Prediction of the air-bone gap: can it be done without a bone conductor?

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Introduction

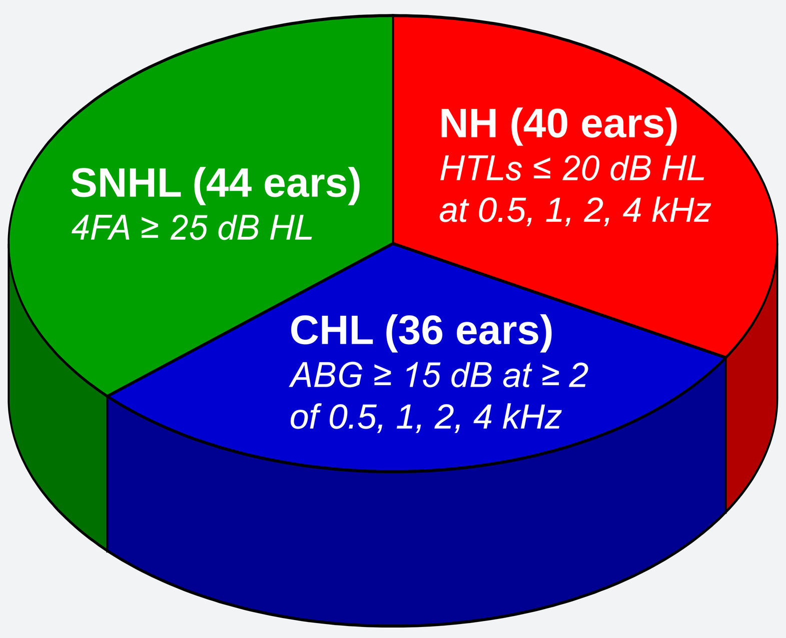
Identification of conductive hearing loss (CHL) is a critical component of audiological assessment, as the aetiology of the loss will often dictate the appropriate rehabilitation pathway. In a clinical setting, a combination of otoscopy, tympanometry, and pure tone air- (AC) and bone-conduction (BC) audiometry is used to determine the site of lesion. However, there are several contexts in which BC audiometry, in particular, is impractical or impossible. These include self-administered adult hearing screenings, in situ measurements of hearing thresholds, and self-fitting hearing aids that rely on the reliability and validity of both of the above.

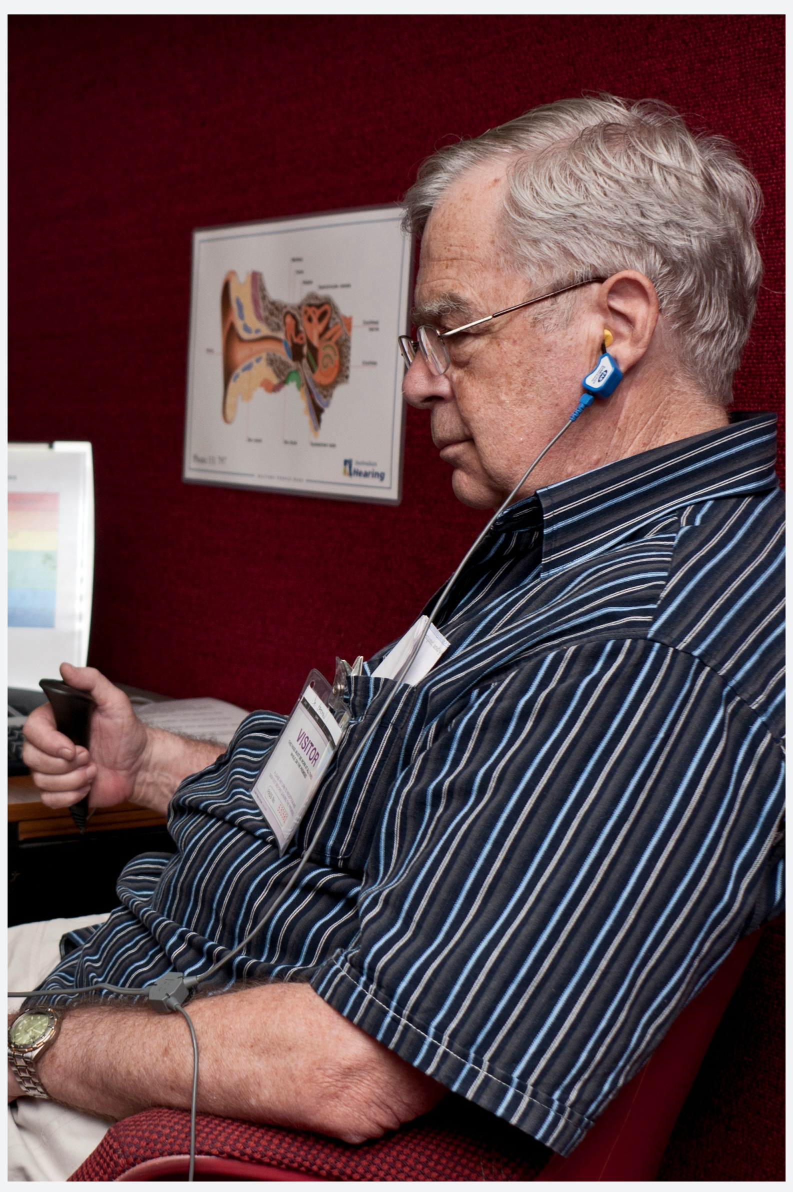
The aim of this study was therefore to determine whether a combination of conventional AC audiometry and a tone-in-noise (TIN) threshold test can reliably and validly detect the presence and size of an air-bone gap (ABG). Our hypothesis was that participants will perform differently on these tests according to their loss type:

	AC thresholds in quiet	TIN thresholds
NH	normal	normal
CHL	*outside normal range* (loss of sensitivity)	normal (normal cochlear tuning)
SNHL	*outside normal range* (loss of sensitivity)	*outside normal range* (impaired cochlear tuning)

Method

Data were collected from 120 ears on 64 participants, 33 female and 31 male. Participants ranged in age from 18 to 81 years, with a median age of 62 years (s.d. = 20 years). Only participants with stable hearing thresholds (according to self-report) were included in the study group.





Five hearing tests were given in a randomised order. All tests were presented monaurally via an insert earphone at 0.5, 1, 2, and 4 kHz.

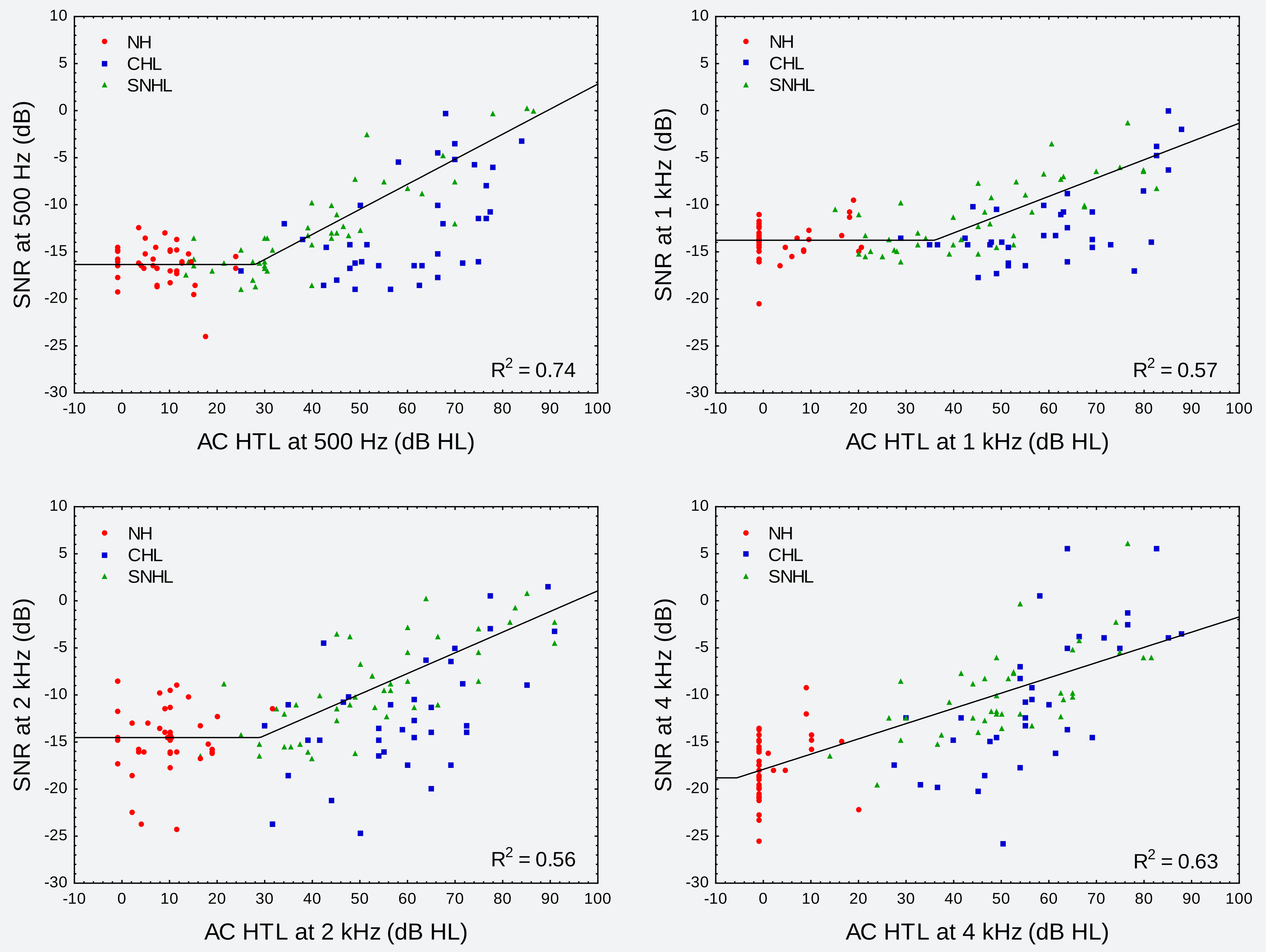
- Manual AC and BC audiometry
- Automatic AC audiometry (test-retest)
- Automatic TIN test (test-retest)

What is the TIN test?

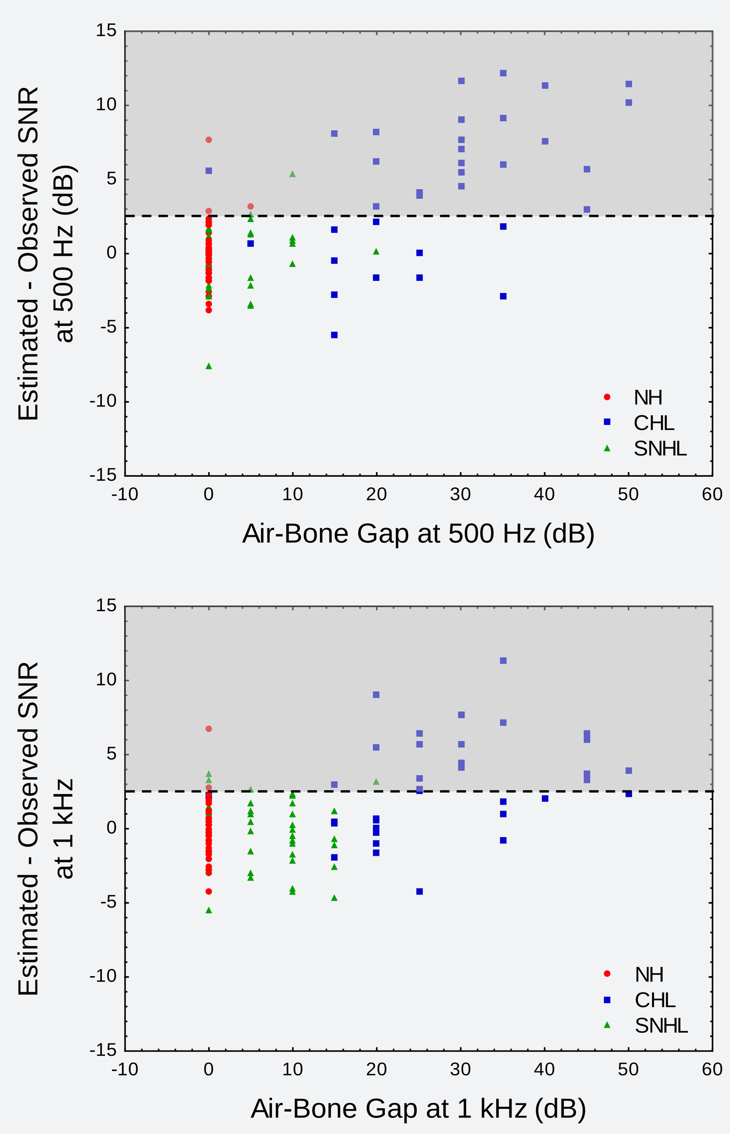
The TIN test determines the lowest signal-to-noise ratio (SNR) at which a pure tone can be detected in a background of modulated narrowband noise (NBN).

Results

The figures below show thresholds in noise as a function of thresholds in quiet. For hearing-impaired participants without CHL (green triangles), TIN thresholds increased linearly with their thresholds in quiet. Many participants with CHL (blue squares), however, demonstrated normal TIN thresholds despite impaired thresholds in quiet.



A non-linear function was fitted to the data obtained from the 84 ears without CHL and is shown with a black line on the graphs above. The function can be used to predict the TIN threshold from the threshold in quiet for NH and SNHL ears. If the measured TIN threshold deviates sufficiently from the predicted TIN threshold, the presence of CHL is assumed.



The graphs to the left illustrate that if a cutoff value of 2.5 dB is arbitrarily chosen, and if this criterion is met at *either* 0.5 *or* 1 kHz, a **sensitivity of 79%** and a **specificity of 98%** are achieved. These values are only preliminary and will be further optimised.

The size of the ABG also has an effect on the difference between the measured and predicted TIN thresholds. As the ABG grows larger, so too does the size of the deviation.

Preliminary Conclusions

The presence of CHL can be predicted with at least 80% accuracy through the use of two AC tests: standard audiometry and a TIN detection test. The accuracy of the prediction increases with the size of the ABG.