are presented at the remote microphone and at the hearing aid.
- Usually the hearing aid and the remote microphone include a compression of the audio signal.
- It is required that both signals are presented simultaneously.

- Due to the superposition of both signals, the evaluation of the output signal is difficult.
2. Configuration and verification of the transfer characteristic

- As an alternative, the (acoustical) transparency of the WRMS can be checked at 65 dB SPL.
- (Acoustical) Transparency means that an input signal at 65 dB at the remote microphone results in the same output signal as environmental signal of 65 dB.

Using the same operation point, allows for a sequential measurement.
2. Configuration and verification of the transfer characteristic

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2. Configuration and verification of the transfer characteristic

- Checking the transparency is no direct verification of the 10 dB FM advantage
- However, it is practicable check, which result in transfer characteristic probably near to the 10 dB FM advantage
1. Introduction
2. Configuration and verification of the transfer characteristic
3. Evaluation of the individual benefit
4. Summary and outlook
3. Evaluation of the individual benefit

- As shown in the introduction, the benefit of WRMS is well documented and widely accepted
- Nevertheless, an individual and objective evaluation of the benefit is helpful and sometimes indispensable, e.g.
  - To demonstrate the benefits to the patient
  - To get reimbursement
  - To check the functionality
  - To compare different systems

- The main application of a WRMS is in a class or lecture room, which is in most cases not available for tests, e.g. in the office of an hearing aid professional

- How can we realistically and practically measure the individual benefit of a WRMS?
3. Evaluation of the individual benefit

- Class room situation can be emulated with a simplified setup [8-9]
  - dual-channel speech audiometer
  - 3 speakers
3. Evaluation of the individual benefit

- Class room situation can be emulated with a simplified setup
  - dual-channel speech audiometer
  - 3 speakers
3. Evaluation of the individual benefit

- Main differences to the ideal situation

<table>
<thead>
<tr>
<th></th>
<th>Ideal situation, which is emulated</th>
<th>Approximations of the simplified setup</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distance</strong></td>
<td>Listener is 4 m away from the speaker</td>
<td>Sound pressure level is adapted to match the level at 4 m</td>
</tr>
<tr>
<td><strong>Signal source</strong></td>
<td>Human speaker</td>
<td>Loud speaker</td>
</tr>
<tr>
<td><strong>Background noise</strong></td>
<td>Diffuse and homogeneous background noise</td>
<td>Presentation of noise from ±45°</td>
</tr>
<tr>
<td><strong>Position of the remote microphone</strong></td>
<td>Near the moth / around the neck</td>
<td>Fixed distance to the loud speaker with an adaptation of the sound pressure level for both situations (80 dB or 85 dB)</td>
</tr>
</tbody>
</table>
3. Evaluation of the individual benefit

- However, a comparison with a real classroom situation shows good agreement [15]
3. Evaluation of the individual benefit

However, a comparison with a real classroom situation shows good agreement [15].

<table>
<thead>
<tr>
<th>Cond.</th>
<th>WRMS</th>
<th>Background noise level</th>
<th>Microphone characteristic of the hearing aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>60 dB SPL</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>60 dB SPL</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>65 dB SPL</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>70 dB SPL</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>70 dB SPL</td>
<td>Directional</td>
</tr>
</tbody>
</table>
3. Evaluation of the individual benefit

- The setup can clearly demonstrate the individual benefit of a WRMS [10, 12]
- A comparison of different WRMS is possible (here with noise at 60 dB SPL)
3. Evaluation of the individual benefit

- With increasing noise level, the advantages of the digital systems over the analog system become more clear [10, 12]
3. Evaluation of the individual benefit

- The subjective evaluation shows high preference of the digital systems [10, 12]
1. Introduction
2. Configuration and verification of the transfer characteristic
3. Evaluation of the individual benefit
4. Summary and outlook
4. Summery and outlook

- WRMS can be great support especially for hearing impaired children in school
- To this end, it is important that the transfer characteristic is adjusted appropriately
- The transfer characteristics can be checked and adjusted by measuring the transparency of the WRMS
- An individual and objective evaluation of the benefit of a WRMS is helpful and sometimes indispensable
- A simplified setup can be used that is applicable with moderate effort and still provides realistic results

- A detailed guideline is provided by the Europäische Union der Hörakustiker e.V. (EUHA) as free download
  - Wireless remote microphone systems – configuration, verification and measurement of individual benefit (Guideline 04-06)
Thank you for your attention!

Deutsch:  

English:  
References


