Field Study News

Roger Dynamic SoundField

Study shows better speech recognition at higher noise levels

A study by Dr. Jace Wolfe of Hearts for Hearing in Oklahoma found that a Roger Dynamic SoundField system with a single loudspeaker unit resulted in significantly better speech recognition at higher noise levels than a fixed-gain soundfield system with four loudspeakers placed strategically in a classroom. Dynamic SoundField is not a fixed-gain system but adjusts its volume setting automatically depending on the classroom noise level. Furthermore, the patching of a fixed-gain soundfield system with the microphone unit of an adaptive (Dynamic or Roger) personal ear-level receiver system created a significant drop in performance and should therefore be avoided.

Introduction

It is well known that classrooms are noisy places: Choi & McPherson (2005) reported average noise levels of 61 dB(A) in classrooms, Massie & Dillon (2006) reported occupied classroom noise levels ranging from 64 to 72 dB(A), and Sanders (1965) reported average SNRs from 47 classrooms between -1 dB in Kindergarten and +5 dB in elementary and high school.

It is also well known that children have trouble hearing in noise, particularly those with hearing loss. Numerous studies have shown that this difficulty increases for younger children, and that difficulty also increases as the hearing loss increases. Possible solutions are acoustic modifications, soundfield (also known as Classroom Audio Distribution Systems (CADS)), personal (Dynamic) FM or Roger systems, or combinations of these technologies.

Research studies evaluating the impact of fixed-gain soundfield on classroom signal-to-noise ratio (SNR) and speech recognition in noise have shown mixed results.

Personal (Dynamic) FM and new Roger systems are widely recognized as the most effective method of improving speech recognition in acoustically hostile environments. There is however a paucity of research examining the combined use of SoundField + personal (Dynamic) FM/Roger versus personal (Dynamic) FM/Roger alone.

Research objectives

Therefore the objectives of Dr. Wolfe's study were to:

1. Evaluate the benefits of a soundfield system for children with hearing loss, as well as for children and adults with normal hearing.

2. Compare the performance obtained in quiet, and in noise, with a Roger Dynamic SoundField system by Phonak (adaptive, single loudspeaker unit) versus a fixed-gain soundfield system (competitor) utilizing four loudspeakers placed strategically in the classroom.

3. Compare the performance in quiet and in noise obtained with:

    - Roger Dynamic SoundField versus Roger Dynamic SoundField + personal Dynamic FM.
    - Fixed-gain, multi-loudspeaker soundfield versus fixed-gain, multi-loudspeaker soundfield + Personal Dynamic FM.
    - Personal Dynamic FM alone.

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Test subjects and materials

15 children with hearing loss, aged 6 to 13, participated in the study. Their pure tone four-frequency hearing losses ranged between 35 and 68.75 dB. 15 children with normal hearing, aged 5 to 12 years old, and 10 adults with normal hearing, aged 18 to 48 years old, also participated.
A competitor soundfield system utilizing four loudspeakers and a Roger Dynamic SoundField system by Phonak, with a single DigiMaster 5000 loudspeaker unit were used. The competitor system is a fixed-gain system, while the Phonak Roger SoundField system is adaptive; meaning it automatically adjusts its loudspeaker's gain to suit the classroom's noise level. In Figures 1 and 2, schematic diagrams show the test set-up and the location of the loudspeaker units of both soundfield systems.

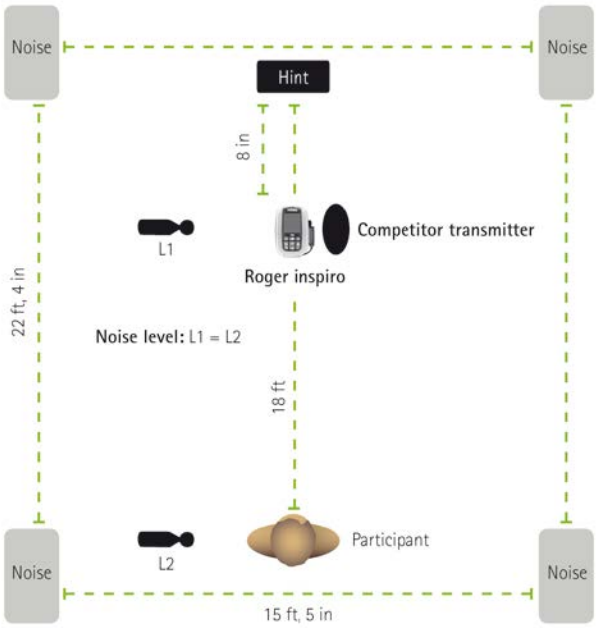

Fig. 1
Schematic diagram showing the dimensions of the test set-up (the soundfield systems themselves are not shown here). Four loudspeakers positioned in the corners of the classroom created a diffuse noise field. Speech was played back through a single cone loudspeaker. The microphones of the soundfield systems were placed 8 inches / 20 cm in front of this loudspeaker. The level of the unamplified speech at the soundfield microphone was 85 dB(A). At the position of the listener, 18 ft / 5.5 m away from the speech loudspeaker, the level of the speech was 64 dB(A).

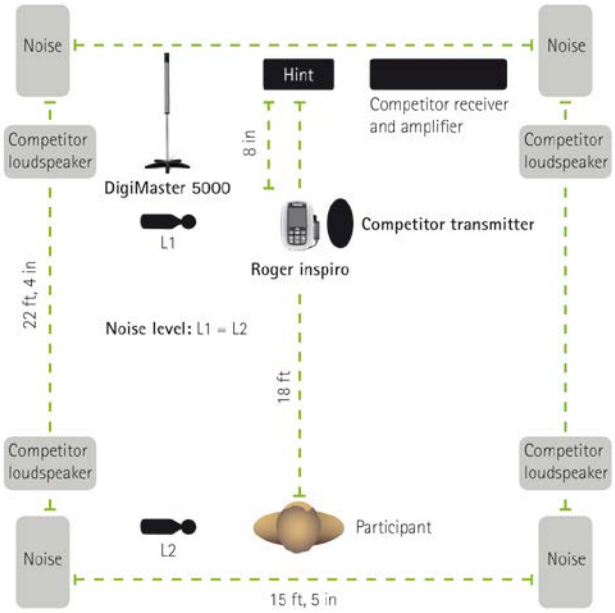

Fig. 2
Schematic diagram of the same classroom shown in Figure 1, now with the competitor system's four loudspeakers positioned at four strategic locations, and the Phonak DigiMaster 5000 loudspeaker unit at the front of the classroom.

Speech recognition tests (HINT) were carried out in quiet and in noise of 50, 55, 60, 65, 70 and 75 dB(A). The level of the noise was set to be equal at the location of the soundfield microphone and at the location of the listener. The volume of the Phonak DigiMaster 5000 loudspeaker unit was left at its automatic default setting. The gain of the competitor system was set to give an equal level to that of the DigiMaster 5000 in quiet at the position of the listener.

Results

Speech recognition scores in noise without a soundfield or a personal Dynamic FM/Roger system were higher for normal-hearing adults than for normal-hearing children, and higher for normal-hearing children than for children with a hearing loss. The differences between these groups increased at higher noise levels. The performance also became progressively poorer from 60 to 75 dB(A). These results came as no surprise and conform to the findings of previous studies.

With a soundfield system adults' speech recognition in noise improved at noise levels of 65, 70 and 75 dB(A). The Phonak DigiMaster 5000 SoundField system provided better speech recognition in noise than the competitor system at 70 and 75 dB(A) for both normal-hearing adults, normal-hearing children (see Figure 3) and children with hearing loss.

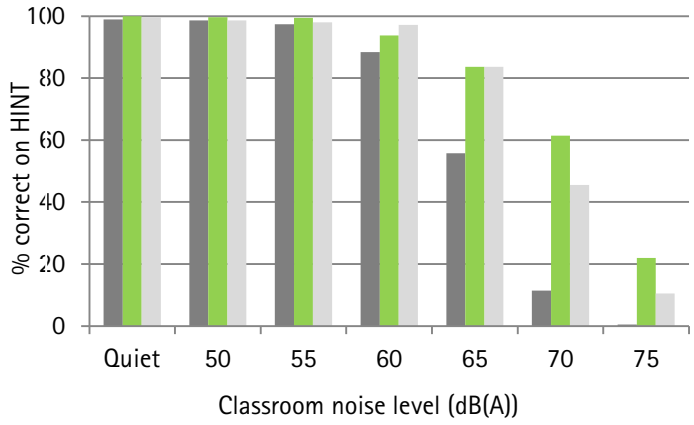

Fig. 3
Results for speech in noise recognition for normal-hearing children. The dark gray bars represent the condition without soundfield amplification, the green bars represent the condition with the Phonak Roger SoundField system, and the light grey bars indicate the condition with competitor system.

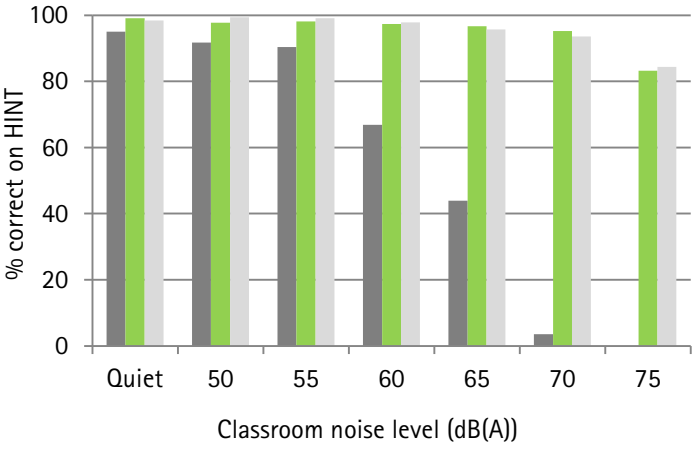

Fig. 4
Speech recognition scores for children with hearing loss. The dark gray bars represent the condition with hearing aids only, the green bars the condition with hearing instruments, personal Dynamic FM and Roger Dynamic SoundField, and the light gray bars the condition with hearing instruments and personal Dynamic FM.

In noise of 60 dB(A) and louder personal Dynamic FM performed better than both soundfield systems. Children with hearing loss who wore hearing aids benefitted, at all noise levels, from also wearing a personal Dynamic FM system (see Fig. 4). There is apparently no difference between personal Dynamic FM alone and personal Dynamic FM plus Roger Dynamic SoundField.

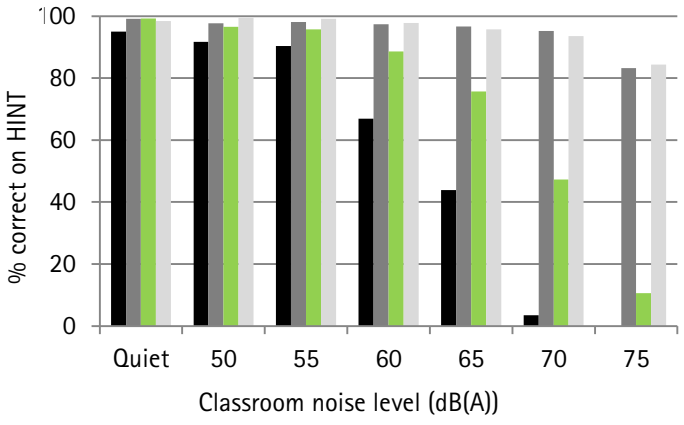

Fig.5
Speech recognition scores for children with hearing loss using: only hearing aids (black bars), Phonak Roger SoundField plus personal Dynamic FM (dark gray bars), competitor soundfield plus personal Dynamic FM (green bars), and personal Dynamic FM only (light gray bars).

The combination of soundfield with personal Dynamic FM was also tested. For the Roger Dynamic SoundField the inspiro microphone unit was used to send the speech wirelessly to the DigiMaster 5000 loudspeaker and in parallel to the Dynamic FM ear-level receivers attached to the listener's hearing instruments. For the combination of the competitor soundfield system and the personal Dynamic FM receivers competitor microphone was used to send the speech wirelessly to the amplifier unit that was connected to the four loudspeakers, and from an audio output of that amplifier the received signal was fed into the audio input of the inspiro microphone, which sent it onwards to the Dynamic FM receivers. Subjects who used either a personal Dynamic FM system alone, or this same system alongside Roger Dynamic SoundField, performed markedly better at 60, 65, 70 and 75 dB(A) than those who used the competitor soundfield system with a personal Dynamic FM system (see Figure 5).

What are possible reasons for the combination of competitor system with personal Dynamic FM performing so much worse than the combination of Roger Dynamic SoundField with personal Dynamic FM? This could be a result of the loss of adaptive (Dynamic) FM behavior when the output of the competitor amplifier system was wired into the audio input of the Phonak inspiro microphone, or an insufficient input from the audio output of the competitor system to the inspiro microphone unit.
We can conclude that feeding the output of a fixed-gain soundfield system into the audio input of an adaptive (Dynamic FM or Roger) system should be avoided.

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