Simposio ASI
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Non-invasive Neuromodulation in Space as a Countermeasure for Cardiovascular and Immune Dysfunction

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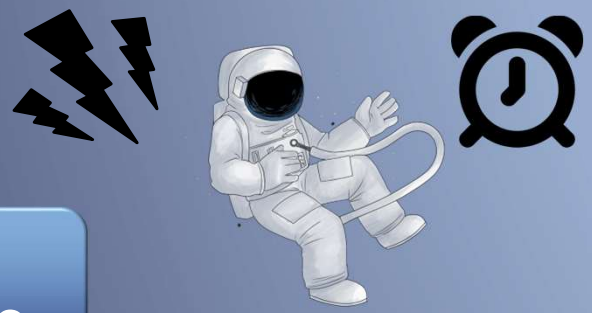
Introduction

physical factors



Space Exposome

psycho-social factors

- Immune dysfunction
- Malignancies
- Thromboembolic events
- Cardiovascular alterations
- Sleep disturbances
- Deconditioning
- Depressive symptoms

The Multiple Connections of ANS

AUTONOMIC NERVOUS SYSTEM

Central Nervous System

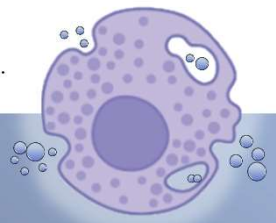
- Modulation of Default Mode Network (e.g., Major Depressive Disorder)
- Effects on synaptogenesis

Tobaldini, E. et al.
Neurosc & Biobehav Reviews 116 (2020).

Immune System

- Modulation of inflammatory pathways

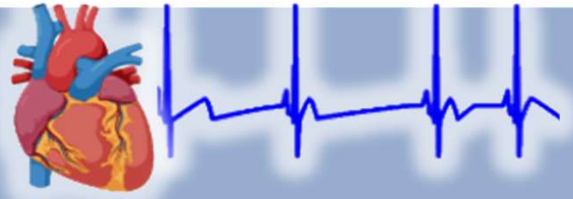
Bellocchi, C. et al.
Int J Mol Sci 23 (2022).



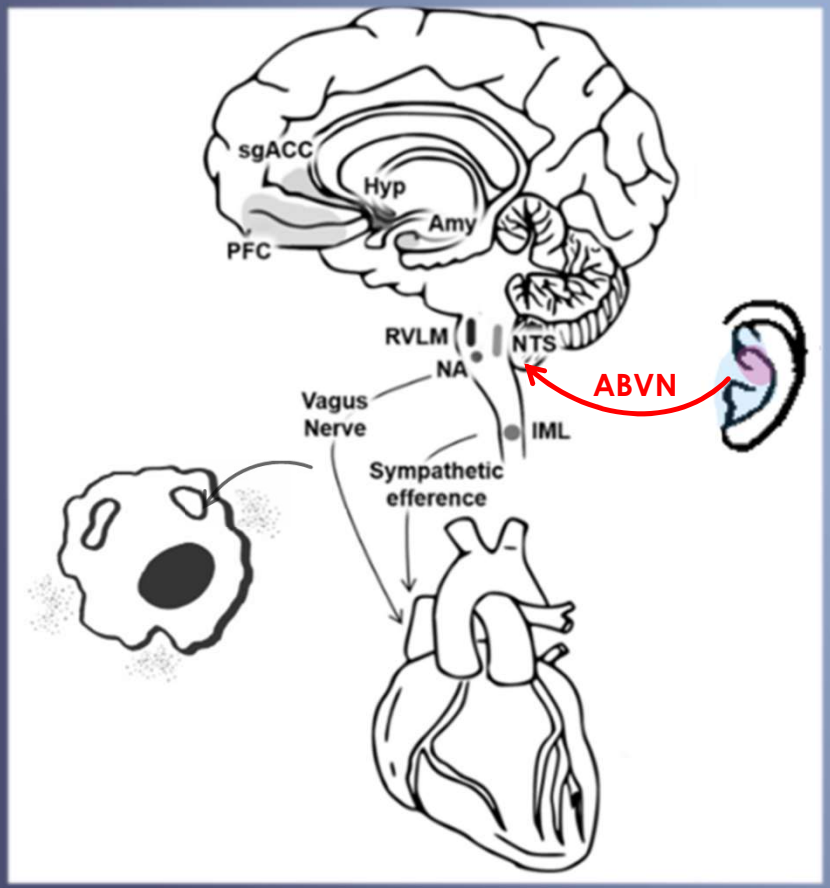
Cardiovascular System

- Modulation of heart rate variability and cardiovascular plasticity
- Influence on cardiovascular risk

Carandina, A. et al.
Autonomic Neuroscience 236 (2021).



The Vagus Nerve



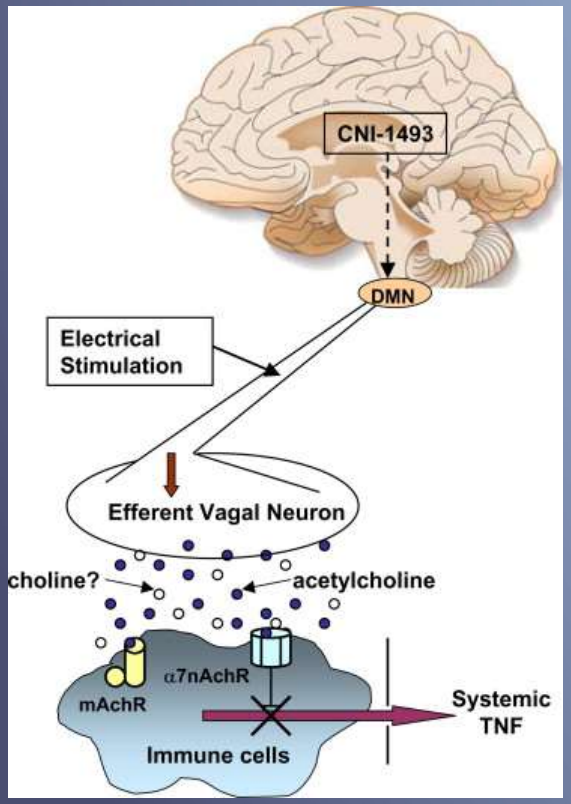
*Franzini A et al. J Int Neuromodulation Soc. oct 2008;11(4):267–71.
*Chakravarthy K et al.. Curr Pain Headache Rep. dec 2015;19(12):54.
*Xie H, et al.. Epilepsy Behav EB. 7 feb 2023;140:109107

Vagal Nerve Stimulation, treatment for:

- refractory epilepsy*
- uncontrolled migraine*
- depression*

- <u>transauricular</u> **Vagus Nerve Stimulation (tVNS) is a non-invasive neuromodulatory tool that proved to be effective in several chronic diseases;**
- **tVNS is a stimulation technique with a high safety profile**
- **tVNS can be performed anywhere with highly portable ad hoc devices**

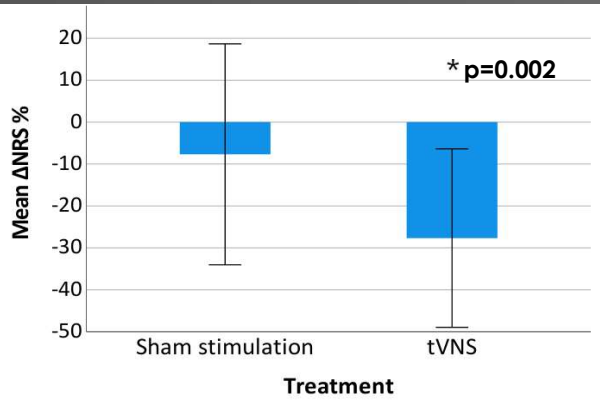
The Anti-Inflammatory Effect

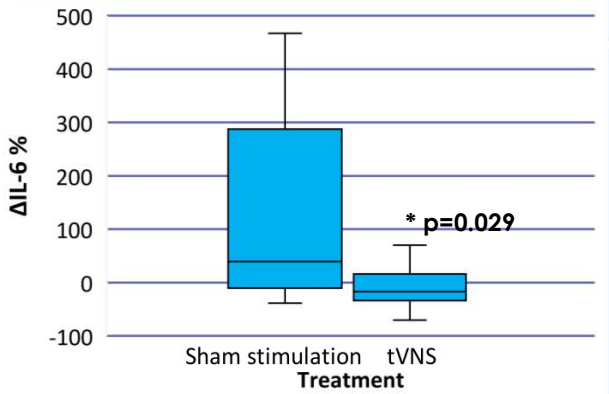


Pavlov, V. A. & Tracey, K. J.
Brain Behav Immun 19 (2005).

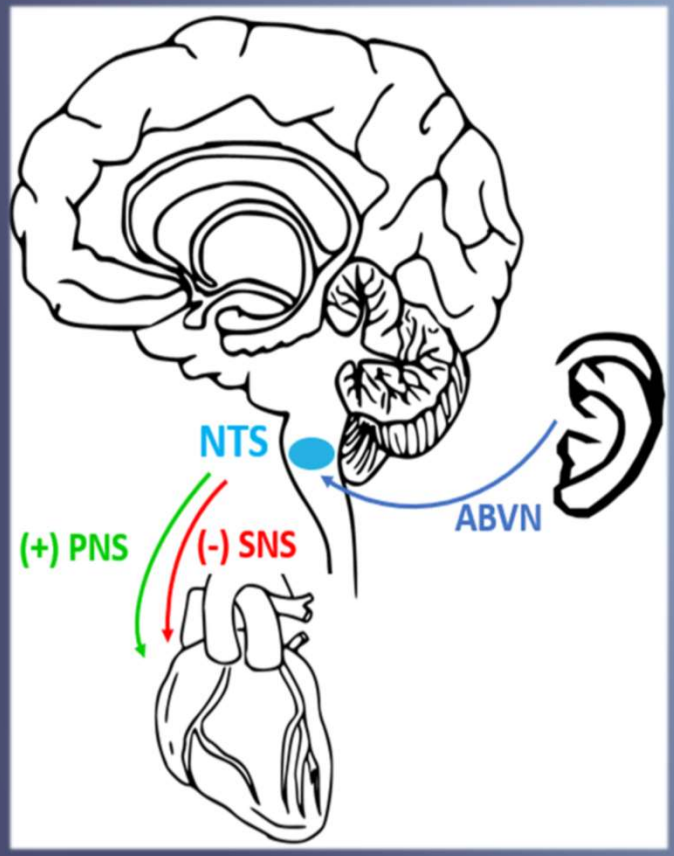
- tVNS preserves the homeostasis of immune response through the a7nAChR mediated anti-inflammatory reflex;
- tVNS → as therapeutical approach to autoimmune diseases featuring inflammation and chronic pain.

Transcutaneous auricular vagus nerve stimulation ameliorates chronic pain in patients with systemic sclerosis: results from a pilot interventional trial (under review)

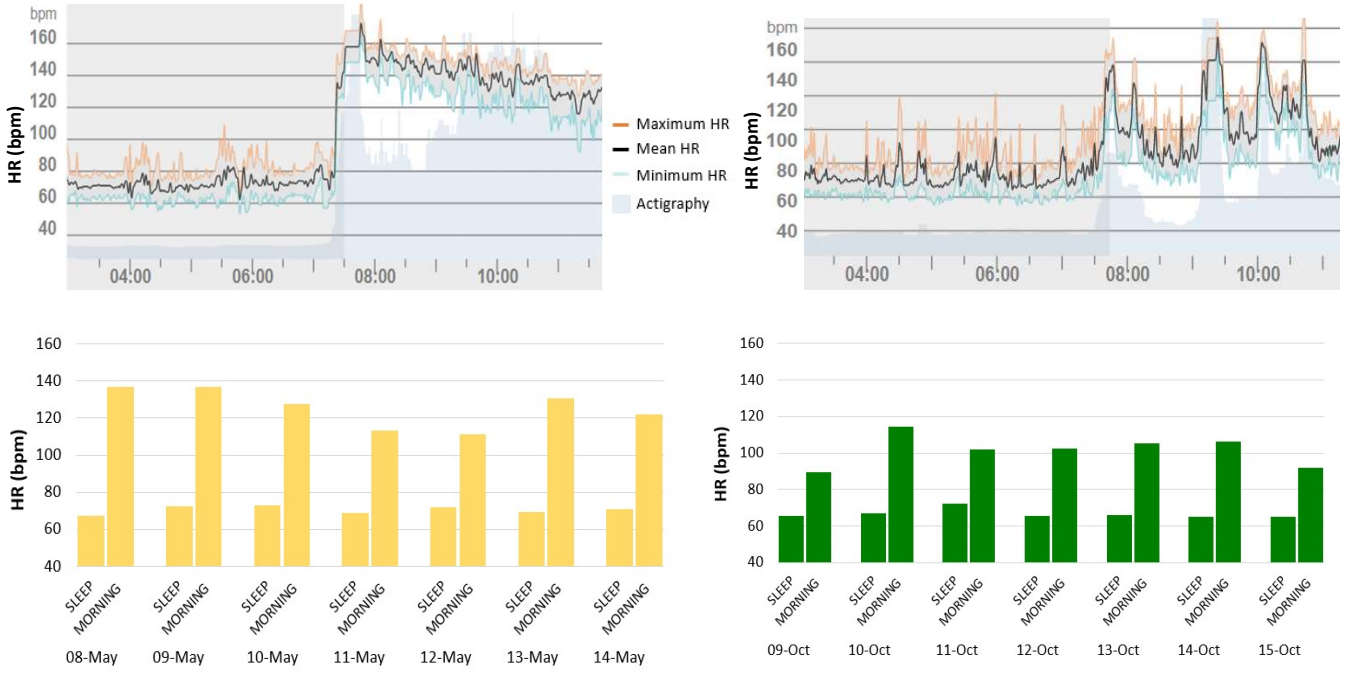




The Cardiovascular Autonomic Modulation

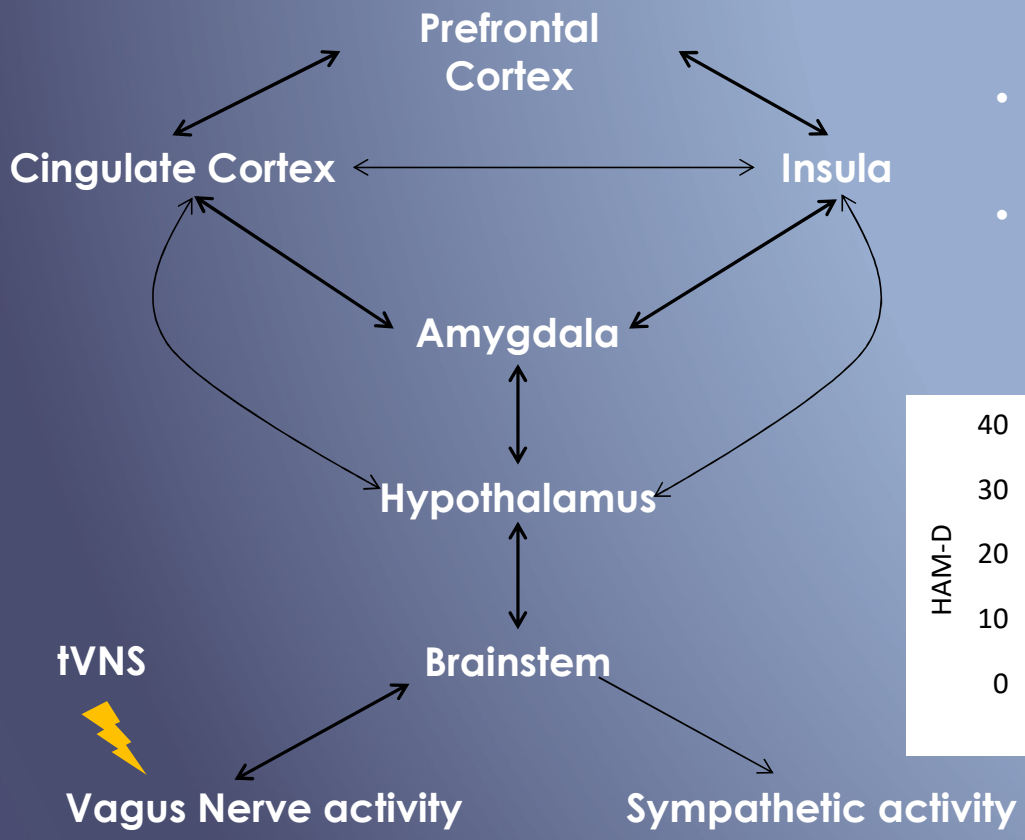


Efficacy of vagal neuromodulation in one case of Postural Orthostatic Tachycardia Syndrome



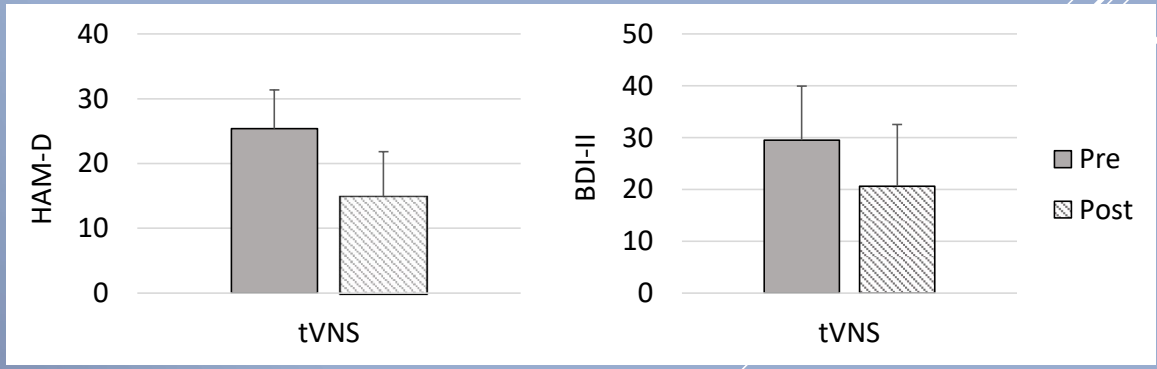
(under review)

The Antidepressant Effect



Adapted from Thayer & Lane
Neurosci Biobehav Rev 33 (2009).

- tVNS can significantly modulate the functional connectivity of Default Mode Network;
- tVNS can significantly reduce multiple symptoms of depressive patients, including anxiety and sleep disturbance.

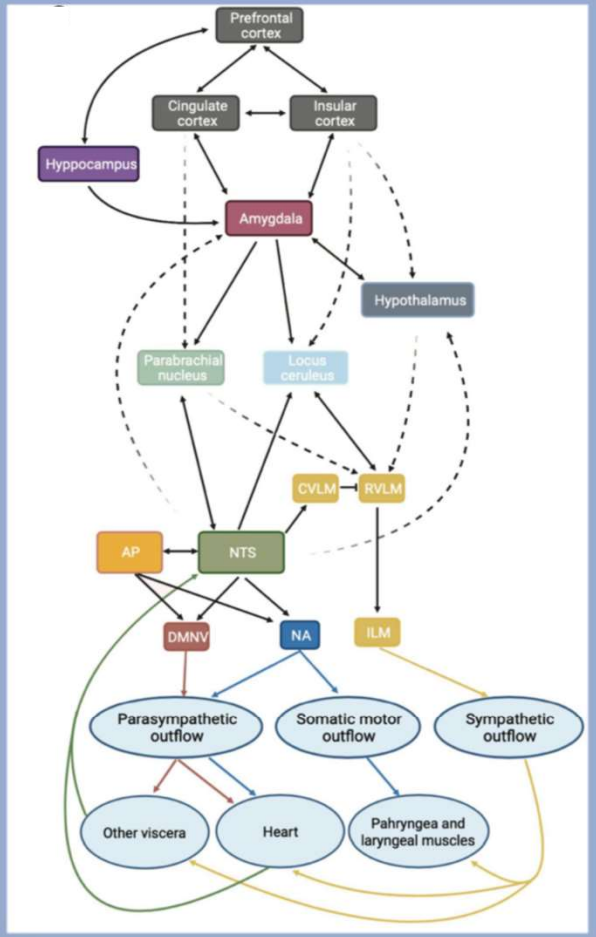


(unpublished data)

Take-Home Message

The tVNS:

- **represents an safe non-invasive neuromodulation technique**
- **is portable and low-cost**
- **has shown a great potential for the treatment of a wide range of Space-induced alterations due to its pleiotropic effects**



Ottaviani, M. M., et al.
Frontiers in Cardiovascular Medicine 9 (2022).

Acknowledgments

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