# Brainstem Auditory Evoked Potentials(BAEP)

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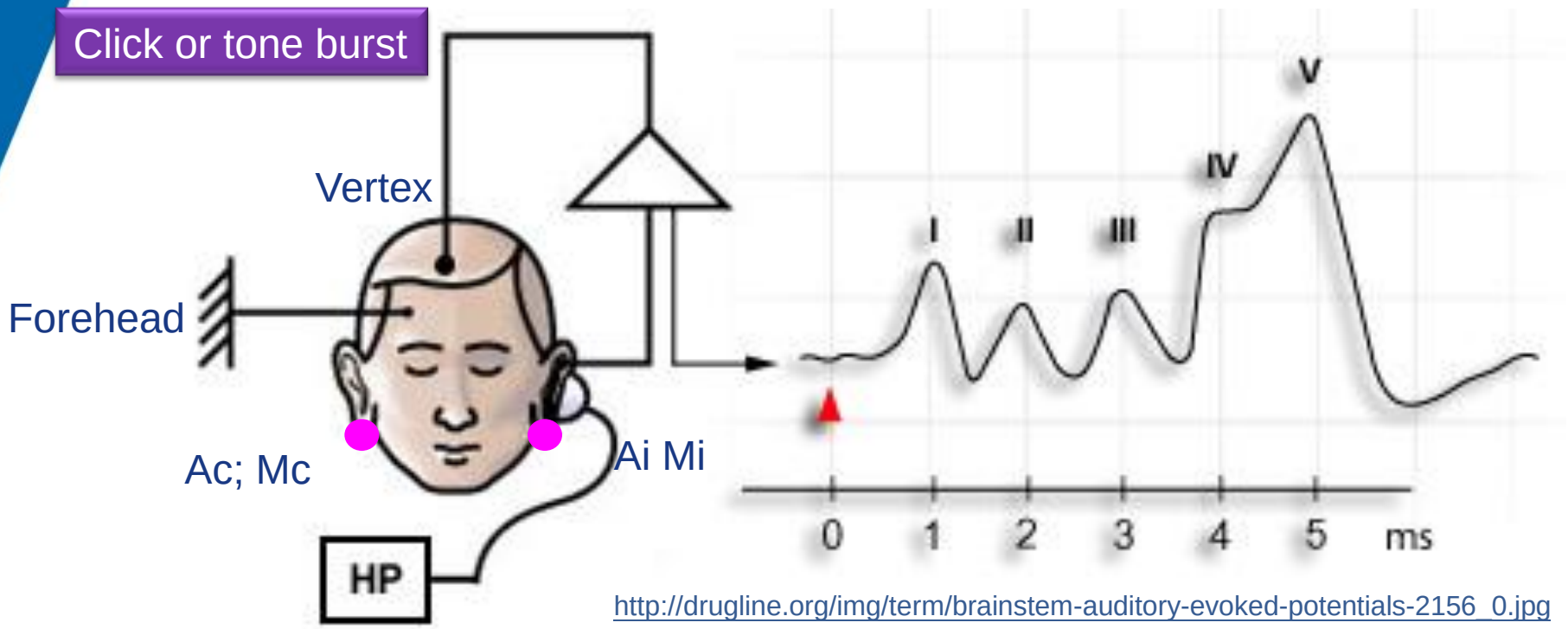
# Introduction

- Auditory Evoked Potentials(AEP) has been divided to 3 type as **short-latency(~10ms)**, intermediate, and long-latency.
- Auditory brainstem response (ABR) is a neurologic test of auditory brainstem function. First described by Jewett and Williston in 1971



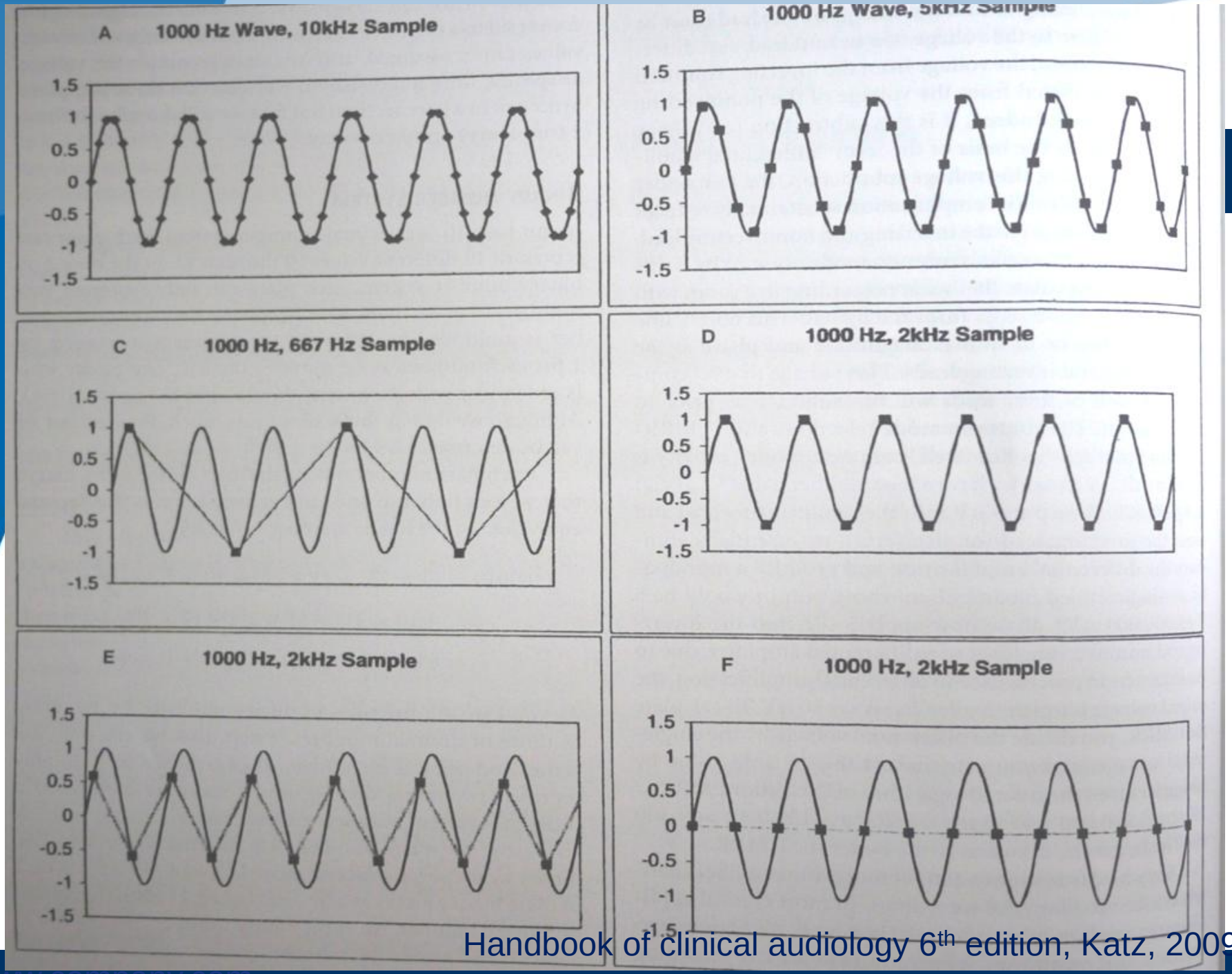

http://drugline.org/img/term/brainstem-auditory-evoked-potentials-2156_0.jpg

# Stimulation

- Click stimuli:
  - monophasic square pulse of 100-μsec duration
  - Rate: 10 Hz
  - Frequency of click: broad-band, wide frequency range
- Intensity: 60-65dB
  - Increased if hearing loss is present
  - Loud enough without discomfort
- Stimuli can reach the other ear via air and bone conduction with volume attenuation(40~70dB) and generate the evoked potential of contra-lateral ear
  - If no noise masking, the delayed V wave was noted
  - If masking(30~40dB), no elicit any reproducible BAEPs
- Compression click ; Rarefaction click

# Recording

- Recording electrodes: vertex(Cz) and both ear lobes or mastoid(smaller wave I) ; ground➔ forehead
- Impedance: 5 kΩs or less (also equal between electrodes)
- Avoid needle electrodes
- A typical analog filter bandpass: 100 or 150 to 3000Hz
- A epoch duration: 10.24msec
- The analog-to-digital conversion should use at least 256 points per epoch, sampling interval 0.4msec, sampling rate of 25000Hz
- The number of epochs per trial is typically 2000, although a larger number may be required if the poor singal to noise ratio




Handbook of clinical audiology 6th edition, Katz, 2009

# Physiology

- ABR typically uses a click stimulus that generates a response from the basilar region of the cochlea.
- The signal travels along the auditory pathway from the cochlear nuclear complex proximally to the inferior colliculus.
- ABR waves I and II correspond to true action potentials.
- Later waves may reflect postsynaptic activity in major brainstem auditory centers
- In the U.S. , wave I, III, and V are positive peaks. In other countries, the waves are plotted with a negative voltage.

# The Ascending Auditory Pathway

Primary Auditory Cortex

VI, VII

Medial Geniculate Body

V

Inferior Colliculus

Lateral Lemniscus

IV

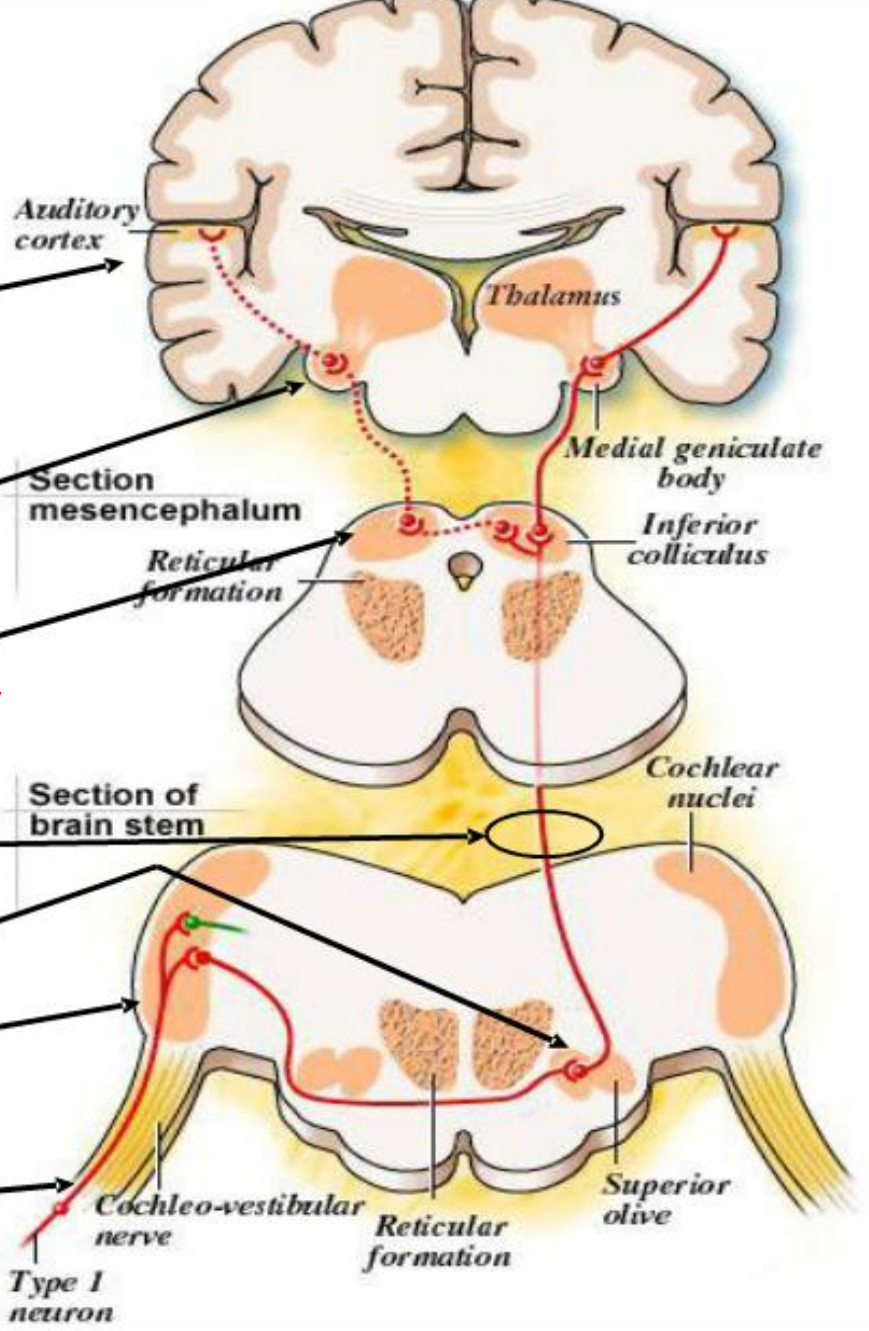
Superior Olivary Complex

Cochlear Nucleus

III

VIIIth Nerve

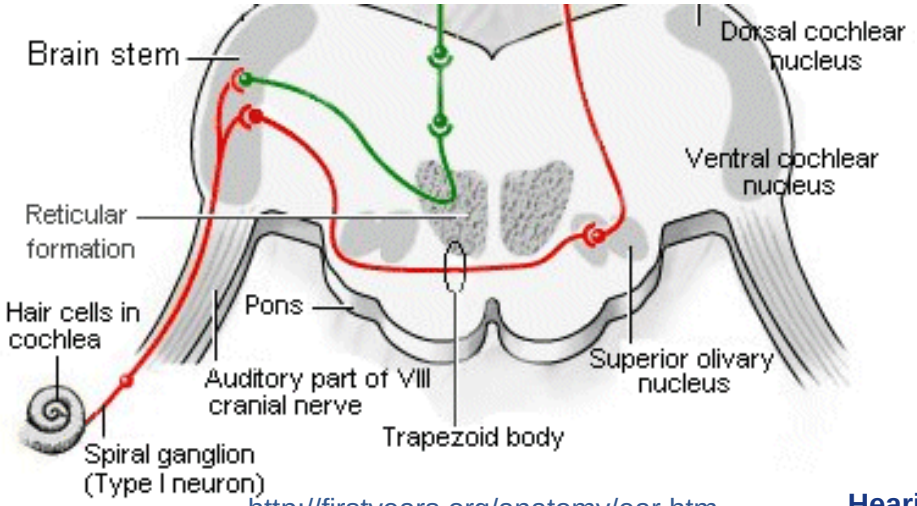
I, II



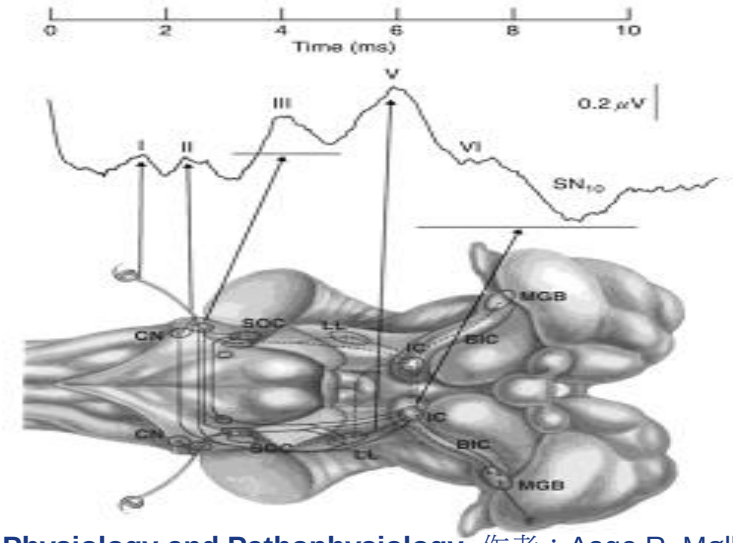

http://www.docstoc.com/docs/126098489/The-Auditory-Nervous-System---PowerPoint

# Waveform components

- Wave I:
  - The ABR wave I response is the far-field representation of the compound auditory nerve action potential in the distal portion of cranial nerve (CN) VIII.
  - The response is believed to originate from afferent activity of the CN VIII fibers (first-order neurons) as they leave the cochlea and enter the internal auditory canal.
- Wave II:
  - The ABR wave II is generated by the proximal VIII nerve as it enters the brain stem.



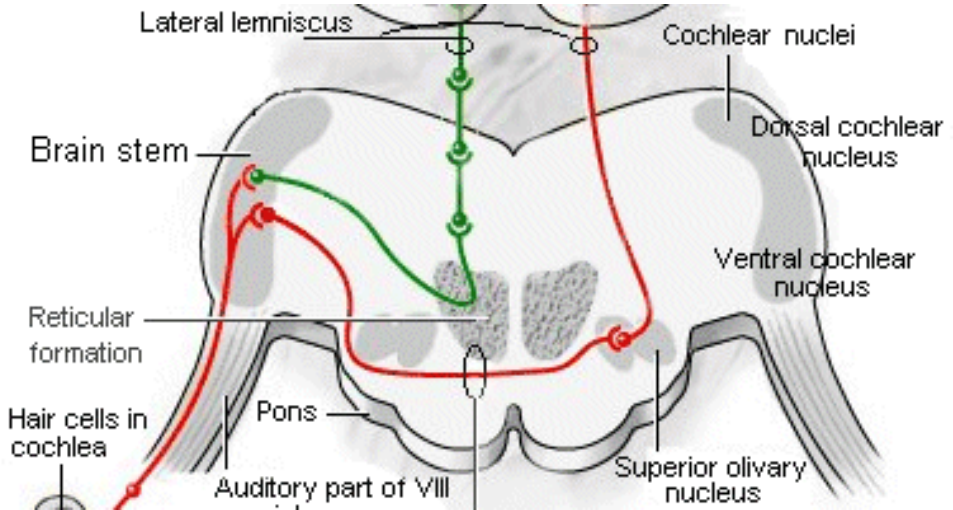

http://firstyears.org/anatomy/ear.htm




**Hearing: Its Physiology and Pathophysiology** 作者：Aage R. Møller

# Waveform components

- Wave III:
  - arises from second-order neuron activity (beyond CN VIII) in or near the cochlear nucleus.
  - Caudal portion of the auditory pons.
- Wave IV:
  - often shares the same peak with wave V➔ IV/V complex wave
  - arise from pontine third-order neurons mostly located in the superior olivary complex
  - additional contributions may come from the cochlear nucleus and nucleus of lateral lemniscus.

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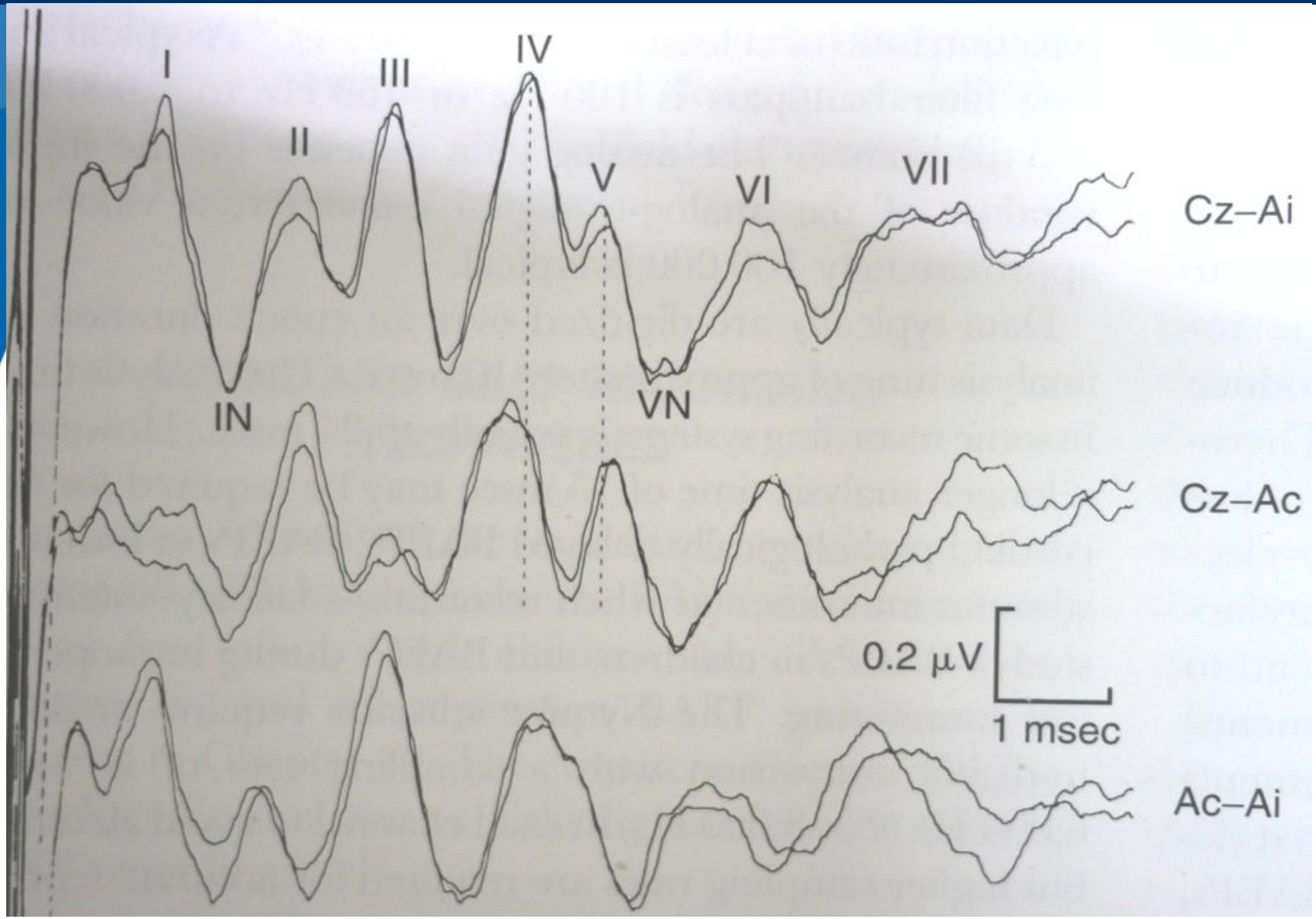
# Waveform components

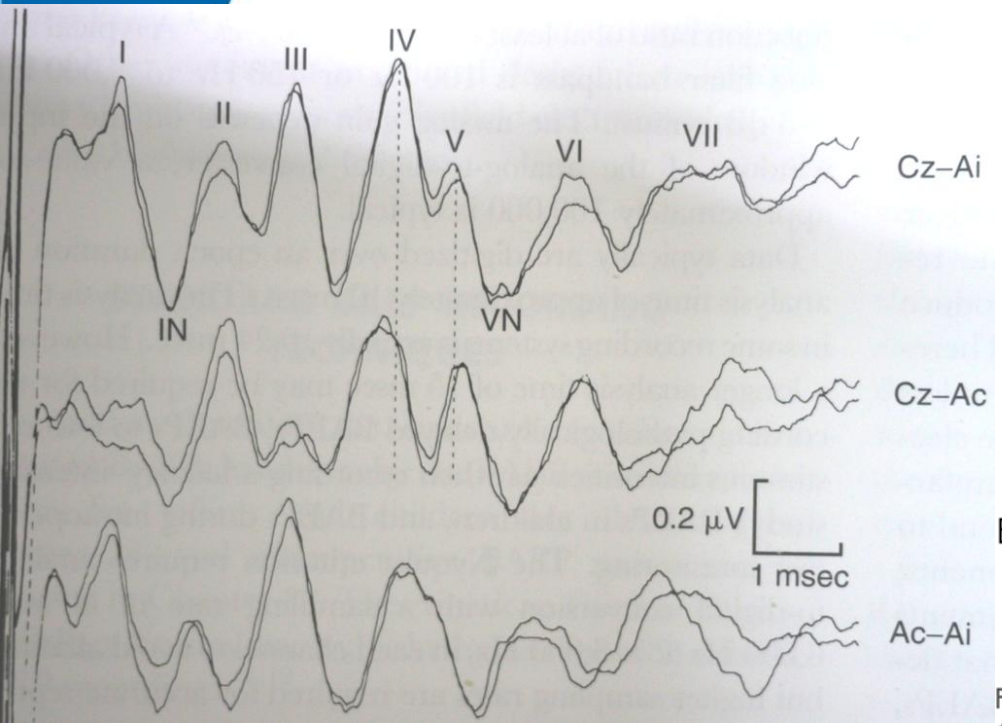
- Wave V: Generation of wave V likely reflects activity of multiple anatomic auditory structures.
  - Analyzed most often in clinical applications of the ABR.
  - Originate from the vicinity of the inferior colliculus.
  - The inferior colliculus is a complex structure, with more than 99% of the axons from lower auditory brainstem regions going through the lateral lemniscus to the inferior colliculus.
- Wave VI and VII:
  - Thalamic (medial geniculate body) origin is suggested for generation of waves VI and VII
  - Less clinical application

# Discussion




Aminoff's electrodiagnosis in clinical neurology 6th edition, 2012

- Another nerve firing ??
  - Stimuli can reach the other ear via air and bone conduction with volume attenuation(40~70dB) and generate the evoked potential of contra-lateral ear
- Auditory conduction route
- Ipilateral:
  - cochlear nerve(distal to proximal)➔ cochlear neucleus(dorsal)➔ lateral lemniscus➔inf. colliculus
- Contralateral:
  - cochlear nerve(distal to proximal)➔ cochlear neucleus(ventral)➔superior olivary complex➔lateral lemniscus➔inf. colliculus

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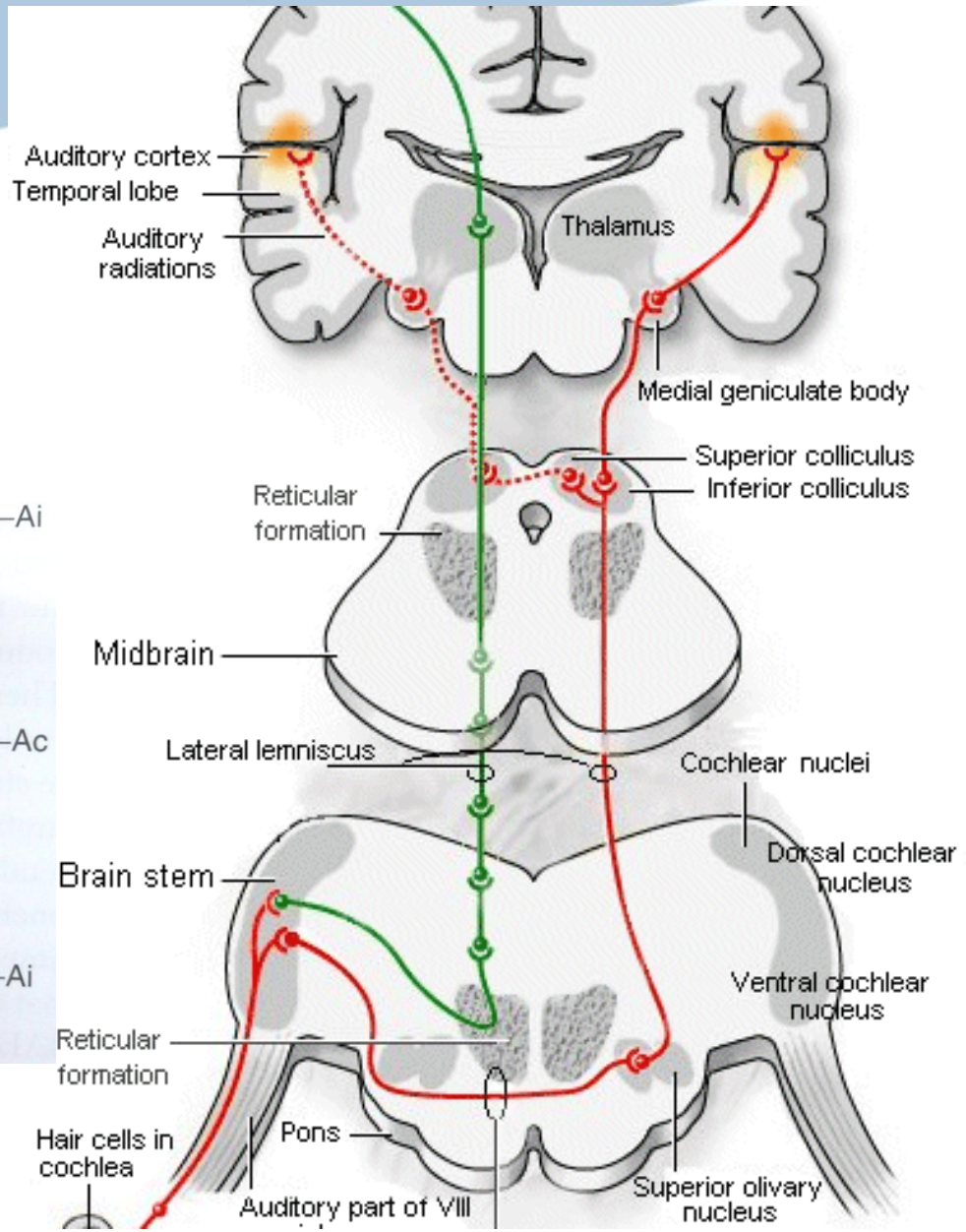


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# Consideration in interpretation

- Degree and type of hearing loss
- Intensity, Rate, Type of signal
- Recording montage
- Pathology
- Gender
- Body temperature
- Age
- Medication

# Applications

- **Identification of retrocochlear pathology**
  - An effective screening tool in the evaluation of suspected retrocochlear pathology such as an acoustic neuroma or vestibular schwannoma.
  - If abnormal ABR finding ➔ MRI of the cerebellopontine angle.
- **Symptoms of eighth nerve pathology**
- Clinical symptoms may include but are not limited to the following:
  1. Asymmetrical or unilateral sensorineural hearing loss
  2. Asymmetrical high-frequency hearing loss
  3. Unilateral tinnitus
  4. Unilaterally or bilaterally poor word recognition scores as compared with degree of sensorineural hearing loss
  5. Perceived distortion of sounds when peripheral hearing is essentially normal
- Hearing Threshold
- Nerve monitoring during surgery

# Reference


- Aminoff's electrodiagnosis in clinical neurology 6th edition, 2012
- Auditory electrophysiology, a clinical guide. 2012
- Handbook of clinical audiology 6th edition, Katz, 2009
- Medscape

# Thank you for listening