Evaluation of a new hearing aids fitting formula customized for China: Adaptive Phonak Digital Tonal

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Abstract
This project aims in developing and validating a fitting formula adapted to the special requirements of hearing impaired people in China (Adaptive Phonak Digital Tonal, APDT), and compare the performance of APDT with the proprietary fitting formula (standard Adaptive Phonak Digital, APDS) [8].

A pilot study was conducted to determine a new formula based on APDS to achieve better speech quality for tonal languages. In the pilot study, 19 hearing impaired subjects from Beijing evaluated sound samples recorded with hearing aids fitted to their hearing loss and modified in terms of gain model and adaptive parameters. The best rated modification was used for the formal study of APDT validation. In the validation study, 30 subjects with moderate to severe hearing loss were fitted with both APDT and APDS in random order. Speech tests were conducted in three conditions: unaided, aided with APDS and APDT. A subjective evaluation was performed to compare both fitting formulas.

The pilot study suggested the modification with tonal gain model and dual compression was rated the best and therefore was implemented into APDT. For the validation study, the speech test results showed significant differences in speech intelligibility between APDS and APDT in quiet (p<0.05) and in noise with 5dBSNR (p<0.05) and 10dBSNR (p<0.005). In addition, subjective evaluation also showed significant differences in overall impression between the two fitting formulas (p<0.005). Compared to APDS, the default settings in APDT resulted in clear first order advantages both in speech intelligibility and perceived overall impression by the subjects. APDT has become available in Phonak fitting software since May 2015.

Background and Motivation
- Mandarin (Putonghua) is a tonal language spoken by 1.3 billion people in mainland China. The main difference to non-tonal languages is the change of the lexical meaning of a syllable by changing the tone pitch or pronunciation. While the Long Time Average Speech Spectrum (LTASS) is regarded as similar across languages [1], various retrieved Frequency Important Functions (FIF; see fig. 3) suggest a higher importance of the low frequency area below 125Hz and the area around 2000Hz for Mandarin than English [2][9][10].
- Internal analyses of hearing loss configurations and fitting data revealed that many Chinese customers choose a monaural fitting when their (binaural) hearing loss is at least moderate in low frequencies. The initial fitting process is relatively hard for customers with a moderate to severe hearing loss given that longer deprivation of the auditory nerve leads to a more difficult adaptation phase [4]. Additionally, monaural fittings require a different gain setting than binaural fittings, which are less common in China than in other countries. In addition, there's a large variability of professional training among the fitters in China, so the hearing aid fitting process in China is performed in various ways with some differences to other countries, e.g. the preferred use of another coupling (see fig. 4). Considering the above differences in languages, hearing loss configurations and fitting processes within China compared to those in Western countries, a new customized process is desired to meet the local HCP's and customers’ requirements as much as possible.

Research Questions
- Which modification of the standard fitting formula are preferred in terms of loudness, timbral balance, clarity, naturalness and overall impression by Mandarin native speakers? Will the tonal adaptation based on the most preferred modifications result in 1) a benefit in terms of speech understanding and 2) a better subjective rating compared with APDS?

Participants & Methods

- Subjects
  - 30 subjects
  - 18 inexperienced, 12 experienced with hearing aids
  - Moderate to severe binaural hearing loss
  - Mean age 80 years (younger 26, oldest 86 years)

- Test Devices
  - Phonak Bolero O50 P and SP with universal ear tip
  - Fitted according to APDS or APDT

- Settings
  - Monaural fitting
  - Default acoustic parameters in the fitting software: APDS: slim tube and slim tip, APDT: standard tube and universal ear tip
  - Programs “Calm situations” and “Speech in noise” activated for the different conditions (speech in quiet and speech in noise) manually selected

- Data Collection Location
  - Otolaryngology - Head & Neck Surgery, Beijing Tongren Hospital, Beijing Institute of Otolaryngology, Capital Medical University, Beijing, China

- Audiological Tests & Outcome Measures
  - Unaided
  - Speech in quiet 65dB
  - Speech in noise SNR10dB and SNR5dB (speech 65dB) 50%NR
  - Subjective assessment (with questionnaire)
    - Loudness and familiarity of own voice
    - Clarity of ambient noises and sound from fitting software
    - Overall preference of APDT vs. APDS

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Discussion and Conclusion

The speech test results support that Adaptive Phonak Digital Tonal is a well-working precancellation. It fulfills the most important requirements for an initial fit in China, with significant improvement of speech intelligibility as well as a high spontaneous acceptance rate. The new tonal adaptation provides a good first-fit speech intelligibility and a comfortable listening experience for Mandarin speakers.

In order to investigate any long time effects or improvements, the fitting formula should be validated in home trials. This would help further confirm the real life benefit of the proposed approach.

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References