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Simulation results with combined electric and acoustic stimulation (EAS) at the same ear for speech intelligibility in noise.

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Electric acoustic stimulation (EAS) means the simultaneous stimulation of high frequency hearing with a cochlear implant (CI) and of residual low frequency hearing by an acoustic stimulation with hearing aid at the same ear. This simultaneous excitation of the hearing nerve is also called "hybrid stimulation". Patients using this technology need a preoperative stable residual low frequency hearing up to approximately 500 Hz. Hybrid hearing patients show significant better results in speech intelligibility tests in complex noise situations (Rader 2008) compared to bilateral implanted CI patients. To investigate this positive effect it is important to simulate the hybrid stimulation with a computer model and to test this with normal hearing subjects.

The speech recordings of a German sentence test (Oldenburger Satztest, OLSA) and different types of noise (speech modulated Fastl-noise and unmodulated Olnoise) were modified in a signal processing pathway to simulate the hybrid hearing.

First the continuous spectrum was filtered to the 12 center frequencies of a CI speech processor (Med-El DUETT) and resynthesized using a 12 channel narrow noise vocoder (same 12 frequencies) to represent the part of electrical hearing with cochlear implant. A low pass filtered part of the original signal (cut off frequency 500 Hz) is added to represent the residual low frequency hearing. The two types of noise were processed at the same way as described above.

The speech reception threshold (SRT) was measured using an adaptive procedure. 22 normal hearing subjects participated the EAS simulation experiment using a binaural presentation of the speech test via headphones. These results are compared to the data of six patients supplied with Med-El EAS system. The median values of both conditions show a great conformance between simulation (SRT=-0.9 dB SNR) and reality (SRT=-2.5 dB SNR) for the Olnoise condition.