Laboratory paired comparisons based on the CoSS framework

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ABSTRACT

A laboratory paired-comparison test for evaluating hearing-aid preference was developed and evaluated in a pilot study. Based on the CoSS framework, the test focuses on intentions and real communication situations.

The preliminary results look promising in terms of the test's ability to predict real-life hearing-aid benefit. Further studies are needed, e.g., investigating test sensitivity, the need for individually selected scenarios, and the need for a more refined loudspeaker setup.

BACKGROUND

Prescription study 2015
In a previous study, we compared two hearing-aid settings in the field and in the laboratory using paired comparisons. We found that the correlation between the data collected in the laboratory and in the field was low. Specifically, the laboratory data could not predict individual overall preference in the field (Dahlquist et al. 2015).

Common Sound Scenarios 2016
Listening situations people encounter in real life were investigated using a literature study, and the Common Sound Scenarios (CoSS) framework was developed (Wolters et al. 2016). Three intention categories were formed:

- *Speech communication*
- *Focused listening* (without own speech)
- *Non-specific* (including monitoring surroundings and passive listening)

Most laboratory tests only tap into the "Focused listening" intention category. Neither speech communication, nor more passive listening situations are usually investigated.

Based on our observations, a new laboratory paired-comparison (PC) test was developed. In a pilot study, the new method was tried, and the results were compared to paired-comparison data obtained in the field using Ecological Momentary Assessments (EMA).

TEST METHODS

EMA Field PC
Paired comparisons in the field, using an EMA paradigm with prompted responses, was included as a reference.
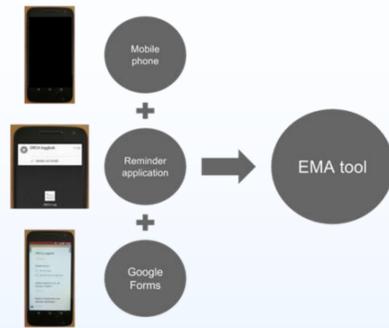
CoSS-based lab PC
For the laboratory test, the stated purpose was to broaden testing into intention categories not normally tested. Sound scenarios were created based on the task the test participant had to solve in a scenario. Examples:

- Communication, two or more people
- Focused listening
- Monitoring surroundings

Picture cards were used to create communication situations. Compared to traditional lab PC:

| Traditional Lab Paired Comparisons	CoSS-based Lab Paired Comparisons
Focused listening to reproduced sound	Varying intentions, e.g., communication and monitoring
Pre-defined (static) acoustical parameters such as overall SPL and SNR	Varying SPLs and SNRs relevant to the situation (noise and test participant)
No visual cues	Visual cues, e.g., real person to talk to
Lack of "social pressure" to hear and react appropriately	Added "social pressure" in communication situations
Test environment and task potentially fatiguing	Creating tasks and situations engaging to the test person

PILOT STUDY METHOD

Participants
- 10 experienced HA users (5 female and 5 male)
- Average age: 72 years

Hearing aids
- Widex UNIQUE 440 RIC
- Standard domes (7 tulip, 3 double dome)
- Default feature settings
- Two gain settings, A and B
- Remote control for program switching

Setting B provided less gain than setting A in the mid-frequency range
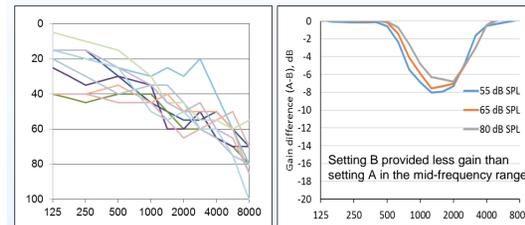
Field PC
- EMA using smartphone
- Two 1-week field-trial periods
- Prompting every 1½ hours
- Possibility to evaluate un-prompted
- Participants classified situations into seven CoSS task categories
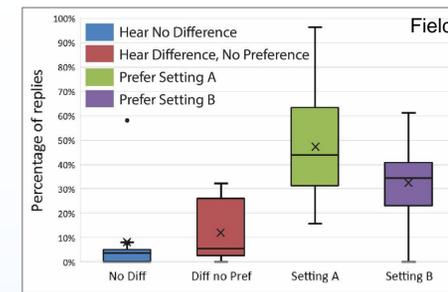
Lab PC
- CoSS-based lab PC
- 5 mandatory scenarios:
  - Communication 2 people (quiet and restaurant noise)
  - Communication 3 people (quiet)
  - Focused listening to TV
  - Monitoring surroundings, vacuuming
- Up to 6 individual test scenarios, selected from a list of situations experienced in the field trial (max 2 *important*, 2 *challenging*, 2 *common* situations) in a set of pre-defined noise backgrounds
- Same EMA test setup as in the field

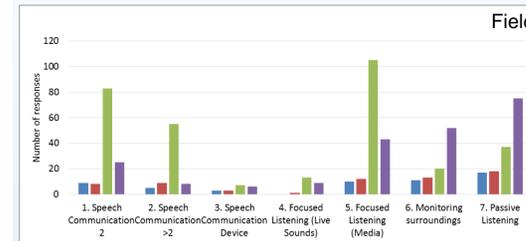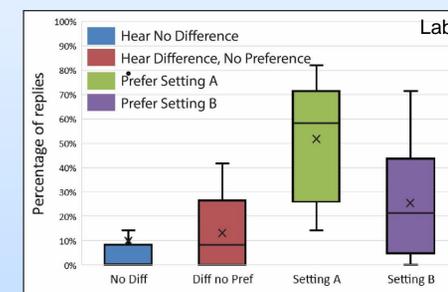Example Test Case: Two people communicating in restaurant noise

1 Test loudspeakers
2 Laptop for test administration
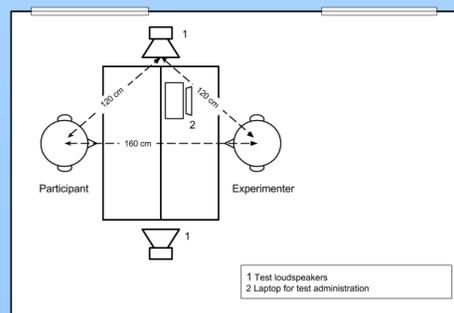
RESULTS

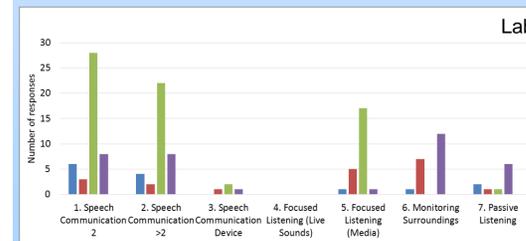**Field PC, Overall Preference**

Field PC, Preference per CoSS category

Lab PC, Overall Preference

Lab PC, Preference per CoSS category

Test-retest reliability: Preference agreement (setting A – inconclusive - setting B) was 80-90% for speech communication situations. Lower reliability for non-communication situations.

Comparison Results from Field and Lab
Relationship between results in field and lab stronger than in the previous prescription study. Overall preference in the field could be predicted by the lab test for 8 out of 10 participants.

Subject	Field Preference Overall (week 1 / 2)	EMA (A/B)	Lab Preference Lab PC (A/B)
1	A / A	50% / 37%	71% / 29%
2	B / B	37% / 61%	29% / 71%
3	B / B	60% / 33%	82% / 9%
4	A / A	96% / 0%	71% / 14%
5	A / A	72% / 25%	58% / 42%
6	A / no pref	16% / 51%	50% / 31%
7	A / A	50% / 37%	19% / 50%
8	A / B	19% / 19%	14% / 0%
9	A / A	38% / 26%	63% / 6%
10	A / A	36% / 36%	58% / 0%

DISCUSSION

Potential to predict real-life hearing-aid preference better than with "traditional" lab methods
- Focus on common scenarios (mandatory)
- Possibility to add own common/ important/ challenging scenarios
- Focus on intention, especially realistic communication aspects (e.g., own voice, visual cues, "social pressure")
- Realistic speech levels and SNRs (tailored both to background noise and to listener)
- Participants found lab scenarios to correspond "well" (55%) or "partly" (45%) with situations experienced in the field.

On the other hand
- Less controllable test conditions
  - How much talking/listening?
  - Speech levels and SNRs can vary within / between test sessions
- Resource heavy if communication with more than two people included
- Passive scenarios difficult to implement

Method refinement
- How important is better acoustical representation (loudspeaker setup)?
- Larger range of background sounds
- Detailed studies of test leader/participant communication
- Evaluation of sensitivity

Clinical use?
- If 5 or 6 mandatory test cases are presented once, the test is expected to be performed in 20 minutes. Reliability?

REFERENCES

Dahlquist M, Larsson J, Hertzman S, Wolters F, Smeds K. (2015) Predicting individual hearing-aid preference in the field using laboratory paired comparisons. In: *5th International Symposium on Auditory and Audiological Research (ISAAR)*. Nyborg, Denmark.

Wolters F, Smeds K, Schmidt E, Christensen EK, Norup C. (2016) Common Sound Scenarios: A context-driven categorization of everyday sound environments for application in hearing-device research. *Journal of the American Academy of Audiology* 27: 527-40.

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