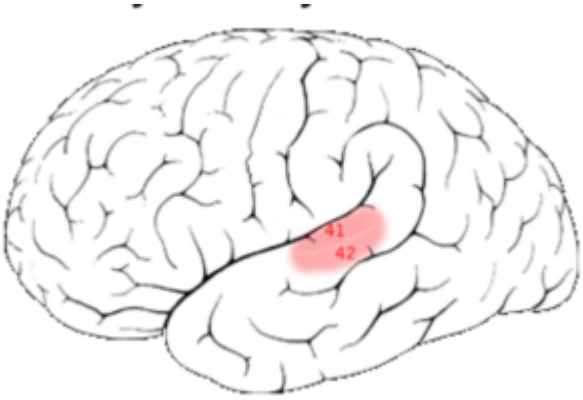
Primary auditory cortex



The primary auditory cortex is the part of the temporal lobe that processes auditory information in humans and other vertebrates. It is a part of the auditory system, performing basic and higher functions in hearing.

It is located bilaterally, roughly at the upper sides of the temporal lobes – in humans on the superior temporal plane, within the lateral fissure and comprising parts of Heschl's gyrus and the superior temporal gyrus, including planum polare and planum temporale (roughly Brodmann areas 41, 42, and partially 22).

Unilateral destruction results in slight hearing loss, whereas bilateral destruction results in cortical deafness.

Using high-field (3 Tesla) functional magnetic resonance imaging (fMRI), Foxe et al., demonstrate that auditory and somatosensory inputs converge in a subregion of human auditory cortex along the superior temporal gyrus. Further, simultaneous stimulation in both sensory modalities resulted in activity exceeding that predicted by summing the responses to the unisensory inputs, thereby showing multisensory integration in this convergence region. Intracranial recordings in macaque monkeys have shown similar auditory-somatosensory convergence in a subregion of auditory cortex directly caudomedial to primary auditory cortex (area CM). The multisensory region identified in the present investigation may be the human homologue of CM. The finding of auditory-somatosensory convergence in early auditory cortices contributes to mounting evidence for multisensory integration early in the cortical processing hierarchy, in brain regions that were previously assumed to be unisensory [1)].

The temporal details of processing non-auditory stimuli in the human auditory cortex still remain unclear, due to the low temporal and spatial resolution of the adopted imaging techniques.

In a study, using Intrinsic optical imaging of intrinsic signals (iOIS) recording techniques, detailed cortical activations within the auditory cortex in response to auditory and somatosensory stimulation were recorded from three intraoperative anesthetized patients with brain tumor located at superior temporal gyrus.

At both green-light (545±13 nm) and red-light (610±10 nm) illumination, the primary and secondary

auditory cortices showed to be respond significantly to the somatosensory stimulation. As induced by the somatosensory stimulus, the average overlapping rate of the activated region was 74.51% ± 0.15%, and the peak responding time occurred at post-stimulus 7-8 seconds. In addition, there was no significant difference of the peak responding time between auditory and somatosensory stimuli ($P<0.01$, paired t-test).

These findings provide novel evidence for multisensory interplay within human auditory cortex at early stage of cortical processing, which extends the understandings of multisensory mechanism of human brain functions [2].

References

1)
Foxe JJ, Wylie GR, Martinez A, Schroeder CE, Javitt DC, Guilfoyle D, Ritter W, Murray MM. Auditory-somatosensory multisensory processing in auditory association cortex: an fMRI study. J Neurophysiol. 2002 Jul;88(1):540-3. PubMed PMID: 12091578.

2)
Zhou Q, Wang Y, Yi L, Tan Z, Jiang Y. Multisensory interplay within human auditory cortex: new evidence from intraoperative optical imaging of intrinsic signal. World Neurosurg. 2016 Oct 26. pii: S1878-8750(16)31089-0. doi: 10.1016/j.wneu.2016.10.100. [Epub ahead of print] PubMed PMID: 27794511.