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Masking Level Difference (MLD): Literature Review

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Abstract

Masking Level Difference composes a tests set for the central auditory processing behavioral evaluation and estimates decoding binaural interaction abilities. MLD test consist of auditory level measurement by emitting a pulsatile clear tone to both ears, at the same moment as a masker rustle is being emitted. This work has the objective of reviewing literature over MLD, providing general information concerning to the test. Binaural Interaction Tests evaluate central auditory nervous system (CANS) on processing dissimilar information, but complementary, emitted to both ears. The rustle has the objective of masking the auditory signal, in a permanent stage. On that test, the individual is submitted simultaneously to an auditory signal and to a rustle. However, emitting a rustle to the other ear becomes the auditory sign more audible.

MLD is a psychological/auditorial phenomenon, in which detection or recognizing a binaural or monoaural sign emitted, is improved adjoining a competitive binaural rustle. An individual is normally evaluated at the same stage (speaking, pulsatile tone, masker rustle in both ears) and in a different stage (one of the signs is emitted to 180ºC [356ºF] in a diverse way from the initial one, just to one ear, while the other one is kept in a reverse stage). The test allows identifying individuals with compromised low brainstem.

Keywords: Masking Level Difference; MDL; Masking Auditory Processing

Introduction

Hearing is a fundamental meaning to life, because it is the basis of human communication allowing the insertion of the individual in society. The auditory system allows the processing of acoustic events whose function is to select speech sounds over competitive factors such as noise [1-10]. The auditory processing refers to the efficiency and effectiveness with which the central nervous system (CNS) uses auditory information. It is the basis for complex actions such as understanding spoken language, not being a closed process, interacting intimately with other neural systems and being influenced by experience, environment and active training; its alteration affects negatively the quality of life of many people [11].

Among the central auditory functions that comprise auditory processing, we find temporal processing and binaural interaction. It is highlighted that temporal auditory processing is especially important in speech perception, discrimination of subtle clues, recognition of phonemes and their distinctive features and discrimination of similar words. On the other side, binaural interaction is described as a process that allows the integration or separation of stimulus related to inter-hemispheric cooperation. The binaural interaction is evaluated through two main behavioral procedures: the Binaural Fusion and Masking Level Difference (MLD) tests [12-21].

Because it is part of the evaluation of binaural interaction, the Masking Level Difference (MLD) deserves to be highlighted because of its importance, justifying this literature review. In performing the MLD, peculiarities concerning the performance of the test must be well known in order to avoid mistakes in the interpretation of the result. The main objective of this review was to describe the central aspects regarding the achievement, interpretation and clinical utility of MLD [22-26].

Method

This review was carried out through the search of the subject descriptors «Masking Level Difference», «MLD», «Masking» and «Auditory Processing», «Temporal Processing» in the Virtual

Health Library (BVS) databases, including articles in English and Portuguese languages, published from 1982 to 2010. From this primary selection, scientific papers and medical books were selected and added.

Literature Review

Central Auditory Processing

Speech perception involves the experiences of the individual during his life and the importance he or she attributes to the auditory stimulus; these aspects involved in this process are not dependent only on the peripheral and central auditory system. Auditory processing involves, besides the auditory discrimination, the abilities of localization and lateralization of the sound, recognition, temporal aspects, tests of dichotic listening and with degraded acoustic signals. Auditory discrimination involves the perception of acoustic stimulus in very fast sequences requiring accuracy of the information that is brought to the brain, consequently enabling the decoding and understanding of speech mainly in unfavorable situations, such as with the presence of background noise and competitive speech [27-34]. In short, the auditory processing is the effective use of auditory information, that is, what the human being does with what he or she hears [35].

Temporary Auditory Processing

Temporal auditory processing can be defined as the perception of sound or sound alteration within a defined and restricted period, that is, it refers to the ability to perceive or differentiate stimulus that are presented in rapid succession, becoming a fundamental component for greater auditory processing capacity [36-40]. Much evidence suggests that temporal processing skills are the basis of auditory processing, specifically regarding to speech perception. The argument that supports this proposition is that many characteristics of auditory information are, in some way, influenced by time [41-46].

Therefore, the temporal processing can be defined as the perception of the sound or its change within a time domain. It can be observed in many levels from the most basic (regulation of neural time in the auditory nerve) to the most complex (cortical processing of binaural hearing and speech perception). Therefore, it allows the human being to perceive the sounds of the speech and comprehension of oral language [46-54].

Binaural Interaction

Among the behavioral tests that evaluate auditory processing there is the binaural interaction test that evaluates the ability of the central auditory nervous system to process different but complementary information presented to both ears [55-60]. Auditory complaints concerning difficulties in locating the direction of the sound source, perceiving speech in noisy environments, or perceiving speech in environments where there are many people speaking at the same time may be associated with impairment of normal binaural integration functions [61-65]. In summary, binaural interaction is the ability to perceive and organize the sounds of the environment, which depends heavily on the simultaneous use of the two ears, on the neural interaction that occurs with the signals received by the two ears, and on how the hearing information is processed [65-67]. The evaluation of binaural interaction consists of two main behavioral procedures: the Binaural Fusion test and the Masking Level Difference (MLD) test.

Masking Level Difference (MLD)

First described by Hirsh [68-78], MLD can use a pure a tone stimulus or a speech one. The Masking Level Difference is a psychoacoustic phenomenon in which the detection or recognition of a monaural or binaural signal presented is improved in the presence of a competitive binaural noise. This improvement results from the use of the auditory system of a subtle binaural event and differences in amplitude levels between simultaneously presented signals or masked signals. The MLD represents an advantage in the detection or recognition of the altered binaural phase in reference to the unchanged condition phase. Normal CANS listeners demonstrate masking suppression under MLD conditions, while listeners with auditory system alterations do not demonstrate comparable masking suppression. Even though MLD is a central process of interaction of the two ears (sub thalamic), it can be affected by the peripheral auditory system [78-86].

Masking Level Difference (MLD) refers to the detection of a breakpoint to the signal that can occur in two masking conditions - S0N0, homophase and SπN0, antiphase - both signal and masking; they are binaural in phase and out of phase. The test consists of 10 homophasic stimulus, 12 anti-phasic stimulus and 11 no-tone stimulus. It starts from the most favorable signal-noise ratio to the least favorable in the three conditions (S0N0, SπN0 e NT) The subject hears a chirp for a few seconds; during this chirping, sometimes he or she hears a tone and sometimes not. At each presentation, he or she tells the examiner whether there is the tone or not. The breakpoint difference at which the signal is last perceived under the conditions S0N0 and SINN determines the MLD result [87-89].

Musiek et al. [89-92] gave a brief introduction on how to perform the MLD test. The authors did the test using a pure tone at 500Hz, presented in both ears along with a continuous broadband noise presented at 60 dBHL. Musiek et al. [93] named both as homophase and antiphase conditions. They reinforced both the importance of symmetric and normal breakpoint for MLD research, as well as the variables that may interfere in the study as type of signal used (pure tone, spondaneous words); the type and level of sound pressure of the noise used and the condition of phase change of one of the stimulus. They reported that values lower than 6dB are not considered normal for adults and that this test is sensitive for brainstem lesions.

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Wilson et al. [94] performed a series of experiments in order to develop a protocol for MLD (500 Hz) of simple application that could be used in clinical practice. The authors observed that 95% of the listeners presented MLD greater than or equal to 10 dB, this being the reference value of normality for the test. The version of the MLD that uses pure tones with the help of the audiometer consists of the presentation of a pulsatile tone, usually at 500Hz in both ears, at the same time as a narrow band masking noise presented binaurally at 40 dBNA. The differential frequency breakpoint of the 500 Hz frequency is determined using steps of 1 dB between three different test conditions: Noise and pure tone presented in the same phase, reversed phase noise in one ear and pure tone in the two ears, pure tone in inverted phase in one of the ears and phase noise in both ears. The patient is advised to warn when they no longer hear the stimulus presented. The first errors of both conditions are subtracted; the result is obtained in decibels (dB).

MLD can also be performed using the CD produced by Richard Wilson and marketed by Auditec St. Louis. Novak and Anderson [27] observed that elderly patients with «neural presbycusis» had significant reductions in MLD size. Wilson et al. [94] studied MLD comparing two different types of noise: filtered white noise and modulated amplitude noise, and they described that these two different types of noise showed different MLD values for differing in their masking effectiveness. The authors reinforced the idea that a clinician using the MLD method in the search for central changes should develop their own normality criteria. Kramer et al. [95,96] reported that stutterers had lower MLDs than non-stutterers did. This result was interpreted as follows: stutterers have worse auditory processing abilities than non-stutters and probably have greater difficulty with temporal processing.

Hall and Grose [30], in a longitudinal study, demonstrated that MLD in children younger than 5/6 years old was lower than MLD in adults. The study concluded that reduced MLD did not appear to be a result of peripheral factor, but was attributed to developmental differences probably related to central auditory processing. Since MLD is one of the binaural interaction tests that are designed to evaluate the ability of the Central Auditory Nervous System (CANS), to receive information in both ears and to unify them in a perceptual event; it is believed that this unification occurs in the brainstem. As a consequence, it is assumed that this test is sensitive for pathologies of the brainstem and may have results affected by brain lesions; corroborating that listeners who present alterations of the auditory system do not demonstrate release of masking, suggesting probable impairment of brainstem [45-50].

There are no Brazilian studies that present normality values for MLD, and the values of international surveys are accepted as references in clinical practice. This bibliographic study evidences the importance of continuity in the study of binaural interaction abilities, including the Masking Level Difference (MLD) test, which demonstrates to be closely linked with the ability to locate the sound source and speech recognition in the presence of noise.

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