Transcutaneous Vagal Nerve Stimulation as a Potential Treatment Option for Neuropsychiatric Conditions: A Meta-Analysis of Neuroimaging Evidence

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Introduction

Dysfunction of the autonomic nervous system has been implicated in the pathophysiology of multiple neuropsychiatric conditions. Considering the pivotal role of the vagus nerve to the brain's central autonomic network, transcutaneous vagal nerve stimulation (tVNS) has been proposed as a novel therapeutic intervention to restore disease-driven autonomic disruption. Further, numerous tVNS-induced clinical benefits have been observed in depression and disorders affecting cognition. However despite its clinical efficacy, the central mechanism of this device on the brain remains unclear.

Aim

Synthesising all available brain imaging data, we conducted a meta-analysis to identify the best approximation of the brain effects of tVNS.

Methods

A total of 157 studies were identified from the Web of Science and PubMed databases, 4 of which were appropriate for neuroimaging-based statistical analysis, encompassing 60 healthy subjects (aged 18-65). Using activated likelihood analysis estimation, we established brain activity changes from tVNS statistically contrasted to both null and sham stimulation.[1]

Results

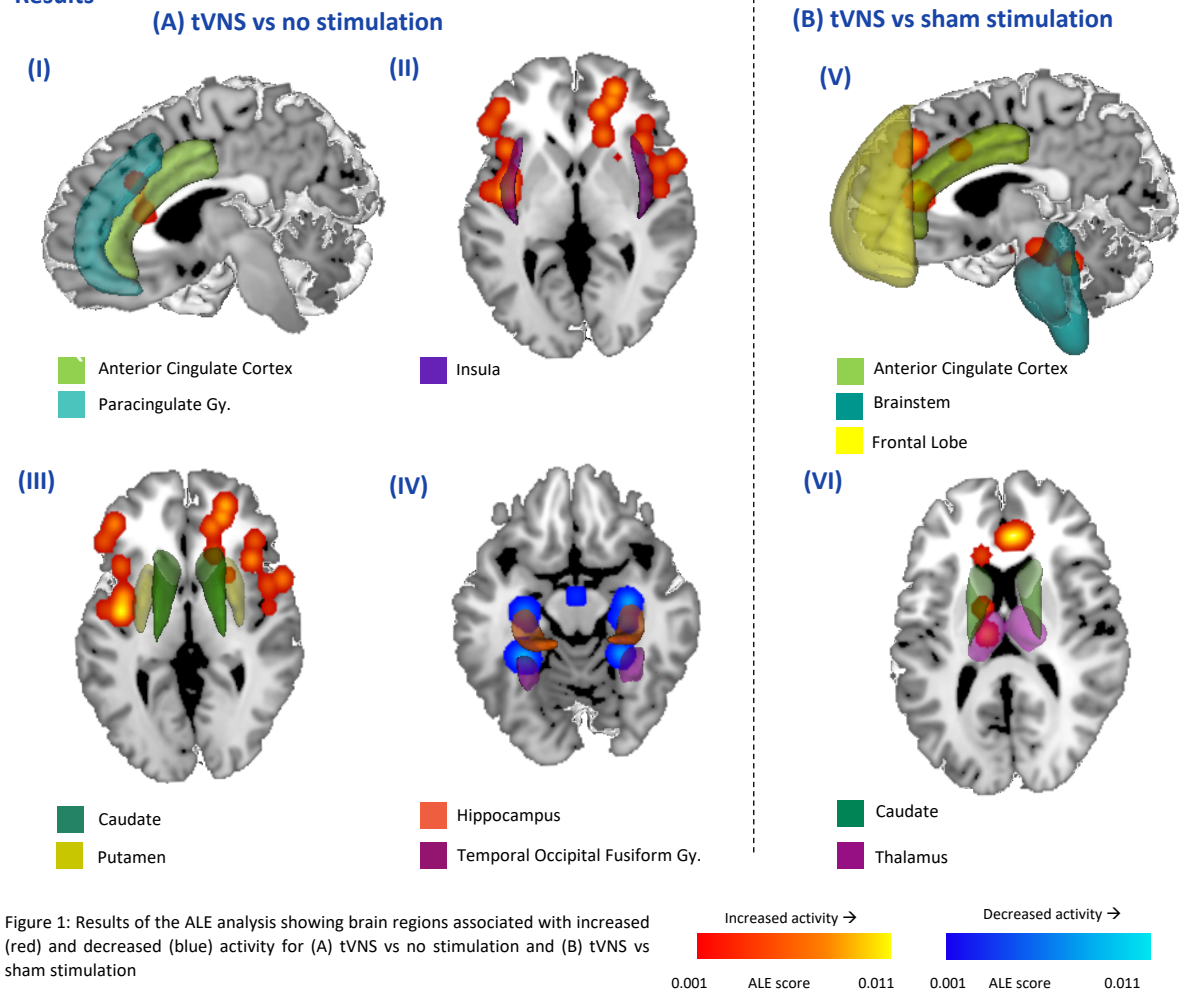
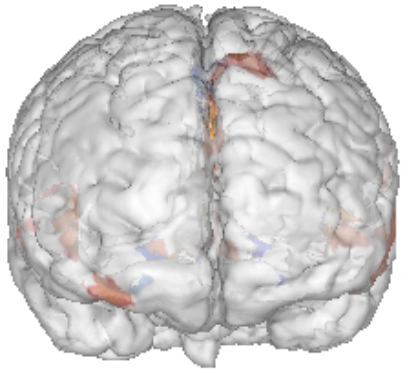


Figure 1: Results of the ALE analysis showing brain regions associated with increased (red) and decreased (blue) activity for (A) tVNS vs no stimulation and (B) tVNS vs sham stimulation



Conclusion

We provide the first meta-analytic map of the brain effects of tVNS by coalescence of all relevant prior brain imaging in healthy human subjects, using a validated meta-analytic framework. We illustrate that numerous brain regions illustrate a change in their activity sequential to tVNS, ranging across the cortex, including frontal and temporal lobes; subcortex, including basal ganglia and thalamus; and brainstem level. Considering the functional importance of these brain structures in regulating emotion, cognition and autonomic activity, these findings could provide a physical correlate for the therapeutic effects observed in prior psychiatric research. Future work should build upon this approximation of tVNS brain effects to investigate use of this novel treatment in other neuropsychiatric conditions, especially where current options are limited.

[1] Eickhoff, SB., et al., 2009. Hum Brain Mapp 30, 2907–2926. https://doi.org/10.1002/hbm.20718

No conflicts of interest.