



Hearing Aid Technology Today

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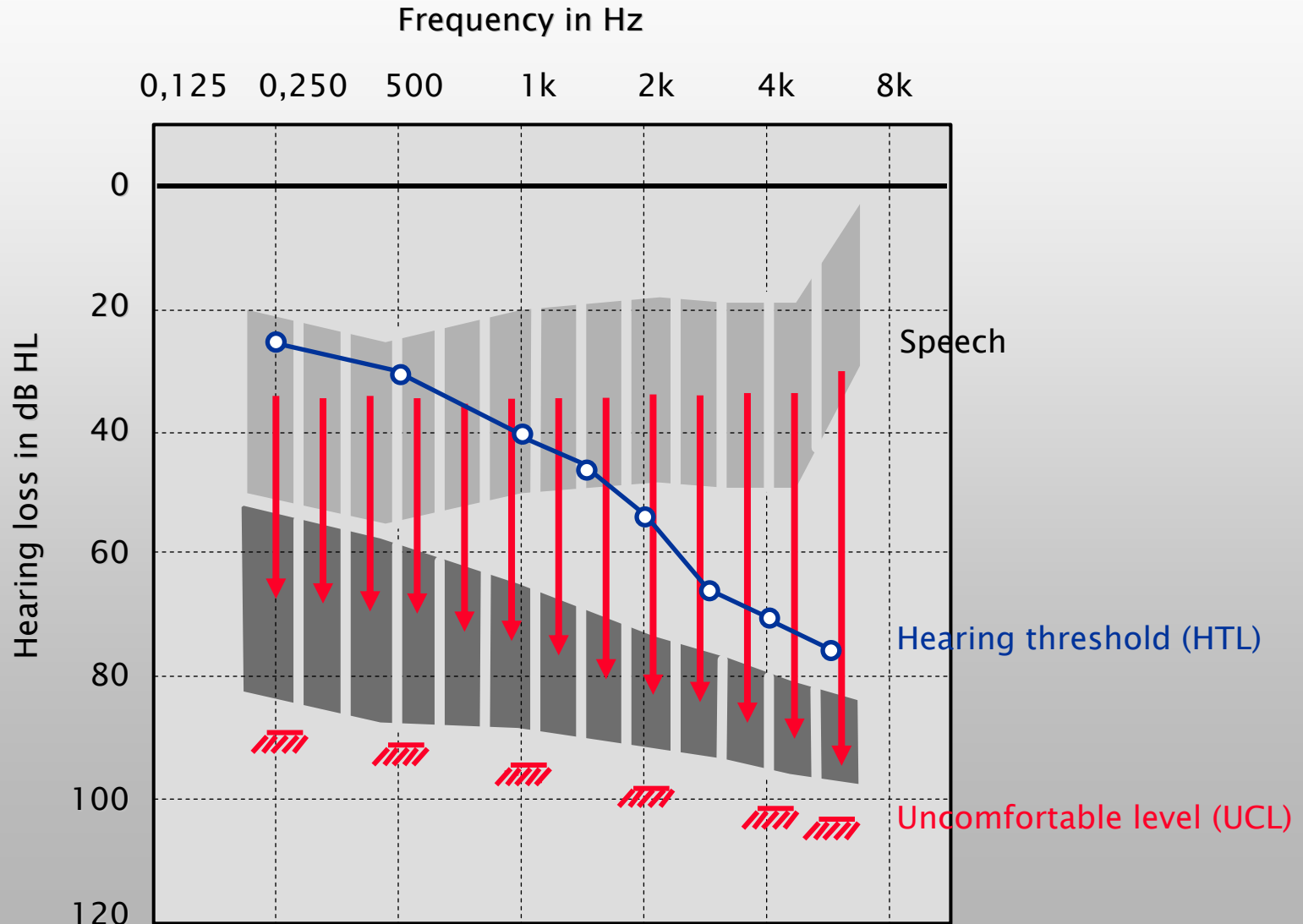
My Personal View



Jürgen Kießling
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Universitätsklinikum Gießen und Marburg, Standort Gießen

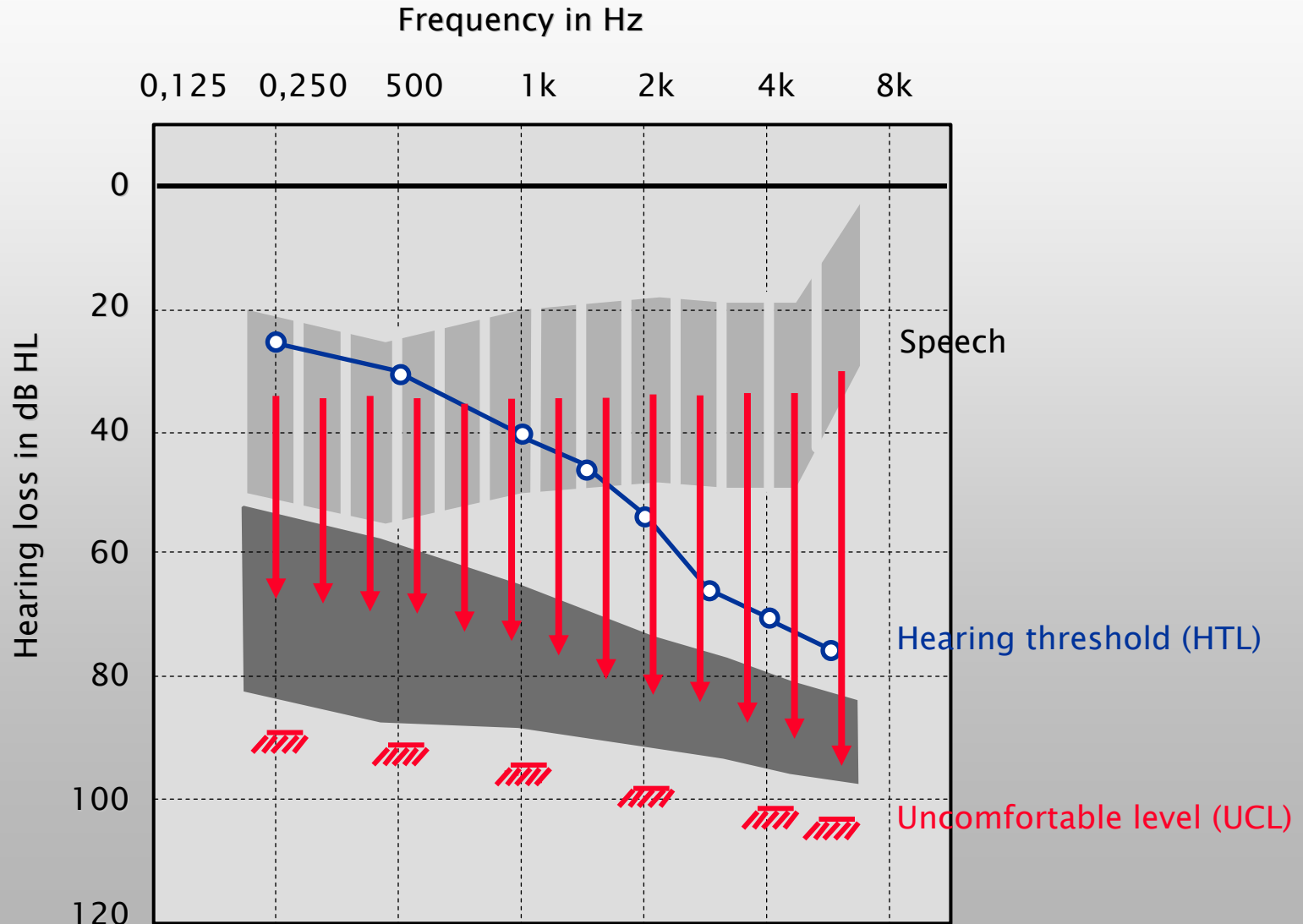
Basic hearing aid functions

Transformation of signal in residual dynamic range



Basic hearing aid functions

Transformation of signal in residual dynamic range



Special hearing aid features today

My priority list in terms of user benefit

1. Feedback suppression
Allows open fittings for most users,
i.e. no occlusion effect and better wearing comfort
 - Notch filters
 - Addition of antiphase noise
 - Bilateral algorithms
2. Noise reduction
 - One-microphone-approaches:
estimation of signal/noise, modulation analysis followed by
filtering, spectral subtraction, Wiener filter etc.
 - Multi-microphone-approaches:
directional microphones, beamformer
 - SNR improvement:
Wireless link to signal source, e.g. external microphone,
telephone, TV, HiFi, computer etc.
3. Listening programs/optimal settings for special environments
 - Manual switching
 - Automatic switching based on environmental detector & classifier
 - Self-learning systems (→ fitting)
4. Others

Special hearing aid features today

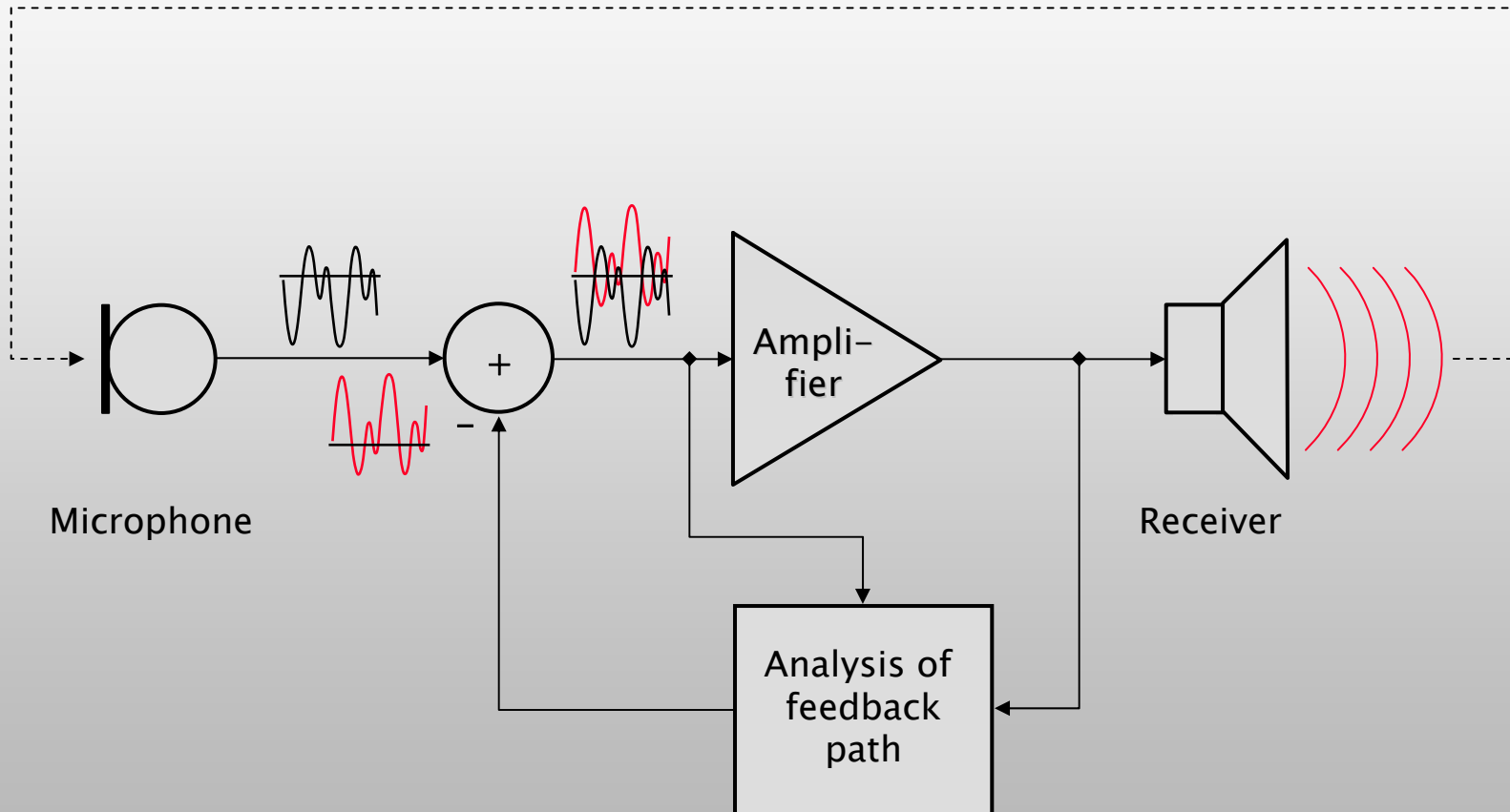
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Feedback suppression

One common option: addition of “antiphase noise”

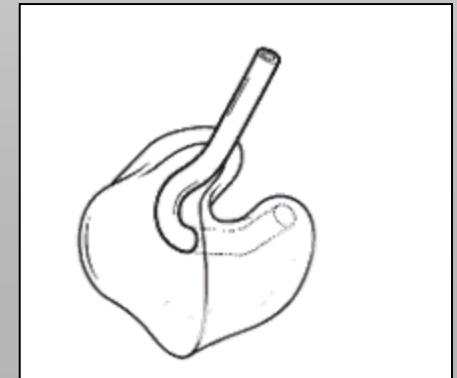
Acoustic feedback path



=> about 70 % of all users can be fit “open”

Open vs. traditional/closed fittings

My rating of benefit =>	Open fittings ★ ★ ★	Traditional/closed fittings ☆ ☆ ☆
Pros	<ul style="list-style-type: none">• Natural sound• Higher wearing comfort• Sufficient gain by efficient feedback suppression	<ul style="list-style-type: none">• Higher gain without feedback
Cons	<ul style="list-style-type: none">• Not feasible in users who need higher gain (i.e. not feasible in about 30 %)	<ul style="list-style-type: none">• Unnatural sound quality (occlusion effect)• Less wearing comfort



Open systems

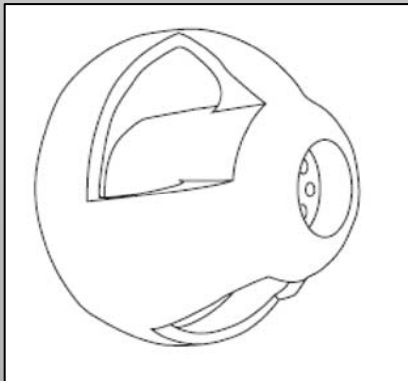
Micro tube system vs. receiver in the ear canal (RIC)



Option 1: Micro tube with open fitting (Open standard domes or open individual ear molds)



Option 2: External receiver in the ear canal with open fitting (Open standard domes or open individual ear molds)

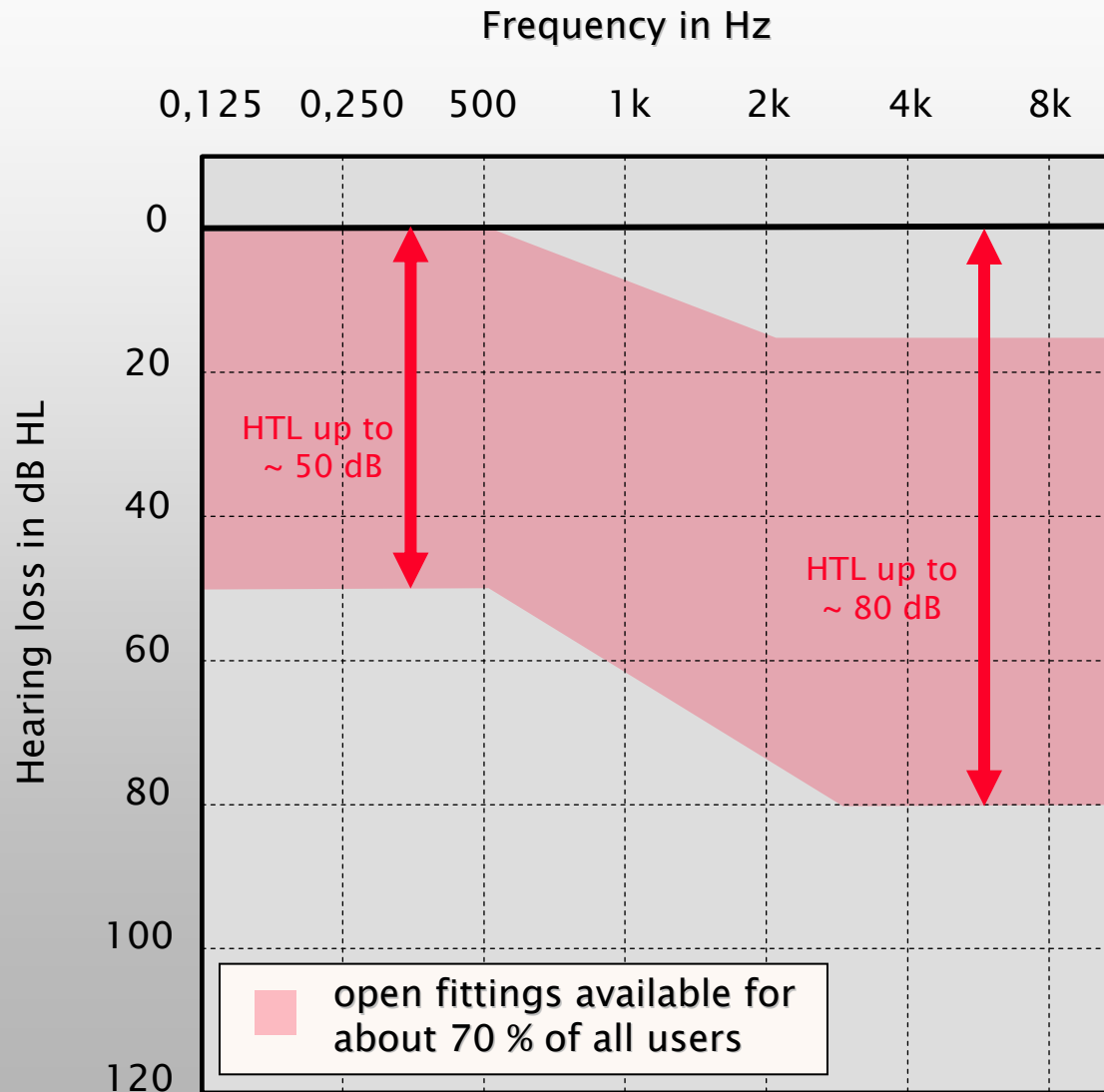


Micro tube systems vs. RIC systems

My rating of benefit =>	Micro tube systems ★★☆☆	Receiver-in-the-ear canal systems ★★☆☆
Pros	<ul style="list-style-type: none"> • Higher degree of openness • Fewer receiver defects 	<ul style="list-style-type: none"> • Less resonances (Flatter frequency response) • More gain in high frequencies
Cons	<ul style="list-style-type: none"> • Tube resonances • Less gain in high frequencies 	<ul style="list-style-type: none"> • Lower degree of openness • More frequently receiver defects



Fitting range of open systems



Special hearing aid features today

My priority list in terms of user benefit

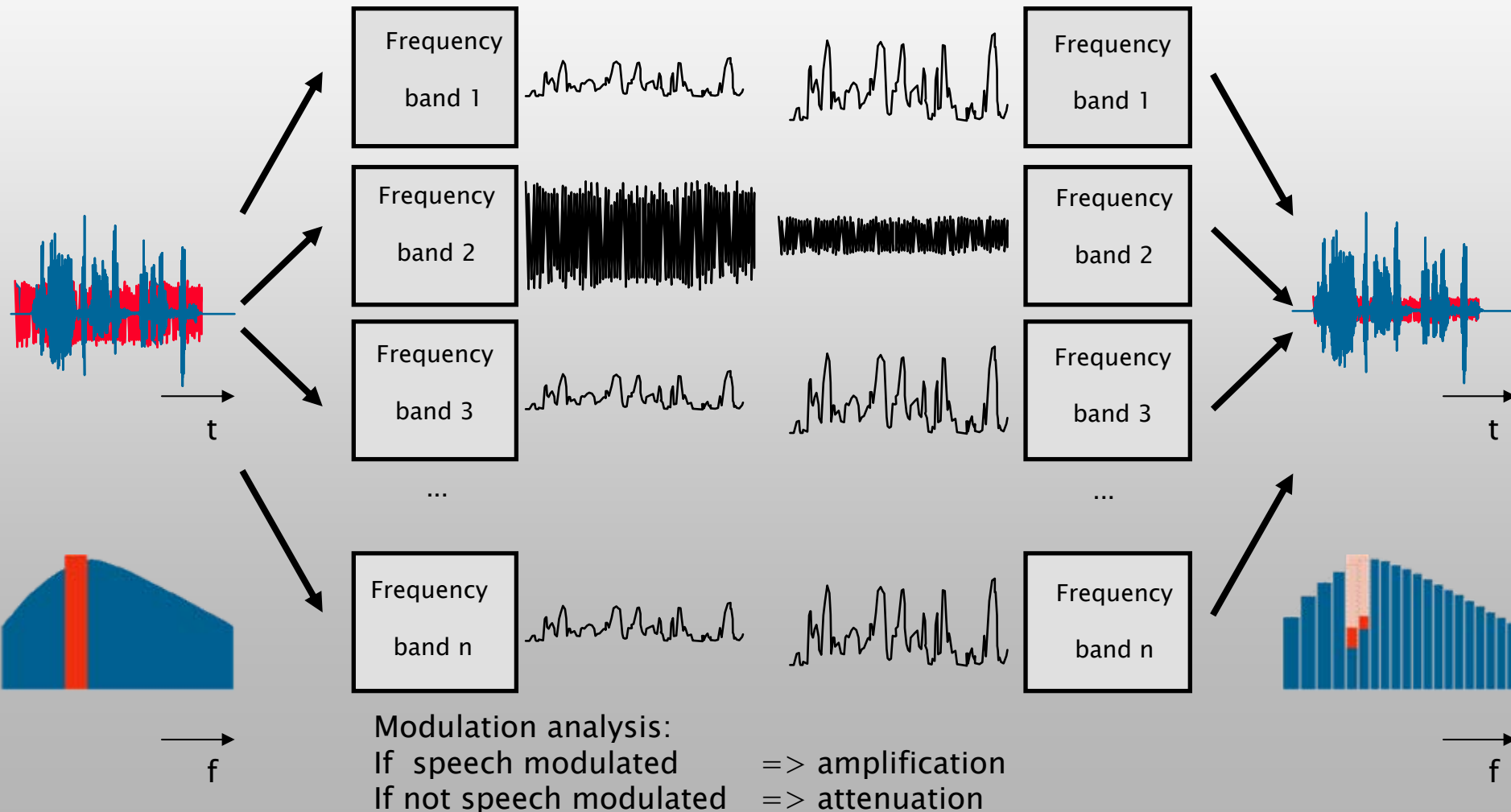
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Noise reduction

One common option: Modulation-based noise NR

Input signal:
Speech + noise

Output signal after
Signal processing



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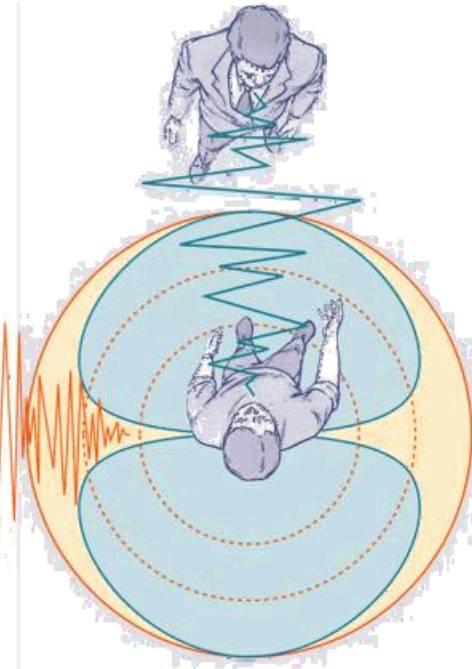
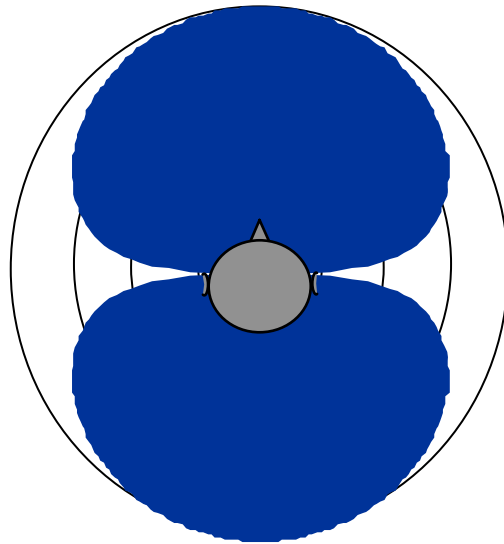
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Noise reduction by adaptive beamforming

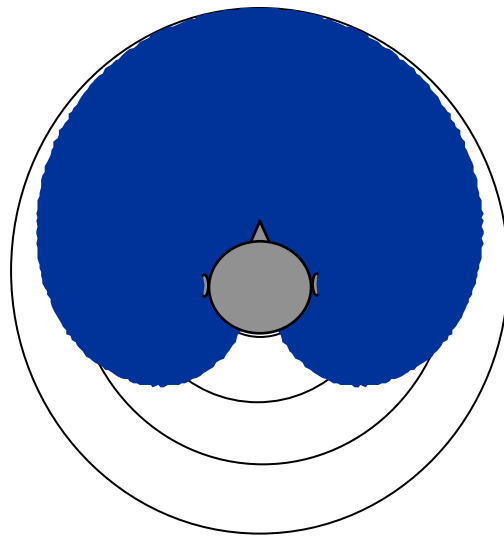
Adaptive beamforming:
attenuates the strongest noise source
in each frequency band

Major
noise source

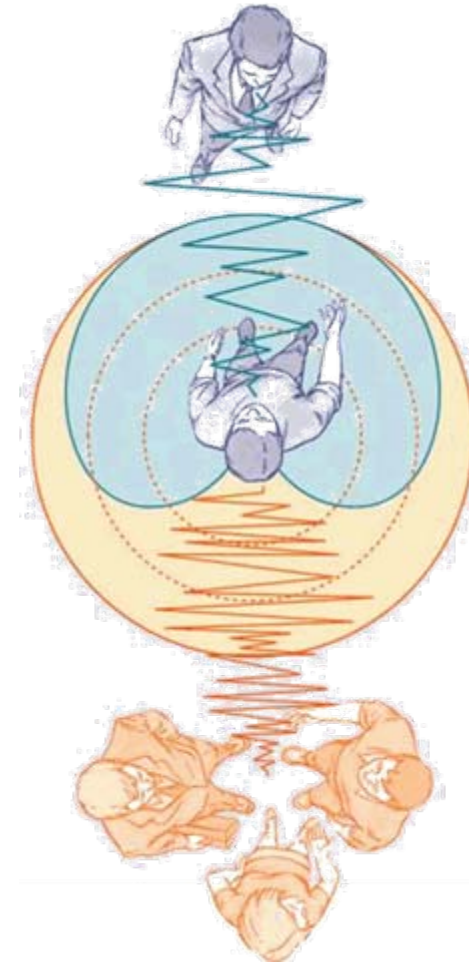


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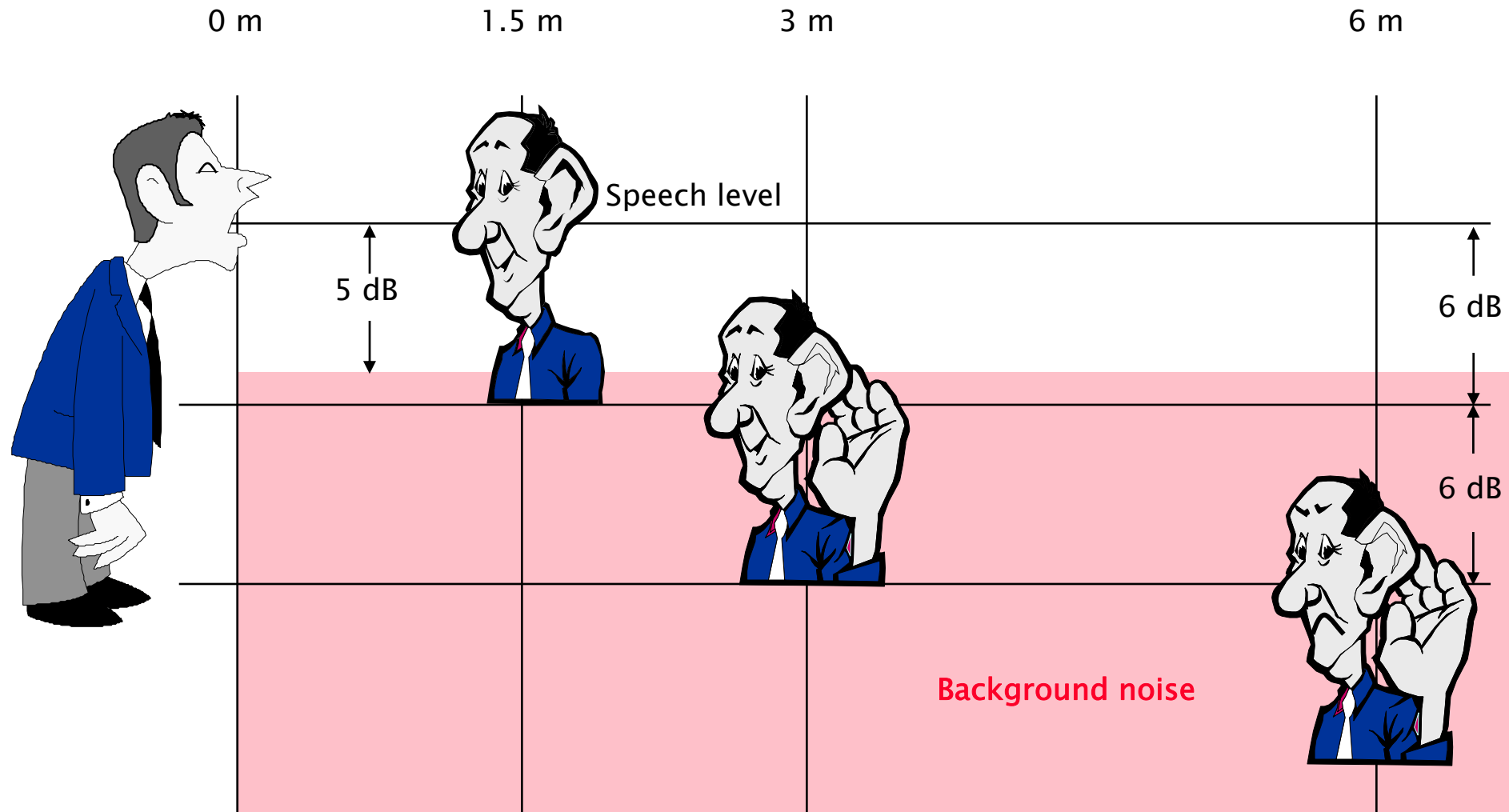


Special hearing aid features today

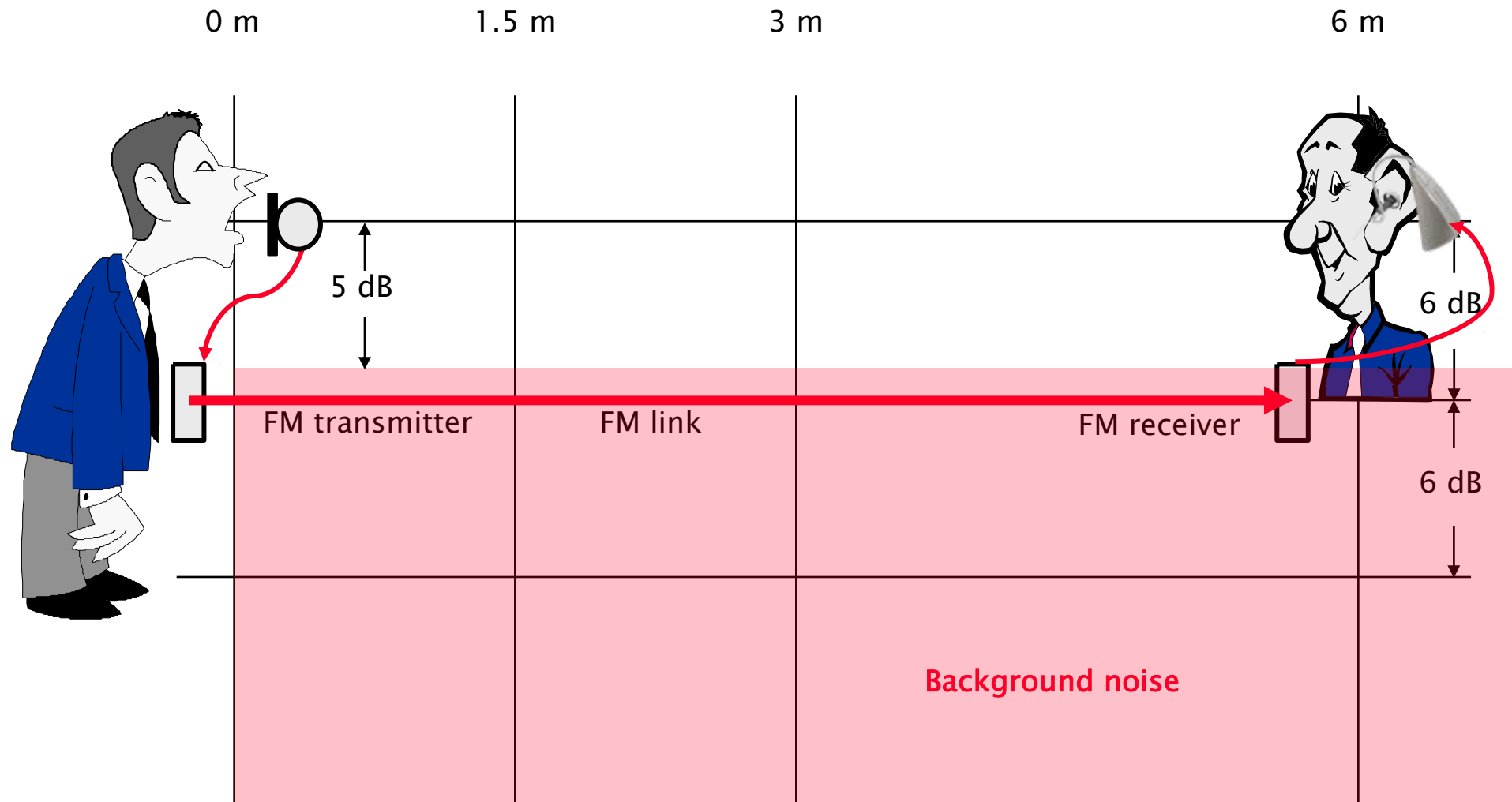
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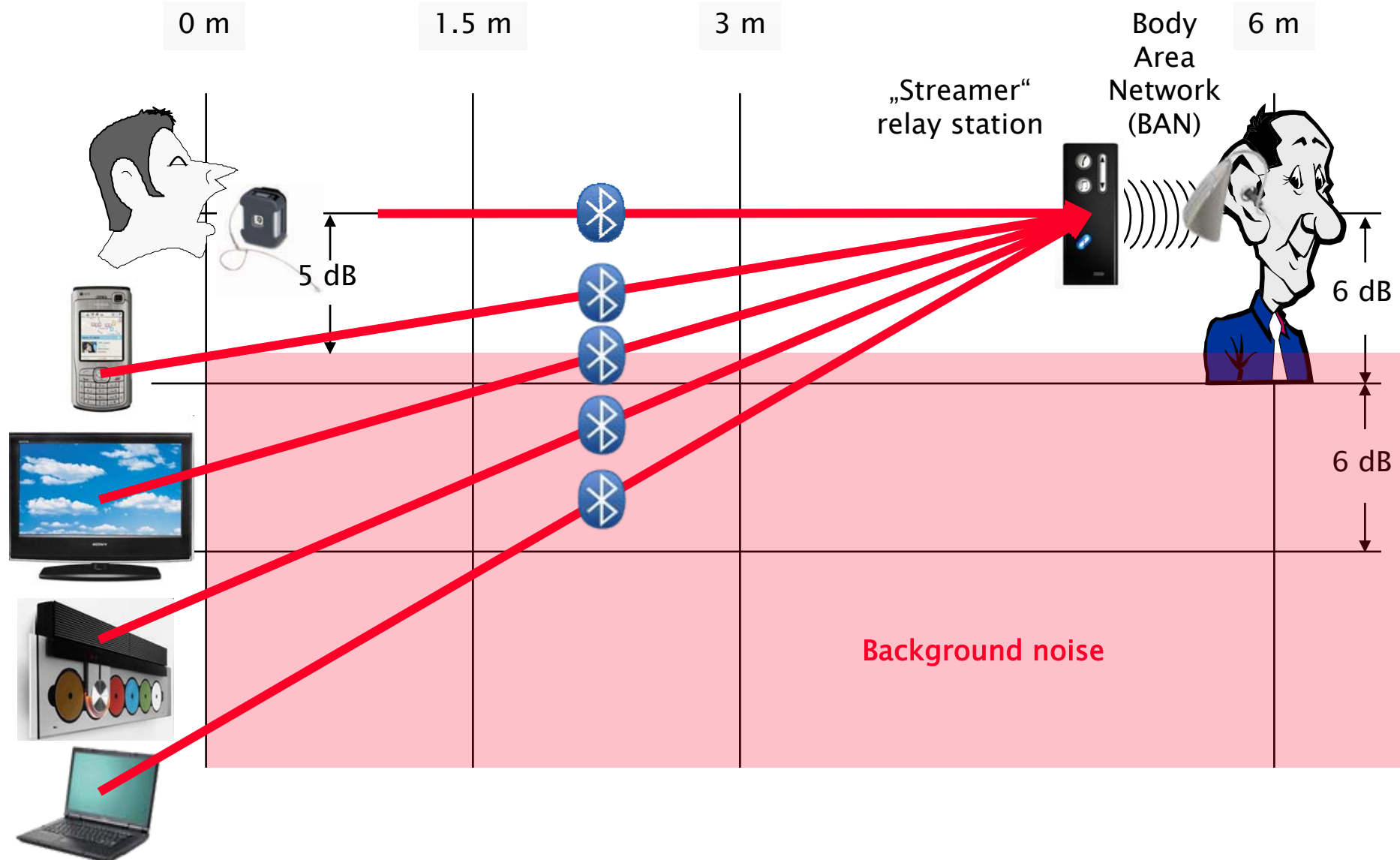
Effect of background noise without wireless technology



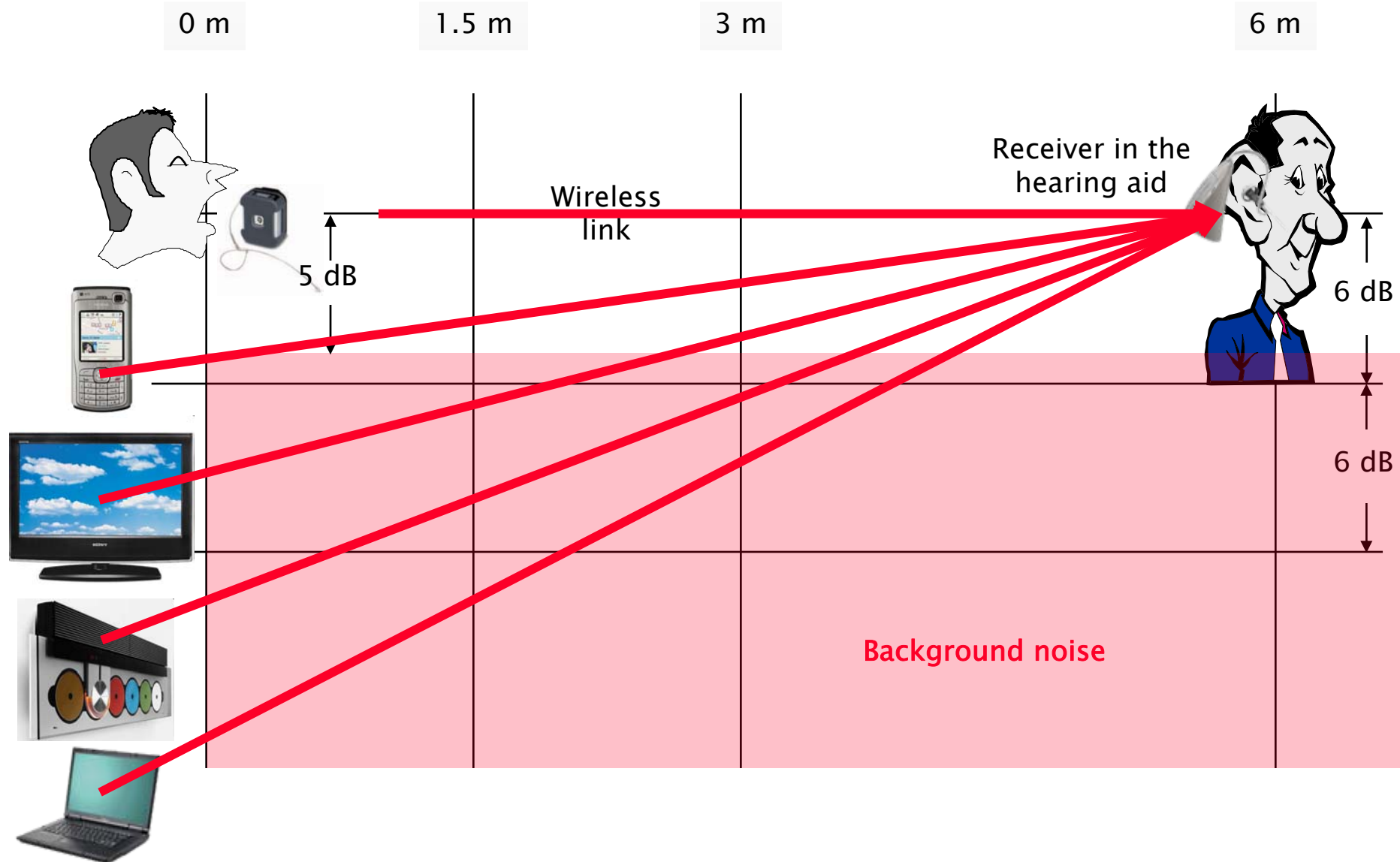
Noise reduction by conventional FM technology



Noise reduction by wireless technology via „streamer“

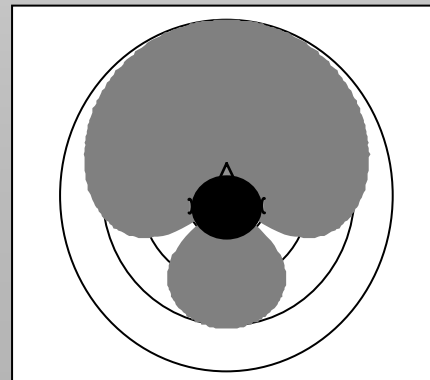
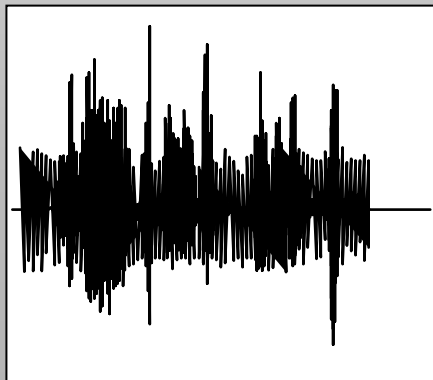


Noise reduction by wireless technology: direct link to the hearing aid



Comparison of noise reduction strategies

	One-microphone-approaches	Multi-microphone-approaches Directionality	Wireless technology SNR improvement
My rating of benefit =>	★☆☆	★★☆	★★★
Pros	<ul style="list-style-type: none"> Improvement of ease of listening 	<ul style="list-style-type: none"> Efficient SNR improvement 	<ul style="list-style-type: none"> Very efficient SNR improvement
Cons	<ul style="list-style-type: none"> In most listening situations no or just little SNR improvement 	<ul style="list-style-type: none"> Helps only in particular listening situations, e.g. 1-2 talkers in diffuse ambient noise 	<ul style="list-style-type: none"> Helps only in particular listening situations, e.g. with external mics, telephone, TV, HiFi, computer etc.



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Manual listening programs



Manual listening programs



Manual listening programs



Manual listening programs



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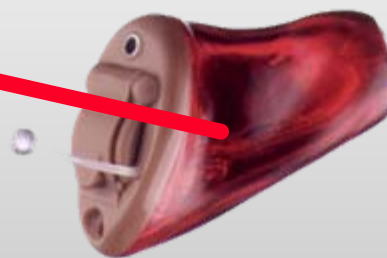
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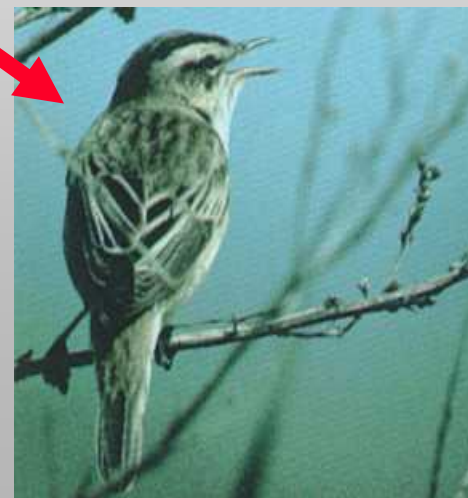
Automatic listening programs Based on environmental classifier



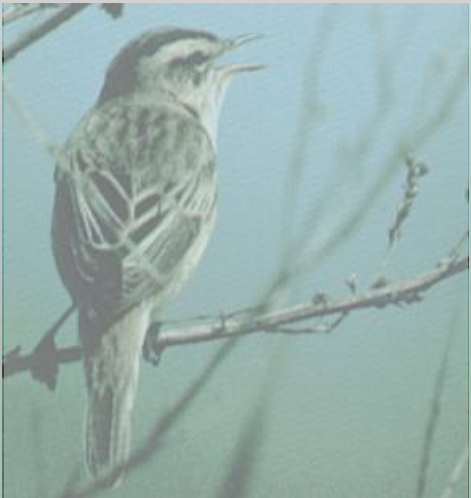
Automatic listening programs Based on environmental classifier



Automatic listening programs Based on environmental classifier



Automatic listening programs Based on environmental classifier



Manual vs. automatic listening programs resp. environmental optimizer

My rating of benefit =>	Manual programs ★ ★ ☆	Automatic programs or environmental optimizer ★ ★ ☆
Pros	• User decides what to do	• No user action needed • Completely inappropriate settings can be avoided
Cons	• Rarely used • If used, frequently wrong choice • No discretion	• Environmental classifiers need improvement still • Some users do not like automatic changes (“want to be in the drivers seat”)



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- 
- Suppression of
 - wind noise
 - sound peaks
 - reverberation etc.
 - Datalogging (for counseling & fine-tuning)
 - Frequency compression/frequency transposition
 - Wireless link between L/R hearing instruments
 - Exchange of setting information:
Synchronization of volume control and listening programs
 - Exchange of algorithmic information:
Compensation of delay times → better spatial hearing & speech recognition
 - Exchange of full audio signal:
“real binaural” hearing instruments

- Along with basic functions, such as frequency specific amplification and compression, modern hearing aid systems provide numerous special features
- These features offer helpful solutions for most communication problems
- Nevertheless, there is still ample room for improvement, particularly communication in noisy environments and telephone communication is still a challenge for most hearing aid users
- Future development will close this gap step by step, but my expectation is:

Hearing aid systems will never allow

- normal communication
- in all environments
- for all users

Thanks for your attention!