

A new Potential “Self-treatment” for Impact-induced TBI

Mats Ericson

Professor Emeritus

Division of Ergonomics

Department of Technology & Health

Royal Institute of Technology, KTH

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CLINTEC – Division of Surgery and Oncology

Karolinska Institute

Military background – Amphibious corps



Swedish Defence University



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- **Traumatic Brain Injuries (TBIs) are a serious concern in high-risk occupations**
- **High-speed vehicles (boats, helicopters, etc.) can cause impact-induced TBI**
- **Need for acutely self-administered, non-invasive, field-friendly interventions**

DISCLAIMER

Title of presentation: A new Potential “**Self-treatment**” for Impact-induced TBI

- All treatment of serious illnesses, such as various forms of traumatic brain injury, must **ALWAYS** be prescribed and supervised by trained medical personnel.
- “**Self-treatment**” primarily refers to physician-prescribed treatment during the subacute or chronic phase.
- There is still a need for acutely self-administered, non-invasive, field-friendly interventions after TBI!

Four general stages of traumatic brain injury (TBI)

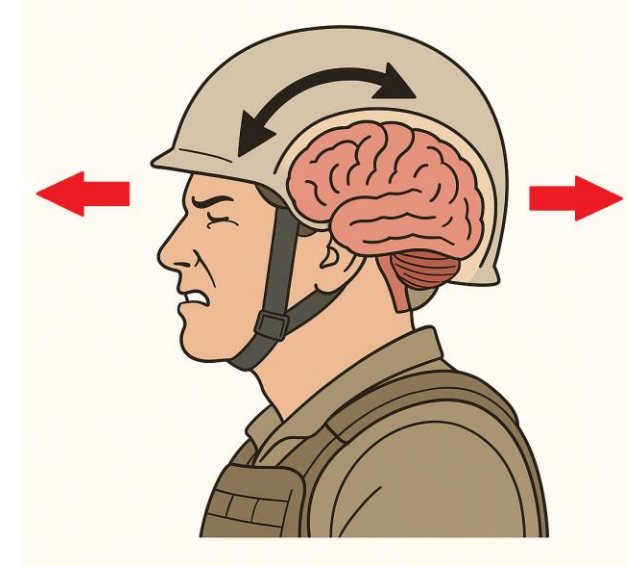
- **Mild (Concussion)**
Brief loss of consciousness or confusion; symptoms may include headache, dizziness, and memory issues.
- **Moderate**
Loss of consciousness for minutes to hours; cognitive, physical, or emotional impairments may last weeks or longer.
- **Severe**
Prolonged unconsciousness or coma; significant long-term impairments in movement, cognition, or behavior.
- **Very Severe / Catastrophic**
Extended coma or unresponsive state; often leads to permanent disability or a vegetative state.

Five main types of traumatic brain injury (TBI)

- **Impact-Induced TBI**
 - Triggered by explosive pressure waves (e.g., IEDs)
 - Common in military/combat settings
 - May cause diffuse brain injury without visible external trauma
- **Acceleration-Deceleration TBI**
 - Occurs without direct impact—brain shifts violently inside the skull
 - Seen in car crashes or falls
 - Often causes diffuse axonal injury
- **Blast-Induced TBI**
- **Penetrating TBI**
- **Hypoxic–Ischemic Brain Injury**

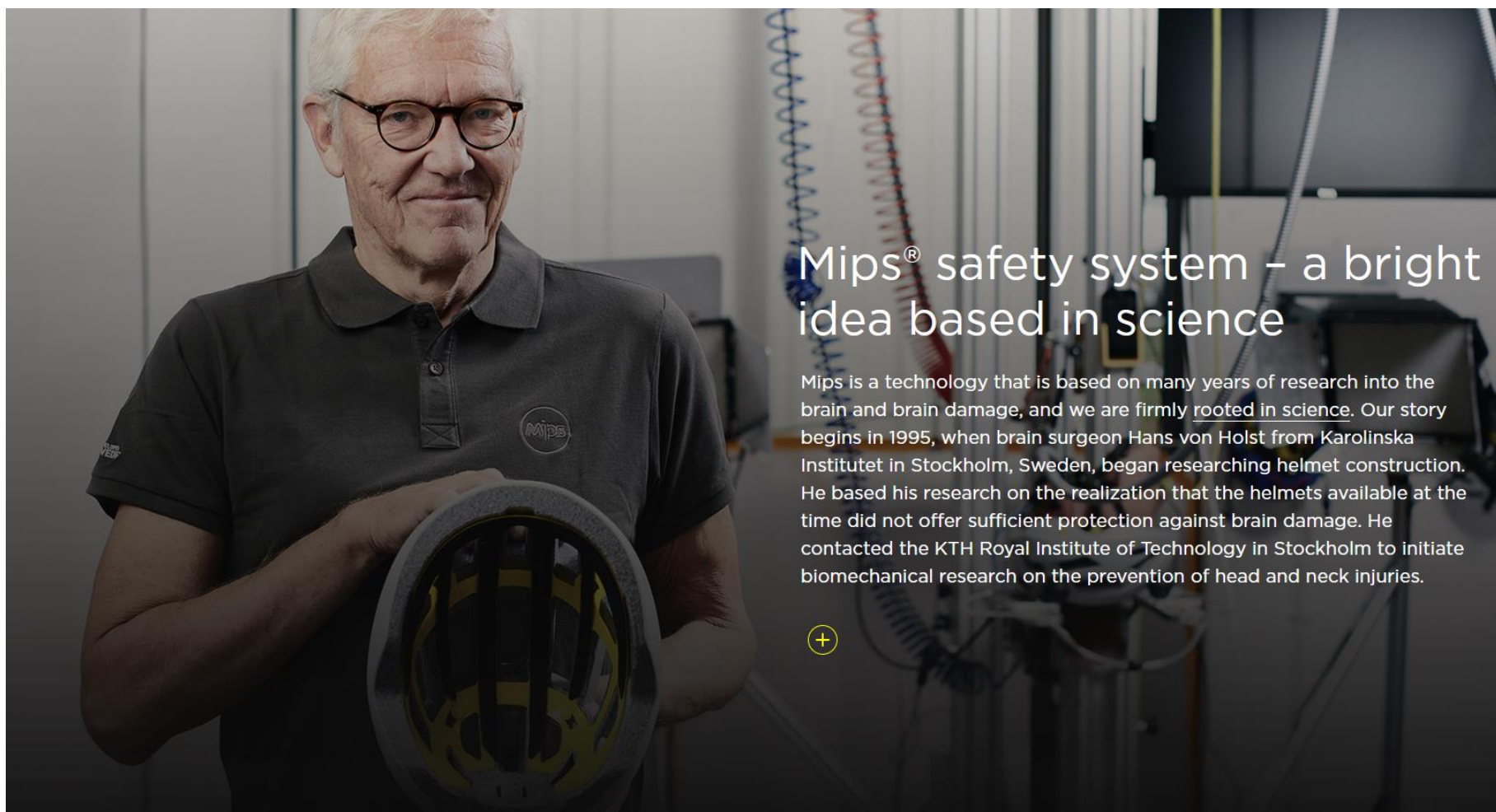
Mechanisms of Impact-Induced & Acceleration-Deceleration TBI

- **Sudden acceleration/deceleration AND/OR rotation → brain moves within skull**
- **Results: bruising, axonal shearing, diffuse brain injury**



Mips safety system –

A thin, movable layer is placed between the helmet shell and the head, which allows the helmet to rotate 10-15 mm relative to the head during angled impacts and reduces rotational acceleration on the brain



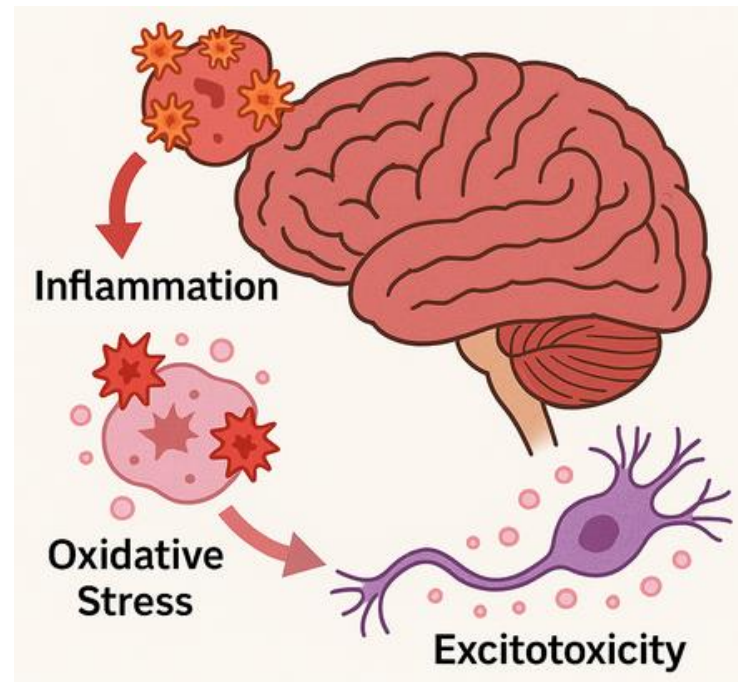
Mips® safety system – a bright idea based in science

Mips is a technology that is based on many years of research into the brain and brain damage, and we are firmly rooted in science. Our story begins in 1995, when brain surgeon Hans von Holst from Karolinska Institutet in Stockholm, Sweden, began researching helmet construction. He based his research on the realization that the helmets available at the time did not offer sufficient protection against brain damage. He contacted the KTH Royal Institute of Technology in Stockholm to initiate biomechanical research on the prevention of head and neck injuries.



Secondary Injury Cascade

- **Begins minutes to hours after primary injury**
- **Includes inflammation, oxidative stress, and brain cell overload (excitotoxicity)**



- **Can worsen cognitive and neurological outcomes**
- **Target for therapeutic intervention**

Current Treatment Landscape

- **Focus on:**

Stabilization



Pressure
Control



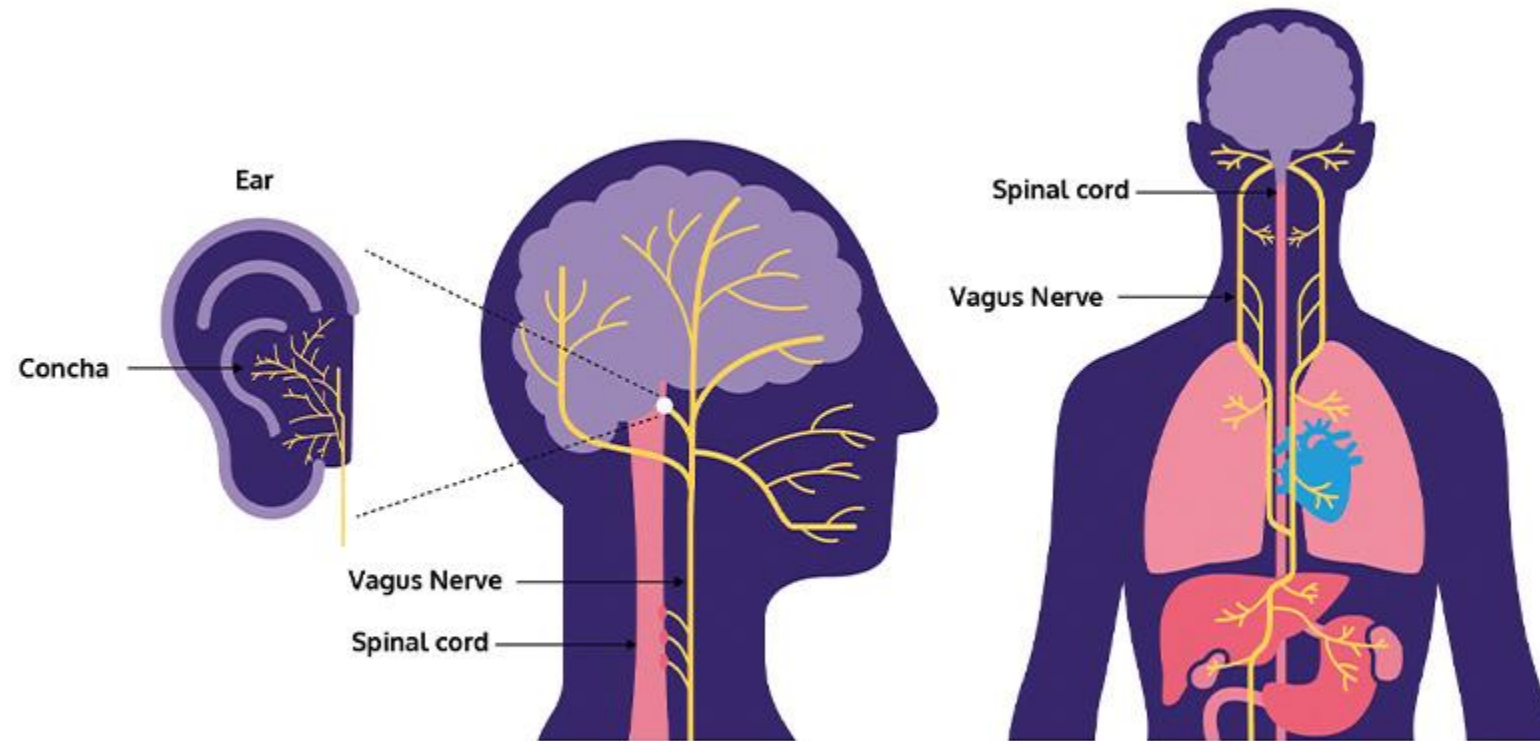
Long-Term
Rehab



- **In-field limitations:** access, time sensitivity, training
- **Gap:** interventions during early post-impact phase

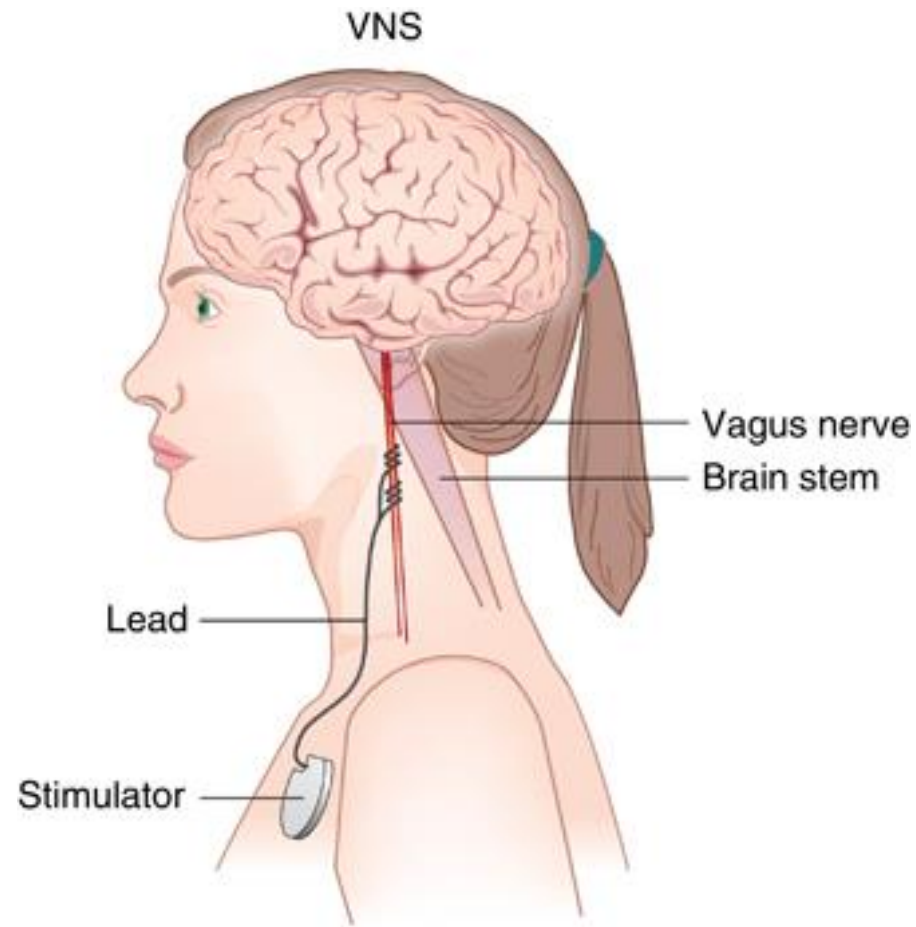
Vagus Nerve Stimulation (VNS)

- **Vagus nerve: major parasympathetic pathway**
- **Modulates inflammation, stress response, neuroplasticity**



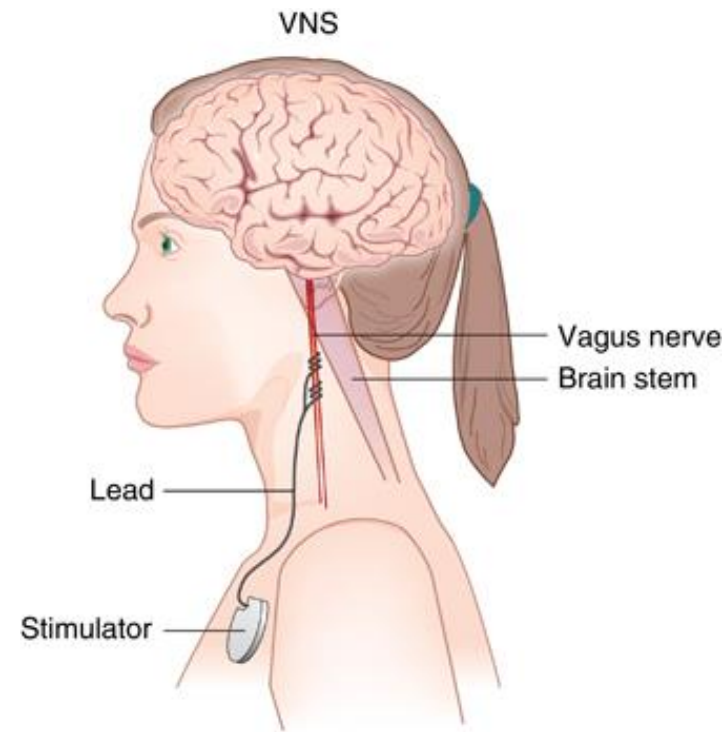
Vagus Nerve Stimulation (VNS)

- **Invasive Vagus Nerve Stimulation (iVNS)**
- **iVNS = implanted device, FDA approved for use in epilepsy, depression & stroke rehabilitation**



Evidence for iVNS in TBI

- **Preclinical TBI-studies: reduces inflammation, protects neurons**
- **Enhances recovery post-TBI in animal models**
- **Challenges: surgical risks, long-term implantation, not feasible in the acute phase**



tVNS as Non-Invasive Alternative

**Transcutaneous vagus nerve stimulation (tVNS):
external stimulation via skin**

tcVNS: neck



Portable, no surgery, easy to apply, safe, low cost

tVNS as Non-Invasive Alternative

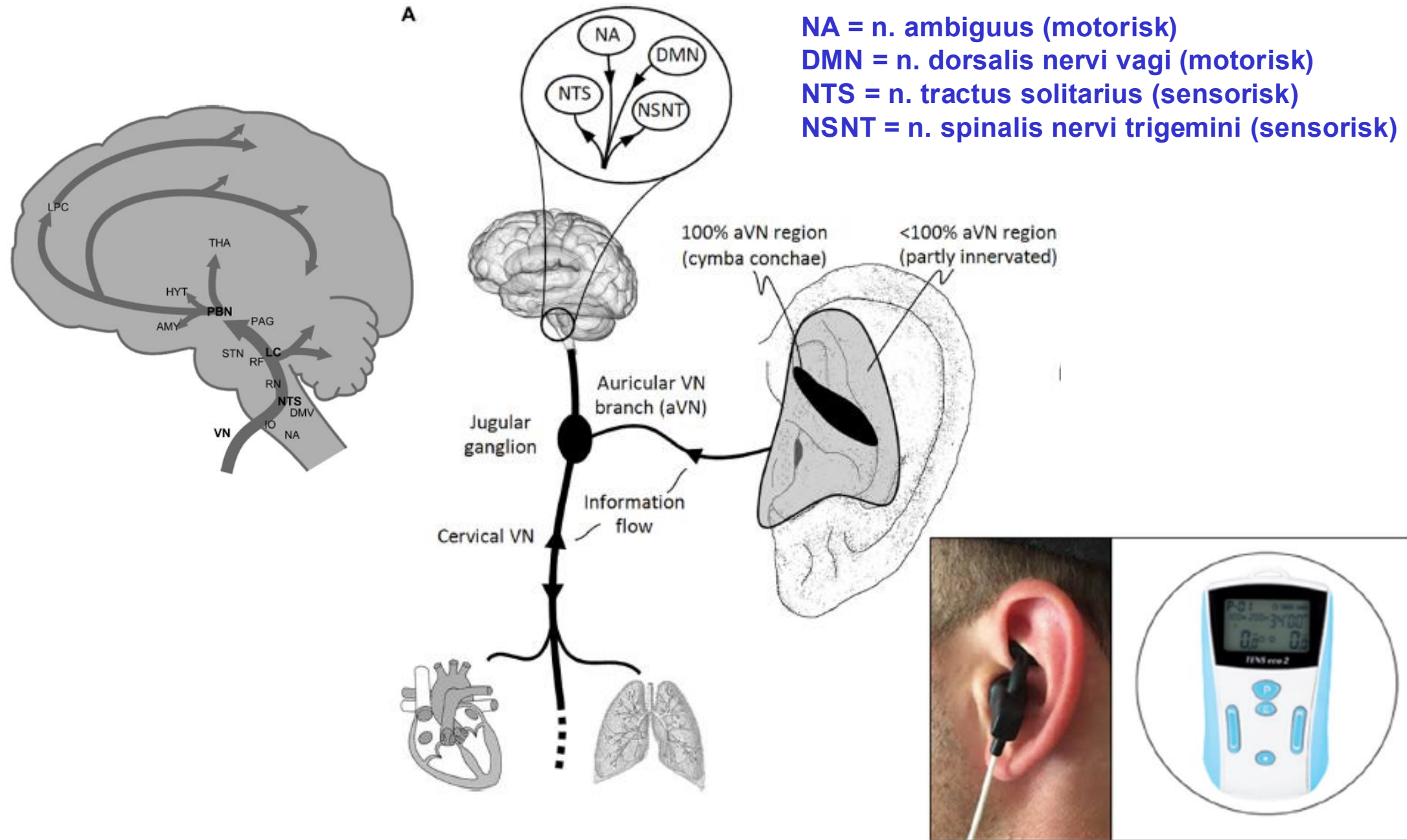
**Transcutaneous vagus nerve stimulation (tVNS):
external stimulation via skin**

taVNS: ear



Portable, no surgery, easy to apply, safe, low cost

Transcutaneous auricular vagus nerve stimulation (taVNS)



Therapeutic Effects of tVNS

- **Reduces inflammation & brain cell overload (excitotoxicity)**
 - **Supports brain repair & formation of new neurons (neurogenesis)**
 - **Increases brain plasticity;**
 - **Modulates brain connectivity**
 - **Improves sensorimotor function**
 - **Improves cognitive recovery**
- **Restores function !**

Yet only two clinical feasibility studies of tVNS treatment for TBI

- **Hakon et al 2020: *Transcutaneous Vagus Nerve Stimulation in Patients With Severe Traumatic Brain Injury: A Feasibility Trial.***
- **CONCLUSIONS:** We conclude that VNMS is a safe and feasible treatment option for patients with TBI with cognitive dysfunction.
- **Zhang et al 2024: *Transcutaneous Cervical Vagus Nerve Magnetic Stimulation in Patients With Traumatic Brain Injury: A Feasibility Study.***
- **CONCLUSIONS:** We demonstrated that tVNS is a feasible and safe VNS strategy for patients following severe TBI. Controlled studies are needed to clarify whether tVNS has a potential to promote recovery of consciousness following severe TBI.

Clinical studies of taVNS treatment for acute stroke

A research group at Washington University in St. Louis, Missouri, USA, led by neurosurgeon Eric C. Leuthardt as principal investigator (PI), published the first three clinical studies of taVNS as an adjuvant treatment in acute stroke—both ischemic (“clot”) [Laurido-Soto et al 2025] and hemorrhagic (“bleed”) [Tan et al 2025, Huguenard et al 2025]—in early 2025, all with positive results.

- **Laurido-Soto et al 2025: *Transauricular Vagus Nerve Stimulation Reduces Inflammation and Improves Outcomes in Ischemic Strokes: the NUVISTA Trial.***
- **Tan et al 2025: *The effect of transcutaneous auricular vagus nerve stimulation on cardiovascular function in subarachnoid hemorrhage patients: a safety study.***
- **Huguenard et al 2025: *Auricular vagus nerve stimulation for mitigation of inflammation and vasospasm in subarachnoid hemorrhage: a single-institution randomized controlled trial***

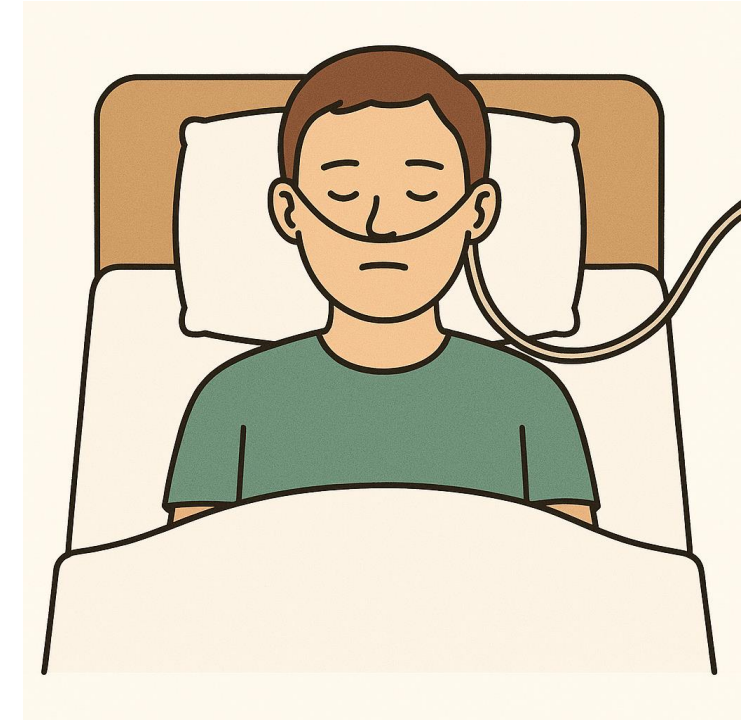
tcVNS for Headache Relief

- **Headaches are common post-TBI**
- **FDA-approved for migraine and cluster headache**
- **Adds quality-of-life and functional value**



tVNS in Disorders of Consciousness (DOC)

- **Some TBI patients develop DOCs (e.g. Coma, Vegetative state or Minimally Conscious State)**
- **tVNS may help by stimulating arousal networks**
- **Potential to improve responsiveness & recovery but not yet approved**



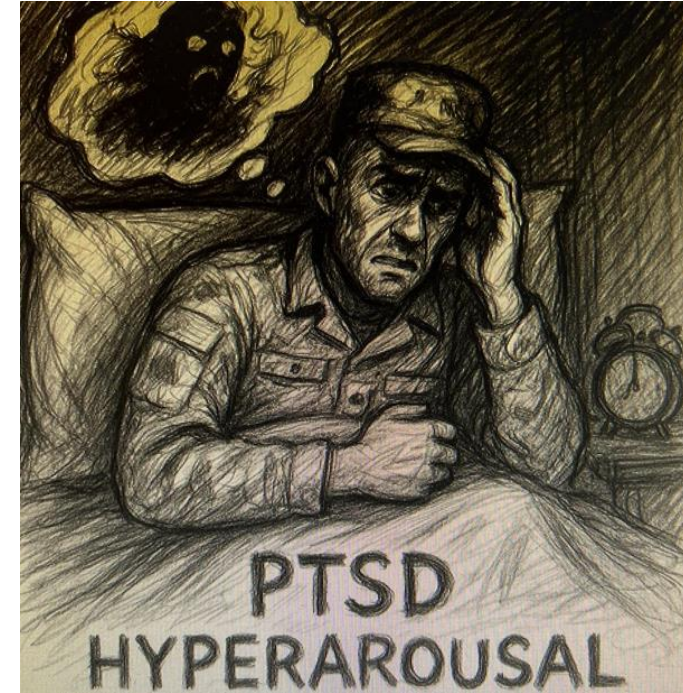
tVNS and Mood Disorders

- Depression/anxiety common after TBI
- tVNS most probably useful for depression treatment – **not yet approved for tVNS, but since 2005 FDA approved for iVNS.**
- Dual benefit: mood stabilization + neuroprotection



tVNS and Post Traumatic Stress Disorder (PTSD)

- **Lower stress level, decreased sympathetic activity, less hyperarousal, less inflammatory response**
- **Can help with memory extinction, less conditioned fear response**
- **Gives better sleep, less insomnia problems**



tVNS as Potential Self-Treatment

- **Compact, non-invasive, easy-to-learn and apply, safe and low cost**
- **Potential for early or field-based application**
- **Promising adjunct treatment to conventional care**
- **May be part of military/police/rescue medical kits**



Research Needs and Next Steps

- **Controlled studies in TBI populations**
- **Define optimal treatment parameters (timing, duration)**
- **Assess long-term outcomes and safety**
- **Develop protocols for field use**

Summary & Take-Home Message

- **tVNS is a promising, low-risk intervention after TBI**
- **May improve outcomes in impact-induced TBI**
- **Suitable for “self-treatment” in high-risk professions**
- **Call for collaboration in clinical evaluation and deployment !**



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Presentation pre-recorded on video:

**[https://play.kth.se/media/Mats+Ericson+-
+A+New+Potential+Self-treatment+for+Impact-
induced+TBI+-250522/0_n5kr37m2](https://play.kth.se/media/Mats+Ericson+-+A+New+Potential+Self-treatment+for+Impact-induced+TBI+-250522/0_n5kr37m2)**