

How hearing loss and hearing aid usage affect communication behavior

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Introduction: Moving from the Lab to the Field (Daily Life)

**Laboratory Research:
Efficacy**



**Intermediate: Virtual
Acoustics**



**Daily Life:
Effectiveness**



Reliability

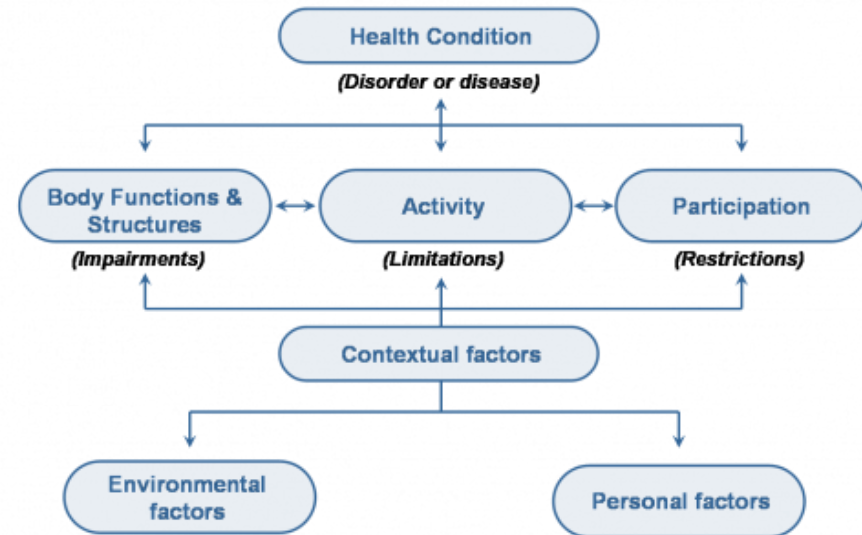
Ecological Validity

New Outcome Measurements in Audiology

- Currently: Efficiency measurements, such as PTA, speech in noise tests, listening effort and questionnaires
- Quality of Life measurements are related to the subjective perception from the perspective of the users and have impact on health economical evaluations
- In Future: Demands for a more realistic, everyday, and ecological valid evaluation of hearing aids reflecting not only subjective perception, but also behavioral data from the user along classified dimensions, e.g. the **ICF concept**

The ICF concept in Audiology*

The ICF concept (International *Classification* of Functioning, Disability and Health) is a framework for describing and organizing information on functioning and disability



*Mc Ardle et al, 2005, Granberg et al. 2014

Source: Rehab-Scales.org

Behavioral analyses*

- Moderated group discussions to induce communication situations and behavior with a group of users
- Room: Communication Acoustics Simulator (C-A-S) to reproduce diffuse sound scenarios (with or without reverberation times) semi-natural setting under controlled conditions
- Video controlled with a separated room with one way window
- Analyzing behavior following the Grounded Theory (Glaser/Strauss 1967*) with basic statistical analyses (descriptive, (non-) parametrical test of significance)

The basic concept/setting of the behavioral analyses*

- Group discussions each 15 min; four topics (see Exp. 1). Sound scenario: super market
 $L_{Aeq_15min} = 67$ dB.
- Group discussion with each of three hearing aids (directionality) and one mode (omni-directionality)



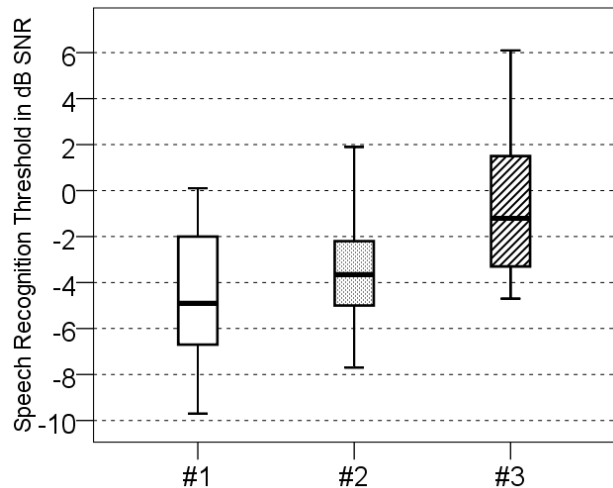
Comparison of 3 ITE's

- Participants: Two groups á 5 users; 6 male, Age: 57-84 years, Mean = 72.6 years, Hearing Loss: Better Ear (PTA 0.5, 1.0, 2.0 + 4.0 kHz)= 49.7 dB HI
- Randomization scheme:

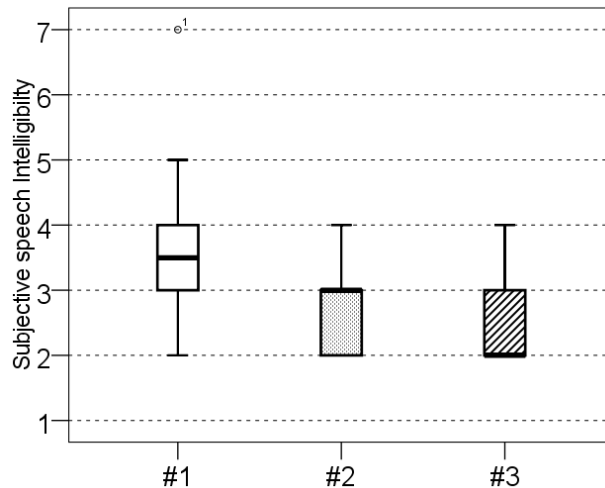
	Device #1	Device #2	Device #3	OMNI
Group 1	1	2	3	4
Group 2	3	2	1	4

Validation of the communication scenario with different ITE brands

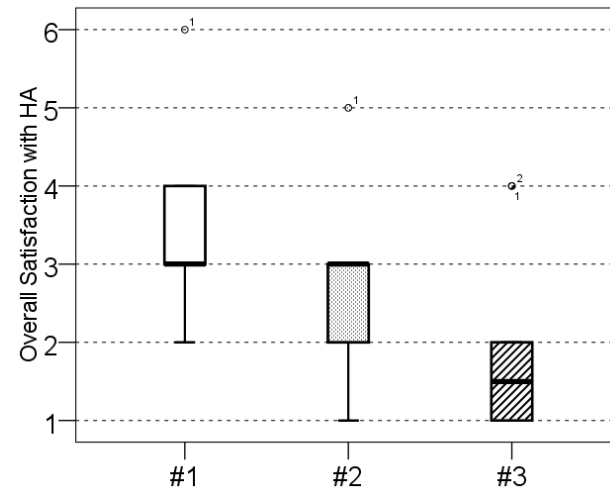
SRT



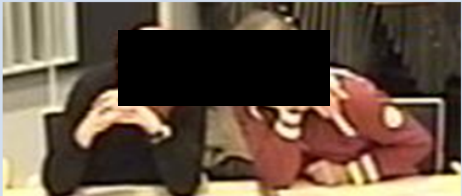
SI, subjective



Overall



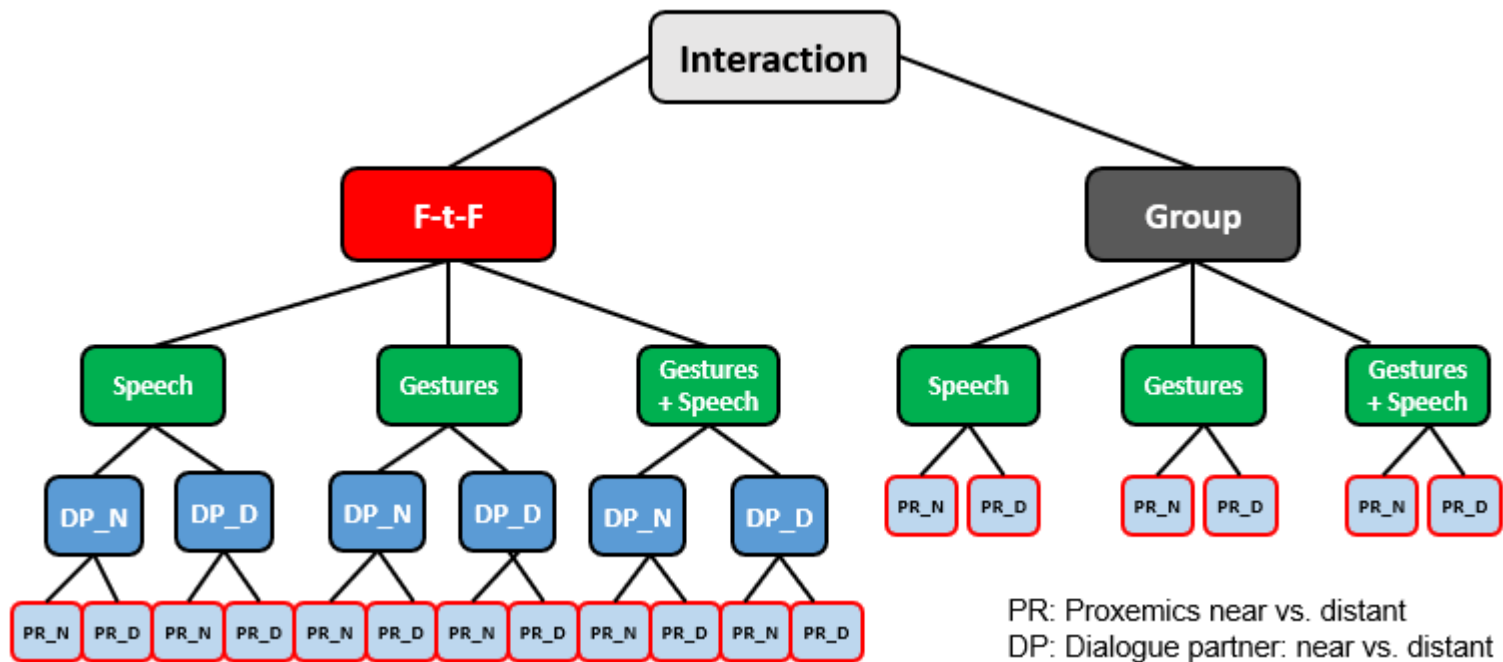
Development of an offline behavior code system and evaluation with ITEs

Recording	Phenomena	Indicators	Concepts
	<p>Two persons are situated side by side. The left one leans his head slightly to the side and the right one moves his lips.</p> <p>Both of them are wearing glasses.</p>	<p>The left person listen closely to what the other person had said. The right person leans forward, to be better understood.</p>	<p>A verbal interaction.</p> <p>Face-to-face.</p> <p>loud environment.</p>
...

Iterative formulation of codes based on Grounded Theory

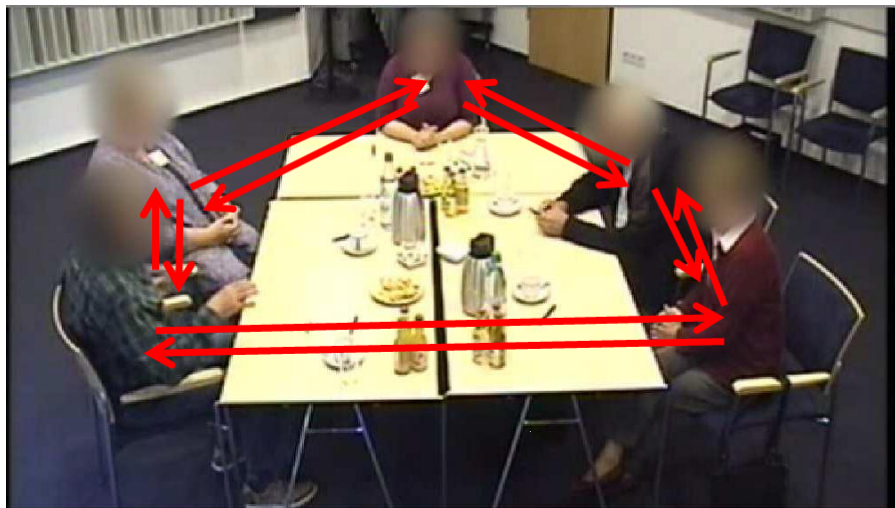
I General forms of interaction	II General forms of interdependence	III Forms of interaction: Distance to the dialogue partner	IV Inter-dependence: Proxemics
<p>F-t-F vs. group communication to distinguish between those two general communication situations. [F-t-F: The conversation takes place in direct contact with only one person, so a total of 2 people <u>are</u> involved in the interaction. Group: verbal communication in a group is when the speaker turns to several people and listens to more than one person]</p>	<p>Speech vs. gestures vs. combined gestures and speech communications. To distinguish between these communication patterns. [Speech contributions and gestures: all non-verbal gestures, such as moving, shaking, and nodding head, blocking ears, moving arms and torso, but classifying in each to the dichotomy near vs. distant proxemics]</p>	<p>Near vs. distant dialogue partner (only for F-t-F communications) [Near dialogue partners are those who sit to the right and left of a person as direct neighbors; distant dialogue partners are those who sit diagonally opposite or directly opposite the person to be observed, see screenshot of the setting]</p>	<p>Near vs. distant torso movements [Near: Sitting position of the upper body leaned forward ($< 90^\circ$) to the conversation partner; Distant: Sitting position of the upper body in neutral upright position or leaning back ($\geq 90^\circ$) on the chair]</p>

Offline Annotation scheme: 18 codes

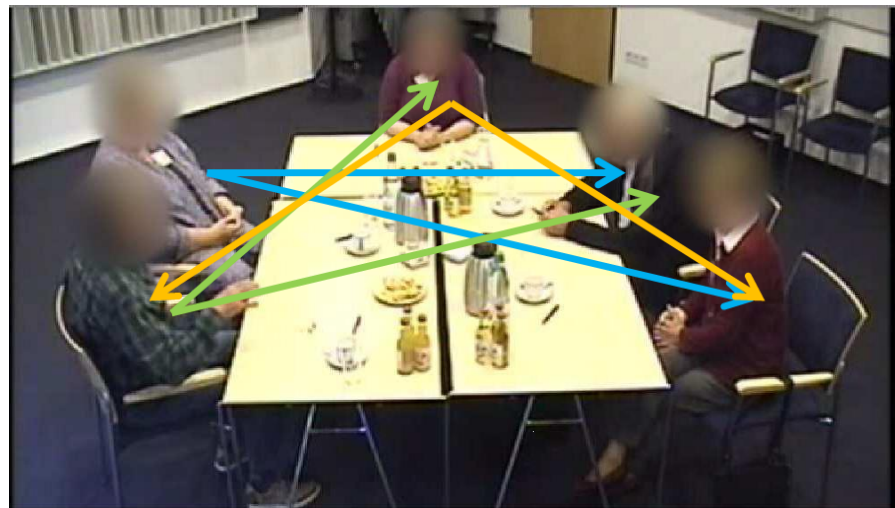


Annotation scheme in detail: Dialogue partner

Near



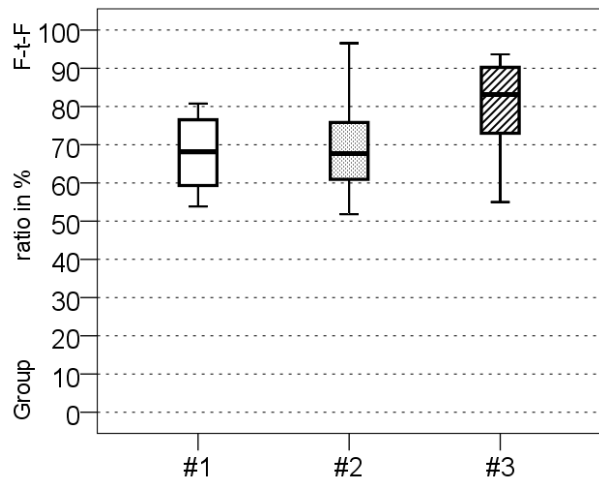
Distant



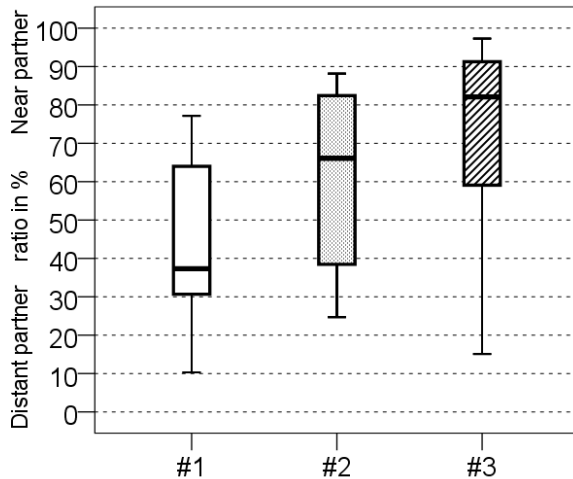


Results of the 3 ITE's

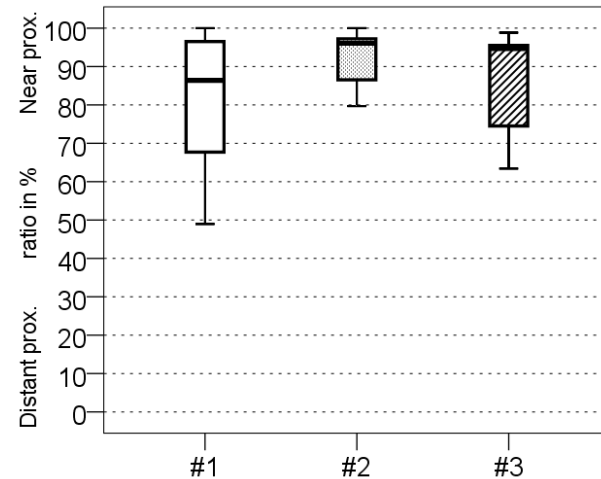
Group vs. F-t-F



Dialogue partner



Proxemics



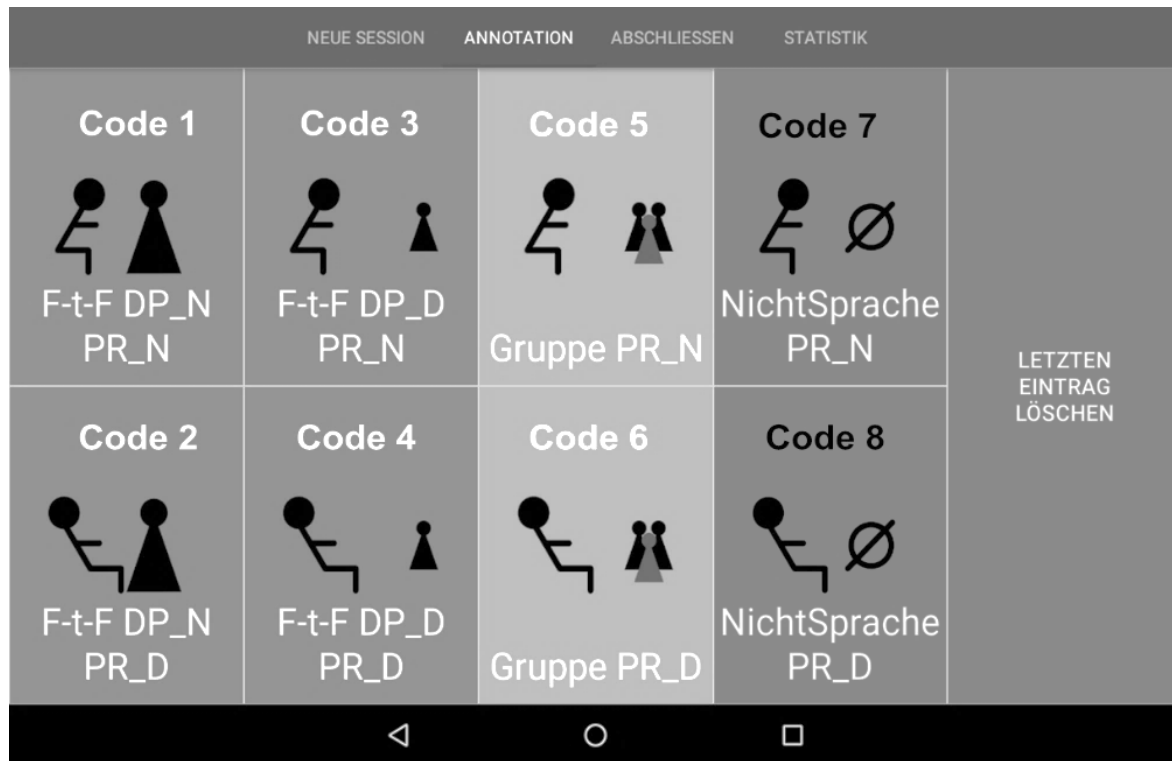
Second iteration: ICF expansion, scaling, and on-the-spot-coding

ICF (sub-) categories/scale	Rater		A-B		B-C		A-C	
	K	r _{Sp}	K	r _{Sp}	K	r _{Sp}	K	r _{Sp}
b140_1 Sustained attention face partner (low-medium-high)	.39	.58	.32	.56	.44	.65		
d3504_1 Communication (F-t-F-balanced-group)	.47	.58	.36	.38	.57	.70		
d3504_2 Frequency verbal comm. (seldom-sometimes-frequent)	.51	.72	.52	.68	.43	.70		
d3504_3 Communication partner (near-balanced-distant)	.59	.73	.62	.70	.72	.79		
d3504_4 Proxemics (forward-balanced-backward)	.57	.68	.38	.52	.50	.59		
d3504_5 Change torso position (seldom-sometimes-frequent)	.13	.26	.33	.56	.39	.57		
d3504_6 Non-understanding gestures (seldom-sometimes-frequent)	.07	.29	.35	.40	.16	.32		
d3504_7 Speech supporting gestures (seldom-sometimes-frequent)	.24	.51	.26	.39	.46	.57		

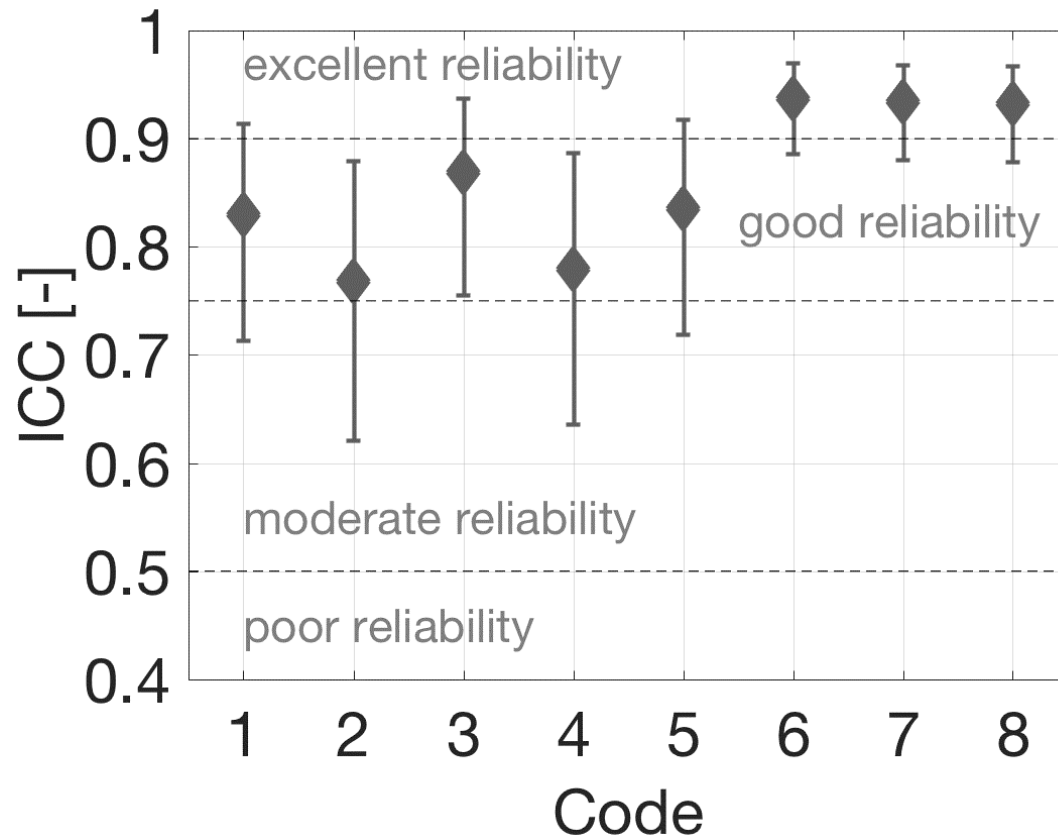
Legend: A-C=3 raters; κ = Cohen's kappa, r_{Sp} = Spearman's rho;

Cohen's kappa: Agreement: <0 = „poor“, 0-0.20 = „slight“, 0.21-0.40 = „fair“, 0.41-0.60 = „moderate“, 0.61-0.80 = „substantial“, 0.81-1.00 = „almost perfect“; see Landis and Koch (1977).

Third iteration: App development, instantaneous coding, and reliability

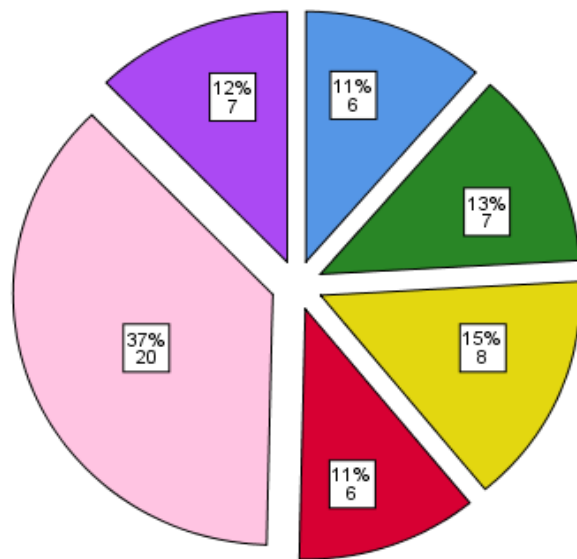


Reliability by intra-class correlation coefficients

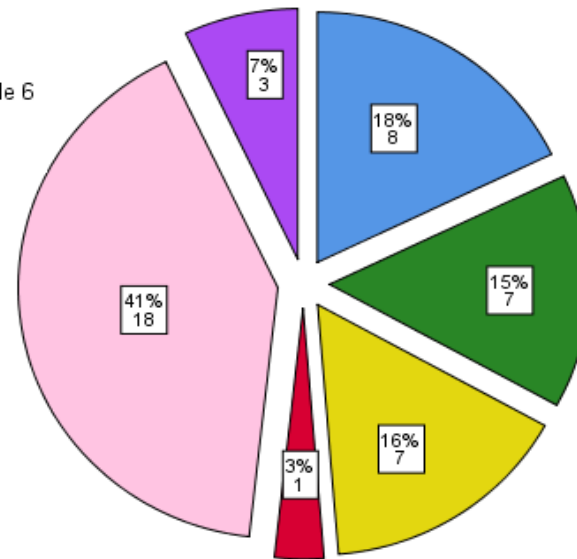


Application of the scheme in the field (IRC project)*

Before (new) HA



After (new) HA



- Code 1
- Code 3
- Code 5
- Code 2, Code 4, Code 6
- Code 7
- Code 8

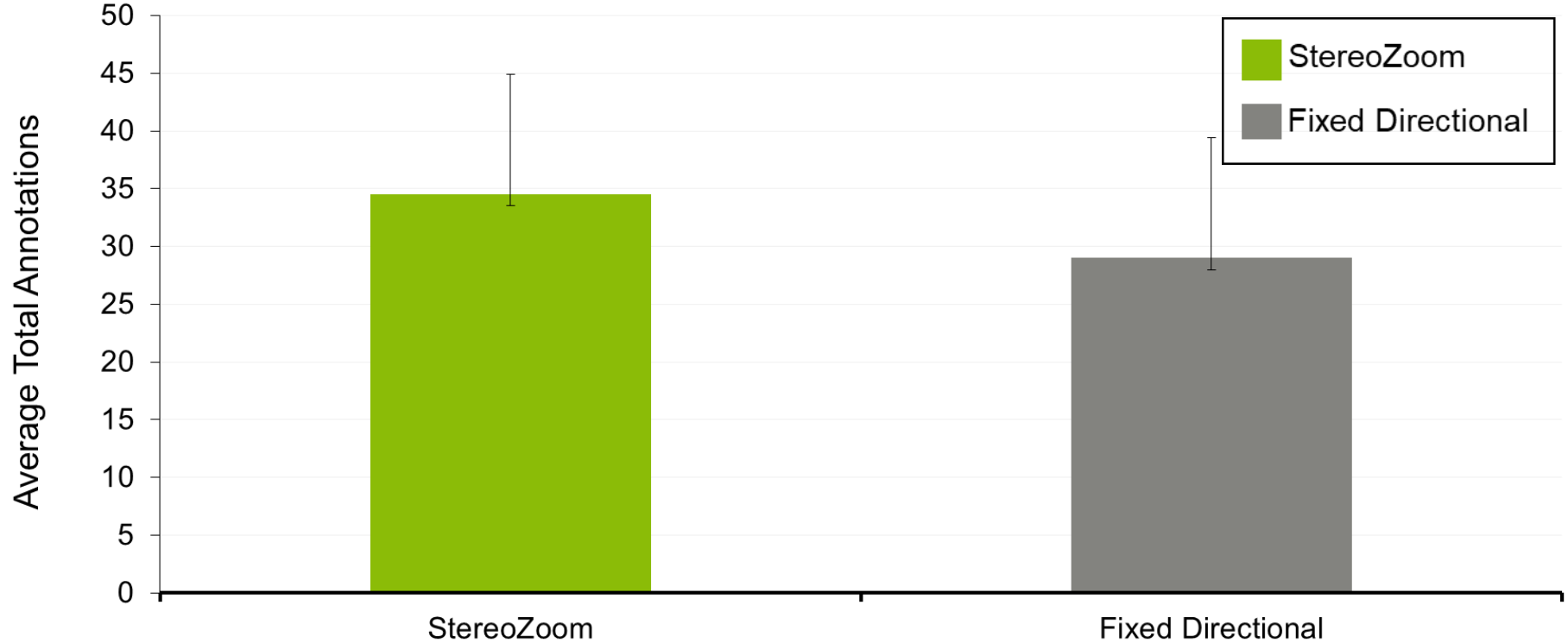
Comparison of two beamformers*



Diffuse noise: Shopping mall 71 dB

*Michael Schulte, Markus Meis, Melanie Krüger, Matthias Latzel & Jennifer Appleton-Huber / September 2018
Phonak white paper

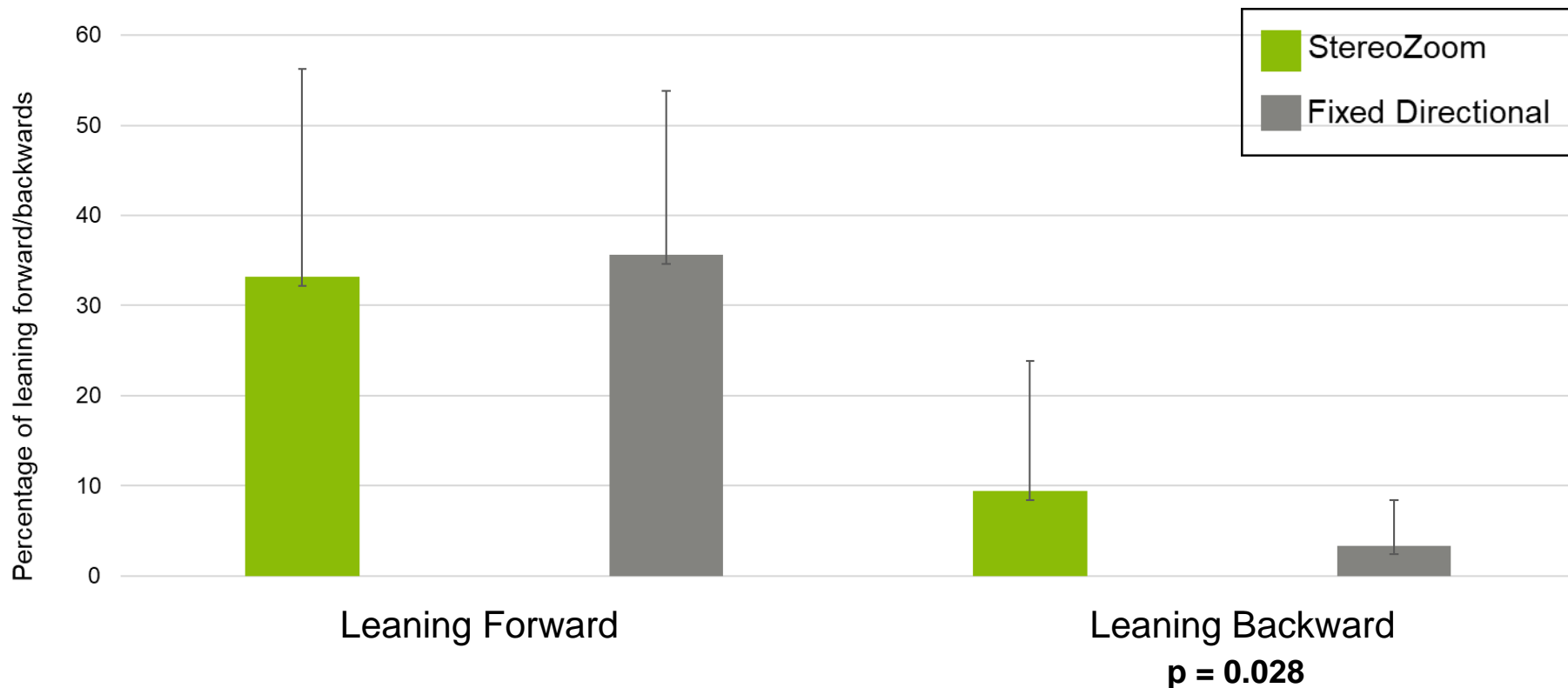
Results: overall communication



Participants communicated more with StereoZoom than with the Fixed directional

***p = 0.013**

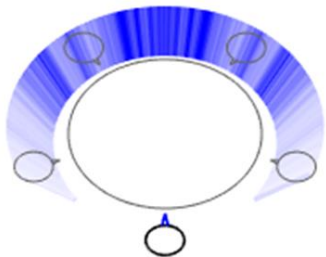
Results: body position



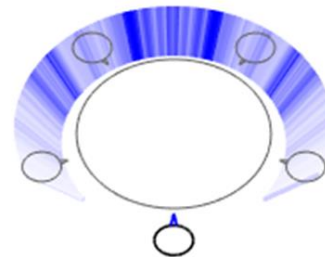
The subjects lean back with the StereoZoom more often than with the Fixed Directional

Head Tracking data

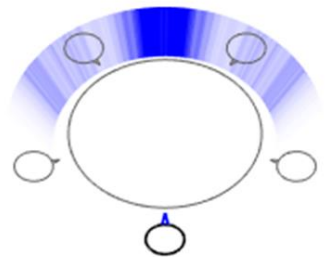
StereoZoom



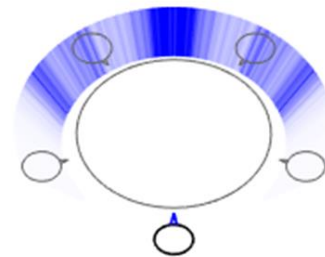
Head
Tracking



Fixed
Directional



not talking



talking

Subjects intuitively turned their head more to make use of the additional StereoZoom benefit

Summary: Annotation scheme and first experimental results

- The method is suitable for evaluating the benefit of hearing solutions in conversation situations, but is restricted for virtual acoustics/semi-natural settings, and not for natural settings in the field
- Behavioral results correlate with speech intelligibility ratings, questionnaire, and partly with head tracking data
- Differences between the Face-2-Face and group communication, as well as in the choice of the conversation partner were shown.
- Finding denotes a forced choice communication partner strategy indicating participation restriction following the ICF d_3504, conversation with many people



Thank you for your attention!

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