

**Nova Southeastern University
Audiology Department**

**Electrophysiology: Auditory
AUD 7120**

**Detailed Course Outline: October 8-11, 2009
LONDON, UK**

INSTRUCTOR:

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COURSE DESCRIPTION: AUD 7120 Electrophysiology: Auditory. Students will study of cochlear physiologic and auditory neurophysiologic evaluation procedures, including evoked responses for all latencies and otoacoustic emissions. Interpretation of test results will be discussed in relation to underlying anatomy and physiology. (4 credits)

Learning Outcomes

After successful completion of the course, students will:

1. Describe the endocochlear, cochlear, compound action and summing potentials.
2. Describe the anatomical structures that contribute to various evoked potentials.
3. Describe the principles of operation of otoacoustic emissions and evoked potentials systems, and explain how manipulating stimulus and acquisition parameters affects the responses obtained.
4. Interpret the results of otoacoustic emissions tests
5. Describe OAE and ABR findings typical of auditory neuropathy.
6. Describe the use of electrophysiologic tests in the assessment of central nervous system function and describe the use of these tests in the evaluation of auditory processing.
7. Compare and contrast the various exogenous vs. exogenous responses in auditory processing assessment
8. Compare and contrast the various methods of attaining estimates of hearing sensitivity using evoked potentials.
9. Explain how non-pathologic factors affect the ABR.
10. Describe the MLS ABR, and stacked ABR techniques.

Unit One Integrating Electrophysiologic Measures into Diagnostic Testing

Professor Charles Berlin, Ph.D.

Reading assignments will be posted in WebCT.

Review: Anatomy & Physiology notes and text material. Be able to:

Describe how hair cell polarization and depolarization occurs in response to stimulation.

Describe the active mechanism of the ear

Define cochlear microphonic, summing potential and action potential

Review: Review material on otoacoustic emissions.

In this unit, Dr. Berlin challenges you to think critically about the potentials evoked and otoacoustic emissions measured, and to integrate your knowledge of auditory physiology to arrive at a site-of-lesion diagnosis. Please read the assignments before his class meetings.

Additional post-class readings and assignments are at the discretion of the professor.

See last page of syllabus for a supplemental study aid.

Dr Berlin will give an essay exam for his material, which will be graded by audiology faculty. He will determine due dates.

Unit Two – Evaluation of the CANS above the Level of the Lateral Lemniscus.

In this course section, the middle and late latency potentials are discussed, and their use in the evaluation of auditory processing is presented.

1. Modelling CANS function; evoking exogenous and endogenous potentials; the middle latency response
2. The late auditory evoked potentials; N1, P2, N2, N4; acquisition parameters and scalp distributions
3. Special event-related potentials: P300, Mismatch Negativity, Contingent Negative Variation
4. Integrating behavioral and electrophysiological measures for assessing auditory processing; neuropathological findings

Unit Three. Short-Latency Evoked Response Testing

1 Generators of the ABR

Technical Aspects:

Relationship of acoustic stimulus and evoked responses

Repetition rate and polarity

Transducer effects

- Calibration
- Contralateral masking
- Electrode montage
- Acquisition parameters
- Overview of the tone burst ABR

2. Technical aspects:

- Time domain signal averaging
- Differential amplification
- Filtering
- Artifact rejection
- Review of Neurologic Site of Lesion Assessment
- Procedures to Enhance Wave I Recording
- Case Studies
 - Review of Typical Procedures and Interpretation
 - Stacked ABR, MLS ABR, BIC, Chained-Stimuli

3. Electrocochleography & case studies

4. Threshold Estimation Using Evoked Potentials

- What's wrong with clicks
- Derived responses
- Using tone bursts
- ASSR Overview
- Acquiring and Interpreting ASSRs

5. Pediatric Screening & Testing

- Hearing Aid Fitting Appendix I. ABR Overview

Review of Technical Aspects

1. Montage – refers to how the electrodes are attached

- Non-inverting vertex or high forehead
- Inverting on earlobe
- Ipsilateral / contralateral
 - Use ipsilateral on infants
 - Use both where possible
 - Contra shows better IV/V separation
 - Ipsi shows better wave V and generally larger waves
- Scrubbing matters!
 - Equal impedance is important
 - Low impedance is important
 - Don't skimp! Really affects the quality of the responses.

2. Filter Settings

- Refers to the filtering of the EEG setting, has nothing to do with the stimulus that elicits the ABR.
- Affects the appearance of the wave
 - Low-pass smoothes waves
 - High-pass removes slower variations, excludes some myogenic low-frequency noise (NOT ambient noise)

3. Artifact Rejection

- High EEG voltages are rejected. The “sweep” containing that voltage is not included into the average. You can adjust the voltage that triggers the artifact rejection. Bring it down to be more selective, raise it and you let in sweeps that are of poorer quality.
- If a given artifact rejection setting is held, the more rejection the more myogenic activity is present. (When the patient moves, more sweeps are rejected.)

- If a given patient state remains constant, the more you “clamp down” on the artifact rejection circuit, and the more it rejects, the cleaner your waves will be. (Flutter control runs)

4. ABR Measurements

- Wave V is typically the most robust wave – it is seen down to the lowest intensity level.
- Babies may have robust wave I
- Wave V latency varies with stimulus characteristics and with hearing loss.
- Wave V latency is therefore not the best indicator of VIII n/ lower brainstem pathology. The I-V interpeak latency (IPL) is the better indicator.
- Wave I can be hard to record, various techniques are employed to make it more distinct. Slow the rate, try a different polarity, increase the intensity, be sure to examine the ipsilateral trace, use ECoG recording parameters to find wave I.

5. Repetition Rate

- Affects latencies. Faster rate – longer latencies. V is affected more than I, so the I-V IPL prolongs.
- Higher rep rate makes waves “less pretty”
- Probably affects threshold slightly
- Stresses the CNS, theoretically

6. Polarity of clicks

- Rarefaction often separates IV/V more
- Condensation may give better I
- Individual specific results. Obtain both polarities if you do not have a clear I and an easy to mark V.
- There will be a slight difference in latency with rarefaction usually shorter.

Review of Threshold Estimation with ABR

Thresholds evoked are *correlated* with hearing thresholds but this is not a hearing test, it is a test of neural synchrony.

1. Click Stimuli

- Not frequency specific. Does it predict high freq hearing? Pure tone average?

- Using click stimuli allows one to record the ABR with more restrictive electrophysiologic filters (100-3k), so is a bit more robust to myogenic noise.
- Latency – intensity function can be examined to infer whether recruitment is present, but has limitations. Better to do bone conduction if concerned about site of lesion.

2. Tonal Stimuli

- Slower onset means you may not see I, III
- Latencies are affected by both onset time and traveling wave
- Only wave V, which may be broad, is observed most times
- Need to open filters to allow low-frequency EEG energy in or else the wave V is distorted

3. Estimating threshold

- Won't evoke a response to threshold level signals
- Threshold is probably 10 dB below minimal response level for high frequencies, perhaps 20 dB below for low frequencies

4. Maturation affects

- Latency prolongations below one year of age
- Threshold not affected (unless there is a conductive component)

Review of Neurological Testing

1. Absolute wave V latency

2. IPLs

- I-III
- III-V
- I-V
- Inter-aural comparisons

3. Rate increase

- 21 to 71 c/s should give no more than about a 0.6 ms increase
- should still have identifiable waves
- probably not highly useful, but typical to include

4. Control runs still needed to assess the quality of your recordings, make sure the lack of replication isn't myogenic.

Appendix II Berlin's study aid.

Test	Normal	Outer Hair Cell	Inner Hair Cell/Auditory Neuropathy	Conductive
Tympanometry	Type A	A	A	TYPE B OR C
Middle Ear M Reflexes	Present at 75-95 dB HL	Present at 75-95 dB unless h.l. exceeds 65 dB HL	ABSENT OR HIGHLY ABNORMAL AND ELEVATED	USUALLY ABSENT OR ELEVATED
Otoacoustic Emissions	Normal..over 3 dB above background noise	ABSENT	PRESENT FOR A WHILE!!	OBSCURED
ABR (COMPARE CONDENSATION TO RAREFACTION CLICKS, NOT	Normal Latency-intensity function	NORMAL AT HIGH LEVELS	GROSSLY ABNORMAL OR ABSENT...WATCH FOR COCHLEAR	DELAYED BUT NORMAL AT HIGH INTENSITY,

ALTERNATING, NEED TO USE INSERT EARPHONES.)			MICROPHONIC TO MASQUERADE AS AN ABR	REFLECTIVE OF HEARING LOSS.
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