Field Study News

Digital or Dynamic FM?

Which gives better speech understanding in noise?

Abstract

Speech understanding in noise measurements were carried out with 3 different types of FM systems: (1) a digital body worn non-dynamic FM receiver with inductive neck loop (a non-Phonak product), (2) a body worn Dynamic FM receiver with inductive neckloop (Phonak MyLink+), and (3) an ear level Dynamic FM receiver directly connected to the hearing instrument (Phonak MLxi). Noise levels varied from 55 to 80 dB(A). The ear level Dynamic FM system (MLxi) performed better than the body worn inductive Dynamic FM receiver (MyLink+) with the difference in performance increasing with increasing noise levels. The digital body worn non-dynamic FM system with inductive neckloop performed significantly worse than both Dynamic FM receivers for noise levels of 65 dB(A) and higher. At 80 dB(A) noise level the ear level Dynamic FM solution offered on average 87% speech recognition, where the digital non-dynamic system offered 20% speech recognition. A digital transmission of an FM signal apparently does not offer better or equal speech understanding in noise than Phonak's Dynamic FM.

Introduction

At Phonak we have often been asked whether all different brand FM systems give the same speech understanding benefits in noise or not. After all, some manufacturers now offer wireless systems with a digital transmission and strong claims are sometimes made by various manufacturers, including:
"Microphones capture sound which is then cleaned up by a sophisticated digital sound treatment. Disturbing background noises are removed while speech is emphasized and sent digitally to a receiver. Crystal clear. Without time lag."
and
"Sound is picked up by the transmitter or receiver and converted into digital data. Speech is clarified and annoying background noise is eliminated."
These are strong claims, stating that certain digital products remove all background noise. This however is not easy to do in practice and it remains to be seen whether users in real live situations would agree with such statements. To this end formal research was carried out looking at speech understanding in noisy conditions with listeners who use hearing instruments. Objective data were collected to test the hypothesis that a system with a digital wireless transmission performs better than a Dynamic FM system in noise. It needs to be said however, that also with Phonak's Dynamic FM systems, digital signal processing takes place both at the transmitter and at the receiver end.

Test subjects and devices

Raised measurements were carried out in a controlled lab environment to evaluate speech recognition scores at various noise levels. 5 adult subjects (4 males and 1 female) with hearing loss used their own BTE hearing instruments in three different wireless technology conditions:

1) A non-Phonak digital wireless system consisting of the manufacturer's most advanced transmitter and most advanced receiver, which features an inductive neckloop.

2) Phonak's Dynamic FM wireless system consisting of the ZoomLink+ Dynamic FM transmitter and the MyLink+ Dynamic FM receiver with inductive neckloop.

3) Phonak's Dynamic FM wireless system consisting of the ZoomLink+ Dynamic FM transmitter and the MLxi ear-level Dynamic FM receiver and matching audio shoe (to interface the MLxi with the hearing instruments).

Measurements took place in a lab room with normal reverberation and low background noise level. The room measured 7,20 x 6,95 meters. Four loudspeakers in the corners of the room created a diffuse noise field. One loudspeaker positioned in the middle of one wall generated the target speech, and the listener was positioned opposite that loudspeaker at a distance of 4,5 meters (see Figure 1).

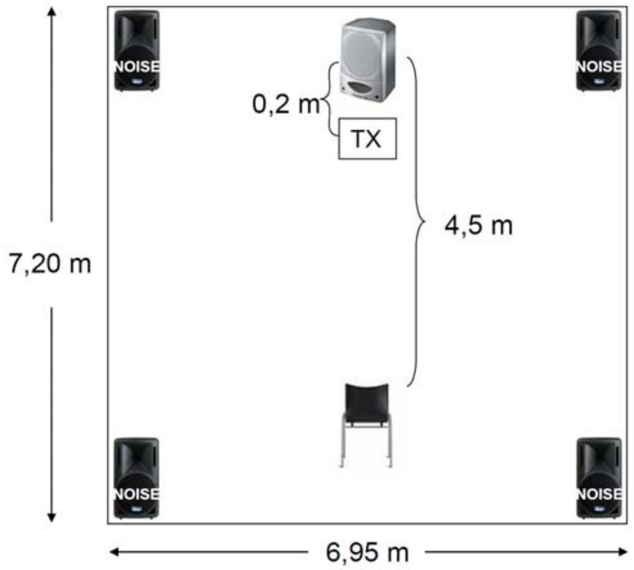

Figure 1. Schematic set-up of the test room. TX indicates the position of the transmitter. The test subjects were sat at 4,5 m distance from the loudspeaker that produced the OLSA test sentences.

The background noise conditions were speech noise generated by an Aurical PLUS (GN Otometrics) at 55, 60, 65, 70, 75 and 80 dB(A). A sound pressure meter confirmed that noise levels were equal at the position of the transmitter and the position of the listener.
The competitive transmitter and the ZoomLink+ were positioned in front of the loudspeaker, picking up the speech at a distance of 20 cm. Both transmitters were set to their best performing beam former, which for the ZoomLink+ is SuperZoom mode.
The speech understanding in noise test used was the German Oldenburger Satztest (OLSA). All sentences were presented at a fixed normal conversation level (70 dB(A) at 1 meter), randomized across all conditions, and the order of technology tested was also randomized across all participants. For each technology condition the noise level was increased gradually in steps of 5 dB. For each technology condition one run was performed in quiet as a baseline measurement prior to all background noise level conditions.
The hearing instruments were set to MT for use with the receivers with inductive neckloops, and to FM+M for the directly connected MLxi ear-level receivers, as these are the hearing instrument programs typically used with these receiver types. Keeping the ear-level microphone active and available increases the user's acoustical awareness of the environment, embeds the user in the nearby sounds from all directions, and allows him to control his own voice. All subjects wore their hearing instruments binaurally.
Preceding to the actual testing for both receivers with inductive neck-loops, a check was made to see if the inductive coupling created a loudness that was either too soft or too loud. To that end the test leader spoke in a controlled way into the wireless microphone and OLSA sentences were played from the loudspeaker, while the listeners could adjust the volume of their inductive receivers. No changes were made to the volume of any hearing instrument and for the MLxi no volume changes at all were made or requested.

Results

Out of all the subjects 3 left the MyLink+ in the default volume setting, one subject preferred it one step (2 dB) softer and one other subject preferred it 3 steps (6 dB) softer than the default volume setting. For the non-Phonak receiver condition all subjects chose their own preferred volume setting, but the device did not indicate how much dB difference there is between steps.
Speech understanding scores averaged across all subjects in quiet were approximately equal for all technology conditions. This could have been influenced by ceiling effects as the scores were on average 94.8%. With increasing noise levels, performance differences appeared between the three different technology conditions. The ZoomLink+ & MLxi combination performed the best in all noise conditions of 65 dB(A) and louder, and the non-Phonak combination performed worst in all noise conditions of 55 dB(A) and louder. At the loudest background noise condition of 80 dB(A), the ZoomLink+ & MLxi combination gave on average 87.2% correct word recognition, the ZoomLink+ & MyLink+ combination gave on average 69.2% correct word recognition and the non-Phonak combination gave on average 20.4% correct word recognition (see Figure 2).

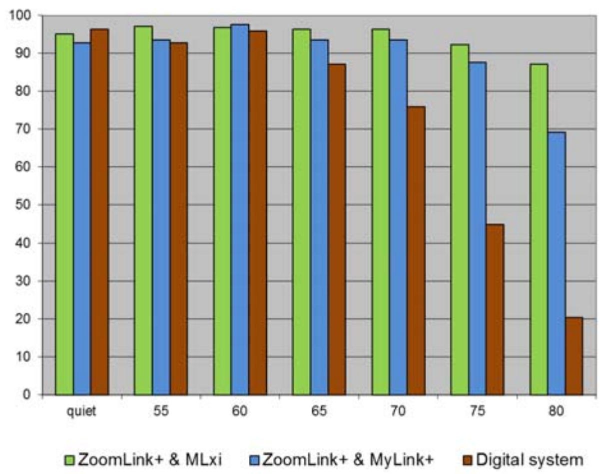

Figure 2. Speech recognition for different technology options. Different background noise levels are indicated on the horizontal axis (in dB(A)). Dynamic FM (green bars for MLxi and blue bars for MyLink+) gives better performance in increasing background noise than the non-Phonak digital FM system (brown bars).

Conclusion

Despite the low number of subjects used in this investigation, significant differences in performance between the different technologies were observed at higher noise levels. These differences can be explained by the technology used. The Adaptive FM Advantage of Dynamic FM increases the Signal to Noise Ratio (SNR) at the listener's ear, irrespective of the hearing instrument or cochlear implant, for increasing noise levels compared to non-dynamic FM systems (Thibodeau 2010; Wolfe, 2009). Whether the transmission is performed digitally or in an analogue way does not influence system performance in noise. The lack of an Adaptive FM Advantage in the digital system however results in poor speech understanding in very noisy conditions. In addition, depending on the user's environment, interference (or static) is picked up by the hearing instrument's T-coil, whereas the MLxi is immune to such interference. It is also worth noting that the performance of MyLink+ is better than that of the digital body worn receiver with inductive neckloop. The adaptive FM Advantage is implemented in MyLink+, therefore the inductive field strength increases alongside increasing background noise levels. A better SNR and better speech understanding in noise is observed than with the non-dynamic fixed FM Advantage that the non-Phonak digital FM system offers.

References

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For more information, please contact Hans Mülder at hans.mulder@phonak.com