The neuroscience of tinnitus
Perspectives from human neuroimaging studies

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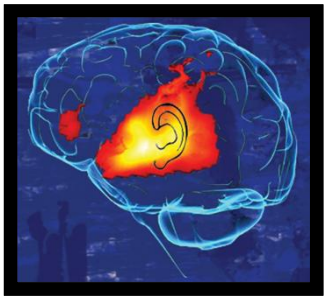
Cyclotron Research Center Coma Science Group University of Liège Professeur S. LAUREYS



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Neuroimaging methods

STUDY OF CHANGES IN LOCAL BRAIN ACTIVITY

Positron Emission Tomography (PET)

Functionnal Magnetic Resonance Imaging (fMRI)

STUDY OF ELECTRICAL BRAIN ACTIVITY

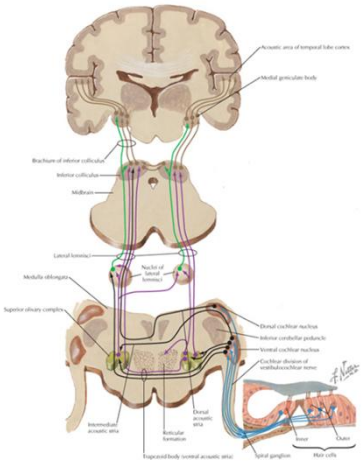
Electroencephalography (EEG)

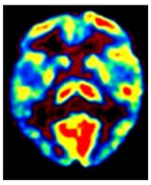
Magnetoencephalography (MEG)

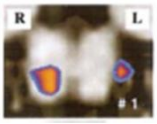
Auditory regions

While the loss of afferent input to the central auditory system can initiate tinnitus, thereafter, central mechanisms play an important role in maintaining it

Tinnitus is generated in the brain



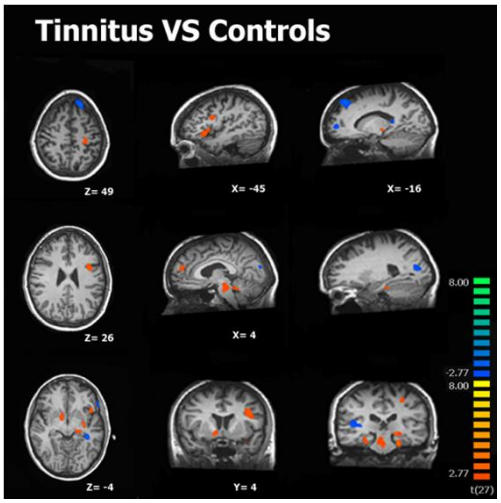




Arnold, J ORL Relat Spec, 1994
Melcher, J Neurophysio 2000

Tinnitus implies extra-auditory regions

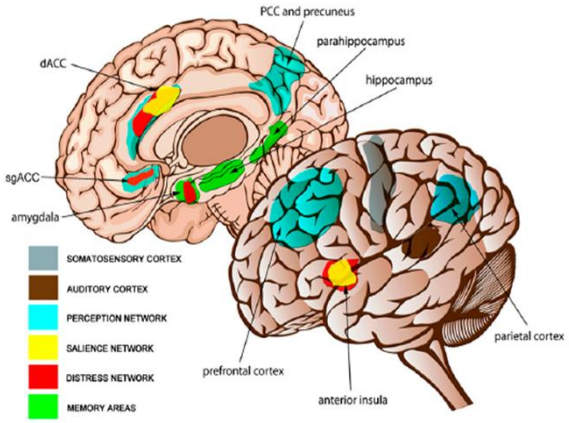
Interactions exist between auditory, sensory, affective, cognitive and memory areas.



Maudoux, PLoS One 2012

Tinnitus implies extra-auditory regions

The Tinnitus Network



De Ridder PNAS 2011

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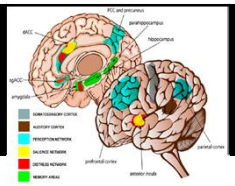
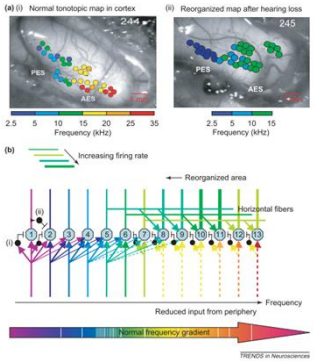


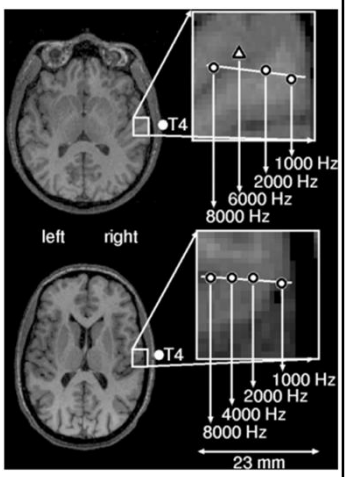
Auditory structures / Conscious perception / Salience - Distress / Memory

Tinnitus is associated to modified neuronal activity in central auditory structures

Tinnitus is a plasticity disorder

Increased spontaneous firing rate, increased neuronal synchrony and tonotopic changes are putative neuronal correlates of tinnitus.





Eggermont Trends Neurosciences 2004
Muhlnickel, PNAS 1995

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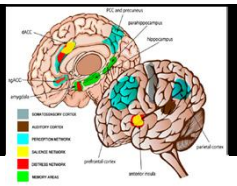
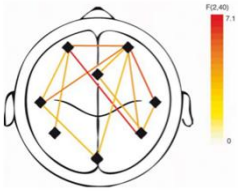
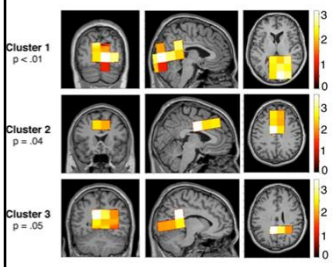


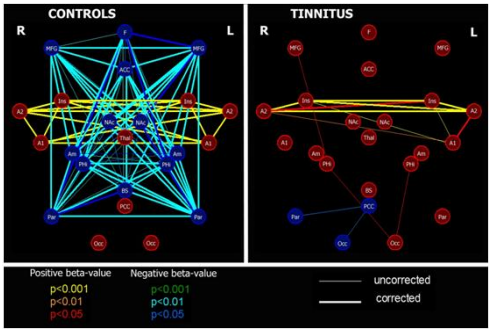
Auditory structures / Conscious perception / Salience - Distress / Memory

Conscious perception of tinnitus





Schlee, PLoS One 2008
Schlee, BMC Biology 2009



Maudoux, Brain research 2012

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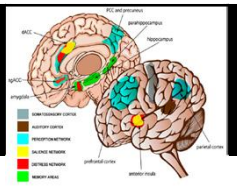


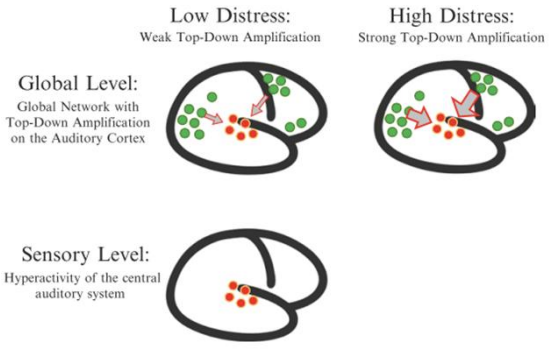
Auditory structures / Conscious perception / Salience - Distress / Memory

Conscious perception of tinnitus

Global Brain Model of Tinnitus

In order to form a conscious percept of a stimulus two conditions are required:
-there should be a neuronal activity of the sensory cortex of the respective modality
- this activity should spread to the global neuronal workspace consisting of fronto-parietal-cingulate regions.

Neuronal activity of the sensory areas can be enhanced by global workspace top-down influence



Schlee and Weisz, Textbook of tinnitus 2011

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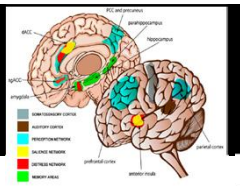
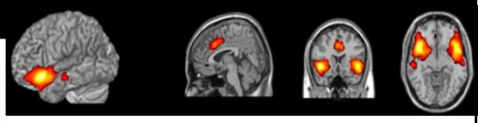


Auditory structures / Conscious perception / Salience - Distress / Memory

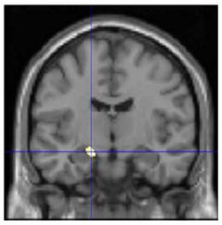
The Salience network / Tinnitus distress



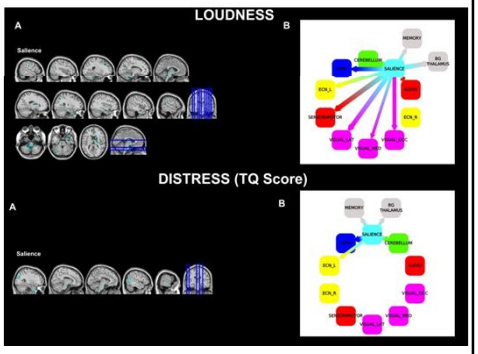
Salience network is involved in the orientation of attention to relevant (salient) events.

Prerequisite to conscious perception?

Activation of the limbic and autonomic nervous system.



Landgrebe, Neuroimage 2009



Maudoux and Vanneste in prep

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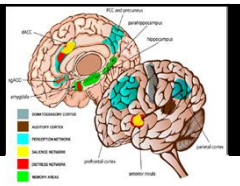
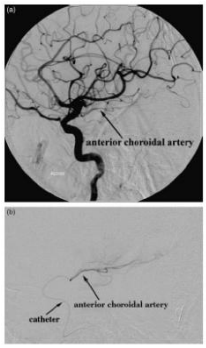


Auditory structures / Conscious perception / Salience - Distress / Memory

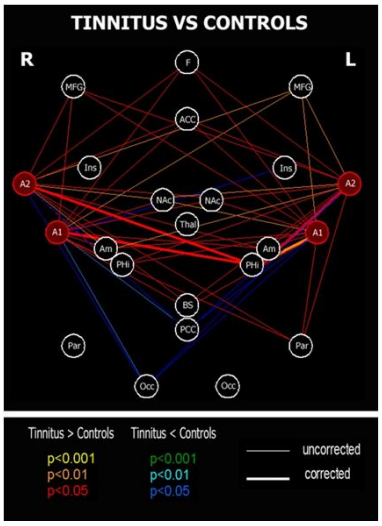
Memory areas

(Para)hippocampal area
Sensory gating function for irrelevant and redundant auditory inputs.

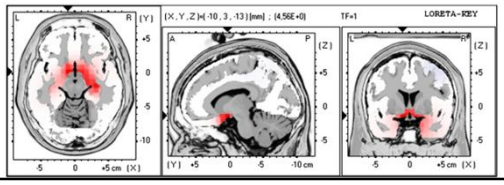
Phantom sound (tinnitus) pulled out of memory.



De Ridder, ActaORL 2006

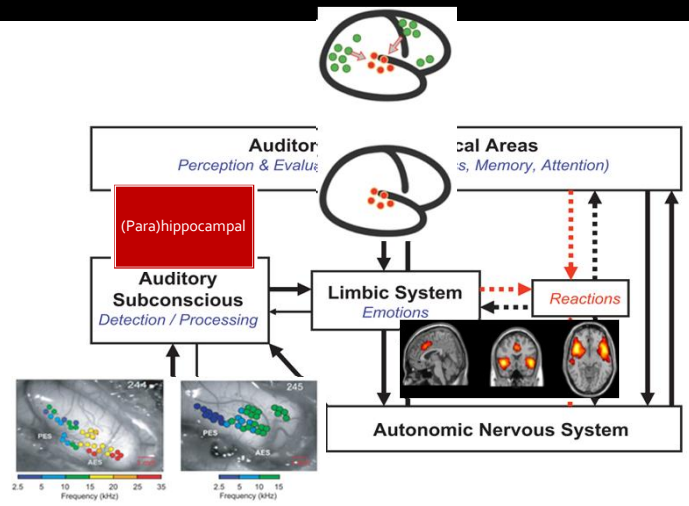


Maudoux, Brain research 2012



Vanneste, Neuroimage 2010

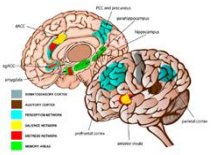
Conclusions



Jastreboff

Conclusions

- Tinnitus is generated in the brain:
  - Changes of brain activity in auditory cortices accompany tinnitus
  - Activity in the auditory cortex by itself is not sufficient to explain the observed diverse clinical characteristics of tinnitus: tinnitus is the emergent property of modified interaction between audiotry and non-auditory regions.



THANK YOU

- Colleagues

- Collaborations
  - Antwerp
    (De Ridder, Vanneste)