# SIMULATION DATA AND A MODEL APPROACH FOR SPEECH PERCEPTION WITH ELECTRIC-ACOUSTIC STIMULATION (EAS)

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Electric acoustic stimulation (EAS) denotes simultaneous stimulation of high frequency hearing by means of a cochlear implant (CI) and of residual low frequency hearing up to 500 Hz by acoustic stimulation. Patients implanted and fitted according to the EAS concept show significantly higher speech intelligibility in complex noise environments compared to bilateral implanted CI patients. To investigate the effect of EAS on speech perception in noise we developed a simulation to mimic hybrid stimulation and obtained speech perception scores employing this simulation in a group of normal hearing subjects.

Speech recordings of a German sentence test (Oldenburg Sentence Test) and different types of competing noise (speech-like amplitude modulated noise (Fastl, 1997) and un-modulated noise) were used as stimulus and processed by the presented model to simulate hearing with EAS. The acoustic time signal was transformed by means of an ear related spectral transformation with subsequent peak picking into a stream called part tone time pattern (PTTP). Part tone frequency was reordered following the 12 center frequencies of a MED-EL DUET CI speech processor and re-synthesized employing a 12 channel sinusoidal vocoder to simulate electrical stimulation. The acoustic part of the stimulus signal was generated in different patterns: 1) low pass filtering with corner frequencies set to 200 Hz or 500 Hz, 2) extracted fundamental frequency $f_0$ with fixed level and 3) extracted fundamental frequency $f_0$ with fixed frequency. The acoustic low frequency signal was then added to the 12-channel vocoder simulation to investigate the influence either of fundamental pitch ($f_0$) or $f_0$-level on speech perception in noise.

Speech reception threshold (SRT) was measured using an adaptive procedure. 12 normal hearing subjects participated in the experiment. Binaural presentation of test stimuli was accomplished via headphones. Results measured with modulated Fastl-noise were: 1) SRT=-0.4 dB SNR for 200 Hz and -10.1 dB SNR for 500 Hz corner frequency 2) SRT= 2.9 dB SNR for $f_0$ with fixed level and 3) SRT=0.8 dB SNR for $f_0$ with fixed frequency.

Finally an optimized speech recognition system (HTK-Toolkit) was fed with the different stimuli to establish a model for speech perception with EAS or CI in quiet and in noise.

The present results demonstrate the benefit obtained with residual low frequency acoustic hearing in combined electric acoustic stimulation and thus underpin the importance of fundamental pitch fine structure information for speech perception in noise.