Tinnitus perception and the effects of a self-programmable hearing aid on hearing fluctuation due to Ménière's disease

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Abstract

Fifty patients with Ménière's disease rated their subjective perception of tinnitus loudness just before measuring their own hearing thresholds 3 times a day for a period of 8 weeks. Tinnitus loudness was recorded using a subjective scale 1-5. Hearing thresholds were recorded in dBHL as tested in-situ at 14 frequency bands using a portable programmer connected to custom fitted hearing aids. This equipment allowed the hearing aids to be automatically programmed to the given hearing loss at the end of each self-hearing testing. Patients were given the option to continue wearing the hearing aids and portable programmer to adjust for hearing fluctuation.

Data analysis showed no correlation between changes in tinnitus loudness perception and hearing fluctuation. Usage of self-programmable hearing aids caused a positive impact on tinnitus perception in this group: 20% reported not hearing their tinnitus while wearing their aids, 69% perceived their tinnitus softer and 11% did not notice any changes. Importantly, none of the patients in this group noticed an increase in tinnitus loudness while wearing optimally fitted hearing aids.

Tinnitus is one of the symptoms afflicting patients with Ménière's disease along with fluctuating hearing loss, ear fullness and episodic vertigo. Hearing loss is known to impact on tinnitus severity.[1] It was assumed that patients with Ménière's disease would perceive their tinnitus as more severe when hearing thresholds were worse.

Hearing aids are recommended as treatment to reduce tinnitus perception.[2] A survey amongst a group of 126 patients with tinnitus due to various aetiologies who wore optimally fitted hearing aids showed that 31% did not perceive tinnitus while wearing suitable amplification and 42% noticed a significant reduction in tinnitus loudness when with their hearing aids on.[3]

Fluctuating hearing however, complicates the fitting of hearing aids in patients with Ménière's disease but this maybe overcome by using a self-programmable hearing aid.[4,5]

This study investigated the correlations of hearing fluctuation with changes in tinnitus loudness and the effects of a self-programmable hearing aid on tinnitus perception in a group of patients with Ménière's disease.

Methods

Ethics—Ethical approval for this project was obtained from Macquarie University Ethics Review Committee (Human Research).

Subjects and protocol—Fifty participants were chosen if they had a hearing loss in at least one ear due to Ménière's disease as diagnosed by a specialist in otolaryngology. Diagnostic criteria were based on Gibson's 10 points scale with score equal or greater than 7,6 or the AAOHNS level of "Certain Ménière's".7 They also needed to be conversant with technology and prepared to test their own hearing at home several times a day for a period of at least 8 weeks. They were all given the option to wear the hearing aid(s) during the period of the study as long as those inexperienced with amplification followed a strict acclimatization protocol. The subjects who had not received amplification before were

explicitly instructed to start by wearing the hearing aid for only one hour, building up an extra hour daily and not to wear the new instrument outside their homes or in a noisy environment for at least the first week. At the end of data collection they were given the option to continue wearing the hearing aids and portable programmers.

Instruments and procedures—The Widex Senso Diva and Inteo range of hearing instruments were selected because they interface with a portable programmer (SP3 and IP5) and allow in-situ unaided hearing threshold measurement (Sensogram™) through the hearing aid set in test mode. Sensogram results are used to automatically program the hearing aid for the given hearing loss, according to proprietor fitting algorithm.

Participants were fitted either monaurally or binaurally, according to their hearing loss, with hearing aids selected according to the available range for each individual's needs. Participant's preferences were considered when more than one hearing aid style was suitable. Ear impressions were taken by the audiologist and custom hearing aids (ITC or CIC) or ear moulds for BTE style were made by Widex Australia.

Hearing aid fitting protocol was based on the Widex proprietor's procedure using the expanded Sensogram.[8] The audiologist performed the fitting in the clinic, using the Widex Compass software connecting the hearing aid to a desktop computer via the Noah Link interface and the proprietor's fitting protocol was followed using the "expanded Sensogram". This protocol comprises of measuring the hearing thresholds in-situ (through the hearing aid) followed by the feedback test. The Widex Compass software automatically programs the hearing aids based on these two measurements. Fine-tuning of the hearing aids was performed as required, following the proprietor's software guide.

Self-hearing test and hearing aid programming using the portable programmer—Participants were instructed to connect their hearing aids to the portable programmer device and to measure their own hearing thresholds performing an expanded Sensogram (Figure 1). The Widex IP5 interfaced to the hearing aid and set on "test mode" produces 14 frequencies of narrow band noises in 5dB steps. The instrumentation allows for accurate hearing test providing the hearing aid receiver and ear canal are free of debris and the procedure is conducted in a quiet environment.

Figure 1: Photograph showing participant using portable programmer

Data collection—Hearing thresholds were measured in dBHL at 14 frequencies using 5 dB steps. Subjective perception of tinnitus loudness (without the hearing aid) using a scale 1-5 was recorded immediately prior to measuring the hearing thresholds in a quiet environment. Data was collected 3 times a day over a period of 8 weeks and recorded (Table 1).

Table 1: example of records obtained by one participant over a 24 hour period. *Meaning of grading 1-5 for tinnitus loudness perception: 1= no tinnitus, 2= mild tinnitus, 3 = moderate tinnitus, 4 = severe tinnitus, 5 = extreme tinnitus

Date: 7/2/03 Time: 2pm	**250 Hz**	**350 Hz**	**500 Hz**	**630 Hz**	**800 Hz**	**1000 Hz**	**1250 Hz**	**1600 Hz**	**2000 Hz**	**2500 Hz**	**3200 Hz**	**4000 Hz**	**6000 Hz**	**8000 Hz**	***Tinnitus**
Right ear	50dB	60dB	60dB	60dB	60dB	60dB	55dB	60dB	45dB	25dB	35dB	40dB	40dB	40dB	3
Left ear	50dB	55dB	50dB	50dB	45dB	45dB	45dB	50dB	65dB	65dB	75dB	80dB	80dB	80dB	2
Date: 7/2/03 Time: pm	250 Hz	350 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3200 Hz	4000 Hz	6000 Hz	8000 Hz	Tinnitus
Right ear	50dB	50dB	45dB	40dB	35dB	20dB	15dB	25db	25db	25db	50db	55dB	55dB	60dB	2
Left ear	45dB	55dB	50dB	45dB	45dB	45dB	45dB	60dB	65dB	70dB	80db	80dB	80dB	80dB	2
Date: 7/2/03 Time:7pm	**250 Hz**	**350 Hz**	**500 Hz**	**630 Hz**	**800 Hz**	**1000 Hz**	**1250 Hz**	**1600 Hz**	**2000 Hz**	**2500 Hz**	**3200 Hz**	**4000 Hz**	**6000 Hz**	**8000 Hz**	**Tinnitus**
Right ear	60dB	55dB	55dB	55dB	50dB	50dB	45dB	45dB	35dB	30dB	35dB	45dB	45dB	45dB	4
Left ear	45dB	55dB	50dB	50dB	45dB	45dB	50dB	65dB	65dB	70dB	80dB	80dB	80dB	80dB	3

Self-tested hearing thresholds and grading of tinnitus loudness perception, as provided by participants, were entered into a Microsoft Excel spreadsheet and exported into SPSS software for analysis.

Results

Sixty-nine ears were fitted with hearing aids and the data from every ear provided by each of the 50 participants were displayed in a graph.

Only one single tested frequency out of the total 14 was used from each individual ear to facilitate the analysis of hearing fluctuation over time. The chosen frequency was the one presenting the greatest dB change for each individual's ear.

Correlation between tinnitus loudness and hearing fluctuation—Graphs from the results of 69 ears were obtained showing hearing thresholds and tinnitus loudness fluctuation over time from data provided by the 50 participants. Observation of these graphs did not suggest any consistent relationship between hearing fluctuation and changes in perception of tinnitus loudness. An obvious feature of these results was the variability over participants. The coefficients varied from negative to positive.

Figures 3, 4 and 5 are examples showing hearing fluctuation at one single frequency and changes in tinnitus perception (Y-axis) over time (X-axis).

Y-axis shows hearing thresholds (dBHL) as measured at the frequency (Hz) with greatest hearing fluctuation for that individual ear, together with the variation of tinnitus perception graded 2, 3, 4 or 5 over the number of measurements (observations).

To increase visualization on the Y-axis, for the purpose of these graphs, tinnitus grading was re-classified as 10, 20, 30 and 40 (for subjective ratings of 2, 3, 4 and 5 respectively) and as zero (for participant's ratings of 1).

The numbers on the X-axis represents each time a measurement was obtained (observations) by the participant during data collection.

Correlations are described at the bottom of each graph. A positive correlation indicates a tendency for hearing thresholds to worsen as tinnitus loudness increases, while a negative correlation means an improvement in hearing as tinnitus perception decreases.

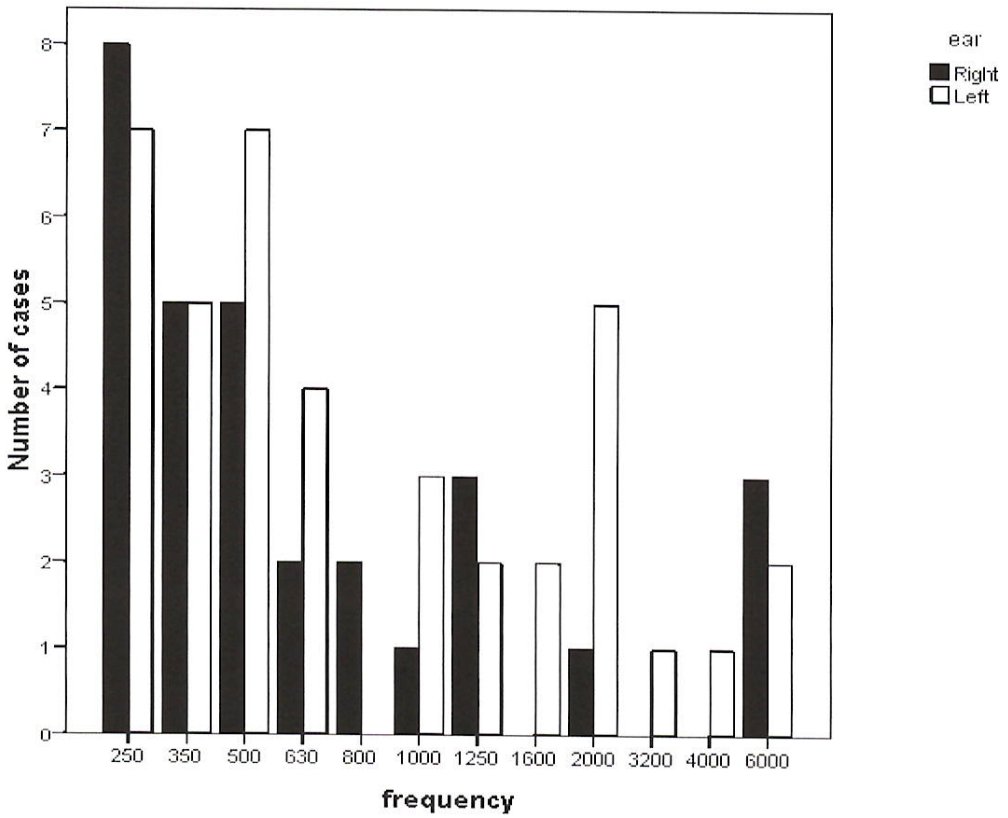

Figure 2: Frequencies that presented the greatest hearing threshold fluctuation (X-axis) for right and left ear of individual participants (Y-axis).

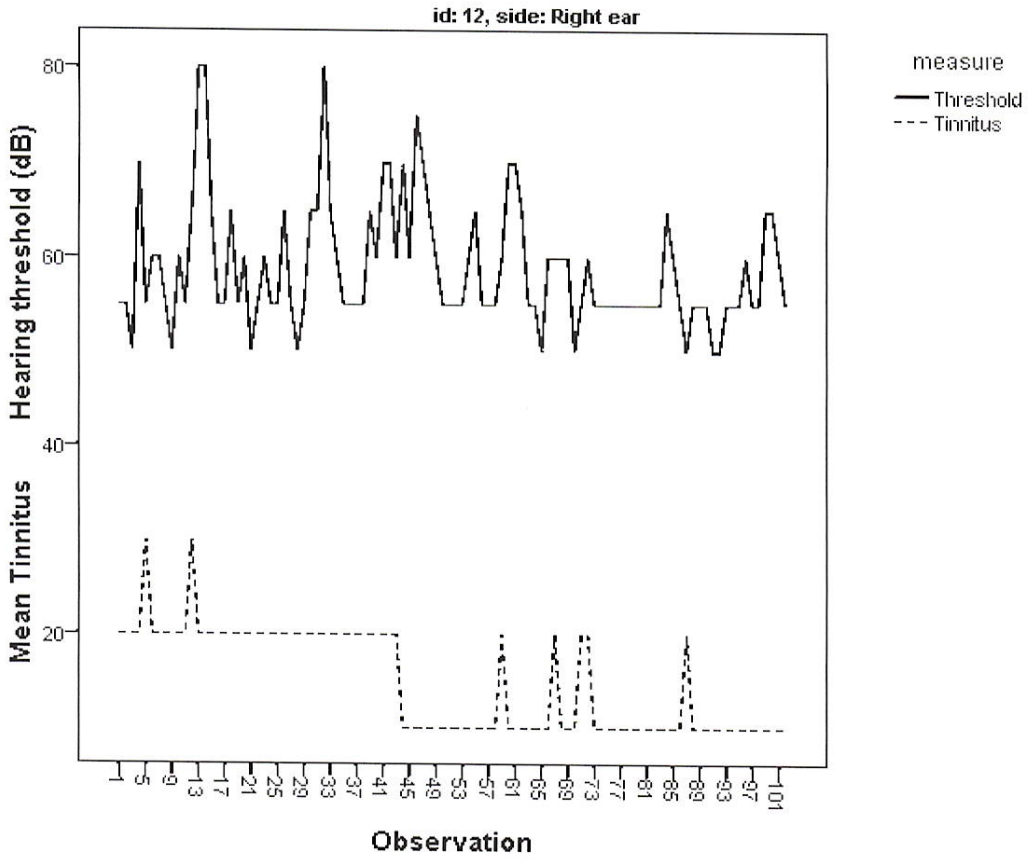

Figure 3: Participant 12's hearing thresholds and tinnitus fluctuation in the right ear during data collection. Correlation between hearing threshold and tinnitus was –0.229

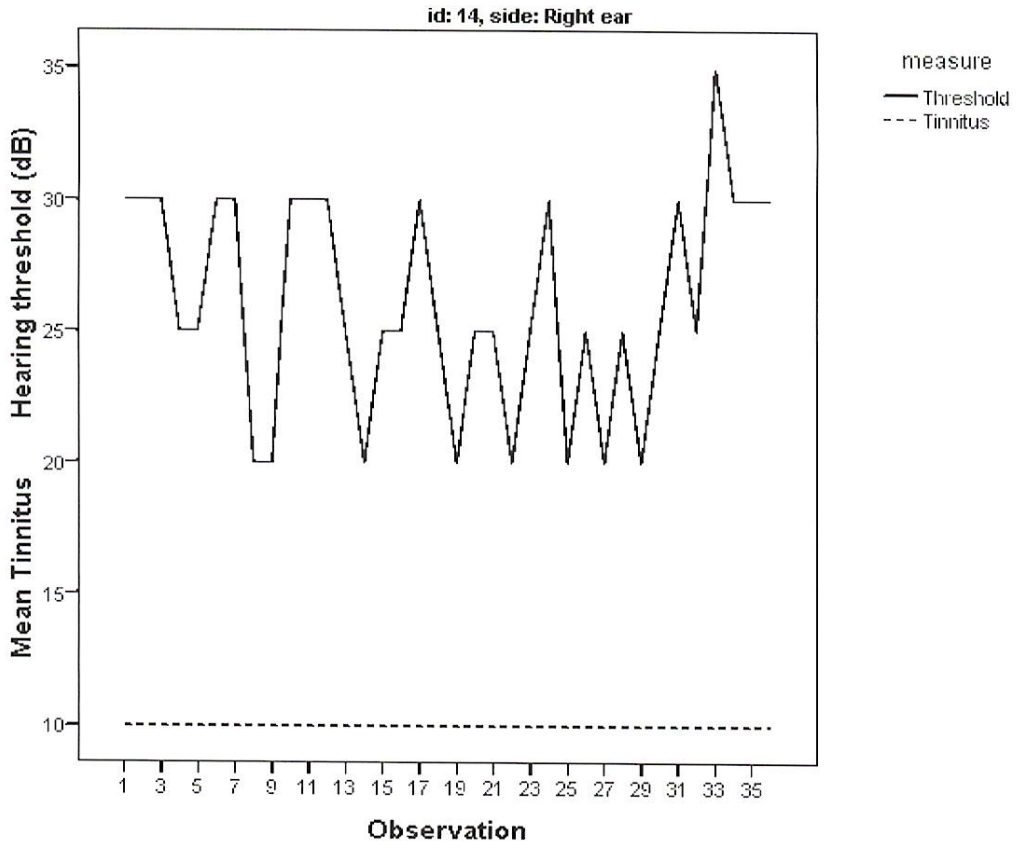

Figure 4: Participant 14's hearing fluctuation in the right ear and no changes in tinnitus during data collection.

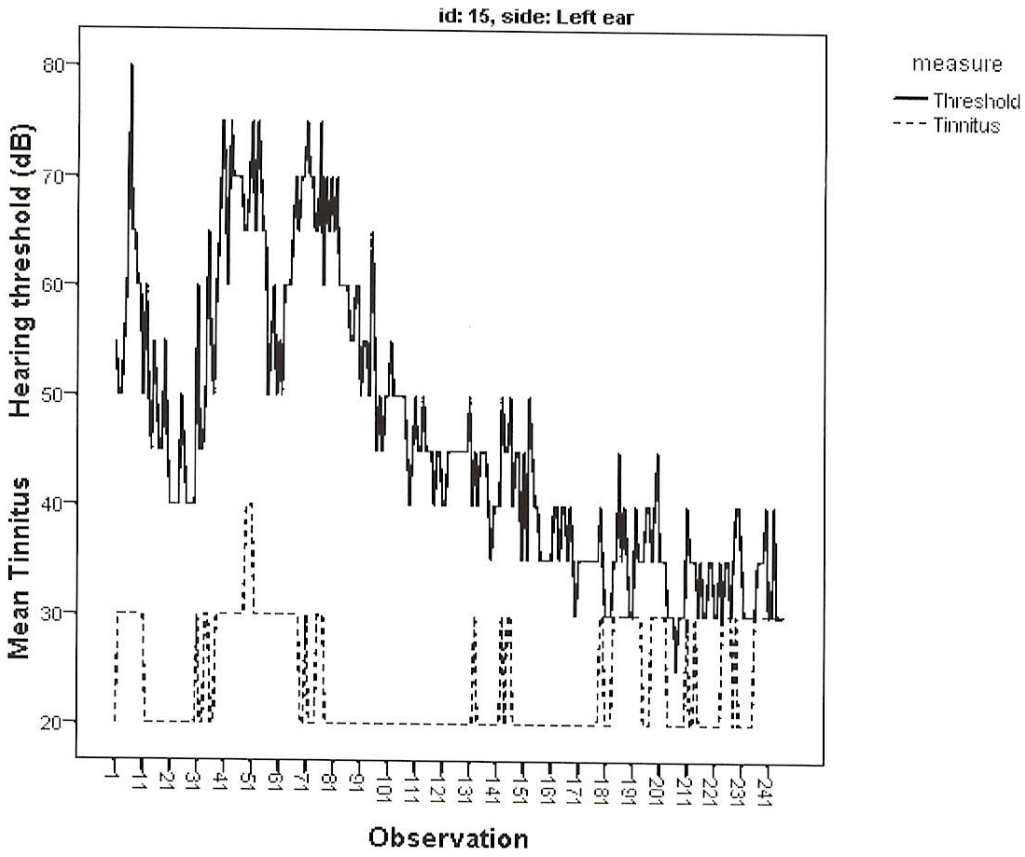

Figure 5: Participant 15's hearing and tinnitus fluctuation in the left ear during data collection. Correlation between hearing threshold and tinnitus was 0.202

Statistical analysis—The relationship between tinnitus loudness perception and hearing threshold fluctuation over time was further analysed by computing cross-correlations between tinnitus grading and hearing threshold at one single frequency over all observations. These were calculated separately for each tested ear of every subject.

Participants who did not report any variation in tinnitus perception during the study period were excluded from this analysis. First order differences were used to remove the effects of systematic changes over time in either of the measures on the correlations.

As noted in the analysis, there was a great variability of the results over participants. The means, medians, minima and maxima for the distribution of each cross-correlation are shown Table 2.

Table 2: means, medians, minima and maxima for the distribution of each cross-correlation

Statistics

Cross Correlation

2 Max threshold variation in the left ear with Tinnitus	N	Valid	37
		Missing	0
	Mean		.12701
	Median		.09601
	Std. Deviation		.229047
	Minimum		-.570
	Maximum		.627
5 Max threshold variation in the right ear with Tinnitus	N	Valid	25
		Missing	0
	Mean		.02042
	Median		.00019
	Std. Deviation		.216036
	Minimum		-.429
	Maximum		.564

These results do not suggest any consistent relationship between changes in tinnitus loudness perception and hearing threshold fluctuation for this group of patients with Ménière's disease.

Effects of hearing aids on tinnitus loudness perception—Participants who chose to continue wearing the hearing aids after data collection were further contacted through a survey. A follow-up questionnaire reached 49 of them and 44 replied to a multiple-choice question. They were asked to rate their tinnitus loudness perception while wearing the hearing aids as either: a) louder, b) softer, c) the same, d) cannot hear it.

Figure 6 is a summary of the results. The majority of respondents (69%) reported hearing their tinnitus softer; 20% cannot hear it at all; 11% perceived no changes and none noticed the tinnitus any louder with their hearing aids on.

This survey indicated that optimally fitted hearing aids are useful as a tinnitus management tool for approximately 90% of these participants with Ménière's disease.

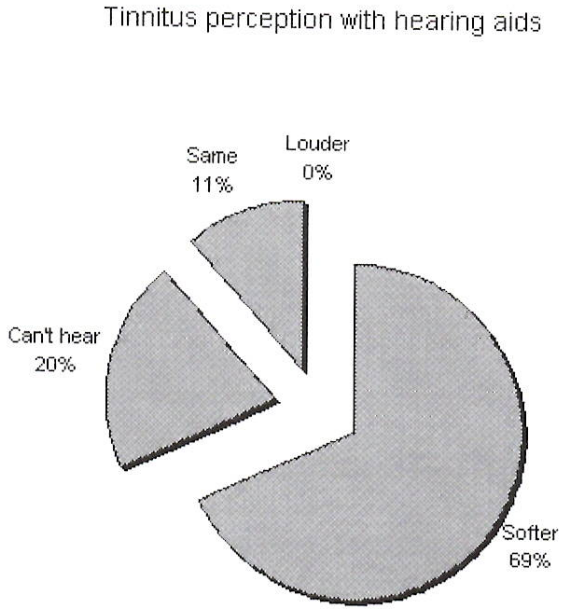

Figure 6: Summary of tinnitus perception with hearing aids

Conclusion

This study demonstrated that tinnitus loudness in patients with Ménière's disease may be reduced by self-programmable hearing aids in spite of any lack of correlation between tinnitus loudness perception and fluctuating hearing loss.

Self-programmable hearing aids were shown to be effective to address the complications of fitting hearing aids for individuals with fluctuating hearing losses. Optimally fitted hearing aids also showed to reduce tinnitus perception for patients with Ménière's disease and the positive effects observed is no different than for other individuals with hearing loss and tinnitus due to other aetiologies.

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