

Stimulation optimization with "Selected Groups" coding



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"Selected Groups"

Outline

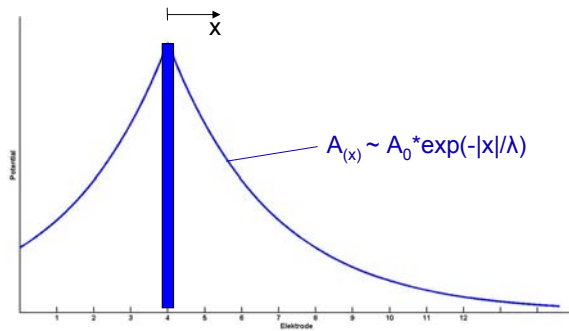
- Spatial channel interaction
- Action potentials in neurons
- Masking
- "Selected Groups" (SG)
- Preliminary results SG vs. CIS
- Discussion and outlook

Spatial channel interaction

The cochlea (scala tympani) is filled with a conductive fluid

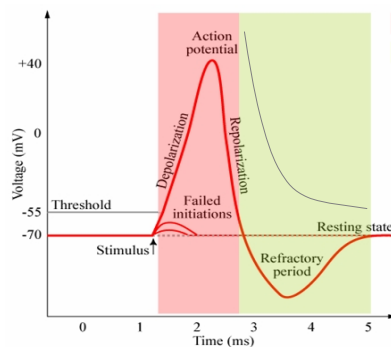
→ Approximately exponential spatial current field ($\lambda \sim 5-10$ mm)

→ Therefore a wider area of neurons is effected (action potentials)



Action potentials in neurons

- Electrical stimulation of a neuron causes an action potential
- After excited action potential the neuron is in a refractory period:
 - a) Absolute refractory period
 - b) Relative refractory period



Typical values for cochlear neurons:

- Abs. refractory period $\sim 0,8$ ms
- Rel. refractory period 7-10ms

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Masking

We have seen:

- Current spread causes a broader stimulation of neurons (spatial masking)
- Neurons have refractory behavior (temporal masking)

We can sum up:

→ Pulses may be partially masked by spatial and temporal effects

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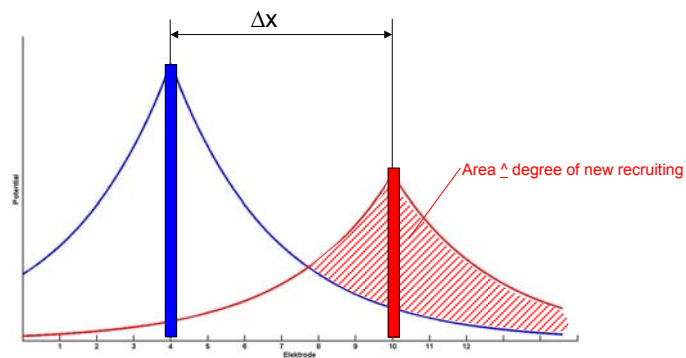
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"Masking" example

$$I_{\text{stim2}} = 0,6 \cdot I_{\text{stim1}}$$

$$\Delta x = 6 \text{ electrodes}$$

t_0 : Stim1
 $t_0 + \Delta T$: Stim2
 $\Delta T < T_{\text{abs.ref.per.}}$



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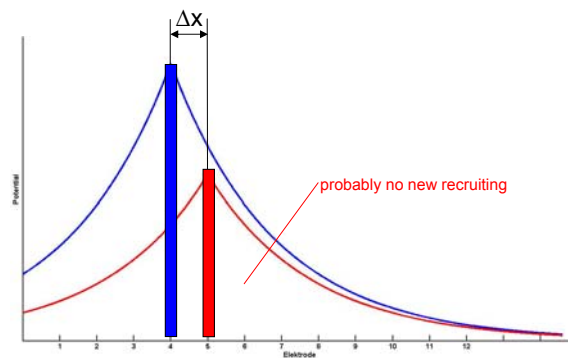
"Masking" example

$$I_{\text{stim2}} = 0,6 \cdot I_{\text{stim1}}$$

$$\Delta x = 1 \text{ electrode}$$

t_0 : Stim1
 $t_0 + \Delta T$: Stim2

$$\Delta T < T_{\text{abs.ref.per.}}$$



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Idea of "Selected Groups" (SG)

The basic of SG:

- Masked pulses play only a minor role at the perception

→ Detect "masked" Pulses and omit it

Zierhofer, "Electrical stimulation of the acoustic nerve based on selected groups", Patent (2005)

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“Selected Groups“

SG: Algorithm

- Electrode array is subdivided into groups with high channel interaction (e.g. neighbouring electrodes)
 - Only the electrode(s) with the highest amplitude(s) are determined and activated for stimulation
- Masked pulses with low stimulation efficacy are avoided

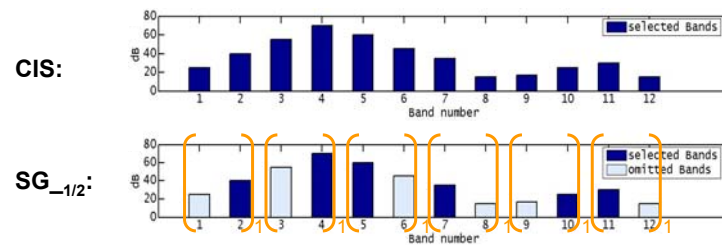
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CIS vs. SG

Filter bank signal with two spectral peaks:

- CIS: all channels stimulated
- SG: 50% of the channels stimulated

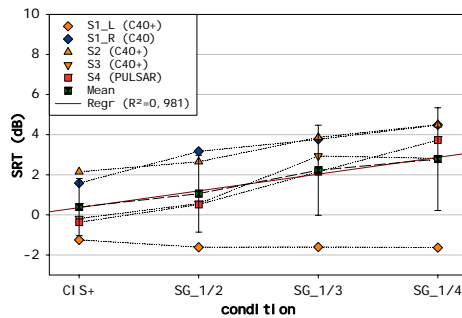


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Preliminary results SG vs. CIS

The "Speech Reception Threshold" (SRT) in noise was measured depending on group size



Statistics:

• $p=0,289$ no statistically significant difference was found ($\alpha=0,05$)

“Selected Groups“

Discussion and outlook

Discussion

- Omitting probably masked pulses increases the SRT only slightly even in extreme conditions (Group size of 4 ~ 33% of pulses are used)
 - With the condition neighbouring pairs (Group size of 2) the patients don't report any subjective difference in hearing quality
- The basic assumptions of SG seem to be accurate

Outlook

- Measurements on more patients
- Using time benefit to increase stimulation rate on designated fine structure stimulation channels (CSSS for musical hearing improvements)

“Selected Groups“

Thank you!