

QUIZ 1: Psychophysics and Audition STUDY GUIDE

Will consist of multiple-choice, fill in the blank, true/false, and short answer questions.

NOTE: If a question asks: "What is ____", you must be able to define that term, not describe what happened in the lab. Be sure that you can define terms, identify and label structures in images, and explain the process of hearing as well as the ways we can scientifically assess hearing.

Psychophysics

- Know the 3 main psychophysical methods to determine thresholds
 - Method of Constant Stimuli: (method of right and wrong cases) A psychological method in which many stimuli, ranging from rarely to almost always perceivable (or rarely to almost always perceivable from a reference stimulus) are presented one at a time (e.g. random order of frequency and intensity, color, and illumination)
 - Method of Limits: (method of just noticeable differences) A psychological method in which a particular dimension of a stimulus, or the difference between 2 stimuli, is varied incrementally until the participant responds different (e.g. ordered quiet to loud or vice versa, bright to dark)
 - Method of adjustment: (method of average error) the method of limits for which the subject controls the change in stimulus, attempts to improve accuracy (the true threshold) with subject controlled change, but least precise of the 3 methods because it is difficult to have the subject reliably adjust the stimulus to the same threshold across trials. Results often more variable (subject finds own intensity)
- Who is Gustav Fechner
 - Father of psychophysics (the science of quantitative relationships between physical and psychological/subjective events)
 - physical (x-axis)
 - subjective (y-axis)
- Understand the difference between a logarithmic scale and a linear scale
 - Linear scale y-axis increases by addition, you perceive a wide range of physical stimuli
 - Log scale increases by a factor, making large number "appear" smaller, better representation of values with a high range without sacrificing resolution at low end

Audition

- Know the two qualities of sound waves
 - frequency: pitch, rate of recurrence of oscillations/vibrations, measured in Hertz
 - amplitude: loudness/intensity, amount of change in pressure, measured in decibels
- Structure/Anatomy of the ear (outer, middle, and inner) – know which structures fall into each category
 1. Outer Ear:
 - Pinna: important in localizing sound, only found in mammals
 - Ear Canal
 - Tympanic Membrane

2. Middle Ear: separated by outer ear by tympanic membrane, air filled
 - Ossicles: 3 bones, malleus, incus, stapes (conducts sound vibrations: joints between bones make them work like levers, concentrates energy from larger surface to smaller surface); muscles: tensor tympani and stapedius
 - Oval Window: separates middle ear and inner ear
 3. Inner Ear:
 - Cochlea: (audition)
 - Semicircular canals: vestibular system
 - Otolith Signals: vestibular system
- Pathway of sound waves from physical vibration to electrical signals in the brain
 - 1) Air pressure wave is funneled by the pinna through the auditory canal to the tympanic membrane, which vibrates back and forth in time with the sound wave
 - 2) The tympanic membrane moves the malleus, which moves the incus, which moves the stapes, which pushes and pulls on the oval window
 - 3) The movement of the oval window causes pressure bulges to move down the length of the vestibular canal, and these bulges in the vestibular canal displace the middle canal up and down
 - 4) This up-and-down motion forces the tectorial membrane to shear across the organ of Corti, moving the stereocilia atop hair cells back and forth
 - 5) The flexing of the stereocilia opens mechanical channels which allow potassium to pass through which initiates rapid depolarization that results in the release of neurotransmitters into synapse between the hair cells and dendrites of auditory nerve fibers
 - 6) These neurotransmitters initiate action potentials in the auditory nerve fibers that are carried to the brain
 - What does tonotopic mean? How does this relate to the cochlea and the auditory cortex?
 - Tonotopic: organization of neurons according to their characteristic frequency (frequency that increases the neuron's firing rate at the lowest intensity); all structures in the auditory system show an organizational pattern where neurons are aligned respective to the frequencies that they are most sensitive
 - high frequency sounds stimulate the base of the cochlea, whereas low frequency sounds stimulate the apex
 - What happens inside the cochlea? Specifically, how does transduction occur in the cochlea?
 - Cochlea: like a rolled up straw that has 3 canals instead of 1
 - a) 3 parallel fluid-filled canals, rolled up like a snail
 - b) Vestibular canal and tympanic canal separated lengthwise by middle canal and cochlear partition
 - c) Reissner's membrane separates vestibular canal and middle canal
 - d) Basilar membrane separates middle canal and tympanic canal
 - e) Organ of Corti is a structure on the Basilar membrane composed of hair cells and dendrites of auditory nerve fibers, overlain by tectorial membrane
 - f) Cochlear partition: combined basilar membrane, tectorial membrane, and organ of Corti (responsible for transduction)
 - Transduction:

- 1) Tectorial membrane is attached on one end, extend over hair cells (tall stereocilia of outer hair cells embedded in tectorial membrane and stereocilia of inner hair cells barely touch tectorial membrane)
 - 2) Vibration displacement of cochlear partition makes tectorial membrane sheer across width of cochlear partition which leads to the bending of stereocilia back and forth
 - 3) Stereocilia bend toward tallest tip links and stretch pull open potassium channels
 - 4) Fluid surrounding the cilia (called endolymph) has a very high concentration of potassium, so potassium flows into hair cell
 - 5) Depolarization causes voltage gated calcium channels in body of hair cell to open, lets calcium into cell
 - 6) Neurotransmitter (glutamate) released from base of hair cell onto fiber of auditory nerve, starts action potential
- What are the different types of deafness? What is the difference between them?
 - Hearing loss: does not refer to complete loss of hearing, but rather a partial loss, resulting in elevated thresholds for some frequencies
 - Conductive hearing loss: ossicles lose their ability to convey vibrations to the oval window, caused by ear infections or otosclerosis (abnormal growth of ossicles)
 - Sensorineural hearing loss: more common, result of damage to the hair cells or auditory nerve, antibiotics or cancer treatments can damage hair cells
 - Typical human hearing range and different ways it is measured
 - Human hearing range: 20-20,000 Hz
 - What are habituation and expectation in terms of the psychophysical methods?
 - Habituation: participant hesitates to switch his response, participant continues to responding y or n too long, they get used to responding a certain way (forget, zone out, tune out)
 - Expectation: participant expects the stimulus to increase (or decrease) and thinks that the stimulus should now be detectable and thus responds that it did increase (or decrease) even if the stimulus is not yet at threshold
 - Difference between interaural sound localization processes and the brain structures involved in these processes
 - Interaural time delay (ITD): difference in time between a sound arriving at one ear compared to the other, varies for different sound source positions, input from either ear increases the firing rate of neurons in the medial superior olive (first place in brain where info from both ears converge), excitatory input from the two ears arrives coincidentally at one of an array of cells in MSO, therefore firing rate peaks in different cells of MSO for different sound positions
 - Interaural level difference (ILD): difference in intensity between a sound arriving at one ear compared to the other, the lateral superior olives compare excitatory input from ipsilateral ear and inhibitory input from the contralateral ear, and if the sound comes from one side the inputs to the lateral superior olives from that side will be stronger
 - Know the auditory pathways from the vestibulocochlear nerve through the auditory cortex
 - 1) 8th cranial cranial nerve: vestibulocochlear
 - 2) Cochlear nucleus: Medulla, ipsilateral
 - 3) Superior Olivary Nuclei (MSO and LSO): Pons, contralateral, ITD and ILD occur here
 - 4) Inferior Colliculus: Midbrain, from both ears
 - 5) Medial Geniculate Nucleus (MGN): nucleus of the thalamus, from both ears