"Rhythmológos": A Web-based Environment for Musical Timing Test Procedures

Dr. GEORGIOS PAPADELIS - Dr. KONSTANTINOS PASTIADIS - DEPARTMENT OF MUSICAL STUDIES - ARISTOTLE UNIVERSITY OF THESSALONIKI - GREECE
PANAGIOTIS GEORGIOPOULOS - ATHANASIOS FOULOULIS - DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING - ARISTOTLE UNIVERSITY OF THESSALONIKI - GREECE
Dr. KATIE OVERY - INSTITUTE FOR MUSIC IN HUMAN AND SOCIAL DEVELOPMENT - SCHOOL OF ARTS - CULTURE AND ENVIRONMENT - UNIVERSITY OF EDINBURGH, UK

introduction

1 The paper presents a novel software implementation of a set of previously introduced musical tests that may enable researchers to study various aspects of musical rhythm perception and related motor behavior. The musical tests and their subsequent analyses are grouped together into a suite of tools under the name of "Rhythmológos" (a compound word made up of two words: "rhythm" and "lógos" which is ancient Greek in origin. "Lógos" in its verbal form has a meaning that is closely related to the concept of reasoning).

The suite's modular structure allows for discrete implementation tests and processing algorithms as independent modules, thus supporting upgradeability and operational enhancement.

The system aims at the design and implementation of musical test procedures for the investigation of learning disabilities in pre-school and early primary-school childrens.

The testing procedure is based on a sequencial philosophy; first, data acquisition, and second, analysis, graphical representation and storage of processed data.

No specialized hardware equipment is required except for a pair of loudspeakers for sound presentation and a hand-tapping apparatus (such as a small drum with a miniature microphone connected to the PC sound card's input) for the acquisition of the examined child's rhythmic responses.

Supported Test Procedures

2 Currently 4 tests focusing on the perception/production of musical rhythm and melody, are implemented. These tests which examine tasks such as song rhythm tapping, rhythm copying, rhythm discrimination, and melody discrimination are based on a rivised version of the Music Aptitude Tests (MATs) [Overy, 2003]. A short description of each subtest and the associated interface is given below.

3 In the first test ("Happy Birthday test") the child is asked to synchronously tap the rhythm of a well known melody such as the Happy Birthday song (Fig. 1). Visual or plain text representation of results is also available at the end of the procedure.

FIG. 1

4 In the second test, rhythm and tempo copying capabilities are investigated. Short rhythmic patterns are presented over the speakers and the child is asked to repeat them by tapping on a portable tapping apparatus. The test procedure includes 14 test patterns of graded complexity and 4 patterns of isochronous beats at various tempi. An introductory phase using 2 task accomplishment examples may precede the testing session. The number of items that have to be run through in order to complete the test are indicated throughout the procedure. Visual or plain text representation of results is also available here (Fig. 2).

FIG. 2

Supported Test Procedures (Contd.)

5 The third and fourth tests, refer to rhythm and melody discrimination respectively. The child is asked to respond in a same/different manner, while listening to pairs of rhythm or melodic patterns which are presented sequentially over speakers. Each test procedure includes 14 trials of increasing difficulty. Both interfaces share the same layout (Fig. 3).

FIG. 3

Data management and navigation tools

6 "Rhythmológos" acquires child's responses and stores data into a specially designed database system. Moreover, the database system keeps a record under a unique ID strategy for each child. All stimuli and performance data are also stored on a per session basis.

7 Navigation among records, together with analysis results' representation, can be carried out through a specially designed web-based interface, employing data retrieval tools and structures (Fig. 4).

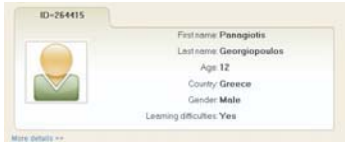

FIG. 4

Data analysis

8 A set of basic tools and algorithms for analysis and representation of responses are designed and implemented in the system. They include timelines, tables, percentage bars, signal, beat-index, and cyclic notation event visualizations. Each type of representation may be suited best to specific testsa and to different categories of users. Research-oriented users might need numerical-type information while typical examiners might prefer graphical representations.

Timelines illustrate child's tapping intervals in relevance to the correct ones (Fig. 5).

FIG. 5

Data analysis (Contd.)

9 Tables may contain numerical measures or tabulated comparisons between original and response data. For example, success or error indices for each test and examined person may be calculated and represented in the form of a percentage bar (Fig. 6, 7).

T1	T1p	T1cum	T1p cum	T1orig & p cum	abs diff	diff perc
	5058			5058		
1000	1041	1000	1041	1000	41	4.1%
1000	1082	2000	2123	2000	82	8.2%
1000	1091	3000	3214	3000	91	9.1%

92.867% Success for T1

FIG. 6

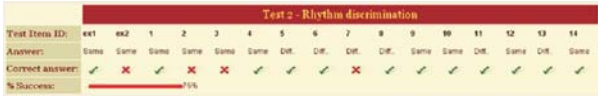

FIG. 7

10 Finally, representation of the original rhythm events and the corresponding tapping responses along a time axis, together with special visualizations of cyclic notation for both the original and performed rhythmic patterns may support performance evaluation (Fig. 8).

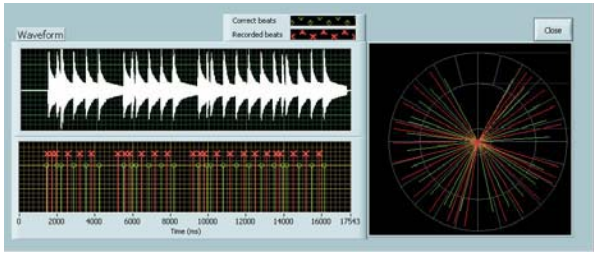

FIG. 8

A tool for subjective rating of rhythm pattern similarity

11 An additional tool for the subjective evaluation of childrens' rhythm copying capabilities was also developed. Musicians or persons with a high level of music experience are asked to evaluate resemblance between original and performed rhythmic patterns, on a Likert-type scale from 1 to 5 (Fig. 9). In this way, objective measures of musical performing acuity may be associated to subjective evaluations, thus offering the possibility for further research on expert, system- based intelligent modelling and recognition of disability-specific performance patterns. The tool is web-based and affords ease of remote access and execution by a large number of subjects.

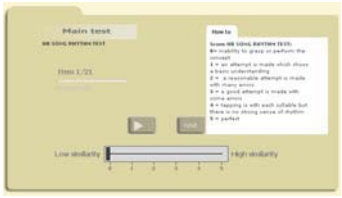

FIG. 9

2 Currently 4 tests focusing on the perception/production of musical rhythm and melody, are implemented. These tests which examine tasks such as song rhythm tapping, rhythm copying, rhythm discrimination, and melody discrimination are based on a rivised version of the Music Aptitude Tests (MATs) [Overy, 2003]. A short description of each subtest and the associated interface is given below.

3 In the first test ("Happy Birthday test") the child is asked to synchronously tap the rhythm of a well known melody such as the Happy Birthday song (Fig. 1). Visual or plain text representation of results is also available at the end of the procedure.

FIG. 1

4 In the second test, rhythm and tempo copying capabilities are investigated. Short rhythmic patterns are presented over the speakers and the child is asked to repeat them by tapping on a portable tapping apparatus. The test procedure includes 14 test patterns of graded complexity and 4 patterns of isochronous beats at various tempi. An introductory phase using 2 task accomplishment examples may precede the testing session. The number of items that have to be run through in order to complete the test are indicated throughout the procedure. Visual or plain text representation of results is also available here (Fig. 2).

FIG. 2

Data management and navigation tools

6 "Rhythmológos" acquires child's responses and stores data into a specially designed database system. Moreover, the database system keeps a record under a unique ID strategy for each child. All stimuli and performance data are also stored on a per session basis.

7 Navigation among records, together with analysis results' representation, can be carried out through a specially designed web-based interface, employing data retrieval tools and structures (Fig. 4).

FIG. 4

Data analysis

8 A set of basic tools and algorithms for analysis and representation of responses are designed and implemented in the system. They include timelines, tables, percentage bars, signal, beat-index, and cyclic notation event visualizations. Each type of representation may be suited best to specific testsa and to different categories of users. Research-oriented users might need numerical-type information while typical examiners might prefer graphical representations.

Timelines illustrate child's tapping intervals in relevance to the correct ones (Fig. 5).

FIG. 5

rhythmic patterns may support performance evaluation (Fig. 8).

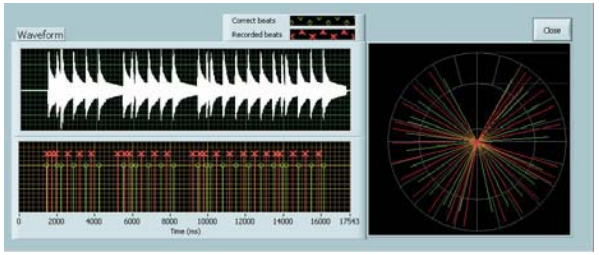

FIG. 8

A tool for subjective rating of rhythm pattern similarity

11 An additional tool for the subjective evaluation of childrens' rhythm copying capabilities was also developed. Musicians or persons with a high level of music experience are asked to evaluate resemblance between original and performed rhythmic patterns, on a Likert-type scale from 1 to 5 (Fig. 9). In this way, objective measures of musical performing acuity may be associated to subjective evaluations, thus offering the possibility for further research on expert, system- based intelligent modelling and recognition of disability-specific performance patterns. The tool is web-based and affords ease of remote access and execution by a large number of subjects.

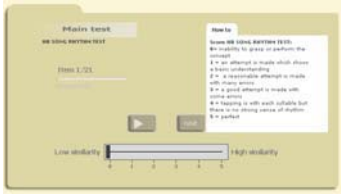

FIG. 9

Further Work

Our research aims to the development of a complete and portable system for the investigation of learning disabilities, based on evidence from musical performance. Rhythmologos provides both a user friendly interface that may be accessible to psychologists as well as musicians, and an analysis and representation infrastructure that permits further research on the domain. The suite may well be used for investigation of children between age 5 to 8. Currently, various statistics and special pattern recognition algorithms are being developed and studied, aiming towards disability and severity identification, based on stored examination data. New visualization schemes are implemented in order to support comprehension of performance patterns. Additional large scale examination using the proposed system is also scheduled.

References

Overy, Katie. (2003). Dyslexia and Music: From Timing Deficits to Musical Intervention. Annals of the New York Academy of Sciences, 999, 497-505.

Overy, Katie; Nicolson, Roderick; Fawcett, Angela and Clarke, Eric. (2003). Dyslexia and Music: Measuring Musical Timing Skills. DYSLEXIA, 9, 18-36.

Scavone, Gary; Lakatos, Stephen and Harbke, Colin. (2002). The Sonic Mapper: An interactive program for obtaining similarity ratings with auditory stimuli. Proceedings of the 2002 International Conference on Auditory Display, July 2-5, Kyoto, Japan.

Toussaint, Godfried (2004). A Comparison of Rhythmic Similarity Measures. School of Computer Science, McGill University, Montreal, Quebec, Canada. August 18, 2004.

Penel, Amandine and Drake, Carolyn (1998). Sources of timing variations in music performance: A psychological segmentation model. Psychol Res 61, 12-32.

Paulus, Joun and Klapuri, Anssi. (2002). Measuring the Similarity of Rhythmic Patterns. International Conference on Music Information Retrieval. Paris, France: ISMIR

Converce, Tim; Park, Joice and Morgan, Clark. PHP and MySQL Bible. WILEY.

Contact info

Georgios Papadelis - papadeli@mus.auth.gr

Konstantinos Pastiadis - pastiadi@auth.gr

Panagiotis Georgiopoulos - panageo@gmail.com

Athanasios Fouloulis - afululis@auth.gr

Katie Overy - k.overy@ed.ac.uk