

# MOST COMFORTABLE LOUDNESS (MCL)

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October 31, 2025

## RECOMMENDED CITATION

mohammad looti (2025). *MOST COMFORTABLE LOUDNESS (MCL)*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=63504>

## MOST COMFORTABLE LOUDNESS (MCL)

**Primary Disciplinary Field(s):** Audiology, Psychoacoustics, Speech-Language Pathology

### 1. Core Definition

The **Most Comfortable Loudness (MCL)** is a fundamental psychoacoustic and clinical measure defining the sound intensity level that an individual perceives as optimally comfortable for continuous listening. This level represents the subjective midpoint between the minimal sound pressure required for detection (the hearing threshold or threshold of audibility) and the maximum sound pressure tolerated before discomfort or pain is reached (the Uncomfortable Loudness Level, or UCL). MCL is not merely a preference; it is a critical physiological and psychological parameter used extensively in clinical settings to gauge the individual's usable dynamic range for auditory stimuli. While the specific decibel level of MCL varies widely across the general population, it generally clusters around 40 to 55 dB Hearing Level (HL) for speech stimuli in normal-hearing adults. Determining the MCL is essential because it provides direct insight into how a patient processes and interprets sounds within their auditory system, serving as the benchmark for setting appropriate amplification levels, especially in the context of hearing aid fitting and cochlear implant mapping.

The measurement of MCL is distinct from the assessment of absolute thresholds, which focus solely on the detection of sound presence. Instead, MCL requires a cognitive and judgmental task from the listener, prompting them to actively select the intensity that feels neither too soft, requiring undue effort to attend, nor too loud, inducing irritation or potential discomfort. This measurement is intrinsically linked to the concept of auditory processing efficiency and overall listening satisfaction. A sound presented at the MCL is typically perceived as having sufficient loudness to be engaging and clear without causing acoustic overload or fatigue. In cases where the auditory system is compromised, such as in sensorineural hearing loss, the MCL often shifts higher in intensity or, more crucially, the range between the MCL and the UCL narrows considerably, a phenomenon known as loudness recruitment. This compression of the auditory dynamic range makes the accurate determination of MCL even more vital for effective clinical intervention.

The definition provided in historical source material emphasizes the personalized nature of this measurement, stating that "Each individual has a most comfortable loudness, which is the most comfortable level for listening to music." While the principle holds true for music, MCL is typically assessed clinically using calibrated speech materials, as speech is the most common and functionally significant sound signal that hearing devices are designed to optimize. The precision and reliability of MCL measurement are paramount, influencing the successful integration of amplification technology into a patient's daily life. If the calculated MCL is inaccurate, the resulting device settings may lead to under-amplification, causing the patient to strain to hear, or over-

amplification, leading to rejection of the device due to excessive loudness and discomfort. Therefore, MCL serves as the acoustic anchor point around which all restorative auditory prescriptions are formulated.

## 2. Etymology and Historical Development

The concept of preferred listening levels began to gain prominence in the early to mid-20th century, coinciding with the rise of standardized audiological testing and the development of electronic hearing aids. Before the formal standardization of clinical audiology, researchers recognized that a patient's capacity to hear was only one part of the rehabilitative puzzle; the patient's tolerance and comfort with amplified sound were equally important. Early audiological evaluations often included informal probes to gauge the intensity at which the patient would prefer to listen to conversational speech, laying the groundwork for the formalization of the MCL procedure. The need for a reliable measure became acute during and immediately following World War II, as military and civilian populations required robust methods for fitting newly engineered vacuum tube hearing devices. These early devices lacked the sophisticated compression circuitry of modern technology, making the initial setting of the optimal output level based on the MCL a necessary prerequisite for user satisfaction.

The term **MCL** emerged formally as part of standardized test batteries aimed at quantifying the entire auditory dynamic range, often including the determination of the Speech Reception Threshold (SRT) and the UCL. Pioneers in audiology, such as Hallowell Davis and Ira Hirsh, contributed significantly to establishing the necessary protocols for measuring sound perception beyond simple detection. The historical evolution of MCL measurement is closely tied to the debate over the optimal method of presentation--whether to use continuous discourse, recorded pure tones, or warble tones--and the instruction set provided to the patient. By the latter half of the century, MCL became a mandatory component of most comprehensive audiological evaluations, especially those involving rehabilitative prescription. The development of prescriptive fitting formulas for hearing aids, such as the National Acoustic Laboratories (NAL) formulas and the Desired Sensation Level (DSL) methodology, cemented the MCL as a key input parameter, transforming it from a general observation into a precise clinical target.

The historical development of MCL measurement techniques has shifted primarily from the simple "bracketing" or ascending method to more sophisticated approaches designed to minimize variability. Early methods relied heavily on the examiner manually adjusting the intensity and asking the patient to signal when the sound was "most comfortable." Modern clinical practices often incorporate automated procedures or the use of specific speech materials (e.g., connected speech test materials) presented through calibrated sound systems. This evolution reflects an ongoing effort to improve the **reliability** and **validity** of the MCL measure, recognizing that the subjective nature of the task inherently introduces fluctuation. Furthermore, the advent of digital

hearing technology has allowed for multiple MCLs to be programmed across different frequency bands, acknowledging that an individual's comfort level for low-frequency sounds may differ significantly from their comfort level for high-frequency sounds, particularly in cases of sloping high-frequency hearing loss.

### 3. Key Characteristics and Measurement Protocols

MCL is fundamentally characterized by its subjectivity and variability. Unlike the hearing threshold (SRT or PTA), which relies on an objective response to sound presence, MCL relies on a listener's conscious judgment of preference. Key characteristics include its dependence on the acoustic stimulus, the testing environment, and the psychological state of the patient. For instance, MCL measured using music stimuli may differ substantially from MCL measured using fast-paced speech, due to differences in crest factor and frequency content. Clinically, MCL is almost universally measured using calibrated speech signals (Speech MCL or S-MCL) because this is the primary signal that patients require optimal access to. The resulting value is typically reported in decibels referenced to the normative hearing level (dB HL) or the sound pressure level (dB SPL).

There are several standardized clinical protocols used to determine MCL, all of which fall under the category of psychoacoustic scaling procedures. The two most common techniques are the Method of Adjustment and the Method of Limits. In the **Method of Adjustment**, the patient controls the intensity level of the stimulus (via a volume knob or button) and is instructed to adjust it to the level they find "most comfortable." This method is often quick but can be highly susceptible to patient inconsistency. In the **Method of Limits**, the examiner controls the intensity, presenting the sound in a series of ascending or descending steps. The patient indicates when the sound moves from "too soft" to "comfortable" or from "too loud" to "comfortable." A common variation involves the "bracketing" technique, where the examiner rapidly alternates between an intensity slightly above and slightly below the anticipated MCL, narrowing the gap until the patient consistently selects a specific level.

**Stimulus Type Selection:** While pure tones can be used, clinical determination of S-MCL typically employs continuous discourse (e.g., narrative speech) or a randomized word/sentence list, as these stimuli better approximate the complexity of real-world listening environments.

**Instruction Phrasing:** The precise instructions given to the patient are crucial. The instructions must explicitly guide the patient to choose the level they would prefer for extended listening, avoiding interpretations such as "the softest sound you can hear comfortably" or "the loudest sound you can tolerate." Ambiguous instructions can significantly skew the resulting MCL value.

**Test Reliability:** Due to the subjective nature of comfort, MCL measurements often exhibit lower test-retest reliability compared to thresholds. Clinicians frequently take multiple measurements and average the results to ensure a more stable and representative value for use in prescriptive fitting.

## 4. Factors Influencing MCL and Dynamic Range

Multiple intrinsic and extrinsic factors govern an individual's MCL. The most significant intrinsic factor is the individual's hearing status. For those with normal hearing, MCL is relatively stable, typically falling within a narrow range. However, individuals with **sensorineural hearing loss (SNHL)** often experience a fundamental shift. SNHL, particularly cochlear damage, frequently leads to **loudness recruitment**--an abnormal growth in the perception of loudness. Because of recruitment, the difference between the hearing threshold and the MCL can become dramatically reduced. The auditory system needs less intensity change to go from barely audible to comfortable, and often, only a small additional increase in intensity leads rapidly to the Uncomfortable Loudness Level (UCL). This compression of the auditory dynamic range necessitates extremely precise fitting based on the measured MCL to prevent over-amplification discomfort.

Extrinsic factors, such as the environment and the specific acoustic characteristics of the sound, also influence MCL. The perceived comfort level for speech in a quiet room will inevitably be lower than the preferred listening level in a noisy environment, as the listener attempts to maintain a favorable signal-to-noise ratio. Furthermore, the spectral complexity of the signal plays a role; individuals may tolerate higher overall intensity for broadband noise than for pure tones, or they may find music, with its complex harmonics, more tolerable at higher levels than sharply modulated speech. Psychological factors are also relevant; an anxious or fatigued patient may report a lower MCL simply due to reduced tolerance for sensory input, underscoring the importance of a well-controlled, patient-friendly testing environment.

The relationship between MCL and the dynamic range is central to clinical audiology. The auditory dynamic range is generally defined as the interval between the lowest intensity sound that can be perceived (threshold) and the UCL. The MCL ideally sits in the middle third of this range, representing the optimal utilization of the remaining hearing capacity. In a normal ear, this range is quite wide (often 100 dB or more). In a recruiting ear, however, this range may be compressed to 30 or 40 dB. Therefore, determining the MCL allows the audiologist to calculate the necessary **gain** (amplification) required to lift quiet sounds into the MCL region without pushing loud sounds into the UCL region. This calculation is the foundation of modern prescriptive fitting methods, ensuring that amplification is frequency-specific and tailored to the unique compressed dynamic range of the hearing-impaired ear.

## 5. Clinical Applications in Hearing Restoration

The primary and most critical application of MCL is in the prescription and fitting of amplification devices, including conventional hearing aids and cochlear implants. MCL provides the essential target for setting the linear and compression characteristics of a hearing device. Prescriptive fitting

formulas, such as NAL-NL2 (National Acoustic Laboratories - Non-Linear 2) or DSL (Desired Sensation Level), rely on the measured MCL to determine the ideal output targets across various input levels and frequencies. The goal is to ensure that average conversational speech, which is typically presented at an input level of 65 dB SPL, results in an output level within the patient's ear canal that matches their previously determined MCL.

In digital hearing aids, the MCL guides the setting of the **output compression ratio**. Digital hearing aids use sophisticated compression circuitry to selectively amplify sounds. Soft sounds are amplified significantly to cross the patient's threshold, while moderately loud sounds are amplified just enough to reach the MCL. Loud sounds, critically, are limited to ensure they do not exceed the UCL. Without an accurate MCL measurement, the fitting algorithm lacks the necessary reference point to balance audibility and comfort, leading to suboptimal performance. If the MCL is underestimated, the patient will complain that sounds are too soft; if overestimated, the patient will complain of discomfort and loudness, often leading to non-use of the device.

Furthermore, MCL measurements are indispensable in the mapping of **cochlear implants (CIs)**. CIs bypass the damaged cochlea and directly stimulate the auditory nerve using electrical current. The CI audiologist must determine two crucial parameters: the T-level (Threshold, the minimum current required for detection) and the C-level or M-level (Comfort or Maximum acceptable level, analogous to MCL/UCL). The M-level in CI mapping is meticulously set to ensure the patient perceives amplified speech as loud but comfortable, maximizing speech understanding while preventing uncomfortable electrical stimulation. Regular adjustments of the M-level based on subjective MCL judgments are vital for long-term CI success, reflecting the ongoing adaptation of the auditory system to electrical stimulation.

## 6. Debates and Methodological Limitations

Despite its clinical importance, MCL measurement is fraught with methodological challenges and continues to be an area of debate within audiology research. One of the foremost limitations is the aforementioned subjectivity and resulting poor test-retest reliability. Because "comfort" is a psychological construct influenced by factors like mood, fatigue, and motivation, measurements taken on different days or by different clinicians often vary substantially, sometimes by as much as 5 to 10 dB. This level of variability poses a significant challenge when attempting to apply precise prescriptive fitting formulas that require accuracy within 1 or 2 dB.

A second major limitation concerns **ecological validity**. MCL is almost always measured in a quiet, controlled environment (a sound-treated booth), using standardized, often monotonous, speech materials. This setup does not accurately replicate the complex, noisy, and dynamic acoustic environments of daily life (e.g., restaurants, traffic, group conversations). A level deemed "most comfortable" in a quiet booth may be wholly inadequate or excessively loud in a real-world

setting, necessitating continuous adjustments by the user or the hearing aid's automatic processing systems. The debate centers on whether clinical MCL should be measured using more complex, realistic stimuli, or if the simplicity of the current quiet-booth standard is sufficient for deriving basic amplification parameters.

Finally, there is a lack of consensus regarding the optimal presentation strategy (ascending, descending, or bracketing). Research indicates that the specific instruction and measurement technique can significantly bias the final reported MCL. For example, instructions that emphasize tolerance ("How loud can you stand it?") tend to push the reported level toward the UCL, while instructions emphasizing clarity ("What level sounds clearest?") might yield a lower MCL. Continuous research attempts to find standardized, evidence-based instruction sets and measurement procedures that minimize cognitive load and maximize the predictive accuracy of the MCL measurement relative to real-world listening satisfaction.

## 7. Further Reading

[Most Comfortable Loudness Level \(MCL\) - General Overview](#)

[American Speech-Language-Hearing Association \(ASHA\) - Audiology Practice](#)

[Psychoacoustics and Clinical Audiology Procedures \(Reference to Loudness Scaling\)](#)