

## CONTEMPORARY ACHIEVEMENTS IN THE FIELD OF PERCEPTUAL MEASUREMENT OF MUSICAL ABILITIES

**Igor Nikolić**

University of Niš, Faculty of Arts in Niš, Serbia, [igornik.fu@gmail.com](mailto:igornik.fu@gmail.com)

**Slobodan Kodela**

University of Priština, Faculty of Arts, Zvečan – Kosovska Mitrovica, Serbia, [kboban64@gmail.com](mailto:kboban64@gmail.com)

**Bogdan Pindović**

University of Priština, Faculty of Arts, Zvečan – Kosovska Mitrovica, Serbia,

[bogdan.pindovic@art.pr.ac.rs](mailto:bogdan.pindovic@art.pr.ac.rs)

**Abstract:** Musical abilities and the possibilities of measuring them have drawn the attention of both music educators and music psychologists for decades. Due to parallel development of these disciplines, the assessment of musical abilities can be categorized into two main types – evaluation by music educators (primarily based on reproduction assessment) and the measurement of perceptual abilities through tests. Although the majority of standardized psychological tests for musical abilities emerged during the 20th century, it is evident that this issue continues to inspire researchers in more recent times. Consequently, there is a considerable number of newer tests for assessing musical abilities. The aim of this study is to present the characteristics of tests published after the year 2000, highlighting their potential applications in educational practice and within the scope of research on musical abilities across different disciplines. The following instruments have been analyzed: Goldsmiths Musical Sophistication Index (Gold-MSI), Montreal Battery of Evaluation of Amusia (MBEA), University of Washington Clinical Assessment of Music Perception Test, The Montreal Battery of Evaluation of Musical Abilities (MBEMA), MBEMA on tablet, Implicit Tonal Ability Test (ITAT), Musical Aptitude Test (MAT), Musical Ear Test (MET), Profile of Music Perception Skills (PROMS), Brief PROMS, PROMS-S, Mini-PROMS, and Micro-PROMS. The results of the research reveal evident differences in the content and purpose of the tests. Some tests can be applied as early as the age of 4 to 6 years (MBEMA on tablet), from 6 to 8 years (MBEMA), and from 6 to 12 years (ITAT), while others are intended solely for adult participants. Variations also exist in the content of the tests, determining which types of musical abilities will be measured. While MET includes only two subtests (Melody and Rhythm), others incorporate tasks such as Harmony, Dynamics (MAT), Tuning, or Loudness (PROMS). Another significant variable is the duration of the assessment, ranging from as little as 10 minutes for implementation (Micro-PROMS) to as much as 90 minutes (MBEA). Depending on the research needs, the manner of expressing results should be considered, as most tests calculate a total score, whereas MAT presents results in the form of a five-dimensional profile. In conclusion, there is a solid selection of tests for musical abilities published after the year 2000, accessible to researchers. Some of them are adapted for online use, enabling a broader range of participants in research in the field of music pedagogy and other disciplines. We hope that the test overview presented in this study will aid researchers in selecting suitable instruments for their investigations, taking into account different types of abilities in relation to research needs, participant age, or planned assessment time.

**Keywords:** musical abilities, measurement, assessment, tests, music pedagogy

### 1. INTRODUCTION

Assessment, measurement, and evaluation of musical abilities are processes that, on one hand, serve practical and pedagogical purposes by categorizing individuals based on their abilities and implementing appropriate educational measures. On the other hand, these processes hold significance in scientific research, influencing the development of various disciplines such as psychology, pedagogy, sociology, medicine, and others. The parallel development of music pedagogy and music psychology has led to specific approaches to studying, categorizing the procedures belonging to the assessment of musical abilities into two categories. One involves the assessment of abilities by music educators, often including the reproduction of musical material. The other category encompasses perceptual examinations of musical abilities using psychological tests.

In contrast to traditional musical assessments, perceptual measurement of musical abilities often excludes performance (reproduction) of music. Instead, psychological tests for musical abilities are based on the observation of musical phenomena and writing down responses. This process does not involve knowledge of musical notation but primarily focuses on auditory discrimination. Tasks within these tests often require recognizing whether two auditory stimuli are identical or different.

The tradition of psychological testing in music is considered to have originated in 1883 when Carl Stumpf proposed a series of auditory tests to facilitate the selection of students by teachers based on their musical abilities (Hallam,

2006). Most well-known and standardized tests worldwide emerged during the 20th century, from C. Seashore's tests in 1919 to well-developed solutions by E. Gordon published in 1982 and 1988. These tests primarily aimed to identify children's potential for musical achievement (Law & Zentner, 2012a). Notably, the absence of work on creating tests for musical abilities in the last 30 years is identified as a factor negatively impacting progress in research across various scientific fields (Law & Zentner, 2012b). Examining tests from Seashore's to those applied today suggests that the content, based on perceptual tasks, has not changed significantly.

However, authors consistently contribute to the validity, reliability, and other characteristics of these measurement instruments using various approaches. In this regard, recent efforts in this field, some involving testing musical abilities through computer interfaces, are evident. This paper aims to present the characteristics and achievements of newer tests for measuring musical abilities, which could be beneficial in music pedagogy or interdisciplinary research.

## 2. MATERIALS AND METHODS

In order to examine and present advancements in the measurement of perceptual musical abilities, we analyzed some of the tests that emerged after the year 2000. These tests include Goldsmiths Musical Sophistication Index (Gold-MSI), Montreal Battery of Evaluation of Amusia (MBEA), University of Washington Clinical Assessment of Music Perception Test, The Montreal Battery of Evaluation of Musical Abilities (MBEMA), MBEMA on tablet, Implicit Tonal Ability Test (ITAT), Musical Aptitude Test (MAT), Musical Ear Test (MET), Profile of Music Perception Skills (PROMS), Brief PROMS, PROMS-S, Mini-PROMS, and Micro-PROMS. The research encompassed an analysis of the content of these measurement instruments, their characteristics, the method of task reproduction, specific considerations regarding age, the time required for test implementation, the number of tasks, and other variables.

## 3. RESULTS AND DISCUSSIONS

Upon reviewing current scientific and professional literature, it is evident that there is a growing interest in creating instruments dedicated to assessing musical abilities in psychological and pedagogical practices. One noteworthy recent development that potentially indicates a perspective for future paths in the measurement of musicality is the **Goldsmiths Musical Sophistication Index** or **Gold-MSI** (Müllensiefen et al., 2014), developed at Goldsmiths, University of London. It underwent an extensive study through the BBC project "How Musical Are You?" in which over 190,000 participants took part during 2011 and 2012. The processed results reported by Müllensiefen et al. (2014) pertain to an impressive sample of 147,633 participants. The instrument is designed for testing the general population, and results are expressed as the "musical sophistication index," a concept introduced by the authors to define the complex phenomenon of musical expertise.

Gold-MSI includes tasks to assess musical perception, covering:

- A test of melodic memory, where pairs of identical or different phrases are presented. This test differs from most standardized tests in that the second phrase in the pair is often transposed, i.e., performed in a different key.
- A test of rhythmic pulsation perception, presenting various musical fragments (including popular music), and participants must determine if the metronome sound (or "click") follows the pulsation of the given excerpt.
- A test of sound similarity containing very short musical excerpts, 800ms in length. Participants are tasked with grouping the presented phrases based on sound similarity.

In addition to perceptual tasks, this instrument also involves a rhythmic reproduction aspect, setting it apart from most tests. Participants are required to "feel" and reproduce the basic rhythmic pulsation of the musical fragments they hear on the computer keyboard. Gold-MSI also includes extensive questionnaires (Self-Report Inventory) collecting data on various types of musical activities, musical experience, affinity with musical content, emotional responses to music, and other musical characteristics.

Some music-perceptive tests are designed for specific groups of participants or are purposefully created for younger ages. **The Montreal Battery of Evaluation of Amusia (MBEA)** (Peretz, Champod & Hyde, 2003, cited in Wallentin et al., 2010) consists of six subtests. In the first five, participants compare musical phrases as same or different, involving changes in contour, scale, intervals, rhythm, and meter. The sixth subtest focuses on testing musical memory, requiring participants to recognize whether an individual phrase has been previously played. However, given its purpose, the Montreal Battery has somewhat lower demands, with a success rate of 88% for musically uneducated adults. The test also takes approximately 90 minutes to complete, limiting its broader application. Another specialized test, for adults with cochlear implants, is the **University of Washington Clinical Assessment of Music Perception Test** (Kang et al., 2009). It includes tasks related to determining the direction of

tone movement, recognizing melodies, and identifying timbre. Notably, the first group of tasks is constructed based on adaptive testing principles, adjusting the difficulty of tasks based on participants' musical abilities.

Building on the MBEA test, which, in the authors' experience, cannot be used with participants under 10 years old, **The Montreal Battery of Evaluation of Musical Abilities (MBEMA)** was developed to assess musical abilities in children aged 6 to 8 (Peretz et al., 2013). The test includes subtests for contour, interval, scale, rhythm, and memory, using 20 melodies in 10 different tonalities. Tested in Canada and China, the authors believe that "MBEMA can serve as an objective, short and up-to-date test of musical abilities in a variety of situations, from the identification of children with musical difficulties to the assessment of the effects of musical training in typically developing children of different cultures" (Peretz et al., 2013: 1). To enable testing for children under 6, **The Montreal Battery of Evaluation of Musical Abilities on tablet** was derived from this test, representing a shortened version with three subtests containing 12 tasks each – melody discrimination, rhythm discrimination, and memory recognition of unfamiliar tonal melodies (Peretz et al., 2021). To maintain children's attention, the authors used 10 different timbres (e.g., flute, guitar, piano, marimba) to present melodies. The test is adapted for tablet use, where questions and answers are displayed using appropriate images, facilitating understanding for younger children. The use of images for younger children was previously applied by E. Gordon in his Primary Measures of Music Audiation (PMMA) tests, published in 1979 and 1982.

For testing abilities in children, the **Implicit Tonal Ability Test (ITAT)** is noteworthy, described as "a valid measurement instrument for elementary school children to measure the level of implicit tonal abilities with regard to five distinct musical features (pitch, tonality, timing, loudness, and timbre)" (Wolfs et al., 2023: 1). The test comprises 49 tasks, with four answer options for each task, of which only one is correct. Research conducted with 223 children aged 6 to 12 demonstrated that the test successfully differentiates students into two ability groups, though the authors suggest that categorizing into three ability levels would enhance the test's practical application in primary education. One of the primary implications of the test is the grouping of students with similar musical abilities to differentiate teaching requirements. Notably, the authors prepared and used three versions of ITAT with different task arrangements, with ANOVA showing no statistically significant differences.

**The Musical Aptitude Test (MAT)**, developed by Edwards et al. (2000), differs from standardized psychological tests primarily in its purpose and application. It aims to assess musical abilities necessary for working with a specific auditory interface. The auditory interface's designers are tasked with ensuring its usability for individuals with varying degrees of musical ability. Therefore, a result indicating that a particular design is accessible only to those who score high on the MAT test may suggest poor auditory interface design. The test is computer-based and, due to its specific response communication method, requires individual administration. Participants listen to a sound stimulus (tones, chords, rhythmic phrases) twice and must identify the identical auditory stimulus by activating the mouse over several provided fields. This unique approach is not commonly found in standardized psychological tests. Participants can listen to the provided answers an unlimited number of times, while the additional option "Don't know" reduces the chance of random guessing.

The MAT comprises around 200 tasks grouped into eight subtests: Pitch awareness, Rhythm – duration, Rhythm – meter, Harmony – chord awareness, Harmony – chord structure, Rhythm – structure, Pitch and rhythm – melody discrimination, and Dynamics awareness. Instead of summing up the results of these subtests as a single "MAT musical coefficient," the authors find it more useful to create a five-dimensional profile. This presents each participant's results in five categories: pitch (test 1), rhythm (tests 2, 3, and 6), melody (test 7), harmony (tests 4 and 5), and dynamics (test 8). The tasks in the test follow a graduated difficulty, which, according to the authors, facilitates learning. Thus, Edwards and colleagues suggest that in future research using MAT, tasks should be randomly arranged to eliminate potential learning effects. Practical drawbacks of this instrument include the exclusion of higher-order abilities (judgments about the artistic quality of music) and the average testing duration of 57 minutes.

**The Musical Ear Test (MET)**, created and published by Wallentin et al. (2010), serves as an instrument to assess the development of musical abilities and skills, i.e., the degree of musical expertise, applicable in practical settings. It is based on the perception of two fundamental musical elements – melody and rhythm, requiring only 20 minutes for completion. The test comprises a total of 104 tasks, 52 for the melodic and rhythmic sections each. Each task presents two short phrases, melodic (performed on the piano) or rhythmic (played on a woodblock), which participants compare and determine as identical or different. Tasks are not graded in difficulty but randomly distributed. The test is administered via an audio device, where participants receive instructions, including two examples with displayed solutions for each test part.

Empirical validation of MET was conducted through several experiments, demonstrating its success in distinguishing participants based on their level of musical expertise (Wallentin et al., 2010). Correlation with a test involving the reproduction of musical content (The Imitation test) was also examined. Results indicate a high overall

correlation between MET and the Imitation Test, leading the authors to conclude that "auditory discrimination abilities may be used as a surrogate measure for general musical competence" (Wallentin et al., 2010: 191).

In order to verify the validity and reliability of the Musical Ear Test (MET), we conducted a study with students from the Faculty of Arts in Niš in 2014. For the purposes of this research (Nikolić and Kodela, 2015), as well as for the future application of the instrument, test instructions were translated into Serbian with the permission of the authors and recorded in audio format, while melodic and rhythmic phrases were not modified, i.e., presented in their original form. The validity of MET was assessed by comparing the results with the success of students in solfeggio instruction. The results showed a significant positive correlation between the total test score and the average grades in reproduction (singing) and perception (N=55, R=0.811, p<0.001). Examining the results by categories, MET scores showed a significantly higher correlation with perception assessments (N=55, R=0.875, p<0.001) compared to singing (N=55, R=0.576, p<0.001). Although perception and interpretation are considered "complementary parts of the same process" (Milanković, 1998: 11), we can conclude that the results of this perceptual test are more strongly associated with perception and work on dictations in solfeggio instruction than with intonation, which additionally relies on the function of the vocal apparatus.

For the purpose of testing the reliability of MET, the Cronbach's alpha method was used on the results of the entire sample, where we obtained a coefficient of  $\alpha=0.81$  for the entire test. Summarizing the findings, we concluded that the "implementation of the Musical Ear Test represents a significant scientific contribution, which relates to its future application in music-educational, psychological, sociological, medical, and other research, where a wide range of variables can be examined according to the level of musical abilities." The significance of this accessible, valid, objective, and time-efficient instrument is also evident in its "practical pedagogical application - in the context of entrance exams or in organizing instruction that involves the selection and grouping of students based on the level of musical abilities, or the level of acquired knowledge and skills" (Nikolić and Kodela, 2015: 624).

The possibility of online implementation of MET was examined in the study by Correia et al. (2022). The authors used the Gorilla platform (<http://www.gorilla.sc>) for the online test administration, and the study included a sample of 608 participants aged 18 to 88 years. The research concluded that "online administration of MET is a valid and reliable alternative to traditional in-person measurement of musical abilities" (Correia et al., 2022: 966). In another study on the characteristics of MET with a sample of 523 undergraduates at a Canadian university, it was concluded that "MET appears to have adequate psychometric characteristics that make it suitable for researchers who seek to measure musical abilities objectively" (Swaminathan et al., 2021).

The instrument called the **Profile of Music Perception Skills (PROMS)** (Law & Zentner, 2012a; 2012b) was created with the aim of providing researchers with an objective assessment of the ability to perceive musical elements, i.e., the perceptual musicality of the participants. When designing this instrument, the authors started with the requirement that the test be suitable for participants with different qualities of musical experiences, include more musical-perceptual features compared to previous tests, and meet contemporary standards for validity and reliability. The PROMS battery consists of 9 subtests, each containing 18 pairs of musical tasks. Although participants perceive the heard phrases as either the same or different, the characteristic way of solving tasks involves a larger number of provided answers: "definitely the same," "probably the same," "probably different," "definitely different" (where a correct "definite" answer earns 1 point, and a "probably" answer earns half a point), as well as the option "I don't know," which reduces the possibility of guessing.

The first test, melody, is similar to previously created tests of musical abilities and brings pairs of melodic phrases graded according to the requirements from simple to more complex (atonal). The phrases are performed on the harp, with a more neutral, "less familiar" timbre. The second test is the rhythm test, which contains rhythmic phrases of two measures in 4/4 meter. Here, a clear and bright percussive timbre (snare drum rim) is used. The third subtest represents a novelty in perceptual melodic-rhythmic requirements by presenting tasks of rhythm recognition in a melodic context. Participants first memorize a rhythmic phrase performed on percussion, after which they assess whether the melodic phrase contains the same rhythm. The melodies in these tasks are simple and tonal so as not to distract attention from the perception of the rhythmic component. The fourth test, in terms of construction, is similar to the second (rhythm test) but brings changes in accent. In it, pairs of identical rhythmic phrases are presented, where the accentuation of individual beats is changed. The fifth test consists of pairs of sound stimuli, some of which are performed at different tempo. It starts with larger tempo differences (7 beats per minute), while the most demanding pairs of phrases differ by only one beat. It is characteristic that different tasks in the tempo subtest contain different combinations of timbres: some items are performed on percussion, while others, thanks to the presence of a larger number of instruments, include melodic and harmonic components. The sixth, pitch test, is based on principles used by Seashore in his tests, as the authors use pure tones, constant initial frequency and intensity, as well as a difference of less than a musical semitone (from 12 to 2 hertz). In the seventh, timbre test, a C major chord (notes C-E-G-C) is used, performed on instruments of the symphony orchestra, where in more complex

tasks, participants need to recognize a change in timbre on only one note. The eighth, tuning test, examines the sense of harmony using the same chord from the previously described timbre subtest. Changes involve subtle changes in the tonic third (from 50 to 10 cents) that affect the consonant sound of the chord. This test was performed on a piano timbre. The last, ninth subtest examines the sensory property of loudness perception, for which, as in the sixth (pitch test), pure tones are used. Differences in intensity range from 7 to 1 decibel. The reliability coefficient for the complete test obtained by the Cronbach's alpha method is  $\alpha=0.94$ .

Although PROMS covers a wide range of musical-perceptual features, it does not include higher-order musical abilities (assessment of phrasing, balance, musical expression), as emphasized by the authors themselves (Law & Zentner, 2012b). Another negative factor is the length of the entire test, which takes about 60 minutes. For this reason, the authors propose a shortened version of the test – **Brief PROMS** – which includes four out of the total nine subtests: melody, tuning, accent, and tempo. It has been found that this more time-efficient version is highly correlated with the full test ( $R=0.95$ ,  $p<0.01$ ) and possesses a satisfactory reliability coefficient ( $\alpha=0.84$ ), justifying its practical application.

Based on the PROMS and Brief PROMS tests, shortened versions of the instruments were created. **PROMS-S** contains eight subtests (excluding loudness subtest from PROMS) with a reduced number of tasks (68) and a test duration of about 25 minutes. **Mini-PROMS** is a test version that can be implemented in about 15 minutes, containing four subtests and 36 tasks (Zentner & Strauss, 2017). The latest and most time-efficient version of the test is **Micro-PROMS**, designed to "assess musical ability that taps into a broad range of music perception skills and can be administered in 10 minutes or less" (Strauss et al., 2023: 1). It includes a total of 18 tasks, where the reference stimulus is played twice, followed by the comparison stimulus. A characteristic feature is that the tasks are taken from all subtests of the full-length PROMS, except for the loudness subtest. Although it is the shortest version of the test, research has shown that it is highly correlated with the previously mentioned Musical Ear Test. The authors emphasize that Micro-PROMS is "particularly useful in situations where time is critical, and researchers are primarily interested in a summative, overall estimate of musical ability" (Strauss et al., 2023: 13). Another positive aspect of this test is the fact that it is adapted for online use (considering the specificities of the operating system and browser), which proved to be particularly useful during the 2020-2022 pandemic.

#### 4. CONCLUSIONS

In discussing the assessment of musical abilities, two main approaches were hinted at – oral assessment of musical reproduction and the measurement of perceptual musical abilities through tests. According to Radoš (2010), the basic characteristics of psychological testing in relation to traditional musical approaches are: greater validity of results (since a large number of musical features are covered by the examination), greater reliability of results (due to a relatively large number of tasks), and complete objectivity, as the test "is administered and evaluated in the same way by anyone, achieving independence of test results from the personalities of the examiner and the examinee" (Radoš, 2010: 50). We would add a positive aspect of testing related to time efficiency. The process of perceptual assessment of musical abilities, where tasks are acoustically presented via an audio device while participants silently record their responses, allows for group testing. This enables the examination of a large number of children during one or two school hours. On the other hand, many musicians consider the lack of vocal and manual reproduction as the main drawback of these tests, citing these activities as primary forms of expressing musical abilities. As a compromise, it can be recommended to use both oral reproduction assessment and perceptual measurement tests simultaneously. Such research can identify students with good perceptual abilities who may not be identified through performance and regular teaching activities (Haroutounian, 2008).

When it comes to assessing students' musical abilities in schools with the aim of fostering abilities and organizing differentiated teaching, the question arises about the age at which testing should be performed. In connection with this, we can cite the results of a study in which the authors tested the musical abilities of children aged 5 to 10 years and conducted measurements again after 5 years. One conclusion of this longitudinal study is that "early musical abilities significantly predicted later abilities, demonstrating that individual differences are stable over time" (Kragness et al., 2021: 2). Therefore, the assessment of students' musical abilities should start at an early age. With this goal in mind, the paper presents tests that can be applied at the ages of 4 to 6 years (MBEMA on tablet), 6 to 8 years (MBEMA), or 6 to 12 years (ITAT).

The analyzed tests of musical abilities in this paper can successfully assess primarily basic musical abilities (abilities related to a sense of pitch, sense of rhythm, and musical memory). Almost all tests contain tasks in which melodic or rhythmic motifs are evaluated as the same or different, which undoubtedly requires active involvement of musical memory. While some tests cover only the areas of melody and rhythm (e.g., MET), others include tasks related to harmony, dynamics, (MAT), tuning, or loudness (PROMS), so the choice of the test will depend on the research needs. The duration of the tests also varies significantly, with some tests taking only 10 minutes for implementation

(Micro-PROMS) while others require up to 90 minutes (MBEA). The manner of expressing results should also be taken into account because most tests offer an overall score, while, for example, MAT results are presented in the form of a five-dimensional profile.

All the above leads to the conclusion that, concerning research needs, age, or test duration, appropriate tests can be selected that include corresponding subtests, as this measures different types of musical abilities. Another contribution is the fact that some of the mentioned tests have been adapted for online use (e.g., Gold-MSI, Micro-PROMS), allowing them to be more easily applied to a larger number of participants for research purposes in music education or other disciplines.

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