

AUDITORY THRESHOLD I

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1. Core Definition and Distinction

The **Auditory Threshold I**, often referred to synonymously with the Absolute Threshold of Hearing (ATH), represents the minimum sound intensity or pressure level required for a human or other organism to reliably detect the presence of a sound stimulus. This detection is typically defined statistically, requiring the subject to correctly identify the sound 50% of the time, thereby accounting for random chance and natural variability in sensory perception. Measured in units of sound pressure level (SPL), usually expressed in decibels (dB), the absolute threshold serves as the fundamental zero reference point against which all perceived sound intensities are compared, particularly in clinical and research settings focused on human hearing capabilities.

It is crucial to understand that the auditory threshold is not a static physiological boundary but rather a psychoacoustic measurement, influenced by both internal biological factors and external methodological factors. Physiologically, the threshold involves the complete transduction process, beginning with the physical vibration of the tympanic membrane, the mechanical amplification via the ossicular chain in the middle ear, and finally, the hydro-mechanical and electro-chemical conversion performed by the hair cells within the cochlea. A sound reaching the threshold must generate just enough vibrational energy within the inner ear to trigger a sufficient neuronal firing rate in the auditory nerve to be recognized by the central nervous system as a conscious auditory event.

The designation "I" often differentiates this fundamental measurement of detection from the broader category of hearing thresholds. While the absolute threshold focuses purely on the minimum sound energy required for *awareness*, other thresholds describe specific functional limits of the auditory system. These include the **Difference Threshold** (the smallest detectable change in intensity or frequency), the **Uncomfortable Loudness Level** (UCL), and the **Threshold of Pain**, which marks the upper boundary of safe and tolerable sound input. Thus, the Auditory Threshold I acts as the foundation of the auditory experience, defining the lower limit of the entire dynamic range of hearing.

2. Theoretical Framework: Psychophysics

The systematic study and quantification of the auditory threshold originated within the field of psychophysics, pioneered by 19th-century researchers like Gustav Fechner. Psychophysics aims to establish precise, mathematical relationships between physical stimuli (e.g., sound pressure) and the psychological experiences they evoke (e.g., detection). Determining the auditory threshold

requires overcoming the inherent variability in human response, which necessitates sophisticated experimental paradigms to isolate the true sensory limit from confounding factors like attention, expectation, and environmental noise. Classical psychophysical methods provided the foundational techniques for modern audiology, ensuring standardized and reliable threshold measurements.

Three primary classical methods are employed to estimate the absolute threshold. The **Method of Limits** involves presenting stimuli in ascending (starting too quiet to hear) or descending (starting too loud to hear) series, with the threshold being calculated as the average point at which the subject transitions between hearing and not hearing the sound. The **Method of Adjustment** allows the subject to control the intensity of the sound themselves, adjusting it until it is just barely audible. Finally, the most rigorous method, the **Method of Constant Stimuli**, presents various fixed sound intensities randomly, requiring the subject to report detection; the threshold is then precisely interpolated from the resultant psychometric function as the level corresponding to 50% correct detection. These methods ensure that the measured threshold is robust against predictable response biases inherent in sequential testing.

The advent of **Signal Detection Theory** (SDT) in the mid-20th century provided a critical theoretical refinement to classical threshold measurements. SDT recognizes that detection is not merely a passive physiological event but an active decision-making process influenced by both sensory sensitivity (d') and the observer's criterion (β)--the internal bias toward reporting a sound, even if faint. In the context of the auditory threshold, SDT demonstrates that the measured 50% point can be shifted depending on whether the subject is conservative (requiring stronger evidence) or liberal (quick to guess). Modern audiometry often incorporates SDT principles, especially in research, to ensure that the measured threshold accurately reflects the listener's true sensitivity rather than their response strategy.

3. Key Measurements and Related Concepts

The measurement of the Auditory Threshold I is formalized through several key concepts essential for clinical and standardization purposes. The most representative physiological measure is captured by the **Audibility Curve**, also known as the Minimum Audible Field (MAF) or Minimum Audible Pressure (MAP) curve. This curve graphs the absolute threshold of hearing as a function of frequency across the entire audible spectrum (typically 20 Hz to 20,000 Hz). Critically, the human ear is most sensitive (i.e., the threshold is lowest) in the range of 2,000 to 5,000 Hz, requiring significantly less sound energy to detect tones in this mid-frequency range compared to very low or very high frequencies.

Clinically, the primary tool for mapping an individual's auditory threshold is the **Audiogram**. An audiogram plots hearing sensitivity, measured in dB Hearing Level (dB HL), across standard test frequencies (e.g., 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz). The dB HL scale is a

normalized scale where 0 dB HL represents the average hearing threshold of young, healthy adults at a specific frequency, defined by international standards (e.g., ISO standards). This standardization allows clinicians to quickly identify deviations from normal hearing--where thresholds above 0 dB HL indicate hearing loss, requiring sounds to be louder than average for detection.

A key methodological distinction exists between Minimum Audible Field (MAF) and Minimum Audible Pressure (MAP) measurements. MAF measures the sound pressure level at the location of the listener's head in a free field environment, often requiring the sound to travel through the air before reaching the listener. MAP, conversely, measures the sound pressure level directly within the ear canal using a probe microphone coupled to the earphone (supra-aural or insert). MAF thresholds are generally slightly better (lower) than MAP thresholds, particularly at higher frequencies, due to the beneficial resonance effects of the outer ear and ear canal which enhance sound presentation in a free field setting, highlighting the influence of methodology and ear acoustics on the perceived threshold.

4. Factors Influencing the Absolute Auditory Threshold

The measured absolute auditory threshold is subject to variation based on a complex interplay of environmental, physiological, and methodological variables. Environmental factors are significant; for instance, the presence of even minimal background noise, known as masking, will effectively raise the threshold, requiring a louder signal to be perceived above the noise floor. Similarly, ambient temperature, humidity, and the characteristics of the testing environment (such as reverberation or acoustic dampening) must be strictly controlled in clinical and research settings to ensure that measured thresholds are accurate and comparable across sessions.

Physiological factors introduce substantial individual differences. **Age** is the most widely recognized factor, leading to a progressive high-frequency hearing loss known as presbycusis, which causes the threshold to rise significantly, especially after the fifth decade of life. Exposure to high-intensity noise can cause either temporary threshold shifts (TTS), where hearing recovers after a period, or permanent threshold shifts (PTS), resulting in irreversible damage to the cochlear hair cells. Furthermore, general health conditions, otological diseases (e.g., otitis media), and genetic predispositions can all modulate the sensitivity of the auditory system, shifting the measured absolute threshold higher or lower depending on the mechanism of impairment.

Methodological parameters also critically affect threshold determination. The duration of the stimulus presentation (temporal integration) plays a role: short sounds require greater intensity to reach the threshold than longer sounds (up to about 200 milliseconds). The specific transducer used (headphones, insert earphones, or loudspeaker), the calibration of the equipment, and the training and focus of the test subject all contribute to the final measured value. For reliable clinical

diagnostics, strict adherence to standardized measurement protocols, such as those established by the American National Standards Institute (ANSI) or the International Organization for Standardization (ISO), is mandatory to minimize variance attributable to testing procedures rather than actual hearing sensitivity.

5. Types of Auditory Thresholds (Beyond Absolute)

While Auditory Threshold I specifically addresses the minimum level of sound detectable, the term "auditory threshold" broadly encompasses a variety of critical boundaries defining the functional limits of hearing, often categorized by the nature of the stimulus or the resulting physiological response.

Difference Thresholds (Just Noticeable Difference or JND): This threshold, also known as the difference limen (DL), is the smallest change in a physical dimension of sound (such as frequency, intensity, or duration) that an individual can detect 50% of the time. According to Weber's Law, the JND is proportional to the magnitude of the original stimulus, meaning that it takes a larger physical change to perceive a difference when the initial sound is already loud or high in frequency.

Pain Thresholds: Located at the high end of the dynamic range, the pain threshold represents the sound intensity level (typically around 120-140 dB SPL) at which sound ceases to be purely auditory and causes physical discomfort, pain, or immediate damage to the delicate structures of the middle and inner ear. This threshold defines the absolute upper limit of safe listening.

Acoustic Reflex Thresholds: This is the minimum sound level necessary to trigger the involuntary contraction of the stapedius muscle (and sometimes the tensor tympani) in the middle ear. This muscular contraction, known as the acoustic reflex, stiffens the ossicular chain, serving as a protective mechanism that reduces the transmission of intense low-frequency sound energy to the cochlea. Measuring the acoustic reflex threshold is a crucial diagnostic tool in audiology for evaluating the integrity of the middle ear and the auditory brainstem pathways.

Bone-Conduction Thresholds: Unlike air-conduction thresholds (which measure sound traveling through the outer and middle ear), bone-conduction thresholds measure hearing sensitivity by stimulating the inner ear directly through mechanical vibration applied to the skull (typically the mastoid process). By comparing air-conduction thresholds to bone-conduction thresholds, audiologists can determine the source of hearing loss--a significant difference indicates a conductive hearing loss (problem in the outer/middle ear), while similar thresholds indicate sensorineural hearing loss (problem in the inner ear or auditory nerve).

6. Clinical Significance and Applications

The precise determination of the absolute auditory threshold is the cornerstone of clinical audiology

and otolaryngology. The audiogram derived from threshold measurements provides the foundational data for diagnosing the presence, degree, configuration, and type of hearing loss, which is essential for determining appropriate intervention strategies. If a patient exhibits thresholds greater than 25 dB HL, they are generally classified as having some degree of hearing impairment, ranging from mild to profound. Accurate threshold testing ensures proper classification and subsequent treatment planning, whether that involves medical intervention, surgical procedures, or amplification.

In applied settings, auditory threshold measurements are critical for occupational health and safety. Regulatory bodies mandate regular audiometric testing for workers exposed to high levels of noise (e.g., manufacturing, aviation) to monitor for noise-induced hearing loss. Establishing baseline thresholds allows employers and health professionals to track subtle increases in threshold over time, indicating potential hearing damage, and implement preventative measures before permanent damage occurs. This proactive monitoring relies entirely on the precision and consistency of repeated absolute threshold determinations.

Furthermore, thresholds are vital for hearing rehabilitation. The results directly inform the selection and fitting of hearing aids and other assistive listening devices. Hearing aid prescription requires mapping the patient's individual dynamic range--the region between their absolute threshold and their uncomfortable loudness level (UCL)--to ensure that amplified sounds are audible without being painful. Advanced auditory prosthetics, such as cochlear implants, are programmed based on psychoacoustic tests designed to establish the minimum necessary electrical stimulation level (threshold) and the maximum comfortable level for the patient, directly translating the concept of the auditory threshold into electrical current levels.

Further Reading

[Audiology](#)

[Psychophysics](#)

[Absolute threshold](#)

[Audibility curve](#)

[Audiogram](#)