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Neuroanatomical correlates of induced tinnitus

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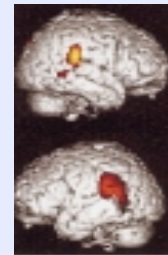
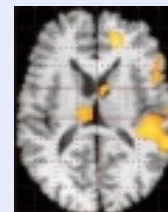
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Introduction

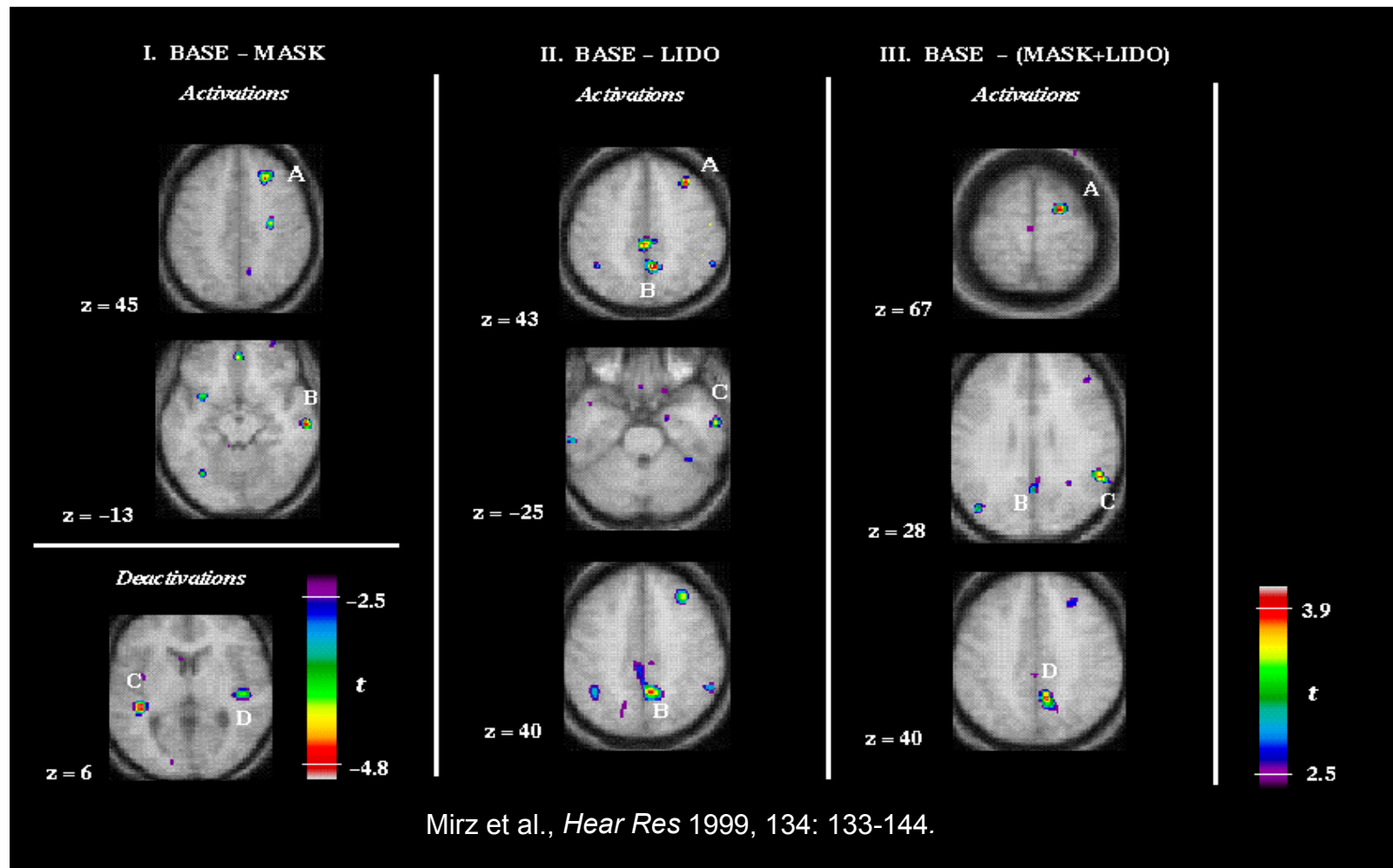
- The perception of tinnitus implies activity in the cerebral cortex
- A few functional neuroimaging studies have attempted to reveal such activity with varying results

Studies on tinnitus

- Arnold *et al.* → primary auditory cortex
[*ORL (Basel)* 1996, 58:195-199]
- Cacace *et al.* → temporo-parietal auditory association cortex
[*Audiology & Neuro-Otology*, 1999, 4: 247-257]
- Lockwood *et al.* → primary and associative auditory cortices
→ left hippocampus
[*Neurology* 1998, 50:114-120]
- Giraud *et al.* → temporo-parietal auditory association cortex
[*Neuroreport* 1999, 10:1-5.]



Studies on tinnitus



Introduction

- ***Aim:*** to generate a model of tinnitus perception that can predict the cerebral sites involved in such perception
- In the model exposure to aversive auditory stimuli induces a tinnitus-like sensation in normal subjects

Materials and Methods

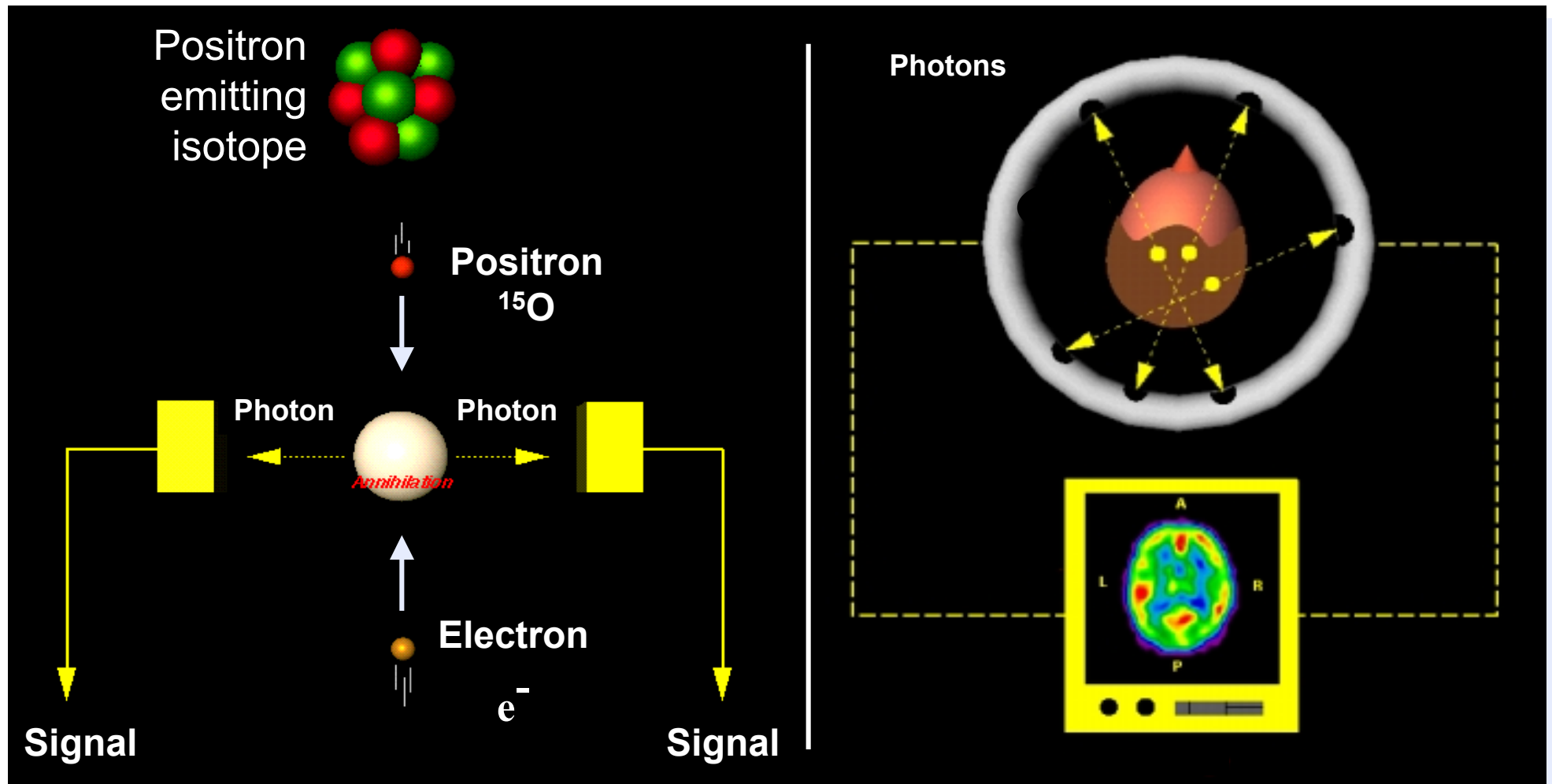
Subjects:

- Seven healthy volunteers (1 female; 6 males)
- Mean age: 24 years (range 23-27 years)
- Audiometric assessment revealed normal findings

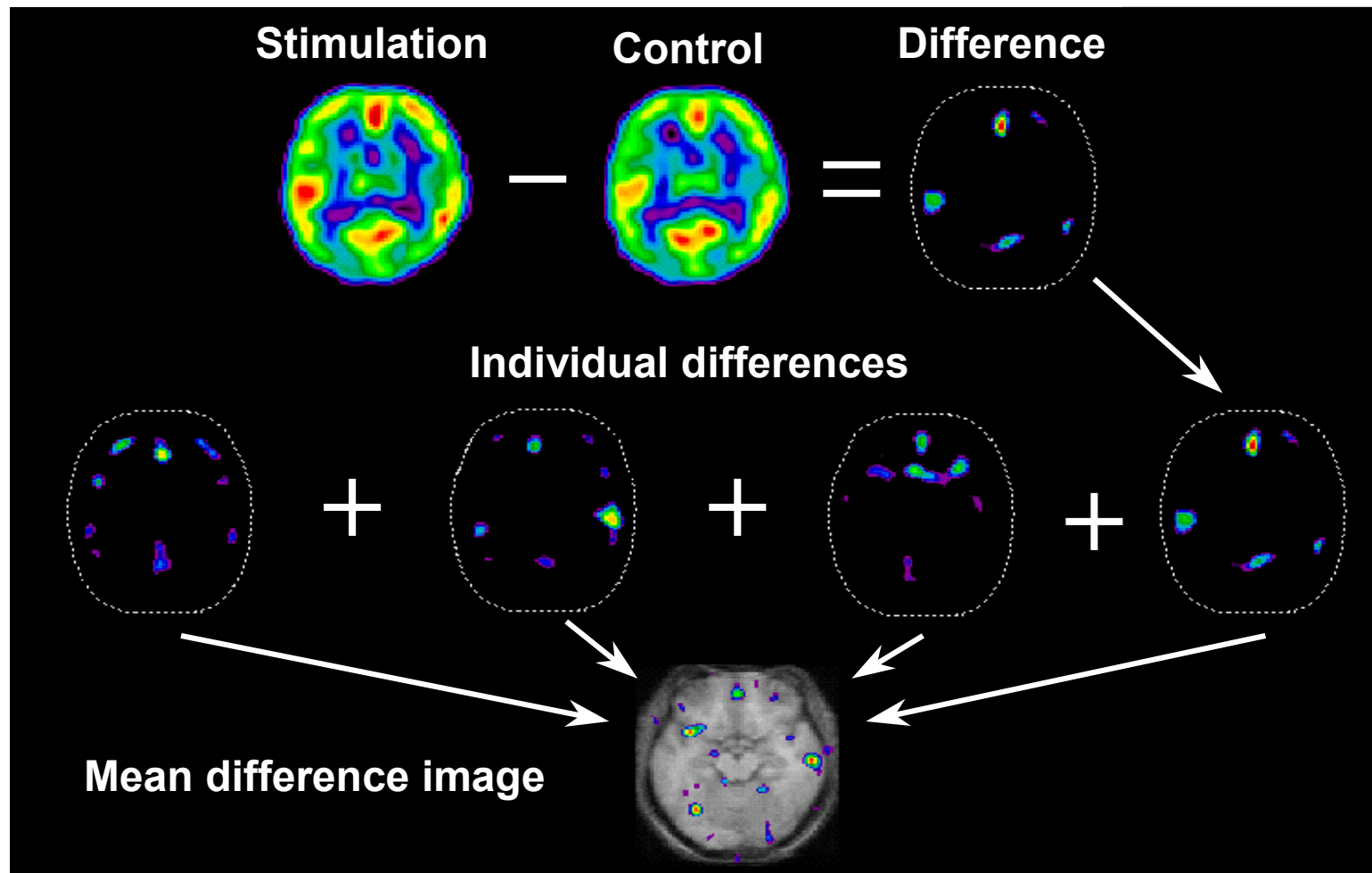
Neuroimaging:

- One transmission scan, five emission scans in random order
- H₂¹⁵O as tracer (radioactive isotope) given 10 sec prior to each PET-scan
- MR-imaging to coregister with PET-images

Positron emission tomography



Positron emission tomography



Materials and Methods

Acoustic stimuli:

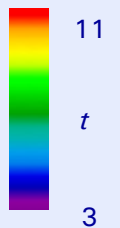
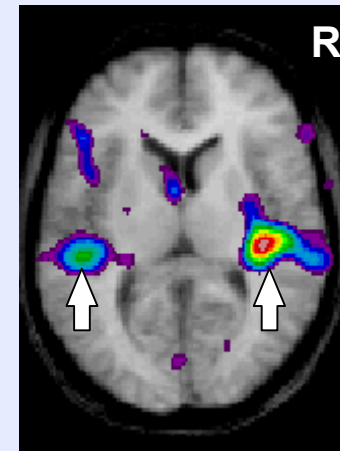
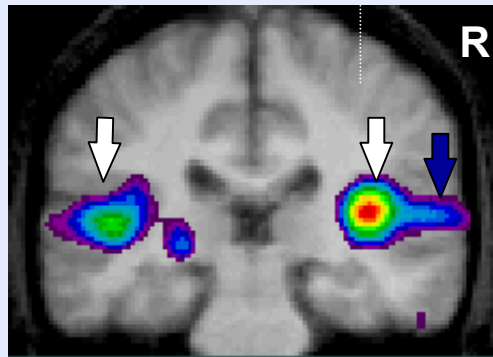
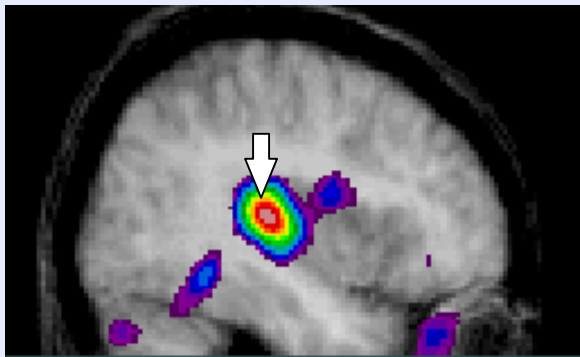
- Based on descriptions from tinnitus patients 20 aversive sounds were generated
- Ten subjects not otherwise engaged in the PET study determined and rated the aversion caused by these sounds on visual-analogue-scales (VAS)
- The four highest rated sounds were chosen as stimuli for the PET study
- Stimuli were presented binaurally through insert earphones

Materials and Methods

Acoustic stimuli:

- Continuous pure tone, 8 kHz, 85 dB SPL → **AS1**
- Continuous pure tone, 8 kHz with a 30 Hz bandwidth, 85 dB SPL → **AS2**
- Sound synthesized from a recorded sound sample (scraping knife against plate), 85 dB SPL → **AS3**
- Sound synthesized from a recorded sound sample (scraping knife against plate) with 40 randomly placed gaps of 20-50 ms, 85 dB SPL → **AS4**
- Baseline scan without acoustic stimulus → **B1**

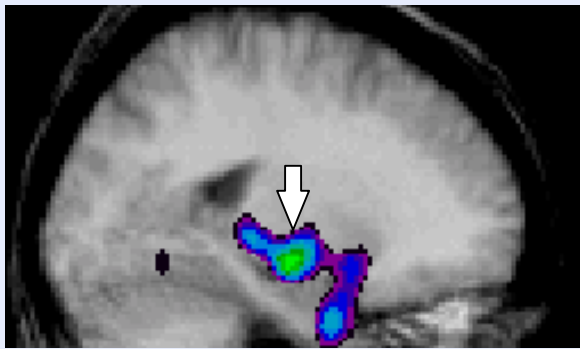
Results



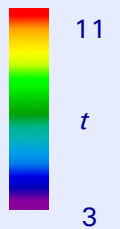
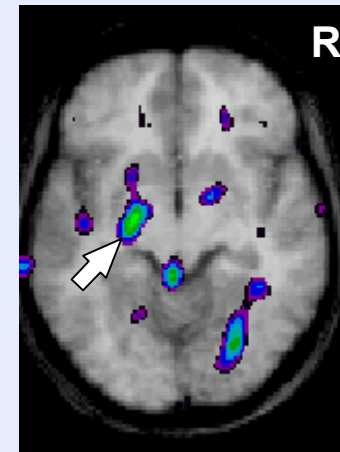
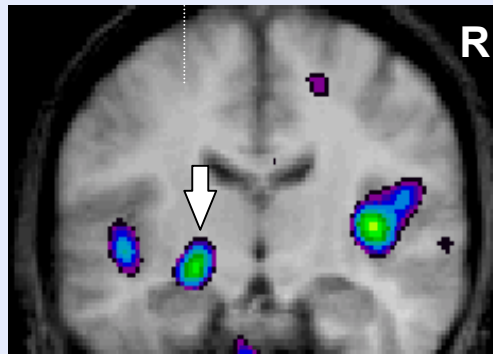
Right and left transverse temporal gyri \Rightarrow
Right superior temporal gyrus \rightarrow

Activation of the auditory cortical system

Results

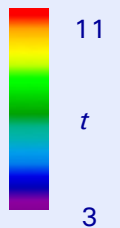
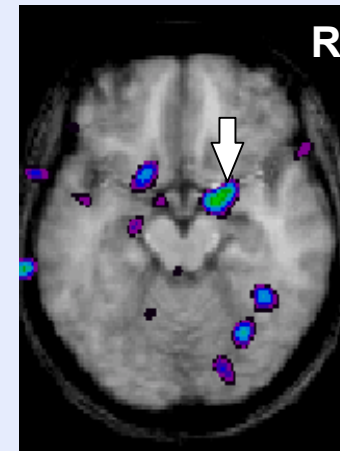
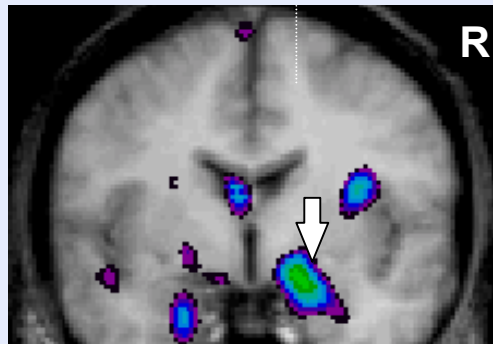
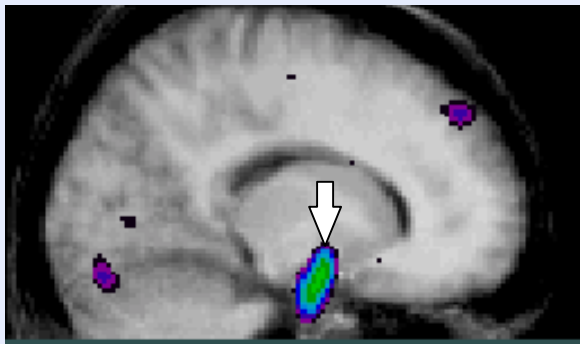


Left amygdaloid body →



Activation of the limbic system (1)

Results

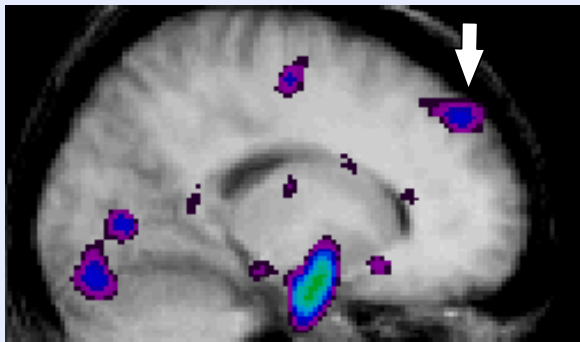


Right amygdaloid body / Right parahippocampal gyrus

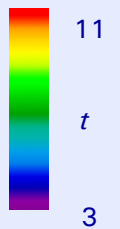
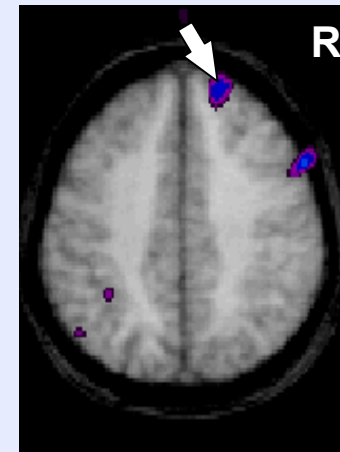
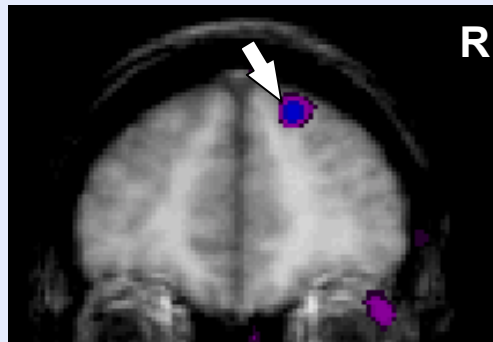


Activation of the limbic system (2)

Results

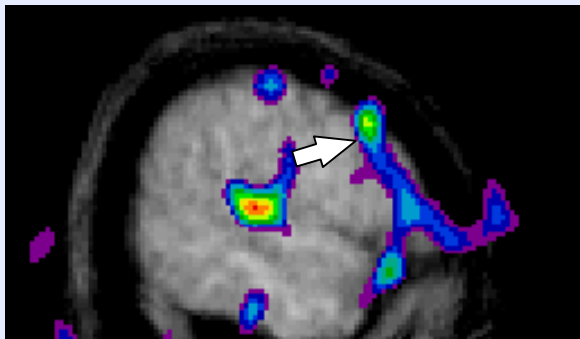


Right superior frontal gyrus

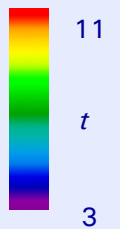
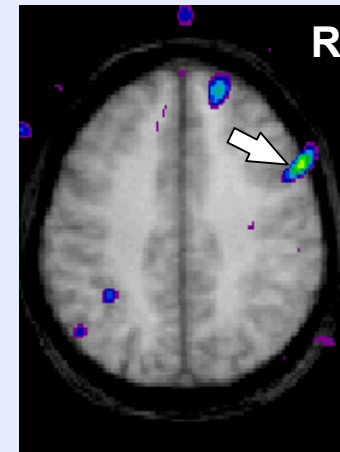
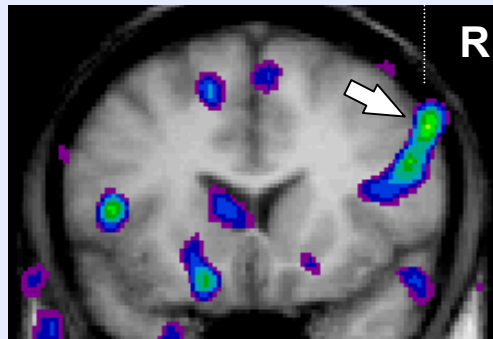


Activation of the right prefrontal area (1)

Results

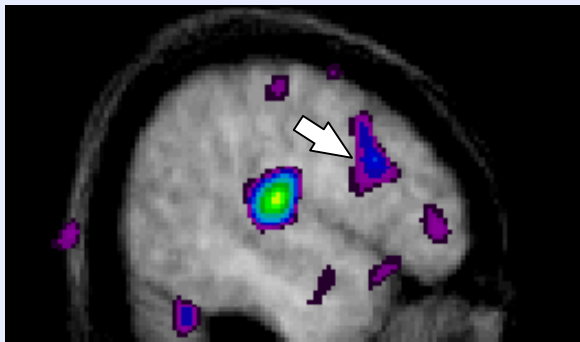


Right middle frontal gyrus

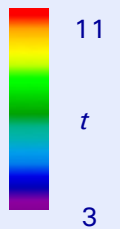
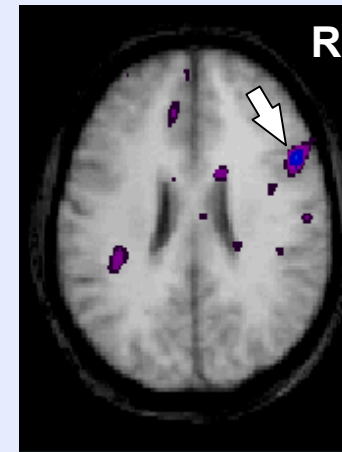
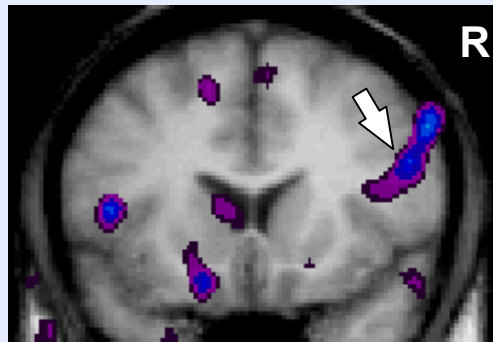


Activation of the right prefrontal area (2)

Results

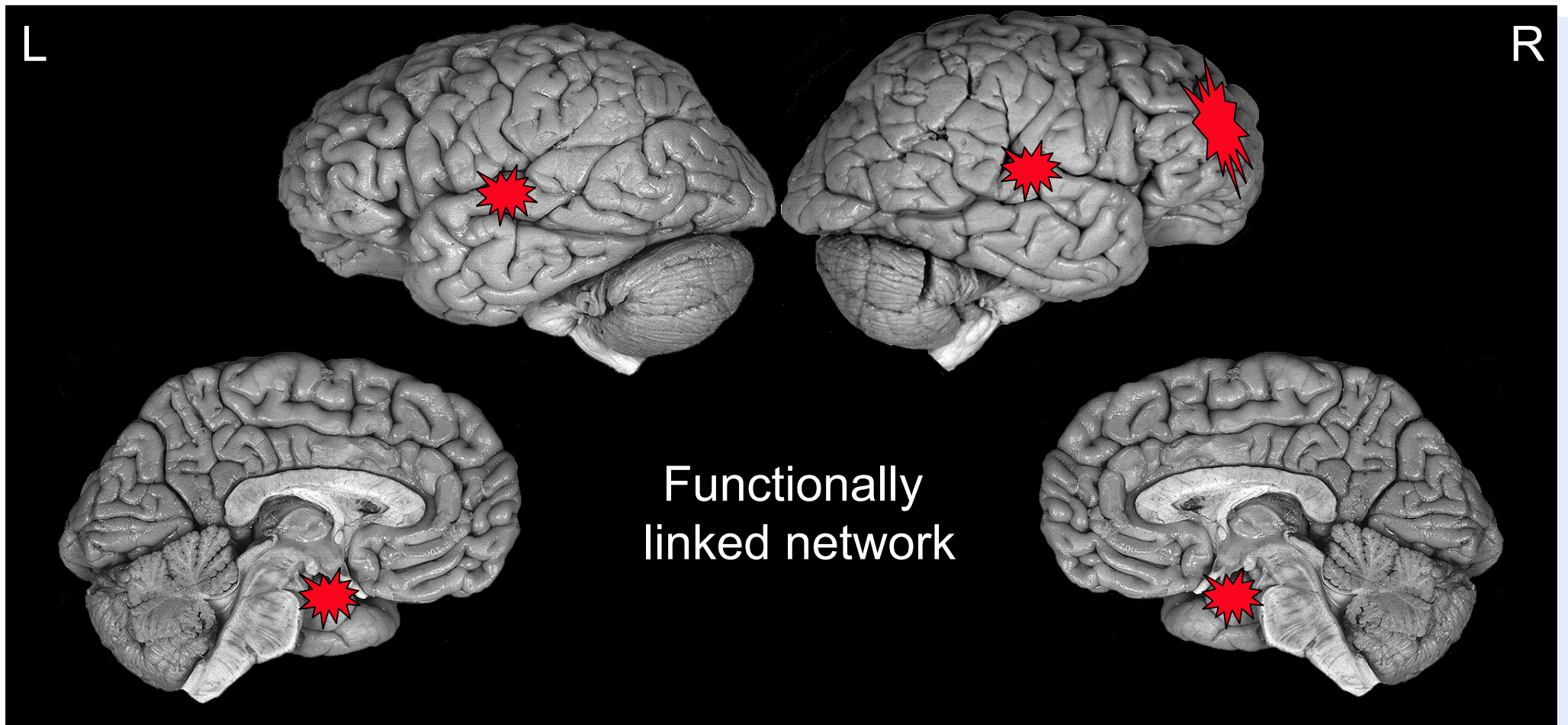


Right inferior frontal gyrus



Activation of the right prefrontal area (3)

Summary





Conclusion



Central processing of aversive auditory stimuli engages:

- **auditory sensory regions**
- **dorsolateral prefrontal sites** (attention)
- **the limbic system** (emotion and memory)

Phantom auditory perception tinnitus may involve the same functionally linked network.

More neurofunctional imaging studies are needed to unveil all details of the central mechanisms subserving tinnitus.

