Effects of eight weeks of perceptual motor training on perceptual motor performance and neuromuscular coordination in children aged 8-10 years

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Abstract

Background: The main objective of the present study was to evaluate the effects of eight weeks of perceptual motor training on perceptual motor performance and neuromuscular coordination in 8-10 years old children. The research was conducted through a quasi-experimental method. The study population included elementary school students from two northern and southern parts of the city of Kermanshah who were studying in the school year 2012-2013.

Materials and methods: The study sample included 320 children who were randomly assigned to two active (experimental) and non-active (control) groups. First, all participants underwent a pre-test. Then, the active group had practiced perceptual motor exercises for eight weeks (24 sessions); after the mentioned period, the post-test was conducted for both groups. Perceptual motor performance and neuromuscular coordination were assessed through Lincoln Oseretsky test. Data were analyzed using descriptive and inferential statistical methods. In order to determine the mean difference between active and non-active groups, independent T test was used and to determine differences between pre-test and post-test in two groups dependent T test was used.

Results and discussions: The results showed an increase in perceptual motor performance and neuromuscular coordination in active group compared with those of non-active group. In addition, there was no significant difference between the sexes of children. It can be inferred from the findings that perceptual motor training improves perceptual motor performance and neuromuscular coordination of children. The perceptual motor activities play an important role in the development of motor capabilities of children.

Conclusion: Since living in the future world requires human beings with high perceptual motor capabilities, it is necessary for education and training systems of a society to educate and train such a capable generation. Thus it is recommended to implement such programs at primary schools.
Introduction

Theories and researches related to child development suggest that children, from the early stages of life to the maturity, pass through various stages of growth. During infancy and childhood, they experience the first stages of sensory-motor development. At this stage, children experience the surrounding environment via sensory and kinetic abilities. Children slowly approach the perceptual stage via touching, grabbing and taking, releasing, balancing, crawling, and walking. At this point, children develop the ability to understand concepts and skills such as: symbolization, abstraction, verbal expression, reading, etc (Salman et al., 2002). According to Gottman theory, to obtain perceptual motor skills, an individual must pass a certain stage and go the next stage (Tabrizi, 2005). The child can learn a motor activity only when he/she reaches enough physical growth stage required to do that activity. However, the capability to perform a motion does not depend only on physical growth, but it also depends on the growth of the neuromuscular system. The development of the neuromuscular system, however, is the result of experiences and physiological changes caused by the natural increase of age (Schmidt, 1992). Miller (2006), showed a significant correlation between neuromuscular coordination and the performance of basic motor skills of elementary school children. Improving child's performance and the development of child's body movements can play an important role in training him/her (Mohamadi et al., 2009). Playing and physical activities have a critical and empowering role in the promotion of child’s perceptual motor abilities (Khalaji, & Emad, 2002). Although perceptual motor abilities are, with different degrees, attributable to heredity and environment, one of the most important environmental factors in the development of these capabilities is how to get over the early critical years of a child's life.

Early childhood education and training is the interest of many experts and specialists in the fields of training and physical education. Almost every action can be said to be a kind of perceptual motor skill. Human movements depend on its position, condition, and surrounding environment where he / she is located. In order to develop perceptual motor abilities, the early kinetic experiences of children are especially important (Haywood, 1980). Hosseini et al. (2011) studied the effect of exercise training on perceptual motor skills and physical fitness factors in children and found a positive correlation among the variables (Hosseini Panahi & Naghilo, 2011). Perception of motion reactions has a critical role during the various stages of child growth and development (Dortag & Asemi, 2012). The perceptual and motor skills will not develop apart from each other, but rather they are mixed and every voluntary movement is linked with an element of perception, and there is an important link between perceptual and motor processes (Mohamadi et al., 2009). Perception is the recognition and justification of stimulus which brain perceives as nerve stimulations through sensory organs; the perceptual motor reactions are the motor responses resulting from the analysis of perceptual motor actions in brain (Marandi, 1996). The term perceptual motor implies the interpretation and the changes in the individual response to a stimulus (Harrow, 1990). A hyphen is used between the two words of perceptual and motor because of two special reasons. First, it explains that intentional voluntary activity depends on some types of perceptual information. Second, hyphen indicates that the growth of perceptual skills of a person is partly dependent on his / her motor activity (Mohamadi et al., 2009). Santrak (2001) noted that, from a dynamic systems perspective, perceptual development and motor development generally do not happen independently, rather they are mixed. Thus, people perceive to experience motion, and move to experience perception (Gallhui & Ozman, 2005). In fact, all motor behaviors of children, whether kinetic or non-kinetic or musculoskeletal, are based on perceptions in a way and are associated with motor development (Mohamadi et al., 2009). Salman et al (2009) concluded that, compared with the control group, the perceptual motor exercises in experimental group improved developmental coordination disorder. This type of exercise, actively involves most perceptual motor capabilities such as balance, harmony, understanding spatial relationships and orientation of all or part of the body (Carmeli et al., 2008). Everke (2009) in a research concluded that the motor program improved perceptual motor abilities. He also showed that there is a positive relationship between cognitive and motor abilities. Information transmitted through sensory and motor nerves are a kind of electrical energy and are referred to as the nerve impulses. Stimulating the motor nerves, muscles that are connected to these nerves will contract. Stimulated sensory receptors send some information to the central nervous system through the sensory nerve. Sensory nerves in the central nervous system transmit the information to the appropriate
motor nerve which in turn sends information to the muscles. As the muscles contract, a person starts to react to incoming stimuli (Fox & Mathews, 1994-1999).

Perceptual motor exercises not only provide a good tool to train basic motor skills, but also can affect cognitive processes, attention, perception, concentration, neuromuscular coordination, and the growth of personal and social skills (Carmeli et al., 2008). Khalaji and Emad (2002) investigated the effects of selected activities on perceptual motor performance in children aged four to six years using Lincoln Oseretsky tests and they concluded that the selected exercises raise improved perceptual motor performance and neuromuscular coordination in both sexes. Performing movement skillfully requires a good muscle organization so that performed skill leads to the achievement of the desired goal. The organization property is the basis of the definition of coordination. When learning a skill, a person must create a model for the harmony of movement (Blakemore et al., 2008). Ismaeelzadeh et al. (2011) found that rhythmic movements improve the coordination of hands and feet in girls with coordination disorder. Basic motor skills are the main element of motor development (Reeves et al., 1999). These skills which denote targeted motor models and patterns, such as moving, include skills which are used to move the body in an environment, for instance running, jumping, etc. The motor patterns of object control require the exercise of giving power to and receiving power from an object, such as throwing and receiving a ball. Manipulative skills include hitting and rolling an object and stability skills include spinning, dodging, etc. These skills are developed in early childhood due to physical growth, training, and practice and they are prerequisites of games and more specialized movements (Gregory et al., 2005). In a study, Bos et al (2009) found that there was a significant positive relationship between physical fitness and perceptual motor abilities.

Papadopoulos et al. (2008) compared children's motor skills and physical activity. Results showed that gender did not affect motor function and physical activity in children. In general, we can say that gender based behavioral expectations are initiated at the early childhood. Gender role conflict is observed when girls seek to participate in an activity. In our society, it is possible that the negative beliefs about women’s and girls’ physical activity and sport affect people’s view toward an individual. The law number IX, 1972, reduced the sex discrimination in education programs, and provided equal number of physical education and sports for boys and girls (Gregory et al., 2005). Blackmore et al (2008) concluded that there are low differences between boys and girls in terms of nerve-motor skills.

This study aimed to assess the effect of perceptual motor training on perceptual motor performance and neuromuscular coordination in children. It seems necessary to conduct this study because it is easier to reform and train people at the early stages of life than at older ages. Thus, considering the importance of coordination of movements in children for performing daily activities and implementing sports skills, it seems necessary to practice perceptual motor exercises to improve perceptual motor performance.

Materials and methods

The research was conducted via quasi-experimental method. In this field research we used pre-test and post-test design. The study population included 320 children aged 8 to 10 years old living in Kermanshah province (160 girls and 160 boys). Using cluster sampling method, they were randomly selected from four schools located in two northern and southern parts of the city. Participants were assigned to two groups: experimental group (80 girls and 80 boys) and control group (80 girls and 80 boys). From any school 40 children 8 years old and 40 children 10 years old were selected who were divided into two equal groups with regard to gender. We selected equal number of participants from each gender because we aimed to assess the effects of gender and perceptual motor training on perceptual motor performance and neuromuscular coordination of active and non-active children. First, Lincoln oseretsky test was performed in both groups as the pre-test. Then, the experimental group had practiced perceptual motor exercises for eight weeks (24 sessions); meanwhile, the control group performed their routine daily activities. The same test was used to post-test both groups.

Lincoln oseretsky motor development scale is designed to assess the motor skills of children aged five to 14 years old. The scale is run individually and has 36 items and assesses a variety of motor skills, such as: finger dexterity, coordination of eyes, hands and the large muscles in arms, legs, and upper part of the body. Reliability coefficients of the abovementioned tests for boys and girls of all ages was 0.96 and 0.97, respectively. Considering these coefficients, the test had high internal reliability (Seif Naragi & Naderi, 1992). The subjects in experimental group had practiced perceptual motor exercises for a period of eight weeks (24 training sessions) which included 60 minutes a day, three days a week. Perceptual motor exercises were performed in the following manner: five minutes of walking and jogging, five minutes of warm-up exercises and stretching, 45 minutes of perceptual motor exercises including: identifying different directions, balancing,
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Simultaneous movements, throwing the ball toward a goal, receiving and sending a ball, moving skills (running, galloping, hopping, springing, jumping, slipping), manipulative skills (throwing skills, hitting with feet, receiving, hitting an object, rolling), stability skills (bending and opening, rotating, dodging, walking on balance beam), and five minutes of exercises to get back to original state (Salman et al., 2009). Descriptive and inferential statistical methods were used to evaluate and statistically analyze the results of pre – test and post – test. In order to determine the mean difference between active and non-active groups, independent T test was used and to determine differences between pre-test and post-test in two groups dependent T test was used.

All statistical tests were performed at a significance level of (p = 0.05) using SPSS 19 software.

Results and discussions

To assess the descriptive statistics, the subjects’ age, height, and weight were measured (the mean age of subjects in this study was 9 years; the mean height of boys and girls was 137.43 and 141.57, respectively; the mean weight of boys and girls were 35.64, and 39.3, respectively). The results are summarized in table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Index</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Boy</td>
<td>9</td>
<td>1.001</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>9</td>
<td>1.001</td>
</tr>
<tr>
<td>Height</td>
<td>Boy</td>
<td>137.43</td>
<td>4.25</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>141.57</td>
<td>6.18</td>
</tr>
<tr>
<td>Weight</td>
<td>Boy</td>
<td>35.64</td>
<td>7.64</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>39.13</td>
<td>8.14</td>
</tr>
</tbody>
</table>

Dependent t-test was used to compare the mean score of perceptual motor pre-test and post-test in two active and non-active groups. The results are summarized in Table 2.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre test</th>
<th>Post test</th>
<th>Variance percentage</th>
<th>t</th>
<th>df</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active group</td>
<td>4.95±1.62</td>
<td>5.93±1.51</td>
<td>-0.981</td>
<td>-8.62</td>
<td>159</td>
<td>.000</td>
</tr>
<tr>
<td>Non-active group</td>
<td>4.73±1.71</td>
<td>4.84±1.62</td>
<td>-0.112</td>
<td>-.829</td>
<td>159</td>
<td>.408</td>
</tr>
</tbody>
</table>

There was a significant difference between the mean scores of perceptual motor performance (active group) pre-test and post-test (p=0.000, t=-8.62, df=159).

Since the obtained significance level i.e. 0.0001 is less than 0.05, the H0 hypothesis is rejected. Therefore a significant difference between pre-test and post-test was established.

Table3. Comparison of the mean scores of post-test for perceptual motor training in two active and non-active groups

<table>
<thead>
<tr>
<th>Index Variable</th>
<th>Post-test for non-active group</th>
<th>Post-test for active group</th>
<th>t-test for independent groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
<td>Mean</td>
</tr>
<tr>
<td>Flexibility</td>
<td>4.84</td>
<td>1.62</td>
<td>5.93</td>
</tr>
</tbody>
</table>

As presented in Table 3 there was a significant difference between the post-test scores of active and non-active groups.
As shown in Figure 1, after eight weeks of perceptual motor training, the post-test was performed for active group and their perceptual motor performance increased from 4.95 to 5.93, but there was a little difference in the non-active group. The increase might be due to the relationship between perpetual motor exercises and the subsequent increase in children’s perceptual motor performance. However, there was no significant difference in the non-active group.

Table 4. Comparison of mean scores of pre-test and post-test for neuromuscular coordination in two active and non-active groups

<table>
<thead>
<tr>
<th>Index</th>
<th>Mean and standard deviation</th>
<th>Dependent t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Active group</td>
<td>2.59±4.01</td>
<td>2.59±5.76</td>
</tr>
<tr>
<td>Non-active group</td>
<td>2.27±3.58</td>
<td>2.07±3.60</td>
</tr>
</tbody>
</table>

According to the table above, there was a significant difference between the mean scores of neuromuscular coordination (active group) in the pre-test and post-test (p=0.000, t=-8.22 df=159).

There was no significant difference between the mean scores of neuromuscular coordination (non-active group) in the pre-test and post-test (p=0.000, t=-8.22 df=159).

Table 5. Comparison of mean scores of post-test for neuromuscular coordination in two active and non-active groups

<table>
<thead>
<tr>
<th>t-test for independent groups</th>
<th>Post-test for non-active group</th>
<th>Post-test for active group</th>
<th>t-test for independent groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>index variable</td>
<td>Mean</td>
<td>Standard deviation</td>
<td>Mean</td>
</tr>
<tr>
<td>neuromuscular coordination</td>
<td>3.6</td>
<td>2.07</td>
<td>5.76</td>
</tr>
</tbody>
</table>

According to Table 5, it can be observed that there was a significant difference in post-test scores of active and non-active groups.

As observed in Figure 2 after perceptual motor trainings the post test was performed for active group and the mean neuromuscular coordination increased from 4.01 to 5.76, but there was no significant difference in the non-active group.

Figure 2. Pre-test and post-test of neuromuscular coordination of active and non-active individuals
According to the findings presented in Table 6, considering the results of Lincoln oseretsy test there was no significant difference between boys and girls (in terms of perceptual motor performance and neuromuscular coordination) (P<0/05).

**Conclusion**

The results of this study showed that perceptual motor exercises improved perceptual motor performance and neuromuscular coordination in children. However, no significant difference was found in terms of gender. Although hereditary and innate factors determine the boundaries of individuals’ abilities, environmental factors affect people’s success in utilizing these potentials (Khalaji & Emad, 2002). The study results suggested that perceptual motor training enhanced the perceptual motor performance and improved neuromuscular coordination in children. Payne and Isaacs (2002) reported that when a person makes any movement, he / she are involved in a type of perceptual motor process. Every activity is the result of a kind of perceptual motor ability and these capabilities would be developed through voluntary movements; it is consistent with the results of our study. The only difference was in term of the exercises performed. During a physical activity the following physiological changes occur: body and muscle temperature increases which leads to increased enzyme activity in cells and thus enhance the blood capacity to release oxygen to the muscles; the speed of chemical reactions in the body increases which enhances the capacity of joint fluid to lubricate and reduce friction in the joint surfaces, improves the activity of sweat glands, increases the return of venous blood, and reduces the potential damage of musculoskeletal system through enhancing the flexibility. It seems that performing exercises (perceptual motor) can increase the input of mechanical sensors in muscle spindles and consequently improve individual’s perceptual motor performance when exercising (Khalaji et al., 2002). In a study by Dortaj and Asemi (2012) it was found that the selected motor exercises had a positive effect on the development of perceptual motor capabilities of children. The results of their study also support our findings. When information is transferred to brain through afferent or input nerves, brain receives and processes the information. In this process, new information is combined with previous similar experiences, then the efferent or output nerves command muscles to make a move. As soon as the movement is started, a feedback is given to the agent. The feedback is facilitated and enhanced by information from the senses. Sight, hearing, touch, and proprioception play an important role in the feedback process (Gregory et al., 2005). Perceptual motor exercises increase neuromuscular coordination and improve the performance of proprioception receptors (Aimee et al., 2006). Increasing the compressive forces, these exercises increase postural and dynamic stability, enhance joint coordination, and retrain proprioception receptors. Hence, these kinds of exercises are recommended for retraining joints’ sense. In addition, as neuromuscular links improve, the proprioception’s errors reduce (Khalkhaali et al., 2004). According to the results of this research perceptual motor exercises increase neuromuscular coordination in children.

Olmosted et al. (2003) in their studies found that lower extremity require a proper range of motion, good strength, proprioception, and neuromuscular control. In this study only lower extremity were tested, while we studied the general neuromuscular coordination in children. Each exercise needs different levels of sensory perceptual – motor processes to perform skills and maintain neuromuscular coordination (Norasteh et al., 2010). The special changes in perceptual – motor system, which are caused by exercises, are multi-dimensional (Ashton & Miller et al., 2001). One of the most important environmental factors to develop these capabilities is the accessibility of training chances and active environments to obtain perceptual – motor experiences during critical stages of growth, especially in childhood. Training experiences enhance neuromuscular coordination in athletes. Therefore, we can say that in the programs which are aimed to promote perceptual motor growth, the perceptual motor exercises can play a stimulatory role.
for nervous system (Ghasemi, 2012). Based on Gallhuu-ozman research (1998), the maximum perceptual motor growth occurs during preschool and primary school years; therefore, perceptual motor trainings make the most significant effects during these stages of life.

In preparation programs to promote children’s perceptual motor development, perceptual motor skills training may play a stimulatory role for the nervous system. This type of exercise is one of children’s favorite training methods. These exercises and activities are fundamentally coordinated, and the proper implementation of these exercises requires organized administration of several motions with a given sequences (Bradinova, 2005). One of the most important environmental factors to develop these capabilities is the accessibility of training chances and active environments to obtain perceptual – motor experiences during critical stages of growth, especially in childhood. Therefore, considering the significance of growth period for children, we implemented perceptual – motor trainings for this age group.

In a study by Stabrun et al. (1981) it was concluded that there was a positive relationship between physical education program and children’s perceptual – motor performance. Gigororic et al (2011) conducted a study involving 1165 male and female students aged 7.5 to 11 years who were selected from urban and rural areas. They found a positive correlation between perceptual skills and academic skills of children. Every sport needs a different level of perceptual motor processing to perform skills and protect neuromuscular system against injuries. For example, soccer players require high levels of neuromuscular coordination and balance to perform many motor skills such as passing, dribbling, and shooting via lower extremities (Ghasemi et al., 2012). The increased simultaneous recall of motor units might be a likely reason for the improved neuromuscular performance. Increasing blood lactate can improve neuromuscular excitability and invoke more motor units. Moreover, the present results may be justified in view of simultaneous activity of synergistic muscles of the lower extremities with increased inhibition of antagonist muscles which is caused by the activation of the stretch reflex (Berenjian et al., 2011). Motor fitness does not depend only on physical growth, but it is also associated with the development of the nerve neuromuscular system. The development of the neuromuscular system is the result of experience and physiological changes that occur naturally as age increases (Dortaj & Asemi, 2012). Muscles have two types of motor and sensory nerves. Motor nerves originate from the central nervous system (brain and spinal cord) and when they are stimulated, they cause muscle contraction. The ending part of a motor nerve in a muscle is known as neuromuscular junction (stimulus plate). The sensory nerves transfer information about body members from muscles to the central nervous system (Fox & Mathews, 1994-1999). The information transmitted and enhanced by the motor and sensory nerves are electrical energy and are referred to as the nerve impulses. A nerve impulse is an electrical disturbance at a stimulated nerve that moves along the full length of axon automatically.

The actual procedure of producing and releasing a nerve impulse in response to a stimulus is as follows. When a nerve fiber is lax, Na ions are more concentrated on external surface of the nerve; consequently, the outer part of the nerve is electrically positive (+0 and its inner part is negative (-). When facing a nerve stimulus, it becomes permeable to sodium ions and these ions seep into the nerves. Consequently, the outer part becomes negative (-) and the inner part becomes positive (+). In other words, a proper stimulant reverses the positive (+) and (-) poles of the nerve. In addition to action potential, a strong flow will be generated at the surface where stimulation happened. It is also applied to adjacent areas which create a nervous flow throughout the whole nerve. It is accompanied with the arrival of the impulse at the synapse and generates potential at the nervous fiber. Cholinesterase uptakes acetylcholine generated by impulse, and crosses the synapse and makes a potential nervous fiber. Through absorbing acetylcholine, cholinesterase inhibits further provocations of muscles at the quickest time (Fox & Mathews, 1994-1999).

Perceptual motor exercises enhance coordination between stimulus and a quick and proper response and also increase the coordination between nerves and muscles and consequently improve children’s neuromuscular coordination. Berenjian et al. (2011) found a significant relationship between vibration exercises for the whole body and neuromuscular performance; their study was different from our study in terms of exercises performed. It can be said that perceptual – motor exercises have greater impact on neuromuscular coordination in children. The results of a survey on Iranian adolescents showed that only 35.9% of girls, compared with 61.4% of boys, are engaged in physical activity and the average daily time spent on physical activity in girls was 31.82 minutes. However, it is recommended for children and adolescents to have 60 minutes of daily physical activity for five times or more a week (Ramazani & Madvani, 2012). With reference to sex differences, it should be stated that most gender differences in boys and girls occur after puberty age; accordingly, it can
be concluded that sex differences do not have a significant impact on motor capabilities of children (Hashemi, 2011). Kambas et al. (2003) examined the impact of age and gender on the performance of children before and after school age; they used Lincoln Oseretsky test to assess the coordination ability. They found that gender has no effect on children’s performance, but age is an important effective factor; their results are in line with the results of our study. Since 1980s many experts have proposed different ideas about perceptual – motor abilities and they have classified these abilities differently (Gallhue & Ozman, 2005). There are still many scholars who are studying and documenting the effects of perceptual – motor training programs on growth and development of people. There are many evidences suggesting that perceptual – motor trainings can affect the perceptual motor development of children (Aimee et al., 2006). Perceptual – motor training programs are a type of valid physical education programs which are designed based on the evolution level and they share a set of similar elements. The objective of these programs is to enhance children’s academic success or progress in school. Increasing body awareness can help to direct children toward the development of motor skills. Perceptual motor activities play an important role in the development of motor abilities of children (Salman et al., 2009). Since living in the future world requires human beings with high perceptual motor capabilities, it is necessary for education and training systems of a society to educate and train such a capable generation (Dortaj & Asemi, 2012). Thus it is recommended to implement such programs at primary schools (Harrow, 1990).

References
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