 EEG Resting State Networks of Tinnitus – Dare to Listen?

Patrick Neff1,2,3,4, Martin Meyer1,2,3, Colette Hemsley5, Nicole Peter5, Steffi Weidt6, Tobias Kleinjung6

1Neuroplasticity and Learning in the Healthy Aging Brain (HAB LAB), Institute of Psychology, University of Zurich, Switzerland
2University Research Priority Program “Dynamics of Healthy Aging”, University of Zurich, Switzerland
3International Normal Aging and Plasticity Imaging Center, University of Zurich, Switzerland
4Institute for Computer Music and Sound Technology (ICST), University of the Arts (ZHdK), Zurich, Switzerland
5Department of Otolaryngology, University Hospital Zurich, Switzerland
6Department of Psychiatry and Psychotherapy, University Hospital Zurich, Switzerland

Introduction

- Neuronal correlates of tinnitus in auditory (temporal) and non-auditory (frontal, parietal, limbic) brain regions suggest the existence of a wide-spread neural network responsible for tinnitus awareness and distress (e.g., De Ridder et al., 2013).
- Previous neurophysiological studies mainly focused on tinnitus patients vs. controls, correlations with questionnaires and seldom subgrouping/typing.
- No study systematically compared different perceptual modes of tinnitus (i.e. actively listening to the tinnitus sensation).
- Closest “relative”: PET study comparing regional cerebral blood flow (rCBF) in a distractor task vs. normal rest in tinnitus patients -> activated bilateral auditory cortices in resting condition (i.e. tinnitus).

(Patrick et al., 2016)

- Primary aim:
  - Cortical activity and connectivity in different tinnitus perceptual modes (i.e., actively listening (AL) vs. normal rest (RS))

- Secondary/future aims:
  - Local EEG and psychometrics database according to TRI standards (Landgrebe 2010)
  - Further subtyping of tinnitus
  - Development of tomographic neurofeedback protocols
  - Construction of guidelines for neuroscientific TRI/TINNET standard operating procedures (SOP)

Methods

- Sample
  - N=45 tinnitus patients with full tinnitus questionnaires, audio- and psychometric data
  - Age: 42.78 (SD=11.97, range: 23-65)
  - 11/3 (female/male)
  - Tinnitus duration: 82.71 months (range: 6-708)
  - Age of tinnitus onset: 35.58 (SD=12.94)
  - Recruited at Department of Otolaryngology at University Hospital Zurich
- Brainamp DC 64 Channel EEG System (Brainproducts)
- Shielded and decoupled, very quiet room
- Global and topographical power analysis (frequency bands 0.5-100 Hz)
- sLORETA software suite
  - EEG analysis

Results

- Increased alpha2 connectivity between left subgenual anterior cingulate cortex (sgACC) and left auditory core cortices during AL

  - The projection (not implying any directionality) from the sgACC to the transverse temporal gyri (TTG, core primary auditory cortex, -45 -30 10) was more pronounced (h=3.26, p<0.1; p-extreme (pe)=0.065) compared to the connection to the STG (-55 -25 5, t=3.11, p<0.01).
- Significant increase in all tinnitus parameters assessed by the short questionnaire during AL (p<.01 to .001, Cohen’s d: 0.45 to 0.8).
- Decreased alpha2 (10.5-12.5 Hz) current density in left paracortical areas during AL

Discussion

- AL differs from “normal” RS in tinnitus patients as elicited by psychometry and neurophysiology:
  - Main finding: An increased connectivity between left frontal-medial limbic systems and left auditory cortices in AL possibly reflects the (heightened) tinnitus percept or an active “noise cancelling” system (Rauschecker et al., 2010)
  - Clear-cut left-hemispherical preference as observed in tinnitus and other auditory phenomena (Geven et al., 2014)
- Significant increase in tinnitus parameters of short questionnaire reflect heightened presence and annoyance of tinnitus enabling solid interpretation of the EEG data

Conclusion/Directives

- Limbic-auditory interactions are responsible for heightened tinnitus awareness and annoyance
- “EEG” Resting state connectivity analyses are a promising alternative to power analyses for both tinnitus basic research and neuromodulatory therapy (cf. Hartmann et al., 2014)

Literature


WEB: http://www.tinnitusresearch.org
http://tinnet.tinnitusresearch.net

Contact: patrick.neff@uzh.ch