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Motor Skill Performance of Children with Sensor Impairments

Danijela Ilić-Stošović and Snežana Nikolić
University in Belgrade, Faculty of Special Education and Rehabilitation
Republic of Serbia

1. Introduction

According to ICD – 10 (1993) there are two big groups of specific developmental disabilities: learning disabilities and motor disabilities. The first includes a group of disorders which characterize problems in school achievement, especially in reading and math. The second includes a group of disorders in motor coordination, balance, lateralization, which cannot be explained by general problems in intellectual development or any other specific neurological disorder. The etiology of these disorders is unknown, but there is a hypothesis that they are the consequence of interaction between biological factors and the influence of social environment, as much as interaction between those two factors and quality of educational processes.

Motor skills play a crucial role in the social and emotional functioning of a child and may impact quality of life and well being (Poulsen, Ziviani, Johnson & Cuskelly, 2008; Skinner & Piek, 2001; Sleeuwenhoek, Boter & Vermeer, 1995; Verrips et al., 1999, as cited in Houwen et al., 2009b).

Williams et al. (2008) found that preschool children with poorer motor skill performance were less active than children with better-developed motor skills. They concluded that the relationship between motor skill performance and physical activity could be important to the health of children, particularly in obesity prevention.

The results of research (Šarenac, 1999; Nikolić et al., 2000; Urošević, 2001) conducted with early childhood age children in regular primary school show that 10-15% of children with poor motor skills have low school success. These children need support to overcome developmental and learning difficulties.

Barnet et al. (2009) assessed children's proficiency in object control (kick, catch, throw) and locomotor (hop, side gallop, vertical jump) skills with the aim of investigating whether skill proficiency predicts subsequent physical activity. The research results indicate that object control proficient children were more likely to become active adolescents. According to these authors motor skill development should be a key strategy in childhood interventions aiming to promote long-term physical activity.

With the aim of further understanding control impairments seen in children with developmental coordination disorder (DCD) and the effect of these impairments on motor performance in these children, Grovea and Lazarusb (2007) assessed 30 children with and without DCD. It was found that children with DCD had greater difficulty maintaining postural control when visual and somatosensory feedback were compromised in sensory conflict environments ($p = .031$). Group differences in postural control were independent of age. It was pointed out that their results demonstrated that impaired ability to utilize vestibular feedback while re-weighting somatosensory and visual feedback for orientation may be responsible, in part, for the postural control impairments observed in some children with DCD.

Coordination, balance, body position sense and motor sequential organization are not in themselves prerequisites to academic success. The effectiveness of gross motor output plays a role in personality development. Youngsters who are not able to compete in team sports will generally lack a sense of ″motor mastery″ and may suffer from diminished self-esteem, social rejection and general feelings of inadequacy. Gross motor disabilities may be the outward indicators of central nervous system dysfunction. A history of difficulty catching a ball, general awkwardness, poor balance and trouble learning to ride a bicycle, to hop and to skip may lead one to suspect a gross motor lag (Abroms, 1980, as cited in Nikolić & Ilić-Stošović, 2009).

The detection of motor skill disorders then is an important indicator of delayed or lower quality motor maturity. Prompt inclusion of these children into treatment programmes prevents mild disorders from developing marked difficulties in school (Nikolić & Ilić-Stošović, 2009).

The problem becomes more complex when considering the terms of sensory impairment influence on the motor skill performances.

Childhood hearing impairment is a significant public health problem which is associated with long-term academic and communicative difficulties (Davis, 1997, as cited in Rajendran & Roy, 2011). Children with hearing impairments have a higher risk for deficits in balance and gross motor skills compared with children who are developing typically. As balance is a fundamental ability for the motor development of children, a valid and reliable assessment to identify weaknesses in balance is crucial (De Kegel et al., 2010).

Research results related to motor skill performances of children with hearing impairments are very different. Cushing et al. (2008) found that large differences existed in the balance ability of children with sensorineural hearing loss requiring cochlear implantation compared with age-matched controls (children with normal hearing). Implant activation, however, conferred a slight advantage in accomplishing balance-related tasks. An et al. (2009) examined the relation between age and single-limb standing balance in children with and without deafness, and concluded that the postural stability of profoundly deaf children improves as a result of adaptive sensory compensation, both visual and somatosensory. In addition, it appears that postural control is more highly dependent upon visual input than on somatosensory input. Gayle and Pohlman (1990) measured the dynamic, static and rotary balance of deaf and hearing children. Significant differences were noted between groups for dynamic balance and rotary balance. Although not significant, there was a difference of 57.8% in a number of trials for successful completion of static balance in favour of the hearing children. In the present study, overall balance in deaf children was significantly inferior to the balance in hearing children. The authors highlight that knowledge of these differences may aid those working with deaf children in physical education. Horak et al. (1988) examined vestibular status and motor proficiency of 30 hearing-impaired and 15 motor-impaired learning-disabled children to determine whether vestibular loss can account for deficits in motor co-ordination. Reduced or absent vestibular function in 20 hearing-impaired children did not affect development of motor proficiency, except in specific balance activities. However, sensory organization deficits in the learning-disabled group and in three of the hearing-impaired children were associated with widespread deficits in motor proficiency. A few studies related to motor skill performances of persons with hearing impairment indicate that, with the exception of balance impairment, there are no significant differences in this area between persons with hearing impairment and those who can hear (Garet & Levin E, 1970). But, the research conducted by Vujasinović (1997), states that the children with hearing impairment show the delaying in motor development. Depending on age, this delaying varies from 8 months (at the age of four), to two years and nine months at the age of eleven. The delaying in motor development in relation to the chronological age increases with the age itself. Narančić (1997) examined practognostic organization of children with hearing impairment and showed that, generally speaking, their abilities to master the psychomotor performance in the service voluntarily given model were not reported. Butterfield (1986) evaluated and summarized the gross motor development of 132 hearing-impaired children between the ages of 3 and 14 year. Delays were noted in catching, kicking, jumping and hopping. It was determined that gross motor skill performance was not related to etiology of deafness or to the sex of the subjects. Rine et al. (2000) also found evidence of delayed gross motor development regardless of age, but only children less than 5 years[1] of age had developmental balance deficits on initial testing. Both gross motor and balance development scores were lower on repeated testing. Kohen-Raz and Masalha (1988) found significant correlations between the basic arithmetic and motor skills, within the hearing as well as within the hearing-impaired groups; these remained significant even within the small subgroups of the latter. Thannhauser et al. (2001), examined psychomotor efficacy of children with hearing disorders. It was found that children with impaired hearing reach worse psychomotor efficacy in the range of hand movement co-ordination and precision. Psychomotor efficacy examined at particular age undergoes development and sex was not a differentiating factor, and compared environments were not univocally found to influence the development of the examined features. In a study aimed at examining motor performance in deaf elementary school children and its association with sports participation, Hartman et al. (2011) found that the deaf children had significantly more borderline and definite motor problems than the normative sample: 62% (manual dexterity), 52% (ball skills) and 45% (balance skills).

As routine screening for children with hearing impairment does not include assessment of balance and motor deficits, physical therapy services are not included in the educational programme, unless obvious neurological or orthopaedic disorders are diagnosed. However, teachers and parents of these children often report incoordination, clumsiness and balance deficits which may hinder the child's optimal performance (Butterfield, as cited in Rajendran & Roy, 2011). Moreover, many paediatric health care providers are often too busy or inadequately trained in conducting elaborate developmental screening tests during the

[1] In this study gross motor development was examined in 24 to 83 - month-old children with sensorineural hearing impairment.

regular clinics. These tests are performed only when the child presents with an obvious deficit (Omondi et al., 2007 as cited in Rajendran & Roy, 2011).

From the other side vision plays an important role in motor skill performance as vision guides and controls the acquisition, differentiation and automatization of motor skills (Brambring, as cited in Houwen et al., 2009). Functions of visions in motor skill acquisition are (a) incentive function - to motivate children to move, (b) spatial function - to provide information about distance and direction of movements and objects, (c) protective function - to anticipate dangerous situations, and (d) controlling/feedback function - to detect errors and correct the ongoing movement by online regulation of the movement. Furthermore, vision enables children to imitate movements made by others (Brambring, 2006, as cited in Houwen et al., 2009b, pp. 465). The objective of Taylor Kulp's (1999) study was to examine the relationship between visual motor integration skill and academic performance in kindergarten through to third grade. The children's regular classroom teachers rated the children with respect to reading, math and writing ability. Second and third grade children were also rated on spelling ability. They found that performance on a visual analysis and visual motor integration task is significantly related to academic performance in 7, 8 (reading, writing and math achievement ratings) and 9 year olds (writing, spelling and math achievement ratings). Performance on the visual motor integration was found to be significantly related to teachers' ratings of the children's reading, math, writing and spelling ability.

The visual control is necessary for all targeted movements in the function of their correction. The children with visual impairment at the earliest age have badly expressed and incoordinated movements of hands, they are passive and show a low curiosity for the objects in their surroundings. As we could read, there are a lot of studies that are related to the motor skill performances of children and adolescents with visual impairment. Jablan (2003), examined the motor skill development quality of elementary-school age children with severely visually impairment. It was found that 55.8% of children had harmonious development of motor functions. The most difficulties were found within melokinetic praxia and the coordination of bi-manual activities. Houwen et al. (2009a) examined the physical activity levels of children with and without visual impairments. It was further investigated whether the degree of visual impairments was associated with activity level, whether body composition was associated with activity level and whether interrelationships existed between activity level and motor skill performance. All participated children (96) were ages 6 to 12 years and attended mainstream schools. It was found that total activity was significantly higher in children without visual impairment than in children with visual impairment. Participation in moderate to vigorous physical activity was significantly higher in children without visual impairments versus children with visual impairments. Light activity was positively associated with locomotor scores; total activity and moderate to vigorous physical activity were positively associated with object control scores. For children without visual impairments, total activity and time spent in moderate to vigorous physical activity were positively associated with locomotor scores and time spent in sedentary activity was inversely associated with object control scores. The authors concluded that the results of their research emphasize the importance of promoting an active lifestyle in children. Special attention has to be paid to children with lower visual acuities and children with higher body mass index. From the other side, the research conducted by Norris, Spaulding and Brodie (1957) (as cited in Garet & Levin, 1970) indicates that the development of the children with severe visual impairment is approximately equal to the development of the children who can see, except for the tasks requiring specific experience. The skills in fine motor coordination and the success in mastering spatial relations were found out to develop spontaneously in the visually impaired children who had adequate opportunities for rough motor activities and who were allowed to freely research their environment, although usually in a later age than in children without visual impairment. A similar conclusion can be found at Warren (1994) who indicated that variables linked to impaired vision, such as environmental opportunities and barriers for movement, rather than vision impairment per se, have an impact on the motor skill performance of persons with visual impairment. Houwen et al. (2009) reviewed 39 studies, 26 of which examined the effects of child, environmental and/or task variable (sell) on motor skill performance, 13 of which reported suggestions by experts about variables related to performance. In this review study weak evidence was found for three relationships: (a) between the degree of visual impairment and the performance on dynamic balance and manual dexterity (Gipsman, 1981; Houwen et al., 2008; Leonard, 1969; Pereira, 1990; Reimer et al., 1999; Ribard et al., 1987; Wyver & Livesey, 2003 as cited in Houwen et al., 2009b); (b) between amblyopia/strabismus and fine motor skills (Caputo et al., 2007; Hrisos et al., 2006; Weber et al., 2008, as cited in Houwen et al., 2009b); (c) between movement interventions and motor skill performance (Aki et al., 2007; Dye, 1983; Jospeh, 1984; Lieberman, Stuart et al., 2006; Palazesi, 1986; Poncillia et al., 2005, as cited in Houwe et al., 2009b). In addition, weak evidence was found to refute a relationship between gender and static balance (Leonard, 1969; Pereira, 1990; Ribadi et al., 1987, as cited in Houwen et al., 2009b).

As it could be seen through reviews of previous studies, motor functioning of children with sensory impairments can be very variable.

Every limitation or poor motor skill performances, in their own way disturbed the process of integration in school and threatens effectiveness of participation in educational activities. Poor motor skill may lead to poor performance in physical activities, which may reduce a child's sense of competence. This may lead to withdrawal of movement activities that would, in turn, lead to limited opportunities to practice motor skills and participate socially (Skinner & Piek, as cited in Houwen et al., 2009b).

2. Method

The aim of this research is to establish the prevalence, form and the quality of motor skill performance in children with sensor impairment. The research results will focus on two groups of school aged children: children with visual impairment and children with hearing impairment. First, the findings on variables associated with prevalence, form, level of motor disorders and quality of motor skill performances are analyzed in each group of children. "*Motor skill performance* is a broad term which is defined as the observable act of movement and task characteristics (Hutzler, 2007; Newell, 1986; Shumway-Cook & Wollacott, 2001; Warren, 1994; WHO, 2001, as cited in Houwen et al., 2009b). *Motor skills* are acts or tasks dependent on practice and experience for their execution (Payne & Isaacs, 2002, as cited in Houwen et al., 2009b). In the purest sense, the term motor refers to underlying biological and mechanical factors that influence movement (or observable action), however, the terms movement and motor are frequently use interchangeably (Gabbard, 2007; Sherill 2004, as cited in Houven et al., 2009b, pp. 467)".

The quality of motor skill performance, in this research, is analyzed in three areas of motor functioning: neuromaturation, coordination and balance. The study provides data on interaction between: (1) motor skill performance and visual or hearing impairment (between groups and single analysis). Findings are compared with the aim of establishing if there is strong evidence for or against the effect of visual or hearing impairment on motor skill performance; (2) motor skill performance of children with visual impairment, as much as motor skill performance of children with hearing impairment, with the aim of establishing if there is a similarity or some kind of pathway which can help professionals in creating rehabilitation programmes, as much as programmes for adaptive physical education; (3) motor skill performance and common child variables, such are gender and age. Gender differences in motor skill performance for children and adolescents in general may exist because of differences in body composition during growth and maturation, and social influences regarding physical activity. Generally, the magnitude of differences in motor performance between boys and girls is low to moderate during childhood, and girls are low to moderate during childhood, but this changes quite markedly after puberty when boys tend to outperform girls (Thomas & French, 1985, as cited in Houwen et al., 2009b); (4) the previous findings of the authors Nikolić, Ilić-Stošović (2009) that are related to motor skill performance of children with typical development are examined in all three groups with the aim of establishing differences or a similarity in prevalence and structure of motor skill performance.

Why did we decide to do such a study? Sensor integration is essential for obtaining a complete experience of phenomena and activities that surround us. It is basic for mostly learning situations. Sensor integration, thus integration of auditive and visual information, is basic for creating, defining and interpretation of terms. Disabilities in this area may influence development of all academic skills, and also other skills, especially motor skill. From the other side, integration of perception and motor activities primarily is related to visual-motor coordination and audio-motor integration. Visual-motor integration implies ability of visual and motor coordination. Difficulties in this area, potentially, can disturb all areas of a child's life: social, academic, sports and practical. The child, because of lack of visual control of motor activity, organises its movement in space and time inadequately. Audio-motor integration includes compliance of motor activities with verbal and non-verbal stimulus, such as melody, rhythm etc.. Spurious capacitance response in this area can be directly reflected in the development of academic skills (Gligorović et al., 2010). The situation becomes more complicated if a child is born with sensor impairment, or during early development copes with sensor impairment. What than happens with motor skill development and performance? Is it possible, although both with sensor, but one group with visual and the other with hearing impairment, that there are some similarities? This was a question that we tried to answer through our research.

The truth is that there are a lot of studies that are related to motor skill performance of children with visual impairment and a lot of articles with the studies that are related to balance disorders and motor outcomes of children with hearing impairment. Also, many of those studies compared the motor skill performance of children with visual or hearing impairment and children with typical development. But there are only a small number of studies that examined motor skill performances (not only balance) in children with hearing impairment, in spite of some evidences (see in Vujasinović, 1997; Narančić, 1997; Butterfield, 1986; Rine et al., 2000; Kohen-Raz & Masalha, 1988; Hartman et al., 2011) that children with hearing impairment have some delays in motor development and lower results in motor skill performances scores in relation to children without any impairment. It was challenging to compare the motor skill performance of the two, considering the type of sensor impairment and different groups of children, although there are not a lot of studies that compared variables, such are neuromaturation, lateralization or coordination between those two groups of children with sensory impairment.

In that way this research can contribute in enabling differentiated diagnostic criteria for establishing the level and the quality of motor skill performance, prevalence and of the form of the manifestation of motor skill performance disorders in pupils with sensory impairment. The main idea was to point to the importance of including assessment of motor skill performance in routine screening of children with sensor impairment. Second, the results of this research can give implications for therapeutic approaches related to improvement of motor skill performance. Third, the results of this research can contribute in creating sports activities for children with sensor impairment.

2.1 Sample characteristics

The 73 pupils were children with different degrees of hearing impairment (HI) and 83 were children with different degrees of visual impairment (VI). The group of children with visual impairments consisted of two subgroups: children with blindness whose range of vision ranges from 0.02 to a complete absence of quantitative and qualitative vision, and children with low vision, whose range of vision ranges from 0.3 to 0.05. The sample is a balanced representation of the children with blindness (41.94%) and low vision (48.38%). The group of children with hearing impairments consisted of children whose level of hearing loss ranged from 45-59dB (ASA) or 56-70 dB (ISO) of them 17.73%, then 25.32% of children with hearing impairments whose level of hearing loss ranged from 60-70 dB (ASA) or 71-90 dB (ISO) and 56.95% of children with very hard hearing impairments (80 dB and more (ASA) ili 91 dB and more (ISO))[2].

According to psychological documentation, all children were of average intelligence. All children were between 7 and 14 years of age. The distribution of the total sample according to gender is equal (boys 53.2% and girls 46.8%) and does not show a statistically significant difference (Pearson's R: Value ,022; Approx. T (b), 268; Approx. Sig. ,789(c)).

All children attended schools for education children with visual/or hearing impairment (special schools) in Belgrade, Republic of Serbia.

2.2 Material

The main criterion for the selection of test materials was that the methods used had to be appropriate for testing children of middle childhood age (psychological/pedagogical periodization of children's development) and to evaluate the most important functions for this period of life: neuromaturational maturity (a symptom of synkinesia, diadochokinesia

[2] This paper shows an empiric segment of the macro-project "Phenomenology of Developmental Disturbances and Disorders", which was realized at the Faculty for Special Education and Rehabilitation, University of Belgrade, and approved by the Ministry of Science and Technology of Republic of Serbia (number of license: MNTR 1611).

and motor impersistence, as much as symptom of dyslateralisation); balance; and coordination (general motor skills and visuomotor coordination). Levin M.D. (1980) tests were used for evaluation of neuromaturation and Bruininks-Oseretsky Test of Motor Proficiency (Bruininks 1978) and the ACADIA test (Atkinson, Johnston, Lindsay, 1972) were used to evaluate coordination and balance. The tasks were selected on the basis of chronological age of the children, because they have been widely used in similar research and because they have standardized methods for interpreting the results. The outcome of Dügers et al.'s (1999) study, with the primary objective to research the relationship between motor abilities and demographic characteristics, such as age and sex, in healthy children aged 4-11 years, revealed that the Bruininks-Oseretsky test can be useful to investigate unexplored aspects of motor development. This was one more reason to choose this test for our research.

Every child was tested individually in separate rooms, without other children present, but with presence of two researchers and a class teacher. The testing did not start until the child was relaxed and ready to cooperate. Tasks were explained verbally to the child. In the situation where the child couldn't understand verbal directions, the researchers demonstrated the desired response. We took into account that, regarding the children with hearing impairment, we had to say the tasks clearly, simply, in short sentences, and for the pupils of higher classes we had prepared the tasks written in big Cyrillic letters. In some cases, if a task was not clear, we used demonstration as well. Children with visual impairment perceive verbal demands well, and constructing the protocol we took into account its adaptability for this category (the imitation tasks were omitted, as well as those which first require the reception of visual information and then motoric performance). Small help of the researchers was given, mainly for balance and coordination tasks.

3. Results

3.1 Quality and the effect of type of sensor impairment on motor skill performance

3.1.1 The prevalence and distribution of symptoms of delayed neuromaturation

The neuromaturation tasks were scored as either some symptom of neuromaturational delaying is present or not. The video recording made it possible for both researchers to score the tests independently in order to obtain a reliable score. After having done so, both researchers agreed on every test. An alpha level of .05 was used for all statistical tests.

Neuromaturational evaluation implies the detection of symptoms of synkinesia, diadochokinesia and motoric impersistence.

Synkinesis is involuntary movements and it is associated with voluntary motor activity. Some authors considered it a secondary event and interhemispheric interaction in the functional organization of motor acts (Zaytseva, Sami Walid, Berdichevskaia, 2009). Execution of useless movement during performance of motor activity and/or sleep may represent an expression of the slow maturation of structures responsible for achieving basic levels of inhibitory control, which is reflected in the performance of complex tasks. In assessing the synkinesis, the child is expected to lay hands on the table and … lift each finger independently one after the other, first on one and on the other hand. Assessments forced open the possibility of occurrence of isolated fingers and synkinesis at the same or in a different hand.. In assessing diadochokinesis, the child is given an order to relax one arm next to the body and the other bent at the elbow near the body, and then to perform rapid, alternating movements of supination and pronation.. This assessed the presence of second hand synkinesis and separation of the shoulder and elbow forces on active hands.

Motor impersistence is examined by requesting for the child to stand upright, arms outstretched in front of him, fingers outstretched, mouth open, eyes closed for 30 seconds. Assessments are based on the possibility of maintaining a given position, without vocalization, moving the fingers, tongue and other body parts. Inhibitory control mechanisms are used to control interference, modulation or interruption of ongoing activities, which are basically a series of other cognitive functions and abilities such as attention, working memory, understanding, planning, regulation of motivation and emotion (Brocki, Bohlin, 2004; Eisenberg, Smith, Sadovsky, Spinrad, 2004), theory of mind and social competence (Carlson, Moses, 2001). Inhibition of motor activity usually matures about 6-7 years, unlike the inhibition of linguistic, conceptual and mnestic stimuli showing a longer development trend (Welsh, 2002). Inhibitory control deficit, which is one of the basic mechanisms of executive functions, is a very important factor in the weak achievement in all tested parameters of sensomotor skills and abilities that are prerequisite for the development of academic skills.

These indicators of possible delay in the development of the central nervous system are normally present in children before they start to attend school. Related to our sample, there are 26.9% of the children with symptoms of synkinesis, 26.3% with symptoms of diadochokinesia in 23.1% of the children with signs of motoric impersistence.

Comparing children with hearing impairment and children with visual impairment, we can see that symptoms of synkinesis were noticed in 31.5% of children with HI and in 22.9% of children with VI. Symptoms of diadochokinesia were noticed in 13.7% children with HI and in 37.3% children with VI. Symptoms of motoric impersistence were noticed in 26% of children with HI and in 20.5% children with VI. (Figure 1). In relation to the type of sensory impairment, the results indicate an equal distribution of the symptom of synkinesia (Pearson's R: Value -,097; Approx. T (b) -1,208; Approx. Sig. , 229(c)), and of motoric impersistence (Pearson's R: Value -, 066; Approx. T (b) -, 817; Approx. Sig. , 415(c)), but the prevalence of diadochokinesia is statistically significantly and increased in the children with visual impairment (Pearson's R: Value, 268; Approx. T (b) 3,454; Approx. Sig., 001(c)). The reason for such increasing of symptoms of diadochokinesis in children with visual impairment can be found in the lack of opportunities for movement experience, lack of effects of graphomotor experience (writing), which has important influence on neurological development of muscles that control fine motor movements. It is believed that children with visual impairment often have fewer opportunities to interact with the environment, which may lead to limited movement experience. Furthermore, it is generally assumed that those with a greater amount of task-specific experience perform better (Houwen et al., 2009)

Additional research is needed in this area. Issues that need to be addressed include association of level of hearing/visual impairment with delaying in neuromaturnational development. Also, it is important to research how school programmes, environment and special or mainstream education influence development of this motor skill performance.

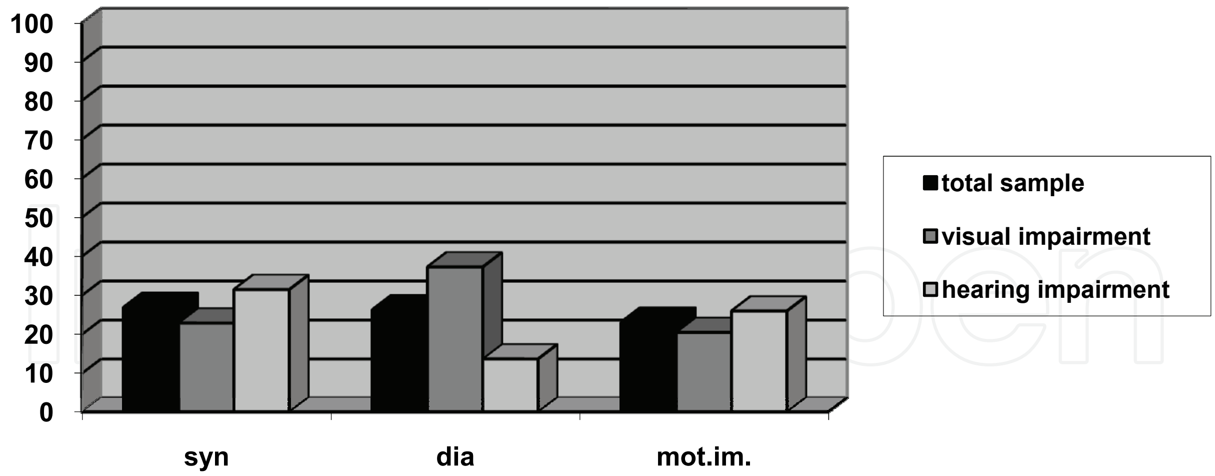


Fig. 1. The prevalence and distribution of symptoms of delayed neuromaturation in the total sample and in pupils with visual and hearing impairment.

Nikolić & Ilić-Stošović (2009) examined prevalence, form, level and quality of motor skill disorders in 1,165 children, aged between 7.5 and 11 years, with no detected impairment and with average intelligence scores. It was found that the symptom of synkinesis was present with 38.45%, diadochokinesia was present with 33.39% and the symptom of motor impersistence was present with 26.18%. In correlation with the results of our research we can conclude that there are no differences in prevalence and distribution of symptoms of delayed neuromaturation between groups of children with and without sensor impairment. Given that our sample included children older than the survey sample Nikolic & Ilić-Stošović, we can say that age does not significantly improves motor skill performances in chilren with sensor impairment.. Additional research is needed in this area. First of all, it is important to examine prevalence and distribution of neuromaturnational delaying in children and adolescents with typical development, between 11.5 and 14 years. Then, we will be able to state that there are no differences in neuromaturnal development between children with and without sensor impairment.

In addition, in order to explain why is so important to examine neuromaturation in children with sensor impairment, we will cite Kohen-Raz and Masalha (1988) who found significant correlations between the basic arithmetic and motor skills, within the hearing as well as within the hearing-impaired groups. The hearing-impaired performed as well on arithmetic tasks and on the tests of synkinetic control as their normal peers who were four years younger, while on static balance they were even inferior to the latter. Raz and Masalha (1988) concluded that as these results cannot be accounted for by low intelligence and neurological disturbances, or by direct or indirect effects of deficient language development, the assumption is supported that some type of neurological immaturity, unrelated to hearing loss, interferes with the acquisition of numerical skills in deaf children.

3.1.2 The prevalence and distribution of dyslateralization

The process of the maturation of the domination of extremities in the manipulative field is usually connected with the age between 6 and 8. Any ambivalence of the movements from this period represents delaying in maturity of structures and functions determining lateralization of the movements.

Harmonious lateralization implies identical dominant eye, arm and leg lateralization. There are, in our research 51, 9% of children with harmonious lateralization. With total disharmony between the domination of arm, leg, eye and ear were 3.8% of our participants. There are 44.2% of children, in our sample, that are described as "with symptoms of dyslateralization". This means that those children were found to have disharmony between the domination of arm and the domination of eye, or between the usable and the spontaneous lateralization of upper extremities.

Comparing the group of children with HI and the group of children with VI, it was found that the category of children with sensory impairment does not indicate any significant influence on this variable (Pearson's R: Value ,133; Approx. T(b) 1,662; Approx. Sig. ,099(c)). In the sample of pupils with visual impairments, we noticed the presence of dislateralization in 7.2%, disharmonious lateralization in 44.6% and harmonious lateralization in 48.2%. In the sample of the pupils with hearing impairments, we noticed the presence of disharmonious lateralization in 43.8% of the pupils and harmonious lateralization in 56.16%.

The results of Nikolić and Ilić-Stošović's (2009) study are equal to ours. More studies are needed for strong evidence of whether sensor impairments have influence to the process of lateralization. From our study we can conclude that the type of sensor impairment does not influence to process of lateralization.

3.1.3 The prevalence and distribution of balance dysfunction

The stage of balance development begins in the period of middle childhood and this stage is characterized by the stabilization of head in spatial strategy, even if there are more requirements for the balance, and it is the result of predomination of dynamic and vestibular contributions to the balance control, unlike earlier stages, when visual contributions are dominant in balance control (Assiante, 1998).

Apart from the close association between balance skills and young children's motor performance, a dysfunction in postural control may be used as an indication of various types of developmental deficits. Children with disabilities, ranging from mild to severe ones, have a poor performance on balance tests (see: Cinelli & De Paepe, 1984; Gagnon, Friedman, Swaine, & Forget, 2004; 2001; Visscher, Houwen, Scherder, Moolenaar, & Hartman, 2007; Wright, Galea, & Barr, 2005, as cited in Venetsanou & Kambas, 2011). Physical therapists and occupational therapists have historically placed high priority on the treatment of patients with postural control problems because this control appears to be an integral part of all motor abilities (Westcott et al., 1997, as cited in Venetsanou & Kambas, 2011). Additionally, the examination of postural stability and motor control is essential to the vestibular evaluation of infants and children as bilateral vestibular failure may manifest itself as deterioration or delay in motor milestones (Snashall, 2007, as cited in Venetsanou & Kambas, 2011).

Damage to the vestibular system causes gaze and balance impairments (Rine, 2009, as cited in Rajendran & Roy, 2011). To determine the incidence of static and dynamic balance dysfunction in a group of children with profound sensorineural hearing loss receiving a cochlear implant and to assess the impact of cochlear implant activation on equilibrium, Cushing et al. (2008) tested 41 children (ages 4-17 years) with cochlear implants and 14 children with normal hearing served as controls. All participants performed a standardized test of static and dynamic balance function (Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT2), balance subset). Children with implants performed the BOT2 under the two randomized conditions. The group that had undergone implantation, however, performed significantly more poorly (12 (6) points; 95% CI, 10-14) than either the control group or the published test mean (P = .004). Children with implants performed better with their implants on than with their implants off (mean (SD) difference, 1.3 (2.7) points; 95% CI, 0.3-2.3; P = .01).

The balance was estimated through tasks of the Bruinincks-Oseretsky Test of Motor Proficiency. All tasks were appropriate to the age of the child. We estimated static and dynamic balance. In the results of our research in the area of balance in the pupils with visual and hearing impairments, we found good balance in 50.6% of the pupils, the absence of the balance was found in 27.6% and the difficulties in maintaining balance were recognized in 21.8% of the pupils. (Figure 2).

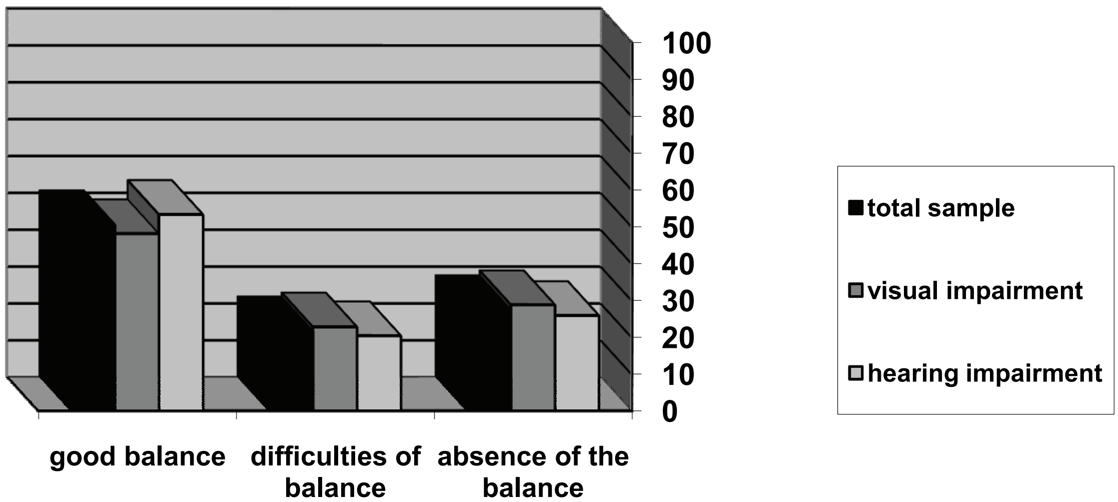


Fig. 2. The prevalence and distribution of balance dysfunction in pupils with visual and hearing impairments.

Opposite to our hypothetic view, but very close to different results of previous research, we did not notice any significant presence of balance dysfunction in the pupils with hearing impairment. The frequency of balance dysfunction has an equal distribution in both examined groups. The absence of balance was noticed in 26% children with HI and 28.9% children with VI. The difficulties in balance were noticed in 20.5% children with HI and 22.9% children with VI. Good balance was noticed in 53.4% children with HI and in 48.2% children with VI. The influence of the category of impairment is not statistically significant (Pearson's R: Value ,047; Approx. T(b) ,590; Approx. Sig. ,556(c)).

Potter and Newman Silverman (1984) also found that balance skills were not significantly related to the level of vestibular response. No significant sex differences were found in the vestibular or balance status of the deaf children. They concluded that the differences in the characteristics of vestibular function and static balance skills in the deaf children compared with hearing children are important to therapists working with the deaf. Therapists should consider that these differences exist when they identify those deaf children with learning or other sensory-motor problems. Crowe and Horak (1988) investigated the relationship of vestibular function to motor proficiency, including balance, in children with hearing impairments. The test results of this study indicated that the children with hearing impairments and normal peripheral vestibular function exhibited normal motor proficiency, including balance. The children with hearing impairments and loss of peripheral vestibular sensitivity also demonstrated normal motor proficiency, except for balance ability. The children with hearing impairments and sensory organization deficits, however, exhibited motor deficits in many areas. The results of this study indicate that motor proficiency in children with hearing impairments depends on vestibular function. So, while children with hearing impairment can compensate for vestibular deficit through the visual and kinaesthetic system to maintain static balance with eyes open or closed (Potter & Silverman, 1984, as cited in Rajendran & Roy, 2011), and it appears that postural control is more highly dependent upon visual input than on somatosensory (An et al., 2009), we can conclude that children with visual impairment have less opportunity for compensation, besides an absence of damage of the vestibular system. From the other side, many studies (Johnson-Kramer et al., 1992; Johnson/Kramer, Sherwood, French & Canabal, 1992; Ribadi, Rider & Toole, 1987; Gipsman, 1981, as cited in Houwen et al. 2009) underscore the role of vision in static and dynamic balance, but also showed that subjects who are blind adapt to their condition.

O`Reilly et al. (2010) examined prevalence of vestibular and balance disorders in children, and concluded that the prevalence of balance disorders in children was low. Children diagnosed with these disorders typically did not present with chief complaints related to balance. Significant associations existed between sensorineural hearing loss, syncope and headache in children diagnosed with balance disorders. Nikolić and Ilić-Stošović (2009) did not examine associations between balance dysfunction and the presence of some other health problems in children, but, in their study, conducted on prevalence and distribution of motor skill disorders in children with typical development, the percentage of children with balance dysfunction is equal (30.12%) with the percentage we found in our research.

3.1.4 The prevalence and distribution of dyscoordination

Coordination involves rhythmically organized sequential and/or simultaneous use of both sides of the body, which can be divided into two categories - uterus coordination and coordination of upper and lower extremities. Both types of coordination are dependent on the quality of interhemispheric communication (Kennerley, Diedrichsen, Hazeltine, Semjen, Ivry, 2002; Brakke, Fragaszy, Simpson, Hoy, Cummins-Sebree, 2007; Muetzel, Collins, Mueller, Schiessel, Lim, Luciana, 2008). Significant developmental changes in the field of coordination arise from 4 - 10 years (Otte, Van Mier, 2006). Coordination of motor activity is the product of a complex system of interaction of perceptual, motor and cognitive skills (especially executive functions, in charge of motivation, planning and control activities), and the significant correlation with all parameters estimated abilities that are prerequisites of adopting academic skills, is expected. Coordination can also be divided into static and dynamic. This division of coordination is often used.

The evaluation of the coordination of movements is made on the basis of the evaluation of coordination during the performing of alternating movements, coordination while walking and visuo-motor coordination. General motoric skills of upper extremities, of lower extremities and of the whole body was evaluated through the kicking of a puck to the finish line, jumping over a rope, synchronized jumping and clapping hands, special requirements of walking manner etc.

There are, in our research, 24.4% of children with sensor impairment that had the representation of totally inappropriate coordination. The representation of the coordination with mistakes was found at 27.6% of children, whereas good coordination is represented with 48.1%.

The type of impairment indicated a significant influence on the ability of coordination (Pearson's R: Value ,309; Approx. T(b) 4,038; Approx. Sig. ,000(c)). Comparing the two groups of children it was found that there is, in the group of children with VI, 65.07% of children with the coordination disturbance, while in the group of children with HI, this phenomenon was noticed in 36.99%. Good coordination is present with 34.93% in the sample of children with VI, while in the sample of the children with HI, it was present with 63.01%. (Figure 3).

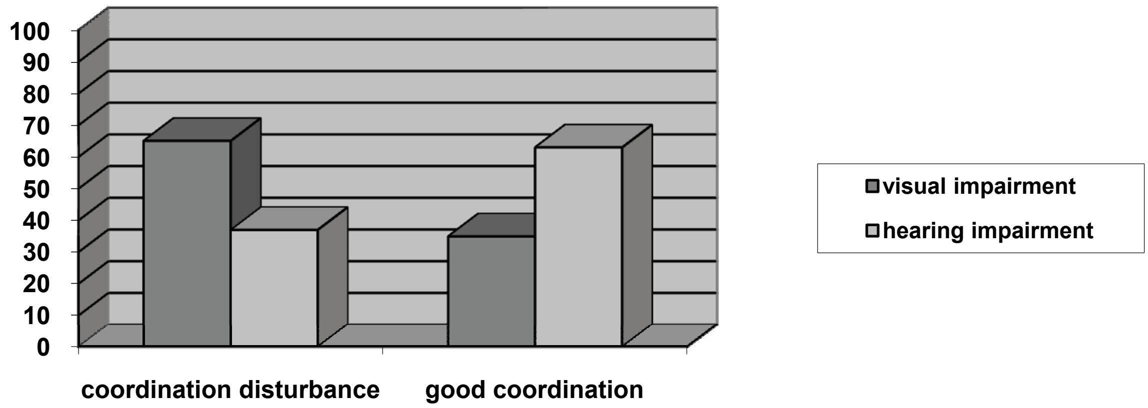


Fig. 3. The prevalence and distribution of dyscoordination in pupils with visual and hearing impairments.

Comparing our research results with the study conducted by Nikolić and Ilić-Stošović (2009) addressed to coordination skill in children with typical development, we can conclude that children with sensor impairment have more problems in solving the tasks what require good coordination skill than children with typical development. In the sample of children with typical development, the representation of totally inappropriate coordination was 7.72%, the representation of the coordination with mistakes was 27.72%, whereas good coordination was represented with 64.54%.

In relation to single aspects of motor skill performance, it is interesting to notice that the disorders in coordination occur in the greatest number - some 52% of the children in the sample. The symptoms of disorders in lateralisation and balance occur in a slightly smaller percentage. The symptoms of delayed neuromaturation mostly occur among the children age 7, and regarding the total number of the disorders, they are represented with 25.4%. The age of the children, i.e. the class they attend, contributes to the reduction of the symptoms of neuromaturation delaying.

3.2 Relationship between age, type of sensor impairment and motor skill performance

As sighted children grow older, their motor skill performance improves because of maturation, experience, age and heredity (Gallahue & Ozmun, 2002, as cited in Houwen et al., 2009).

The research that has been conducted on differences in motor skill between various age groups of children with visual impairment gave insufficient evidence to establish this relationship. In a few studies (Bouchard & Tetreault, 2000; Pereira, 1992; Gipsman, 1981, as cited in Houwen et al.) the influence of age on motor skill performances of children with visual impairment was not found. From the other side, in a few studies the clear effect of age was found on tasks that examined manual dexterity performance (Reimer et al., 1999, as cited in Houwen et al., 2009), and on a novel motor task (dart throwing) in children and adolescents who were totally blind (Joseph, 1984, as cited in Houwen et al., 2009).

When we discuss the relationship between age and balance, it is important that the child imitates the adult pattern of postural control by the age of 7-10 years. According to the sensory systems' perspective, young children depend on the visual system to maintain balance. As they grow older, there is a progressive domination of the somato-sensory system and the vestibular system (Weisz, 1938; Forssberg H & Nashner, 1982; Foundriat et al., 1993, as cited in Rajendran & Roy, 2011).

An et al. (2009) found that the age-related changes in single-limb standing balance of the profoundly deaf children were notably affected by sensory conditions, in contrast with those of the normal hearing children, which were not influenced by sensory conditions. In standing on a firm surface with eyes open and standing on a foam surface with eyes open, where visual information was enabled, the mean time of maintaining single-limb standing for the profound deaf children significantly increased with age, and even reached levels similar to those of the normal hearing children. However, in the condition of standing on a firm surface with eyes closed and covered, where visual input was removed, the deficit of single-limb standing balance in the profoundly deaf children persisted. In the condition of standing on a foam surface with eyes closed and covered revealed no significant age-related changes in the profoundly deaf children. From the other side, Siegel et al. (1991) compared balance skills of hearing-impaired children with those of hearing children, in order to determine whether a deficit in balance exists in hearing-impaired children and to ascertain whether this deficit is age-related. Balance was measured by the use of the Balance subtest of the Bruininks-Oseretsky Test of Motor Proficiency, and the age of the participants was similar to participants in our research (from 4.5 to 14.5). The results showed that for each age group, the mean score for the hearing-impaired children was lower than the standard score. Both older groups had significantly higher scores than the youngest group, but the mean scores of the older groups were not significantly different. No difference between the subjects' balance scores and the Balance subtest standard scores was found among the age groups, suggesting that the balance deficit was not age-related.

The purpose of Butterfield and Ersing (1986) study was to examine the influence of age, sex, etiology and degree of hearing loss on the static and dynamic balance performance of hearing impaired children and youth, ages 3 to 14 years. The subjects were individually assessed on Items 2 and 7 of Subtest 2 of the Short Form of the Bruininks-Oseretsky Test of Motor Proficiency. Performance on both tasks improved with chronological age. The sex of the child as well as extent of hearing loss did not affect performance in either task.

There is a usual opinion that the process of the differentiation of the tonus and the appearance of frequent movements on the edges of upper and lower extremities occur toward the end of the sixth year (Bojanin, 1985). The presence of synkinesis and diadochokinesia indicates the immaturity and insufficient differentiation of the basic tonus of muscular structures performing the movements. Some researchers, however, (Golubović Š., 1999) consider this a physiological phenomenon in this period of life, judging by the number of the children showing the immaturity of the muscular tonus in the area of wrist and hand, related to the maturation of cortical structures. Results of our research confirm that same trend is present in children with sensor impairment. According to our research, the symptoms of delayed maturation occurs in 25.43% of the children in the total sample. The greatest representation of all the elements of insufficient maturation appears among the children age 7 to 8 years, but they persist in a certain number of children age 13 to 14 years. Such tonus/neurological organization can disturb the efficacy in school requirements, particularly regarding graphomotor expression. As reported in a study conducted by Nikolić and Ilić-Stošović (2009), the influence of age on the development of this neuromaturation symptom, in children with typical development, was obvious. Most cases occurred in the 2nd-class pupils (32.84%), there was a slight decrease in the 3rd class (29.85%) and the fewest cases occurred among the 4th-class pupils (16.54%). The presence of motoric impersistance decreases with age. The effect of age was statistically significant, $F (26,909) = 16.74$, $p = .000$.

In our research the greatest number of children with synkinesia symptoms was noticed in the 1st class[3] (72.7%), 2nd - 42.85%, decreasing with the higher class. That leads to 20.4% of pupils with synkinesia symptoms in 7th-8th class.

The symptom of diadochokinesia is mostly present at age 7 (54.5 %) and 8 years (42.8%), while the lowest frequency was noticed among the children between 13 and 14 years (9.09%).

The inability to control the mobility of the body or impersistance appears in the children with delaying in neuromaturation and attention deficits. The influence of the age on the development of this neuromaturation symptom is obvious. Most cases were noticed among the children of 7 years old (54.5%), they slightly decrease at the age of 8 (35.71%), and the fewest cases were noticed among the children between 13 and 14 years (25%). The presence of motoric impersistance decreases with the age, but the effect of age was not statistically significant (Pearson's R: Value ,130; Approx. T (b) 1,624; Approx. Sig. ,106(c)). (Table 1.)

With the limitation of a lack of more studies addressing the relationship between age and neuromaturation symptoms in children with sensory impairment, we can conclude that

[3] First class in the Serbian education system correlates with children aged 7 years, Second class - 8 year old children, Third class – 9 year old children, Fourth class – 10 year old children, Fifth class – 11 year old children, Sixth class – 12 year old children, Seventh class – 13 year old children, Eighth class – 14 year old children.

there are no differences in the relationship between age and neuromaturation symptoms in children with sensor impairment compared with children without impairment.

We noticed extremely bad findings of balance capability at the age of 13 and at the age of 14 (50%). Bad results are, also, noticed at the age of 10 (38%), when the children were required to keep balance standing on one foot or standing on the toes, but with closed eyes.

Nikolić and Ilić-Stošović (2009) in their study, also, established that in children with typical development, keeping balance while kneeling, with the arms raised sideways and the eyes closed, was impracticable for a certain number of the 2nd-class pupils (compatible with age of 8) (6.97%). Extremely poor balance capability was noticed in children age 9 years (61.13%) and in children age 10 to 11 years (59.14%) (children were required to keep balance standing on one foot or standing on the toes, but with their closed eyes). The effect of age was statistically significant (F (104, 638) = 61.117, p= .000.).

As we can see in Table 1. in our research, the relationship between age and motor skill performance in children with sensor impairment is confirmed following motor skill performances: synkinesis, diadochokinesia and balance. (Table 1.).

Correlation between age and symptoms of delayed neuromaturation - Synkinesis		Value	Approx. T^b	Approx. Sig.
Interval by Interval	Pearson'sell R	,213	2,704	,008
Correlation between age and symptoms of delayed neuromaturation - Diadochokinesis		Value	Approx. T^b	Approx. Sig.
Interval by Interval	Pearson'sell R	,323.	4,239	, 000
Correlation between age and symptoms of delayed neuromaturation - Motor impersistence		Value	Approx. T^b	Approx. Sig.
Interval by Interval	Pearson's R	,130	1,624	,106
Correlation between age and dyslateralyzation		Value	Approx. T^b	Approx. Sig.
Interval by Interval	Pearson's R	, 017	083	., 834
Correlation between age and balance dysfunction		Value	Approx. T^b	Approx. Sig.
Interval by Interval	Pearson's R	-,356	-4,727	,000
Correlation between age and dyscoordination		Value	Approx. T^b	Approx. Sig.
Interval by Interval	Pearson's R	-,028	-,352	,725

Table 1. Correlation analysis between age and motor skill performance of children with sensor impairment.

3.3 Relationship between gender type of sensor impairment and motor skill performance

Thomas and French (1985) analyzed 64 studies that reported gender differences on motor performance during childhood and adolescence. As cited in this study (there were 15,518 female and 15,926 male participants, aged 3 to 20 years), age was regressed on effect size, and the relation was significant for 12 of 20 tasks (e.g., balance, catching, grip strength, shuttle run, throw velocity, tapping). Several types of age-related curves were found; the curve for a throwing task was the most distinctive. Five of the tasks followed a typical curve of gender differences across age. For 8 tasks, gender differences were not related to age, and effect sizes were small.

The results of Nikolić and Ilić-Stošović's (2009) study confirmed that the effect of a gender was statistically significant in the presence of neuromaturation symptoms. Girls had significantly better scores on evaluation of three symptoms of neuromaturation than boys. How can we explain such a difference in our results and the results of Nikolić and Ilić-Stošović's (2009) studies? It is necessary to do more research to give the answers to the question: why is that so? It is obvious that sensor impairment, in its own structure, influences development, functioning, experience of children affected with it, and somehow equalizes development of fine motor structure, between girls and boys. So, it is necessary to examine what is the issue, besides existing similarity in prevalention and distribution of neuromaturation symptoms overall and according the age between groups of children with sensor impairment and without, influences this difference according to gender.

Venetsanou and Kambas (2011) examined the effect of age and gender on balance skills in preschool children. Gender was found to have a statistically significant effect on the total balance score. Regarding individual items, the girls outperformed the boys on standing on the preferred leg on the floor, standing on the preferred leg on a balance beam, standing on the preferred leg on a balance beam – eyes closed, walking forward heel-to-toe on a walking line, walking forward heel-to-toe on a balance beam while the boys had statistically significant higher scores on walking forward on a balance beam.

There are not a lot of studies related to gender differences and motor skill performance of children with sensor impairment. Most research addressed the relationship between gender and balance skill, but there are not many studies related to the relationship between gender and some other motor skill performances. Leonardo (1969, as cited in Houwen et al., 2009), found no differences in static balance between boys and girl with blindness, but found higher median dynamic balance scores for boys than girls with blindness. Similar results found in Pereira (1990, as cited in Houwen et al., 2009), examine static and dynamic balance in children with visual impairment aged 6-13. No relationship was found between gender and this motor skill performance. Ribadi et al. (1987, as cited in Houwen et al., 2009) examined dynamic and static balance in adolescents who were congenitally blind aged 14-17, and did not find a relationship between gender and balance. Joseph (1984, as cited in Houwe et al., 2009) found a relationship between gender and success on dart throwing tasks in children who were totally blind. Boys performed significantly better than girls.

Potter and Newman Silverman (1984) examined balance skill in children with hearing impairment and no significant sex differences were found in the vestibular or balance status of the deaf children. Butterfield and Ersing (1986), also, found no relationship between gender and performance on dynamic and static balance tasks in children ages 3-14 years, with hearing impairment.

The effect of a gender, in our research, was not statistically significant in the presence of neuromaturation symptoms. The girls did not have significantly better scores on evaluation of three symptoms of neuromaturation than the boys among the pupils with sensory impairments. There are the same results related to gender and neuromaturation symptoms in a group of children with hearing impairment, as much as in a group of children with visual impairment.

The gender of the pupils with sensory impairment does not indicate any significant influence on lateralization of the variable sampled (Pearson's R: Value ,017; Approx. T (b), 083; Approx. Sig., 834(c)).

The results of our research indicate that the effect of gender to balance dysfunction was not statistically significant (Pearson's R: Value-,058; Approx. T(b) -,719; Approx. Sig. ,473(c)).

The effect of gender to distribution of dyscoordination was not statistically significant (Pearson's R: Value-,084; Approx. T(b) -1,040 Approx. Sig , 300(c)).

4. Conclusion

The aim of this research was to establish prevalence, form and the quality of motor skill performance in children with sensor impairment. The research results were focused on two groups of school aged children: children with visual impairment and children with hearing impairment. The findings on variables associated with prevalence, form, level of motor disorders and quality of motor skill performances was analyzed in each group of children. The quality of motor skill performances, in this research, was analyzed in three areas of motor functioning: neuromaturation, coordination and balance. The study provides data on interaction between: (1) motor skill performance and visual or hearing impairment (between groups and single analysis); (2) motor skill performance of children with visual impairment, as much as motor skill performance of children with hearing impairment, with the aim of establishing if there similarities or some kind of pathway which can help professionals in creating rehabilitation programmes, as much as programmes for adaptive physical education; (3) motor skill performance and common child variables, such as gender and age; (4) previous findings of the authors Nikolić and Ilić-Stošović (2009) that are related to motor skill performance of children with typical development with the aim of establishing differences or a similarity in prevalence and structure of motor skill performance in all three examined groups.

There are the same laws in the development of motor skills in the children with visual and hearing impairments as those in the development of the children without these impairments. But nevertheless, it is possible to notice constant deviations in some areas. Garet and Levin (1970) refer to the research of Norris, Spaulding and Brodie (1957), which indicates that the development of the children with severe visual impairment is approximately equal to the development of sighted children, except for the tasks requiring the ground of specific experience. According to these authors, the delayed mastering appears most expressively in some types of motor reactions. When talking about the manifestation of neuromaturation symptoms, the results of this research coincide with the results of Nikolić and Ilić-Stošović (2009), in the research of the neuromaturation of the children without sensory impairments: in the sample of the children with sensory impairments, the presence of the malfunction of neuromaturation was noticed in 25.49% of the total sample, and in the sample of the pupils attending mainstream schools, it was 25.74%. In relation to the type of sensory impairment, the results indicate an equal distribution of the symptom of synkinesia and of the motor impersistence, but the prevalence of the appearance of diadochokinesia is statistically significantly greater in the children with visual impairment. Almost the same frequencies also appear in the comparative analyses of balance situation i.e. of the appearance of balance dysfunction: in the sample of the children with sensory impairments, the presence of balance dysfunction was noticed in 49.4% of the total sample, and in the sample of the children attending mainstream schools, it was 48%. Opposite to our hypothetic view and to previous research, we did not find any significant presence of balance disorders in the pupils with hearing impairment. Children with visual impairment have the problem of maintaining balance because of the lack of visual information, which are very important for maintaining the position of the body. The feature that is characteristic is the frequency of the phenomenon of dyscoordination, and that in the category of visually impaired children (65.07%), which is significantly greater also in relation to the pupils with a typical developmental course (37.3%, and to the sample of the pupils with hearing impairment (36.99%). Regarding the immense influence and the active role of visual information in movement control, the correction of errors and the entire coordination, such a result is not surprising. When we discuss the relationship between motor skill performance in children with and without sensor impairment, an important difference between these two groups of children can be seen in the relationship between gender and distribution of symptoms of delayed neuromaturation. Opposite to the research results of Nikolić and Ilić-Stošović (2009), that confirmed a relationship between gender and symptoms of delayed neuromaturation in children with typical development, it was not found in our research. The answer for this difference can be found in the relationship between experience and motor development. Although, all children in our sample attended special schools because of their increased need for individual and adaptive education, it is possible that lack of experience needed for development of neuromaturation (e.g. specific game) brought equalization in this area of motor skill performances between boys and girls. Additional research is needed in this area. Issues that need to be addressed include the association of education model (inclusive vs. special) and development of motor skill performance.

Assuming all presented studies related to the relationship between age and balance skill, age is a very important factor in balance skill for children with and without sensor impairment, but only if we consider type and difficultness of tasks. If we accept the opinion that it appears that postural control is more highly dependent upon visual input than on somatosensory (An et al., 2009), than we can conclude that we did not find strong evidence for a relationship between age and balance skill, but we did find a strong relationship between visual input and this motor performance skill. It is necessary, for further research to examine how different task demands (with and without visual input) influence balance skill in children with typical development. It is also necessary to examine how children with sensor impairment develop their motor skill performance and how the specifics in that development influence to scores measured at balance skill testing. Houwen et al. (2009) state that motor skill performance may be a function of age and experience.

A significant representation of isolated motor disturbances in the pupils with sensory impairments must concern and require the earliest possible intervention. The therapy approach to the disorders in motor development implies above all a properly established diagnosis, on the basis of which the kind and the form of the treatment to be applied will be determined. A timely treatment within the re-education, directed to the delaying in neuromaturation, disharmonic lateralization, balance and coordination disorders, may give favourable results. Also, it is very important to improve motor skill performance of children with sensory impairments, because it might contribute positively to their sports participation.

The construction and the application of screening protocol which contain the evaluation of neuromaturation maturity (symptom of synkinesia, diadochokinesia and motoric impersistence), the evaluation of lateralization, balance, coordination (general motoric skills), enabled differentiated diagnostic criteria for establishing the level and the quality of motoric functioning, as well as of the prevalence and the form of the manifestation of motoric disorders in the pupils with sensory impairment.

Interventions for motor deficits in children with hearing impairments must consider vestibular function as well as motor performance (Crowe & Horak, 1988).

However, this research has some limitations. First, in this research, correlation between type of hearing impairment (conductive or perceptual), as much as level of hearing loss, was not considered in the aim of establishing a relationship between motor skill performance. Second, correlation between congenital and other type of hearing loss or visual impairment was not considered in the aim of establishing a relationship between prevalence and distribution of motor skill performance. In that way, further research should consider this. Next, opportunities for movement experience of both groups of children with sensor impairment are very important factors that influence quality of motor skill performance. Restricted opportunities for movement and deprivation of practice have been shown to interfere with children’s abilities to perform motor skills at adequate level (Gallahue & Ozmun, 2002, as cited in Houwen et al., 2009). In literature it is expressed that an adequate environment that reinforces positive environmental interactions is important for stimulating motor skill practice in children with visual impairment (Schneekloth, 1989, as cited in Houwen et al., 2009). There is no reason to believe that there is an opposite rule for children with hearing impairment. So, stronger evidence for a correlation between motor skill performance in children with sensor impairment could be found if further research considers it. Lastly, we examined only motor skill performance in children with sensor impairment educated in special schools. So, when we discuss our results, we must consider that our participants had such a level of sensor impairment what needed education in special circumstances. It might be possible that distribution and prevalence of symptoms of delayed motor skill performance would be different if we correlated motor skill performance in children with sensor impairment educated in mainstream schools and children educated in special schools. Unfortunately, this was not possible as, in the period that we did our research, inclusive education was not an option in the Republic of Serbia.

5. References

An, MH., Yi, CH., Jeon, HS. & Park, SY. (2009). Age-related changes of single-limb standing balance in children with and without deafness. *International Journal of Pediatric Otorhinolaryngology*, Volume 73, No. 11, (November, 2009), p. 1539-1544, ISSN 0165-5876.

Atkinson, SJ., Johnstone, B., Lindsay, A. (1981). *ACADIA test razvojnih sposobnosti*, Fakultet za defektologiju, Sveučilište u Zagrebu

Barnett, LM., van Beurden, E. & Morgan PJ. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of Adolescence Health*, Volume 44, No. 3, (March, 2009, Epub, 2008, Octobar), pp.252-259, ISSN 1054-139X.

Brakke K., Fragaszy DM., Simpson K., Hoy E., & Cummins-Sebree, S. (2007). The production of bimanual percussion in 12- to 24-month-old children. *Infant Behavior and*

Development, (February, 2007, Epub. August, 2005), Vol. 30, No.1, pp. 2-15, ISSN 0163-6383.

Brocki, KC., & Bohlin, G. (2004). Executive functions in children aged 6 to 13: a dimensional and developmental study. *Developmental Neuropsychology*, Vol. 26, No.2, pp. 571-593, ISSN 8756-5641.

Bruininks, RH. (1978). *Bruininks-Oseretsky Test of Motor Proficiency- Owner's Manual*. Circle Pines, MN: American Guidance Service.

Butterfield, S.A. & Ersing, W.F. (1986). Influence of age, sex, etiology, and hearing loss on balance performance by deaf children. *Perceptual and Motor Skills*, Volume 62, No.2 (April, 1986), pp. 659-663, ISSN 0031-5125.

Butterfield, SA. (1986). Gross motor profiles of deaf children. *Perceptual and Motor Skills*, Volume 62, No. 1, (February, 1986), pp. 68-70, ISSN 0031-5125.

Carlson, SM., & Moses, LJ. (2001): Individual differences in inhibitory control and children's theory of mind. *Child Development*, (July-August, 2001), Vol. 72 No. , pp. 1032-1053, ISSN 0009-3920.

Crowe, TK. & Horak, FB. (1988). Motor proficiency associated with vestibular deficits in children with hearing impairments. *Physical Therapy*, Volume 68, No. 10, (October, 1988), pp. 1493-1499, ISSN 0031-9023.

Cushing, SL., Chia, R., James, AL., Papsin, B. &, Gordon, KA. (2008): A test of static and dynamic balance function in children with cochlear implants: the vestibular olympics. *Archives of Otolaryngology Head and Neck Surgery*, Volume 134, No.1, (January, 2008), pp. 34-38, ISSN 0886-4470.

De Kegel, A., Dhooge, I., Peersman, W., Rijckaert, J., Baetens T., Cambier D. & Van Waelvelde H. (2010). Construct validity of the assessment of balance in children who are developing typically and in children with hearing impairments. *Physical Therapy*, Volume 90, No. 12, (December, 2010, Epub, October, 2010), pp. 1783-1794, ISSN 0031-9023.

Eisenberg, N., Smith, C.L., Sadovsky, A., & Spinrad, T.L. (2004). Effortful control: relations with emotion regulation, adjustment, and socialization in childhood. U Baumeister R.F. i Vohs, K.D. (Eds.) *Handbook of Self-Regulation: Research, Theory and Applications*. New York: Guilford Press.

Garet, FDž., Levin, E. (1970): *Psihološka praksa sa fizičkim invalidima*, Savezni odbor Saveza gluvih Jugoslavije, Beograd.

Gayle, GW. & Pohlman, RL. (1990). Comparative study of the dynamic, static, and rotary balance of deaf and hearing children. *Perceptual and Motor Skills*, Volume 70, No. 3 (Pt1), (June, 1990), 883-888, ISSN 0031-5125.

Gligorović, M., Radić Šestić, M. (2010). Procena sposobnosti neophodnih za uspešno ovladavanje akademskim veštinama kod dece sa smetnjama u učenju. *Specijalna edukacija i rehabilitacija*, Vol. 9, No.1, pp. 15-36, ISSN 1452-7367.

Grovea, CR. & Lazarusb, J-AC. (2007). Impaired re-weighting of sensory feedback for maintenance of postural control in children with developmental coordination disorder. *Human Movement Science*, Volume 26, No. 3, (June, 2007), pp. 457-476, ISSN 0167-9457.

Hartman, E., Houwen, S. & Visscher, C. (2011). Motor skill performance and sports participation in deaf elementary school children. *Adapted Physical Activity Quarterly*, Volume 28, No. 2, (April, 2011), pp. 132-145, ISSN 0736-5829.

Horak, FB., Shumway-Cook, A., Crowe, TK. & Black, FO. (1988). Vestibular function and motor proficiency of children with impaired hearing, or with learning disability and motor impairments. *Developmental Medicine and Child Neurology,* Volume 30, No.1, (February, 1988), pp.64-79, ISSN 0012-1622.

Houwen, S., Hartman, E. & Visscher, C. (2009a). Physical activity and motor skills in children with and without visual impairments. *Medicine and Science in Sport and Exercise*, Volume 41, No. 1, (January 2009), pp. 103-109, ISSN 0195-9131.

Houwen, S., Visscher, C., Lemmink, K.A.P.M., Hartman, E., (2009b): Motor Skill Performance of Children and Adolescents With Visual Impairments: A Review. *Exceptional Children,* Volume 75, No. 4, (Summer, 2009), pp. 464-492, ISSN 0014-4029.

Jablan, B. (2003): Motorne sposobnosti dece sa oštećenjem vida, *Beogradska defektološka škola,* No. 3, pp. 97 – 106, ISSN 0354-8759.

Kennerley, S.W., Diedrichsen, J., Hazeltine, E., Semjen, A., & Ivry, R.B. (2002). Callosotomy patients exhibit temporal uncoupling during continuous bimanual movements. *Nature Neuroscience*, (April, 2002), Vol. 5, No.4, pp.376-381, ISSN 1097-6256.

Kohen-Raz, R., Masalha, M. (1988). Relations of basic arithmetic and motor skills in deaf elementary school children. *Perceptual and Motor Skills*, Volume 66, No. 1, (February, 1988), 275-282, ISSN 0031-5125.

Levine, DM. (1980). The child with learning disabilities, in Scheiner P.A., Abroms F.I. *The practical management of the developmentally disabled child*, Toronto-London: C.V. Mosby Company.

Muetzel, RL., Collins, PF., Mueller, BA., M Schissel, A., Lim, KO., & Luciana, M. (2008). The development of corpus callosum microstructure and associations with bimanual task performance in healthy adolescents. *Neuroimage*, (February, 2008), Vol. 39, No.4, pp. 1918-1925, ISSN 1053-8119.

Narančić V. (1997): Gnostička organizovanost slušno oštećene dece, *Beogradska defektološka škola,* Beograd: BIG štampa, No. 1, pp. 29 – 37, ISSN 0351-2169.

Nikolić, S., Ilić-Stošović, D. (2009): Detection and prevalence of motor skill disorders, *Research in Developmental Disabilities,* (November-December, 2009), Vol.30, No.6, pp. 1281-1287; ISSN 0891-4222.

O'Reilly, RC., Morlet, T., Nicholas, BD., Josephson, G., Horlbeck, D., Lundy, L., Mercado, A. (2010). Prevalence of vestibular and balance disorders in children. *Otology and Neurotology*, Volume 31, No.9, (December, 2010), pp. 1441-1444, ISSN 1531-7129.

Potter, CN. & Silverman, LN. (1984).*Physical Therapy,* Volume 64, No. 7, (July, 1984), pp. 1071-1075, ISSN 0031-9023

Rajendran ,V. & Roy, FG. (2011). An overview of motor skill performance and balance in hearing impaired Children. *Italian Journal of Pediatrics*, p. 37:33, (July, 2011), doi:10.1186/1824-7288-37-33, Available from: http://www.ijponline.net/content/37/1/33, ISSN 1824-7288

Rine, RM., Cornwall, G., Gan, K., LoCascio, C., O'Hare, T., Robinson, E. & Rice, M. (2000). Evidence of progressive delay of motor development in children with sensorineural hearing loss and concurrent vestibular dysfunction. *Perceptual and Motor Skills*, Volume 90, No. 3 (Pt 2), (Jun, 2000), pp. 1101-1112, ISSN 0031-5125.

Šarenac, D. (1999): Komparacija psihomotornih sposobnosti školske dece sa i bez prethodnog boravka u predškolskim ustanovama, Magistarska teza, Defektološki fakultet u Beogradu.

Siegel, JC., Marchetti, M. & Tecklin, JS. (1991). Age-related balance changes in hearing-impaired children. *Physical Therapy*, Volume 71, No. 3, (March, 1991), pp. 183-189, ISSN 0031-9023.

Svetska zdravstvena organizacija. (1993). ICD-10 Klasifikacija mentalnih pormećaja i poremećaja ponašanja. Zavod za udžbenike i nastavna sredstva, Beograd

Taylor Kulp, M. (1999). Relationship between Visual Motor Integration Skill and Academic Performance in Kindergarten through Third Grade. *Optometry & Vision Science*, Volume 76, No. 3, (March, 1999), ISSN 1040-5488.

Thannhauser, J., Borodulin-Nadzieja, L., Buldanczyk,a A. & Jurecka, M. (2001). Psychomotor efficacy of children with hearing disorders. *Journal of Human Kinetics*, Volume 5, pp.37-46, Available from: http://www.johk.pl/pdfy/nr5/05_than.pdf

Thomas, JR., French, KE. (1985). Gender differences across age in motor performance: A meta-analysis. *Psychological Bulletin*, Volume 98, No. 2, (September, 1985), pp. 260-282, ISSN 0033-2909.

Venetsanou, F. & Kambas, A. (2011). The effects of age and gender on balance skills in preschool children. Facta universitatis - series: *Physical Education and Sport* , Vol. 9, No 1, (March, 2011), pp. 81 – 90, ISSN 1451-740X

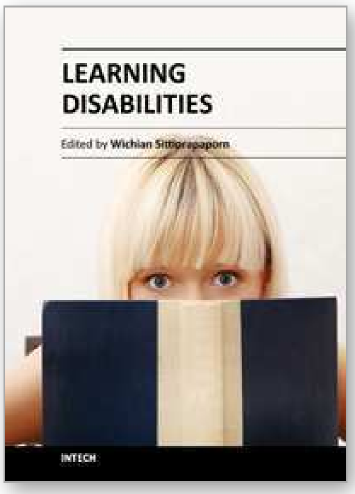
Vujasinović, Z. (1997): Uticaj pokreta i telesnih impulsa na razvoj govora i slušne percepcije gluve ličnosti. *Beogradska defektološka škola*, No. 1, pp. 7 – 27, ISSN 0351-2169.

Warren, DH. (1994). Blindness and children: An individual differences approach. Cambridge, UK: Cambridge University Press.

Welsh, M.C. (2002). Developmental and clinical variations in executive functions. In: D.L. Molfese & V.J. Molfese (Eds.) *Developmental Variations Learning: Application to Social, Executive function, Language and Reading skills*. Lawrence Erlbaum Associates.

Williams, HG., Pfeiffer, KA., O'Neill, JR., Dowda, M., McIver, KL., Brown, WH. & Pate, RR. (2008). Motor Skill Performance and Physical Activity in Preschool Children. *Obesity*, Volume 16, No. 6, (April, 2008), pp. 1421–1426, ISSN: 1930-7381.

Zaytseva, NV., Sami Walid, M., & Berdichevskaia, EM. (2009). Interhemispheric interaction in the motor domain in children with cerebral palsy. *Neurology India* . (Jul-Aug 2009), Vol 57, No. 4, pp. 411-417, ISSN 0028-3886.



Learning Disabilities

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Learning disability is a classification that includes several disorders in which a person has difficulty learning in a typical manner. Depending on the type and severity of the disability, interventions may be used to help the individual learn strategies that will foster future success. Some interventions can be quite simplistic, while others are intricate and complex. This book deserves a wide audience; it will be beneficial not only for teachers and parents struggling with attachment or behavior issues, but it will also benefit health care professionals and therapists working directly with special needs such as sensory integration dysfunction.

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
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中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821