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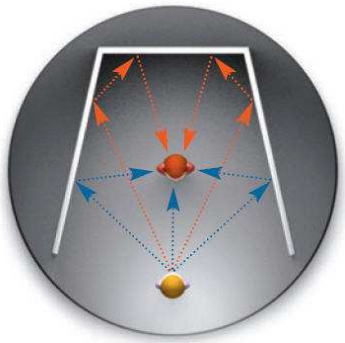
Digital Bionics

Field Study News

EchoBlock: Proven to be highly effective in reverberant situations

Summary
Reverberation is present in many real-life situations. It reduces speech intelligibility and listening comfort. The EchoBlock feature in Savia detects reverberation effectively and suppresses its negative impact. The results of a clinical trial show that EchoBlock significantly improves the perceived hearing comfort, and is clearly preferred when there is reverberation. At the same time, the subjects report that speech understanding is improved.



Reverberation is caused by reflections of sounds from walls, ceilings, or windows. These reflections generate delayed, slightly spectrally modified and attenuated copies of the original source signal. At the ear of the listener, a superposition of the direct sound from the source and its reflections is perceived.

In effect, the original signal is temporally smeared. Reverberation is characterized by reverberation time, which indicates how long reflections are present. Typical reverberation times T_{rev} range from about 0.4 sec in offices and small lecture rooms to up to 4 sec or more in concert halls and churches. Reverberation reduces and further degrades speech intelligibility in quiet and noisy situations, respectively.[1] In addition, the directional benefit from microphones is reduced in reverberant environments.[2]

Savia EchoBlock
With Savia, a hearing system is able to efficiently attenuate reverberation for the first time due to EchoBlock technology. EchoBlock detects and suppresses the "reverberation tail" after the offset of the direct sound source. EchoBlock is a unique functionality that can be optionally activated in various listening programs. In addition, Savia offers a specific listening program for optimized listening in reverberant situations. The benefit of EchoBlock was evaluated in a clinical study*.

Setup
In total, 21 hearing impaired subjects participated in the trial. Their age ranged from 22 to 78 years (average: 60 years). The average hearing loss (PTA) was 66 dB. The subjects were fit bilaterally with Savia 211 dSZ BTE hearing systems. Two hearing programs were activated, namely the base program "Calm Situations" in default settings, and the program "Reverberant Room" with the EchoBlock feature. Two types of outcome measures were taken:

1. Paired comparisons between both settings in different environments
2. Speech tests in different environments

Different environments (both "dry" and reverberant) were realized in a test room which applies virtual acoustics. Thus, the test conditions were well-controlled. For the paired comparisons, two environments were used: a simulated non-reverberant living room (T_{rev}=0.5 s) with a news commentator at 65 dB SPL, and a large reverberant room (T_{rev}=3.9 s) with speech babble at 65 dB. For both environments, the subjects could switch

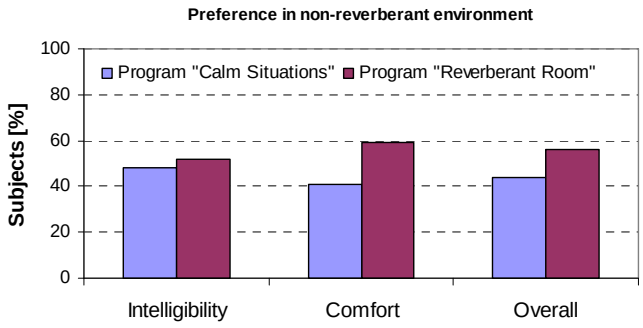


Figure 1: Paired comparisons: Balanced preference for Savia hearing programs in simulated living room

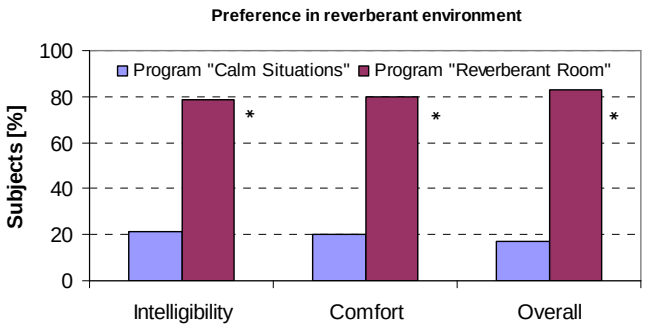


Figure 2: Paired comparisons: Significant preference for program "Reverberant Room" in simulated reverberant room

between their two hearing programs as often as needed. They had to indicate their preference in terms of speech intelligibility, comfort, and overall preference. The paradigm was a two-alternative forced choice, i.e., the subjects had to prefer one program over the other.

The speech test[3] was conducted without background noise, but in two simulated environments with different degree of reverberation (living room and reverberant room, as described above). The speech material was presented at 55 dB SPL. In both environments, the speech test was conducted in two Savia hearing programs ("Calm Situations" and "Reverberant Room").

Results

Paired comparisons

The figures above show the subject's preferences in both environments. In the non-reverberant environment, there was no clear preference for one or the other hearing program. As a two-alternative forced choice paradigm was applied, the subjects *had* to indicate a preference, but on average, the preferences were balanced. This indicates that EchoBlock is "transparent" in non-reverberant environments and does not alter the sound of the hearing systems.

In the reverberant environment, in contrast, a clear and significant preference for the hearing instrument program "Reverberant Room" can be seen. Eighty percent of all subjects preferred the designated program in this situation. This holds for all three categories (intelligibility, comfort, and overall preference).

Speech tests

The speech test results showed no significant difference between the two hearing instrument programs in both environments. For the non-reverberant condition, this confirms the findings from the paired comparisons where no clear preference was observed. In the reverberant condition, the subjects had the impression that speech intelligibility was better with EchoBlock (Figure 2), while this could not be confirmed in the speech test.

These results show that there is no trade-off between listening comfort and speech understanding in reverberant situations. EchoBlock significantly improves the perceived hearing comfort, and is clearly preferred when there is reverberation. At the same time, speech intelligibility is not compromised. In fact, the subjects reported that they understand even better.

*The study was conducted by Dr. Birgitta Gabriel, Hörzentrum Oldenburg, Germany.

References

[1] Johnson CE (2000). Children's phoneme identification in reverberation and noise. J Speech Lang Hear Res 43(1):144-57
[2] Ricketts TA, Hornsby BW (2003). Distance and reverberation effects on directional benefit. Ear & Hearing 24(6):472-84
[3] v. Wallenberg EL, Kollmeier B (1989). Audiologische Akustik 38:50-65