Speech Audiometry: Principles, Clinical Applications, and Interdisciplinary Perspectives in Nursing, Biomedical Technology, Epidemiological Surveillance, and Health Assistance

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Abstract
Background: Speech audiometry is a cornerstone of modern audiological assessment that evaluates an individual's ability to detect, recognize, and understand spoken language. Unlike pure-tone audiometry, which measures hearing sensitivity across specific frequencies, speech audiometry assesses functional communication abilities and provides clinically relevant information regarding speech perception in everyday listening situations. It plays a critical role in diagnosing hearing disorders, guiding rehabilitation, optimizing hearing aid fitting, and evaluating communication outcomes across diverse patient populations.
Aim: This review aims to provide a comprehensive overview of the principles, procedures, clinical applications, diagnostic value, and interdisciplinary significance of speech audiometry in nursing practice, biomedical technology, epidemiological surveillance, and health assistance services.
Methods: A narrative review approach was employed to examine contemporary evidence and clinical concepts related to speech audiometry. The review addressed essential components of speech audiometric assessment, including Speech Awareness Threshold, Speech Recognition Threshold, Word Recognition Score, speech-in-noise testing, loudness measurements, calibration procedures, diagnostic applications, interpretation of findings, and factors influencing test performance. Interdisciplinary perspectives relevant to healthcare professionals involved in hearing assessment and rehabilitation were also explored.
Results: Speech audiometry provides valuable information regarding functional hearing abilities that cannot be obtained through pure-tone testing alone. Key procedures such as SRT, WRS, HINT, and QuickSIN contribute to the identification of conductive, sensorineural, and retrocochlear disorders while supporting hearing aid selection, cochlear implant evaluation, and rehabilitation monitoring. Diagnostic tools including the Speech Intelligibility Index, speech banana concept, and rollover analysis enhance clinical interpretation.
Conclusion: Speech audiometry remains an indispensable component of comprehensive hearing assessment. Its ability to evaluate real-world communication performance supports accurate diagnosis, individualized treatment planning, rehabilitation monitoring, and improved patient outcomes across multiple healthcare disciplines.

Keywords: Speech audiometry, speech recognition threshold, word recognition score, hearing loss, audiological assessment, hearing aids, cochlear implants

Introduction
Speech audiometry constitutes a fundamental component of comprehensive audiological assessment and serves as a critical tool for evaluating an individual's capacity to perceive, recognize, and interpret spoken language. As an integral element of hearing evaluation, speech audiometry complements pure-tone audiometry by providing information that extends beyond the measurement of auditory thresholds. While pure-tone audiometry primarily determines the softest intensity levels at which specific frequencies can be detected, speech audiometry assesses the functional aspects of hearing by examining how effectively an individual processes and understands speech signals encountered in everyday communication. Consequently, this modality offers a more realistic representation of auditory performance and communication ability, making it indispensable in modern audiological practice [1]. The clinical significance of speech audiometry lies in its ability to evaluate hearing function under conditions that closely resemble real-world

listening environments. Human communication relies predominantly on speech perception rather than the detection of isolated tones. Therefore, understanding a patient's ability to recognize and comprehend spoken words provides valuable information regarding the practical consequences of hearing impairment. Through the assessment of speech perception abilities, clinicians can obtain a deeper understanding of the impact of auditory dysfunction on communication, social interaction, educational performance, and overall quality of life. This information is particularly important because individuals with similar pure-tone audiometric findings may demonstrate markedly different levels of speech understanding, highlighting the necessity of incorporating speech-based assessments into routine audiological evaluations [1].

Speech audiometry plays a vital role in the identification and characterization of hearing disorders by assisting clinicians in determining both the type and severity of hearing loss. The results obtained from speech-based assessments contribute significantly to diagnostic decision-making and facilitate the development of individualized treatment and rehabilitation plans. Furthermore, speech audiometry provides essential information for the selection, fitting, and optimization of hearing aids and other amplification devices. By evaluating how patients perceive speech at different intensity levels and under varying listening conditions, clinicians can establish appropriate amplification settings that maximize speech intelligibility while minimizing discomfort. Such information is particularly valuable when managing patients who experience communication difficulties in challenging acoustic environments, including settings with significant background noise [2]. In addition to supporting diagnosis and hearing aid fitting, speech audiometry offers important insights into a patient's auditory tolerance, sensitivity to speech stimuli, and overall speech recognition performance. These assessments assist audiologists in determining the most appropriate gain characteristics and maximum output levels for hearing devices, thereby improving listening comfort and communication effectiveness. Moreover, speech audiometry contributes substantially to the monitoring of rehabilitation outcomes and the evaluation of intervention efficacy over time. A comprehensive speech audiometric evaluation typically includes measures such as the Speech Recognition Threshold (SRT) and the Word Recognition Score (WRS). These assessments provide objective information regarding the minimum intensity level at which speech can be recognized and the accuracy with which spoken words are identified. By employing speech materials that closely simulate everyday conversational situations, audiologists can better evaluate the functional impact of hearing loss on daily communication. The resulting data enable the formulation of targeted intervention strategies designed to enhance speech understanding, optimize auditory rehabilitation, and improve overall communicative function. Consequently, speech audiometry remains an indispensable component of evidence-based audiological assessment and patient-centered hearing healthcare [1][2].

Specimen Collection

Speech audiometry is performed within a controlled acoustic environment specifically designed to ensure accurate and reproducible assessment of speech perception abilities. The testing process is typically conducted in two separate rooms, with the audiologist located in a control area and the patient situated in a sound-treated testing booth. This arrangement minimizes environmental noise, prevents visual cues from influencing patient responses, and facilitates standardized administration of speech stimuli. The separation between examiner and patient is essential for maintaining test reliability and ensuring that speech recognition performance reflects true auditory function rather than extraneous factors. The primary equipment utilized in speech audiometry is the speech audiometer, which is commonly incorporated into a comprehensive diagnostic audiometer. Modern diagnostic audiometers are equipped with dedicated speech-testing capabilities and generally contain multiple channels that permit flexible stimulus presentation and monitoring. These systems support a variety of input and output configurations, allowing clinicians to tailor testing procedures according to patient characteristics, clinical objectives, and testing conditions. Input sources may include microphones for live-voice presentation or prerecorded speech materials delivered through digital playback systems and other recording devices. Although live-voice testing may offer greater flexibility during clinical evaluations, recorded materials are often preferred because they provide improved standardization and consistency across testing sessions [3].

The output components of the speech audiometry system are equally important and encompass a range of transducers designed to deliver speech stimuli through different auditory pathways. Conventional supra-aural earphones and insert earphones are frequently employed for air-conduction testing, enabling assessment of each ear independently or simultaneously. Bone-conduction vibrators may also be used when evaluation of cochlear function independent of the outer and middle ear structures is required. In addition, loudspeaker systems positioned within the testing environment facilitate sound-field assessments, which are particularly valuable when evaluating aided hearing performance, cochlear implant outcomes, or auditory function in young children who may not tolerate conventional transducers. Sound-field speech testing often provides a more realistic representation of everyday listening conditions and is especially useful in pediatric audiology because it allows assessment of speech perception without requiring direct placement of earphones [3]. An essential component of speech audiometric testing is the calibration of speech materials and equipment before assessment. Proper calibration is fundamental for ensuring that speech stimuli are presented at precise and standardized intensity levels, thereby maintaining the validity, reliability, and comparability of test results. Calibration procedures are designed to verify that the output generated by the audiometer accurately

corresponds to the intended presentation level and that any variability introduced by equipment or environmental factors is minimized.
The calibration process involves several systematic steps. Initially, the audiometer must be inspected to confirm proper operational status and appropriate configuration for speech testing. Following equipment verification, a calibration tone or standardized speech sample is presented through the system. The volume unit meter associated with the audiometer is then adjusted so that the speech signal consistently peaks at the designated reference level, typically 0 dB on the meter scale. This adjustment ensures that speech materials are delivered at the intended intensity and that patient responses accurately reflect auditory performance rather than inconsistencies in stimulus presentation. Subsequently, verification procedures are conducted using additional speech materials to confirm uniformity and reproducibility across different recordings and testing conditions. Routine calibration is required before each testing session because audiometric equipment may experience gradual changes in performance resulting from normal wear, environmental fluctuations, electronic drift, or variations in input sources. Even minor deviations in calibration can significantly affect speech recognition measurements and compromise diagnostic accuracy. Therefore, maintaining precise calibration standards is critical for ensuring that speech audiometry results remain consistent, reliable, and comparable across different clinical settings and over time. Accurate calibration ultimately enhances the quality of audiological assessment, supports appropriate clinical decision-making, and contributes to effective hearing rehabilitation planning [4][5].

Procedures

Speech audiometry encompasses a range of specialized assessment procedures designed to evaluate an individual's ability to detect, recognize, and comprehend spoken language under controlled clinical conditions. Unlike pure-tone audiometry, which primarily measures auditory sensitivity to isolated frequencies, speech audiometry focuses on the functional aspects of hearing that directly influence communication in daily life. These procedures provide critical information regarding speech perception, auditory processing, hearing aid fitting, and rehabilitation planning. By utilizing standardized speech materials presented at varying intensity levels, clinicians can obtain a comprehensive understanding of a patient’s auditory capabilities and communication challenges [6]. One of the foundational procedures in speech audiometry is the Speech Awareness Threshold (SAT), also referred to as the Speech Detection Threshold (SDT). This assessment determines the lowest intensity level at which a patient can detect the presence of speech at least 50% of the time. Unlike speech recognition tests that require verbal repetition or identification of words, SAT testing only requires the patient to indicate awareness that speech has been heard. This characteristic makes the procedure particularly valuable for evaluating populations who may be unable to provide reliable verbal responses. Young children, individuals who do not speak the language used during testing, and patients with neurological or speech disorders often benefit from SAT assessment because it focuses solely on speech detection rather than speech understanding. Spondees, which are two-syllable words with equal stress placed on each syllable, are commonly employed during this procedure because they are highly recognizable and provide sufficient acoustic information to facilitate accurate detection. In individuals with normal auditory function or relatively flat hearing loss configurations, SAT values are generally observed to be approximately 10 to 15 dB better than Speech Recognition Threshold (SRT) measurements.
Another essential component of speech audiometric evaluation is the Speech Recognition Threshold (SRT), sometimes referred to as the Speech Reception Threshold. This procedure measures the minimum intensity level at which a patient can correctly identify and repeat speech stimuli at least 50% of the time [7]. Spondee words are again utilized because of their familiarity and balanced acoustic characteristics. The SRT serves a particularly important role in cross-checking and validating pure-tone audiometric findings. In most cases, the SRT closely corresponds to the average hearing threshold obtained at 500, 1,000, and 2,000 Hz. A close agreement between these measures, typically within 5 to 12 dB, supports the reliability and accuracy of the audiometric evaluation. The administration of SRT testing requires careful calibration of equipment, selection of appropriate speech materials, and provision of clear instructions to the patient. Speech stimuli are presented at varying intensity levels while patient responses are systematically recorded and analyzed. The final threshold is determined by calculating the proportion of correctly repeated words and identifying the level at which 50% recognition is achieved. Suprathreshold word-recognition testing represents another critical aspect of speech audiometry. This procedure evaluates a patient’s capacity to recognize and repeat single-syllable words presented at intensity levels above the speech recognition threshold. One of the most commonly used outcome measures in this assessment is the Word Recognition Score (WRS), which quantifies the percentage of correctly identified words presented at a comfortable listening level. The WRS provides valuable information regarding speech discrimination abilities and serves as an indicator of functional speech understanding. Higher scores reflect effective speech perception and auditory processing, whereas reduced scores may suggest cochlear pathology, retrocochlear involvement, auditory processing deficits, or sensorineural hearing loss [8]. In addition to its diagnostic value, suprathreshold testing plays an important role in evaluating the benefit derived from hearing aids and other amplification devices by assessing improvements in speech recognition performance.
Sentence testing provides a more realistic assessment of communication abilities by utilizing complete sentences rather than isolated words. This approach incorporates contextual and linguistic cues that closely resemble natural conversational speech. Because everyday communication relies heavily on contextual information, sentence-based

assessments offer valuable insights into how individuals process and understand spoken language in real-world environments. Such testing is particularly useful when evaluating listening performance in noise, determining hearing aid effectiveness, and assessing functional communication outcomes following audiological intervention. An equally important aspect of speech audiometry involves the evaluation of loudness perception through the determination of the Most Comfortable Loudness Level (MCL) and the Uncomfortable Loudness Level (UCL). The MCL represents the intensity level at which speech is perceived as optimally comfortable and clear. For most individuals, this level is typically found approximately 40 to 50 dB above the speech recognition threshold. However, patients with sensorineural hearing loss often exhibit altered loudness perception, resulting in reduced sensation levels. Determining the MCL is essential for hearing aid fitting because it assists clinicians in establishing appropriate amplification settings that maximize speech clarity while maintaining listening comfort. The UCL, in contrast, identifies the maximum intensity level at which speech remains tolerable before becoming uncomfortably loud. This measurement is crucial for defining the upper boundary of a patient's auditory dynamic range and ensuring that amplified sounds do not exceed comfortable listening limits. Together, MCL and UCL assessments provide valuable information for the customization of hearing aid programming and other amplification technologies. By accurately defining the patient's dynamic speech range, clinicians can optimize device performance, enhance speech intelligibility, and improve overall communication outcomes. Collectively, these speech audiometric procedures provide a comprehensive evaluation of speech perception, recognition, comprehension, and loudness tolerance. The information obtained through these assessments supports accurate diagnosis, validates audiometric findings, guides hearing aid fitting, and facilitates the development of individualized rehabilitation strategies aimed at improving communication and quality of life for individuals with hearing impairment [6][7][8].

Indications

Speech audiometry is a fundamental component of comprehensive audiological assessment and is widely utilized to evaluate an individual's ability to perceive, recognize, and understand spoken language. Unlike pure-tone audiometry, which primarily measures auditory sensitivity to specific frequencies, speech audiometry provides valuable information regarding the functional consequences of hearing impairment on everyday communication. Because effective speech perception is central to social interaction, education, occupational performance, and quality of life, speech audiometry serves as an indispensable diagnostic and rehabilitative tool across a broad range of clinical settings. One of the primary indications for speech audiometry is the diagnosis and characterization of hearing loss. By assessing speech detection, recognition, and discrimination abilities, clinicians can obtain information that complements pure-tone audiometric findings and provides a more complete understanding of auditory function. Speech audiometry is particularly useful in differentiating between conductive and sensorineural hearing loss because patients with similar hearing thresholds may demonstrate markedly different levels of speech understanding. Evaluation of speech recognition performance allows audiologists to assess the functional impact of hearing impairment and establish the degree to which communication abilities have been affected. Speech audiometry also plays a critical role in determining hearing aid candidacy and optimizing amplification outcomes. Prior to hearing aid fitting, it is essential to evaluate a patient's ability to understand speech under various listening conditions. The information obtained through speech audiometric testing assists clinicians in selecting appropriate amplification devices and establishing individualized programming parameters. Measures of speech recognition, comfort levels, and loudness tolerance contribute to determining suitable gain settings and maximum output levels, thereby enhancing speech intelligibility while maintaining listening comfort. Furthermore, speech audiometry is valuable in assessing the effectiveness of hearing aids following fitting and during ongoing audiological rehabilitation. Another important indication for speech audiometry is the evaluation of auditory processing disorders. Individuals with auditory processing difficulties may exhibit normal pure-tone hearing thresholds while experiencing substantial challenges in understanding speech, particularly in acoustically complex environments. Speech audiometric assessments can identify deficits related to speech perception in noise, temporal processing, auditory discrimination, and binaural integration. Such findings provide important diagnostic information that may not be revealed through conventional threshold testing alone [9][10][11].

Speech audiometry is also essential for monitoring patients with progressive auditory disorders. Conditions such as Ménière disease, hereditary hearing disorders, age-related hearing loss, and ototoxic medication exposure can lead to gradual deterioration in auditory function over time. Periodic assessment of speech recognition abilities enables clinicians to detect changes in communication performance, monitor disease progression, and make appropriate modifications to treatment strategies, amplification devices, and rehabilitation programs. In the field of cochlear implantation, speech audiometry serves both preoperative and postoperative purposes. Before implantation, speech recognition testing assists in determining whether an individual is likely to benefit from cochlear implant technology. Following implantation, repeated speech audiometric evaluations are used to monitor improvements in speech perception, assess device performance, and guide programming adjustments to maximize auditory outcomes and communicative effectiveness. The differential diagnosis of auditory disorders represents another significant application of speech audiometry. Speech recognition findings can provide valuable clues regarding the location and nature of auditory pathology. For example, patients who demonstrate relatively preserved pure-tone thresholds but disproportionately poor speech recognition scores may have retrocochlear abnormalities, including vestibular schwannoma or other neural disorders affecting auditory signal transmission. Consequently, speech audiometry contributes substantially to the identification and differentiation of cochlear and retrocochlear pathologies. A particularly important indication involves the assessment of speech understanding in noisy environments. Many individuals with hearing impairment report that communication difficulties become most apparent in settings with competing background noise. Specialized speech audiometric procedures, including the Hearing in Noise Test (HINT) and the Quick Speech-in-Noise Test (QuickSIN), evaluate a patient's ability to understand speech under realistic listening conditions. These assessments provide clinically relevant information regarding everyday communication challenges and assist in determining the effectiveness of hearing aids, assistive listening devices, and rehabilitation strategies. In addition, such testing can help evaluate patient tolerance and sensitivity to speech stimuli presented under varying acoustic conditions. Speech audiometry also has important applications in medicolegal and occupational settings. In cases involving hearing loss claims, disability evaluations, workplace assessments, and compensation determinations, speech audiometric findings provide objective evidence regarding the functional impact of auditory impairment on communication abilities. These assessments contribute to the accurate documentation of hearing-related limitations and support informed decision-making in legal, insurance, and compensation proceedings [9][10][11]. Overall, speech audiometry represents a versatile and indispensable diagnostic modality that extends beyond the measurement of hearing thresholds to evaluate the practical consequences of auditory dysfunction. Its broad range of clinical indications makes it essential for diagnosis, treatment planning, rehabilitation, monitoring of disease progression, cochlear implant assessment, and the evaluation of communication abilities in both clinical and medicolegal contexts [9][10][11].

Potential Diagnosis

Speech audiometry is a critical diagnostic instrument that enables clinicians to evaluate the functional effects of hearing impairment on speech perception and communication. While pure-tone audiometry identifies auditory sensitivity across different frequencies, speech audiometry provides insight into how hearing loss influences the ability to detect, recognize, and comprehend spoken language in real-world settings. The results obtained from speech audiometric assessments assist clinicians in identifying the severity and nature of hearing disorders, differentiating between various auditory pathologies, and developing individualized management strategies. The degree of hearing loss significantly influences speech understanding and communication performance. Individuals with mild hearing loss, typically defined as thresholds between 26 and 40 dB hearing level (HL), often experience difficulty detecting soft sounds and understanding speech in environments with competing background noise. Although conversational speech may remain relatively accessible in quiet settings, communication challenges become increasingly apparent in complex listening situations. As hearing loss progresses to the moderate range, between 41 and 55 dB HL, understanding normal conversational speech becomes substantially more difficult, particularly when environmental noise is present. Patients frequently report the need for repetition and increased listening effort during daily interactions. Moderately severe hearing loss, ranging from 56 to 70 dB HL, is associated with significant impairment in speech perception. At this stage, many speech sounds become difficult to detect without amplification, and communication often requires hearing aids or other assistive listening technologies. Individuals with severe hearing loss, characterized by thresholds between 71 and 90 dB HL, experience profound communication barriers because conversational speech is frequently inaudible without amplification. In cases of profound hearing loss, exceeding 91 dB HL, speech comprehension is severely compromised, and patients often depend on visual communication cues, speechreading, sign language, cochlear implants, or specialized assistive devices to facilitate effective communication [12].

Speech audiometry contributes to the diagnosis and monitoring of numerous auditory disorders. Age-related hearing loss, or presbycusis, commonly presents with reduced speech recognition abilities, particularly in noisy environments, despite relatively preserved low-frequency hearing [13]. Ototoxicity resulting from medications or chemical exposure can also produce characteristic speech perception deficits that may precede substantial changes in pure-tone thresholds [14]. Similarly, patients with Ménière disease frequently demonstrate fluctuating speech recognition performance corresponding to changes in hearing sensitivity and disease activity [15]. Retrocochlear disorders, including vestibular schwannoma, also known as acoustic neuroma, represent an important diagnostic application of speech audiometry. These patients often exhibit speech recognition scores that are disproportionately poor compared with their pure-tone hearing thresholds, suggesting neural involvement beyond the cochlea [16]. Noise-induced hearing loss similarly affects speech understanding, particularly in environments with competing background sounds, making speech audiometry an essential component of comprehensive assessment [17]. Conductive hearing disorders such as otitis media with effusion and otosclerosis may also be evaluated using speech audiometric techniques to determine the functional impact of auditory impairment on communication abilities [18][19].

Congenital and inherited forms of hearing loss represent another important category of disorders assessed through speech audiometry. Certain genetic conditions, including Stickler syndrome, Waardenburg syndrome, and mutations involving the connexin 26 gene, may produce characteristic audiometric configurations known as "cookie-bite" hearing loss patterns, characterized by greater impairment in the mid-frequency range [20][21]. Speech audiometric testing provides valuable information regarding the extent to which these abnormalities affect language acquisition, speech development, and communication performance. A particularly valuable concept in audiological assessment is the "speech banana," which graphically represents the frequency and intensity distribution of speech sounds on an audiogram. This banana-shaped region encompasses the majority of speech energy and illustrates where common speech sounds occur within the hearing range. Vowel sounds generally occupy lower frequencies between approximately 250 and 2,000 Hz and are produced at greater intensities, whereas consonant sounds, which are essential for speech clarity and intelligibility, occur primarily at higher frequencies ranging from 2,000 to 8,000 Hz. By superimposing the speech banana onto an individual's audiogram, clinicians can estimate which speech sounds are accessible and which may be inaudible because of hearing loss. This approach is particularly valuable in pediatric audiology, where it assists in evaluating language development and determining amplification requirements [22][23]. The Word Recognition Score (WRS) provides additional diagnostic value by helping distinguish cochlear from retrocochlear disorders. Patients with cochlear pathology often demonstrate improved speech recognition when words are presented at higher intensity levels, whereas individuals with eighth cranial nerve disorders frequently continue to exhibit poor speech recognition despite increased presentation levels. This distinction contributes significantly to differential diagnosis and guides decisions regarding further neurological evaluation.

Speech-in-noise assessments further expand the diagnostic capabilities of speech audiometry by evaluating communication performance under realistic listening conditions. The Hearing in Noise Test (HINT) determines the signal-to-noise ratio required for accurate sentence recognition in both quiet and noisy environments [24][25]. Similarly, the Quick Speech-in-Noise Test (QuickSIN) measures signal-to-noise ratio loss by presenting sentences with competing background noise and identifying the listening conditions necessary for successful speech understanding [26][27]. These assessments are particularly valuable because many patients report that communication difficulties are most pronounced in noisy environments rather than in quiet clinical settings. Pediatric speech audiometry requires specialized testing approaches that accommodate developmental and cognitive differences. Picture-identification procedures allow children to respond by selecting images instead of verbally repeating words. Conditioned play audiometry incorporates game-based activities that encourage participation and facilitate reliable responses to speech stimuli. In very young or nonverbal children, early speech perception tests evaluate recognition of speech sounds through observable behavioral responses. These adaptations ensure that meaningful information regarding auditory function and speech perception can be obtained across a broad range of ages and developmental levels. Overall, speech audiometry serves as a powerful diagnostic tool that extends beyond the measurement of hearing sensitivity to evaluate functional communication ability, identify specific auditory disorders, guide treatment planning, and monitor outcomes across diverse patient populations. Through the integration of speech recognition testing, speech-in-noise assessments, word recognition analysis, and specialized pediatric techniques, clinicians can obtain a comprehensive understanding of hearing function and its impact on everyday communication [12][27].

Normal and Critical Findings

The interpretation of speech audiometry findings is an essential component of comprehensive audiological assessment, providing valuable information regarding auditory sensitivity, speech perception, and functional communication abilities. Normal and abnormal findings obtained through speech audiometric evaluation assist clinicians in diagnosing hearing disorders, determining the site of lesion, assessing the impact of hearing impairment on communication, and developing appropriate intervention strategies. These findings are typically interpreted alongside pure-tone audiometric results to provide a complete understanding of auditory function. A standard audiogram evaluates hearing thresholds across a range of frequencies that encompass and extend beyond those required for speech perception. Commonly tested frequencies include 250, 500, 1,000, 2,000, 3,000, 4,000, 6,000, and 8,000 Hz. Although the human auditory system is capable of detecting sounds from approximately 20 Hz to 20,000 Hz, the frequencies most critical for speech understanding are concentrated between 500 and 4,000 Hz. To summarize hearing sensitivity within this important speech range, clinicians calculate the Pure-Tone Average (PTA), which is derived from the arithmetic mean of air-conduction thresholds at 500, 1,000, and 2,000 Hz. The PTA serves as a useful indicator of hearing ability related to speech perception and provides a convenient measure for comparison with speech audiometric results. However, because it focuses on lower and mid-frequency hearing, it may underestimate the impact of isolated high-frequency hearing loss on speech clarity and comprehension [28][29].

Speech audiometry is routinely incorporated into a complete audiological evaluation and commonly includes the assessment of Speech Awareness Threshold (SAT), Speech Detection Threshold (SDT), and Speech Recognition Threshold (SRT) [30]. Under normal circumstances, SAT and SDT values closely correspond to pure-tone thresholds and represent the lowest intensity level at which speech can be detected. During these assessments, patients are only required to indicate awareness of speech stimuli rather than identify specific words. In contrast, the SRT measures the lowest intensity level at which speech can be accurately recognized and repeated at least 50% of the time. Spondee words, characterized by equal stress on both syllables, are commonly used because of their familiarity and acoustic balance. In individuals with normal hearing, the SRT generally correlates closely with the PTA, often within a range of 5 to 12 dB. Significant discrepancies between these measures may indicate inconsistent responses, nonorganic hearing loss, or other auditory abnormalities requiring further investigation. Word recognition or speech discrimination testing provides additional diagnostic information regarding speech understanding abilities. In this procedure, monosyllabic words are presented at suprathreshold intensity levels, typically 25 to 40 dB above the SRT, and patients are asked to repeat the words accurately. A normal Word Recognition Score (WRS) is generally considered to be 80%

or higher, indicating effective speech discrimination under optimal listening conditions. Lower scores may suggest cochlear dysfunction, neural involvement, or central auditory processing deficits. Particularly important is the phenomenon known as rollover, in which speech recognition performance deteriorates as presentation intensity increases. Rather than improving with louder speech signals, affected patients demonstrate reduced word recognition scores at higher intensity levels. This finding is considered a classic indicator of retrocochlear pathology and may raise suspicion for disorders such as vestibular schwannoma or other lesions affecting the eighth cranial nerve [31].

Additional assessment tools provide further insight into speech perception and auditory performance. Suprathreshold testing for the WRS evaluates the patient's ability to recognize speech presented at comfortable listening levels and offers valuable information regarding functional communication abilities. The Speech Intelligibility Index (SII) serves as a quantitative measure of speech audibility by estimating the proportion of speech information accessible to the listener. Values range from 0 to 1, with higher values indicating greater access to speech cues and improved potential for speech understanding. An SII value approaching 1 suggests near-complete audibility of speech signals, whereas lower values indicate substantial limitations in speech perception. The Count-the-Dots Audiogram is another useful interpretive tool that visually represents speech audibility across the frequency spectrum. This method overlays speech-related frequency importance onto an audiogram, enabling clinicians to estimate how much speech information is accessible to a patient. The number of dots positioned above the hearing threshold curve corresponds to the proportion of audible speech cues. This visual representation assists in counseling patients, predicting communication difficulties, and evaluating the potential benefits of amplification devices. Accurate assessment during suprathreshold speech testing depends heavily on selecting an appropriate presentation level. If speech stimuli are presented at excessively high intensities, patients may experience discomfort, distortion, or abnormal loudness perception, particularly in the presence of sensorineural hearing loss. Conversely, presentation levels that are too low may fail to provide an accurate representation of speech recognition abilities. Therefore, optimal testing conditions generally involve presenting speech materials at approximately 40 dB sensation level above the SRT, ensuring that speech is clearly audible while remaining comfortable for the patient. Careful selection of presentation intensity enhances the reliability of test results and supports accurate clinical interpretation. Overall, normal speech audiometric findings are characterized by close agreement between SRT and PTA values, word recognition scores of at least 80%, appropriate speech audibility across critical speech frequencies, and the absence of rollover phenomena. In contrast, critical findings may include poor speech recognition performance, significant discrepancies between speech and pure-tone measures, reduced speech intelligibility indices, abnormal speech-in-noise performance, and rollover effects suggestive of retrocochlear pathology. These findings provide essential diagnostic information and contribute significantly to the identification, characterization, and management of hearing disorders [28][29][30][31].

Interfering Factors

Speech audiometry is a valuable clinical tool designed to assess an individual's ability to perceive, recognize, and repeat spoken language. Although it provides important information regarding functional hearing performance, the accuracy and reliability of speech audiometric results can be influenced by numerous factors unrelated to peripheral auditory sensitivity alone. These interfering variables may affect speech perception, response accuracy, and test interpretation, making it essential for clinicians to consider them during audiological evaluation. Understanding these factors enhances diagnostic accuracy and ensures that test outcomes accurately reflect the patient's true communicative abilities. One of the primary influences on speech audiometry performance is linguistic complexity. Speech perception involves more than the simple detection of auditory signals; it also requires the processing of linguistic information. Morphological constraints, which relate to the grammatical and lexical characteristics of target words, can affect how easily speech stimuli are recognized and repeated. Similarly, syntactic constraints associated with sentence structure and grammatical complexity influence comprehension by requiring listeners to process relationships between words and interpret contextual meaning. Complex linguistic structures may increase cognitive demands and reduce speech recognition accuracy, particularly among individuals with hearing impairment or limited language proficiency [32]. These effects become even more pronounced in acoustically challenging environments where background noise competes with speech signals. Auditory sensitivity itself remains a significant factor influencing speech audiometry outcomes. Individuals with hearing loss may experience reduced access to important speech cues, especially high-frequency consonant sounds that are critical for speech intelligibility. Even when speech is presented at an audible level, distortion resulting from cochlear pathology may impair the ability to accurately identify and discriminate speech sounds. Consequently, speech recognition performance may not always correspond directly to hearing threshold measurements.

Developmental factors also play an important role in speech audiometric testing. Children often demonstrate greater variability in speech recognition performance than adults due to ongoing maturation of auditory, linguistic, and cognitive systems. Age-related differences in vocabulary, language comprehension, speech production skills, and listening experience can influence test results. Younger children may have difficulty understanding instructions, maintaining attention, or providing consistent responses, thereby affecting test reliability. As a result, pediatric speech audiometry frequently requires specialized materials and age-appropriate testing methods to obtain accurate assessments of auditory function [33]. Cognitive abilities represent another major source of variability in speech audiometry. Successful speech recognition depends on attention, memory, language processing, and executive functioning. Individuals with cognitive impairment, neurological disorders, learning disabilities, or age-related cognitive decline may experience difficulty processing and recalling speech stimuli despite adequate auditory sensitivity. Attention deficits may reduce concentration during testing, while limitations in working memory can impair the ability to retain and repeat spoken information accurately. These factors may contribute to reduced speech recognition scores that do not necessarily reflect peripheral hearing dysfunction alone. To address these challenges, audiologists employ several specialized analytical tools that provide additional insight into speech recognition performance. One important method is the Performance Intensity (PI) function for phonetically balanced (PB) word lists. The PI function graphically illustrates the relationship between word recognition scores and increasing presentation intensity levels, thereby helping clinicians evaluate speech perception characteristics under different listening conditions [34]. In patients with cochlear hearing loss, word recognition performance generally improves as presentation intensity increases until a plateau is reached, reflecting maximal speech recognition ability. This pattern is considered characteristic of cochlear pathology.

In contrast, patients with retrocochlear disorders involving the eighth cranial nerve frequently exhibit a distinctive decline in speech recognition performance at higher intensity levels. This phenomenon, known as rollover, occurs when speech understanding worsens despite increasing loudness. Rather than benefiting from louder speech stimuli, these individuals demonstrate decreasing recognition accuracy, suggesting neural dysfunction affecting auditory signal transmission [35]. The presence of rollover is considered an important clinical indicator of retrocochlear pathology and may prompt further neurological investigation. To quantify the severity of this phenomenon, clinicians calculate the rollover ratio using the formula:

Rollover Ratio = (PBmax − PBmin) / PBmax

where PBmax represents the highest word recognition score achieved and PBmin represents the score obtained at a higher presentation intensity [36]. Larger rollover ratios indicate a greater likelihood of retrocochlear involvement and provide objective evidence supporting differential diagnosis. Another valuable approach involves comparing whole-word scoring with phoneme scoring during speech recognition testing. Whole-word scoring assigns credit only when an entire word is repeated correctly, whereas phoneme scoring evaluates recognition accuracy at the level of individual speech sounds. Phoneme analysis provides a more detailed assessment of speech perception abilities by identifying specific patterns of recognition errors and residual speech processing capacity. This method can be particularly useful when evaluating patients with severe hearing loss or auditory processing difficulties. Statistical analysis also plays a crucial role in interpreting speech audiometry findings. Variations in Word Recognition Scores (WRS) may occur because of normal test-retest variability. Therefore, audiologists use critical difference values derived from binomial distribution analyses to determine whether observed changes in performance represent meaningful clinical differences or merely reflect expected statistical variation. This approach improves diagnostic precision and supports more accurate monitoring of auditory function over time. Overall, speech audiometry results are influenced by a complex interaction of auditory, linguistic, developmental, cognitive, and neurological factors. Recognition of these interfering variables is essential for accurate interpretation of test outcomes and effective diagnosis of hearing disorders. Through the use of advanced analytical techniques such as performance intensity functions, rollover analysis, phoneme scoring, and statistical comparison methods, clinicians can better distinguish true auditory pathology from factors that may otherwise confound speech recognition performance [32][33][34][35][36].

Conclusion

Speech audiometry represents a fundamental component of contemporary audiological practice and provides critical insight into an individual's functional hearing and communication abilities. By assessing speech detection, recognition, discrimination, and comprehension, this diagnostic modality extends beyond traditional pure-tone audiometry to evaluate hearing performance under conditions that closely resemble everyday communication. The information obtained through speech audiometric testing contributes substantially to the diagnosis and classification of hearing disorders, differentiation of cochlear and retrocochlear pathologies, assessment of hearing aid candidacy, cochlear implant evaluation, and long-term monitoring of rehabilitation outcomes. The review highlights the importance of standardized testing procedures, accurate equipment calibration, and appropriate interpretation of findings to ensure reliable clinical outcomes. Speech audiometry also offers significant value in interdisciplinary healthcare settings, supporting nursing care, biomedical technology applications, epidemiological surveillance initiatives, and health assistance programs. Furthermore, advanced assessment techniques such as speech-in-noise testing, word recognition analysis, and speech intelligibility measurements enhance understanding of real-world communication challenges. Collectively, speech audiometry remains an essential evidence-based tool that supports patient-centered hearing healthcare, improves communication outcomes, and contributes to the early detection and effective management of auditory disorders across diverse populations.

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