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ORIGINAL ARTICLE

Relationship between rhythmic ability and type of motor activities in preschool children**Ilias Agdiniotis¹, Elisana Pollatou¹, Vassilios Gerodimos¹, Vassiliki Zisi¹, Konstantina Karadimou¹ & Fani Yiagoudaki²**¹ University of Thessaly, Department of Physical Education & Sport Sciences, Trikala, Greece² Aristotle University of Thessaloniki, Department of Physical Education & Sport Sciences, Thessaloniki, Greece**Abstract**

The purpose of the present study was to investigate the rhythmic ability of pre-school children engaging in motor activities accompanied or not by music. A total of 180 children (90 boys and 90 girls) at the age of 5±0.5 were randomly selected from kindergartens of Magnesia area-Greece to participate in the study. The High/Scope Rhythmic Competence Analysis Test (Weikart, 1989) was used for the evaluation of rhythmic ability using 2 testing tempos: 120 and 130 beats. The 3-way ANOVA revealed that all children performed significantly better in lower tempo ($p < .05$) and girls performed better than boys ($p < .05$). The test scores were significantly different among the three activity groups ($p < .05$) with the best performance shown on the group of motor activities accompanied by music and then the group of motor activities without music. Girls in the first group (activities accompanied by music) significantly surpassed boys of the same group in both testing tempos. In conclusion, motor abilities accompanied by music, play an important role to the development of rhythmic ability. More research is needed on the effects of music on the development of children's rhythmic abilities taking into account gender and maybe former movement repertoire.

Key words: *rhythm, music, rhythmic test, physical activity, preschoolers.*

Introduction

Rhythm is considered the fundamental characteristic of every movement (Cabbard, 1992) and is identified as an important factor for the development, performance and learning of motor abilities. Rhythm contributes to every human activity and gives life a harmonious balance. Gallahue (1996) supports that, when movement is accompanied by rhythm, a child is able to perform the fundamental motor abilities better, and their development is enforced due to the element of rhythm incorporated in all these movements. Derri, Tsapakidou, Zachopoulou, and Kioumourtzoglou, (2001) characterize rhythm as a teaching means which stimulates children's interest while contributing to the development of motor concepts and abilities. Motor education, therefore, through rhythm conduces to the aesthetic refinement of the child (Matei, 1986).

Matei mentioned that the word "rhythm" comes out of the greek word "ρέω" (in english "flow") and it means that something is moving continuously, with flow. (Matei, 1992.) According to Dalcroze it is a "sequence of interconnecting movements which compose a whole and capable repetitive entity" (Findlay, 1971). Huff (1972) supports that "rhythm is the temporal patterns of energy which are conceived by the senses of hearing, vision and kinesthesia".

Oreb and Kilibarda, (1996) mention that when rhythm is exploited in movement, it activates the proper muscle groups at the proper time. Propst (2003) and Bachmann (2002) add that rhythm contributes to the improvement of the emotional state and the

activation of the movement mechanism in children, enabling them to perform movements with uninterrupted flow. Several terms have also been used in order to describe the rhythmic ability such as sense of synchronization, rhythm, smoothness, elegant action etc.

Rhythmic ability constitutes a factor of great importance in development, performance and learning of motor abilities (Thomas & Moon, 1976). By the term of rhythmic ability we define the ability of synchronization of bodily movements by means of sound or musical stimulation (Rose, 1995). Martin (1988) and Gilbert (1980) define the above ability as the ability to observe, control and differentiate the performance rhythm of a movement depending on the requirements of that particular time. This ability facilitates the understanding, memorization and presentation of the movement based on information of the temporal and dynamic structure which contributes to the performance of this movement. Weikart (1989) reports that rhythmic ability is acquired through participation in motor activities, which require accurate response to rhythmic stimulation. Rhythmic ability can better be described as the ability to perform a sequence of normal, repetitive, clear-cut movement events with spatial and temporal accuracy (Derri, Tsapakidou, Zachopoulou, & Gini, 2001; Fitzpatrick, Schmidt, & Lockman, 1996).

In rhythmic ability, as far as gender influence is concerned, there is a relative difference of opinion in the researchers' results. Research conducted by Kuhlman and Schweinhart (1999), High (1987), Thomas and Moon (1976), Smoll (1973; 1974; 1975a; 1975b), Huff (1972), and Gardner (1966) concludes that boys and girls do not differ in their spatial-temporal movement response to rhythmic stimulation. However, some other researchers support that girls perform better than boys in rhythmic ability (Kampas, Ageloussis, Gourgoulis, Barbas, & Antoniou, 2000; Kampas, Beis, Mavridis, Papargiriou, & Taxildaris, 1995; Kuhlman & Schweinhart, 1999; Mitchel, 1994; Schleuter & Schleuter, 1985; Serbezis, & Goulimaris, 1995; Stanley & Schleuter, 1989) a fact that could possibly be attributed to the use of different measurement instruments.

In a research of Derri et al. (2001), where the relation of gender, age and rhythmic ability of pre-school children were studied, it was apparent that girls performed with greater accuracy the bilateral movement of the arms than boys, while boys performed with greater accuracy the bilateral movement of the legs in a seated position. Pollatou, Karadimou and Gerodimos (2005) examined the differences between boys and girls at the age of 5 in their music ability, rhythmic ability and performance in motor abilities and it was apparent that girls performed better in four out of the six movements of the rhythmic movement test.

The review of the worldwide bibliography demonstrates that, in preschool age, there is a connection between rhythmic ability and the performance in language and reading (Haines, 2003; Mitchel, 1994). The systematic exposure of preschool children to musical stimulus contributes to the improvement of their spatial and temporal perception (Rausher & Zupan, 2000; Grandin & Peterson, 1998; Gromco & Poorman, 1998; Rausher et al., 1997; Gardiner, Fox, Knowls, & Jeffrey, 1996). Music-listening (musico-acoustic) ability improves significantly at this age with systematic practice (Blessedel, 1991). Furthermore, it is reported that the systematic training of preschool children in music contributes to the development of mathematical thinking and skills such as classification, comparison, succession and counting (National Council of Teachers of Mathematics, 1989).

The rhythmic ability increases when there is a music-movement program appropriate for preschool age (Zachopoulou, Derri, Chatzopoulos, and & Ellinoudis,

2003). Music, in preschool age and primary school age, helps not only the cultivation of the child's aesthetic perception but also its psychomotor and emotional development (Tsapakidou, Zachopoulou, & Zografou, 2001). Rhythmic accompanying contributes to a better performance of movement concepts (Tsapakidou et al., 2001), static skills (balance), moving skills (galloping, jumping, running) basic motor abilities and affects positively motor accuracy (Martin & Ellerman, 2001), compared to gamelike activities (Derri et al., 2001), while it creates a pleasant learning environment (Karageorgis & Terry, 1997). Moreover, music and rhythm during the motor performance contribute to the simplification of the perceived movement, coordinate (synchronize) the movement with the musical stimulus (Karageorgis & Terry, 1997) and positively affect motor accuracy (Martin & Ellerman, 2001).

It's observed that motor programmes accompanied by rhythm in primary school children (6-12 years) result to greater improvement in the performance of the basic motor abilities, comparing to traditional teaching, which is not accompanied by rhythm (Brown, Sherill, & Gench, 1981). Liemohn and Wagner (1975) found out that the rhythm ability which was demanded for someone to follow the rhythm of metronome was greatly related to the improvement of the level of the motor abilities. In another research of Derri et al. (2001) was studied the effect of a music motor program of 10 weeks to the quality of motor abilities, to children of 4 to 6 years. From the results it came out that the music motor program greatly improves the quality of certain and more complicated kinetic abilities.

Pollatou and Hatzitaki (2001) studied the influence of a program that included rhythmic and motor training to the improvement of basic motor abilities of children of pre school age. The authors concluded that a program of rhythmic motor activities could contribute in the development of fundamental abilities of pre school age children, which are necessary for the future skilled performance in sport skills. Similar were the conclusions by Zachopoulou, Tsapakidou and Derri (2004). They studied the influence of a physical education program including rhythmic motor activities accompanied by music to the improvement of jumping and dynamic balance of children aged 4 to 6 years. Children who followed the certain program for two months, improved significantly their jumping and dynamic balance confirming the hypothesis that a proper music and motor developing program may have a positive influence on the jumping and dynamic balance of pre schoolers.

Trainor, Shahin & Roberts (2009) studied the benefits of musical training on oscillatory brain activity in 5.5 years old children after one year of musical training. They concluded that musical training affects oscillatory networks in the brain associated with executive functions, and that superior executive functioning could enhance learning and performance in many cognitive domains, like language and mathematics.

Having taken into consideration the important role of rhythmic ability in the performance and learning of the motor abilities and the development of the movement-perceptive sector of skills, the aim of this study was to investigate the rhythmic ability of preschool children who occupy themselves with kinetic activities accompanied or not by music. In Greece, research conducted on this theme is scarce (Pollatou, Liapa, Digelidis, & Zachopoulou, 2005; Pollatou, Karadimou, & Gerodimos, 2005). The present research comes to add support to the importance of exercising rhythm, during the performance of any kind of movement and to defend the use of rhythmic approach when learning motor skills. The research hypothesis was that there would be gender differences and some differences in the level of rhythmic

ability depending on the type of motor activities that the children systematically participate.

Methods

Participants

The participants of the study consisted of 180 children (90 boys and 90 girls) of pre-school age ($5\pm 0,5$), from the kinder gardens of the region of Magnesia, Greece. They were separated in 3 groups. In the first group, there were 30 boys and 30 girls who participated in motor activities accompanied by music (22 boys with traditional dances, 8 boys with music education, 15 girls with gymnastics and 15 girls with ballet). In the second group, there were 60 children who participated in motor activities which weren't accompanied by music (15 boys with football, 2 boys with basketball, 10 boys with swimming, 3 boys with karate, 22 girls with swimming, 4 girls with athletic activities and 4 girls with karate). The third group consisted of 60 children (30 boys and 30 girls) who had never participated in any kind of athletic activities. According to the questionnaire which was given to and answered by the parents, the children who took place in the study, were involved in athletic activities at least twice a week, for the last two months and they were all members of athletics teams.

Measurements

The test that was used for the evaluation of rhythmic ability was the High/Scope Rhythmic Competence Analysis Test (Weikart, 1989). This test was designed to evaluate the ability of a person to perform a motor sequence at a stable rhythm. It consists of 6 movements, which the subject is asked to perform in a synchronized way, in two different tempos, 120 and 130 beats per minute, of selected music.

The movements executed in the two different tempos are in detail:

- a. Simultaneous strikes of the hands on the thighs from a seated position
- b. Alternate strikes of the hands on the thighs from a seated position
- c. Marching from a seated position
- d. Marching from a standing position
- e. Walking forward
- f. Walking backwards

The evaluation of the test is conducted based on a scale of three points (0, 1, and 2). In each movement of the test the participant receives 2 points when he achieves to stay tuned to the rhythm at least for 8 consecutive movements (e.g. alternate strikes of the hands synchronized to the music). The participant receives 1 point when the performance of the movement is consistent but not accurate to the beat at least not for 8 consecutive beats and finally receives 0 points when he cannot achieve any of the above. A correct and complete performance of the test at a tempo awards 12 points and in the occasion that the participant succeeds fully in both tempos he/she receives the highest score of 24 points.

Weikart stated the approval of the context of the first publishing $r=79$ (Weikart, Schweinhart, & Larner, 1987). Weikart (1987) also found high reliability between the observers at a video recording that she did during the test. Both tests were used from many investigators and for a variety of ages (Derri et al., 2001; Jordan,

1985; Mitchel, 1994; Zachopoulou et al., 2003). At this certain research the agreement of the judges came up to 92%.

Counting process

The children came individually to the predetermined place, in the beginning the movements were illustrated by the examiner and then the participant performed them without any oral or kinetic interventions. Specific directions were given prior to the test and were common for all participants. A metronome was used for the reproduction of the tempo and the participants executed each set of movements firstly at 120 beats and the at 130 per minute. The evaluation of their effort was made by two judges and the children were recorded on video in every try, in case of a disagreement between the judges.

Statistical analyses

A mixed between-within subjects 2X3X2 (3-way) ANOVA was conducted to evaluate the effects of Gender, Activity Group and testing Tempo on the score of the High/Scope Rhythmic Competence Analysis Test. The between subjects factors was Gender with two levels (boy and girl) and Exercise Group with three levels (Group A= systematic participation in physical activities accompanied by music, Group B= systematic participation in physical activities not accompanied by music, Group C= no systematic participation in any physical activities). The within subjects factor was the tempo of the test, with two levels (120 and 130 beats). Follow-up analyses to significant interactions conducted using Independent Samples t-test. Bonferroni post-hoc tests was used as follow – up analyses to significant main effects. Levene's Test of Equality of Error Variances was not significant for any of the variables ($p>.05$).

Results

The means and standard deviations for the High/Scope Rhythmic Competence Analysis Test scores are presented in Table 1. The ANOVA indicated a significant Gender X Activity Group interaction ($F_{2,174} = 4.24, p<.05$, partial $\eta^2=.05$), and significant main effects for gender ($F_{1,174} = 5.30, p<.05$, partial $\eta^2=.03$) and activity group ($F_{2,174} = 107.35, p<.001$, partial $\eta^2=.55$). The main effect for tempo was significant ($F_{1,174} = 21.07, p<.001$, partial $\eta^2=.11$) but none of the interactions of tempo with the other variables was significant.

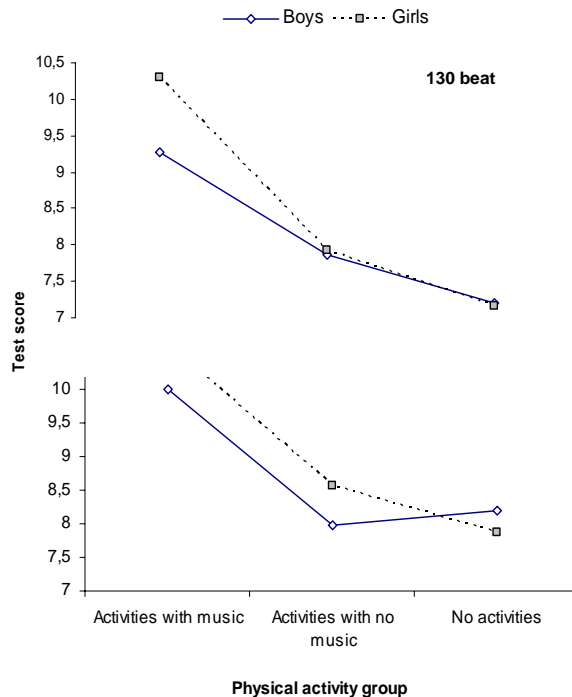
As shown in Table 1 all the participants performed better in the slower testing tempo of 120 beats. Girls in total, performed better than boys in both testing tempos of 120 ($M=9.03$ vs $M=8.69$) and 130 beats ($M=8.47$ vs $M=8.14$). Regarding the physical activity group, according to Bonferroni post-hoc tests, the children that used to participate in activities accompanied by music performed better than the children that used to participate in activities without music (Mean Difference = 1.98, $p<.001$) and the children that didn't participate systematically in any type of organized motor activities (Mean Difference = 2.45, $p<.001$). The children in the activity without music group performed better than the children in the no activity group (Mean Difference = 0.48, $p<.05$).

Table 1. Means and Standard Deviations for the High/Scope Rhythmic Competence Analysis Test at 120 and 130 beats. Significant differences between boys and girls at the three different physical activity groups are noted.

Physical activity group	120 beats						130 beats					
	Boys		Girls		Mean		Boys		Girls		Mean	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
A = Activities accompanied by music	10.00*	1.37	10.67*	1.03	10.33	1.24	9.27*	1.44	10.30*	1.06	9.78	1.35
B = Activities not accompanied by music	7.97	1.72	8.57	1.14	8.22	1.49	7.87	1.03	7.93	1.34	7.95	1.19
C = No activities	8.20	1.52	7.87	1.33	8.03	1.43	7.20	0.96	7.17	1.02	7.18	0.98
Total	8.69	1.79	9.03	1.66	8.86	1.73	8.14	1.43	8.47	1.75	8.31	1.61

* $p < .05$

The Gender X Activity Group interaction is presented in Figure 1. According to the follow up tests, in the group of children that participated in activities accompanied by music (group A) girls performed significantly better than boys in both testing tempos, 120 beats ($t_{58}=2.14$, $p < .05$) and 130 beats ($t_{58}=3.18$, $p < .01$). In the group of children that participated in physical activities not accompanied by music, at the slower tempo of 120 beats girls performed better than boys, these differences however did not reach significance ($t_{58}=1.86$, $p = .068$). At the faster tempo of 130 beats there were quite no differences between boys and girls. The performance of boys and girls in the no activity group (C) was quite similar in both testing tempos.

**Figure 1.** The gender X activity group interaction at both testing tempos of 120 and 130 beats.

Discussion

After processing the results, it was apparent that there was a significant statistical influence of the gender factor on the performance of the children during the rhythmic ability test at 120 beats and 130 beats, with girls performing better than boys. A significant statistical difference was obvious in the three groups, with higher performance rates for the group of children who participate in out-of-school activities accompanied by music in comparison with the two other groups. It was also apparent that there was a significant statistical interaction between gender and athletic activities in the rhythmic ability of the children at 120 and 130 beats per minute. The research hypothesis that there are differences in performance between the two genders, as well as the hypothesis that there are differences in the level of rhythmic ability of the three groups was, therefore, verified.

Regarding the Gender influence on children's rhythmic ability, in the present research there were significant statistical differences between boys' and girls' performances, a result which is in agreement with the conclusions of Kampas et al. (2000), Kampas et al. (1995), Kuhlman and Schweinhart (1999), Mitchel (1994) who supported that, girls had a higher performance than boys, each one using a different measurement instrument. However, the research of Gardner (1966), High (1987), Huff (1972), Kuhlman and Schweinhart (1999), Smoll (1973; 1974; 1975a; 1975b), and Thomas and Moon (1976) resulted in the different conclusion that boys and girls do not differ in spatial-temporal motor response to rhythmic stimulation.

Pollatou, Karadimou and Gerodimos (2005) examined the possibility of existing differences between boys and girls, 5 years of age, regarding their musical ability, their rhythmic ability and motor ability performance. The results showed that there were no significant statistical differences in gender as far as the musical ability and motor ability performance are concerned, even though the girls had a better performance in four out of six movements of the rhythmic kinetic test. Derri, Tsapakidou, Zachopoulou and Gini's research (2001) reached results similar to the present research's results. They studied the relation of gender, age and rhythmic ability of preschool children expressed through the use of one or both arms, bilateral movement and parallel use of both arms and legs. The High/Score Beat Competence Analysis test was used to evaluate the rhythmic ability of 77 children between the aged of 4.5 and 6.5. It was apparent from the results that girls executed the bilateral movement of the arms with greater accuracy than boys.

Grahn, & McAuley (2009) studied the neural bases of individual differences in beat perception. Activation in auditory and motor areas of the brain was correlated with individual differences in beat perception, even when participants performed a timing task in which no behavioral differences occurred. The results support two conclusions. First, a bias toward beat perception is mediated by the activation of cortical circuits involved in rhythm production. Second, some individuals more readily engage these cortical beat-based circuits when making timing judgments than do others.

The "out-of-school activity accompanied or not by music" factor had a significant statistical influence on the rhythmic ability of the preschool children. Particularly, it was apparent from the results that children who participate in gymnastics, ballet and dance had a higher performance in the test, at 120 and 130 beats, than preschool children that participate in basketball, football, and track as well as children who do not engage in any sport activities at all, with the difference of the

first team being significant statistical compared to the other two teams. On account of all the above it was also concluded that there is a significant statistical interaction between the gender and the type of kinetic activities, since girls who participate in kinetic activities accompanied by music have a higher performance in the test compared to the other groups.

The research of Pollatou, Liapa, Digelidis and Zachopoulou (2005) reached similar conclusions, while studying the rhythmic ability of 125 secondary school pupils who participate in activities accompanied or not by music. The High/ Scope Beat Competence Analysis Test (Weikart & Carlton, 1995) was used for the evaluation. It was concluded that pupils who participate in kinetic activities not accompanied by music had a much lower performance than the ones who participated in kinetic activities associated with music. The conclusions reached by Pollatou et al.'s research (2005), enforce the results of the present research, even though the participants in the two researches were of different age, and it illustrates the contribution of music in the development of rhythmic ability.

Gymnastics, ballet and dance are kinetic activities which largely include the element of music and dance, nevertheless, in each one, music is used differently. Music affects positively the rhythmic ability of the participant and children who participate in such kinetic activities, who, in essence, practice rhythm in their every lesson as opposed to the children who participate in football, swimming, karate whose training is based on the specialized techniques and practices of each sport, and does not put emphasis on the practice of the element of rhythm and in contrast with children which don't participate in kinetic activities at all, this does not help them to practice their rhythmic abilities. These sports, however, have relative technical characteristics, common requirements and are characterized by the continuous need for adjustment on the moves due to alternating conditions of their athletic environment, a component of motor ability (Martin, 1988).

Huff (1972) studied the rhythmic perception of 22 dancers, 35 experienced athletes and 32 non athletes. The dancers demonstrated an importantly greater accuracy both in acoustic and total measurements of kinetic responses than the rest of the participants, proving that dancing has a definite effect on the rhythmic perception of the trainees. Kuhlman and Schweinhart (1999) examined the synchronization of 523 children, aged 4-11, with the aid of a metronome and music using the High Scope Beat Competence Analysis Test. It was apparent from the results that participation in dance and music lessons was an important factor of the synchronization response of children in dancing music.

In their research, Zachopoulou et al. (2003) examined the possibility of a music and movement program which lasted ten weeks and was based on Orff and Dalcroze's approach, affecting the level of preschool children's rhythmic ability. The High/Score Beat Competence Analysis test was used to evaluate rhythmic ability and the results demonstrated significant influence exerted by the music and movement program on all rhythmic topics used in the research. In their research concerning the influence of rhythm on rhythmic accuracy Zachopoulou et al.(1998) examined two groups of children aged between 8 and 10 (a tennis group of 50 children and a basketball group of 53 children). The results showed that rhythm practice significantly improved rhythmic accuracy in both experimental teams.

The understanding of the role played by rhythmic ability is especially important in order to improve training programs, particularly at an age during which the linking abilities allow for greater improvement. A Physical Education teacher in his effort to avoid monotony and lack of interest, on the student's part, could embody

educational music-movement programs during preschool age. This alternative way of teaching should on the one hand aim at the deeper understanding of the technique in motor abilities, so that execution of every movement demonstrates flow, synchronization and evenness (Butterfield & Loovis, 1994) and on the other create a pleasant atmosphere aiming at a multi-faceted education of the children.

Rhythm is also strongly associated with reading development in early school-age children. David, Wade-Woolley, Kirby & Smithrim, (2007), investigated rhythm production in 53 children in grade 1 as a predictor of reading ability in the same children in grades 1-5. Rhythm was correlated significantly with both phonological awareness and naming speed. Rhythm predicted significant variance in reading ability at each grade level. Once phonological awareness was controlled, however, rhythm was a significant predictor only in grade 5. When naming speed was controlled, rhythm predicted unique variance in reading ability in grades 2, 3 and 5.

Cheng., Kerr & Bischof, (2008) also studied the multimedia content as an effective tool for enhancing learning and testing in school environment. More specifically, they proposed an interactive framework that uses an innovative test format enriched with audios and videos, for evaluating a student's skills, in this case musical rhythms recognition skills.

Music accompaniment in kinetic activities contributes to the development of rhythmic ability. The fact that there is no research in Greece to investigate the effect of musical motor education as an alternative means of teaching, urges the realization of further research in order to reinforce the results of the present research. Future research could examine the effect of an intervening music movement program of education on the development of rhythmic ability of preschool children in Greece.

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