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Archetypal analysis of auditory profiling data towards a clinical test battery

Raul H. Sanchez[1], Federica Bianchi[1], Sébastien Santurette[1,2] and Torsten Dau[1]

rsalo@elektro.dtu.dk

[1] Hearing Systems group, Department of Electrical Engineering, Technical University of Denmark, DK-2800, Kgs. Lyngby, Denmark

[2] Department of Otorhinolaryngology, Head and Neck Surgery and Audiology, Rigshospitalet, Copenhagen, Denmark

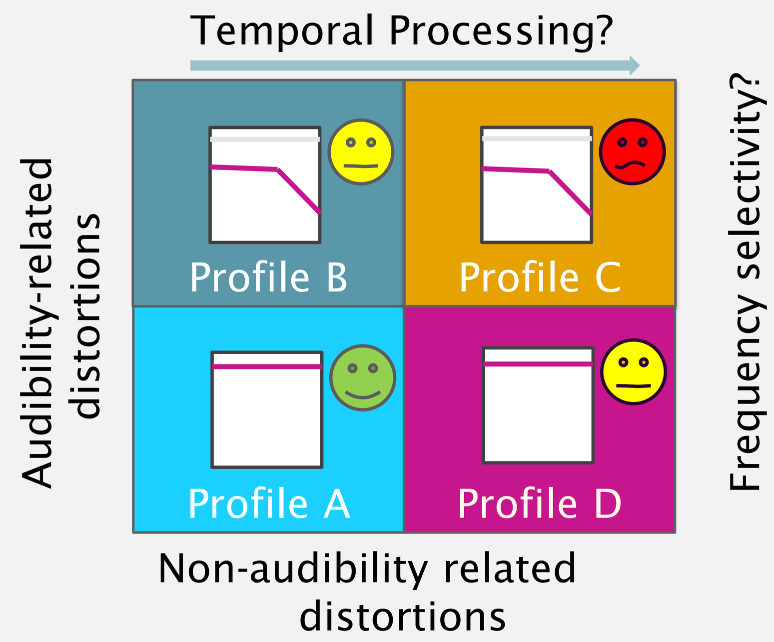
Introduction

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 audibility 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 the 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**.



* Inspired by Strelcyk & Dau (2009)

Method

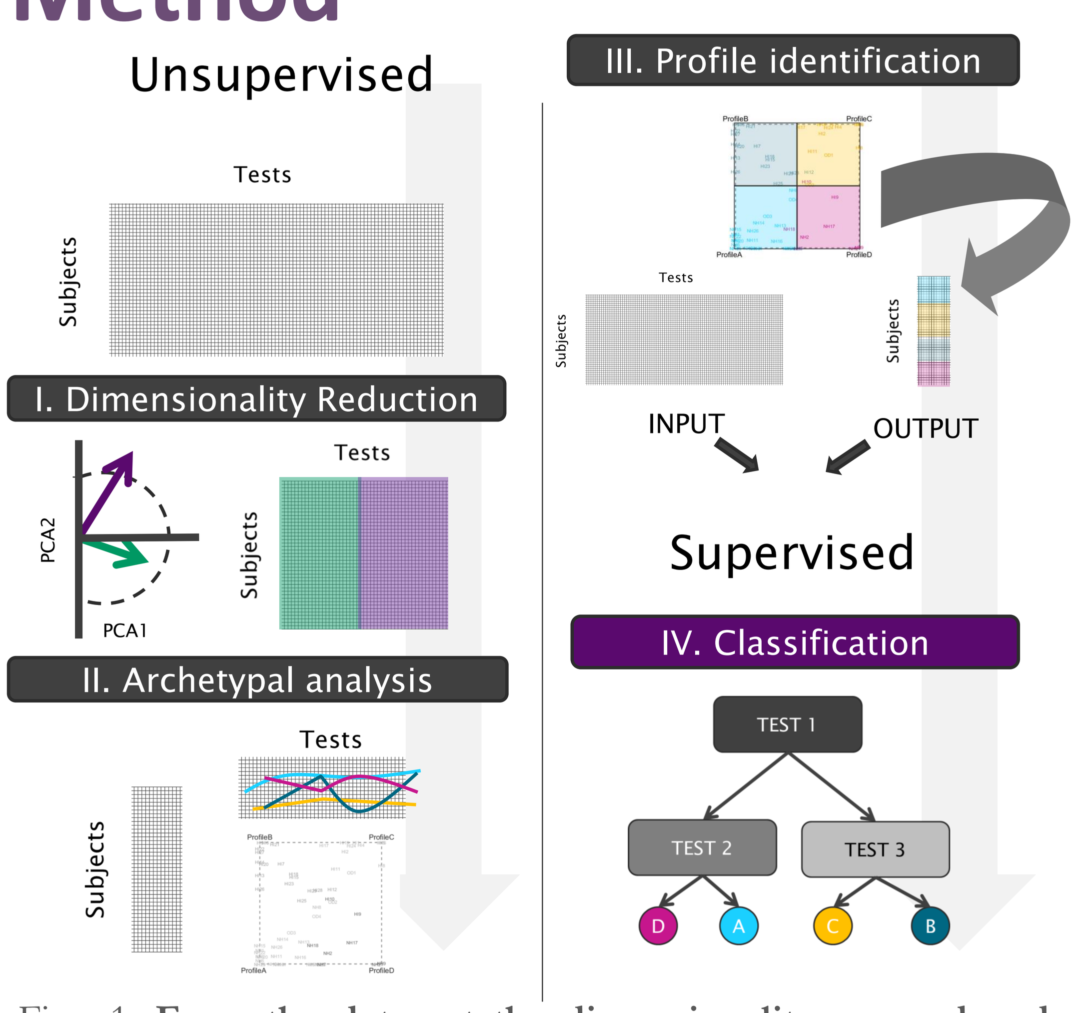


Fig. 1: From the data set the dimensionality was reduced using principal component analysis. Archetypal analysis was used as a technique for data-driven prototype identification (Ragozini et al, 2016). The nearest profile was used to divide the subjects. Then, supervised learning (Decision trees) served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

Test Battery for auditory profiling

Thorup et al. (2016) proposed an extended clinical test battery beyond the audiogram in hearing-aid candidates. In order to verify the hypothesis (fig. 2A). The data were re-analyzed using this approach.

Clinical Experimental Set-up

Domain	Test
Audibility (AUD & SPEECH)	Pure-tone Audiogram Speech Audiometry
Binaural processing (BIN)	Binaural Pitch* & IPD
Speech recognition in noise (SIN)	Danish HINT in LTASS noise Danish HINT in ISTS noise
Working memory (RS)	Reading Span
Spectral and Temporal resolution (F-T Test)	F-T Test
Loudness perception	ACALOS*
HA treatment evaluation	Gothenburg Questionnaire*

* Tests not included in Thorup et al. (2016)

I. Dimensionality Reduction: PCA

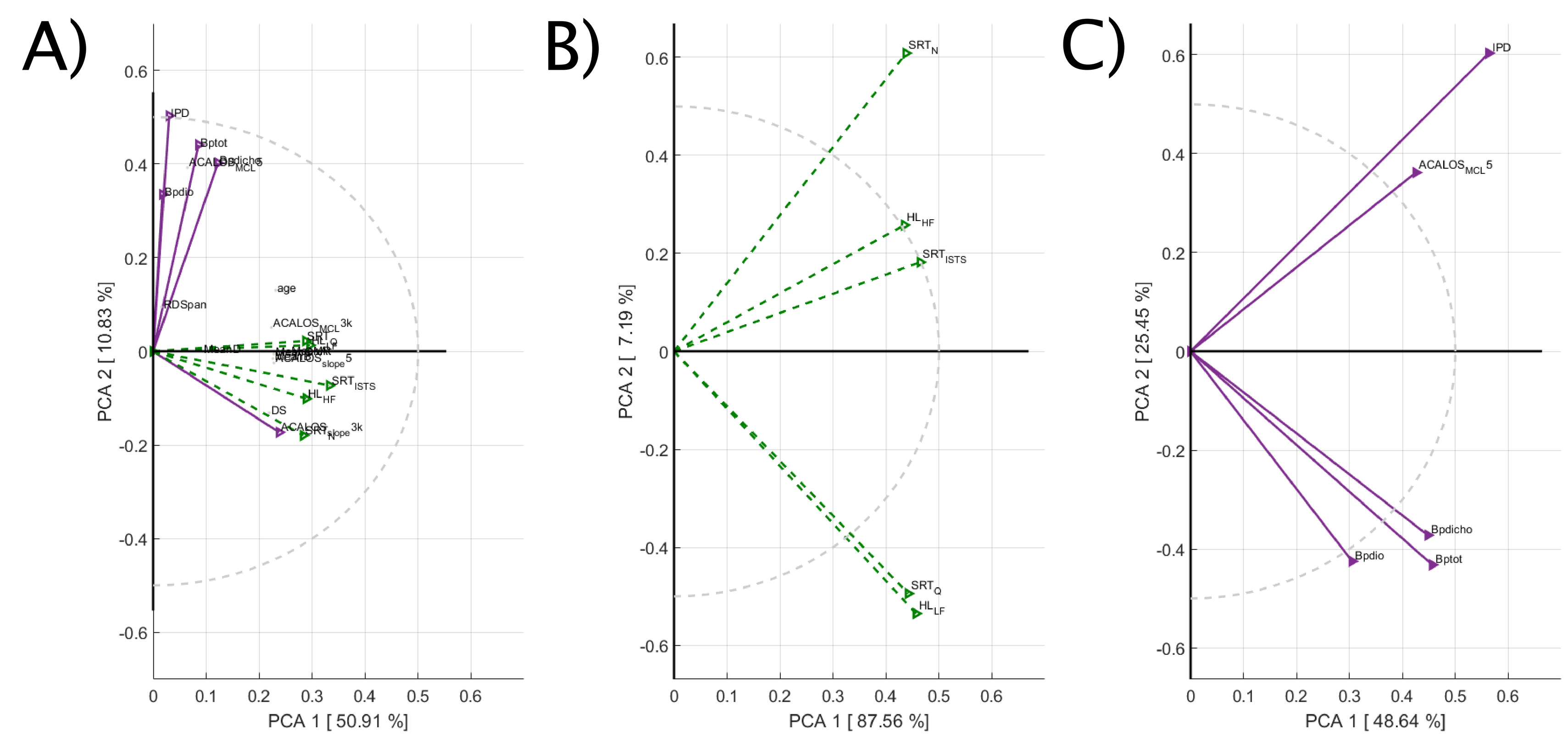


Fig. 3: A) Principal component analysis of the dataset. After crossvalidation the optimal number of components was five. B) PCA after dimensionality reduction by crossvalidation with the 5 variables higly correlated to PCA1 (~95%). C) same as B) but for PCA2 (~73%). Proposed listening tests consisted of the 10 tests in B and C.

II & III. Archetypal analysis and Profile identification

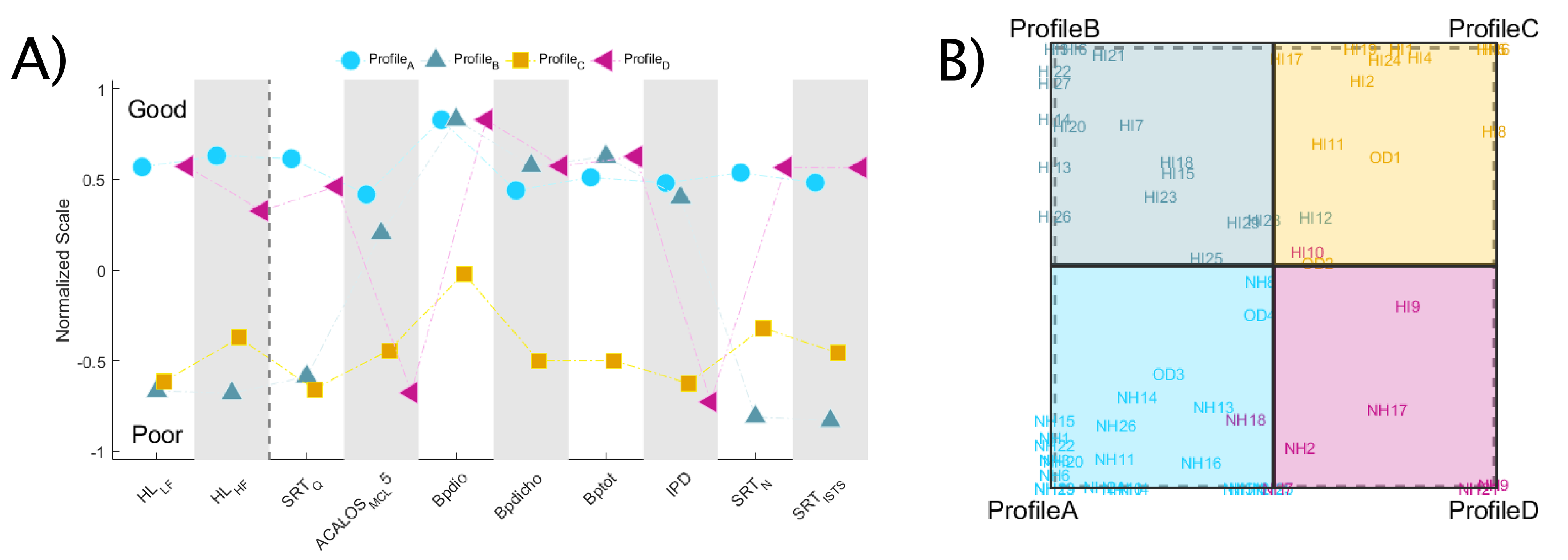


Fig. 2: A) **Arquetypes,** trends found in the data for each profile and for the proposed listening tests. **4 archetypes** resulted from the achetypal analysis which could explain 88 % of the variance. B) Each listener is placed in the "Square Visualization" depending on the similarity to each **archetype.**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

IV. Supervised learning: Classification

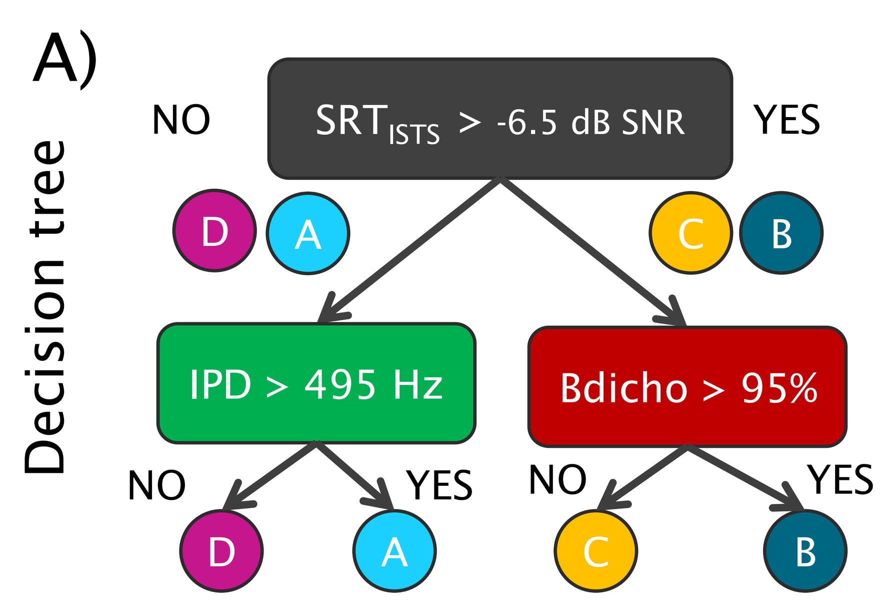
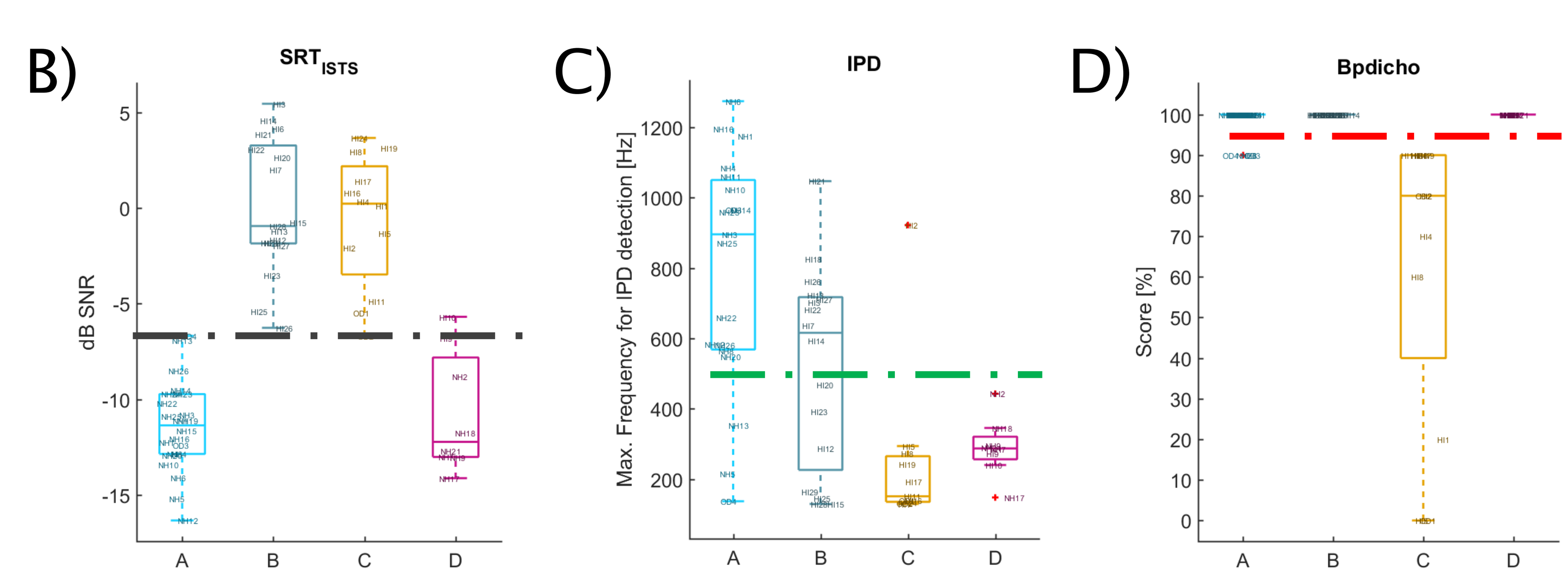


Fig. 4: Supervised Learning. A) Decision tree obtained by using the raw data as an input and the **auditory profiles** as the output. The classification was based in the variables SRT_{ISTS}, IPD and Bpdicho. B) Boxplots of the Speech reception in noise ISTS (SRT_{ISTS}) C) the lowest frequency for detecting interaural phase differences (IPD) and D) Binaural pitch dichotic (Bpdich). The dashed lines correspond to the limits imposed in the decision tree.



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

Plomp, R. (1978). Auditory handicap of hearing impairment and the limited benefit of hearing aids. *JASA*, *63*(2), 533-549.

Ragozini, G., Palumbo, F., & D'Esposito, M. R. (2016). Archetypal analysis for data-driven prototype identification. *Statistical Analysis and Data Mining: The ASA Data Science Journal*, *4*(5), 497–511.

Strelcyk, O., & Dau, T. (2009). Relations between frequency selectivity, temporal fine-structure processing, and speech reception in impaired hearing. *The Journal of the Acoustical Society of America*, *125*, 3328–3345.

Thorup, N et al. (2016). Auditory profiling and hearing-aid satisfaction in hearing-aid candidates. *Danish Medical Journal*.