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TRANSFER EFFECTS OF EYE-HAND CO-ORDINATION SKILLS FROM THE RIGHT TO THE LEFT CEREBRAL HEMISPHERES IN SOUTH AFRICAN SCHOOLBOY RUGBY PLAYERS

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ABSTRACT

The aim of this study was to identify whether an interhemispheric transfer effect of performance in eye-hand co-ordination skills exists. Evidence of inter-manual transfer of reaction time tasks was found. No evidence states which hand gains most advantage from inter-manual transfer. It is believed that the right hand has direct access to what is learned by the left hand and that the right hemisphere controls the integration between the right and left hand movements of the bilateral simultaneous reaction time tasks. A total of 55 subjects (14- 17 years of age) participated in the study. The eye-hand co-ordination skills of the participants were tested using the right hand. These skills were practiced for a period of 5 weeks, after which performance with the right hand was re-evaluated. The control group (n=24) was tested before and after the practice period. The apparatus used, are grouped under the sports vision battery and tested the different components of eye-hand co-ordination. The median values obtained indicated an over-all increase in the experimental group results and a decrease in the control group results. The resultant p-values (< 0.05) showed the study to be statistically significant and the results confirmed the existence of a transfer effect.

Key words: Interhemispheric transfer, eye-hand co-ordination, reaction time.

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INTRODUCTION

Neuroscience has established the fact that the brain's architecture can be changed and improved by practicing new skills as well as skills that are already familiar to the brain (Sherwood, 2000).

Eye-hand coordination skills can be defined as the ability to effectively respond to visual stimuli (Taniguchi, 1999b). Motor learning control processes are also of importance in the learning of an array of movement skills and are responsible for an increased ability to perform complex movement, effective response to external stimuli, the creation of fluent movement, improve the timing of movement and to generate novel, and new movement in order for an individual to accomplish his or her goals. Motor control is a process resulting in an increased ability to control an ongoing motor response (O'Brien & Hayes, 1995).

Eye-hand co-ordination is of importance in the performance of all daily activities. The assessment of the transfer of eye-hand co-ordination skills might be significant in functional optimization of these skills in athletes and neurologically impaired individuals.

Strong evidence for inter-manual transfer of reaction time tasks (RT) has been found. However, no evidence clearly states which hand gains most advantage for RT task skills as a result of inter-manual transfer. This is because the relationship between handedness, lateralization and transfer has not been well established (Uehara, 1998). It is however believed that the right hand has direct access to what is learned by the left hand (Katz, Cermak & Shamir, 1998). Taniguchi (1999b) concluded that the right hemisphere controls the integration between the right and left hand movements of bilateral simultaneous RT tasks.

Considering information acquired from studies conducted by Taniguchi (1999a) and Katz et al. (1998), the assessment of the transfer effect between cerebral hemispheres pertaining to eye-hand co-ordination skills, would show greater results, if the right cerebral hemisphere and therefore the left hand, is used for the practicing of eye-hand co-ordination skills and the right hand is tested for the effect of intervention.

Modern sport is no longer a recreational activity, but has been transformed into a profession for many top sportsmen and women. Athletes are emphasizing the importance of visual training as part of their holistic preparation for specific sports (Porac & Coren, 1981). The existence of a transfer effect of eye-hand co-ordination skills may play an important role in the optimization of these skills in athletes. It may even ensure the maintenance and improvement of these skills to the right-dominant hand during injury by practicing eye-hand co-ordination skills with the left hand.

The primary aim of the study was to determine whether a transfer effect of eye-hand co-ordination performance and consequently motor learning, can occur in rugby players after practicing diverse eye-hand co-ordination skills with the left hand.

Hypothesis (1). There will be a transfer effect from the right cerebral hemisphere to the left after practicing eye-hand co-ordination skills for five weeks with the left hand in schoolboy rugby players, aged 14-17 years.

Hypothesis (2). There will not be a transfer effect from the right cerebral hemisphere to the left after practicing eye-hand co-ordination skills for five weeks with the left hand in schoolboy rugby players, aged 14-17 years.

The information gained by the researchers concerning the transfer effect of eye-hand co-ordination skills, may be of importance in the holistic approach to the rehabilitation of patients with unilateral neurological deficits as well as the improvement of bilateral eye-hand co-ordination skills in athletes.

METHOD

Study design

An experimental quantitative design was adopted to determine a transfer effect of motor learning and eye-hand co-ordination skills by assessing eye-hand co-ordination performance before and after practice.

Sample

A total of 55 subjects (14-17 years of age) participated in the study. The participants were rugby players from secondary schools in Pretoria, Gauteng, South Africa. They were randomly selected from a group of 74 players that were interested in taking part in the study. They were randomly divided into an experimental (31 subjects) and a control group (24 subjects), but during the study six players in the experimental group were injured.

The inclusion criteria were:

(i) any player who was right hand dominant;
(ii) any player between 14 to 17 years of age;
(iii) the subject has to be a rugby player; and
(iv) the subject must be willing to attend the practice sessions.

The exclusion criteria for partaking in this study were:

(i) any player with a shoulder, elbow, wrist or finger injury during the last six months prior to the subject selection;
(ii) any player with a muscular-skeletal isorder that may have an effect on the biomechanics of the upper or lower limbs;

(iii) any player who is not between the ages of 14-17 years;

(iv) any player who has not participated in rugby for at least one season prior to the subject selection; and

(v) any player with below normal visual acuity.

Ethical considerations

Each participant had to complete an informed consent form, which also had to be signed by a parent or legal guardian. The study was organized and conducted in accordance with the regulations laid down by the Faculty of Health Sciences Research and Ethics Committee (University of Pretoria) and approved by the committee.

Materials

Specific apparatus were used to test the different components of eye-hand co-ordination. The specific apparatus used were:

1. Rotator pegboard (Blaupunkt, manufactured in South Africa)

A wooden disc, with 26 holes, is placed on a turntable and rotated at 33.3 rpm. Each of these 26 holes is identified by a letter of the alphabet placed in random order. The subject has three minutes in which to place a golf tee into each hole and this must be done in alphabetical order. The letter reached is recorded, or if Z is reached within the time limit, the time is recorded. The parameters tested are visual concentration and eye-hand co-ordination.

2. Strobespecs (Maximum Performance, manufactured in Roseville, California, USA.)

The subject wears a pair of special purpose glasses with lenses that flash at a given speed allowing the subject limited visual input. A beanbag or tennis ball is thrown from approximately three meters either straight at the subject or to his left or right side, at varying heights. Twenty throws were carried out and the number of successful catches was recorded. The parameter primarily tested is visual anticipation.

3. The Accuvision 1000-test (Wayne Engineering, manufactured in Northfield, Illinois, USA.)

This test is carried out on a display board (130 cm in length, 90 cm in width) with 120 touch-sensitive red light emitting diodes (LED’s).

Digital displays in the top right-hand corner of the display board provide a continuous indication of the selected speed and number of correct responses. Two different tests were done. In the first test, 60 lights flash randomly in quick succession on the Accuvision board and must be touched. As soon as one light is touched, the next one lights up. The subject has to do this as quickly as possible. The parameter tested is pro-action-reaction time that is speed or motor reaction time after sensory input.

The second test consists of 60 lights that are flashed at a certain speed (speed 7 on the Accuvision) and a central green fixation light that can randomly go on and off. If the subject touches the flashing light when the fixation light is off, a negative score is recorded. The score recorded indicates how many lights are touched while the fixation light is on, minus the lights touched while the fixation light is off. According to Du Toit (1999) the parameters tested are peripheral awareness, pro-active-reaction and visual concentration.

The above-mentioned tests were conducted bilaterally on the subjects to obtain baseline- data prior to the intervention. The tests also served as the method for practice to improve the eye-hand co-ordination skills. The subjects in the experimental group participated in the practice session twice a week, for a period of five weeks. Each component of the sports vision battery was practiced once with the left hand, at each practice session. The subjects were re-evaluated after five weeks, using the initial test procedures. The re-evaluation was conducted on the right hand. The control group came in for re-assessment at the end of the five-week period.

Statistical procedures

Descriptive statistics was used for describing the data. The mean, standard deviation, minimum and maximum scores for each measurement per group were determined for reference purposes. A two-sample T-test analysis was conducted to establish whether there was a significant difference between the mean values of the experimental and control groups (Tables 1 to 4).

RESULTS

Forty-nine of the 55 participants completed the five-week program and were re-evaluated.

Table 1: Rotator peg board test (seconds)

	Pre-testing		Post testing	
	Experimental	**Control**	**Experimental:**	**Control**
Number of subjects	25	24	25	24
Mean value	21.750	24.360	34.333	24.000
Standard deviation	7.919	8.760	7.233	8.119
Minimum score	6.000	9.000	19.000	8.000
Median	21.000	22.000	34.500	24.000
Maximum score	37.000	37.000	52.000	34.000

Table 2: Strobe spec test: (number)

	Pre-testing		Post testing	
	Experimental	**Control**	**Experimental**	**Control**
Number of subjects	25	24	25	24
Mean value	8.792	10.520	10.417	9.760
Standard deviation	2.322	2.771	2.620	2.420
Minimum score	4.000	5.000	6.000	5.000
Median	9.000	11.000	10.500	10.000
Maximum score	13.000	15.000	15.000	14.000

Table 3: Accuvision test 1 (number)

	Pre-testing		Post testing	
	Experimental:	**Control**	**Experimental**	**Control**
Number of subjects	25	24	25	24
Mean value	33.042	35.560	44.417	31.120
Standard deviation	5.465	10.829	3.682	7.737
Minimum score	20.000	10.000	31.000	17.000
Median	32.500	20.000	45.000	31.000
Maximum score	44.000	40.000	50.000	45.000

Table 4: Accuvision test 2: (number)

	Pre-testing		Post testing	
	Experimental	**Control**	**Experimental**	**Control**
Number of subjects	25	24	25	24
Mean value	22.333	20.320	36.875	19.040
Standard deviation	5.990	7.798	4.215	6.846
Minimum score	10.000	10.000	30.000	10.000
Median	23.500	20.000	37.000	20.000
Maximum score	33.000	40.000	46.000	34.000

Table 5: The p- and t-values for the different tests

Test	**df**	**t**	**p**
Accuvision test 1	23	1.872	0.037
Accuvision test 2	23	1.978	0.030
Rotator peg board	23	3.485	0.001
Strobe spec	23	0.966	0.172

In the experimental group, six participants discontinued for the following reasons: One subject sustained a clavicular fracture, two other participants withdrew due to illness and three participants could not attend the practice session due to other obligations.

At the beginning of the experiment there were no significant differences between the test results of the experimental and control group in all the tests. The pre- and post tests in the groups were done at a $p < 0.05$ level of significance, therefore, all the tests except the strobespec test showed a statistically significant increase in the scores obtained after the practice period. Although the strobespec test is of subjective nature and the results are less relevant, it was included in the test battery because most of the earlier research did included it in their test batteries. Because of this the results was disregarded in the calculation of the level of significance. The other three tests are relevant to make this study statistically significant.

DISCUSSION

The goal of this study was to investigate whether a transfer effect exists from the right cerebral hemisphere to the left after unilateral practice of eye-hand co-ordination skills with the left hand. The sports vision battery was used to both assess the eye-hand coordination skills with the right hand and practice these skills with the left hand. Standard testing conditions, strict adherence to protocol and continuous supervision were practiced during these sessions.

The results clearly show a significant increase in the performance of the different parameters of eye-hand co-ordination skills after the five-week practice period (Table 1-4). The p–values for the different tests clearly indicate that the control group achieved no improvement in performance of the different skills. The hypothesis is therefore accepted that a transfer effect of eye-hand co-ordination skills from the right to the left cerebral hemisphere does exist.

The existence of a transfer effect from the right- to the left cerebral hemispheres may contribute to the optimization of eye-hand co-ordination skills in athletes with injury to the right upper limb.

This may be done by practicing these skills with the left hand, during the injury period. Theoretically no transfer effect will occur from the left cerebral hemisphere to the right, because of the location of the integrating center in the brain. Therefore, an improvement of eye-hand co-ordination skills in the left hand will only be obtained by practicing these skills with the left hand. This statement, however, must be investigated further by assessing whether there is a reversed interhemispheric transfer effect.

The results of this study support the existence of an interhemispheric transfer effect as proved by Katz et al. (1998). In this study the transfer effect of eye-hand co-ordination was proven where as Katz et al. (1998) proved a transfer effect of reaction time tasks.

It is recommended that research of a similar nature be conducted on other ball playing sports. The effect of scapula stability on the improvement of eye-hand co-ordination skills may also be assessed. Motor learning refers to a permanent change in behavior, but in this study only the performance effect of transfer was established. Therefore, future research must include a retention test after a time of no practice in order to conclude that motor learning has taken place. Finally, researchers must keep in mind the importance of further investigation in females and other population groups. This study should be applied to a random sample, which represents demography of the South African population.

Limitations

The strobespec test was unreliable, because the execution of the throws was unavoidably inconsistent.

CONCLUSION

The hypothesis that a transfer effect of eye-hand co-ordination skills will occur from the right to the left cerebral hemisphere after a five-week practice period is accepted.

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