Archetypal analysis of auditory profiling data towards a clinical test battery

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Archetypal analysis of auditory profiling data towards a clinical test battery
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Introduction
Nowadays, the pure-tone audiogram alone is used for hearing-aid fitting and characterization of the degree of hearing loss. Nevertheless, some hearing-impaired listeners have shown a so-called speech communication handicap even though the audiometry was compensated for by amplification. Plomp (1978) proposed a classification of the hearing loss based on speech intelligibility tests, the “audibility loss” and the “distortion loss.” Therefore, a different fitting strategy may be needed for compensating the deficits of these two different classes. The aim of the present study is to clarify which tests are needed (in addition to the audiogram) to classify the listeners in different hearing profiles.

Hypothesis
• H1: Hearing-impaired listeners can be grouped in 4 different profiles by identifying trends in the behavioral data. This can be done using unsupervised learning.
• H2: The test used for classifying the subjects can be reduced to only the most relevant tests using supervised learning.

Method
Unsupervised

I. Dimensionality Reduction: PCA

A. Temporal Processing?

B. Frequency selectivity

C. Auditory-related distortions

D. Non-auditory related distortions

Fig. 1: From the data set the dimensionality was reduced using principal component analysis. Archetypal analysis was used as a technique for data-driven prototype identification (Ragazzi et al., 2016). The nearest profile was used to divide the subjects. Then, supervised learning (Decision trees) served to identify the most relevant tests for classification.

II. Archetypal analysis and Profile identification

A. Test

B. Profile A

C. Profile B

D. Profile C

E. Profile D

Fig. 2: A) Archetypes, trends found in the data for each profile and for the proposed testing tests. 4 archetypes resulted from the archetypal analysis which could explain 88 % of the variance. B) Each listener is placed in the “Square Visualization” depending on the similarity to each archetype. Each listener will belong to the auditory profile of the closer archetype, which will be used in IV. Supervised learning.

III. Supervised learning: Classification

A. Decision tree

B. IPD > 495 Hz

C. Bitch > 95%

D. Fig. 4: Supervised Learning. A) Decision tree obtained by using the tree as an input and the auditory profiles as the output. The classification was based in the variables SRTTTS, IPD and Bitch. B) Baseline of the Speech perception in noise test (ETS) (SRTTS). C) The lowest frequency for detecting interaural phase differences (IPD). D) Binaural pitch dichotic (Bitch). The dashed lines correspond to the limits imposed in the decision tree.

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Conclusion

➢ The new analysis provides consistent evidence of the existence of different “auditory profiles” in the data.
➢ The most informative predictors for the profile identification of the HI listeners were related to temporal processing, loudness perception and speech perception.
➢ The current approach seems to be promising for analyzing other existing data towards an efficient auditory profiling.

References

