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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 audiubility 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

Supervised

I. Dimensionality Reduction: PCA

II & III. Archetypal analysis and Profile identification

IV. Supervised learning: Classification

Test Battery for auditory profiling

Thorup et al. (2018) 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.

I. Dimensionality Reduction: PCA

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

II & III. Archetypal analysis and Profile identification

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.

IV. Supervised learning: Classification

Fig. 4: Supervised Learning. A) Decision tree obtained by using the two data as an input and the auditory profiles as the output. The classification was based in the variables SRTTIS, IPD and Bp/dh. B) Respsion of the Speech reception in noise (ETIS) SRTTIS C) the lowest frequency for detecting interaural phase differences (IPD) and D) Binaural pitch dichotic (Bp/dh). 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


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