

## **The interoceptive self: Transcutaneous vagus nerve stimulation as a new tool to investigate heart-brain interactions**

### **ABSTRACT:**

Interoception is the body-to-brain axis of sensations originating from the internal body organs signalling their physiological state. Neurally, these visceral signals are mainly conveyed through the vagus nerve to the Nucleus Tractus Solitarius in the brainstem from where they are relayed to regions such as the locus-coeruleus and the amygdala and, through thalamocortical projections, to higher order structures such as the insula. However, despite the recognized importance of the vagus nerve in the conduction and regulation of autonomic signals, experimental evidence of its role in bringing these signals into consciousness and in emotional processing is still lacking. Here, we investigated the impact of non-invasive stimulation of the auricular branch of the vagus nerve (tVNS) in the modulation of interoceptive information and emotional processing. In Study 1 we show that tVNS is associated with improved performance in a task assessing the ability to consciously perceive heartbeats. Study 2 used an experimental technique that capitalizes on natural fluctuations of arterial baroreceptor firing to show that tVNS modulates the impact of afferent cardiac signals in the processing threat cues. Study 3 employed a task known to rely on the locus coeruleus-norepinephrine system to show the effectiveness of a novel rapid event-related stimulation protocol. Study 4 explored the potential role of tVNS in physiological and subjective empathic reactivity to others' pain but did not find significant effects. Together, these findings enhance our understanding of the mechanisms underlying the interoceptive and emotional processing, and demonstrate the potential of tVNS as an important tool to investigate brain-body interactions.

### **Keywords**

tVNS, Vagus nerve stimulation, Interoception, Emotion processing, Brain-body

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