Introduction: Why consider alternatives to the audiogram for hearing aid fitting?

• Audiograms add significantly to the price of hearing aids, and increase the effectiveness of hearing aid fitting for people who already use hearing aids.

Aims: The specific objective of this study was to investigate the efficacy of a novel tool for the measurement of hearing, hearing aid fitting, fine tuning, and validation. The tool is an online speech perception test (SPT) that generates phonetic and acoustic measures that can be used to generate initial and improved hearing aid fittings and evaluate the bowler scores.

Methods: The SPT is a monosyllabic word test with 50 items that generates a display of information transmission for ten vowel and consonant features that can be used to characterise the shape and degree of hearing loss, analogous to an audiogram. A pilot study was performed with 88 people to assess the sensitivity and specificity of the SPT. Correlation analysis was performed for conventional audigrams and “speech audiograms” derived from the information transmitted for 408 people. Hearing aid fittings were derived from unaided SPT results and added SPTs were used to measure the perceptual benefit of the hearing aids, and fine tune the fittings.

Results: The SPT had high sensitivity (94%) and high selectivity (88%) relative to other online and telephone hearing test methods. At every frequency, there was a highly significant correlation (p<0.001) between conventional audigrams and speech audiograms. Proof of concept for hearing aid fitting and fine tuning based on unaided and added SPT measures has been achieved and illustrated with specific cases. These are in situ measures and do not require corrections for factors such as venting, RECD, microphonics etc. SPT results and hearing aid test box speech maps indicated that actual and predicted performance were at least as good for the SPT-based fittings as for audiogram-based fittings.

Conclusions: The high correlation between SPT results and audiograms demonstrated the feasibility of this approach to hearing aid fitting. Pilot test results and preliminary fitting data indicate that the SPT and the acoustic phonetic analysis are effective tools for the measurement of hearing, hearing aid fitting, fine tuning, and validation.

Significance: When combined with an effective tele-audiology business model, the use of speech perception results and acoustic phonetic measures that are easily understood by the general public have the potential to reduce the costs of hearing aid provision and increase the effectiveness of hearing aid fitting, thereby reducing the financial and social burdens of hearing loss for individuals.

Figure 2. The original ADRO® fitting method started with the audiogram. The most recent fitting method replaced the first step with the SPT and Infogram™ as in Figure 3. The Infogram™ is also used to fine tune and validate the fitting.

Figure 3. The latest ADRO® fitting method starts and finishes with the Infogram™. This client improved from 2 to 40 words correct out of 50 and from 17 to 91 consonants correct out of 100.

Results:

• The distribution of SPT scores showed 94% sensitivity and 98% specificity for hearing loss compared with 65% and 83% for the commonly used telephone digit screening test [2].

• High return rates and in-launch hearing aid fittings indicate that many people are dissatisfied with hearing aids fitted using the conventional audiogram.

Information transmission analysis of the vowel and consonant confusions of the SPT showed the pattern of errors associated with the hearing loss. ADRO® 2012 [3], the 10-Item AB Word test was analysed in a similar way with very variable results. The 50-Item SPT gave much more reliable patterns and it was possible to calculate a “speech audiogram” from the Infogram™ [4]. Similar analysis yielded reliable predictions for equal loudness contours, maximum gains and maximum output levels for hearing aid fitting.

Conclusions:

The SPT and Infogram™ or “speech audiogram” are an effective alternative to the conventional audiogram for hearing aid fitting, with several advantages.

1. The unaided SPT is a measure of what the listener needs to hear and is readily understood by a lay person.

2. The SPT has high sensitivity and specificity for adult listeners with English as their first language.

3. The SPT is freely available online and does not require expensive equipment or highly trained personnel.

4. The SPT fitting method is an in-situ measurement that directly addresses the needs and preferences of the client for comfortable listening, improved speech intelligibility, and improved sound quality, rather than the mechanical tuning of amplification.

5. The method automatically takes into account individual differences between people, minimizing the need for fine tuning. The method makes a direct measurement in speech intelligibility and a high level of satisfaction.

6. Using the Infogram™ to fit hearing aids led to significantly greater improvements in speech intelligibility and a high level of satisfaction compared to the conventional hearing aid based fittings in this study.

7. The added SPT word score is a measure that directly demonstrates the benefit of hearing aids to the listener.

8. The fitting method does not require expensive equipment or a high level of training, potentially making it a low-cost hearing health for millions of people.