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EXERCISE, PERFORMANCE AND SPORTS VISION TESTING

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ABSTRACT

Sport has become a very competitive business that focuses on athletes reaching their full potential. In the past, few aspects like hand-eye co-ordination and visual reaction time have been addressed. Visual involvement in a sport varies according to the environmental demands associated with that particular sport. These environmental demands are matched by a task-specific motor response. The purpose of this study was to determine whether exercise can improve an athlete's visual performance in order to achieve maximal results on the sports ground. Thirty rugby players, aged 16 to 18, were chosen as subjects. To evaluate the effect of physical exercise on hand-eye co-ordination, a pre-test-post-test control group design was adopted for the study. The pre- and post- exercise values of the subjects in the control and experimental group were pooled to determine the averages and differences. The results showed that there was an enhancement in the performances of subjects that were exposed to the physical exercises. The exercises were specific for improvement in hand-eye co-ordination. Sportsmen will have a great advantage over their rivals following improvements in their exercise and training programmes. These training programmes can help to improve and train the athlete's visual co-ordination, increase concentration and focus, hand-eye co-ordination, and anticipation, as well as enable athletes to gain more knowledge about their motor responses. These principles can also be implemented in a similar evaluation of other athletes and non-athletes.

Key words: Hand-eye co-ordination, exercise, anticipation, sport.

INTRODUCTION

In the sports industry, a variety of procedures and training techniques exist to improve and enhance the performance of athletes.

Sport has become a complex science which uses technology to study various aspects of various sports that have been overlooked thus far. Visual performance an important factor for excellence in sport (Haywood, 1984; Granet, 1988; Sale, 1998) as most sporting activities are hampered by poor vision (Wood, Woods & Jack, 1994).

The aim of sports vision is to exercise the athlete's visual co-ordination and to gain knowledge of the required motor responses - which is what the eyes tell the body to do, or how the body should react in response to a specific visual stimulus. There are several aspects that need to be explored when developing athletes in sport. One of the most important abilities a sportsperson requires, especially those that play in a team sport, is peripheral vision or awareness. This form of vision enables athletes to be aware of what is going on in the surrounding environment, without actually looking round. At a developmental level, many coaches have been instructing athletes always to keep their eyes on the ball. Initially, it may be a very good method to train young athletes, but once an athlete reaches an advanced level, keeping his or her eyes on the ball is not always so easy.

The ability to make use of peripheral vision holds advantages for the player and for the team. In the game of cricket, for example, practice with regard to peripheral awareness is very important. If the batsman keeps his eyes on the ball only, it is very likely that he will soon be caught or bowled out. A batsman must constantly be aware of the bowler's 'body language', the pitch and the fielders, all at the same time, and still watch the ball. It is also important to study the effect of physical exertion on hand-eye co-ordination. Most sports involving projectiles (balls) and the use of extended levers (bats), of which cricket is a prime example, involve simultaneous strenuous physical activity and superior hand-eye co-ordination. Athletes who take full advantage of the potentials of sports vision and vision training will have an edge over their counterparts (Hazel, 1995).

Another feature that high-quality athletes have is their ability to concentrate and stay focused. Playing sport for long periods of time can lower concentration levels, but it is the level of experience and the correct training that helps athletes to maintain focus during the game. Hand-eye co-ordination is the ability of the eyes, hands and body to work together. Co-ordination occurs when the motor system composes complex actions by combining simpler sub-movements. The process involves sharing information about the progress of one sub-movement with the centres controlling another sub-movement, to ensure that the second movement happens in appropriate relation to the first (Haggard, 1997). Movement in response to stimuli during a game is one of the most important features of a good sportsman. If an athlete is unable to dodge a ball, manoeuvre around a squash court, or react to a spin ball, then he or she will not succeed in his or her sporting activity.

Another important characteristic of an outstanding sportsman is the ability to anticipate the next move. This can be compared to the game of chess: one wrong move and you can end up in checkmate. To develop the 'art' of anticipation requires some effort.

A variety of tests have been formulated to try and establish this art in athletes. The purpose of this study was to determine if exercise will improve the visual performance of an athlete in competition.

All the traits mentioned above can, through hard work, dedication and the correct training, be developed to better the performances of athletes of the future. If sports vision is neglected, athletes might as well accept checkmate.

MATERIALS AND METHODS

Thirty rugby players, aged 16 to 18, were chosen as subjects. To evaluate the effect of physical exercise on hand-eye co-ordination, a pre-test-post-test experimental group design was used for the study. All players were subjected to repeated measures of protocol using a Sports Vision Battery consisting of four different hand-eye co-ordination tests. The experimental group (n=15) were exposed to a period of isolated exercises as a physical exertion intervention between the pre- and post-tests of the four different hand-eye co-ordination measurements, whilst the control group (n = 15) remained inactive during the period between the initial test and the retest, after which the same sports vision tests were repeated and the results compared.

Heart rate monitoring

An easy and reliable method for determining effort during running is to monitor the heart rate during exercise (Noakes & Granger, 1995). Heart rate monitoring is important for assessing the total level and pattern of energy expenditure and physical activity in medium size and large-scale epidemiological studies (Wareham, Hennings, Prentice & Day, 1997). A general aerobic training intensity with 82% of maximal heart rate was calculated by using heart rate, blood lactate and oxygen consumption as indicators to determine training intensity for cricket players in the off-season. By utilising this specific aerobic training intensity in the off-season, a cricket player, for example, could achieve a good aerobic fitness base without putting undue stress on the body and thus decreasing the risk of injuries, as well as limiting the effect of fatigue (factors that could have affected our post-test results) (De Wet, Du Toit, These parameters were used on the rugby players for the reasons mentioned above. The use of a heart rate monitor as a means of modulating physical activity will enable researchers to set clear, precise, observable limits on physical activity, and facilitate self-control of an acceptable level of physical activity (Bar-Or, Zeevi, Yaaron & Falk, 1999).

Vision testing

The sports vision testing battery comprised four specific hand-eye co-ordination tests, which were used to evaluate different parameters of hand-eye co-ordination. The operational definitions, in conjunction with the procedures, instruments and scoring applied in the tests, were as follows:

A board with 26 alphabets placed randomly around a screen is rotated on the computer screen at a constant speed. The subject had 3 minutes to click on each letter using the mouse. The letters mu[illegible]ked in alphabetical order. Once the subject has successfully clicked on all consecutive letters, the time is recorded. The parameters tested in this specific test include visual concentration and hand-eye co-ordination.

Accuvision 1

In this exercise, 20 lights flash randomly on an accuvision board on the computer monitor. As soon as the subject clicks on the light on the screen, the next light appears. The subject has to complete this exercise as quickly as possible. The parameter tested in this specific test is pro-action-reaction time, i.e. speed of motor reaction time after sensory input.

Accuvision 2

In this test, 60 lights are flashed at a certain speed. A green light flashes randomly. If the subject clicks on one of the flashing lights when the green light is not flashing, a negative score is recorded. The score recorded indicates how many lights are clicked on while the green light is flashing, minus the number of lights clicked on while the green fixation light is not flashing. The parameters tested are peripheral awareness, pro-action-reaction time and visual concentration.

Strobespecs

The above tests are performed while the subject is sitting on a gym ball. This ball introduces a proprioceptive concentration, so that the visual system is tested dynamically. A ball moves around on the monitor at a given speed. At a certain point the ball disappears, allowing the subject limited visual input. The subject must then place a second ball in the anticipated flight direction of the previous ball. The primary parameter tested is visual anticipation.

Exercises done in-between:

- ***Simultaneous ball throw with both hands***

Coach stands 2m from subject and throws 2 balls simultaneously, for the subject to catch.
Technical pointers: Bent knees, feet at about shoulder-width apart. Soft hands bring balls towards body.
Benefits: Improves peripheral vision, concentration and handling of the ball.

- ***Lateral shuffle and ball catch***

The subject is instructed to shuffle from side-to-side between cones, 4m apart. Coach throws ball to subject at any time. Ball must be thrown back to coach while subject keeps shuffling.
Technical pointers: Shuffle side-to-side between the cones; touch the ground at each cone. Look forward, so back is straight. Bend knees to go down or to catch ball. Once ball is caught, continue shuffling from side-to-side.
Benefits: Improves eye-brain-body co-ordination and concentration. Improves anaerobic fitness.

- ***2 vs. 1 ball drill***

Subject is fed balls by 2 coaches. One throws a ball to the subject to catch while he/she is shuffling between 2 cones, 4m apart.
Technical pointers: Bend knees to go down or catch the ball. Once ball is caught, continue shuffling side-to-side to where the next coach is standing.

- ***Simultaneous ball throws from one hand***

Coach stands 2m from subject and throws 2 balls simultaneously out of one hand for the subject to catch.
Technical pointers: Bent knees, feet at about shoulder-width apart. Soft hands bring balls towards body.
Benefits: Improves peripheral vision, concentration and ball handling

➢ ***Ball drop***

Coach drops ball for subject to catch, while subject is in a squat position.

Technical pointers: Bent knees, feet at shoulder-width apart, and hands on knees. Subject must catch ball with wrist supinated. When ball drops, subject must drop into squat position as quickly as possible. Don't snatch at the ball.

Benefits: Improves peripheral vision and foot movement. These exercises were carried out at 82% of the players' maximum heart rate, which was monitored with a heart rate monitor to ensure that the athletes did not become fatigued. Fatigue will result in loss of concentration and co-ordination, which would lead to inaccurate results.

Data Analysis

The pre- and post-exercise values of the subjects in the control and experimental group were pooled to determine the averages and differences, as seen in Table 1.

RESULTS

The results show that there was an improvement in the subjects that were exposed to the physical exercise. The exercises were specific for improvement in hand-eye co-ordination. Comparison of post-exercise values of control and experimental groups, showed an increase in % accuracy (Accuvision 1000 - test 2); decrease in time taken to complete tasks in seconds (Accuvision 1000 - test 1); and a decrease in time [seconds] (rotator pecboard).

The improvement observed in the control group was insignificant, which was probably the result of a learning effect.

DISCUSSION

In order to measure the athletic ability of a sporting individual, it is important not only to measure the cardiopulmonary and metabolic status (West, 1989; Wasserman, 1986) but also the individual's hand-eye co-ordination ability. Theories that visual involvement varies according to environmental demands, and therefore an athlete's visual characteristics vary according to the sport in which he or she specializes, have also been covered (Yuan, Fan, Chin & So, 1995). It is well known that environmental demands are matched by task-specific motor responses.

Table 1. Pre- and post-exercise (control and experimental groups) average values of the different sport vision tests.

Sport vision Tests	Control group		Experimental group	
	Pre-exercise	Post-exercise	Pre-exercise	Post-exercise
Strobespecs (%)	46.40	53.53	37.87	55.13
Accuvision Test 1 (sec)	20.88	20.07	21.80	19.33*
Accuvision Test 2 (%)	55.67	57.33	57.67	66.67*
Rotator pegboard (sec)	64.87	54.60	65.60	52.73*

*$p < 0.1$ when comparing post-exercise values of control and experimental groups.

The extension of this theory shows that visual ability can affect both motor learning and performance and that the nature of the visual involvement will vary according to environmental demands (Christension & Winkelstein, 1988). Using information from the visual assessment, a personal vision programme can be designed by experienced visual trainers. The programmes can be tailored to accommodate individual sessions or packaged sessions, depending on the requirements of the particular team. The sports vision programme is designed to enable sportsmen to perform and achieve their maximum potential. Just as physical exercise and practice increases strength and speed, visual performance can also be improved to achieve maximum results. Hand-eye co-ordination involves the integration of the eyes and the hands/body as a unit. In other words, the eyes must lead and guide the motor (movement) system of the body (Williams, Davids & Williams, 1999). Deficits in hand-eye co-ordination can affect all levels of performance that require movement of the athlete, rackets, bat, ball, etc. (Williams *et al.*, 1999). Since sport is typically performed under temporal constraints and varying levels of physiological stress or fatigue, attempts should be made to examine visual function under more realistic test conditions (Williams & Horn, 1995).

Anticipation is probably the most difficult element of sports vision to test, because of the different anticipation circumstances in different sports. The real situation should, therefore, be simulated. Consequently, it is important to have multiple dependent measures of performance or several methodological approaches (recall, recognition, eye movements, etc.) when measuring anticipation and decision-making in sport (McPherson, 1993a; McPherson, 1993b; McPherson, 1994).

This is a follow-up study to a previous study on teenage girls (16- 17 years). The same experimental procedure was used but this study involved the use of a heart rate monitor to maintain a constant heart rate of 82% of the maximal heart rate of the players. The 82% maximal heart rate value was calculated in a previous study using blood lactate concentrations, heart rate and oxygen consumption as indicators (De Wet *et al.*, 1999). By using this exercise intensity level, the rugby players achieved the advantages of a good fitness base, without putting undue stress on the body, thereby preventing injuries. The reason for using this level of intensity was that the previous study's results may have been affected by fatigue, leading to a loss of concentration and poor hand-eye co-ordination.

The specific exercises used by this experimental group led to an improvement in the post-tests, which enhanced hand-eye co-ordination, accuracy, visual response speed, short visual memory, anticipation and visual concentration. The improvement that was observed in the control group was minor; this may be attributed to learning effect and the subjects thus being accustomed to the test. These results confirm the possibility that physical exercise, especially studies conducted during moderate exercise intensity, improved mental performance (Paas & Adam, 1991). The results also suggest that hand-eye co-ordination is sensitive to the short-term effects of exercise, mediated by several factors (Tomporowski & Ellis, 1986) such as the physical fitness of subjects; intensity and duration of exercise intervention; co-ordination tests selected by investigator; and the time at which the tests were carried out.

This study could fill the gap by advocating a theoretical framework and providing an empirical database to guide and evaluate future research. Future research could test and extend the present findings by employing other manipulations of exercise (e.g. varying duration and intensity of the exercise requirements), and by manipulating the level of difficulty.

CONCLUSION

What these test results showed is that, with the correct training programmes, hand-eye co-ordination tests, and also keeping the heart rate stable at 82% of the maximum heart rate, a vast improvement can be achieved in sporting performance. This will increase all the parameters tested, giving the athlete optimal performance ability and thus a competitive advantage above his/her counterparts.

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