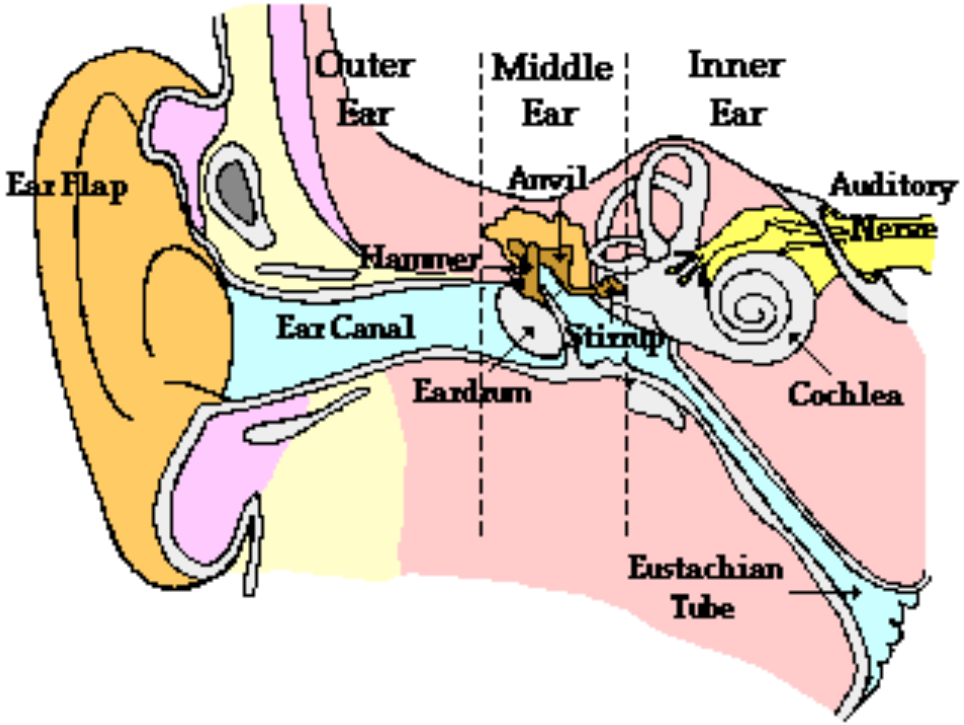
IS SPEECH A SPECIAL SOUND FOR THE BRAIN?

Evidence from disorders

How sound gets to the brain



Outer ear

Collects sound waves. The configuration of the outer ear serves to amplify sound, particularly at 2000-5000 Hz, a frequency range that is important for speech.

Middle ear

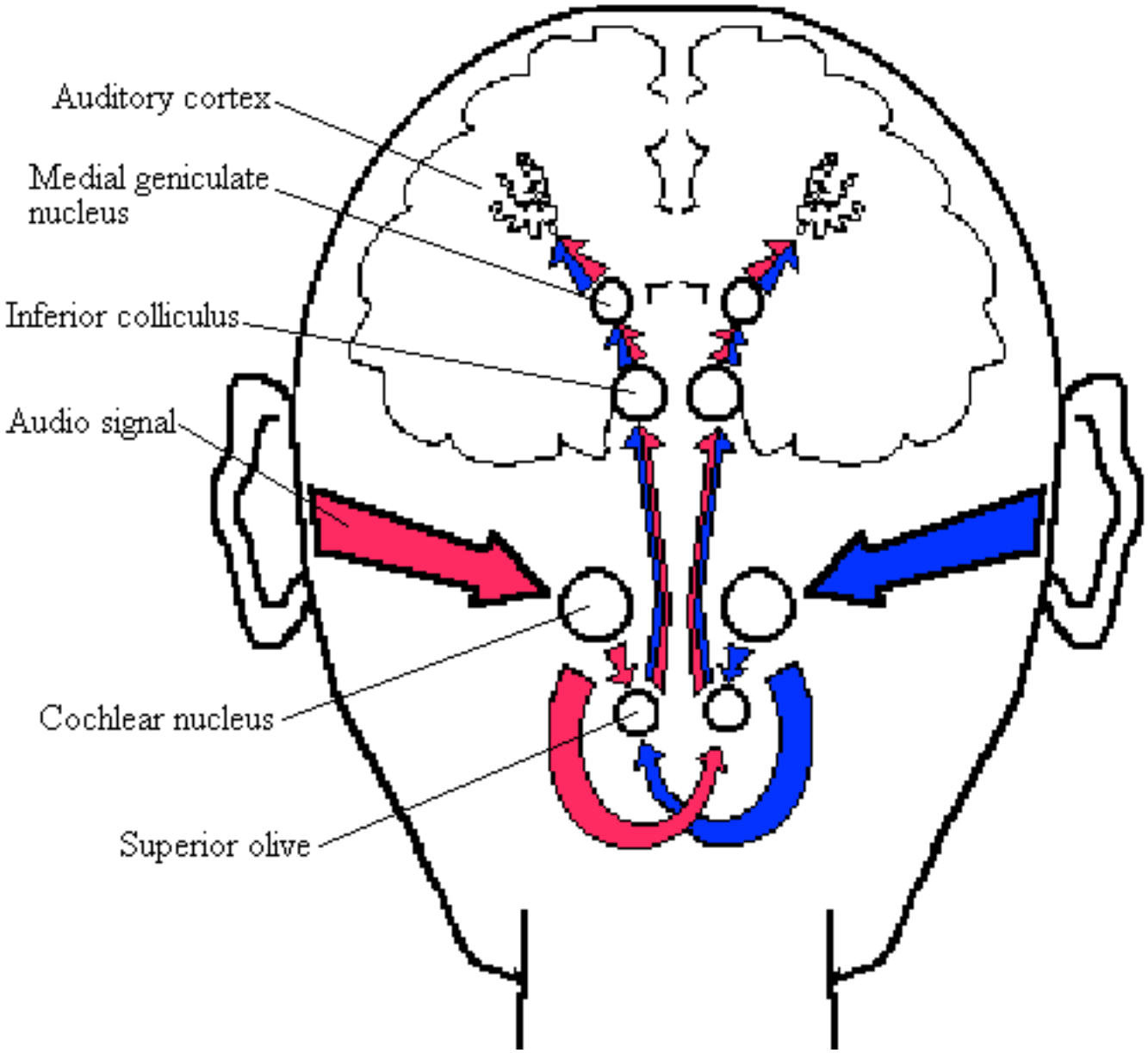
Transforms the energy of a sound wave into the internal vibrations of the bone structure of the middle ear and transforms these vibrations into a compressional wave in the inner ear.

Inner ear

Transform the energy of a compressional wave within the inner ear fluid into nerve impulses which can be transmitted to the brain.

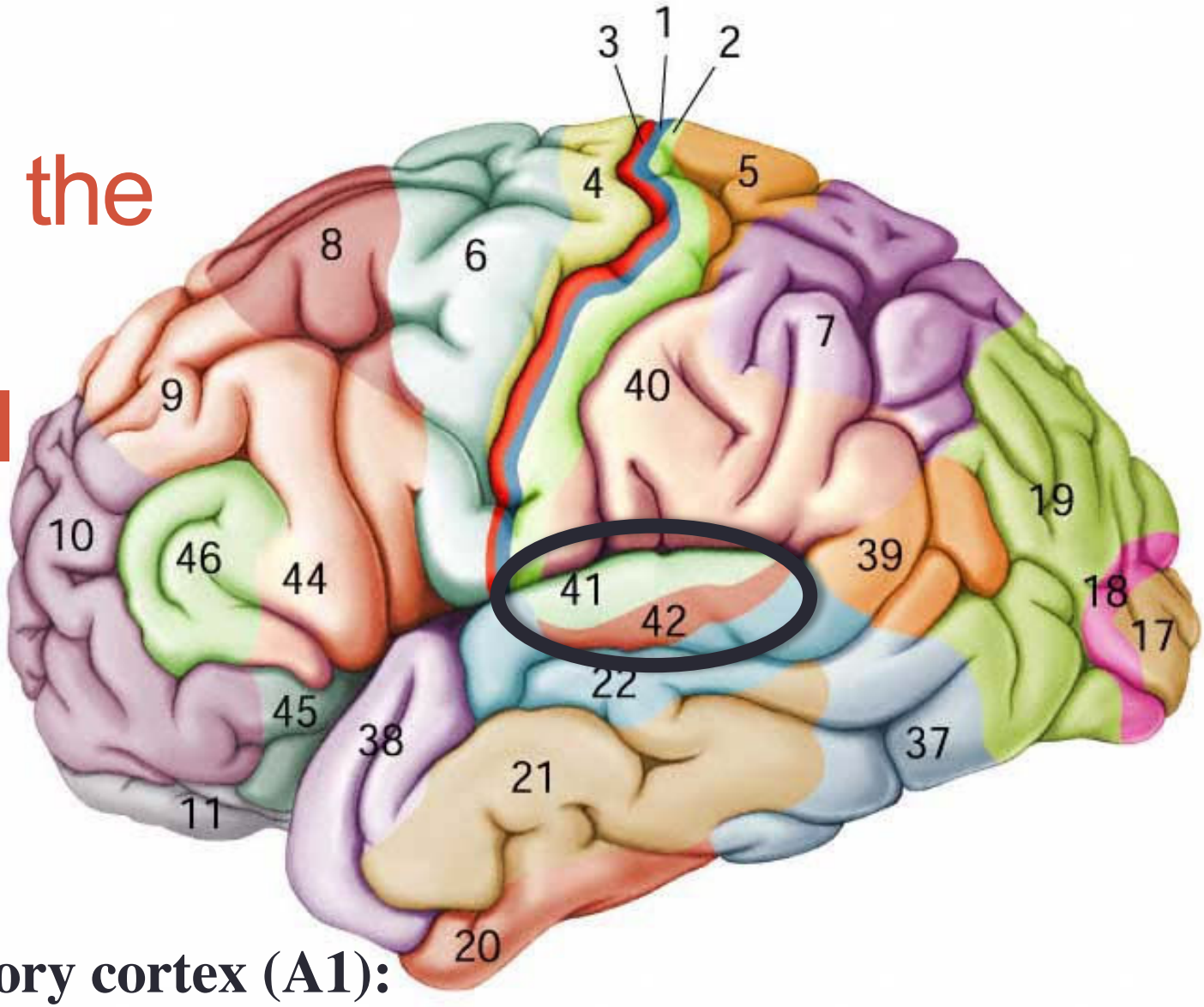
Auditory pathway

- Auditory input reaches primary auditory cortex about 10–15 msec after stimulus onset (Liegeois-Chauvel, Musolino, & Chauvel 1991; Celesia, 1976).



http://www.sis.pitt.edu/~is1042/html/audtrans.gif

Auditory cortex in the superior temporal lobe



Primary auditory cortex (A1): Brodmann areas 41 and 42

http://ist-socrates.berkeley.edu/ ~jmp/LO2/6.html

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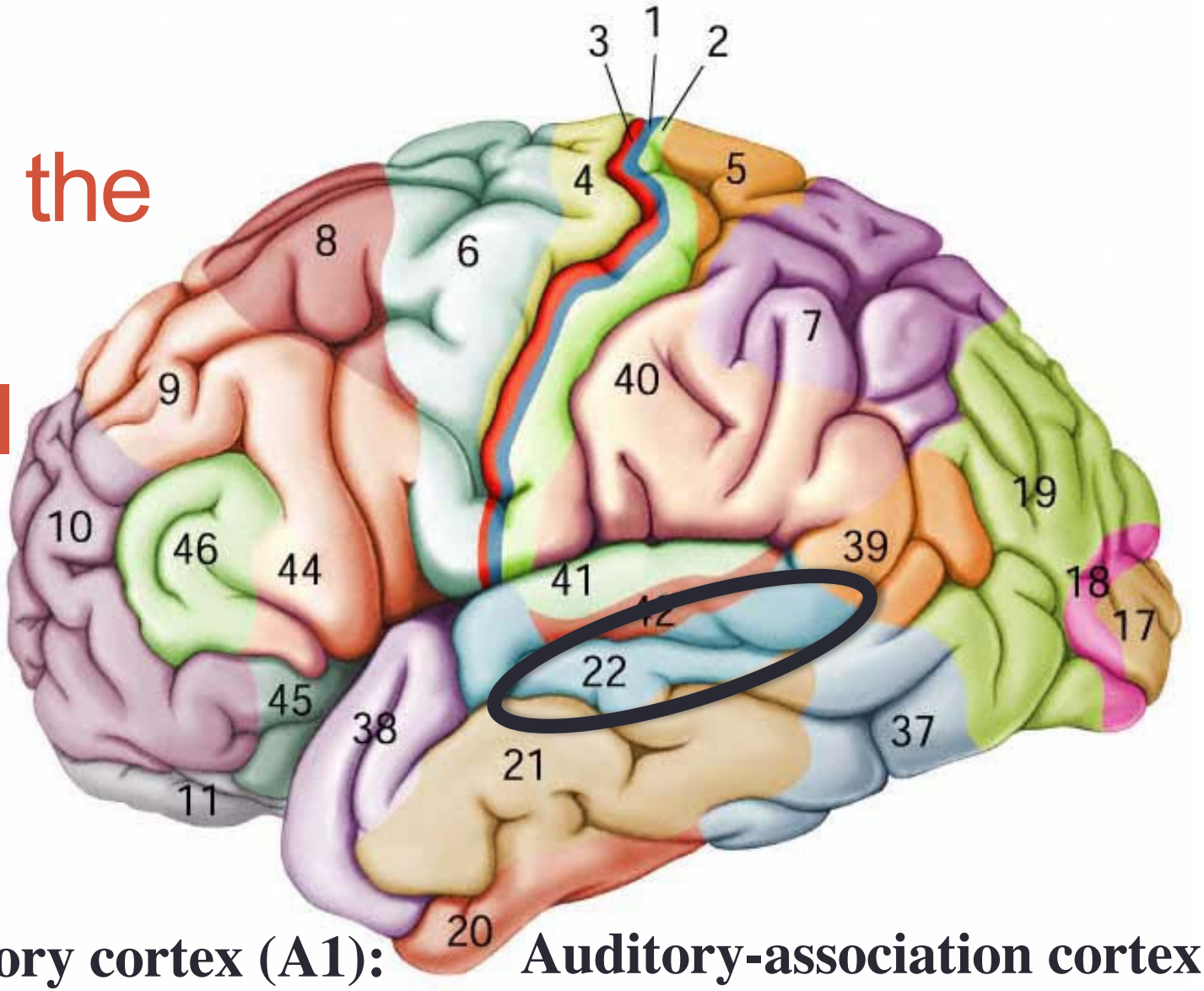

Primary auditory cortex (A1): Brodmann areas 41 and 42

Auditory-association cortex (A2): Brodmann area 22

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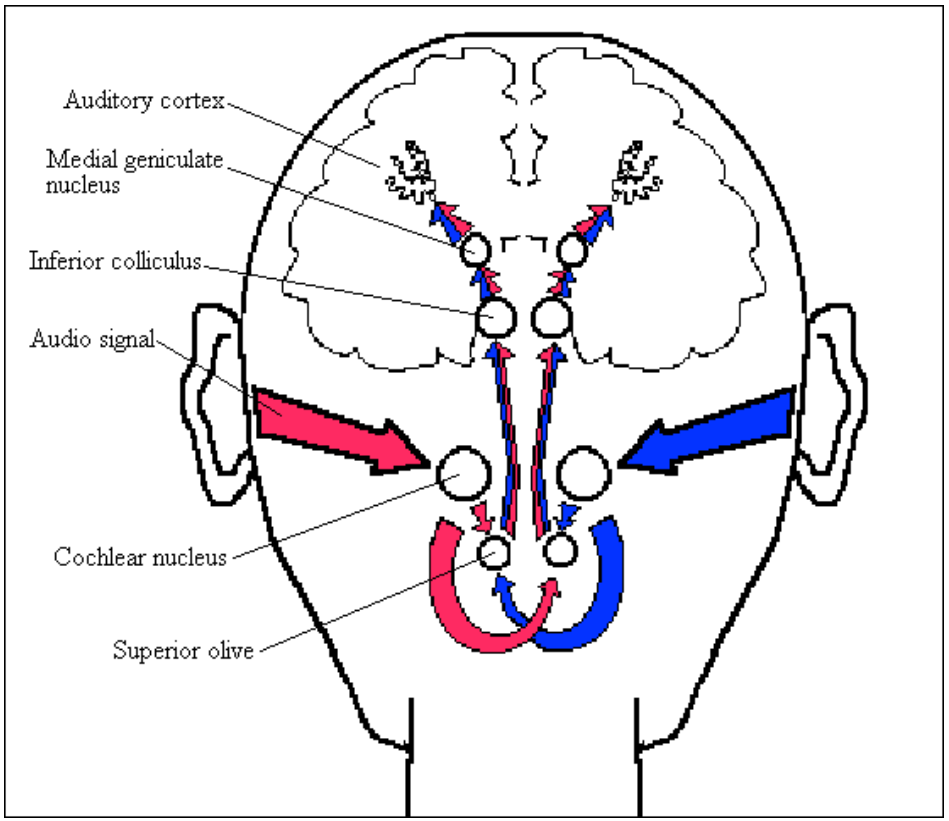
Disorders of auditory processing are rare

- Signal from each ear is processed in both hemispheres (contra visual system).
- Bilateral damage often necessary.
  - Generally requires two separate neurological events.



DISORDER	BEHAVIOR	CHARACTERISTIC DAMAGE SITE
Cortical deafness	Inability to hear sounds without apparent damage to the hearing apparatus or brain stem abnormality.	Extensive bilateral damage to auditory cortex (BAs 41 & 42).
Auditory agnosia	Inability to recognize auditorily presented sounds (e.g., coughing, crying) *independent of any deficit in processing spoken language.*	Damage in auditory association cortex (BAs 22 & 37).
Amusia	Impaired in tasks requiring pattern recognition in music. Relative sparing of speech and (other) non-speech perception.	*Right* hemisphere temporal areas
Pure word deafness	Inability to understand spoken words while auditory perception is otherwise intact & other linguistic skills are intact (reading, speech production)	Either bilateral damage to auditory cortex or a subcortical lesion in the left hemisphere that severs both ipsilateral and contralateral projections to temporal cortex.
Phonagnosia	Impairment in the ability to recognize familiar voices. Speech comprehension is intact. Intact ability to identify nonverbal sounds.	Van Lancker et al., 1988: Double dissociation between memory for familiar voices (temporal damage) and the ability to discriminate between unfamiliar voices (right parietal damage).

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Two take-aways

- In auditory disorders, speech and non-speech can dissociate

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- No one-to-one correspondence between lesion site and type of disorder. E.g., bilateral temporal damage can lead either to cortical deafness or pure word deafness
  - On the basis of lesion data, hard to “draw the line” between neural basis of speech and nonspeech.