Instructor's Resource Manual

for

Introduction to Audiology Today

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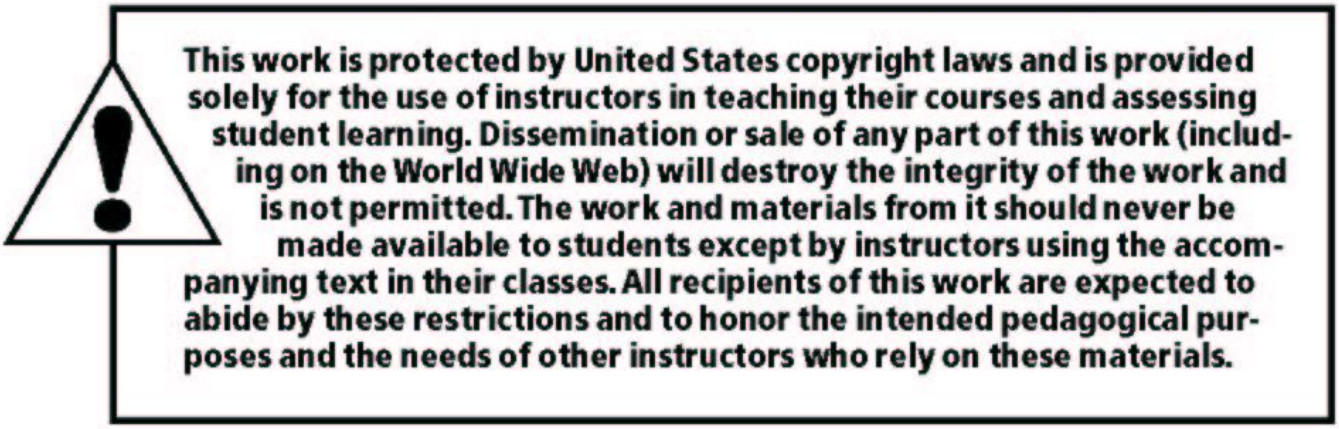

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Contents

PART I: PROFESSION AND PRINCIPLES OF AUDIOLOGY

Chapter I

Audiology Yesterday and Today

CHAPTER OUTLINE

What is audiology?
Audiology yesterday
- Scientific foundation
- Birth of audiology
- Audiology grows up
- Major developments in the new profession

Education of audiologists
- Historical perspective
- The Doctor of Audiology (AuD) degree
  - Admission requirements
  - Distance learning Doctor of Audiology programs
- Wanted…PhD audiologists!
- The clinical scholar

The profession of audiology today
- Current clinical services
  - Adult audiology
  - Pediatric audiology
  - Teachers, preceptors, and mentors
- A diversity of work settings
  - General and teaching hospitals
  - Children's hospitals
  - Veterans Administration (VA) hospitals
  - Military audiology
  - Universities and research laboratories
  - Industry and manufacturers
- Global audiology
  - Different educational models
  - Tele-audiology

Professional issues and organizations
- Credentials and codes
  - Licensure
  - Certification
  - Scope of practice and code of ethics
- Organizations

A highly ranked profession
- A dozen reasons to consider a career in audiology

KEY TERMS

KEY TERMS	DEFINITIONS
Audiology	The profession of specialists in hearing assessment and non-medical management of persons with hearing loss
Audiometer	A device for measuring hearing. The operator of an audiometer can change the frequency and the intensity level of sounds in hearing testing.
Board certification	In audiology the highest credential for clinical practice offered by the American Board of Audiology (ABA)
Clinical scholar	A professional who has expertise in providing patient services combined with research education and experience.
Cochlear implant	A complex electrical device that is used in the management of persons with severe or profound hearing loss consisting of external components for picking up sound and converting the sound to electrical signals and internal components for delivering the electrical signals to the auditory nerve
Code of ethics	A document developed by a professional organization for guiding the professional behavioral of its members. Audiologists and speech pathologists are expected to abide by their respective Codes of Ethics
Doctor of Audiology degree	The minimum academic degree required to practice as an audiologist in the United States
Educational audiology	Audiological services typically offered in a school setting for children aged 5-18 years
Hearing aid	An electrical device that amplifies sound to improve hearing and communication

Hearing science	The area of science that focuses on the ear and hearing. Hearing scientists often have specific interests such as psychoacoustics, the anatomy or physiology of a particular region of the auditory system, or neurophysiological measures of auditory function
Industrial audiology	The area of audiology that focuses on prevention and documentation of noise-related hearing loss in work setting
Licensure	Credential required by states in the US in the regulation of audiologists, speech pathologists, and other professionals.
Otolaryngology	An ear, nose and throat (ENT) medical doctor. An otolaryngologist is a surgeon.
Otology	Specialty within otolaryngology specializing in diagnosis and treatment of ear and related problems like vestibular or balance disorders.
Pediatric audiology	Audiological services focused on newborns, infants, and children
Prevalence	The proportion of a population or number of persons that has a specific condition or disorder like a hearing loss
Scope of practice	A document describing the clinical activities that are appropriate and "within the scope" of practice for a profession like audiology or speech pathology

KEY TOPICS TO EMPHASIZE

1. What an audiologist is and what an audiologist does
2. Hearing loss is a very prevalent condition among adults and children.
3. Scientific foundations of audiology
4. How the relatively new profession of audiology began
5. About the education of audiologist and the Doctor of Audiology degree
6. The different work settings and career options available to audiologists
7. That audiology is growing around the world
8. The credentials an audiologist needs for clinical practice
9. Why audiology is highly ranked as a career choice

DISCUSSION TOPICS

1. Discuss the professional services offered by an audiologist and how they are unique and different from those offered by medical professionals such as otolaryngologists.
2. Have you come across an individual with hearing loss? If yes, how has the individual's hearing loss affected that individual and his/her family, acquaintances, and educators/employers?
3. Give examples of how scientific disciplines like mathematics, physics, and biology have shaped audiology. Is it important for an audiologist to be trained in relevant aspects of these sciences?
4. How is an audiologist different from a hearing technician?
5. Discuss the relevance of audiology in historical and modern times.
6. What aspects of audiology make it a highly ranked career choice?
7. As awareness about hearing loss increases, how can you improve the availability of audiologic services around the world?

INSTRUCTIONAL ACTIVITIES

Require the students to wear earplugs for at least **one hour** during an important activity (such as a movie, dinner, conversation) without endangering themselves. If they do not have earplugs, ask them to use a CD player or an iPod without turning on the music. Have them describe their experience using the following questionnaire.

Questionnaire

‘Name _____ Date _____

1. During what activity did you wear the earplugs?
2. How long did you wear the plugs?
3. Did you or others notice any difference in your hearing and your ability to communicate?
4. If yes, describe how your communication was affected.
5. What mechanisms did you use, if any, to compensate for your temporary problem?
6. Describe the reaction of the people you were with.
7. Were you eager to remove the earplugs?
8. Was this exercise useful? Why/Why not?

Chapter 2
Sound, Acoustics, and Psychoacoustics

CHAPTER OUTLINE

- Introduction
- Properties of sound
  - Vibrations
    - Inertia and elasticity
    - Condensation and rarefaction
    - Displacement
    - Root mean square amplitude
    - Damping
    - Media for sound propagation
  - Frequency
    - Introduction
    - Sine waves and pure tones
    - Phase
    - Wavelength
    - Resonance
  - Intensity
    - Force and pressure
    - Units of force and pressure
    - Power and intensity
    - Defining the decibel
    - Sound pressure and sound intensity
    - Calculations of sound intensities and sound pressures
    - Measurement of sound
    - Calibration
    - Different references for decibels
  - Duration
    - Dimensions of duration
- Psychoacoustics
  - Pitch
    - Just noticeable difference
  - Loudness
    - Just noticeable difference for intensity
  - Duration
    - Temporal integration
    - Just noticeable difference for duration
    - Gap detection
  - Audibility of sound
    - Minimum auditory field and minimum auditory pressure
    - Reference equivalent threshold sound pressure levels
- Propagation of sound
  - Speed of sound
  - Inverse square law
  - Interference with propagation of sound
- Complex sounds
  - Transient sounds
  - Noise
    - Types of noise in hearing testing
  - Speech
    - Fundamental frequency
    - Formants
  - Music
  - Environmental sounds

KEY TERMS

KEY TERMS	DEFINITIONS
Amplitude	The amount of vibration or movement of a mass from the position of rest to the farthest point from the position of rest. Also, a measure of the size or magnitude of an auditory evoked response wave usually made from either a peak to a preceding or following trough or from the peak of a wave to some index of baseline. Amplitude of an evoked response is expressed in µvolts (microvolts).
Condensation	Region of a sound wave characterized by increased density of molecules. Opposite of rarefaction. Acoustic stimulus produced by a positive electrical pulse activating a transducer like an earphone produces condensation stimulus polarity
Cycle	A complete 360 degree course of a single sine wave from beginning to end
Damping	Decrease in the amplitude of a vibrating body over time.
decaPascal	A unit of pressure used in acoustic immittance measurements, such as tympanometry
Decibel	A unit of sound intensity level. A dB is the logarithm of the sound pressure of a sound to a reference sound pressure (usually 0.0002 dynes/cm). Clinically for adult patients, hearing threshold levels of 0 to 20 dB are considered to be within the normal range. Units for describing decibels include dB hearing level (HL), sound pressure level (SPL), sensation level (SL) and, for auditory evoked responses, dB normal hearing level (dB nHL).
Duration	The length of time from the beginning to the end of a stimulus; Duration is described in milliseconds or seconds and includes the rise and fall times, and the plateau in between.
Dyne	A unit of force that is just sufficient to accelerate a mass of 1 gram over a distance of 1 cm^2
Elasticity	The capacity of an object that has been deformed to return to its natural shape
Forced vibration	Vibration of an object that is maintained by the application of ongoing external energy
Frequency	A property of sound defined as the number of complete cycles or oscillations of a vibrating body in a specified unit of time (e.g., 1000 cycles/second). Frequency is usually indicated with the abbreviation Hz (for Hertz)
Inertia	The resistance of any object to change its shape or is state of motion
Instantaneous displacement	A point on a waveform at a specific time
Intensity	The magnitude of sound energy per unit area. The term is commonly used in describing sound levels used in hearing testing
Inverse square law	The principle of physics that defines the decrease in sound intensity as a function of the square of the distance from the source of the sound
Loudness	The psychological correlate to sound intensity. Increases in sound intensity are perceived as increased loudness, The relationship between intensity and loudness is not one-to-one but, rather, logarithmic.
Period	Duration in seconds of one complete cycle of a vibration or a pure tone. The period is the reciprocal of frequency. For example, the period of a 1000 Hz tone is 1/1000 second.
Phase	The zero voltage point at the beginning of the waveform of a stimulus or of a frequency component of a response waveform expressed in degrees or radians, such as 0 or 90 degrees. Phase of a response is related to latency.
Pitch	The psychological sensation related to the frequency of sound. High pitches correspond to high frequency sounds and low pitches to low frequency sounds
Psychoacoustics	Field focused on study of the relation between the physical properties of sound (e.g., intensity and frequency) and the psychological or perceptual aspects of hearing (e.g., loudness and pitch)
Pure tones	A simple vibration with one single frequency
Rarefaction	Region of a sound wave characterized by less dense molecules. Opposite of condensation. Acoustic stimulus produced by a negative electrical pulse activating a transducer like an earphone
Resonance frequency	The natural frequency for vibration of an object where vibrations occur with the least external force
RETSPL	Sound level values that are determined from calibrating sounds with a sound level meter connected to a specific type of coupler
Sound level meter	A device for measuring and quantifying sound intensity level in decibels (dB) sound pressure level (SPL).
Sound pressure level	The amount or intensity of a sound, such as an acoustic stimulus for evoked responses, expressed in decibels (dB); an intensity level of 0 dB SPL is the smallest amount of displacement of air molecules caused by a sound that can be just be detected by the human ear at a given frequency; a physical scale for intensity level. The normal hearing SPL decibel (dB) reference is 20 micropascals, i.e., dB SPL = 20 log (Po/Pref), where Po is observed instantaneous pressure and Pref = 20 µpascals.
Temporal integration	A measure of processing of brief durations of sound. Hearing thresholds are progressively elevated for sounds as sound duration decreases below 200 ms
Tuning fork	A metal device with a stem and two tines that produces a specific frequency like 500 Hz with vibration after it is struck on the hand
Vibration	Back and forth movements of an object that give rise to sound energy
Wavelength	Distance between the same point on two successive cycles of a pure tone

KEY TOPICS TO EMPHASIZE

10. What is meant by the terms vibration, displacement, inertia, and elasticity
11. About the properties of sound, including frequency, intensity, and duration
12. The meaning of words used to describe sound, including phase and wavelength
13. About decibels and how they are used to describe sound intensity and pressure
14. How sound levels are specified and verified with a sound level meter
15. What is meant by the term psychoacoustics
16. Psychoacoustic principles, like pitch, loudness, and temporal properties of sound
17. How to describe the sounds used in hearing testing, pure tones, and complex sounds (speech and noise)
18. Why and understanding of sound is important in hearing testing

DISCUSSION TOPICS

1. Give examples of any vibration (sound or otherwise) that you have come across in your daily lives. Think about what initiates and sustains these vibrations.
2. Describe the vibration you chose (in discussion topic 1) in terms of frequency, amplitude, and duration.
3. Describe five different sounds that you have heard today. Can you label them using the following terms: Sine wave, complex wave, speech, noise, and music?
4. What properties are needed to fully differentiate two different sounds?
5. Why is the decibel a uniquely suited unit of sound level for hearing science and audiology?
6. Why is it important for an audiologist to calibrate his/her equipment on a regular basis?
7. How objective/subjective are psychoacoustic principles like loudness and pitch? How are these different from the physical properties of sound such as intensity and frequency?
8. Discuss why knowledge of acoustics is absolutely essential for audiologists.

INSTRUCTIONAL ACTIVITIES

1. Using a pendulum, illustrate how you can manipulate the frequency, amplitude, and duration of vibration.
2. Demonstrate the phenomenon of temporal integration by playing successive longer durations of a pure tone (fixed in frequency and intensity) and asking the students to judge the loudness of each tone.
3. Play any sound and ask each student for their impression of the loudness and pitch of the sound on an arbitrary rating scale. Demonstrate how the same sound can be perceived as moderately loud by some, loud by others, and possibly uncomfortably loud by others.
4. Demonstrate how the logarithm compresses numbers. For example, start with a large number such as 10,00,000. Show how $\log_{10}$ (10,00,000) = 6. Show how this is used to derive the bel and decibel scales.
5. Illustrate how important it is to specify the reference value used in decibel calculations. For example, give the students the following hypothetical scenario: “A dishwasher salesman claims that the machine when working emits a noise of 53 dB and is so quiet that it is just barely audible for normal hearing individuals. Could the salesman be right?”
6. Demonstrate how you can add sine waves of different frequencies to create various complex waves such as sawtooth, square, and triangular waves. For example, adding a sine wave and its odd and even harmonics (amplitude spectrum with a slope of -6 dB per octave and phase spectrum with equal starting phase for all frequencies) will result in a sawtooth wave. Also demonstrate how to create a broadband noise (add all frequencies within a broad range with random instantaneous amplitudes and starting phases).
7. Measure detection thresholds for students using an audiometer. Demonstrate how the threshold can increase as the duration of the tone becomes shorter (for durations less than 300 ms).

Explain how the results of a hearing test can depend on phenomenon like temporal integration and how important it is for audiologists to have a working knowledge of acoustics.