Individuelle Verifikation und Evaluation von drahtlosen akustischen Übertragungsanlagen

Individual Verification and Evaluation of Wireless Remote Microphone Systems

6. Europäische Pädakustik-Konferenz

6th European Pediatric Conference

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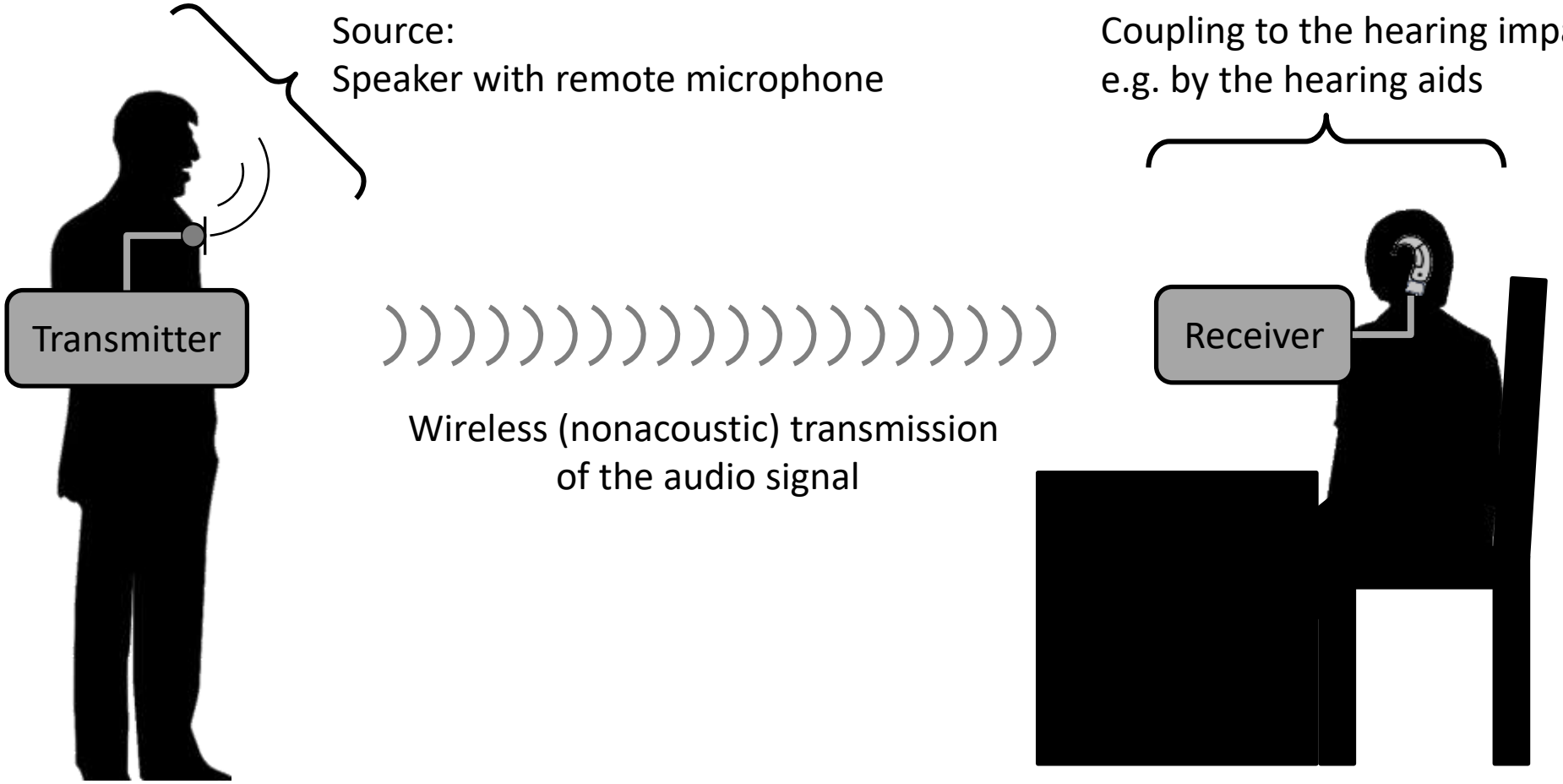
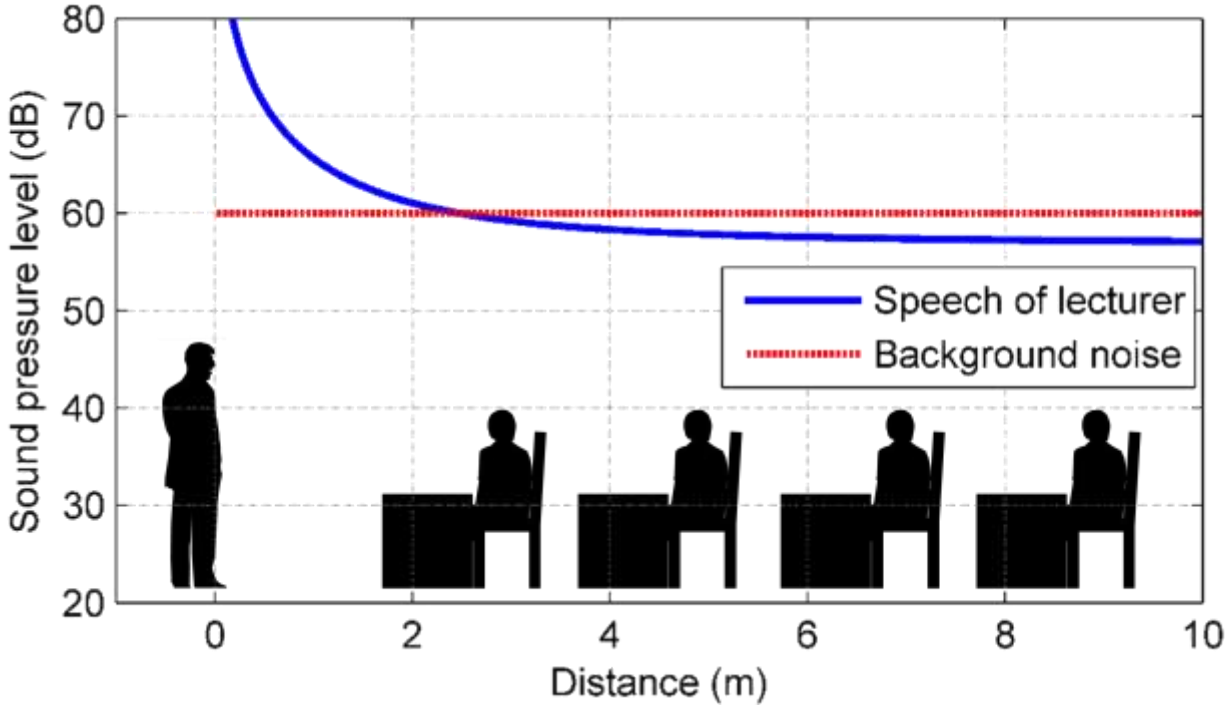
➡ Guideline by the *Europäische Union der Hörakustiker e.V. (EUHA)*
Wireless remote microphone systems – configuration, verification and measurement of individual benefit (Guideline 04-06)

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

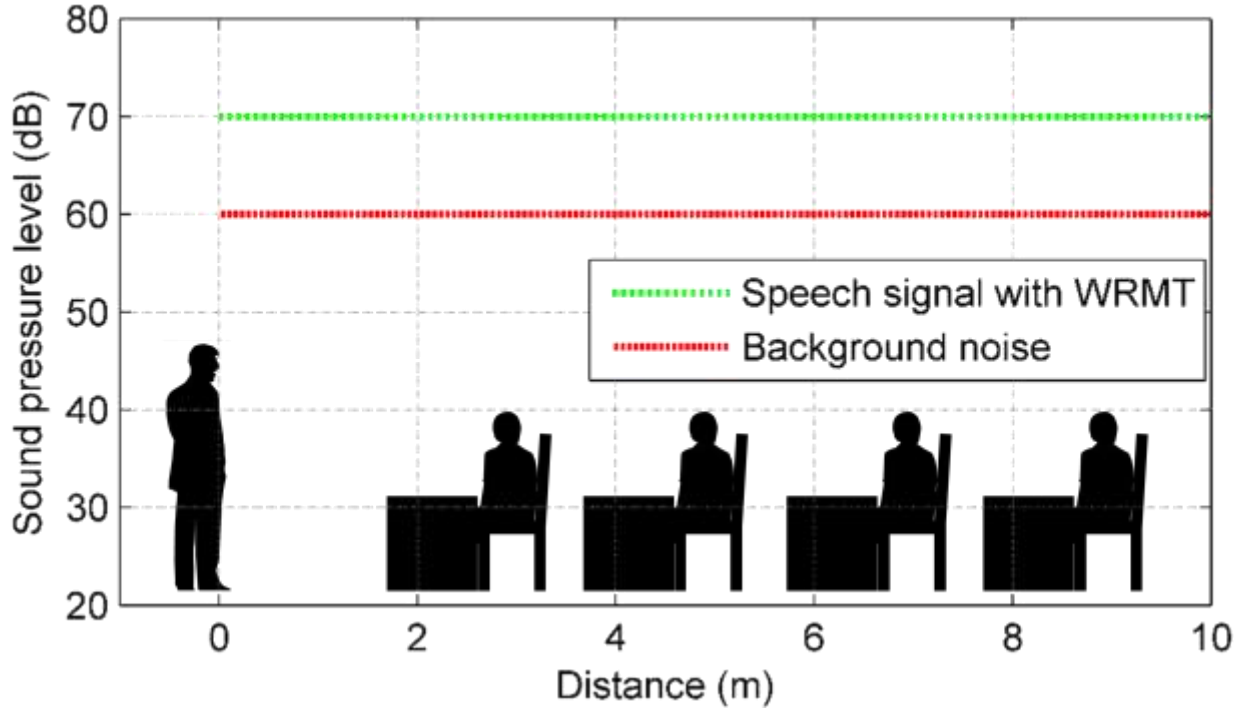


- Wireless remote microphone systems (WRMS) [3-6]
  - can increase the signal-to-noise ratio (SNR)
  - and can reduce effects of the room acoustics (reducing reverberation).

Without WRMS



With WRMS



- 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]**

Agenda

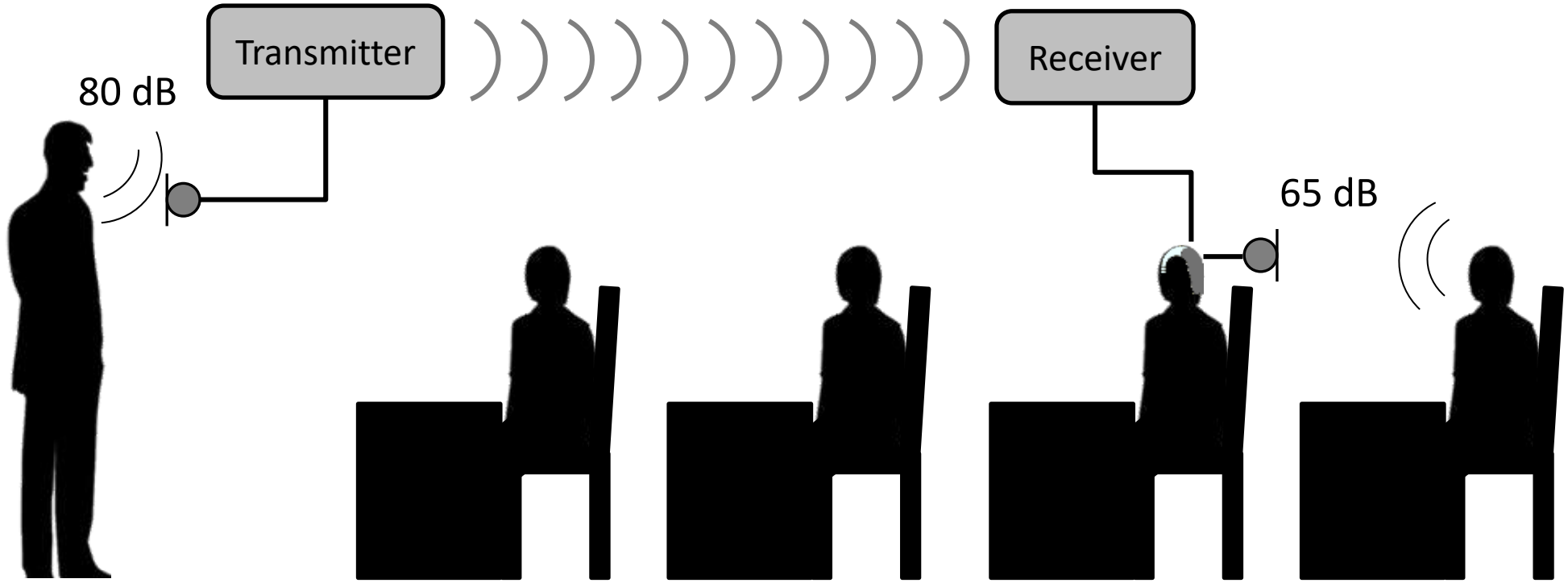
1. Introduction
2. Configuration and verification of the transfer characteristic
3. Evaluation of the individual benefit
4. Summary and outlook

2. Configuration and verification of the transfer characteristic

a) What is an appropriate transfer characteristic?

b) How can we verify the transfer characteristic?

- 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)?



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

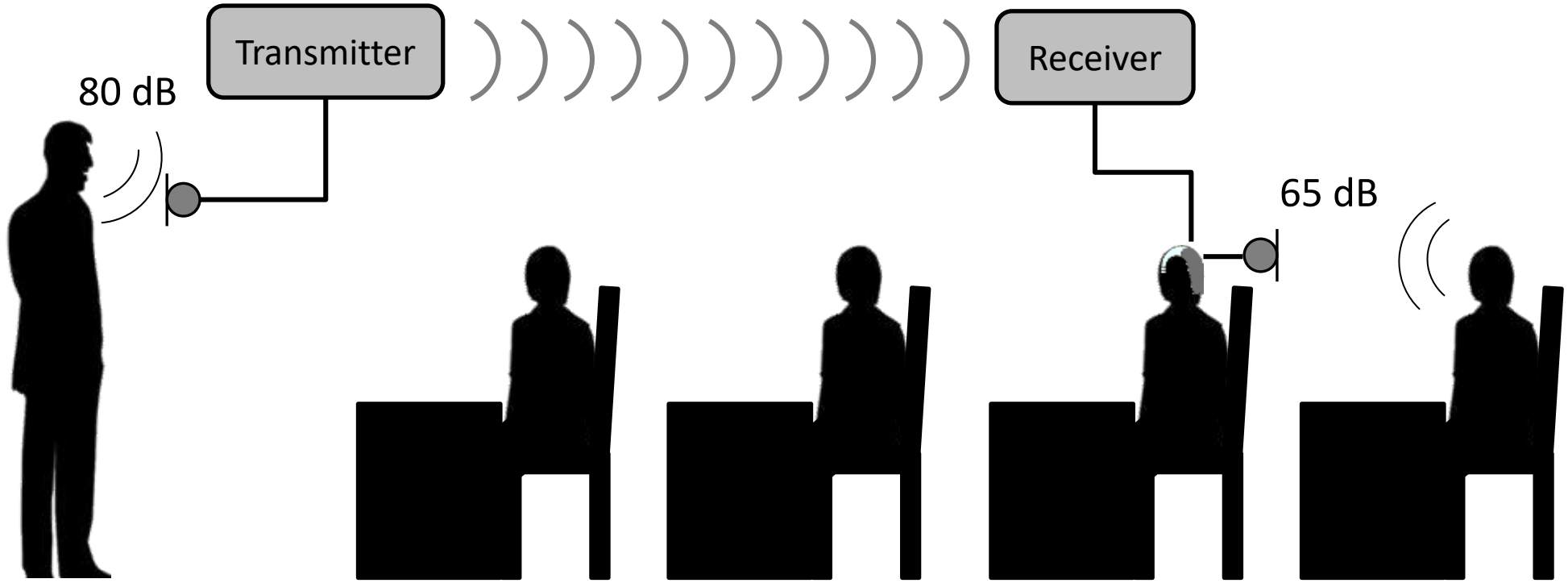
- ❑ Too soft
  - ➢ The remote microphone signal is masked by environmental sounds an background noise
  - ➢ The positive effect of the WRMS is lost

- ❑ 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

❑ 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)



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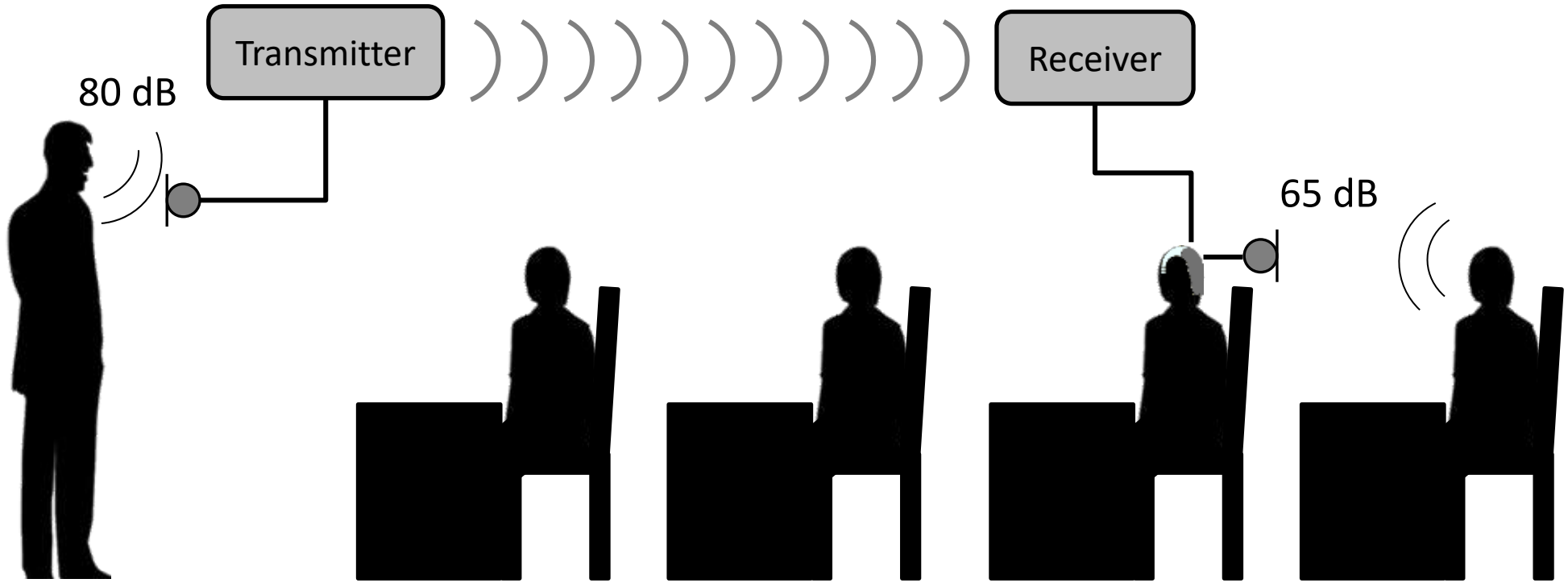
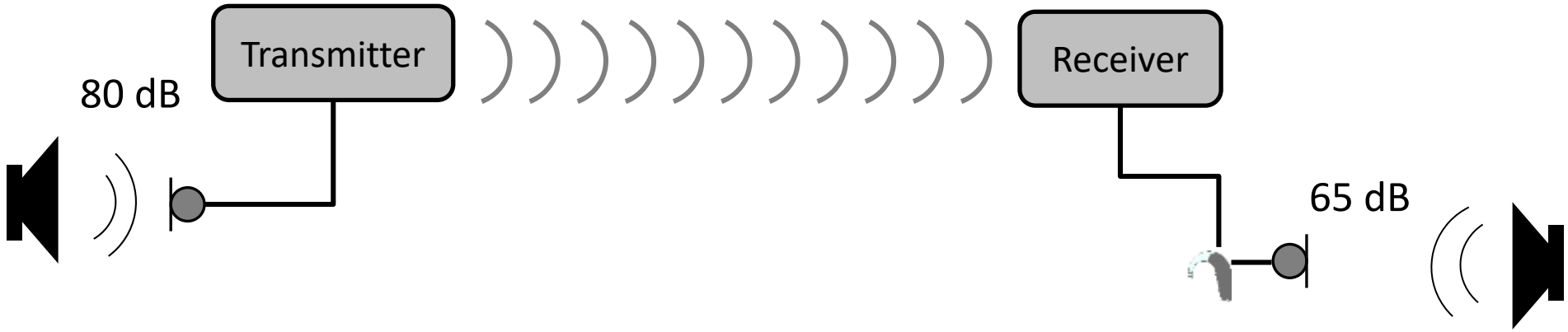
- For the verification, e.g. speech signals are presented at the remote microphone and at the hearing aid

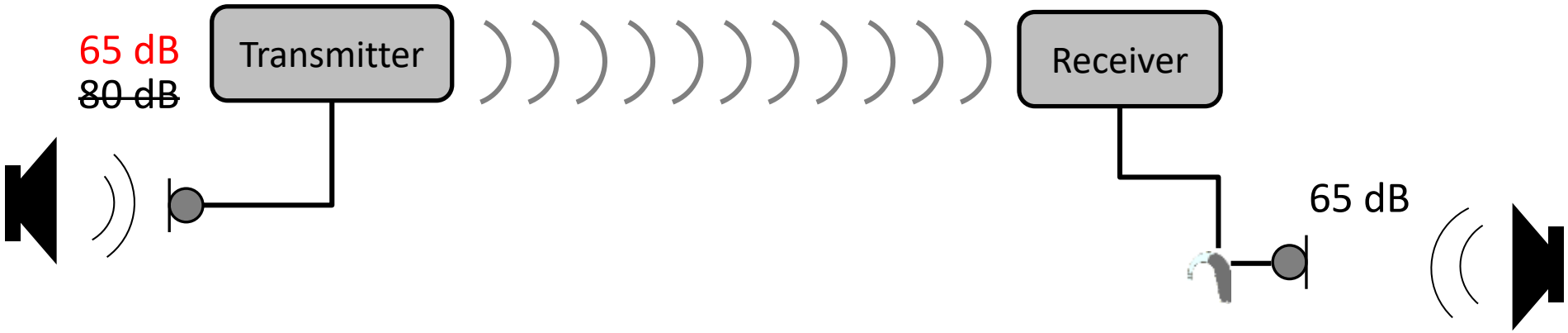


- For the verification, e.g. speech signals are presented at the remote microphone and at the hearing aid
- Usually the hearing aid and the remote microphone include a compression of the audio signal
- It is required that both signals are presented simultaneously



- **Due to the superposition of both signals, the evaluation of the output signal is difficult.**

- 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.**

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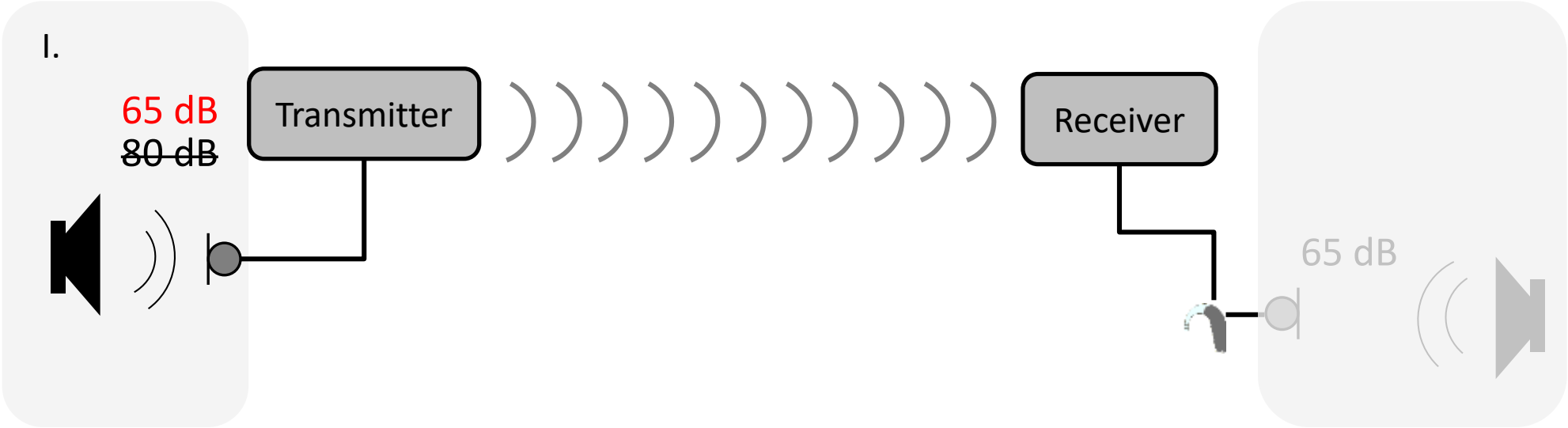

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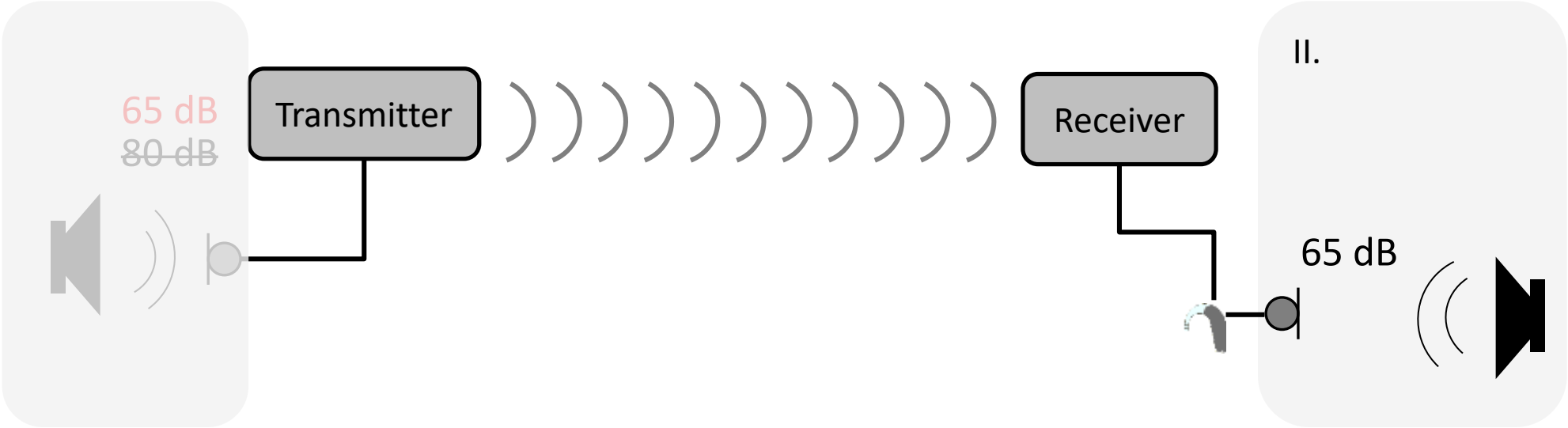
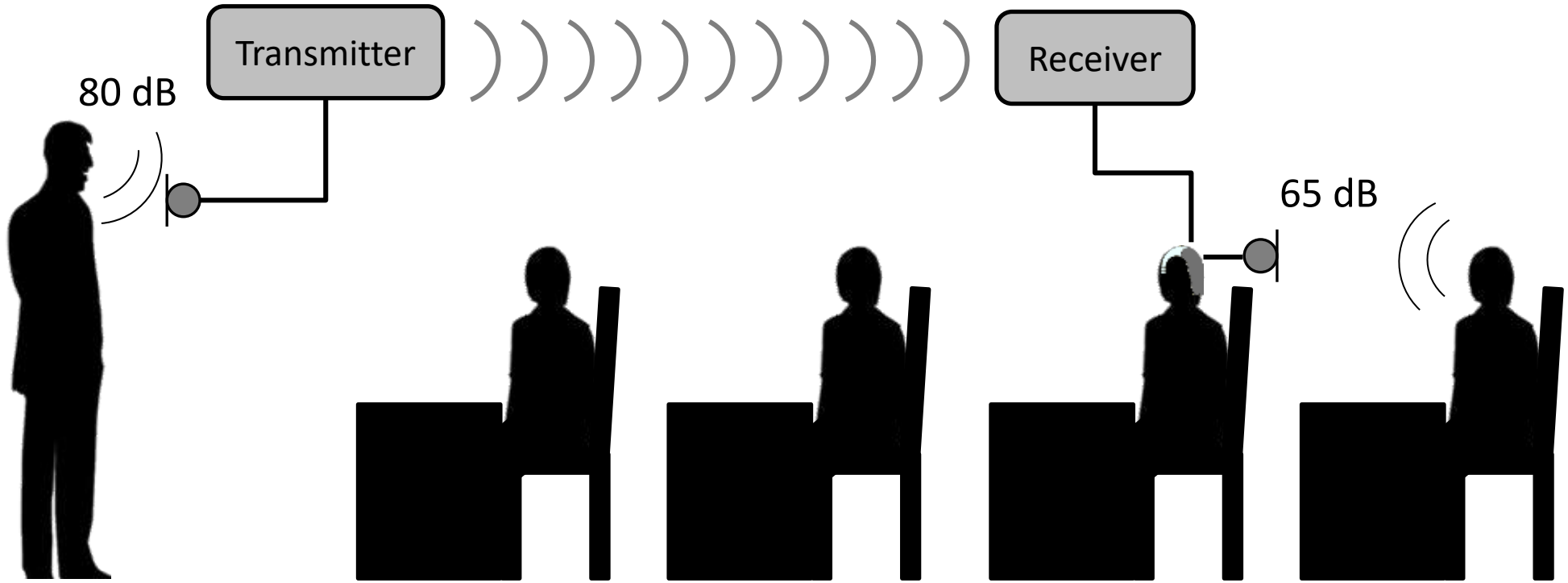


- **Using the same operation point, allows for a sequential measurement.**

- 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



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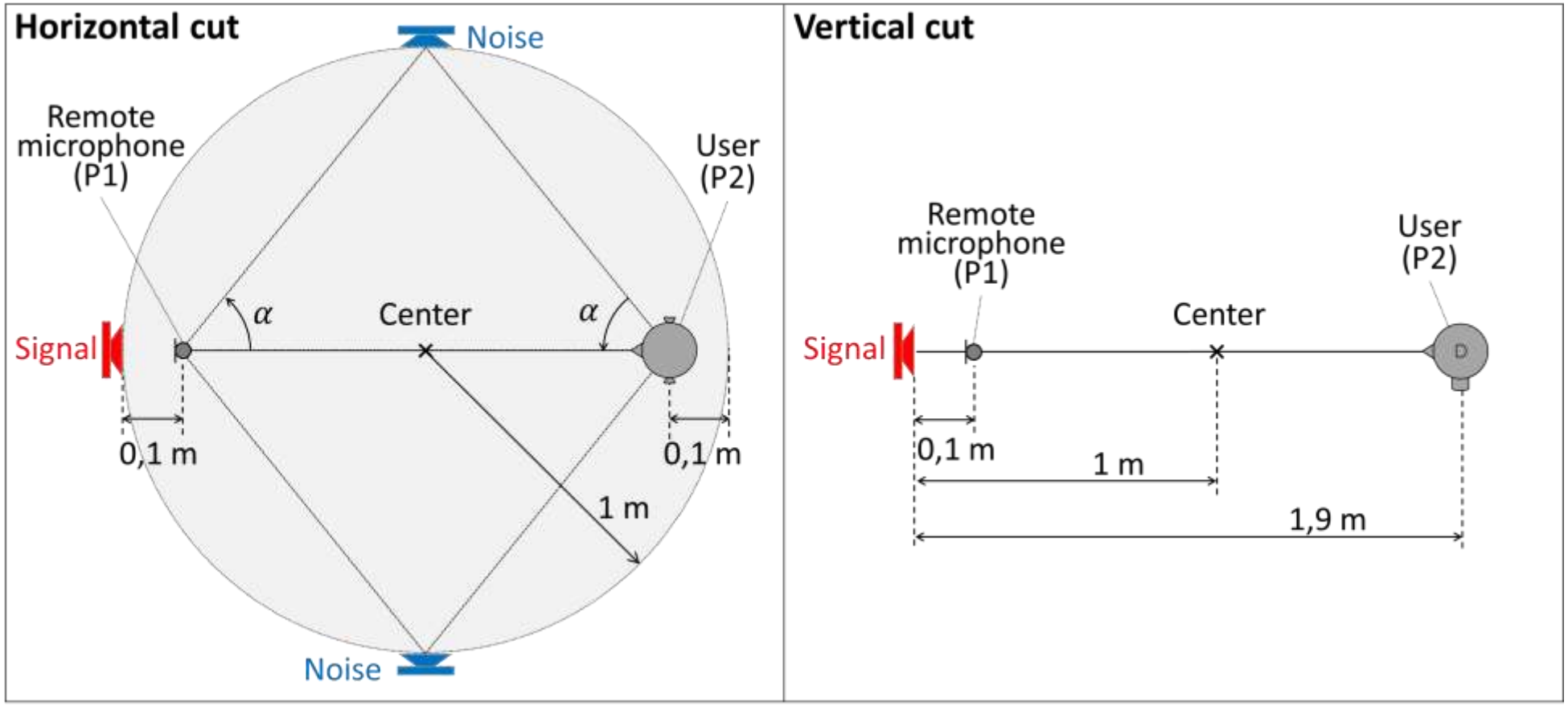
- As shown in the introduction, the benefit of WRMS is well documented and widely accepted
- Nevertheless, an individual and objective evaluation of the benefit is helpful and sometimes indispensable, e.g.
  - To demonstrate the benefits to the patient
  - To get reimbursement
  - To check the functionality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

- Class room situation can be emulated with a simplified setup [8-9]
  - dual-channel speech audiometer
  - 3 speakers

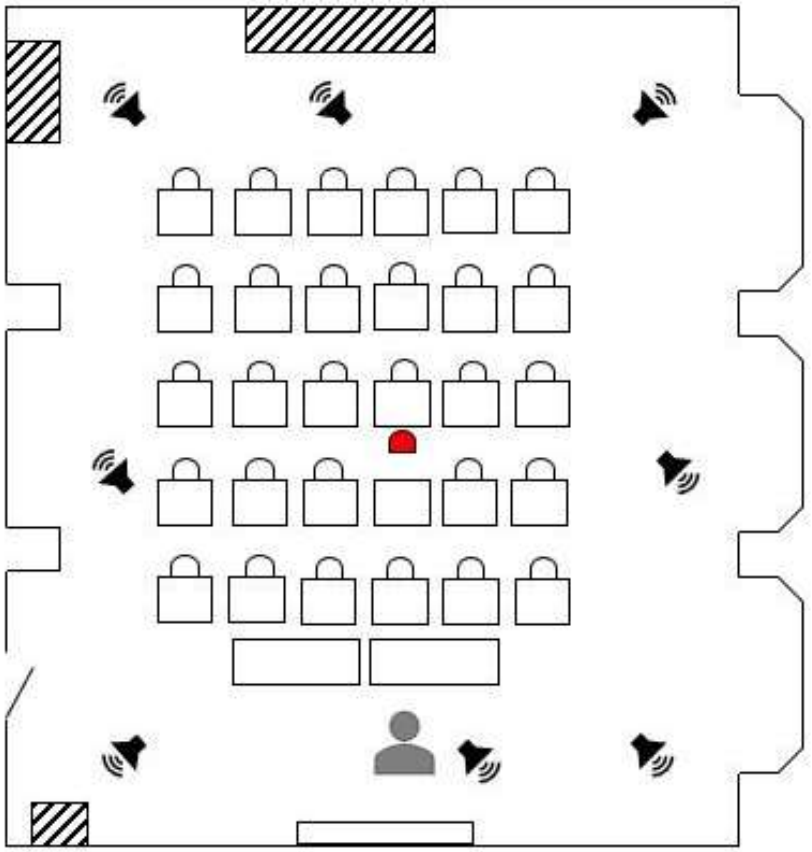


- Class room situation can be emulated with a simplified setup
  - dual-channel speech audiometer
  - 3 speakers

❑ Main differences to the ideal situation

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

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



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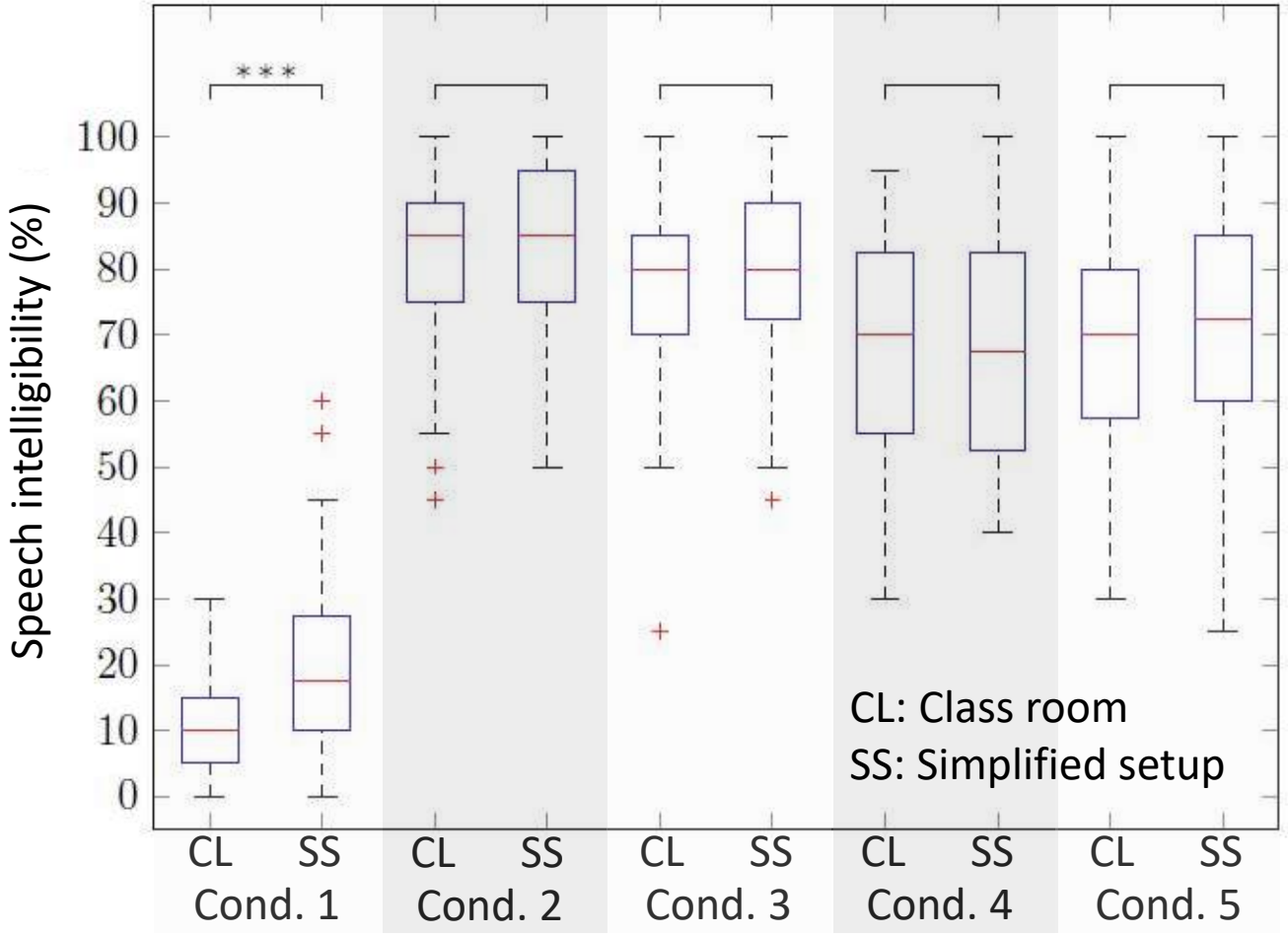
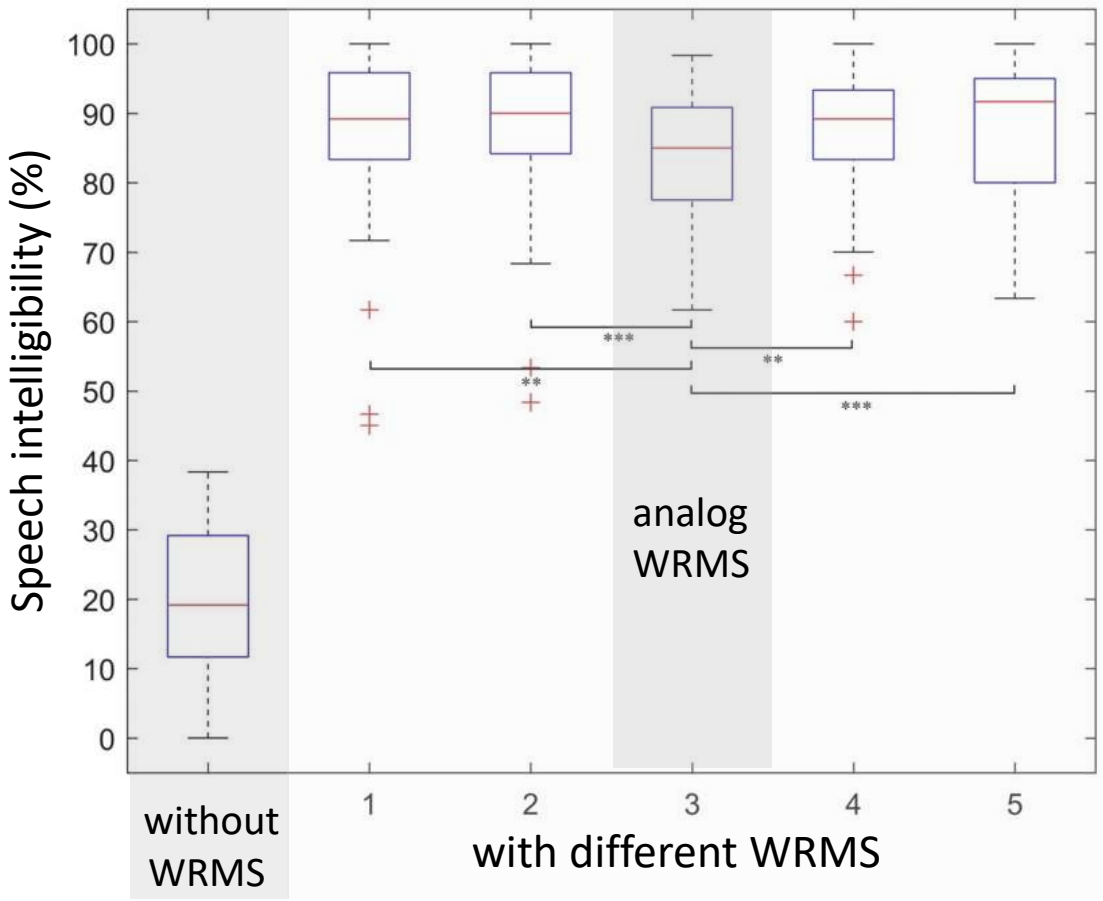
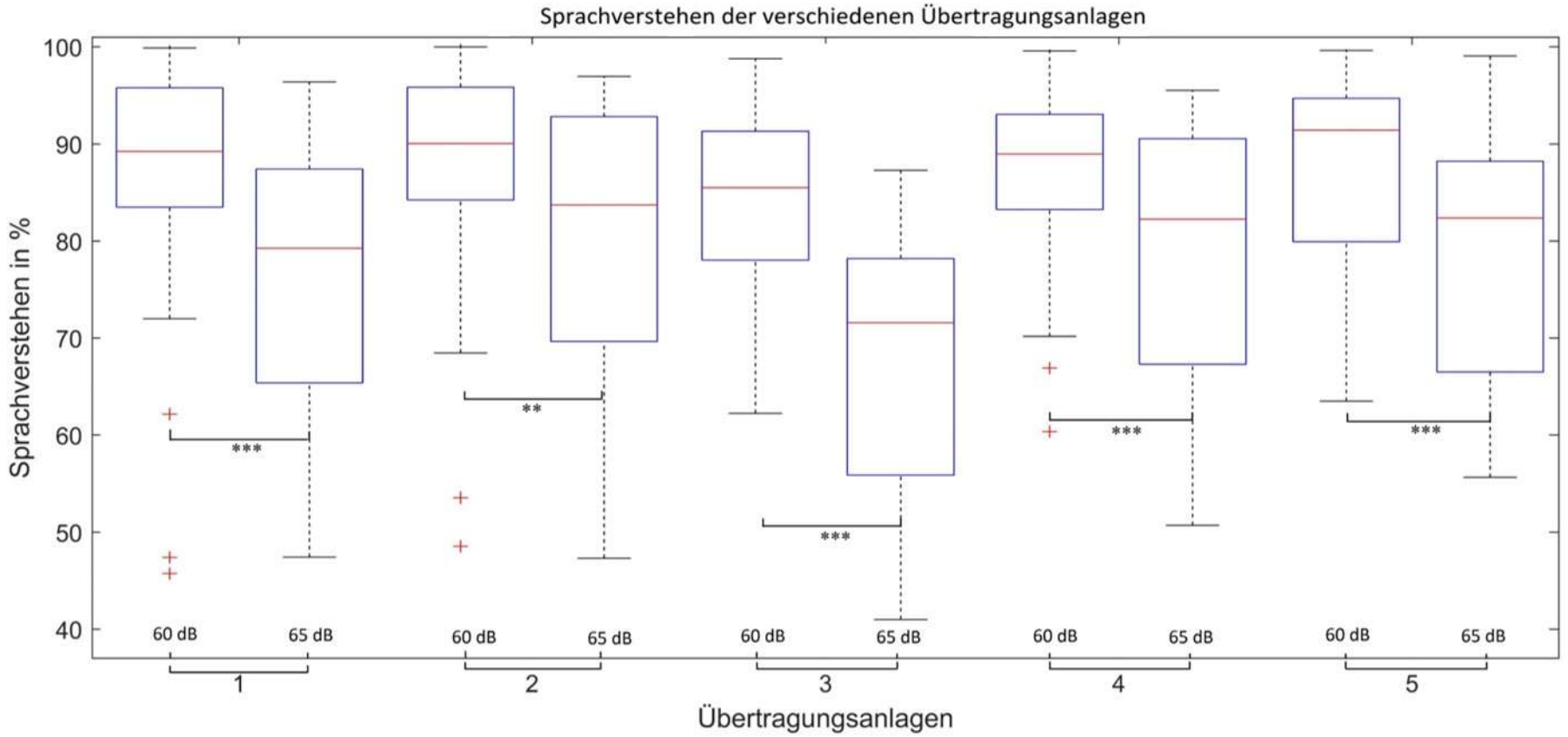


Cond.	WRMS	Bachgroudn noise level	Microphone characteristic of the hearing aids
1	No	60 dB SPL	Omnidirectional
2	Yes	60 dB SPL	Omnidirectional
3	Yes	65 dB SPL	Omnidirectional
4	Yes	70 dB SPL	Omnidirectional
5	Yes	70 dB SPL	Directional

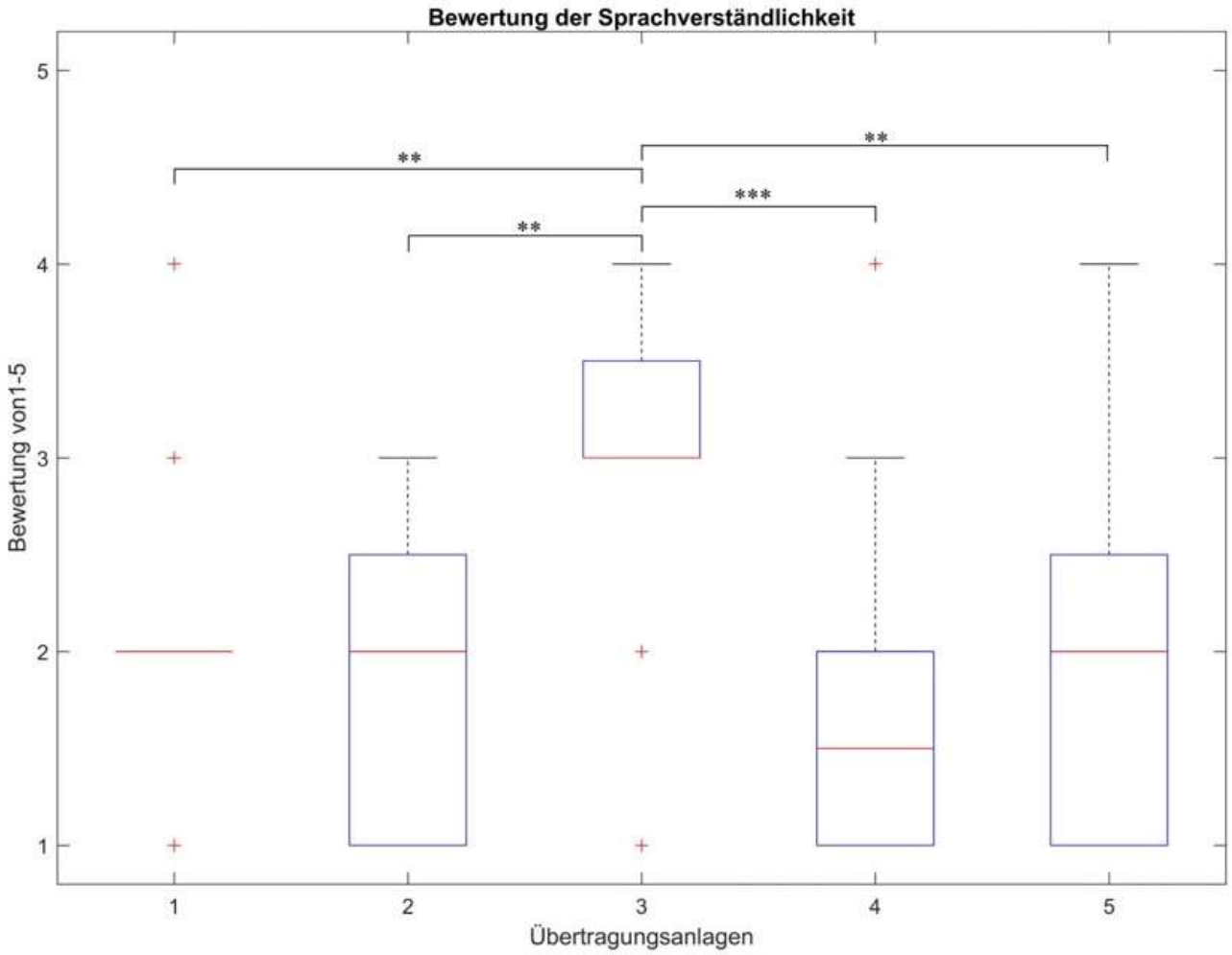
- ❑ The setup can clearly demonstrate the individual benefit of a WRMS [10, 12]
- ❑ A comparison of different WRMS is possible (here with noise at 60 dB SPL)



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



❑ The subjective evaluation shows high preference of the digital systems [10, 12]



5: „very unsatisfied“

4: „unsatisfied“

3: „neutral“

2: „satisfied“

1: „very satisfied“

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- ❑ 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:
http://www.euha.org/assets/Uploads/Leitlinien/Expertenkreis-04-Hoerakustik/EUHA-Leitlinie-04-06-de.pdf

English:
http://www.euha.org/assets/Uploads/Leitlinien/Expertenkreis-04-Hoerakustik/EUHA-Guideline-04-06-en.pdf

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[12] Christina Fitschen, Hendrik Husstedt, „Vergleich des Sprachverstehens bei verschiedenen drahtlosen Übertragungsanlagen“, Hörakustik WIRELESS-Special, Ausgabe 5/2017

[13] Hendrik Husstedt, Christina Fitschen, „Nutzens von drahtlosen akustischen Übertragungsanlagen bei Menschen ohne Hörbeeinträchtigung“, 21. DGA-Jahrestagung, Halle, Deutschland, Februar 2018

[14] Marlitt Frenz, Markus Westerheide, Carsten Gregor, Carolina Zöller, Lena Möllerberndt, Hendrik Husstedt, „Überprüfung der drahtlosen akustischen Übertragungsanlagen von hörgeschädigten Schülern“, 21. DGA-Jahrestagung, Halle, Deutschland, Februar 2018

[15] Sebastian Griepentrog, Marlitt Frenz, Tim Jürgens, Hendrik Husstedt „Comparison of the Individual Benefit of a Wireless Remote Microphone System in the Laboratory with the Situation in a Classroom“, 22. DGA-Jahrestagung, Heidelberg, Deutschland, März 2019