

Evaluation of auditory reality and hearing aids using an ecological momentary assessment (EMA) approach

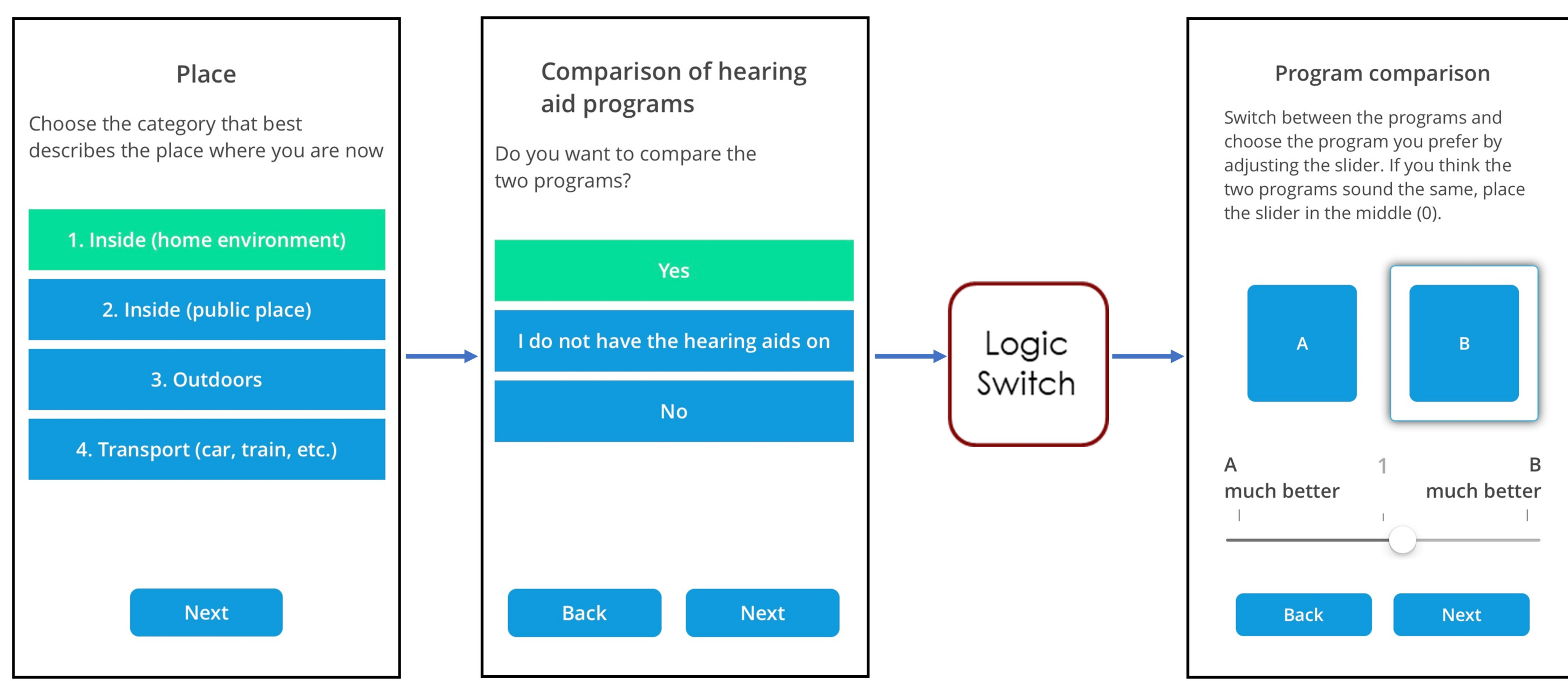
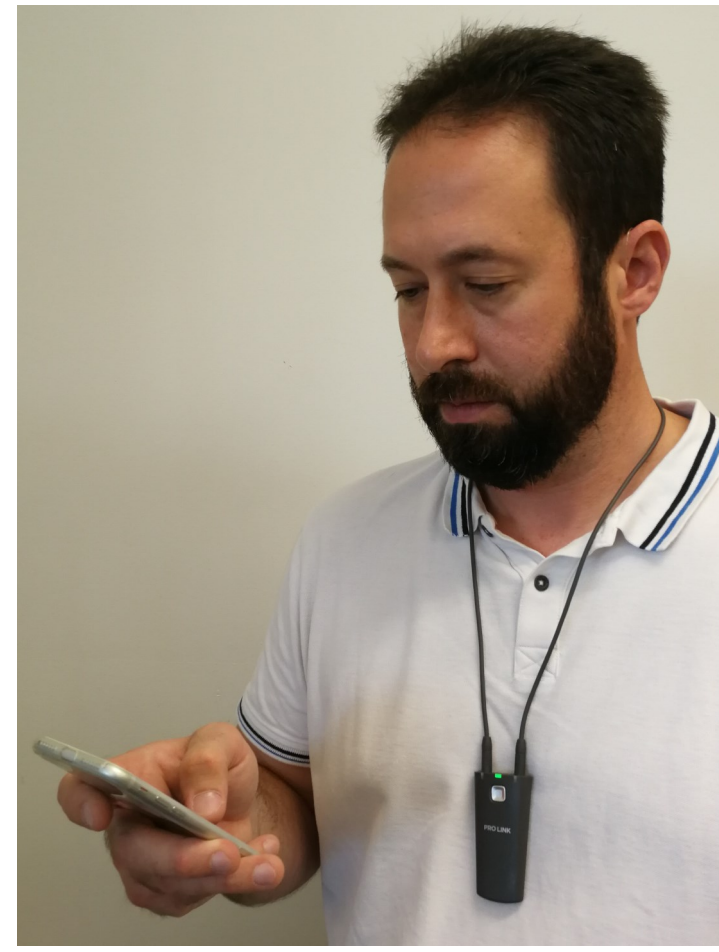
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Introduction

Knowledge about listeners' auditory reality [1, 2] is of significant relevance to hearing research and development of new hearing solutions. Ecological Momentary Assessment (EMA) [3] has been shown to be a promising and valid method to gather such knowledge [4, 5], allowing assessment of listening experiences while they happen in real life. We present data from a study using a newly developed EMA tool that was designed to assess both auditory reality and hearing-aid preference. The study also evaluated the tool itself.

EMA approach

- Equipment
 - ◊ Smartphone (iPhone 7) with proprietary EMA app
 - ◊ PRO LINK device to establish wireless connection between smartphone and hearing aids (HAs)
 - ◊ HAs (RIC type) and remote control (optional)
- Prompted or self-initiated EMA reports
 - ◊ Questionnaire on auditory reality (based on [6, 7])
 - ◊ Paired comparison of two HA programs with slight difference in mid-freq. gain
 - ◊ Retrieving data from HAs, e.g. sound class and sound pressure levels
- Prompting (via smartphone alarm) every two hours (8:30 AM - 8:30 PM)
- All data sent to cloud storage at the end of each assessment



Test protocol

Purpose: To a) collect data on auditory reality, b) assess difference between two hearing-aid programs, and c) evaluate EMA approach.

- $N = 16$ participants (5 females) with hearing loss; 8 Danish and 8 Swedish
- Experienced hearing-aid users; mean age 70 years (SD: 8 years)
- *Visit 1*: Information, instructions and handing out equipment
- *Field trial (EMA)* for approximately one week
- *Visit 2*: Structured interview (evaluating EMA approach)

EMA reports

- Mean compliance (79% of questionnaires completed when triggered by alarm) indicates that the EMA procedure was generally well accepted.
- Large individual variation on all measures.

| | Mean \pm SD | Range |
|--|---------------|------------|
| Number of completed triggered questionnaires | 39 \pm 8 | 22 – 49 |
| Number of user-initiated questionnaires | 2 \pm 2 | 0 – 6 |
| Number of paired comparisons | 25 \pm 10 | 8 – 45 |
| Compliance (%) | 79 \pm 17 | 33 – 94 |
| Time to complete (minutes) | 3.4 \pm 3.4 | 2.0 – 5.1* |

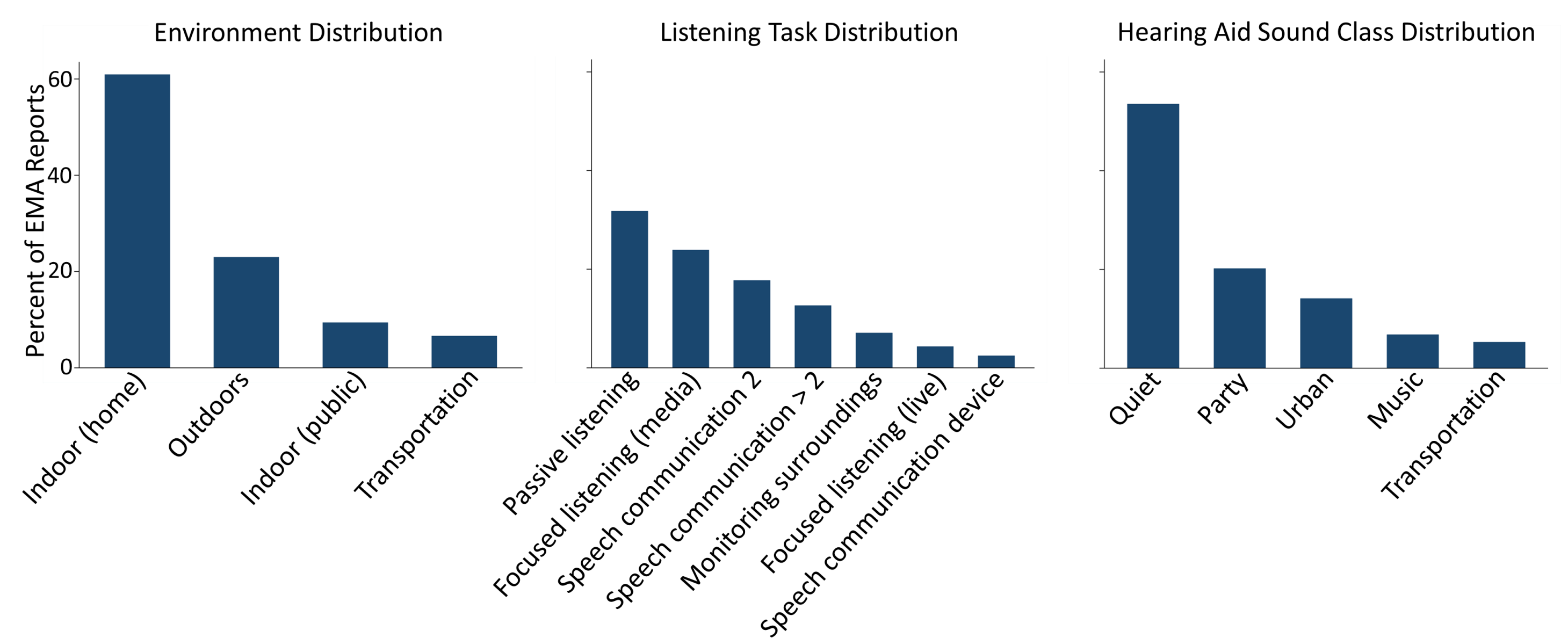
*Range of individual means

Learnings and recommendations

- Large individual variance in number of EMA reports must be expected.
- The frequency of triggered EMA reports is a balance between not annoying/demotivating the participants and getting as many data points as possible.
- Instruction and motivation of participants are important elements.
- Limit the number of questions and keep them short and easy to understand.

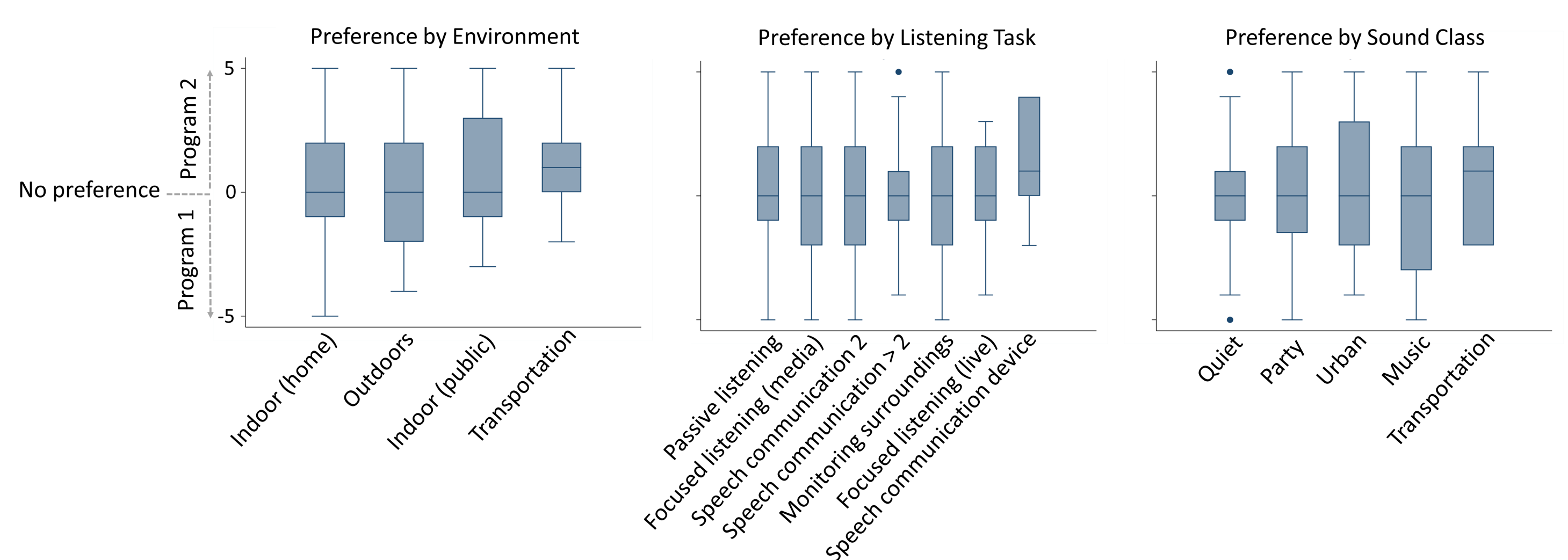
Evaluation of auditory reality

- $N = 648$ completed questionnaires.
- Overall trends in observed distributions are in line with previous findings [7].
- Large variation in individual distributions (not shown) indicates, not surprisingly, that different people have different auditory realities.
- Distributions may be affected by the EMA procedure.



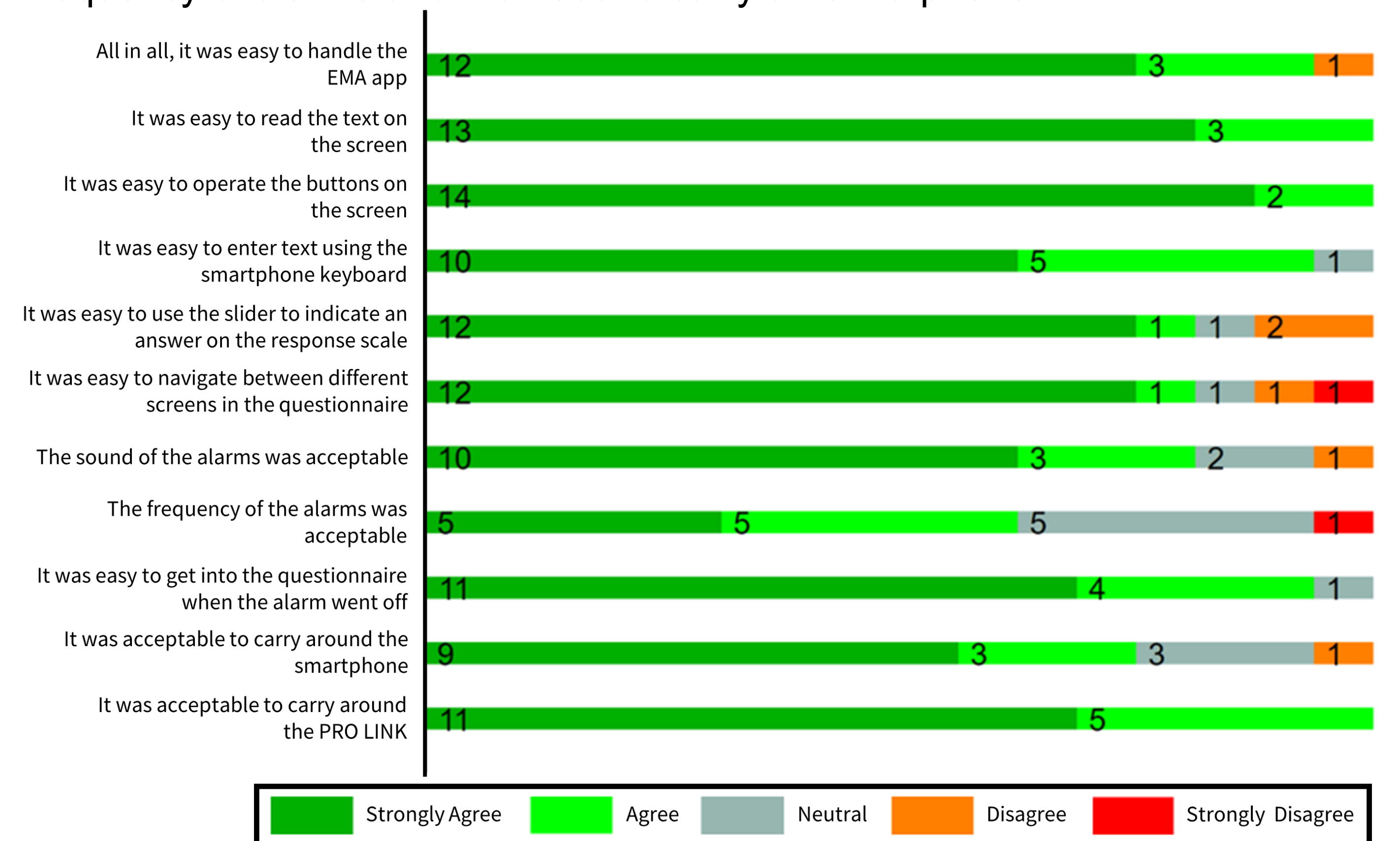
Evaluation of hearing-aid programs

- $N = 396$ completed paired comparisons.
- Plots of preference distributions show quartiles, min/max values, and outliers.
- No significant overall preference between programs, and no effects of listening environment, listening task or sound class on preference.
- Clear individual preferences for both programs were observed.



Evaluation of EMA approach

- Generally the EMA approach was well accepted by the participants.
- Some usability questions indicated issues for some participants, e.g. the frequency of alarms and the need to carry an extra phone.



[1] Smeds K, Wolters F. Towards a Firm Grip on Auditory Reality. *Hear Rev.* 2017;24(12):20-5. [2] Noble W. Auditory reality and self-assessment of hearing. *Trends Amplif.* 2008;12(2):113-20. [3] Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. *Annu Rev Clin Psychol.* 2008;4:1-32. [4] Wu YH, Stangl E, Zhang X, Bentler RA. Construct Validity of the Ecological Momentary Assessment in Audiology Research. *J Am Acad Audiol.* 2015;26(10):872-84. [5] Timmer BHB, Hickson L, Launer S. Ecological Momentary Assessment: Feasibility, Construct Validity, and Future Applications. *Am J Audiol.* 2017;26(3S):436-42. [6] Wolters F, Smeds K, Schmidt E, Christensen EK, Norup C. Common Sound Scenarios: A Context-Driven Categorization of Everyday Sound Environments for Application in Hearing-Device Research. *J Am Acad Audiol.* 2016;27(7):527-40. [7] Smeds K, Wolters F, Larsson J, Herrlin P, Dahlquist M. Ecological momentary assessments for evaluation of hearing-aid preference. *J Acoust Soc Am.* 2018;143(3):1742.