

Correlation between Binaural Perception and Brainstem Lesions

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This talk is based on the published chapter :

“Hearing Disorders in Multiple Sclerosis”

In the book:

“The Human Auditory System: Fundamental Organization and Clinical Disorders”

Edited by Celesia G.G. and Hickok G.

As part of the series:

“Handbook of Clinical Neurology”

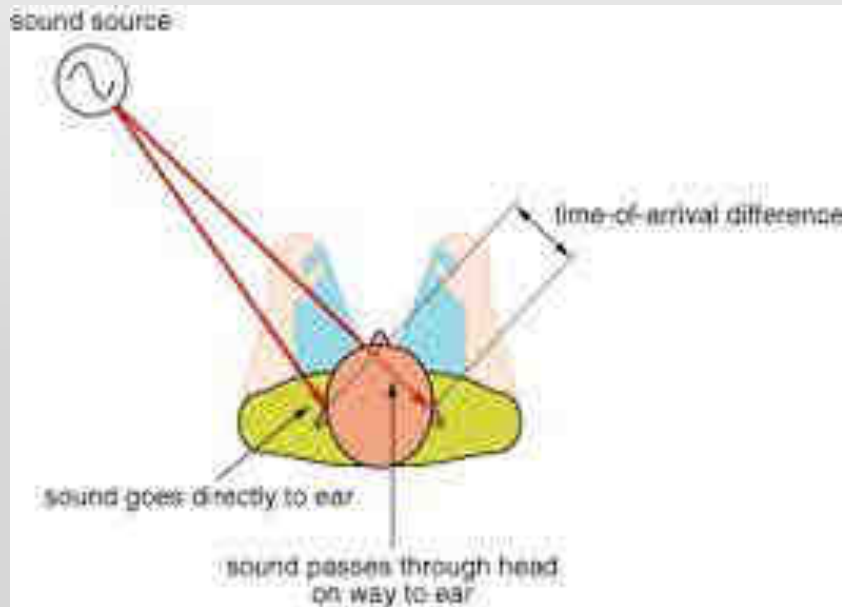
Volume 129 (2015)

Talk Outline

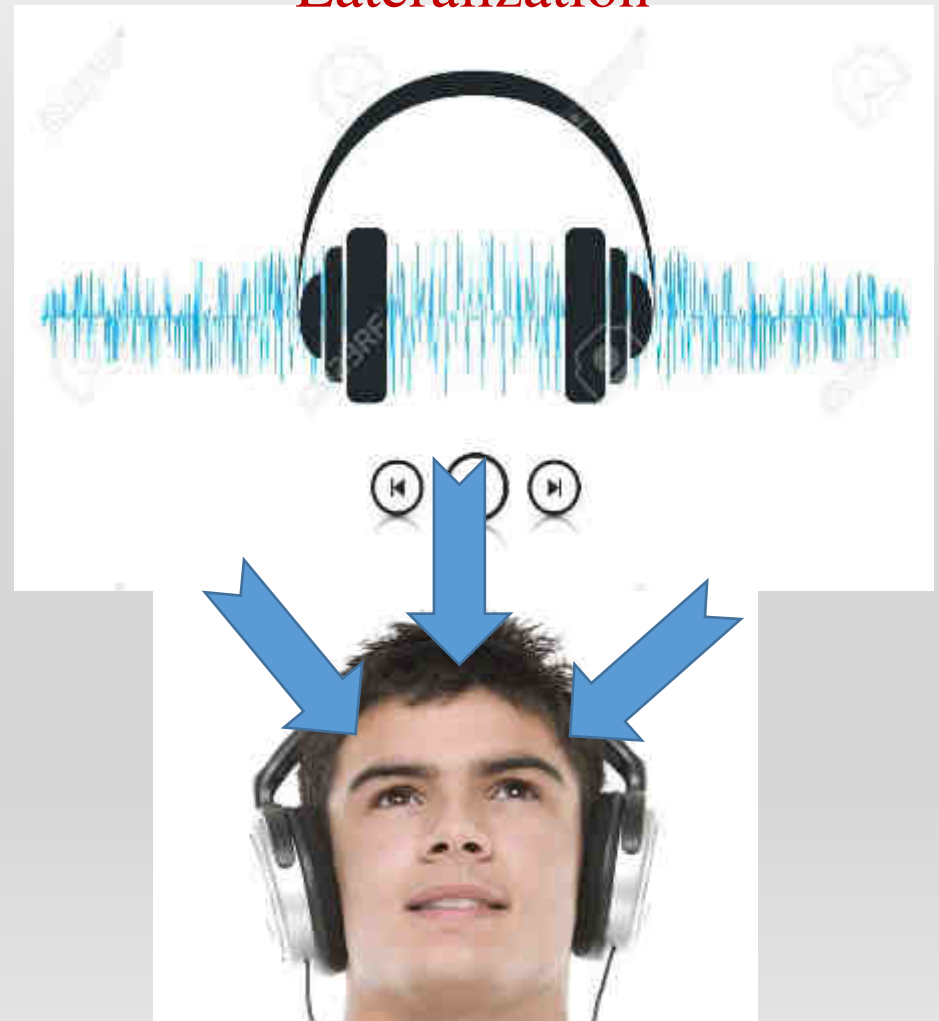
- Binaural Perception in Healthy People
- Binaural Perception in Subjects with brainstem lesions due to either MS or CVA
- Detecting Lesions in the Brainstem Auditory Pathway
- Correlation between the site of the lesions and binaural abilities

Sound Localization and Lateralization

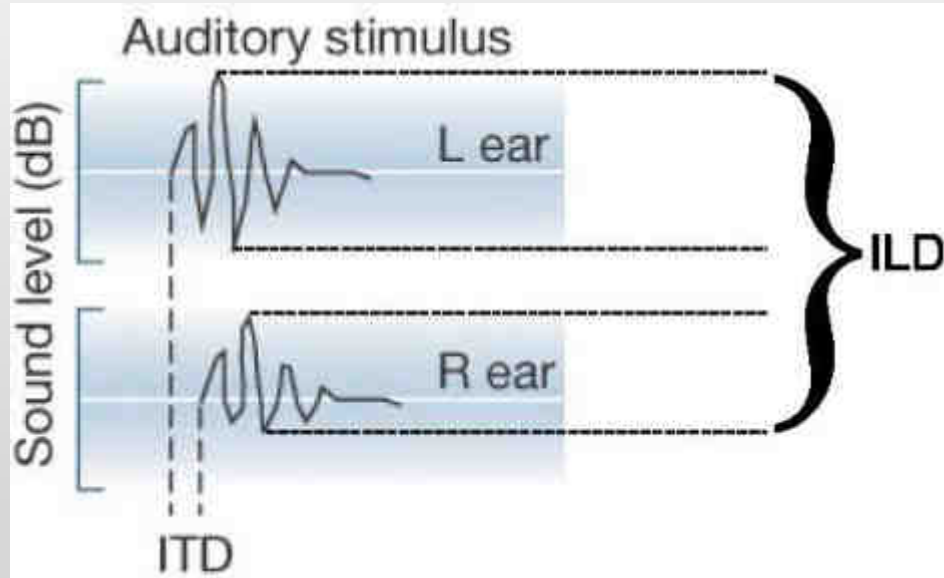
Localization



Lateralization



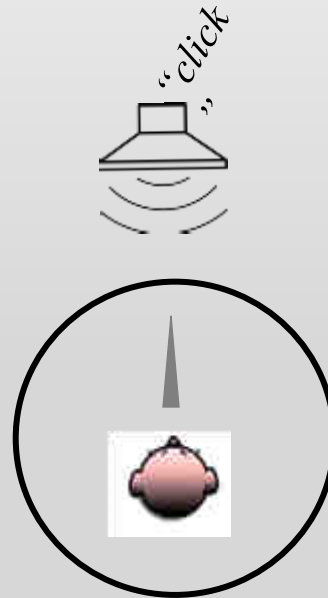
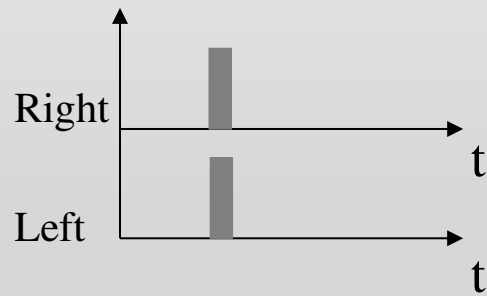
Binaural Cues For Localization and Lateralization



- Interaural Time Delay (ITD)
- Interaural Level Difference (ILD)

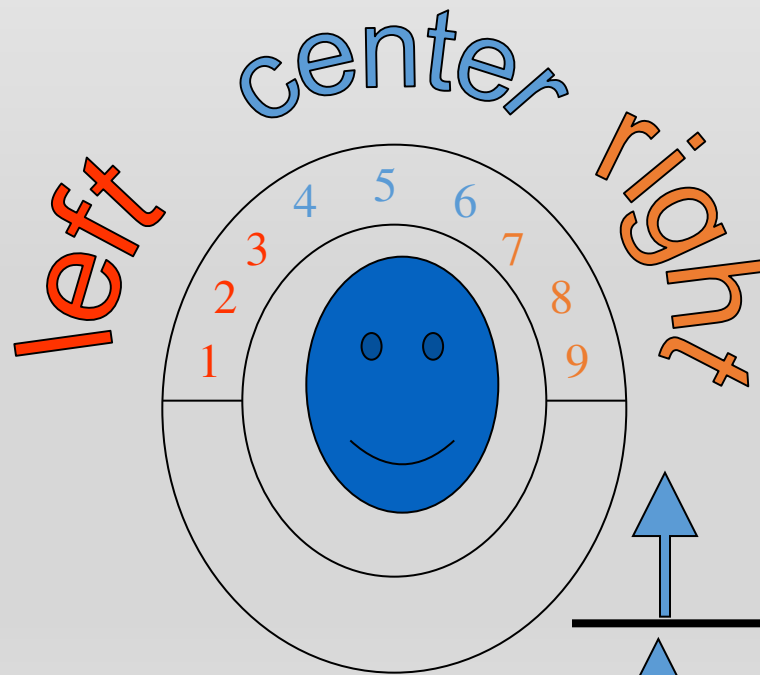
Sound Lateralization with Clicks

The perceived location is by the ITD

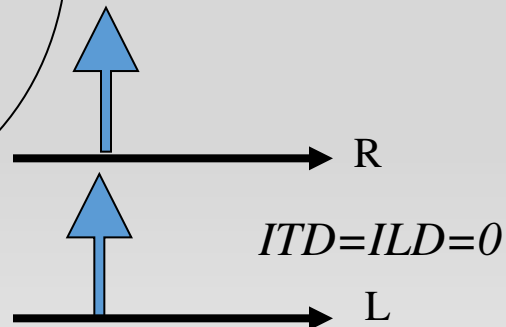
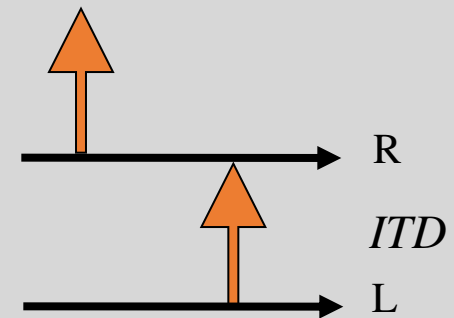
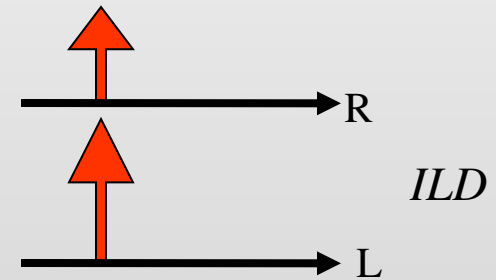


LATERALIZATION EXPERIMENT

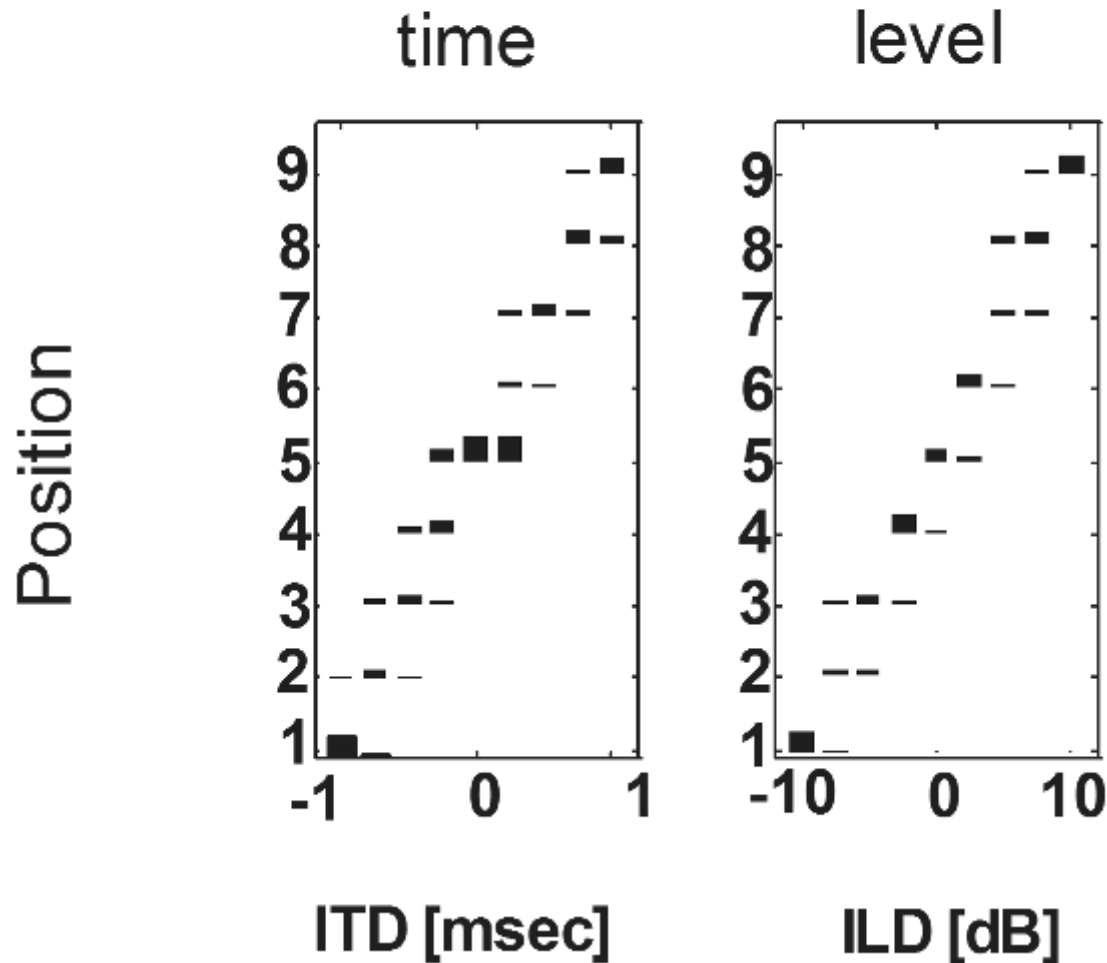
Perception



Stimulus



Normal Performance

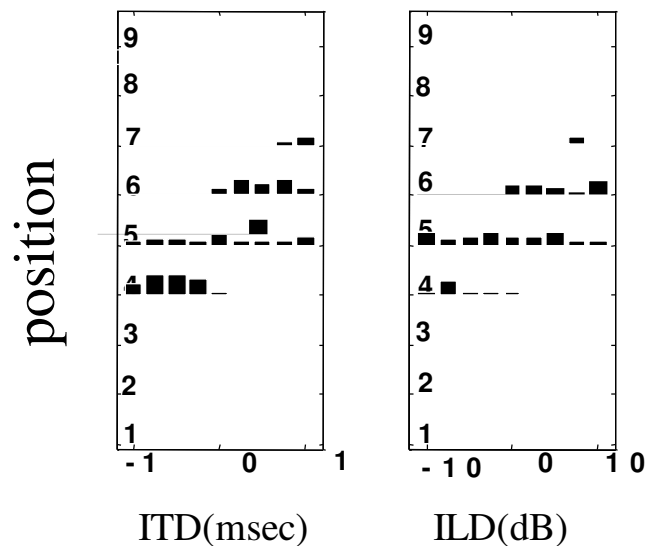


Histograms =

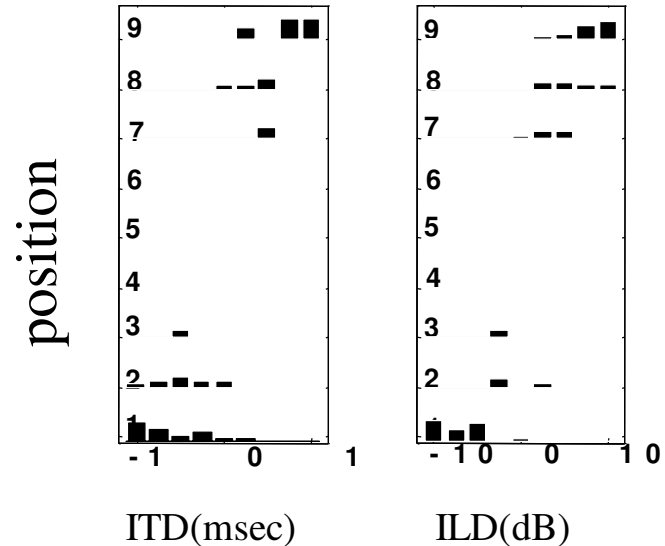
number of times a subject reported perceiving a position when ITD or ILD presented

Abnormal Performance

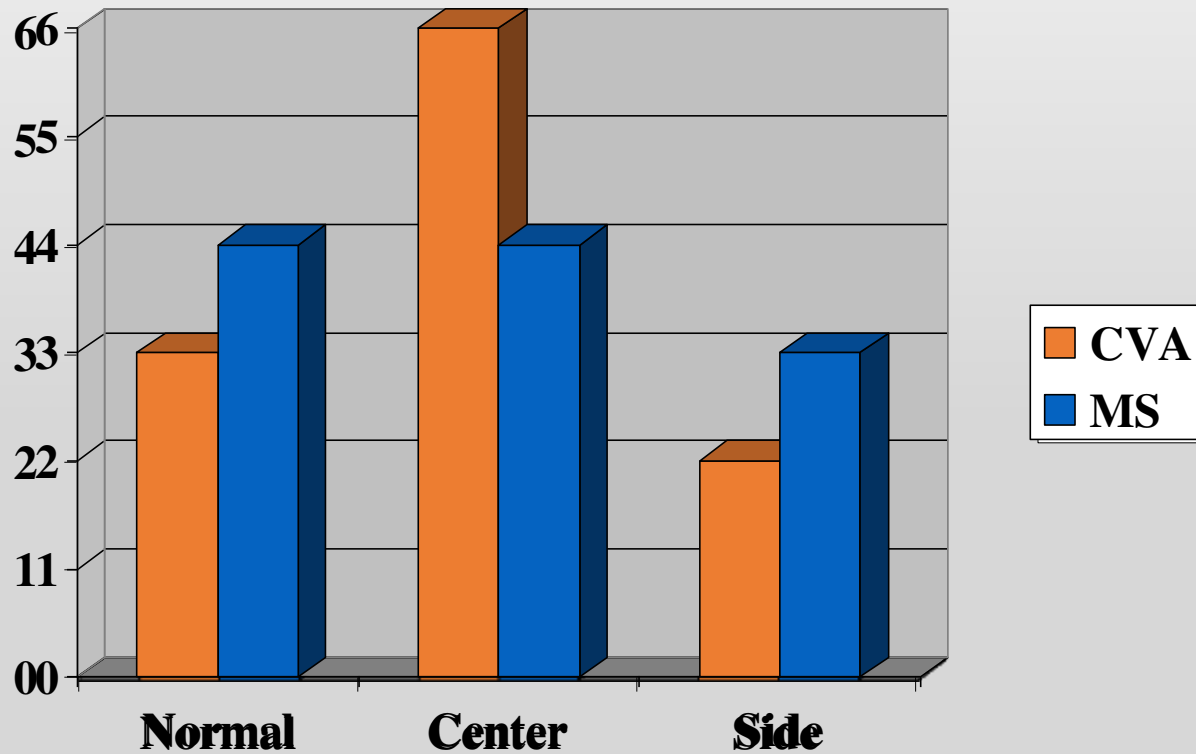
Center-Oriented



Side --Oriented

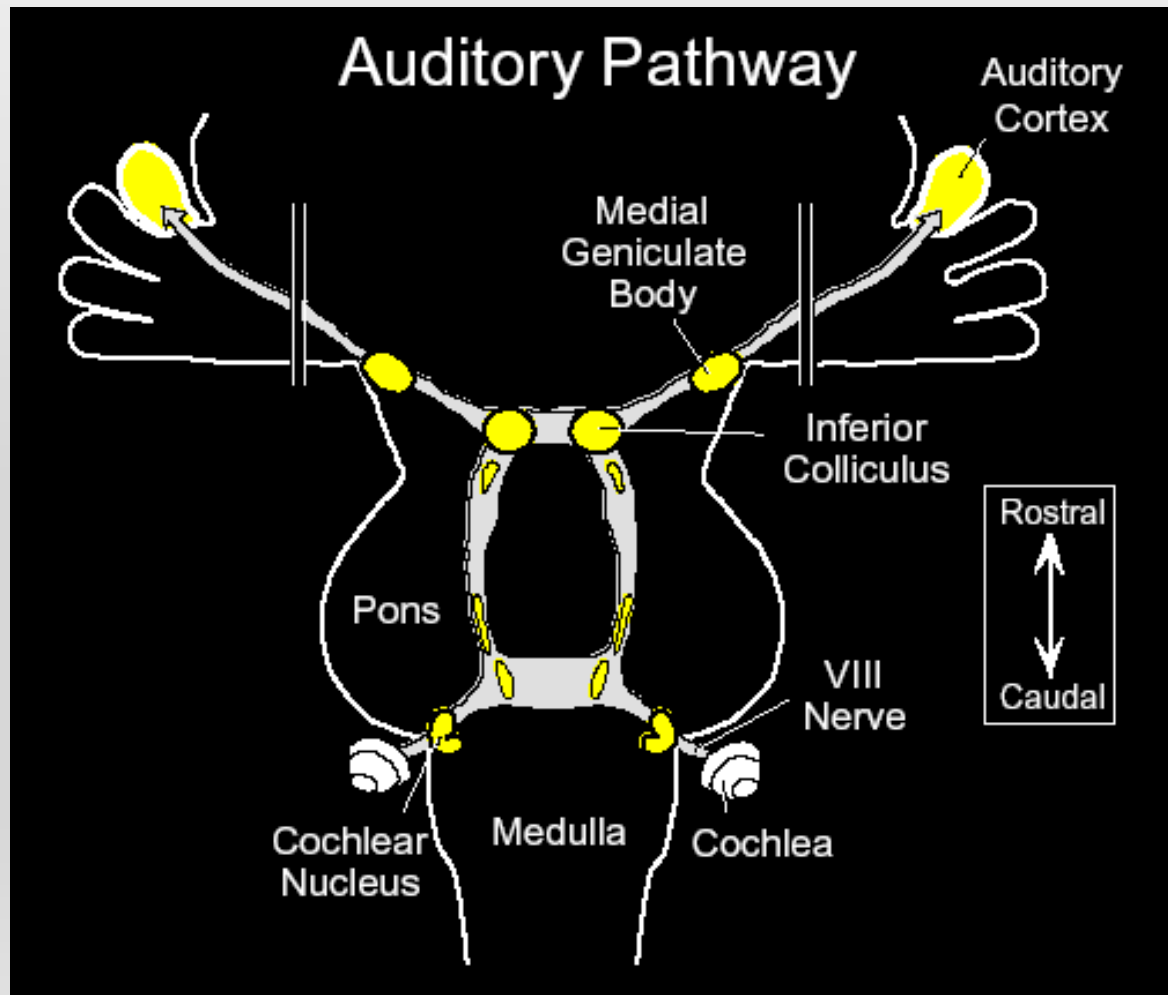


Patients' Performance

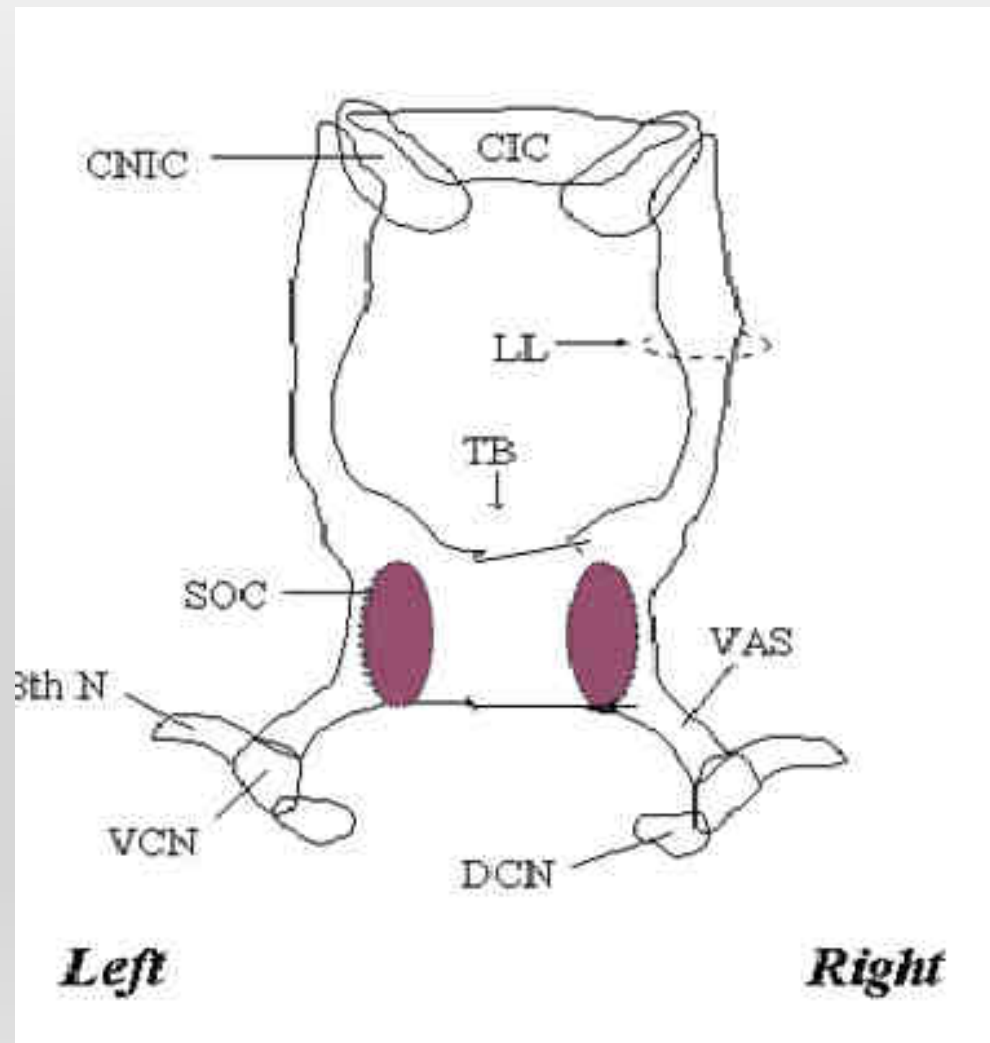


Is Abnormal Performance
Correlates
to an Existing Lesion in the
Auditory Pathway?

Schematic Representation of the Brainstem Auditory Pathway



Human Brainstem Auditory Pathway Atlas

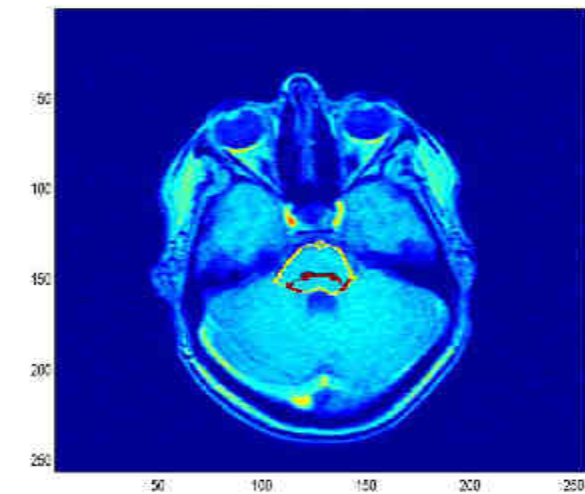


The MRI Protocol

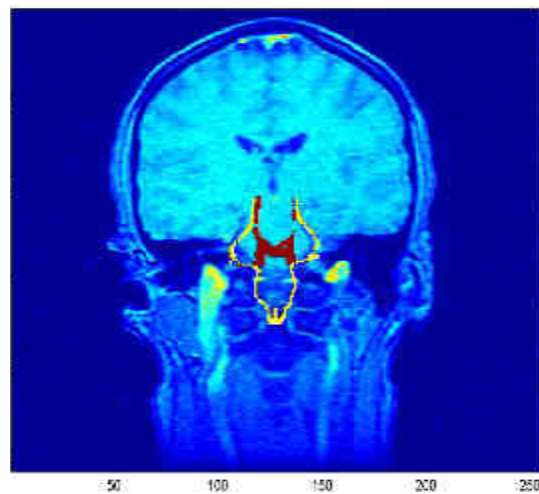
Contiguous 5mm sections were obtained using T2 spin-echo sequences from three orthogonal planes of the brainstem :

- axial: perpendicular to the long axis of the brainstem
- coronal: parallel to the plane of the floor of the fourth ventricle
- sagittal : perpendicular to the plane of the floor of the fourth ventricle and in the plane of the long axis of the brainstem.

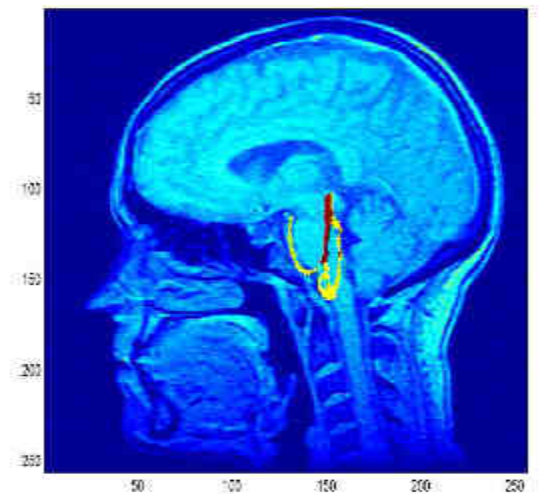
Superimposing the Human Auditory Pathway on MRI Scans



Current First Coordinate: Fixed Coordinate Value:

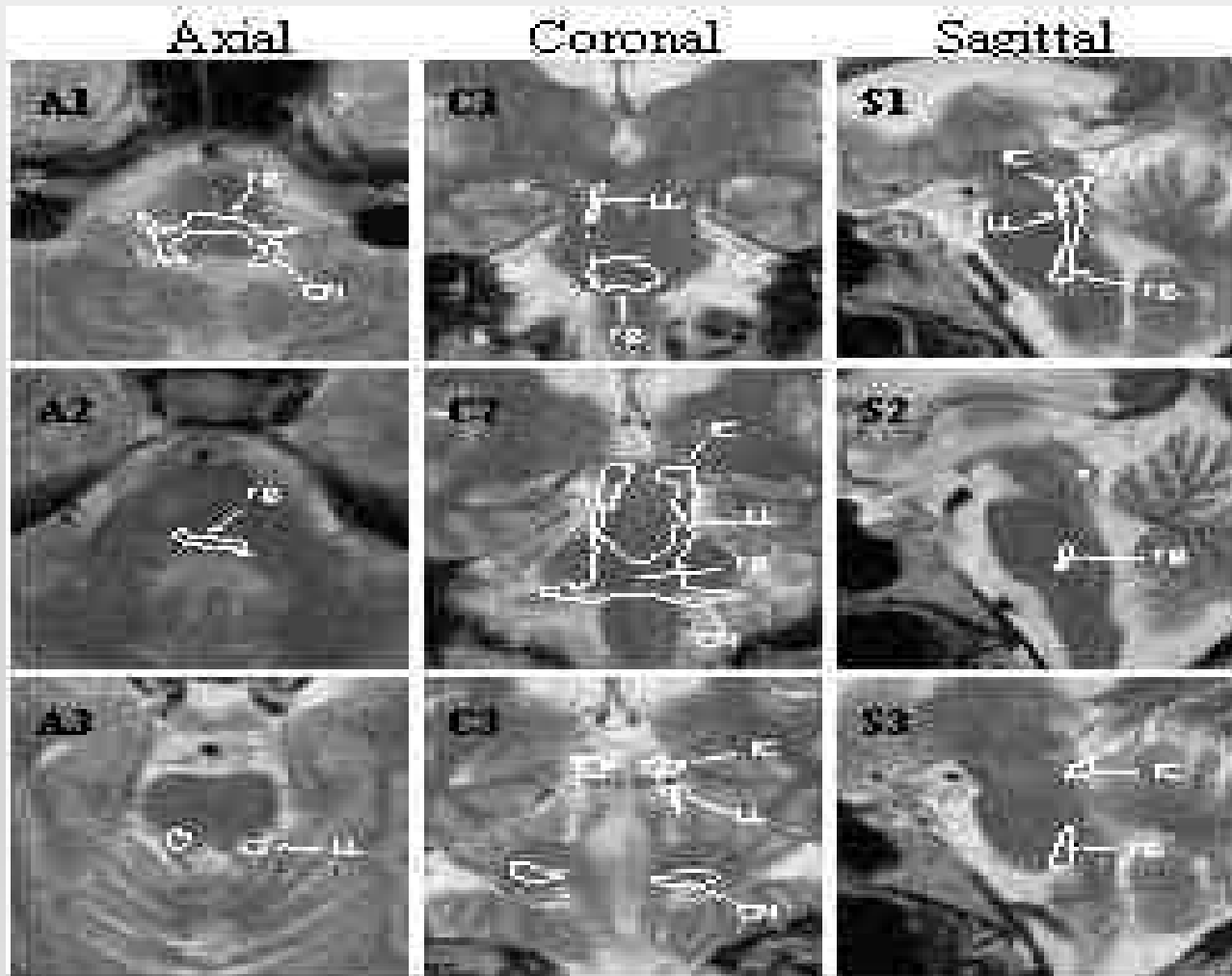


Current First Coordinate: Fixed Coordinate Value:



Current First Coordinate: Fixed Coordinate Value:

Overlap of Auditory Pathway on MRI Scans



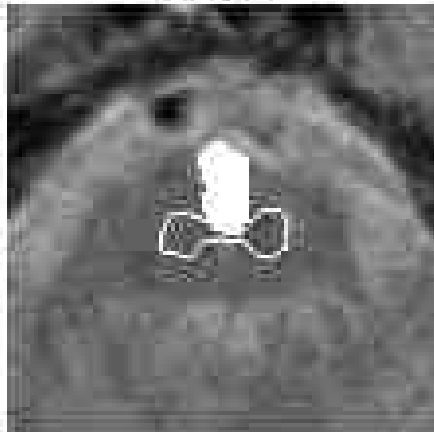
Lesion is defined as
overlapping the auditory pathway

if and only if

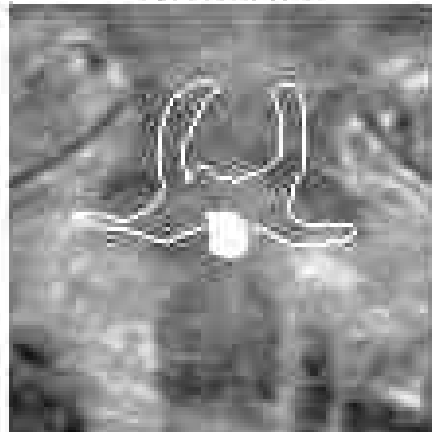
it overlaps the auditory pathway
in at least **2 orthogonal planes**.

Lesion Detection Example

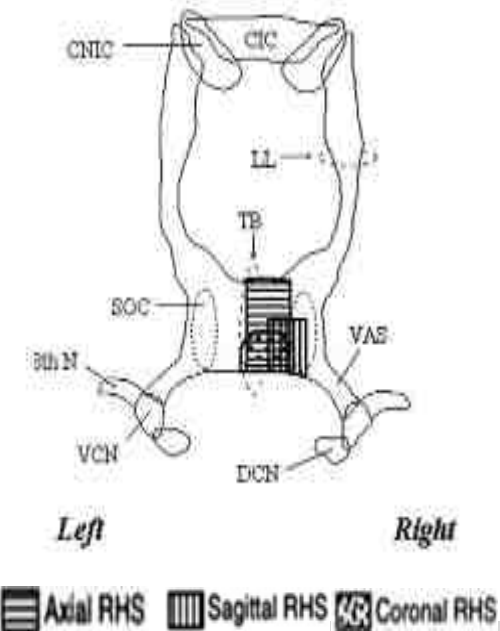
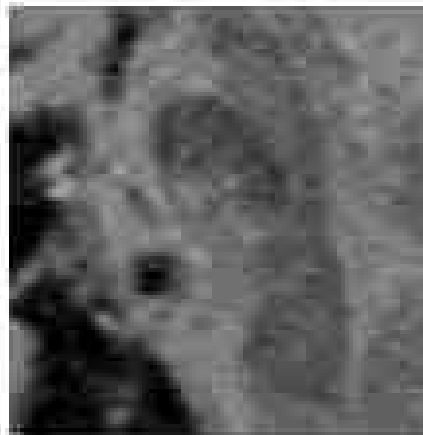
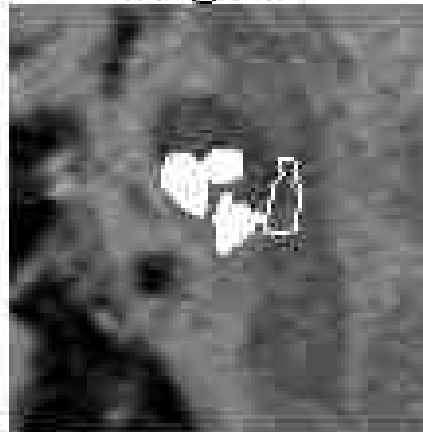
Axial



Coronal



Sagittal

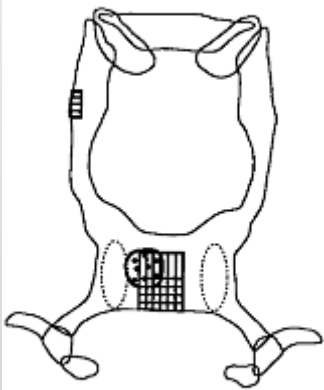


Results

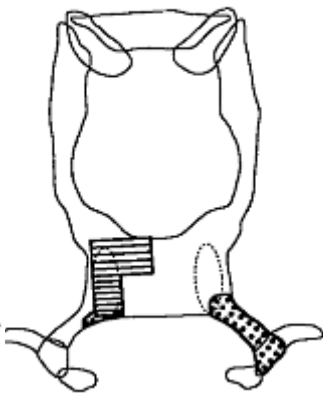
- **All the Patients** that performed **abnormally** in the lateralization experiment **had lesions that overlapped the brainstem auditory pathway**
- **All the Patients** that performed **normally** in the lateralization experiment **did not have lesions that overlapped the brainstem auditory pathway**

Samples of Center-Oriented Lateralization

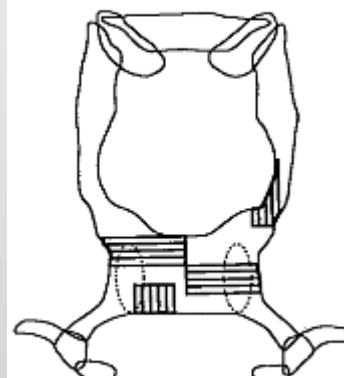
MS 48



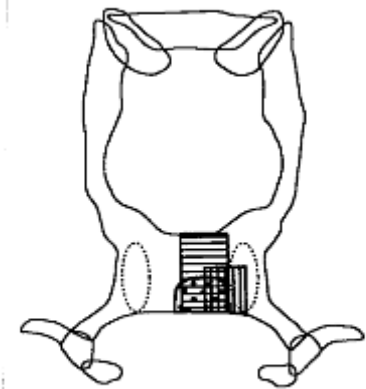
MS 22



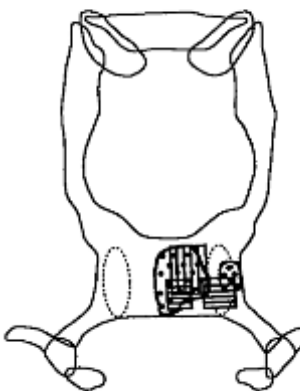
CVA 32



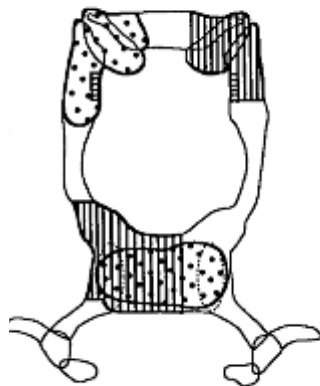
CVA 30



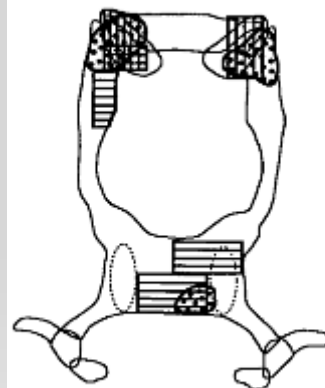
MS 3



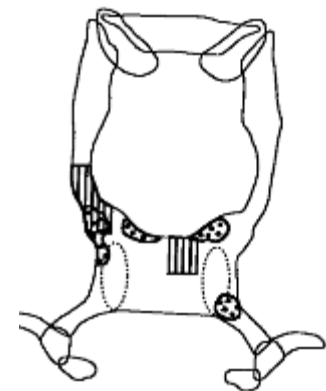
MS 46



CVA 54

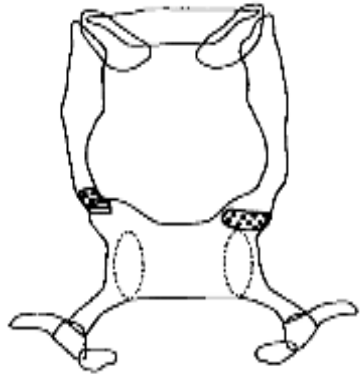


CVA37

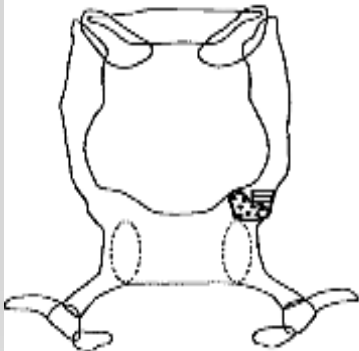


Samples of Side-Oriented Lateralization

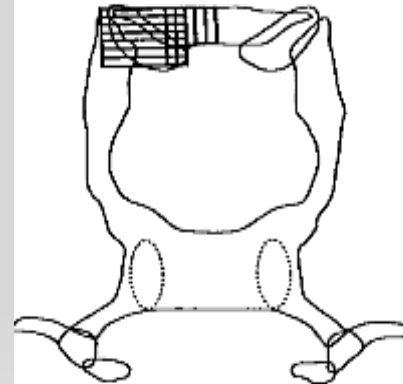
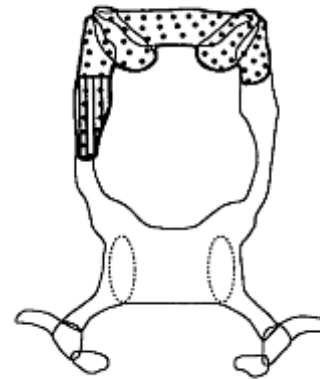
MS 7



MS 15



CVA 43



Correlation between MRI and Lateralization

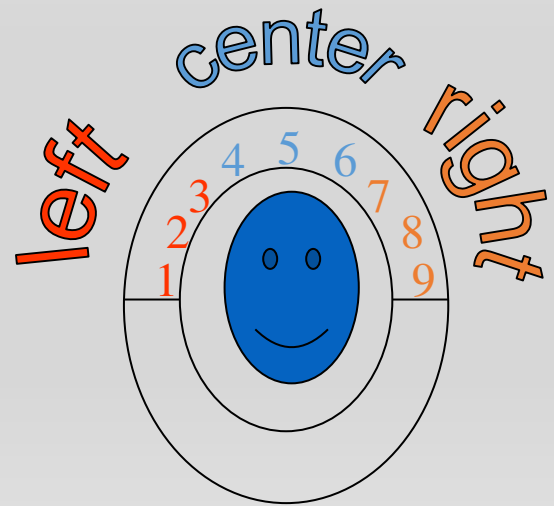
MRI LATERALIZATION	NO LESIONS	TB LESIONS	TB&LL LESIONS	LL LESIONS
NORMAL PERFORMANCE	30%			
CENTER- ORIENTED		25%	20%	
SIDE-ORIENTED				25%

Experimental Summary and Conclusions

- Two types of abnormal lateralization performance were found : **center-oriented** and **side-oriented**.
- Both types of abnormalities were found in patients with either MS or Stroke
- Center-oriented lateralization is correlated with TB/SOC lesions
- Side-oriented lateralization is correlated with LL/IC lesions

Our Suggestion:

Use the Lateralization Experiment
to detect lesions in the brainstem
auditory pathway



Acknowledgments

Thanks to all the colleagues and students who took part in the project:

- **Robert A. Levine**
- **Amos D. Korczyn**
- **Barbara C. Fullerton**
- **Rina Tadmor**
- **Hillel Pratt**
- **Vered Aharonson**
- **Roy Tenny**



- **The study was supported by BSF Grant 89-00447 and ISF 563/12**

