COMPARATIVE STUDY OF MOTOR PERFORMANCE OF DEAF AND HARD OF HEARING STUDENTS IN REACTION TIME, VISUAL-MOTOR CONTROL AND UPPER LIMB SPEED AND DEXTERITY ABILITIES

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Using the Bruininks-Oseretsky Test the motor performance of 34 deaf – hard-of-hearing pupils, 6-14 year, was evaluated in reaction time, visual-motor control and upper limb speed and dexterity. The two-way ANOVA variance analysis for two independent variables, group, age, and the Post Hoc (Scheffe test) for multiple comparisons were used. The analysis indicated no statistically important differences between Deaf and Hard-of--Hearing, but showed statistically important differences in the age factor, visual-motor control ($\underline{F}_{3,16}$ =5.06, $p < .05$), speed and upper limbs dexterity ($\underline{F}_{3,16}$ = 3.65, $p < .05$) and interaction between group and age for the ability of visual-motor control ($\underline{F}_{3,16}$ =4.44, $p < .05$). The results will show if it is necessary to schedule suitable intervention programs for the improvement of the performance in the specific abilities in order to allow the inclusion in the Physical Education courses.

Hearing and consequently the acquisition of speech and linguistic abilities are an essential precondition for the further development of individuality. The lack of hearing and ability of speech from a very young age plays a determinative role in school, social and psychological development (Kourbetis, 1998) and it is assumed to be influencing the development of motor abilities. Physical education and sport activities play an important role in acquiring and maintaining the pupils' corporal and mental health and also in gaining positive attitudes in nutritional and health matters (Guedes, 2007).

Physical Education and other curriculum lessons taught at a Primary School for Deaf Children, like in Schools for Children with Hearing aim at developing balanced and harmonious psychical, corporal, intellectual and social pupils abilities in order to support their educational and social integration. Weekly Physical Education courses improve fundamental motor abilities. This improvement is not only a training result but depended from the increase of corporal mass, the ability to generate strength (Haywood, 1993) and the changes that take place with growing age in sensory and perceptual mechanisms.

A large number of tools have been created for the measurement of the motor performance and the definition of the development level of different motor abilities, which help in diagnosing and defining the deficiency degree of an important number of disabilities. The investigations, till now, indicated that in most cases, deaf people fall short in the sector of natural condition compared to hearing people. When analyzing the results of ten researches, Goodman and Hooper (1992), found out that the levels of deaf and hard-of-hearing natural conditions are comparable. Specifically, in six out of ten studies, statistically important differences were found out between deaf and hearing persons, in three out of the ten no important differences were found, while in only one differences were noticed between deaf and hard-of-hearing. Many researchers attributed this difference to the delay in receiving the stimulus, (Gabler-Halle, & Bembern, 1989), and also to communication problems during the conduct of the tests (Dunn & Ponticelli, 1988). Brunt and Dearmond (1980) from the Louisiana University used the Bruininiks-Oseretsky test of Motor Proficiency in order to study and describe the motor profile of deaf and hard-of-hearing. They evaluated 150 pupils of primary school age, attending a hearing children primary school and a deaf children primary school of the State, suffering from moderate or heavy deafness and simultaneously to the motor evaluation they examined as well the communication

strategies during the test conduct, reaching the same conclusions.
The same general results were also reached by the evaluation of 94 pupils (47 hearing and 47 deaf - hard-of-hearing pupils) performed by Campell (1983) with the Y*outh Fitness Test* (American Alliance for Health, Physical Education and Reaction [AAHPER], 1976). This study established that the performance of the hearing persons group was notably better than in the group of deaf and hard-of-hearing, while the performance of the deaf persons was similar to the one of the hard-of-hearing. At the same time, Winnick and Short (1986) using the *Project Unique Physical Fitness Test* (Winnick & Short, 1985) when evaluating 1730 pupils (686 hearing, 152 hard-of-hearing, 892 deaf), on the one hand they did not notice any differences between deaf and hard-of-hearing but on the other hand, the hearing had a supremacy on the others only in strength and stamina of the abdominal muscles. When comparing deaf boys and deaf girls, Carlson (1972), Lindsey and O' Neal (1976) did not find out important differences in the average motor performance between the two genders, a view also formulated by Brunt and Broadhead (1982) in a relative study. Many researchers have worked in the direction of controlling the reaction time, all of them using the same simple evaluation test, on persons with moderate and heavy intellectual inadequacy, Baumeister and Kellas (1968), Berkon and Baumeister (1967), Lally and Nettelbeck (1977), Wade, Newell and Wallace (1978), reaching the conclusion that these individuals have a longer reaction time, although they follow the same developmental process (sequence) with the normal populations (Kelly , et al., 1987).

According to the literature, the reaction time for fine abilities is shorter than in rough ones. Sage (1977) this is ought to the different distance between brain-hand finger and brain-leg, results as well confirmed by a similar research of Drowatzky (1981). However, on the contrary, Kelly, et al., (1987) did not agree with the results of the previous researchers. They maintain that no important differences are noted in reaction time between fine and rough abilities and the small differences appearing in the average mean values are attributed to the non-normal development of the CNS (Central Nervous System). They also attributed these differences to the disability of these persons to isolate the specific muscle group that should perform and to the activation of non-indispensable muscles during the performance, following an aural or visual excitation.

According to Butterfield, et al., (1993) there is no difference only between deaf and hearing in reaction time, but as well, between congenital deaf and deaf with acquired deafness. The congenital deaf children were significantly inferior in reaction time and in speed of movement, that is the speed of the child's motion from the instant of receiving the excitation until the instant that of completing the movement rhythm of the older children, Gruber, Hall, Kryscio and Humphreies, (1984) conducted the test as well on students' aged 15, 16 and 17 years. The sample for the study consisted of 42 students (ten 15-years old students, twelve 16-years old students, twenty 17-years old students) originating from different socio-economic layers, equivalently distributed per gender (boys-girls), without any kind of other deficiency. An important number of researchers indicated that the deaf children significantly fall short when compared to the hearing. These differences appeared only in certain tests, when evaluating the reaction time ability, Butterfield (1988) and the limb coordination (Savelsbergh & Netelendos, 1992). The reaction time ability affects the visual-motor control and the coordination ability, given that in all these three abilities a good orientation is required.

In relation to the reaction time, Taylor and Campbell (1976) sustain that a sudden [unexpected] aural prompting precipitates the procedure of visual stimulation, with regard to the subject on which it focuses. Similar information is not available for deaf and for this reason it is possible that this absence may increase the reaction time and inhibit the focusing ability on a target out of the visual field.

Trying to justify the lag in deaf persons motor development, Savelsbergh and Netelendos (1992), conducted a research aiming at examining whether the problems of visual orientation affect the motor development, under the precondition, of course, that these children do not present other kinds of deficiencies. For this reason, their study had to answer to the following questions:
Do deaf persons have problems in visual focusing? And if yes, are the problems appearing partially accountable for the perturbations in fine and gross motor abilities?
Is there any association between eyes/head movements during the performance of gross capabilities in persons without incapacities?

The results of the above research have initially indicated statistically important divergences between the two age categories and the two groups–deaf and hearing – and for the three dependent variables, time between reaction and eye and head focusing, and also interval between excitation and eye and head focusing. Deaf children had longer reaction times compared to hearing ones for targets outside their visual field (125^o), while no differences were found for targets inside their visual field (40^o). No differences were noted between deaf and hard-of-hearing during the tests that were conducted.

Carnahan and Marteniuk, (1991) dealt with the issue of visual-motor control that is the temporal organization of the eye, head and hand movements when the individual receives an excitation. They made two assumptions in their endeavor to explain how the three parts of the body, eye, hand and head are coordinated. The first assumption concerns the eventuality that these three parts of the body are controlled by the same motor system and the second is the existence of a special separate motor system for every part of the body. The results demonstrated that in situations of non-expectation (at a sudden, non expected excitation) the subjects being evaluated moved much quicker than in conditions of expectation. The three body parts – eye, finger, head – started to move at the same moment and with the same delay in all three targets of 10^o, 30^o and 50^o. First one to stop moving was the eye, followed by the finger and last the head. The movements requiring focusing at the 10^o lasted notably less than the movements focusing at 50^o. The time length of the 30^o movements did not differ notably from the movement of the 10^o or even the 50^o. With regard to the required movement time of every part, the head appears to be moving quicker, followed by the finger and the head with a longer retardation.

Carnahan's and Marteniuk's, (1991) second experiment defined the impact of the eye and head synchronization on the limbs' movement. The results indicated that as regard the reaction speed, at 26^o, eye and head started to move at the same instant and before the finger, while at 43^o the head was the first to start moving, followed by the finger and then the eye. In conditions of speed, the time of the head and finger movement was shorter than in conditions of precision. When they are asked to react with precision, the results change. When the target is at 26^o, the first to move are the eyes followed by the head and then the finger, while at 43^o, the eyes and the head start to move together and the finger is the last. Now, referring to the order in which they complete the movement, the results indicated the following order: eye, finger and head. The duration of the movement did not seem to differ from the one indicated in the results for both the speed and the accuracy. The percentage of wrong aiming in conditions of accuracy was smaller than the percentage in conditions of quickness. The focusing movements with speed started earlier than the focusing movements with preciseness and the eyes always started the movement earlier than the other members of the body.

Most studies lead to the conclusion that deaf persons have orientation problems when asked to focus outside their visual field and the specific delay in orientation affects the motor behavior of the deaf. The importance in focusing of the eye-head system for the successful space control and synchronization was stressed by researchers; Marteniuk (1978), and Owen and Lee (1986). Savelsbergh, Netelendos and Whiting, (1991), also studied the orientation behaviour of deaf and hearing persons, that is the influence of the spatiotemporal orientation ability on the performance in the ability of receiving a tennis ball (rough performance), which requires a good synchronization of the limbs and the body.

The increase of age leads to a motor maturing which on its turn modifies the motor performance, not only of *normal populations* but also deaf and hard-of-hearing pupils. Brunt and Broadhead (1982) using the short BOT evaluation set, studied the motor performance of 154 deaf pupils, 85 boys and 69 girls, with a degree of auditory loss >60 dB who did not present other kinds of psychological and medical deficiencies. The characteristics of the chronological age of the specific deaf sample were compared to those of the Bruinink's standard national hearing sample. The results of this research indicated an important difference with the rise of the chronological age. And additionally, for certain abilities, children aged 11-14 years were notably better than children aged 7-9. Butterfield (1991) who studied the impact of age, gender, degree of auditory loss, static and dynamic balance in speed development in deaf children reached the same conclusion.

Seeking to define the motor development rhythm of the older children, Gruber, Hall, Kryscio and Humphreies, (1984) conducted the test as well on students' aged 15, 16 and 17 years. The sample for the study consisted of 42 students (ten 15-years old students, twelve 16-years old students, twenty 17-years old students) originating from different socio-economic layers, equivalently distributed per gender (boys-girls), without any kind of other deficiency. The test was conducted at the suitable surroundings and specialists made the measurements. The average mean values of the pupils' motor abilities in the eight abilities for all three ages were compared to the average mean values of the students that were 14 years old. The results indicated that all 42 students of 15, 16, 17 years performed significantly better than the 14-year old children in the abilities of reaction time, visual-motor control and the upper limbs speed and dexterity. Zaichkowsky, Zaichkowsky and Martinek (1980) and Gruber et al (1984) reached the same results and attribute this improvement to the myo-skeletical development and the maturing of the nervous system. Dummer, Haubenstricker and Stewart (1996) examined the influence of the age factor on the deaf pupils' performance. Their sample consisted of 211 deaf students aged 4-18 years, from two deaf children schools from the West USA and Ontario, Canada. The degree of hearing loss of the evaluated pupils was more than 55 dB at the best ear. The final sample was 201, ten pupils with multiple disabilities, learning problems, vision problems, orthopedic injuries and behavioral problems were eliminated. Unknown reasons at a percentage of 53%, genetics 18%, meningitis 11%, rubella 7%, etc. have been mentioned as the deafness cause. Deafness was congenital at a percentage of 70%, pre-linguistic at 21% and acquired at 9%. In both schools, the pupils attended normally physical education programs and participated in different extracurricular activities, focusing on the good natural condition, and on acquiring and improving fundamental motor abilities. Particular accent was given to the training of those abilities that were indispensable for the participation in sports. There were no important differences for children of the same age, between the two schools, in the mode in which the instructions were given as well as their participation in extracurricular sport activities. The researchers and assessors participating in the study were beforehand trained in the use of the U.S. sign language and the test implementation. The Ulrich (1985) test seven was used as a measurement instrument and evaluated seven movement abilities (running, jumping up and down, galloping, sliding … and others) and 5 abilities of ball handling (hit, rebound, cast, catch, kick). The results indicated that in general the average mean values of performances for four through ten year old hearing children of both schools were better than the average mean values of deaf ones. So, it was noted that the age was a decisive impact factor, because the scores increased with the growth in age. Particular comparisons did not show a strong relation between natural condition and performance in both kinds of abilities that have been examined. Comparing the performance of deaf with the performance of the national hearing sample, retardation from one to three years was established in the performance of deaf compared to the hearing. Handling abilities in deaf pupils developed with the following order, catch (9-year), rebound of the ball, kicking (10-year), hit (12-year) and cast (13-year). In deaf children the movement abilities develop with the following order, running, slipping (4-year), gallop (7-year), jumping up and down (8-year), jump and jumping over (10-year), hurdles (16-year). Differences were noted in the performance between the two genders and are listed below. When evaluating the natural condition of deaf – hard-of-hearing and hearing, Winnick and Short (1988, 1985) amended the test by including signals for the initiation and ending of an activity. They used non-verbal means of communication and they also provided written instructions, but because of the low level of performance in English language, even this mode of acquiring information cannot be considered as sufficient, arising thereby questions that have to be clarified. Therefore, the researchers' proposal that the teachers themselves, who will also respect the school philosophy, should conduct the tests seems quite logical.

The conclusions of the above study will provide a clearer image about the Deaf and Hard of Hearing motor performance level at the Greek school environment. This will be the basis for the development of adapted Physical Education Programs.

Method

The measurements were performed during the daily school program at the school unit of the 94th Primary School, which accommodates the 10th Thessaloniki Primary School for the Hard-of-Hearing , as well as the Panorama Special Primary School for the Deaf - Hard-of-Hearing . During the conduct of the measurements at the Special Primary School for the Deaf was used *total communication* The total communication method is a combination of all communication systems: signs, lips reading, finger spelling (Lambropoulou 1989). The communication with the hard-of-hearing pupils was made using oral speech and lips reading. The instructions were given orally to the hard-of-hearing and using the total method to the deaf pupils. A demonstration of the exercise was made both by the physical education professor and using pictures. Before every performance, one or two testing attempts were made, during which it was checked to which extent the examined pupils had understood the exercise. At the end, the pupil performed alone the set of exercises and was evaluated in conformity to the instructions of the BOT (Bruininks, 1978) manual and their performance was registered in the pupil's individual index card.

Sample

The groups were created with layered sampling, equivalently distributed for age and degree of auditory loss. The sample included 17 deaf (MV=126.3months, SD=25.64) and 17 hard-of-hearing pupils (MV=127.7 months, SD=23.69) aged 6-14 years attending the National Institute for the Deaf, Special Primary School of Panorama and the 10th Primary School for the Hard of Hearing of Thessaloniki. These schools were selected because they are the only educational settings for this type of pupils in Northern Greece, and use the same physical education curriculum.

Measurement instrument

The BOT (Bruininks-Oseretsky Test of Motor Proficiency), (Bruininks, 1978) was used for the definition of the children's motor development level. It is a test commonly used in the United States, which evaluates individuals with developmental troubles and various motor specificities, it is well weighed and is used in a wide age spectrum (from 4½ - 14½) (Donaldson, Maurice, 1984). Beital and Mead, (1982) concluded that the BOT set is maybe, the most technically sound and credible evaluation tool for the level of motion development

The conduct of this test allows for teachers, specialists and researchers to evaluate the motor abilities of every individual, to identify the motor dysfunctions, but also, the developmental retardations that may appear, and also to check the suitability of the training programs in use (Gruber, Hall, Kryscio & Humphreies, 1984). The above researchers extended their research even to older ages 15, 16, 17 years, whose conclusions were mentioned previously. A time of about 45-60 minutes is required for the BOT test, which evaluates the rough and fine abilities and includes eight subjects with a total set of 46 tests. The scores for each one of the eight abilities of the test are worked out through the comparison of the performances in the particular test scores with respective table values resulting from the BOT (Bruininks, 1978) weighing up. Thereby, the balance score e.g. is calculated as the sum of the transformed values of the tests.

Analysis

Were formed two experimental groups of deaf (hearing loss >70dB) and hard of hearing pupils (<70 dB). For the definition of the performance level in the abilities of reaction time, visual-motor control and upper limbs speed and dexterity was made only one measurement. The experimental design is represented as 2X4 with two independent variables, group and age. The variable group has two levels: deaf, and hard-of-hearing and the variable age four levels for the four age categories: 7-8, 9-10, 11-12, 13-14.

Table 1

The averages and the sample's population for the comparison of Deaf and Hard-of-Hearing

	Deaf		**Hard-of-Hearing**	
Age	**MV months**	**N**	**MV months**	**N**
7-8 years	84	4	87	4
9-10 years	105	4	112	4
11-12 years	137	5	136	5
13-14 years	151	4	151	4
Total	126.3	17	127.7	17

[*MV= Mean Value, SD= Standard deviation]

Descriptive statistics were made for each ability, group and age categories separately, in which are described the Average MV and the standard deviation SD. For the data analysis was used the two factors variance analysis (two-way ANOVA). The substantiality of the differences among the averages of the cells have been controlled using Scheffe´s Post hoc, with comparisons among all the possible pairs of groups, in order to find out which one indicated a considerable statistic difference among them.

Results

Reaction time

Table 2:

Elements of descriptive statistic (MV ± SD) of the research groups for the ability of the reaction time.

	Deaf		**Hard-of-Hearing**	
Age	**MV**	**SD**	**MV**	**SD**
7-8 years	400	.00	4.00	1.41
9-10 years	6.00	2.83	3.50	2.12
11-12 years	7.00	2.74	6.60	2.51
13-14 years	6.00	3.00	7.67	2.52
Total	6.08	2.50	5.92	2.61

[*MV= Mean Value, SD= Standard deviation]

The two groups deaf and hard of hearing did not show important differences in performance. The MV and SD revealed that the ability of reaction time is improved with the increase of age in both groups, as shown in table 2 (above).

The variation analysis and the multiple comparisons made using the Post Hoc demonstrated (table 3) that there was no statistically important interaction between the factors group and age, $F_{3,16}$ =.57, p=.645. The group and age factor were not found to have any significant impact on the response speed with $F_{1,16}$ =.08, p=.782 and $F_{3,16}$ =1.74, p=.198 respectively (Table 3).

Table 3:
Results of the statistic test for the establishment of main influences and interactions between the investigating groups for the ability of the reaction time

Test for the impacts between the individuals				
	Freedom degrees	**Average Squares**	**F**	**P**
Group	1	.50	.80	.782
Age	3	10.94	1.74	.198
Group *Age	3	3.55	.57	.645

Visual-motor control
The score improvement of the visual-motor control ability, had a linear relation with the age. This ability improved with the growth in age. This linear relation was not noticed as well in the deaf group (this linear association does not seem to exist).

Table 4:
Results of descriptive statistic (MV $\pm$ SD) of the investigating groups for the ability of visual-motor control.

	Deaf		**Hard-of-Hearing**	
Age	**MV**	**SD**	**MV**	**SD**
7-8 years	14.00	4.24	9.50	0.71
9-10 years	18.50	3.54	15.00	2.83
11-12 years	17.00	3.37	18.80	1.79
13-14 years	14.00	2.65	20.67	2.31
Total	16.00	3.38	17.08	4.36

The factor group was not found to have $F_{1,16}$=.01, p=.924, but the factor age was found to have a significant impact $F_{3,16}$ =5.06, p< .05 (table 5). There was a statistically important interaction (Figure 1 next page) between the factors group and age in the performance of the ability of the visual-motor control, $F_{3,16}$ =4.44, p< .05.

Table 5:
Results of the statistic tests for the establishment of the main impacts and interactions among the investigating groups on the ability of visual-motor control.

Test for the impacts between the individuals				
	Freedom degrees	**Average Squares**	**F**	**P**
Group	1	7.10	.01	.924
Age	3	38.08	5	**.012***
Group *Age	3	33.41	4.43	**.019***

For multiple comparisons used Post Hoc set. Founded that the performance in the visual-motor control of children aged 11-12 years was statistically better than for the children aged 7-8 years, with a dMV=6.15, p< .05. The children aged 13-14 performed statistically significant better than the children aged 7-8 years with a dMV=5.58, p<0.05. From the comparisons held among the age groups (7-8 & 9-10), (9-10 & 11-12), (9-10 &13-14), (11-12 &13-14) it appeared that there were no statistically important differences in performance with dMV respectively: (dMV=5, p=.126), (dMV=1.15, p=.917), (dMV=.58, p=.99), (dMV=0.57, p=.983).

Upper limbs dexterity and speed.
The MV and SD for two groups did not show important differences in performance, but the upper limbs dexterity and speed ability increases along with the increase of age in both deaf and hard-of-hearing. (table 6 next page)

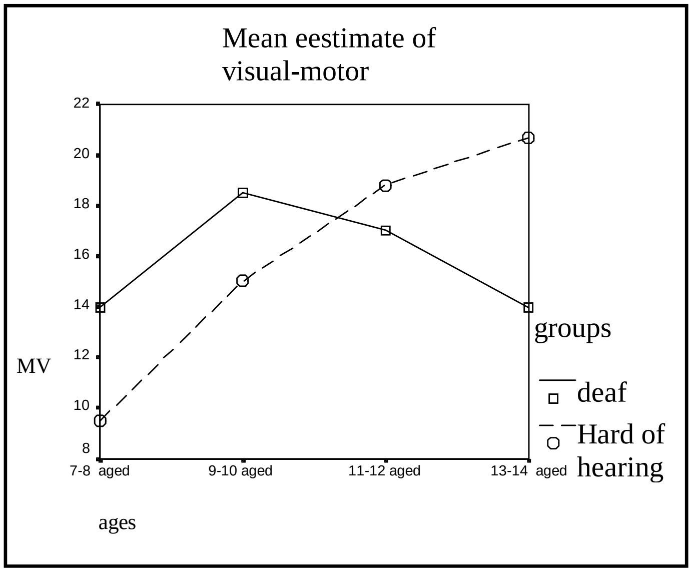

Figure 1. Impact of group and age in the visual-motor control.

Table 6:
Elements of descriptive statistic (MV + SD) of the researching groups on the ability of dexterity and speed of upper limbs.

	Deaf		Hard of Hearing	
Age	**MV**	**SD**	**MV**	**SD**
7-8 years	28.50	2.12	32.00	4.24
9-10 years	38.50	14.85	31.50	3.54
11-12 years	42.20	3.63	39.00	8.22
13-14 years	41.00	3.46	43.00	4.36
Total	39.00	7.30	37.58	7.22

The variance analysis for the control of impacts among individuals, as well as the multiple comparisons realized using the Post Hoc, (Table 7) that there were no statistically important interactions between the factors group and age, $F_{3,16}$ =.67, p= .581. The group was not found to have any main impact on the performance of the upper limbs dexterity and speed ability, $F_{1,16}$= .18, p=.677. The age was found to have a main impact on the performance of the specific ability, $F_{3,16}$ = 3.65, p< .05

Table 7:
Results of the statistic tests for the establishment of the main impacts and interactions between the investigating groups on the upper limb speed and dexterity

Test for the impacts between the individuals				
	Freedom degrees	**Average Squares**	**F**	**P**
Group	1	7.20	.18	.677
Age	3	145.94	3.65	**.035***
Group *Age	3	26.94	.67	.581

The control of the differences inside the cells has shown that the 13-14 age category presented a statistically better performance in the upper limbs dexterity and speed ability than the 7-8 age category dMV=11.75, p<0.05. In comparisons performed among the other age categories (7-8 & 9-10), (7-8 & 11-12), (9-10 & 11-12), (9-10 & 13-14), (11-12 & 13-14), no statistically important differences were noted in the specific ability with dMV respectively: (dMV=4.75, p=.772), (dMV=10.35, p=.092), (dMV=5.6, p=.540), (dMV=7, p=.427) and (Dmv=1.4, p=.979).

Discussion
In the particular comparisons for the *deaf and hard-of-hearing* performance divergences show and all

the research conclusions mentioned in the introduction are not confirmed. The results show that there is no difference between deaf and hard-of-hearing in the abilities of the reaction time, the visual-motor control and the upper limbs speed and dexterity, conclusions reached by Goodman and Hooper (1992), who studied the results of ten researches concerning the motor performance of hearing, deaf and hard-of-hearing persons, and differences were noted in only one among them. Also, the results of the present study agree with the study results of Geddes (1978), Cambell (1983), Winnick and Short (1986), Butterfield (1989, 1991), Butterfield and Ersing (1987), Butterfield and Ersing (1988), who found out that the degree of auditory loss does not affect the level of the basic motor abilities development, since no statistically important differences appear in the performance between deaf and hard-of-hearing. The best performance of the deaf group compared to the hard-of-hearing in the upper limbs speed and dexterity ability, which is attributed by Brunt and Broadhead, (1982) to the training due to the use of the sign language – communication method which is not used at the 10^{th} Hard-of-Hearing primary school, where the pupils use as a means of communication, only the oral speech, was not noted in our research.

For the impact of the factor age on deaf and hard-of-hearing for the abilities of reaction time, of the visual-motor control and the upper limbs speed and dexterity, our conclusions are in agreement with the conclusions of Dummer, Haubenstricker and Stewart (1996), Gruber et al (1984), Brunt and Broadhead (1982), Espenschance and Eckert (1980) as well as Zaichkowsky, Zaichkowsky and Martinek (1980) studies an increase in the scores of the abilities of the visual-motor control and the upper limbs speed and dexterity was found out, with the age maturing. The motor performance differentiates in regards with factor age, with the fourth age category performing statistically considerably better than the others. The improvement of this ability of upper limbs coordination, according to Butterfield and his associates (1993), Cleland and his associates (1993) is attributed to motor experience as well as the opportunities given to a child for playing. But Boyd (1967), Clarson (1971) attribute this improvement along the increase of age to the maturity of the Central Nervous System and the myo-skeletal development.

Deaf and hard-of-hearing pupils appeared to stabilize the performance for the abilities of reaction time of the visual-motor control and upper limbs speed and dexterity at the age of 12 years. The fourth age group (13-14 years) show a better score in the abilities of speed, strength and coordination of upper limbs, conclusions on which Gruber and his associates (1984) agree, attributing this improvement to the continuing training of the motor dexterities.

It is possible to attribute the differences noted by many researchers to the different learning pace, to socio-economic differences, to previous experiences and to the motivations as well as to the training of the motor abilities (Singer, 1975). The practice of the motor dexterities leads to the improvement of the motor performance.

There are researchers who attribute the differences, when they appear, to environmental and socio-economic factors (Malina, 1974), to the type of school, (Decker, 1993), to the motor experience (Cleland, & Gallahue, 1993), to the level of linguistic development (Spencer, 1996), as well as to the opportunities the pupils have for free play, (Butterfield, Mars & Chase, 1993). Important is also the impact of other factors, like the means of communication between assessors and assessed and their experience, (Stewart, Dummer & Haubensticker, 1990), for this reason the communication principles of every school (sign language/oral speech) have been as well respected in the present research (Winnick and Short (1985, 1988).

Conclusions

No statistically significant differences have been found between deaf and hard of hearing in performance for the three abilities. Differences have been reported among the four age group categories. The performances of the fourth age category (13-14) showed significant differences compared to the other age groups for the visual-motor control and the upper limbs speed and dexterity.

Interactions were reported between the factors group, age only for the ability of the visual-motor control. This may be due to the degree of hearing loss which is referred from Loovis and Ersing, (1979) and the reason which caused deafness fact which was assumed from Geddes (1978), Butterfield (1986) and Gayle and Pohlman (1990) researches outcomes.

The lesson of Physical Education actually follows the general Analytic Programme in both its targets and the content of teaching. In the present research no statistically important differences between deaf and hard-of-hearing pupils showed up in the motor performance. However, the international literature indicates important differences between hearing, deaf and hard-of-hearing pupils and consequently, there is a need for the elaboration of a special program of physical education for deaf and hard-of-hearing pupils.

Additional research is required for the other abilities aiming at reaching conclusions necessary in order to adapt and develop special programs that will cover the needs of deaf and hard-of-hearing pupils. If we want to develop suitable physical education programmes in order to allow the inclusion in the Physical Education courses, is necessary to take into consideration the following factors: (a) The reason that caused the deafness, the kind of auditory loss (sensor neural) as well as the time period when deafness appeared (prenatal or acquired deafness), (b) The requirements of every test, that is if the exercise is simple or complex and if the performance technique and precision is assessed, (c) The previous motor experiences of the pupils as well as the opportunities they have in their daily life for playing, (d) The suitability of the Physical Education is being followed in the school attended by the pupil, (e) The kind of school that is if it is a typical deaf school, parallel classes or school functioning within the frame of integration philosophy and (f) The family, school and society structure and philosophy as well as the communication method that they use.

Because of, deaf sport participation is a tradition and part of the Deaf Community culture, school should not face physical education as simply time away from classroom studies but as an essential part of the entire curriculum. It is especially important that physical educators and youth coaches be familiar with the specific needs of Deaf pupils and youth. It is a necessity to support and encouragement them to learn and improve motor skills beyond school-based physical education and competitive sport program. Promoting and integrating a variety of physical activities into daily routines could be facilitated the concept of *Active living* as a health objective.

References

Baumeister, A.A. & Kellas G. (1968). Distributions of reaction times of retardates and normals. *American Journal of Mental Deficiency.*72:715–718.

Beital, P.A. & Mead, B.J. (1982). Bruininks-Oseretsky test of motor Proficiency; Futher verification with 3 to 5 years old children. *Perceptual and Motor Skills 54*: 268-27.

Berkon, G. & Baumeister, A. (1967). Reaction time variability of mental defectives and normals. *American Journal of Mental Deficiency 72,* 262-266.

Boyd, J. (1967). Comparison of motor behavior in deaf and hearing boys. *American Annals of deaf, 112* ,598-605.

Bruininks, R.H. (1978) Bruininks-Oseretsky test of Proficiency (examiners Manual). Circle Pines. MN: American Guidance Service.

Brunt, D. & Broadhead, G.D. (1982), Motor proficiency traits of deaf children, Research Quarterly for Exercise and Sport, vol 53,No 3, 236-238.

Brunt, D. & Dearmond, D.A. (1980). Evaluating Motor Profiles of the Hearing Impaired, *Adapted Physical Education 38*, 50.

Butterfield, S.A. (1987). Influence of age, sex, hearing loss and balance on development of running by deaf children, *Perceptual and Motor Skills, 73,* 624 -626.

Butterfield, S.A. (1991). Physical education and sport for the deaf: Rethinking the least restrictive environment. *Adapted Physical Activity Quarterly, 8,* 95-102.

Butterfield, S.A. & Ersing, W.F. (1987). Influence of age, sex, hearing loss and balance on kicking development by deaf children, *Perceptual and Motor Skills, 65,* 312.

Butterfield, S.A. & Ersing, W.F. (1988). Influence of age, sex, hearing loss and balance on development of catching by deaf children, *Perceptual and Motor Skills, 66,* 997-998.

Butterfield, S.A., Mars, H. & Chase, J. (1993). Fundamental motor skill performances of deaf and hearing children ages 3 to 8. *Clinical Kinesiology, 3,* 2-6.

Butterfield, S.A. (1989). Influence of age, sex, hearing loss and balance on development of throwing by deaf children, *Perceptual and Motor Skills, 69,* 448-450.

Cambell, M.E. (1983). Motor fitness characteristics of hearing impaired and normal hearing children. Unpublished master's thesis, Northeastern University, Boston.

Carlson, B.R. (1971). Assessment of motor ability of selected deaf children in Kansas. *Perceptual and motor skills, 34,* 303 305.

Carnahan, H. & Marteniuk, R. (1991). The τemporal organization of hand , eye, and head movements during reaching and pointing. *Journal of Motor Behavior, Vol. 23, No. 2,* 109-119.

Clealand, F. & Gallahue, D.L. (1993). Young children's divergent movement ability. *Perceptual & Motor Skills*, 77, 535-544.

Decker, J. (1993). Least reastrictive enviroment programming for individuals with hearing impairments: A response to Butterfield. *Adapted Physical Activity Quarterly, 10,* 1-7

Donalson, L. & Maurice, P. (1984). A study of the incidence of students with perceptual motor dysfuction in selected secondary schools in the Hamilton area. *South Auckland Perceptual Motor Dysfunction* Survey, 4-7.

Drowatzky, J.N. (1981). *Motor Learning: principles and practices*, Minneapolis: Burgess Publishing Company.

Dummer, G., Haubenstricker, J. & Stewart, D. (1996). Motor Skill Performances of Children Who Are Deaf. *Adapted Physical Activity Quarterly, 13,* 400-414.

Dunn, J.M. & Ponticelli, J. (1988). The effect of two different communication modes on motor performance test scores of hearing impaired children. *Abstracts of Research Papers,* Reston, VA: American Alliance for Health, Physical Education, Recreation, and Dance, p.246.

Espenschade, A.S. & Eckert, H.M. (1980). Motor Development (2^{nd} ed) Columbus, OH: Charles E. Merill.

Gayle, G.W. & Pohlman, R.L. (1990). Comparative study of the dynamic, static, and rotary balance of deaf and hearing children, *Perceptual and Motor Skills, 70,* 883-888.

Geddes, D. (1978). Motor development profiles of preschool deaf and hard-of-hearing children, *Perceptual and Motor Skills, 46,* 291-294.

Goodman, J. & Hooper, C. (1992). Hearing impaired children and youth: A review of psychomotor behavior. *Adapted Physical Activity Quarterly, 9,* 214-236

Gruber, J., Hall, J., Kryscio, R. & Humphreies, L. (1984). Performance of older adolescents on the Bruininks-Oseretsky Test of Motor Proficiency: A Prelude to Normative Data. *American Corr. Therapy 38,* No 5, 119-121.

Guedes, C. (2007). Physical education and physical activity: a historical perspective; An historical perspective can illuminate the crucial role that physical education plays in the development of lifelong physical activity habits.(Combating Obesity in K-12 Learners), The Journal of Physical Education, Recreation & Dance V. 78, N. 8, , pp. 1-58(58)

Halle, J. W., Gabler-Halle, D. & Bembren, D.A. (1989). Effects of a peer mediated aerobic conditioning program on fitness measures with children who have moderate and severe disabilities. *The Journal of the Association for Persons with Severe Handicaps, 14,* 33-47.

Haywood, K.M. (1993). *Life Span Motor Development.* USA:Human Kinetics.

Kelly, R.L., Barton, J.R. & Abernathy, L. (1987). Reaction times, using fine and gross motor movements of moderately and severely mentally handicapped adults to auditory and visual stimuli. *Perceptual Motor Skills, 65,* 219-222.

Kourbetis, B. (1998). The Greek Sign Language in Deaf persons Education, The Society and the Deaf Persons, Society and Education and Culture of Deafs. EPEAEK Programme : 1st Educational Set for the Training of Teachers and Specialized Scientists Special Education Schooling Units for Deaf and Hard-of-Hearing, Universtity of Patras.

Lambropoulou, V. (1989). Deaf pupils Education, Patra: *Patras University Publication.* p. 35-45.

Lally, M. & Nettelbeck, T. (1977). Intelligence, reaction time, and inspection time. *American Journal of Mental Deficiency, 82*, 273–282.

Lindsey, D. & O' Neal, J. (1976). Static and dynamic balance skills of eight years old deaf and hard of hearing children. *American Annals of the Deaf.*121,49-55.

Malina, R.M. (1975). Anthropometric correlates of strength and Motor performance. *Exercise and Sports Science Review 3,* 249-74

Marteniuk, R.G. (1978). The role of eye and head position in slow movement execution. In G.E Stelmach (Ed.) *Information processing in motor control and learning* (pp 267-288). New York Academic Press.

Owen, B.M. & Lee, D.N. (1986). Establishing a frame of reference of action. In M.G. Wade & H.T.A. Whiting (Eds), *Motor development in children: Aspects of coordination and control* pp 287-307.

Sage, G.H. (1977). *Introduction to motor behavior." A neuropsychological approach* (2nd ed.). Reading, Massachusetts: Addison-Wesley Publishing Co.

Savelsbergh, G.J.P., Netelentos, J.B. & Whiting, H.T.A. (1991). Auditory perception and control of spatial coordinated action in deaf and hearing children. *Journal of Child Psychology and Psychiatry, 32,* 489-500.

Savelsbergh, G.J.P. & Netelentos J.B. (1992). Can the Developmental Lag in Motor Abilities of Deaf Children be Partly Attributed to Localization Problems? *Adapted Physical Activity Quarterly, 9*, 343-

352.
Spencer, E.P. (1996). The association between language and symbolic play at two years: evidence from deaf toddlers. *Child Development 67,3,* 866-876.
Stewart, D.A., Dummer, G.M. & Haubensticker, J. L. (1990). Review of administration procedures used to assess the motor skills of deaf children and youth. *Adapted Physical Activity Quarterly, 7,* 231-239.
Taylor, R.L. & Campbell, G.T. (1976). Sensory interaction: Vision is modulated by hearing. *Perception, 5,* 467-477.
Ulrich, D. (1985). Test of Gross Motor Development. Austin Texas: produced
Wade, M. G., Newell, K. M. & Wallace, S. A. (1978). Decision time and movement time as a function of response complexity in retarded persons. *American Journal of Mental Deficiency, 83*, 135-144.
Winnick, J. & Short, F. (1985). A comparison of physical fitness of segregated and integrated hearing impaired adolescents. *Clinical Kinesiology, 42,*104-109.
Winnick, J. & Short, F. (1988). Physical fitness of adolescents with auditory impairments. *Adapted Physical Activity Quarterly, 3*, 58-66.
Zaichkowsky, L.D., Zaichkowsky L.B. & Martinek T.J. (1980). *Growth and development*. St. Louis, MO: Mosby.