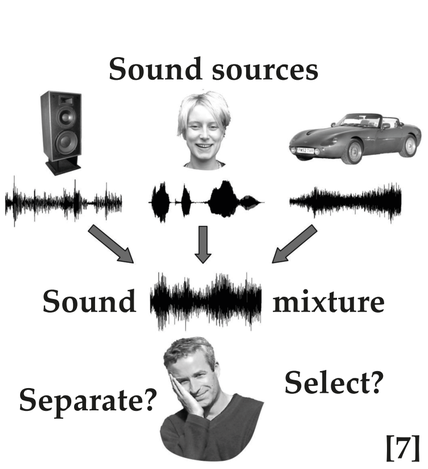
TOWARDS IMPROVING SELECTIVE HEARING IN COCHLEAR IMPLANT LISTENERS

Martin Lindenbeck
martin.lindenbeck@oeaw.ac.at

Acoustics Research Institute, Austrian Academy of Sciences, Wohllebengasse 12-14, A-1040 Vienna
Department of Cognition, Emotion, and Methods in Psychology, Faculty of Psychology, University of Vienna, Liebiggasse 5, A-1010 Vienna

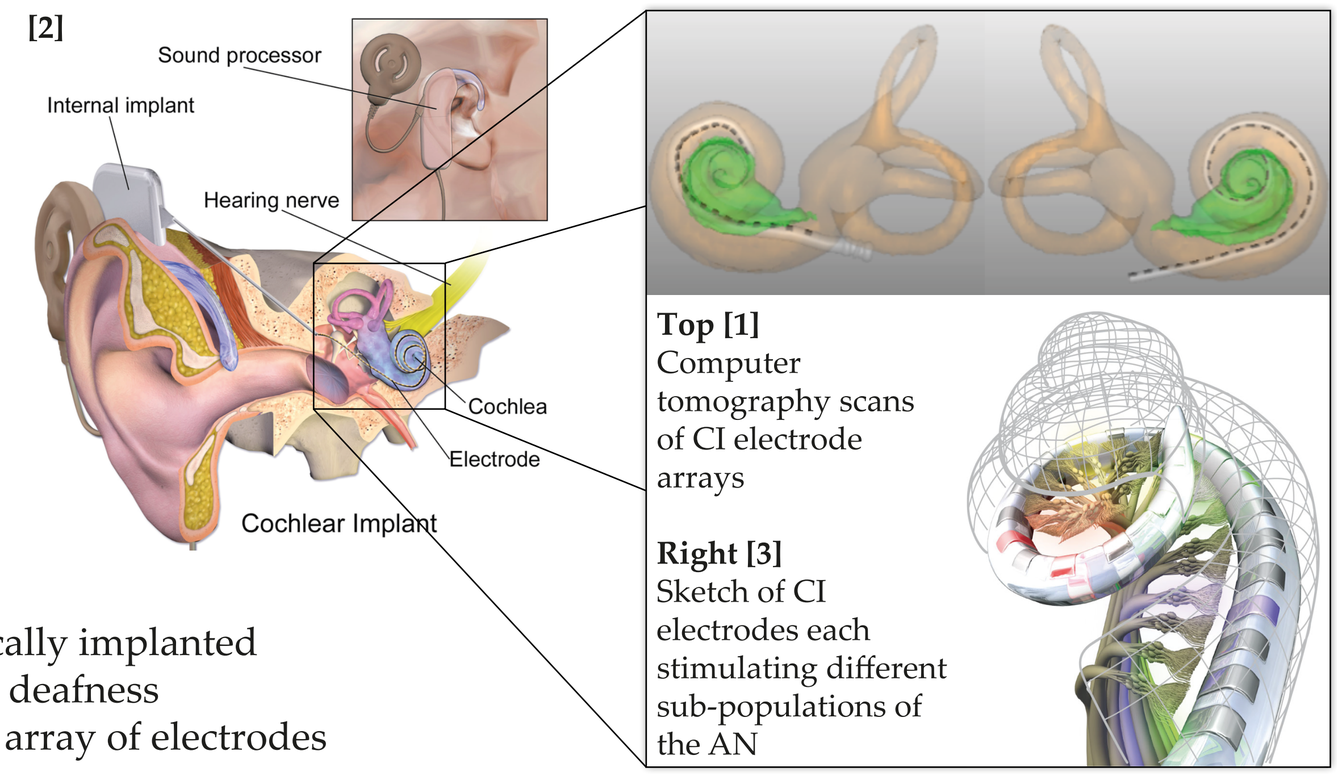
Selective Hearing and Cochlear Implants



[7]

Selective hearing
Decomposition of sound mixtures by means of
- separating the sound sources into auditory streams
- selectively listening to a source of interest

[2]

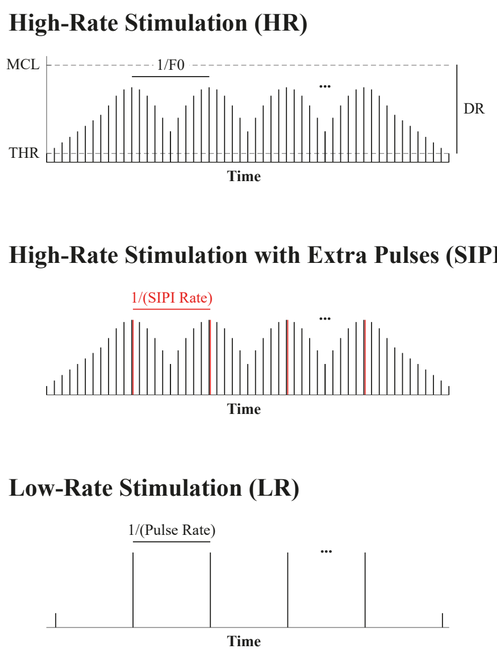


Top [1]
Computer tomography scans of CI electrode arrays

Right [3]
Sketch of CI electrodes each stimulating different sub-populations of the AN

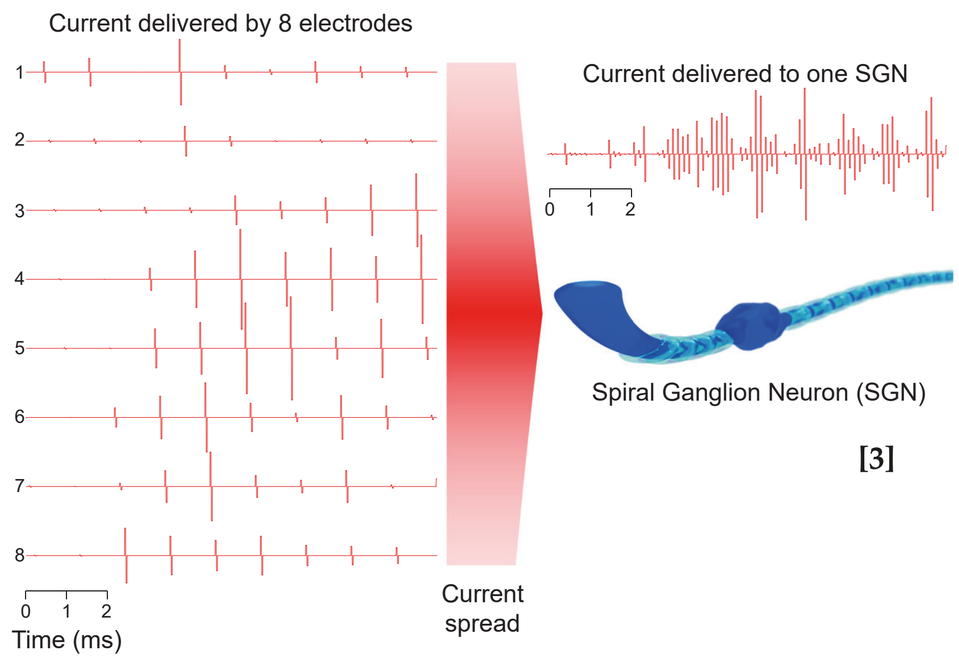
Cochlear implants (CIs)
- most successful neuroprosthesis worldwide, surgically implanted
- used in cases of severe-to-profound hearing loss or deafness
- directly stimulate the auditory nerve (AN) with an array of electrodes

Motivation for DOC Project



Single-electrode CI signals [cf. 5]
SIPI is an experimental signal, HR and LR are used in clinical CIs

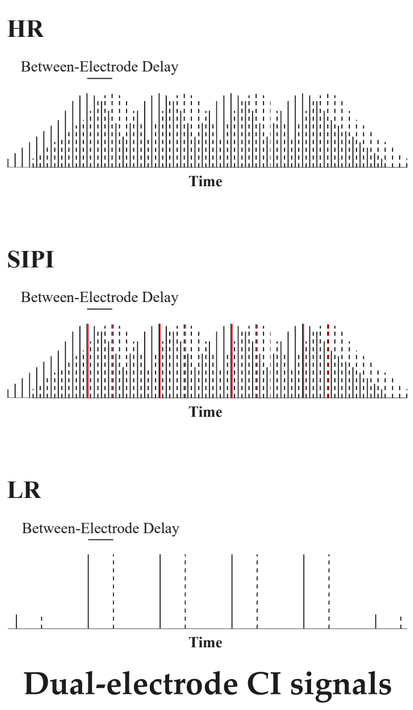
- CIs have to bridge a gap between electrode array and AN
- In this gap, the electric current spreads and stimulates more neurons than intended for a certain electrode (figure on the right), creating so-called channel interactions
- The stimulation approach determines which information is transmitted with CIs (figure on the left): **HR transmits mainly speech information, LR mainly directional (interaural time differences, ITD) and pitch information; HR vs. LR trade-off**
- In our lab, HR-like SIPI signals were shown to provide LR-like ITD & pitch sensitivity on single electrodes [5, 8]



[3]

Current spread and channel interactions
Pulse trains from multiple electrodes sum up in the gap between electrode and neuron. Pulses are interleaved to reduce interactions.

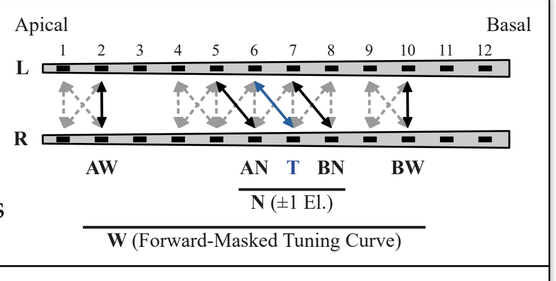
Approach



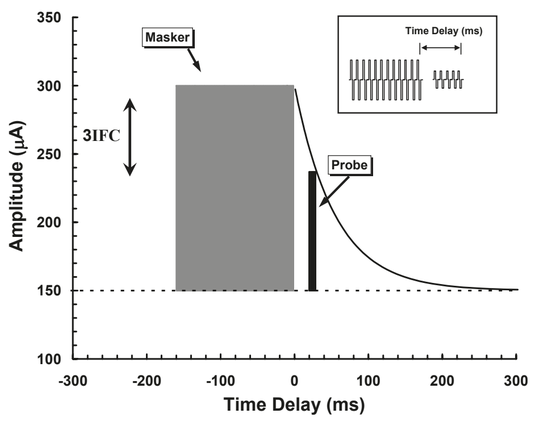
Dual-electrode CI signals

- Selective hearing (here: speech plus ITD plus pitch) requires many electrodes to stimulate
- SIPI has to be tested in multi-electrode settings (figure on the left) to assess its potential to improve selective hearing
- First step: Dual-electrode stimulation
- Between-electrode delay is varied
- Effect of channel interactions on ITD and pitch perception?
- Electrode selection based on fmSTCs and interaural electrode matching (figure on the right)
- Next steps: more electrodes, more complex hearing tasks

Interaural electrode matching [cf. 1, 4]
Between ears, insertion depths of electrode arrays vary. ITD-based interaural electrode pairing maximizes binaural sensitivity.



Forward-masked spatial tuning curve [fmSTC, cf. 6]
fmSTCs are used as an approximator of channel interactions. Both apically (A) and basally (B), dual-electrode stimuli with max. interactions (narrow, N, see figure above) and min. interactions (wide, W) are constructed.



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