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GAMMA-BAND DESYNCHRONIZATION BY TRANSCUTANEOUS VAGUS NERVE STIMULATION

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The ability of a treatment method to interfere with tinnitus-related neural activity patterns has been suggested to indicate its potential in relieving tinnitus [1].

Decreased alpha-band (8–12 Hz) and increased gamma-band (> 30 Hz) activity, especially in temporal areas, have been reported in tinnitus patients. Changes in interareal connectivity have also been identified as possible tinnitus markers [2].

Our aim was to investigate the effects of transcutaneous vagus nerve stimulation (*tVNS*) on evoked and spontaneous auditory cortex activity.

SUBJECTS & METHODS

Table 1 — Characteristic information of the tinnitus patients.

Subject	*THI*	*Age*	*PTA (L/R) [dB HL]*	*Tinnitus frequency [Hz]*
1	36	30	5 / 2,5	8000
2	58	51	14,4 / 12,5	5000
3	30	47	9,4 / 6,9	1177
4	96	29	5 / 5	7086
5	80	40	13,1 / 5,6	5823
6	50	63	17,5 / 13,1	6000
7	20	29	7,5 / 7,5	4000
Avg.	**53**	**41**	**10,3 / 7,6**	**5898**

tVNS-induced changes in spectral power and connectivity measures were studied in two scenarios: during presentation of **tinnitus-matched tones** and in **silence**.

Two 5-min measurement blocks were compared: tVNS vs. baseline in both trials. In the active block, tVNS was applied to the left tragus at 25 Hz and approx. 0.25 mA.

Brain activity was registered using a 306-channel whole-head MEG device (Elekta Neuromag). Stimulator artefacts were removed using tSSS [3]. L2 MNE inverse solution was calculated with the dSPM method. Analysis was carried out using MNE-Python [4].

Auditory cortices (ACs) were determined as the Brodmann areas 42 and 43 on each side. Spectral power of ACs and connectivities (squared WPLI) between ACs and other Brodmann areas were calculated.

RESULTS

TINNITUS-MATCHED TONES

The tVNS-induced changes in connectivity are illustrated in **Fig. 1**.

Gamma connectivity decreased in all subjects between left AC and left ***BA 32*** (*dorsal ACC*, mean decrease 0,021); right AC and right ***BA 6*** (*premotor cortex*, mean decrease 0,02); and right AC and left ***BA 37*** (*fusiform gyrus*, mean decrease 0,012).

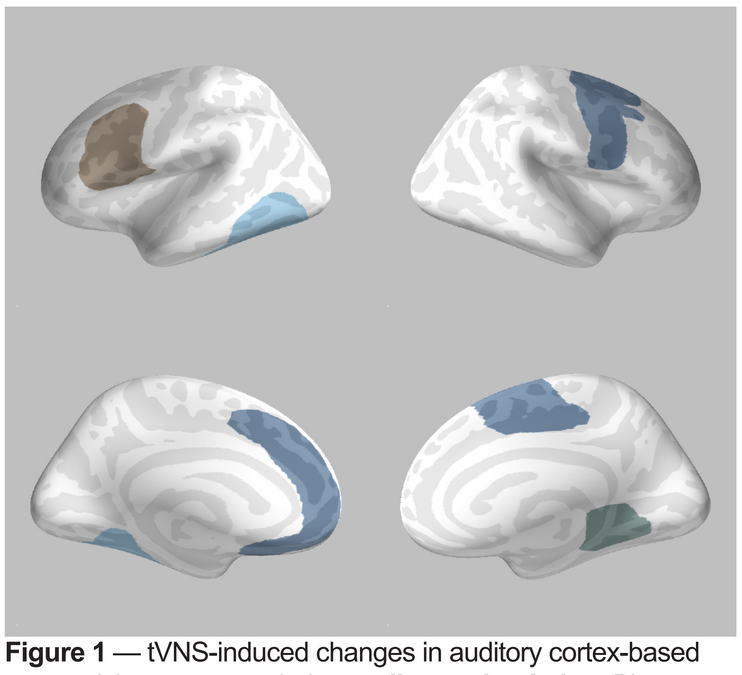

Figure 1 — tVNS-induced changes in auditory cortex-based connectivity measures during **auditory stimulation**. Blue: decreased connectivity; green: positive correlation with THI; Brown: negative correlation with THI.

Further, the change in **gamma** connectivity between right AC and left ***BA 44*** (*Broca's area*) correlated negatively with THI scores ($r = -0{,}964$). Also **beta** connectivity between left AC and right ***BA 35*** (*perirhinal area*) correlated with THI scores ($r = 0{,}964$).

THI scores also correlated with the change in left AC **delta** spectral power ($r = 0{,}964$) and right AC **gamma** spectral power ($r = -0{,}964$).

SILENCE

The tVNS-induced changes in connectivity are illustrated in **Fig. 2** and given numerically in **Table 2**. THI scores correlated with changes in left AC **alpha** power ($r = -0{,}893$); **gamma** connectivity between left AC and right ***BA 23*** (*ventral PCC*, $r = 0{,}893$); and in **alpha** connectivity between left AC and left ***BA 26*** (*cingulate gyrus*, $r = 0{,}964$).

Table 2 — tVNS-induced changes in auditory cortex-based connectivity measures in silence.

Band	*Connection*	*Mean change*
alpha	right AC – right ***BA 20*** (*inf. temporal gyrus*)	−0,044
	right AC – right ***BA 21*** (*middle temporal gyrus*)	−0,073
	right AC – right ***BA 32*** (*dorsal ACC*)	−0,051
	right AC – left ***BA 29*** (*retrosplenital cingulate cortex*)	−0,033
	right AC – left ***BA 30*** (*cingulate cortex*)	−0,065
	right AC – left ***BA 6*** (*premotor cortex*)	+0,021
beta	right AC – right ***BA 4*** (*primary motor cortex*)	+0,031
	left AC – left ***BA 17*** (*primary visual cortex*)	+0,020

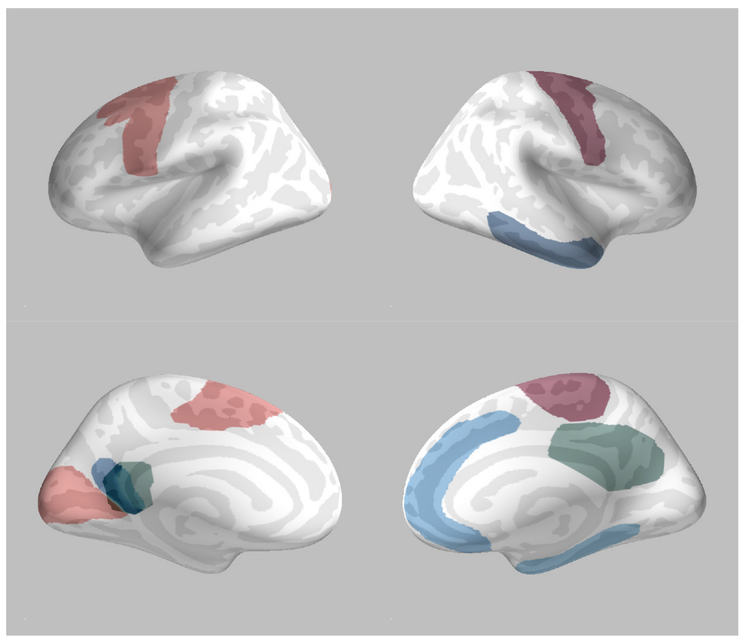

Figure 2 — tVNS-induced changes in auditory cortex-based connectivity measures in **silence**. Red: increased connectivity; Blue: decreased connectivity; Green: positive correlation with THI.

CONCLUSIONS

tVNS-induced changes were most prominent at gamma band for tone-evoked activity, and at alpha band for spontaneous activity.

tVNS may interfere with dysfunctional auditory-limbic connections found in tinnitus [5].

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