Technology for people

TECHNISCHE UNIVERSITÄT WIEN

Aurikuläre **Vagusnervstimulation** - von der **Personalisierung** bis hin zur Anwendung bei kritischen **Covid-19-Patienten**

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Content

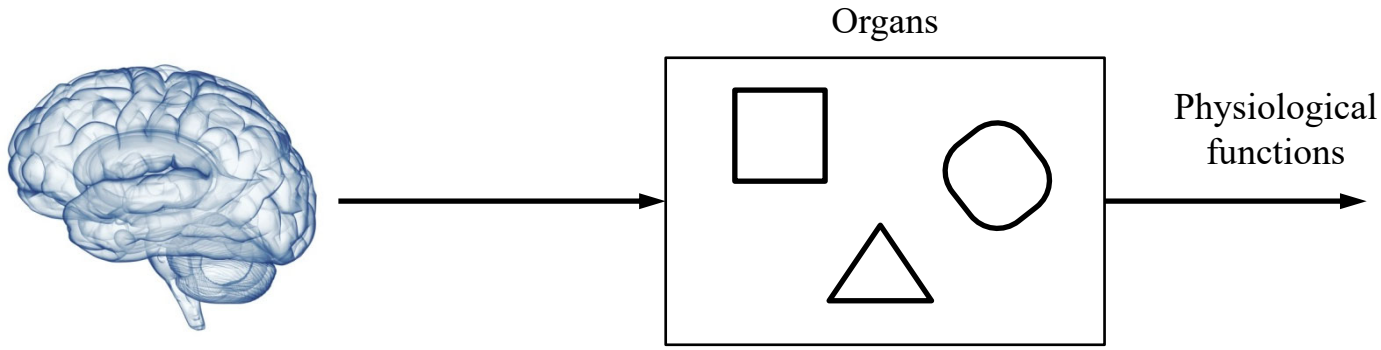
- Vagus nerve stimulation
- Personalized stimulation
- Stimulation in Covid-19

Vagus nerve stimulation

► Why vagus nerve?

- Wanderer nerve

Before Vagus nerve – organ control **without feedback**



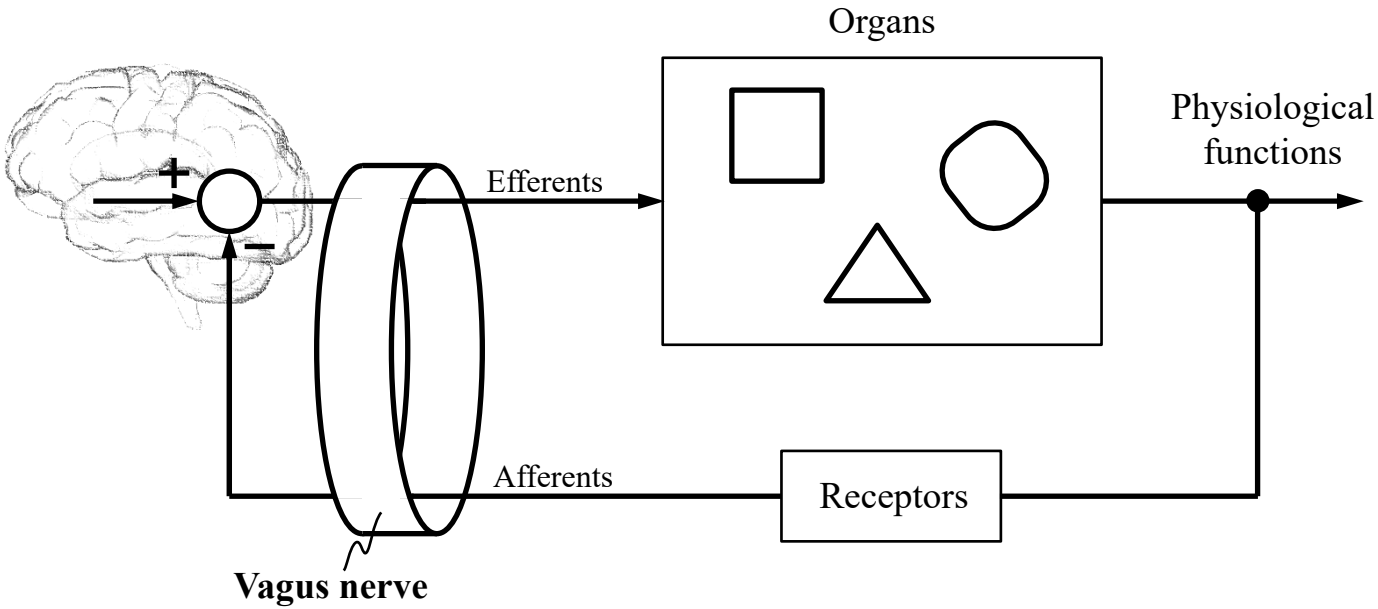
Low adaptivity / weak modulation

Vagus nerve stimulation

► Why vagus nerve?

- Wanderer nerve
- 80% afferent and 20% efferent fibers

After Vagus nerve – organ control **with feedback**



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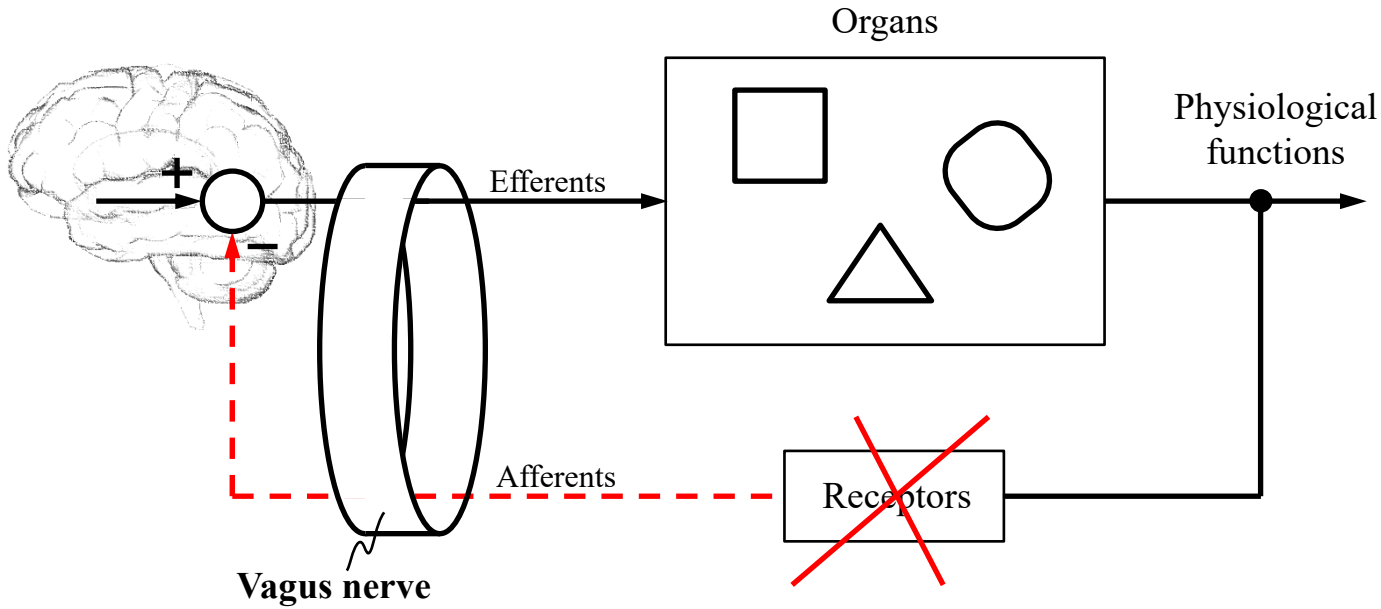
Vagus nerve for **therapy**



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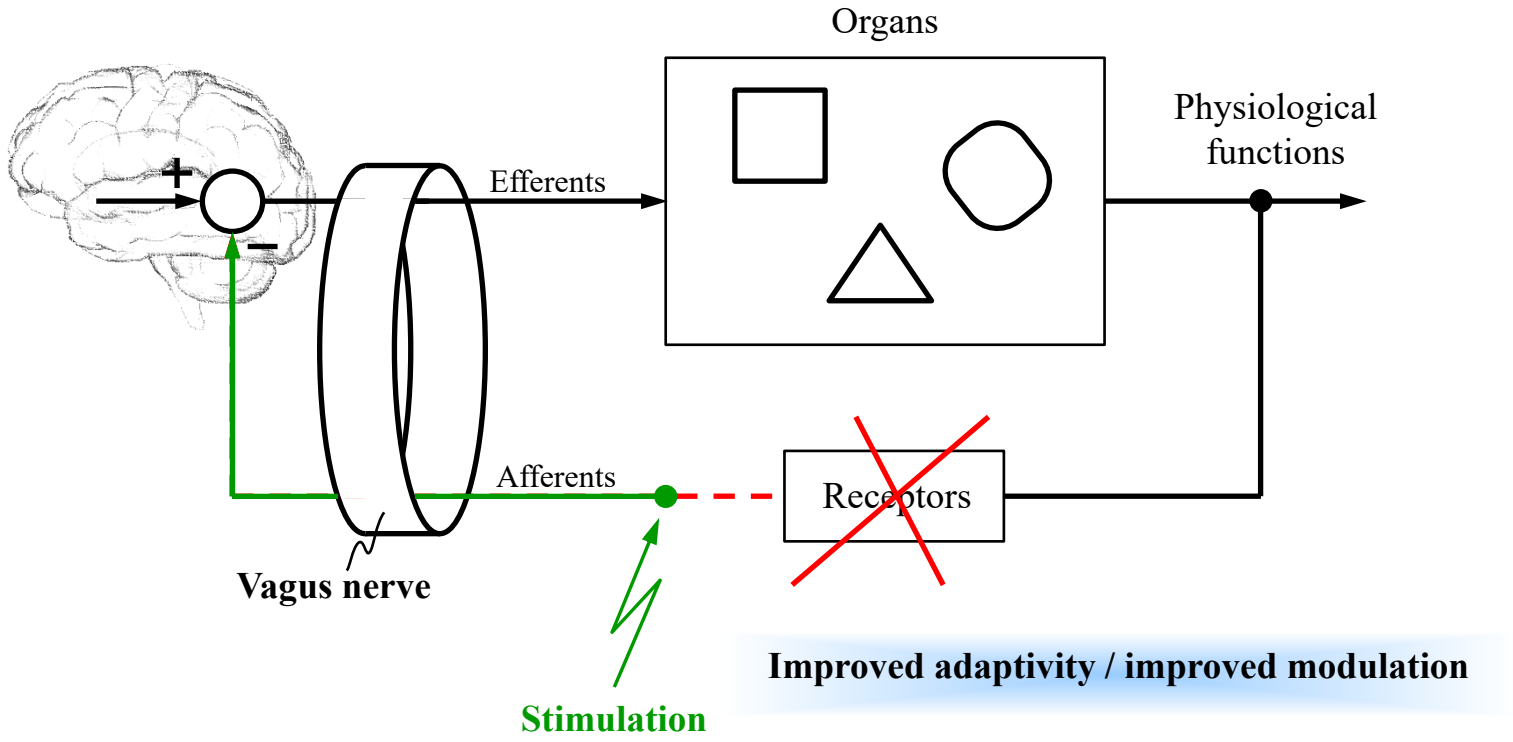

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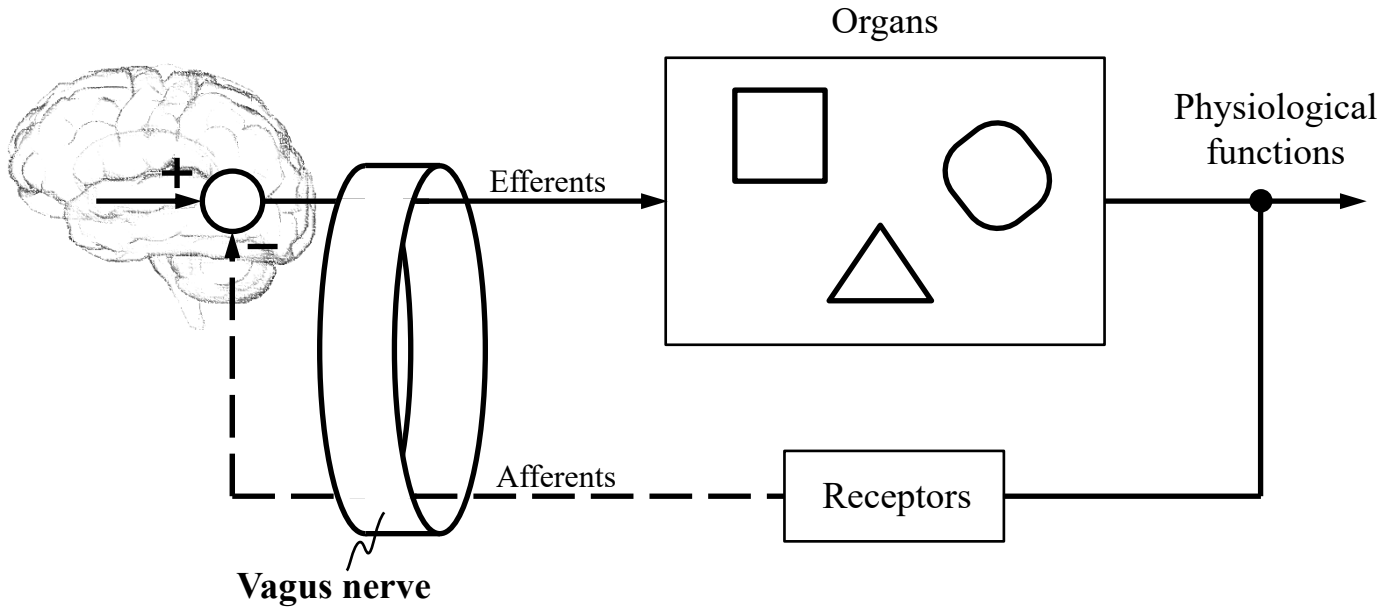


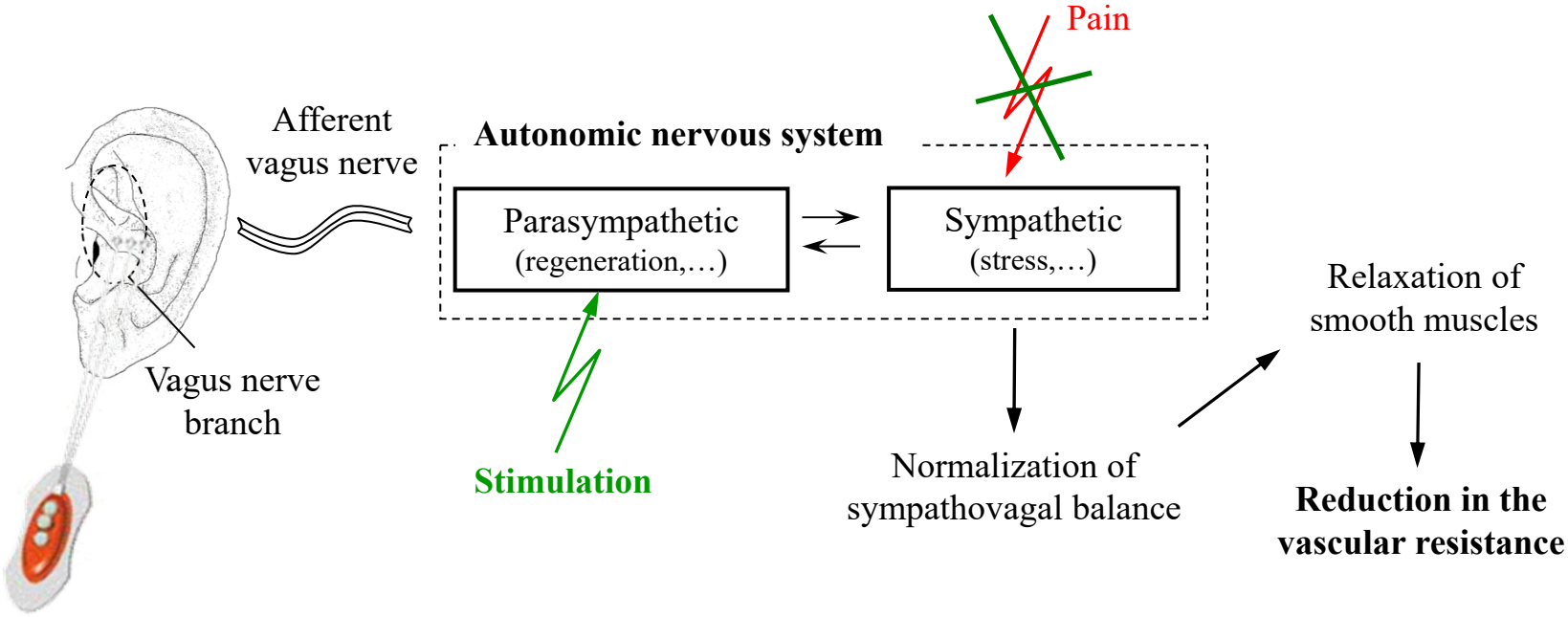
High adaptivity / strong modulation

Vagus nerve stimulation

► Auricular electrical stimulation

Beneficial effects due to

- Gate mechanisms / **afferent stimulation**
- Activation of inhibitory pain control systems
- Release of neurotransmitters…



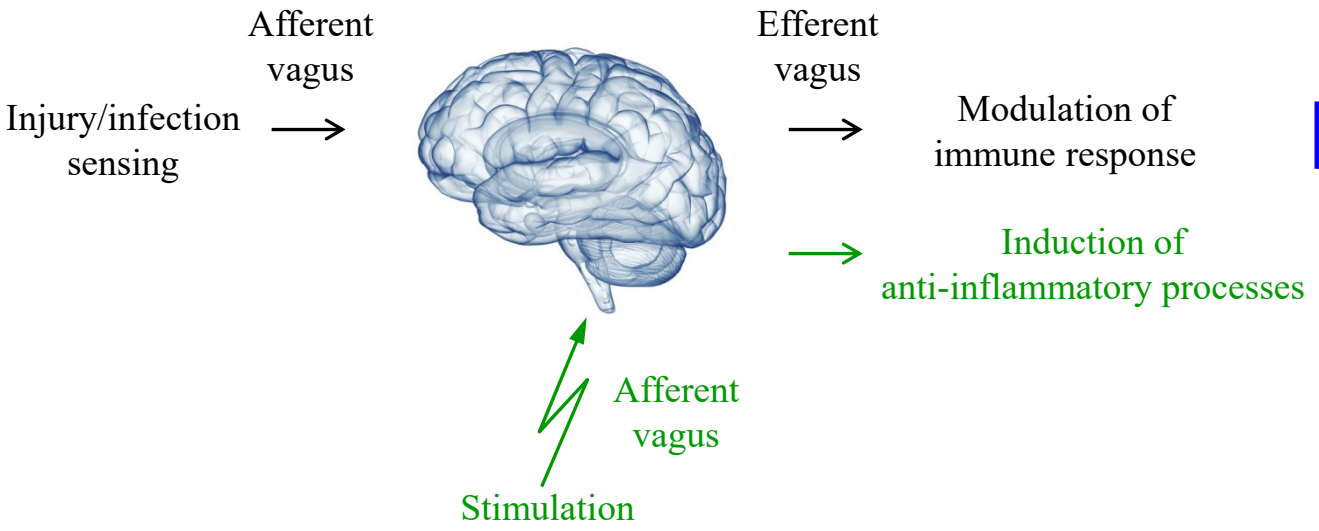
Vagus nerve stimulation

► Auricular electrical stimulation

Beneficial effects due to

…

- Reflex modulation of innate immune response,
  anti-inflammatory processes are induced via cholinergic anti-inflammatory pathway

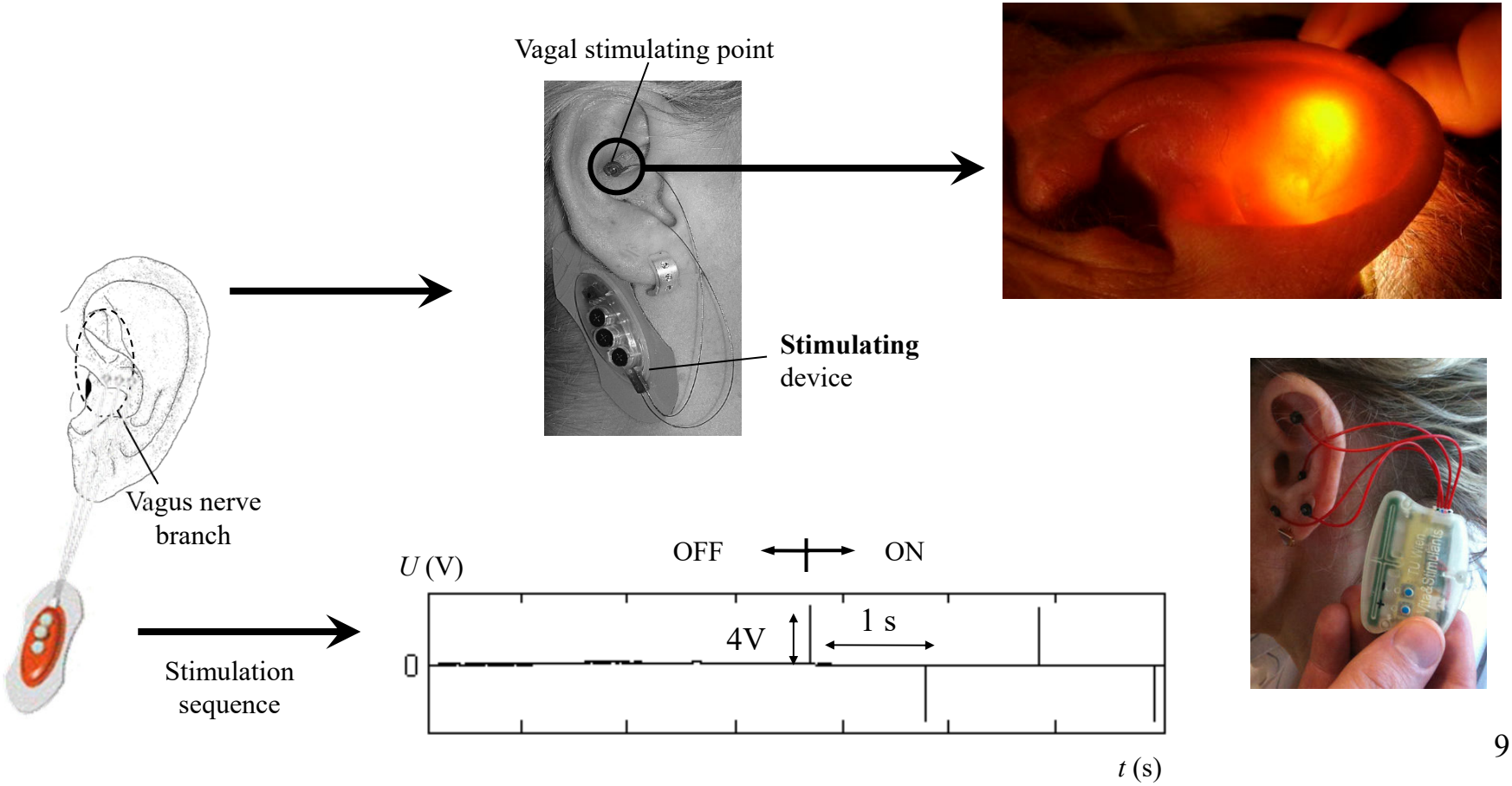


- **Pain** reduction
- **Perfusion** improvement
- **Ani-inflammation** control

Vagus nerve stimulation

► Auricular electrical stimulation

- Stimulation of auricular vagus nerve branches (thick afferents Aβ-fibers)
- Stimulation sequence



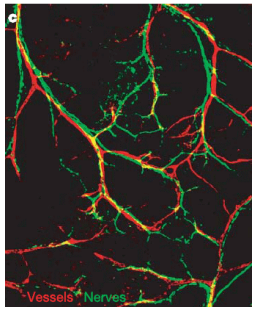
Vagus nerve stimulation

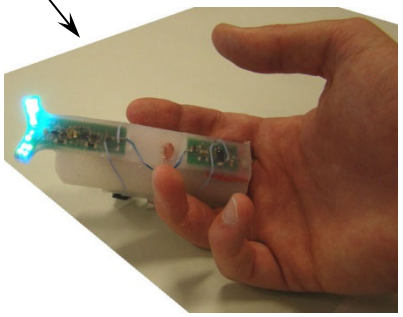
► Finding stimulating points

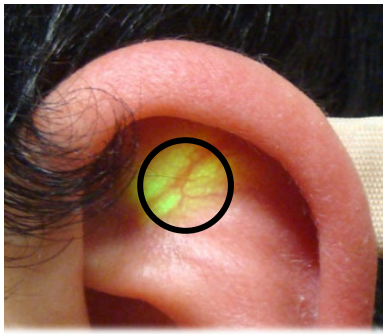
- Electrical method
- Optical method

Electrical method

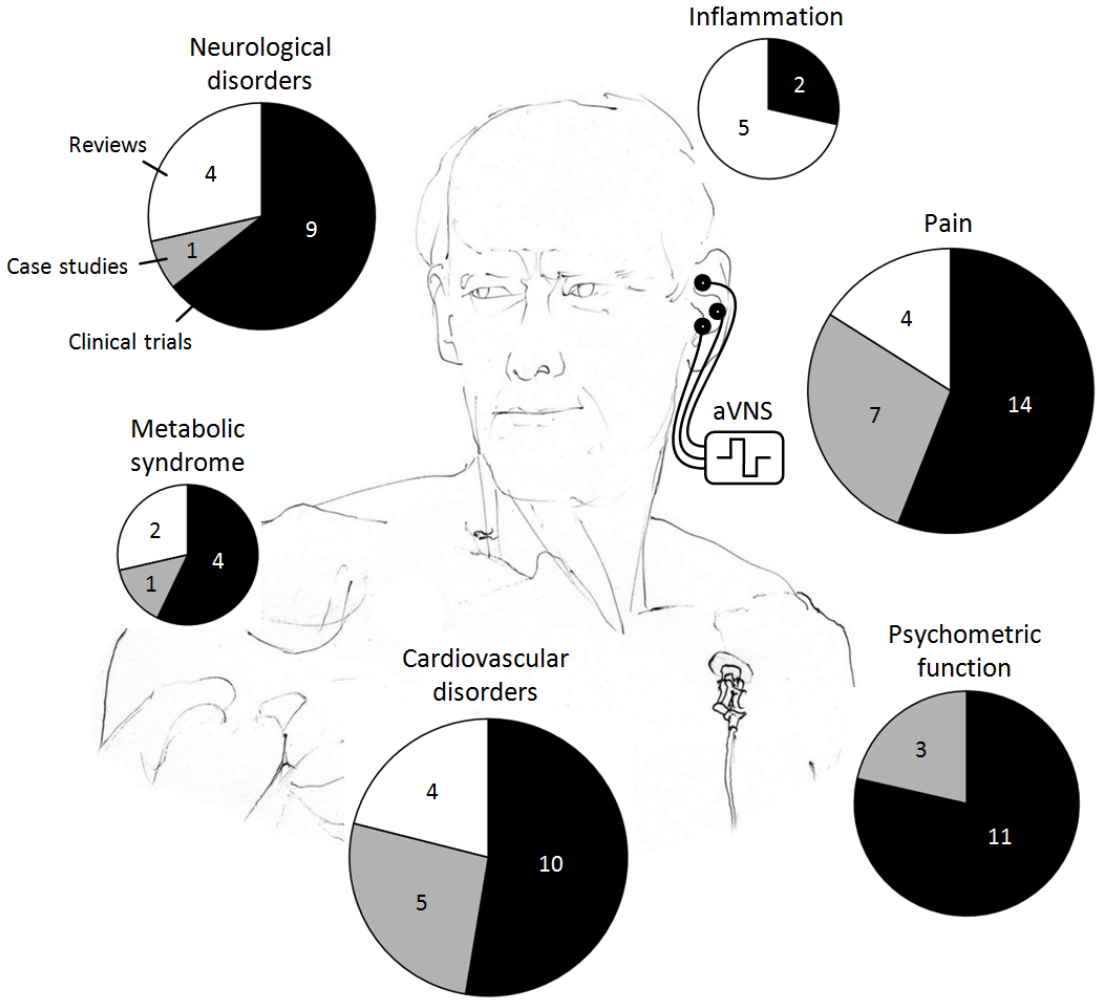
Optical method







Vagus nerve stimulation



(Kaniusas et al, Frontiers in Neuroscience, 2019)

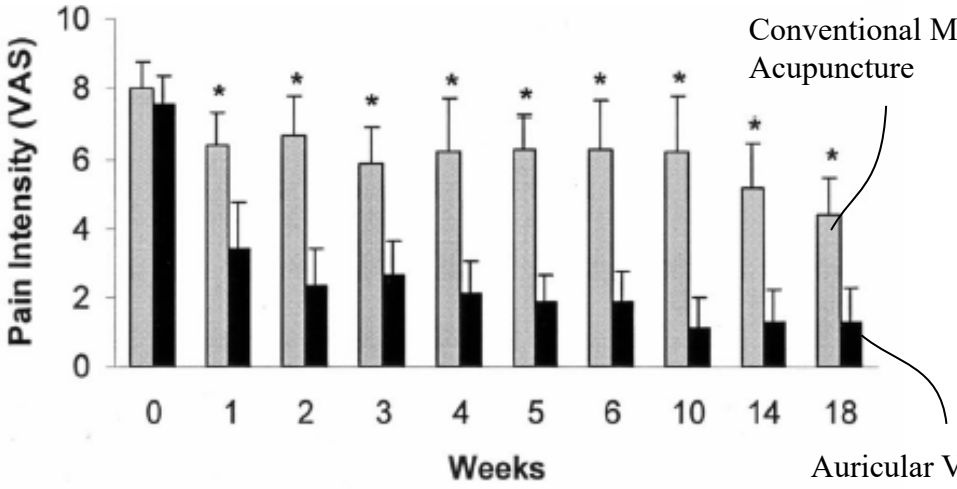
Vagus nerve stimulation

- **Electrical pill for**
  - Pain relieve

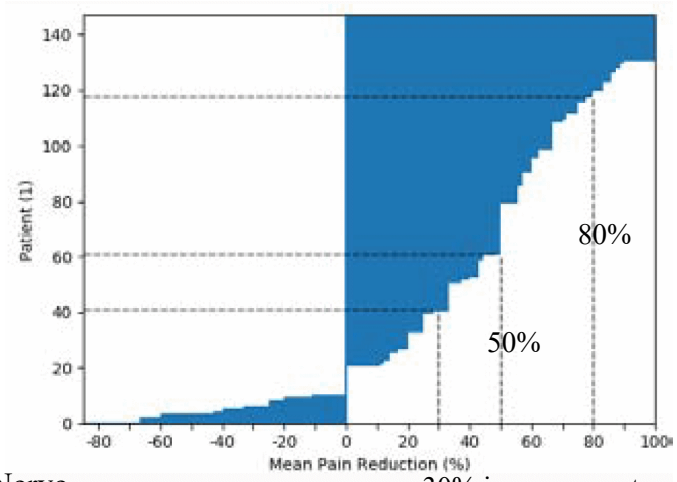
Chronic cervical or low back pain:
~ 83% reduction in pain intensity

Neuropathic pain: ~ 60-75% response rate

Chronic low back pain patients assessed with Visual Analog Scale (VAS)



(Sator-Katzenschlager et al, 2004)

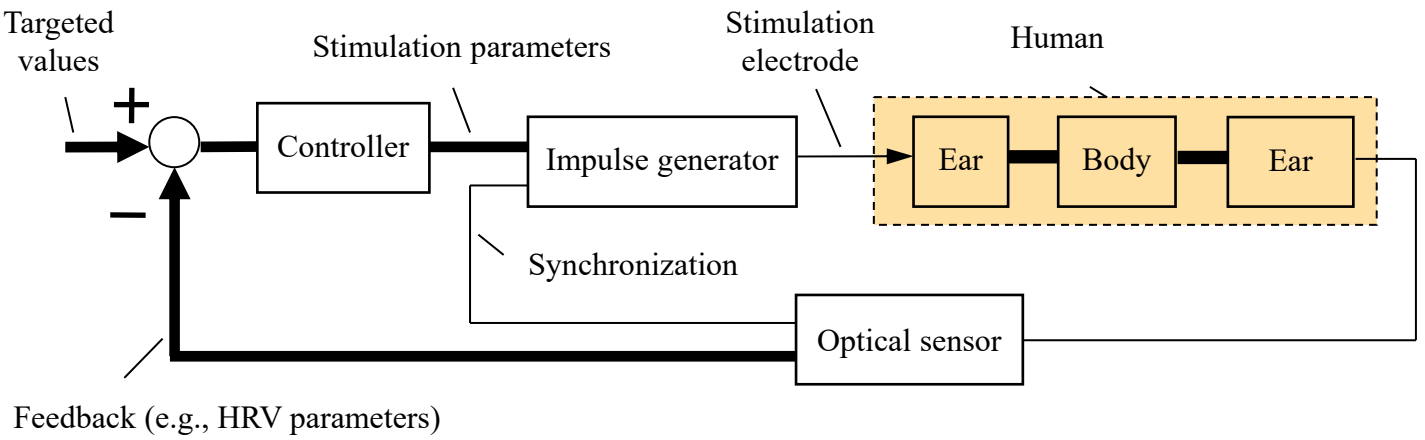


(Szeles et al, 2021)

Personalized stimulation

► Stimulation on demand

- Stimulation on subjective/objective demand, avoid over- and under-stimulation
- Sensors integrated within a feedback-loop
- Synchronization with body rhythms, pathology-related stimulation

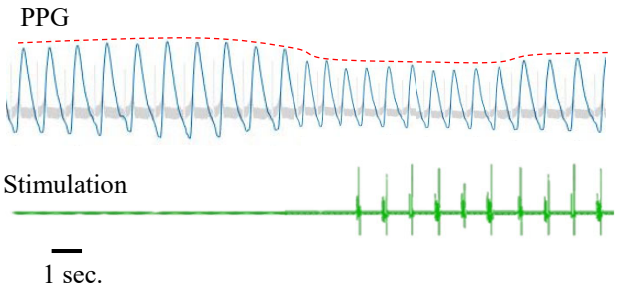


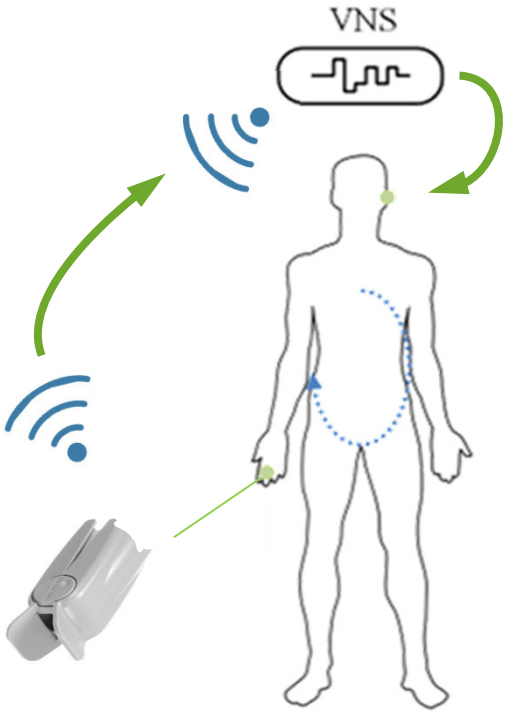
Personalized stimulation

► Feedback-loop based on optic biosignals

- Sensing of
  - Peripheral perfusion
  - Heart rate (variability)
  - Vascular tone

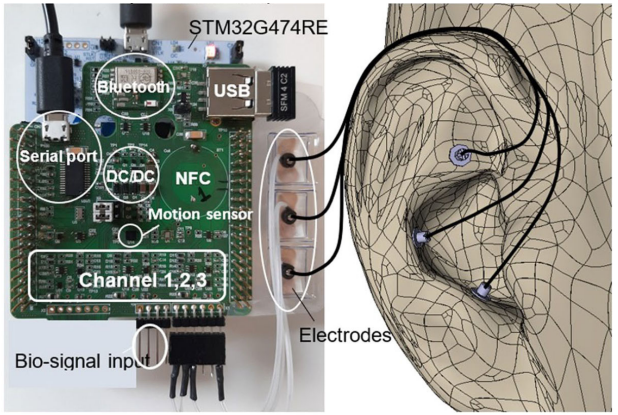
- Potential application in
  - Pain
  - Peripheral arterial disease
  - Diabetes

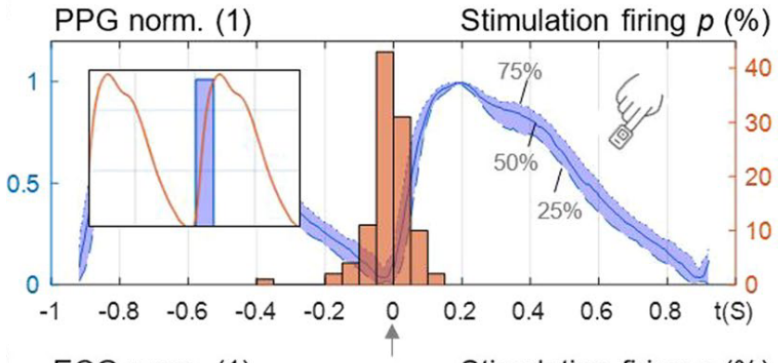


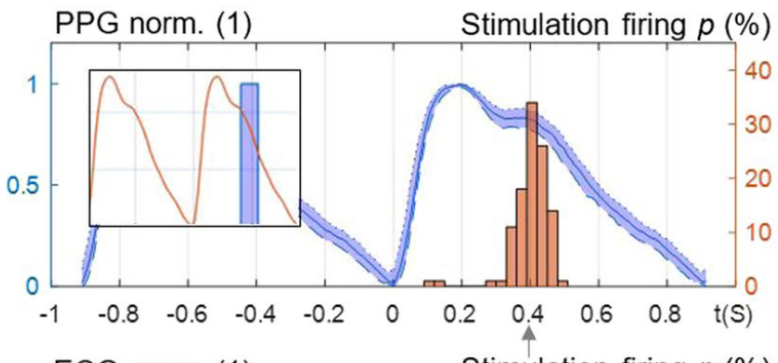


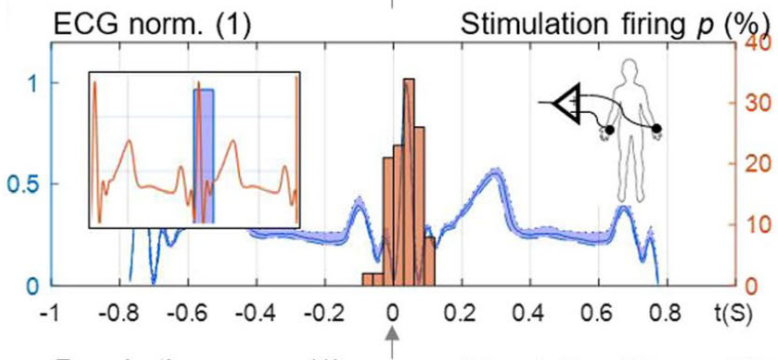
Personalized stimulation

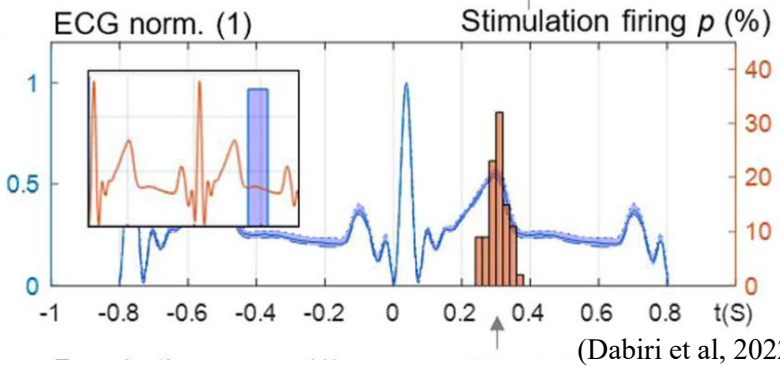
► **Predictive biofeedback loop**











(Dabiri et al, 2022)

Stimulation in Covid-19

► Covid-19

- Viral infection
- Invasion over (mainly) alveolar epithelial cells via ACE2 receptor
- Leads to
  (i) **Cytokine storms**
  (ii) Imbalance of the **sympathetic-parasympathetic activity**
  (iii) Respiratory distress

► Physiological Hypothesis on Vagus Nerve Stimulation

(i) Activation of anti-inflammatory pathways
→ *reduction of storm of pro-inflammatory cytokines*

(ii) Normalisation of sympatho-vagal balance
→ *improved pulmonary and cardiac functions*

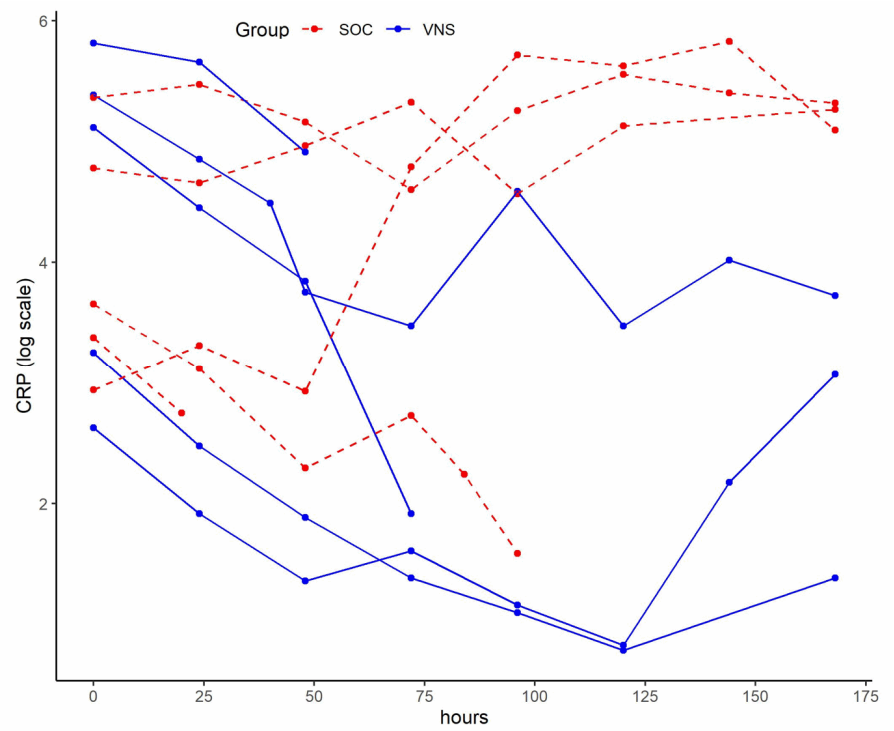
(iii) Improved respiratory control
→ *respiratory feedback will favor lung inflammation control*

endogenous systemic brake

Stimulation in Covid-19

► Results in critical not yet ventilated Covid-19 patients

- **Decreased pro-inflammatory** CRP level by 80% over 7 days
- **Increase anti-inflammatory** IL-10 level by 66% over 7 days
- Reduced hospital stay, reduced costs, …



(Seitz et al, 2022)

Hypotheses versus proof

frontiers in Physiology

HYPOTHESIS AND THEORY
published: 28 July 2020
doi: 10.3389/fphys.2020.00890

Hypothesis

Non-invasive Auricular Vagus Nerve Stimulation as a Potential Treatment for Covid19-Originated Acute Respiratory Distress Syndrome

*Eugenijus Kaniusas[1,2], Jozsef C. Szeles[3,4], Stefan Kampusch[2], Nuria Alfageme-Lopez[5], Daniela Yucuma-Conde[6], Xie Li[7], Julio Mayol[8,9,10], Christoph Neumayer[3,4], Michele Papa[11] and Fivos Panetsos[5,9]**

frontiers | Frontiers in Physiology

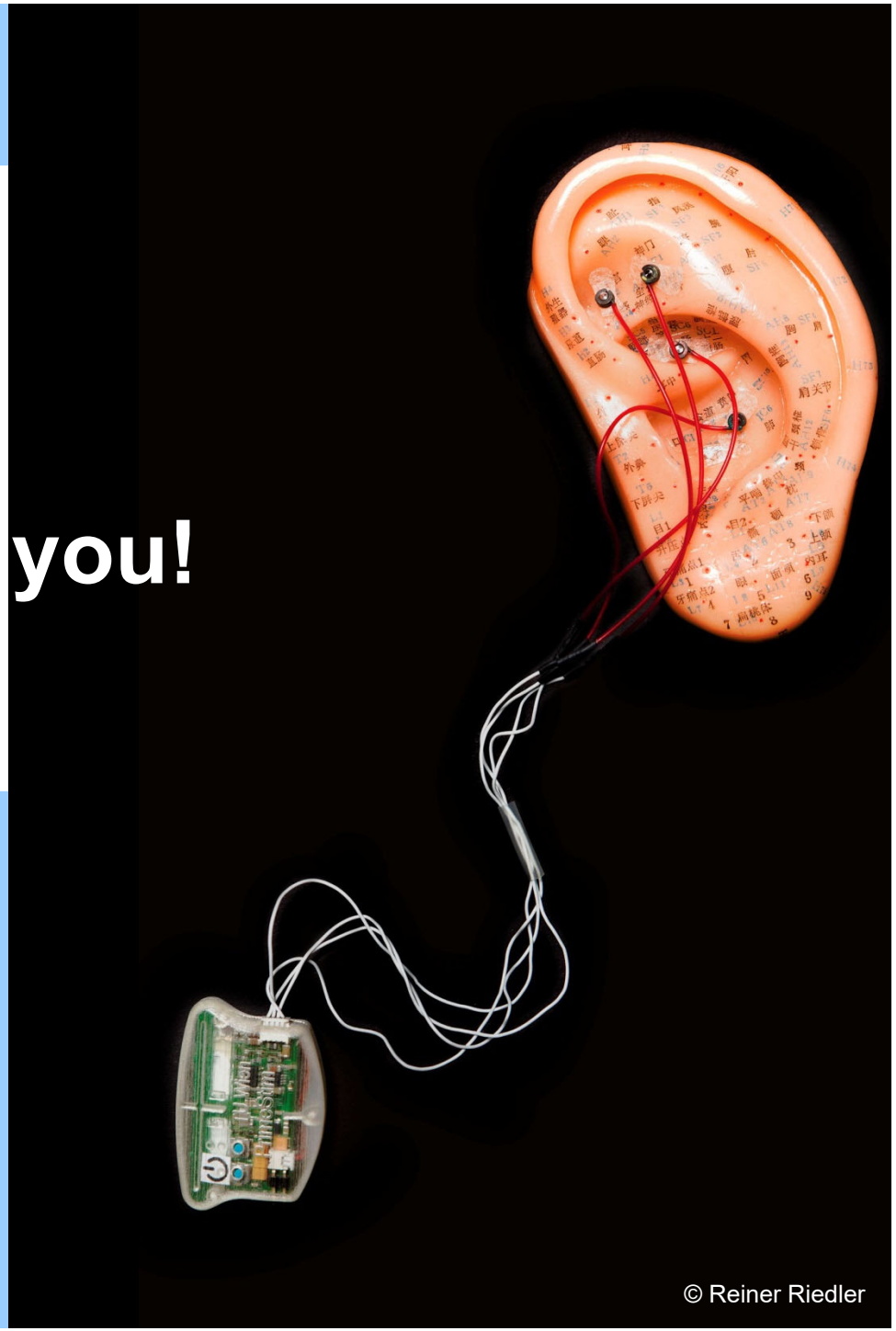
ORIGINAL RESEARCH
published: 04 July 2022
doi: 10.3389/fphys.2022.897257

Proof

Percutaneous Auricular Vagus Nerve Stimulation Reduces Inflammation in Critical Covid-19 Patients

Tamara Seitz[1], József Constantin Szeles[2], Reinhard Kitzberger[1], Johannes Holbik[1], Alexander Grieb[1], Hermann Wolf[3,4], Hüseyin Akyaman[3], Felix Lucny[2], Alexander Tychera[2], Stephanie Neuhold[1], Alexander Zoufaly[1,4], Christoph Wenisch[1] and Eugenijus Kaniusas[5]*

Thank you!



Vienna, 2022