

Dynamic Hearing Protection for People with Hearing Loss

Introduction

Providing effective hearing protection for workers with hearing loss may pose a real challenge for health and safety professionals as the hearing loss of these “workers of concern” is often noise induced and an indicator of low compliancy.

Equipping a person with a moderate to severe hearing loss with a passive protection will add an additional conductive loss and thus isolate this person completely from oral communication, even in less noisy environments. Consequently, he has a tendency to take off his protection when he has a communication need.

As a reduced wearing time reduces quickly the effectiveness of the protection (see e.g. table 1) it is of utmost importance that persons with hearing loss do not get into a vicious circling as sketched in fig. 2 and that they can keep wearing their protection at all times. This can be achieved by simultaneously offering:

- Protections with a very high wearing comfort and
- Protections that do not need to be removed when one needs to communicate

Besides needing a secure protection against noise, hearing impaired workers need a product that does not dampen sound when it is quieter (Ideally it should amplify somewhat in these situations).

Unfortunately, passive hearing protection does not satisfy the requirements as it dampens all sounds, irrespective of their level. Once the noise stops and one needs to listen then the speech and ambient (warning) signals are still attenuated by the same amount. For people with hearing loss, this dampened speech is often too soft leading to lack of speech understanding or removal of the hearing protection devices to understand the speech. This removal is cumbersome and will lead to dissatisfaction and non compliance which in itself will lead to higher noise exposure and more hearing loss.

Active, level dependent hearing protection devices (sometimes also called talk-through devices) are electronic devices which are designed

- (1) To be transparent (or slightly amplifying) in environments with less than 82 dB SPL and
- (2) To limit the noise exposure once above that level. With fast acting electronics this functionality will work well for high static noise levels as well as for impulse noise.

Fig. 3 illustrates the working of such a device.

In this study we present the results of a study carried out with the serenity DP (Dynamic Protection) for people with hearing loss [1]. The serenity DP [2] (fig 4) is a level dependent hearing protection with customized shells. As the latter are designed for optimized wearing comfort (size, fit, weight, compatibility with other headgear like helmets or gasmasks), it completely matches the philosophy of trying to avoid taking the protectors on and off.

As a side benefit, customized shells allow to place the microphones that are required for the active electronics inside the concha. This in turn helps in providing natural sounds and localizing (alarm) signals.

A second appreciable side benefit of the customized shells is that it can be easily verified that they are sealed [3]. Whereas the rationale for a solid verification holds for all wearers of hearing protection, it can be argued that this verification gets a particular meaning and importance for persons with hearing loss.

Methodology

The objective of this study was to compare the difference in speech understanding for people with hearing loss wearing passive (static) and dynamic (level dependent) hearing protection.

All seven subjects were male, aged between 37 and 72 years. The hearing loss in best ear ranged from Fletcher Index 36 dB to 60 dB; in worst ear from 39 to 80 dB. All subjects were hearing instrument users, but the hearing instruments were not used in the testing.

The tests were carried out in a room (normal reverberant with room dimensions of 22*22*8 feet) with 4 loudspeakers presenting diffuse noise fields (no noise, 45,50,55,60,65,70,75,80 dB) and one presenting German speech sentences (Oldenburger Satz test, 70 dB @ 3ft)

The subjects were sitting at 3 and 12 feet from the speaker presenting the speech. All subjects were wearing customized static (serenity SP) and dynamic (serenity DP) hearing protection. All shells were checked with the safety meter excluding any leakage. The sequence of conditions (distance and type of hearing protection) was randomized according to a Latin square design.

Results and conclusions

Figures 5 and 6 shows the average difference in word scores for different noise levels for static and dynamic hearing protection at 1 and 4 meters distances (3 and 12 feet). These figures clearly show that static hearing protection significantly reduces speech understanding in noise levels below 80 dB(A). At the same time, these figures also show that Dynamic hearing protection allows for better speech understanding at non dangerous ambient noise levels than static hearing protection.

Figures 7 and 8 plot the average improvement at 50, 55 and 60 dB(A) noise level at 1 and 4 meter (3 and 12 feet) as function of Fletcher Index of better ear. These figures clearly show that the benefit of dynamic protection tends to increase with increasing Fletcher Index,

Figures 5 through 8 clearly show that people with hearing loss who need hearing protection and who need to communicate or hear ambient signals at times when the noise is not dangerously loud should not get static hearing protection but are better served with dynamic hearing protection.

References:

- [1] H. Mülder, F. Goldberg, "Dynamic Hearing Protection for People with Hearing Loss", efas2009 Tenerife

- [2] Jennifer B. Tufts, Mark A. Hamilton, Amanda J. Ucci, James Rubas, "Evaluation by industrial workers of passive and level-dependent hearing protection devices", in *Noise & Health*, Jan-Feb 2011, Vol 13, Issue 50.
- [3] M. Grigorie, "SafetyMeter", workshop presentation JDVAC2010, see also <http://www.phonak-communications.com/en/hearing-protection/hearing-protection-products/safetymeter-fit-testing-system/>

Maximum protection provided by non-continuous use of Hearing Protection	
Percent time used	Maximum Protection
50%	3 dB
60%	4 dB
70%	5 dB
80%	7 dB
90%	10 dB
95%	13 dB
99%	20 dB
99.90%	30 dB

Fig 1: Effects of wearing time on effectiveness of hearing protection

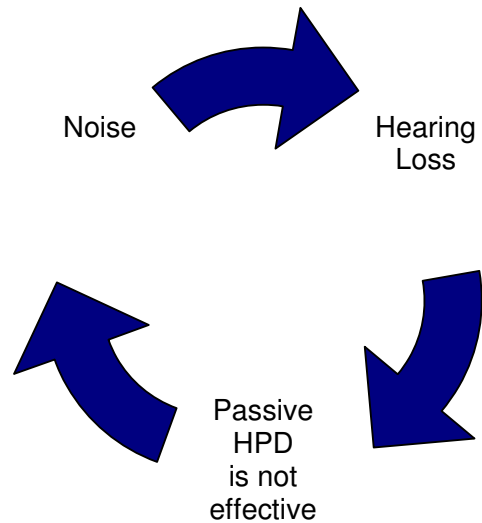


Fig 2: The vicious circle for people with hearing loss

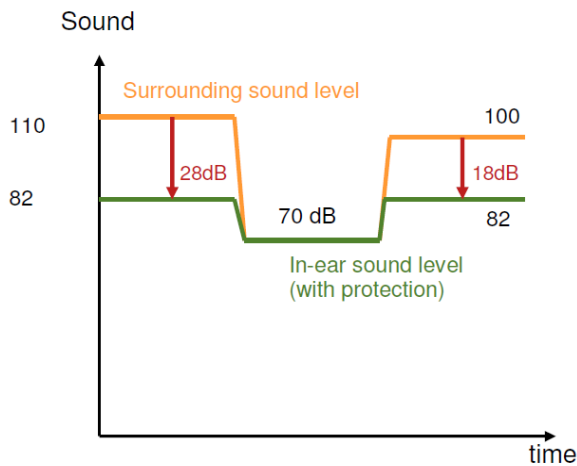


Fig 3: Principle of Dynamic Protection



Fig 4: The Serenity DP

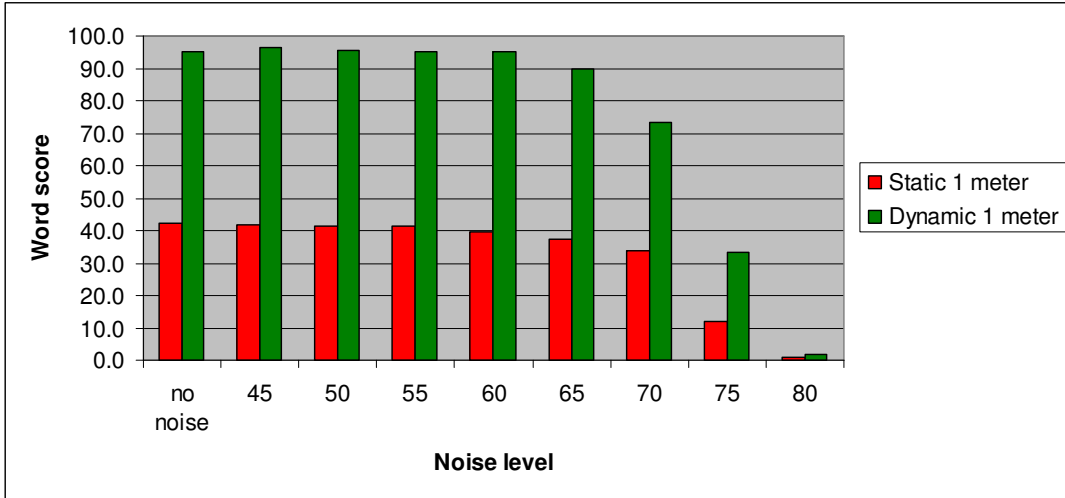


Fig. 5: Word score for different noise levels for static and dynamic hearing protection at 1 meter (3 feet)

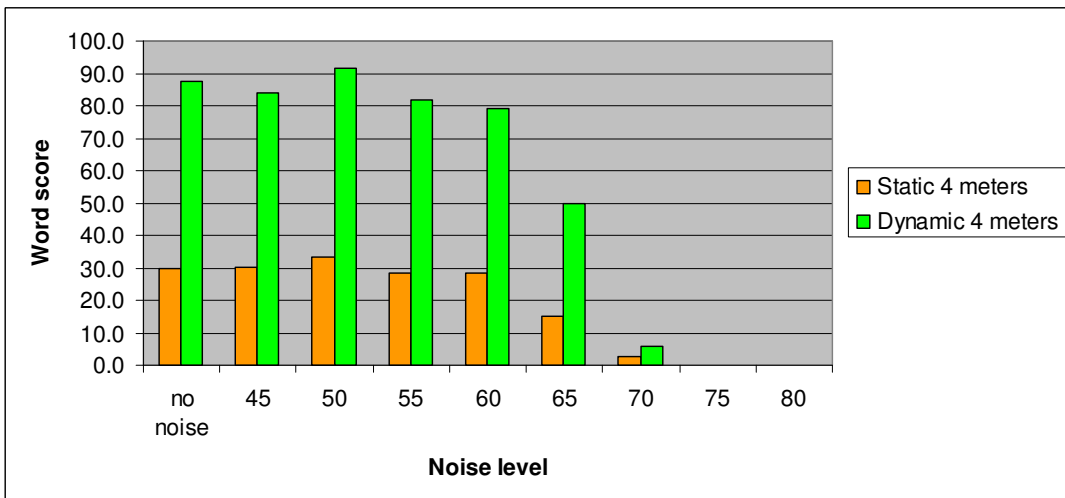


Fig 6: Word score for different noise levels for static and dynamic hearing protection at 4 meters (12 feet)

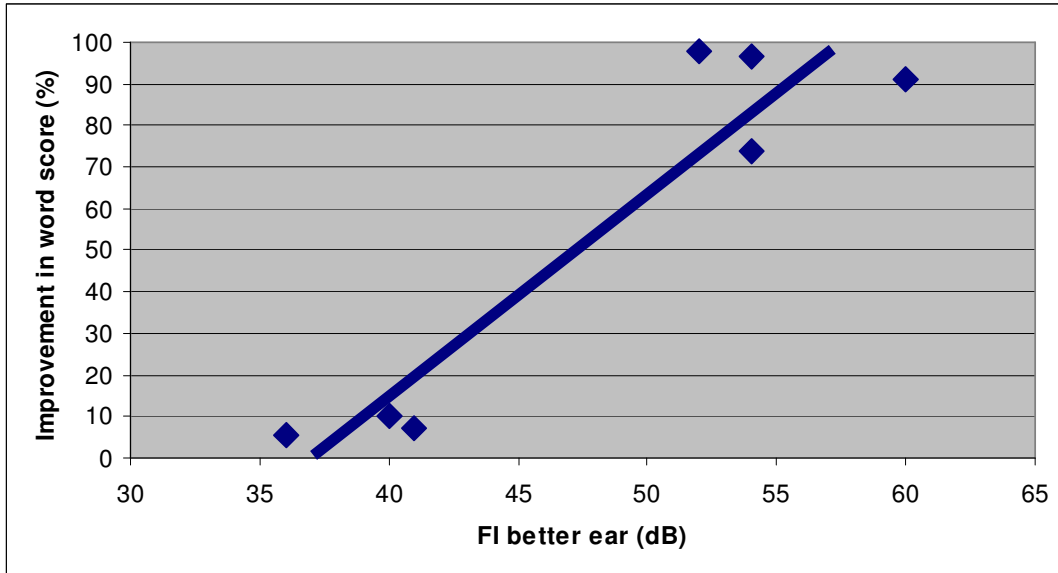


Fig. 7: Average improvement at 50, 55 and 60 dB(A) noise level at 1 meter as function of Fletcher Index of better ear

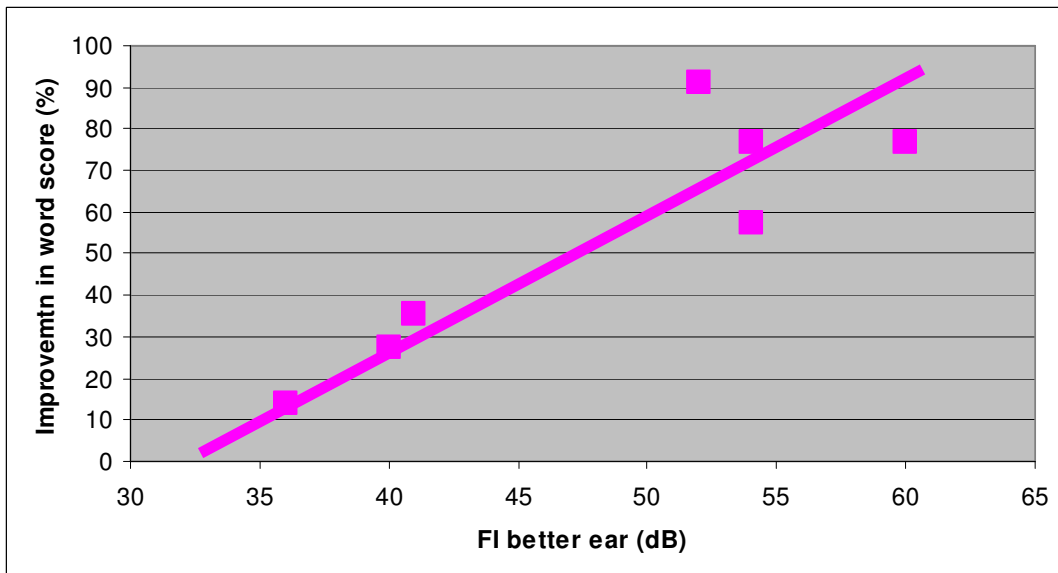


Fig 8: Average improvement at 50, 55 and 60 dB(A) noise level at 4 meter as function of Fletcher Index of better ear