Primary School Music Education and the Effect of Auditory Processing Disorders: Pedagogical/ICT-based Implications

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Abstract

Primary music education introduces children to the world of sound and music. For some children, however, auditory process disorders (APDs) act as a barrier to the comprehension of the sound elements, like rhythmic motives, variations, etc. The effect of APD in music perception is often neglected within classroom activities. This paper tries to shed light upon this effect, by focusing on duration comprehension. Experimental results from APD testing in pupils (9-12 yrs) from three Greek primary schools show that age influences the duration pattern sequence perception. Moreover, sensitivity in spatial sound information is increased in the age of 10 yrs. These results initiate some implications for ICT-based approach in music education that would foster adaptation to pupils' special needs during the educational process.

1. Introduction

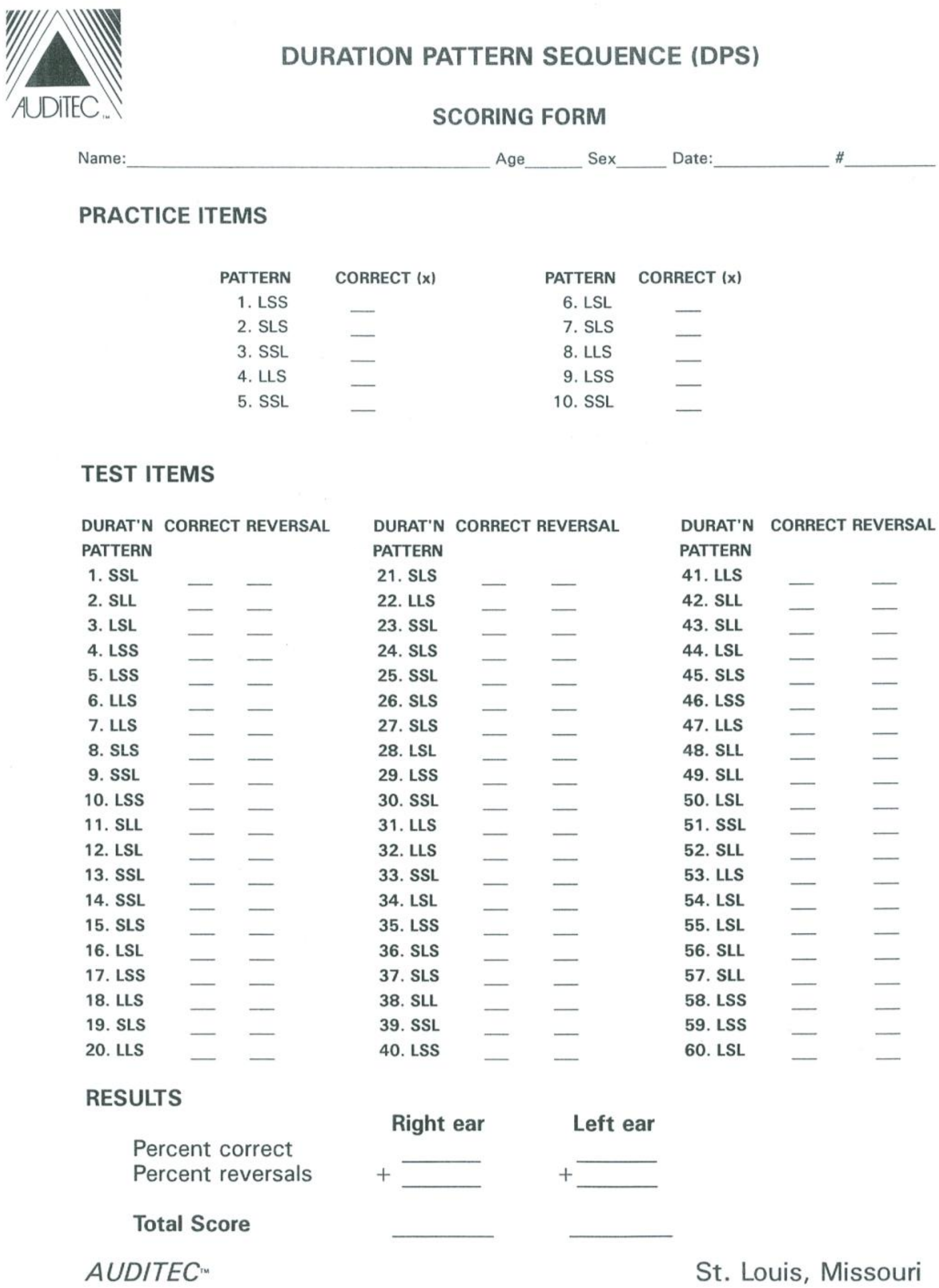
The learning environment in primary classrooms provides a psychologically safe, secure and stimulating climate for children. This is further sustained when creative educational processes evolve, like those in music education. Primary school music educators aim at bringing the world of sound into the classroom, so every child has the opportunity to play music, to listen to music and to create their own music. The listening skills developed in music lessons are relevant and of great benefit to children throughout the whole curriculum, not just in music lessons. The creativity and problem solving skills children develop as they make their own musical compositions are vital to creating a well-rounded child able to perform confidently in the 21st century [1]. In the last decade, the use of information and communication technologies (ICT) in schools is commonplace and, for many teachers, an unquestionable part of everyday teaching and learning. In the case of music education, ICT-based education means (e.g., music performing software, computer-based music lessons, multimedia, etc) have been proposed, providing new ways of access, opening up new musical experiences and even enhancing teaching, in general [2].

Although sound is the aural information carrier, the auditory processing capabilities of children have often been neglected and not considered within a pedagogical framework, despite the possible effect of auditory processing disorders (APDs) in pupils' music appreciation and learning. APD is a complex problem affecting about 5% of school-aged children. These kids cannot process the information they hear in the same way as others because their ears and brain do not fully coordinate. Something adversely affects the way the brain recognizes and interprets sounds. Children with APD present deficiency in sound localization-lateralization, auditory discrimination, auditory pattern recognition, temporal aspects of audition, difficulty with competing signals and/or difficulty with degraded acoustic signals [3]. It is often hard to find an etiological basis for APD in a particular deficit; some etiologies include neurological compromise, cognitive deficit, language [4] or auditory deprivation [5]. The American Academy of Audiology consensus document [6] describes comorbid disorders in APD and proposes differential diagnosis of APD.

In the view of the above, some educational implications that derive from the results of an APD test-case in the primary school are presented and discussed here.

2. Material & Methods

One hundred children [25 (9 yrs; 11 boys; 14 girls), 25 (10 yrs; 11 boys; 14 girls), 25 (11 yrs; 14 boys; 11



AUDITEC™

DURATION PATTERN SEQUENCE (DPS)

SCORING FORM

Name:____________________ Age______ Sex_____ Date:____________ #__________

PRACTICE ITEMS

PATTERN	CORRECT (x)	PATTERN	CORRECT (x)
1. LSS	___	6. LSL	___
2. SLS	___	7. SLS	___
3. SSL	___	8. LLS	___
4. LLS	___	9. LSS	___
5. SSL	___	10. SSL	___

TEST ITEMS

DURAT'N PATTERN	CORRECT	REVERSAL	DURAT'N PATTERN	CORRECT	REVERSAL	DURAT'N PATTERN	CORRECT	REVERSAL
1. SSL	___	___	21. SLS	___	___	41. LLS	___	___
2. SLL	___	___	22. LLS	___	___	42. SLL	___	___
3. LSL	___	___	23. SSL	___	___	43. SLL	___	___
4. LSS	___	___	24. SLS	___	___	44. LSL	___	___
5. LSS	___	___	25. SSL	___	___	45. SLS	___	___
6. LLS	___	___	26. SLS	___	___	46. LSS	___	___
7. LLS	___	___	27. SLS	___	___	47. LLS	___	___
8. SLS	___	___	28. LSL	___	___	48. SLL	___	___
9. SSL	___	___	29. LSS	___	___	49. SLL	___	___
10. LSS	___	___	30. SSL	___	___	50. LSL	___	___
11. SLL	___	___	31. LLS	___	___	51. SSL	___	___
12. LSL	___	___	32. LLS	___	___	52. SLL	___	___
13. SSL	___	___	33. SSL	___	___	53. LLS	___	___
14. SSL	___	___	34. LSL	___	___	54. LSL	___	___
15. SLS	___	___	35. LSS	___	___	55. LSL	___	___
16. LSL	___	___	36. SLS	___	___	56. SLL	___	___
17. LSS	___	___	37. SLS	___	___	57. SLL	___	___
18. LLS	___	___	38. SLL	___	___	58. LSS	___	___
19. SLS	___	___	39. SSL	___	___	59. LSS	___	___
20. LLS	___	___	40. LSS	___	___	60. LSL	___	___

RESULTS

	Right ear	Left ear
Percent correct	______	______
Percent reversals	+ ______	+ ______
Total Score	________	________

AUDITEC™ St. Louis, Missouri

Figure 1. The scoring form by *AUDITEC™* used in the study. *L* and *S* denote short and long duration, respectively.

girls), 25 (12 yrs; 13 boys; 12 girls)] from three public primary schools in Thessaloniki, Greece, were involved in an APD test-case study. A duration pattern sequence (DPS) test, i.e., a 3-tone sequence of short (*s*) and long (*l*) tones, combined with stereo [left (L)-right (R)] testing was performed, using the *AUDITEC™* auditory test recordings and DPS protocol (www.auditec.com). Pupils were initially familiarized with the stimuli by performing a practice phase of 10 various 3-tone patterns (5L/5R). Then, a series of 40 3-tone patterns (e.g., *ssl*;

sll; *lsl*; *lss*, etc, 20L/20R) was performed. All stimuli were presented at an average level of 70 dB SPL at the frequency of 1000 Hz. The *s* sound was 250 msec whereas the *l* one was 500 msec. The inter-tonal interval was set to 3000 msec and the rise and fall times both to 10 msec. The percentage of correctly or reversal (i.e., *s* instead of *l* or mirroring, e.g., *sll* instead of *lls*) identified stimuli formed the scores. Data analysis was performed using Matlab 7.4 (The Mathworks, Inc., USA). Figure 1 illustrates the scoring form used in the study.

3. APD Test-case Results

All the variables were found to follow non-Gaussian distribution (tested with the Kolmogorov-Smirnov test with Lilliefors significance correction); hence percentiles instead of means and standard deviations were used. Medians and percentile range per pupils' grade are presented in Fig 2. The latter denotes that age affects pupils' auditory processing, as variation in auditory scores is noticed for the transition from 9 to 12 years.

Furthermore, the statistically significant decrease (Kruskall Wallis nonparametric test) of the R/(L+R) scores for the age of 11 yrs (5^{th} grade) it is noteworthy. Moreover, the reversal score is kept low and almost constant for all the stimuli. DPS differences between R and L ears were not statistically significant.

Finally, a significant correlation value (Spearman 0.59; $p<0.01$) was found between the R and L scores for pupils of 10 yrs.

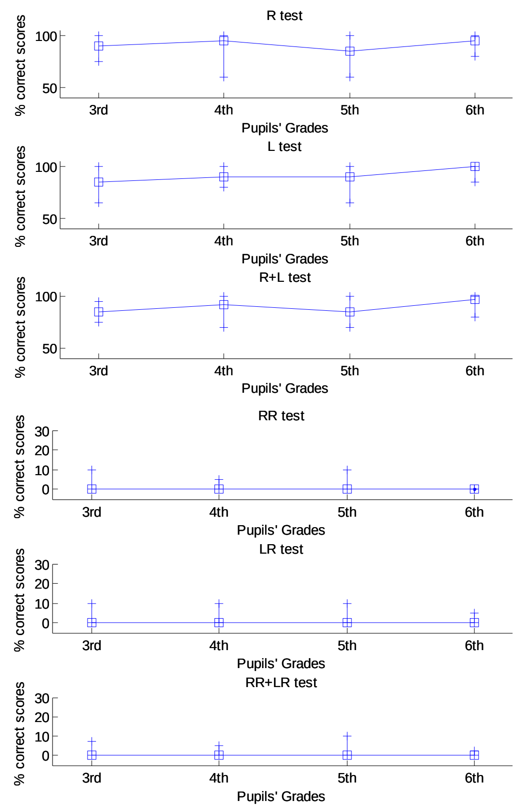


Figure 2. Scores for different stimuli. The *R (*=R, L) corresponds to reversal score for each case. Bars indicate the range between percentiles 10 and 90, whereas the middle line connects the grades medians.

4. Educational implications

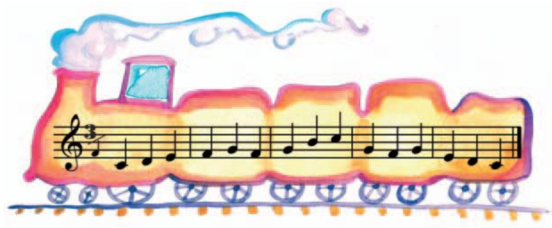
4.1 Rhythm structure perception

From the above DPS test results it is clear that APD could be related with one of the basic characteristics of music, i.e., rhythm. Rhythmic motives (cells) could clearly be seen as musical metaphors of the 3-tone patterns. Consequently, based on the age effect in the audio processing, specific caution could be placed in the manipulation of musical examples for different grades, containing rhythmic cells that form more complex patterns.

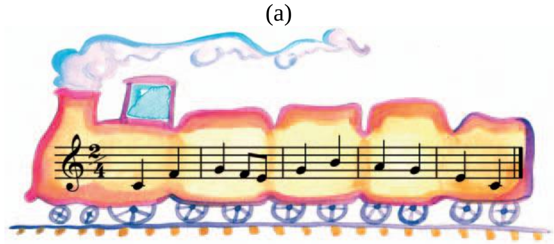
Based upon the aforementioned perspective, some insight in the Greek primary school music curriculum took place, in an effort to identify any possible occurrences of such rhythmical cells in the educational practice. This is of special importance, as the books for the Greek primary school music education are newly introduced, covering just only one year in classroom practice. Consequently, their correlation to APD is totally a new concept for the Greek music education reality.

4.1.1 Third and fourth grades. For these grades, there is a common book in the Greek music curriculum. In that book, the first notion about rhythm is given to the pupils in a graphical way (see Fig. 3). In that graph, the focus is on the periodicity of the rhythm, trying to establish a kind of rhythm reference. Nevertheless, the randomness in the right graph of Fig. 3 could also provoke some rhythm patterns, yet more complex.

Figure 3. Graphical representation of rhythm. Left: periodic rhythm, right: absence of rhythm.



(a)



(b)

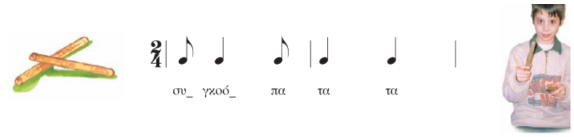
Figure 4. (a) The *lll* pattern within a melody in ¾ time signature (*l* corresponds to quarter), (b) Combination of the *lss* (bar 2) within the 2/4 time signature (*l* corresponds to quarter, *s* corresponds to eighth).

In a more advanced approach, a sequence of similar patterns is introduced (see Fig. 4(a)), where in a ¾ time signature the pattern of *lll* (where each *l* corresponds to quarter) is dominant. Moreover, the *lss* pattern (see Fig. 4(b), bar2) is combined with 2/4 time signature (*l* corresponds to quarter; *s* corresponds to eighth).

Unfortunately, rhythm analysis of the book did not reveal any complex rhythms referring to rhythmic motives, indicating a severe lack of rhythmical patterns, as the combinatory ones used in the APD test.

4.1.2 Fifth grade. In this curriculum, rhythm continues to be quite simple, indicating a lack of combinatory elements and extension of rhythmic motives. Some examples of the use of *sls* motive are shown in Fig. 5(a), along with equivalent representation of a quarter with the *lss*, *ssl* and *lll* patterns (see Fig. 5(b)). Rhythmic combination is met only at the end of the book, where the Greek anthem and some, mainly, traditional melodies serve as examples of rhythm development.

4.1.3 Sixth grade. In this grade, the curriculum tries to establish combinations of rhythm patterns by employing a polyphonic approach in the rhythm structures. As it is clear from the example of Fig. 6, a rhythmical canon is structured consisting of the simple cell of *lss* in delayed repetitions across the four players. The diminished Os denote diminuendo in dynamics across the evolution of the rhythmical pattern.



(a)

(b)

Figure 5. (a) The *sls* pattern within a melody in 2/4 time signature (*l* corresponds to quarter, *s* corresponds to eighth), (b) Combinations of the *lss*, *ssl* and *lll* on the common basis of a quarter.

Figure 6. An example of a rhythmical canon based on the delayed repetition of the *lss* pattern across the four players.

As in the previous cases, the music curriculum of the sixth grade does not involve significant information about the evolution of rhythm, showing a fragmented approach in the rhythm issue.

4.2 Rhythm variation perception

The APD test results showed low values in reversal score. This indicates the efficiency of most of the children to identify subtle variations of the tones duration; hence, to recognize rhythmic variations, even in its ‘primitive’ form. This approach is merely seen in the curriculum of the sixth grade only, where more macroscopic rhythmical structures are used combined with the text structure (e.g., intonation) of traditional folksongs. Such example is depicted in Fig. 7, where the variation in 3-tone cells is evident, e.g., initial appearance as quarter followed by two halves (bars 2-3, *sll* pattern with *s* and *l* corresponding to quarter and halves, respectively) and then in a complementary form (bars 3-4, *lss* pattern with *l* and *s* corresponding to half and quarters, respectively). Moreover, the *lll* pattern in

Figure 7. An example of variation of 3-tone rhythmic cells, following the structure of the text.

bar 25 is followed by the *ssl* pattern (end of bar 26), and the *ssl* pattern (end of bar 28) is followed by the *lss* one (bar 29), employing diminution of halves to quarters (*l*) and quarters to eighths (*s*).

In all cases, however, there is no conscious implementation of the rhythm variation in music lessons, but only incidental occurrence, which denotes that children mostly rely on their natural ability to distinguish rhythm changes and variations, mainly in a short time window.

4.3 Spatial perception

The equal sensitivity of pupils in L/R seen in the results facilitates the recognition of spatial music gestures (e.g., panning, surround, etc), whereas, the age of 10 yrs seems to be more effective to appreciate spatial changes. However, there is no mentioning of the spatial property of the sound in the primary music curriculum, eliminating the opportunity from the kids to imagine spatial movements and gestures, source directions, sound effects (such as delays, reflections, echo, etc) and employ them in their sound perception and gaming practice.

5. ICT implications & concluding remarks

The abovementioned observations could be reflected in ICT-based music applications. In particular, computer-based ear training could incorporate DPS-type test, providing APD quantitative results and improvement indicators to the educators in an objective fashion. Computer music games, which combine playing with music learning, could initiate and sustain targeted auditory processes (e.g., rhythm/melody/lyrics comprehension) during the game. An example of such approach is given in Fig. 8, which previews screenshots from the music education software Music Ace 2

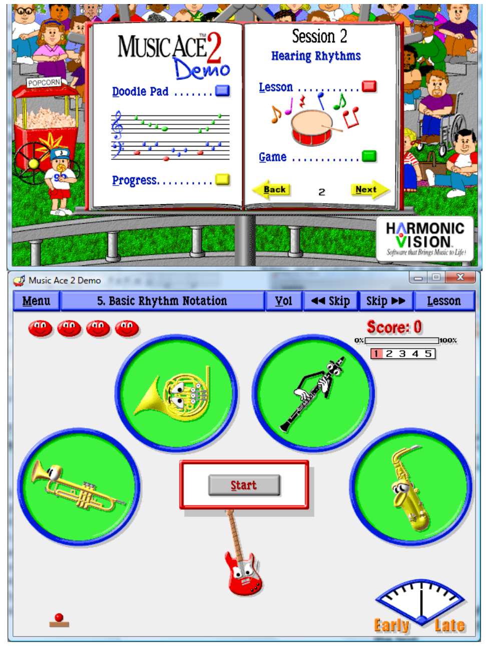


Figure 8. An example of the hearing rhythm game of the Music Ace 2 software.

(www.harmonicvision.com). This software incorporates graphic interface suited to children with a helping companion (like tutor) that helps the navigation across the functionality of the software and provides appropriate rewarding feedback. Moreover, the software combines lessons and games on basic topics of music, such as rhythm, pitch, timbre, etc.

In all cases, ICT embedded in the primary music education could support a customization to the accessibility and usability needs of both disabled and non-disabled pupils.

6. References

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