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Effect of sports vision exercise on visual perception and reading performance in 7- to 10-year-old developmental dyslexic children

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The presented study was aimed at identifying for the first time the influence of sports vision exercises on fundamental motor skills and cognitive skills of 7- to 10-year-old developmental dyslexic Persian children. A pretest-posttest quasi-experimental study was conducted. The statistical population of this study was 7- to 10-year-old dyslexic children referring to two centres of learning disorder in the city of Isfahan. Twenty two of these children were selected using available and purposive sampling from the statistical population and were randomly assigned into two groups of experimental and control. The former (experimental group) participated in sports vision exercise courses for 12 weeks (3 one hr sessions per week) and the latter (control group) continued their routine daily activities during the exercise. Before the beginning and at the end of the exercise, Gardner's test of visual perception test - revised and Dehkhoda's reading skills test was administered to both groups. The results showed that the sports vision exercises increases motor skills, visual perceptual skills and reading skills in developmental dyslexic children. Based on the results of the presented study it was concluded that sports vision exercises can be used for fundamental and cognitive skills of developmental dyslexic children.

Keywords: Sports vision exercise, Visual perceptual skills, Reading skill, Dyslexia

INTRODUCTION

Children diagnosed as developmental dyslexic exhibit deficits attributed to some physical or biological sources such as unbalanced cerebral dominance (Damasio and Geschwind, 1984) visual impairments (Pavlidis, 1981) and genetics (Rack and Olson, 1993). In particular, developmental dyslexics show difficulties in phonological processing of printed language leading to poor spelling and reading abilities (Gleitman and Rozin, 1977; Liberman et al., 1982). In this respect factors such as reading phonologically impoverished compared to transparent scripts (Goulandris, 2003), as well as some psychologically related incidence in the child's development, such as poor environmental and emotional factors during the early years of education (Anyanwu and Campbell, 2001; Elbedour et al., 1997) may be considered as contributing factors to reading impairment.

Much research has been devoted to examining, the above-based theoretical accounts (Vellutino et al., 2004). Particular attention has also been devoted to remedial strategies to tackle the problems associated with developmental dyslexia. For example, Reynolds and Nicolson (2006) reported that a 6-month home-based exercise which showed a significant improvement on a range of cognitive and motor skills for developmental dyslexics in a junior school compared to the controls. However, there are also claims that other techniques such as subtle eye or visual problems cause or increase the severity of the learning disabilities. Thus there are claims that visual training, muscle exercises, ocular pursuit-and-tracking exercises, behavioural/perceptual vision therapy, "training" glasses, prisms, and coloured lenses and filters are effective as direct or indirect treatments for learning disabilities (Han-

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dler and Fierson, 2011; Schulte-Körne et al., 2004). Focusing on the perception of the causes of poor vision in dyslexia attributed to defects in the visual sense (Roach and Hogben, 2004) it could be claimed that perhaps with eye muscle exercises, visual perception and the visual sense and subsequently reading skill can be promoted.

Sport vision exercise

Sports vision exercise is a set of techniques for the development of visual function and is used to improve athletic performance (Abernethy and Wood, 2001). Some evidence suggests that exercise can have an impact on the eye muscles and vision systems for visual perception - proprioception (Abernethy, 1996) and increases the accuracy and speed of the eye muscles and the visual perception skills. Indeed, if developmental dyslexic children have weaknesses in visual perception, they could benefit from sport vision exercise as it can increase the accuracy and speed of eye muscles and the visual perception (Wilson and Falkel, 2004). The cost effectiveness and small space requirement for sport vision exercise is an added bonus if there is indeed an effect on visual perception and reading performance of dyslexic children (and adults).

The aim of the present study

Research on Persian developmental dyslexia is now flourishing, particularly amongst young Persian readers (Baluch, 2005). Indeed there are claims that incidence of developmental dyslexia is more prevalent amongst Persian children due to its phonologically impoverished script (Baluch and Danaye-Tousi, 2006; Baluch and Danaye-Tousi, 2007). Thus finding ways to help dyslexic readers plays a significant role for research. The present study is aimed at examining if visual sports exercise affects visual perception and reading performance of developmental dyslexic Persian readers.

MATERIALS AND METHODS

Populations and sample size

The statistical populations of this study were 7- to 10-year-old dyslexic children referring to two centres of learning disorder in Isfahan. Twenty-two of these children were selected using available and purposive sampling from the statistical population and were randomly assigned into two groups of experimental and control. The former (experimental group) participated in sports vision exercise courses for 12 weeks (3 one hr sessions per week) and the latter (control group) continued their routine daily activities during the exercise.

Materials and procedure

Ethical approval was gained for this research from the Islamic Azad University Ethics Committee. Before the start of the study participants parents announced their consent in a written manner.

All participants in the experimental (the group that engaged in the sport vision exercise) and control group (engaged in routine daily activity) were tested on Dehkhoda's reading skills test (2009) and Gardner's test of visual perception test - revised (1996) at 2 time points (12 weeks gap).

Gardner's visual perception test - revised (1996)

Gardner's (1996) test of visual perceptions skills - revised (TVPS-R) was used to assess visual perceptual skills and reading tests at the two stages of the study namely: a pretest and posttest to determine reading skills of the participants. TVPS-R (1996), was originally developed by Gardner in 1928, and revised in 1996, consists of two scales with three and four subtests. Each subtest included 16 pictorial questions so that in each case the image will be shown to the child and the child must choose the correct option. The test duration is 9 to 25 min (depending on the participant's age) and is applicable for children 4 to 12 years and 11 months old. The seven subtests measure visual discrimination, visual memory, visual spatial relationship, visual form constancy, visual sequential memory, visual figure ground and visual closure and are not dependent on gender, education, race, culture, and language (Gardner, 1996). The number of correct answers by participants in each subscale is calculated as the raw score in subtests. After determining the raw score and given the student age using standard tables, each subtests cognitive age is obtained. According to the raw score, age and test table, scaled score is calculated according to scaled scores, the student's visual perception is determined. Gardner's TVPS-R reliability of this in groups of 4 to 13 years calculated between 74 and 85 percent. The test was standardized in Iran in age class 4 to 7, 7 to 11, 12 to 14 years old and strong validity and reliability (Siminghalam and Ali-Bakhshi, 2011).

Dehkhoda's reading skills test (2009)

The test comprises of 14 of items which measures phonological ability, errors in reading and comprehension. The test has shown to have good test - retest reliability (0.8). Dehkhoda's reading skills test (2009) is now widely used by researcher in Iran as a test of reading ability (Aslani and Movahedi, 2015).

The 14 items of the test is divided into three subsections:

(a) Base (phonological) to acquire the basic skills of phonological, from five subsets of identifying vowels, consonants recognition, the ability, the ability to combine consonants and vowels, spelling ability is used. The results showed that the percentage of low percentages indicate the main problems are the difficulty of low and vice versa.

(b) Common errors: to get the errors, the seven subsets, mirror reading, deleting words, replacing the words, repeating the word or words, adding words, not knowing basic visual words, word for word reading is used.

(c) Track and comprehension: To obtain results songs and comprehension, the second subset, observe the punctuation marks used in reading comprehension.

Dehkhoda's reading skills test (2009), was performed individually, in which case the participant reads text aloud in the presence of the researcher and while doing this, the researcher record the number of errors. After reading the text, the participant must answer questions on text to measure his/her comprehension based on the criteria mentioned above.

The exercise protocol

The exercises consisted of 12 weeks (three sessions per week), each session lasted an hour. Exercises taken by the experimental group during the 8 weeks included: (1) Saccade movements column, (2) saccadic, (3) circle with both hands, (4) piercing O., (5) penny drop, (6) saccade column movements, (7) close eye jump-off, (8) catcho, (9) balanced holding a broomstick, (10) throw a bean bag from behind, (11) visual decision perception (VDP), (12) thinking with VDP, (13) decoding table, (14) chase a flashlight, (15) simon, (16) near the douro table, (17) slow pursuits, (18) auditory span with vision, (19) delayed memory, (20) continuous motion, and (21) VDP table.

For sampling the research objective was explained for learning disorders centres officials and they were promised assistance. Among the clients of the centres 22 children 7–10 years old who had been diagnosed with developmental dyslexia, were selected and randomly allocated into two groups. A week before the start of the exercise both groups were subjected to pretest (Gardner's TVPS-R). In this way, each participant performed each test in a room with the researcher. Before commencing the researchers ensured that the children understood the instructions. The former (experimental group) participated in sports vision exercise courses for 12 weeks (3 one hr sessions per week) and the latter (control group) continued their routine daily activities during the exercise. When the exercise had been completed both groups were subjected the posttest.

RESULTS

Mean scores for the two time periods for the experimental and control groups, together with corresponding standard deviations, are reported in Tables 1-4, followed by relevant one way analysis of covariance (ANCOVA).

As can be seen in Table 1 the difference between time 1 and time 2 testing shows an improvement in visual perception scores for both groups in time 2, however, it appears that the difference is larger for the experimental group compared to the control group. Formal analysis of the data using a one way ANCOVA was conducted to determine if there is a statistically significant difference between the experimental and control groups in time 2 test-

Table 1. Total perception vision for the experimental and control groups in the two time periods

Condition	Time 1	Time 2
Experimental (score)	77.75±17.6	98.41±15.52***
Control (score)	83.5±14.52	87.6±13.07

Values are presented as mean±standard deviation.
***P<0.0001, compared to the control group.

Table 2. Subscale phonology for experimental and control groups in the two time periods

Condition	Time 1	Time 2
Experimental (score)	74.67±90.4	90.4±7.73**
Control (score)	72.59±13.73	79.02±13.6

Values are presented as mean±standard deviation.
***P<0.001, compared to the control group.

Table 3. Subscale error for the experimental and control groups in the two time periods

Condition	Time 1	Time 2
Experimental (score)	11.98±6.65	7.56±5.75***
Control (score)	11.62±7.46	11.69±8.35

Values are presented as mean±standard deviation.
***P<0.001, compared to the control group.

Table 4. Comprehension for the experimental and control groups in the two time periods

Condition	Time 1	Time 2
Experimental (score)	56.25±16.42	63.54±16.39
Control (score)	61.42±12.43	62.5±11.78

Values are presented as mean±standard deviation.

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ing controlling for time 1 data. There was a significant effect for the two groups with $F_{1, 19} = 24.1$, MSe = 51.138, $P < 0.001$. Partial eta-squared $\eta_p^2 = 0.55$.

As can be seen in Table 2 the difference between time 1 and time 2 testing shows an improvement in phonological scores for both groups in time 2, however, it appears that the difference is larger for the experimental group compared to the control group. Formal analysis of the data using a one way ANCOVA was conducted to determine if there is a statistically significant difference between the experimental and control groups in time 2 testing controlling for time 1 data. There was a significant effect for the two groups with $F_{1, 19} = 10.15$, MSe = 52.53, $P < 0.005$. Partial eta-squared $\eta_p^2 = 0.34$.

As can be seen in Table 3 the difference between time 1 and time 2 testing shows a reduction in errors in for both groups in time 2, however, it appears that the difference is larger for the experimental group compared to the control group. Formal analysis of the data using a one way ANCOVA was conducted to determine if there is a statistically significant difference between the experimental and control groups in time 2 testing controlling for Time 1 data. There was a significant effect for the two groups with $F_{1, 19} = 16.82$, MSe = 6.46, $P < 0.001$. Partial eta-squared $\eta_p^2 = 0.47$.

As can be seen in Table 4 the difference between time 1 and time 2 testing shows a small increase in comprehension scores for both groups in time 2, however it appears that the difference is relatively larger for the experimental group. However, formal analysis of the data using a one way ANCOVA was conducted to determine if there is a statistically significant difference between the experimental and control groups in time 2 testing controlling for time 1 data. There was no significant effect for the two groups with $F_{1, 19} = 1.48$, MSe = 685.1, $P < 0.23$. Partial eta-squared $\eta_p^2 = 0.07$.

DISCUSSION

Results showed that sport vision exercises have a positive impact on perceptual vision and reading abilities for developmental dyslexic children in the present study. Whilst there have been studies on the relationship between eye movement and reading ability (Everatt et al., 1998) and the long-term effects of exercise on developmental dyslexics' reading ability (Reynolds and Nicolson, 2006) there has been little research on the effects of sport vision exercise on perceptual vision and reading ability of developmental dyslexic Persian children. The results of the present study are consistent with those of Sherman (1980) which reported a substantiated role of vision in sport, particularly aspects such as visual acuity static, dynamic visual acuity (depth perception), see three-dimensional, detailed imagery, motion and speed vision, peripheral vision and visualization. Sherman (1980) concluded that all of these visual abilities are improvable and trainable through sport visual exercise.

Another finding showed that sports vision exercise affects basic skills, particularly with regard to phonological processing in developmental dyslexic children. This finding is also consistent with recent research examining the effects of visual exercise and visual rehabilitation interventions on reading performance of Persian readers (Aghaee-Sabet et al., 2013; Same-Siahkalroodi et al., 2009; Tahmasebi et al., 2014). Aghaee-Sabet et al. (2013) and Same-Siahkalroodi et al. (2009) pointed out positive effects of visual rehabilitation on reading performance amongst 7- to 10-year-old Persian children with developmental dyslexia. Similarly Tahmasebi et al. (2014) dealt with the effectiveness of vision rehabilitation operations based on assessed reading ability. The researchers reported a positive effect on the ability to read when a group of participants engaged in a visual performance based exercise. Visual performance-based rehabilitation program seems to improve reading ability. However, the findings of the present study showed that sports vision exercise does not affect comprehension of children with dyslexia. It is important to note that whilst rapid word recognition is an important aspect of skilled reading and comprehension (Stanovich, 2000) there is also evidence that dyslexics may have problems with aspects of comprehension such as poor short-term memory. As a result it may hinder understanding and remembering connected discourse thus improvements in rapid word recognition per se may not be sufficient to improve comprehension ability (Vellutino, 1987; Weaver, 1978). Thus it is not surprising that sport vision exercise may not have a direct effect on reading comprehension *per se* although it does affect aspects of reading performance.

In the present study the experimental group, after the intervention of sports vision, showed a significant decrease in mirror-reading errors, deleting words, replacing the wrong words, repeating a word, or not knowing the word's visual features. This is in line with previous studies showing added power to remove false associated with visual impairment and attention deficit and errors related to the incorrect pronunciation and analysis of problems related to their phonological and auditory processing (Pouretemad et al., 2011). In addition, there is evidence to suggest that phonological problems and the ability to recognize words may be related to attentional problems (Frost, 1998). The results of the pres-

ent study also suggest that after the intervention of sports vision, errors associated with incorrect pronunciation significantly decreased. Finally, it was also found that visual exercise can partly improve phonemic skills base. Thus in short it can be said that developmental dyslexics' ability to decode printed words could be improved with intervention in the form of sport vision exercise, but certainly decoding skills alone are not sufficient for comprehension as was found in the present study. Baluch and Danaye-Tousi (2006), Baluch and Danaye-Tousi (2007) reported that whilst Persian developmental dyslexics show impaired short-term memory when they are given instructions and practice trials on what to expect from a short term memory test they choose appropriate strategies to improve their short-term memory. Indeed developmental dyslexics were found to be more efficient than a control group of nondyslexics matched for chronological and reading age. A finding that has also been reported in other languages such as Polish (Nalesnik and Baluch, 2010).

With regards to the significance of sport vision exercise, in light of foregoing literature, it can be noted that the lack of visual attention and visual processing problem can lead to reading disorders (Van der Schoot et al., 2008). Any developmental changes or interventions in the speed of visual perception, enhances reading ability (King et al., 2008). As the present study has reported sport vision exercise can enhance aspects of reading ability, however, any intervention programme should also be designed in accordance with specific reading requirements (Reilly et al., 2009). The inclusion of sports vision exercise programmes and the promotion of sport vision skills can be recommended as an effective strategy for improving the performance of visual skills of children with developmental dyslexia, although this merits further research in conjunction with other aspects of reading such as reading comprehension.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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