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Influence of Basic Military Training on Visual Skills

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Abstract

Studies have shown that visual skills can be subjected to exertion during exercise, thus implying that entrainment of vision is possible through interaction with the environment. It has been established that by simply participating in physical activity, one naturally improves visual awareness as well as visual processing skills and visual-motor integration. The purpose of the present study was to examine the changes in various visual skills during a 20-week military basic training programme. The training included cardio-respiratory endurance, fitness, muscular strength (upper body and abdominal), muscular endurance, speed, power, agility and flexibility. The participants (n=234) consisted of both male and female recruits who were enrolled for basic training at the South African National Defence Force (SANDF). Only those recruits who complied with the inclusion criteria and were willing to give informed consent participated in the study. The data collection occurred before the onset of the basic training programme and again after 12 and 20 weeks of intensive training. This schedule was proposed in order to ensure the specific requirements demanded by the various tests, and to observe the rate at which the visual skills and physiological parameters changed. The improvement of various visual skills observed in this research provides evidence that physical exercise, along with an enhanced state of physical fitness, does have a positive effect on visual proficiency. These findings could be elucidated by an alteration in the neuronal architecture, which subsequently leads to faster decision making, as well as a quicker and more efficient motor response.

Keywords: visual skills; exercise; basic training; military; recruits

Introduction

Vision is a complex process which involves three basic steps: perception, integration, and response. During integration within the central nervous system (CNS), visual information is combined with various other stimuli occurring simultaneously [1]. The information is analysed and interpreted according to previous experiences stored in memory. A response is then formulated and the appropriate stimulus is conducted along motor neurons in order to guide the motor system of the body to respond correctly to the visual stimuli [1]. The ability to interpret and rapidly integrate crucial information and formulate appropriate responses is a fundamental skill necessary for efficiency and performance [2,3] particularly amongst the workforce of the defence sector. [4]

Military personnel are expected to perform occupational tasks which require optimal physical and mental readiness [4]. Activities that are likely to be performed in these sectors include self-defence skills that incorporate various physical activities, as well as firearm training and weapon use [5,6]. These situations require the use of psycho-physical and motor efforts during problem solving [7]. The proficiency of skill execution in such situations is determined by the level of fitness and tolerance towards physical demands and stressful situations [7].

Members of the military are expected to function under stressful situations. Anxiety, resulting from the pressure, has been found to reduce certain visual abilities, namely, the foveal fixation in the eye becomes shorter because the attempts to extract information via the fovea increases, resulting in a decrease in efficiency [8]. However, training under increased conditions of anxiety has a positive effect on the perceptual-motor performance by forcing alterations in the perception of action capability, information detection, perception of affordances, selection of affordances and the realization of affordances [9,10].

Stress also induces increased sympathetic nervous system (SNS) activity which narrows vision by reducing the percentage of visual stimuli processed. Binocular vision is also favoured over monocular vision in stressful situations. Binocular vision can inhibit the accuracy in distance shooting, vision and depth of perception [6,11].

Furthermore, stress can cause attention lapses, short-term memory impairments and biased information processing that can contribute to errors in judgement [6]. Therefore, mental readiness, mental rehearsals and visual motor behaviour rehearsals are vital in training of military recruits since they help reduce acute stress and improve performance in critical events [12,6].

Studies have shown that ocular activities (such as the lens changing shape, work of the ciliary muscles and increased complexity of electrochemical reactions conducted by the retina) can be subjected to exertion during exercise, thus implying that entrainment of vision is possible through interaction with the environment [13,14]. It has been

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established that by simply participating in physical activity, one naturally improves his or her visual awareness as well as visual processing skills and visual-motor integration, thus implying that through sports vision training one can considerably improve performance and skill [15-18]. From a neurological stance, studies have shown that participating in physical activity altered neural activities through visual pathways [19].

Sports vision consists of an integrated network of systems including the visual system, central and somatic nervous systems and the musco-skeletal system. Sports vision has been described as performance oriented, comprehensive vision care programmes focused on the correction, protection, education, enhancement, and evaluation of the individual [3]. Thus, the aim of sport vision is to exercise visual co-ordination, as well as to obtain knowledge of the necessary motor responses. Co-ordination occurs when complicated actions are composed by the motor system by the combination of a variety of more simple sub-movements. The information regarding the progress of one sub-movement is shared with the centres controlling the other sub-movements. This process ensures that the second movement occurs in appropriate relation to the first [2].

Studies revealing that athletes have better visual skills than the general public has increased interest in the role of sports vision in performance [3]. Visual skills such as vergence, visual reaction time, near point of convergence, and saccadic eye-movements have been found to be significantly better in athletes [20]. Since the autonomic nervous system innervates the accommodative system, a more stable, efficient and flexible accommodative system can be expected in athletes [20]. Studies further indicate that the advantage the athlete retains is one of perception [21]. In other words, the athlete is able to attend to specific information, analyse, interpret and use this information more effectively than a non-athlete [21,22]. This confirms results of previous studies which show that perception and action are functionally interdependent [23]. It is important to note that the enhanced visual skills of athletes appeared to be sport-specific [22]. The role of the visual system in a particular sport also varies according to the environmental demands commonly associated with that sport. Likewise, these environmental demands must be matched by a specific motor response [2].

Although much research has been done regarding athletes and improved visual skills the literature lacks reference to visual proficiency amongst non-athletic recruits undergoing an intense training program. In light of this, the present study aims to examine the changes in various visual skills during a 20-week military basic military training (BMT) programme.

Throughout their initial months of military conscription, the recruits are exposed to new knowledge and skills in a very well structured and controlled manner to ensure that the training objectives are met. The purpose of BMT is to equip future soldiers with the required physical work capacity, mental readiness, critical military skills and competencies in order to effectively deal with the possible crisis situations that may arise during their military career. The final outcome of the programme is the transition from amateur recruit to professional soldier, ready for subsequent specialised corps training [24].

Despite technological and mechanical advancement, military tasks still entail a considerable amount of demanding physical effort [25]. This implies that optimal physical fitness and endurance remain important necessities among present day military personnel. As a result, intense physical training forms a fundamental part of the basic training programme.

Aim

The aim of this study was to determine the effect of a 20-week BMT programme on the visual skills of male and female recruits between the ages of 18 and 22.

Methods and Materials

Study design

A pre-test, post-test groups experimental design was used to determine the effect of an intense training programme on various visual skills.

Participants

The sample (n=234) included in the study comprised of 135 male and 99 female participants between the age of 18 and 22 years. These participants were enrolled for BMT. Only those who were willing to complete the informed consent form were used for the study. Those who had a visual disorder or failed to comply with the test procedures were excluded from the study.

All participants were screened and organized to ensure compliance with this criteria. The screening process included: a thorough explanation of the purpose of the study, as well as the procedures and risks; the provision and discussion of pre-test instructions; and the opportunity for subjects to ask any questions. An informed consent form was issued to those who met the inclusion criteria.

Apparatus and procedures

All the tests were conducted under the same terms and conditions. The sports vision evaluation consisted of eight tests of basic visual skills. The visual skills that were tested were: focusing, tracking, vergence, sequencing, hand-eye co-ordination, visualisation, reflex test and colour vision. Visual skills were tested by using the methods of Wilson & Falkel [26].

Basic Military Training

A 20-week BMT programme was followed. The training focused on instilling basic soldier skills such as field craft, musketry, drilling, buddy aid, daily preparations for inspections, as well as combat water safety. This phase of the training program serves as an important building block in fostering common military customs and underpinning military discipline [24]. Formal fitness training comprised daily compulsory physical training sessions during which acyclic-progressive physical training programme was followed [27]. The training included cardio-respiratory endurance, fitness, muscular strength (upper body and abdominal), muscular endurance, speed, power, agility and flexibility. The training intensity of the fitness sessions exceeded 6 metabolic equivalents (METs), with fitness standards being raised incrementally [28].Training consisted of 48 physical training sessions of forty minutes each. Table 1 summarizes the time allocated for each physical training component.

Data analysis

All data that was collected after weeks 1,12 and 20 was captured and statistical analysis were done by means of the statistical package IBM SPSS Statistics 19.

The results from week 1 were compared to weeks 12 as well as 20, and the results from week 12 were compared to week 20 for all eight sport vision tests. A repeated measure MANOVA (Multivariate

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PT programme component	Resistance	Time (min) allocated in 12-week BMT period	No. of exercises completed in 12-week BMT period
Warm-up	None	322	–
Upper body muscle endurance exercises	BW	-	28†
	BW + 20kg wooden poles	-	64††
Abdominal body muscle endurance exercises	BW	-	28†
	BW + 20kg wooden poles	-	64††
Lower body muscle endurance exercises	BW	-	28†
	BW + 20kg wooden poles	-	64††
Jogging	None	950	-
Interval training	None	213	-

BW = body weight. *Further details available in Department of Defence (2000). †From week 1 completed three sets of 10–12 repetitions of exercises performed by muscle groups in this body region and from weeks 1–2 completed two sets of 10–12 repetitions, progressing to three sets of 10–12 repetitions in weeks 3–4 of exercises performed by muscle groups in this body region. ††From weeks 5 to 12 completed all exercises with 20 kg wooden poles in pairs performed by muscle groups in this body region, starting with two sets of 10–12 repetitions and progressing to three sets of 10–15 repetitions.

Table 1: Time dedicated to each physical training (PT) programme component during 12-week Basic Military training (BMT) course* (Wood et al. 2010).

Analysis of Variance) was used to statistically analyse the results to protect against an inflated type I error. Post-hoc analyses consisted of paired t-tests for pair wise comparisons of the data.

Results& Discussion

Descriptive statistics concerning physical characteristics of the participants are indicated in Table 2. Results regarding visual skills show improvement in all visual skills over the 20 week training period, except sequencing and vergence (Table 3, 4, 5& Figure 1). Mean sequencing scores decreased for both males (Table 4) and females (Table 3), resulting in a total sample decrease from 1.57 to 1.5 (Table 5). This may indicate that exercise does not influence how individuals interpret, organize and process visual sequences; and therefore does not promote improved sequential processing. It can also be noted that the mean vergence scores for both males (Table 4) and females (Table 3) increased from week 1 to week 20, giving rise to a total sample mean vergence increase from 3.87 cm to 4.43 cm ($p = 0.009$) (Table 5). The increased mean vergence score suggests a decrease in performance as the distance (cm) required to maintain binocular vision is reduced. These results imply that an intense training programme may not suffice to convey improved vergence results.

Results yielded in this study suggests that a BMT programme, focussing on intense physical training, enhances hand-eye co-ordination, visual response speed, accuracy, anticipation, visual concentration and short term visual memory. These results are in concordance with previous research suggesting that physical exercise, especially exercise of a moderate intensity, results in enhanced mental performance [29]. These results are further verified as studies conducted between experts and novices demonstrate an improvement in eye-hand coordination, reaction time and visuo spatial intelligence, indicating that exercise or an intervention (physical activity) does significantly affect these specific attributes [30,31]. Exercise has also been shown to have a substantial influence in visual concentration, hand-eye coordination, proaction-reaction time, as well as visual response speed and accuracy [17,32,33].

In a review by Hazel [34], it is suggested that exercise enhances one's visual efficiency and in so doing, the brain's reaction to a stimulus is increased and a quicker response can be made. This is further confirmed in a study comparing physical activity and visual attention, where it was shown that even sub-maximal exercise enhances visual acuity and visual attention [35]. In their study Cereatti et al. [35] contended that expert athletes tended to boast superior visual skills due to experience and that they "show highest flexibility in the allocation of visual attention". It is also said that with training, the eyes are able to better locate, focus centrally and functionally as a unit, which could supposedly result in reduced eye fatigue and improved consistency in performance [34]. The same explanation can be applied with regards to recruits as they are in the process of acquiring a wealth of experience in physical demands due to their field of expertise.

Furthermore, the results also suggest that hand-eye co-ordination is sensitive to the short term effects of exercise, which are mediated by several factors [32]. Such factors include physical fitness, the intensity and duration of the exercises, the various co-ordination tests selected by the researcher, as well as the time at which the tests were conducted.

While improving eye-muscle strength is difficult, physical exercise may enhance agility and flexibility. Since the eyes feed information to the brain, accurate information is required for optimum performance. In addition to this, factors such as the eyes' ability to focus clearly, to quickly and efficiently change focus, and to rapidly process visual information, may also be affected. Therefore, sports vision exercises can be used to improve the ability of the eye to effectively interpret and analyse visual information. [22,36]

However, contrasting evidence exists suggesting that regimens such as exercise do not provoke significant changes in visual and motor performance and while there may be an improvement in the battery, it does not transfer to an improvement in sporting performance [21,22]. This can be seen in a study conducted on clay target shooters, where visual differences between expert shooters and novices were negligible and the only significant attribute was reaction time [15, 21] although producing results implicating the benefits of vision testing and training in their study, argue that there could be other factors contributing to the improvement, such as the placebo effect or an "illusory function of expectancy effects".

Characteristic	Gender	Week 1	Week 12	Week 20
Age (years)	M	20.72 ± 1.14	20.88 ± 1.14	20.91 ± 1.42
	F	20.18 ± 1.28	20.39 ± 1.25	20.51 ± 1.27
Weight (kg)	M	63.09 ± 8.40	64.93 ± 7.59	64.49 ± 7.17
	F	62.02 ± 9.76	61.37 ± 8.41	60.48 ± 7.99
Height (m)	M	1.70 ± 0.07	1.70 ± 0.07	1.70 ± 0.07
	F	1.60 ± 0.05	1.60 ± 0.05	1.60 ± 0.05
Body Mass Index	M	21.92 ± 2.41	22.53 ± 2.05	22.21 ± 1.90
	F	24.29 ± 3.54	23.93 ± 3.01	23.48 ± 2.66

Table 2: Biographical information (mean ± SD) of recruits (n = 234; male = 135; female = 99) for weeks 1, 12 and 20.

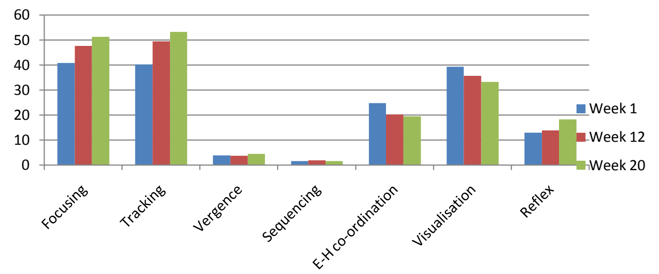

Figure 1: Total sample mean performance

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	Week 1			Week 12			Week 20		
	Mean	min	max	Mean	min	max	Mean	min	max
Focusing	41.64 (± 21.65)	7	97	46.98 (± 19.35)	11	82	51.78 (± 19.12)	9	82
Tracking	43.05 (± 21.38)	6	102	50.46 (± 16.56)	7	81	54.29 (± 17.57)	10	84
Vergence	4.43 (± 3.31)	0	19.0	4.14 (± 3.45)	0	18.0	5.03 (± 3.28)	0	14.00
Sequencing	1.67 (± 0.88)	0	5	1.92 (± 0.69)	0	5	1.62 (± 0.84)	0	5
E-H coordination	25.65 (± 9.43)	10.40	54.16	21.93 (± 7.92)	7.02	53.18	20.86 (± 10.40)	8.27	55.47
Visualisation	34.70 (± 18.50)	9.55	117.3	32.63 (± 14.43)	13.56	86.69	31.18 (± 12.65)	11.56	68.69
Reflex test	10.44 (± 8.19)	0	31	9.84 (± 8.62)	0	33	15.24 (± 8.42)	0	37
Colour vision	10.96 (± 0.20)	10	11	-	-	-	-	-	-

Table 3: Mean (± SD) of visual skills performance of female recruits (n = 99).

	Week 1			Week 12			Week 20		
	Mean	min	max	Mean	min	max	Mean	min	max
Focusing	40.09 (±19.60)	8	77	48.00 (± 16.60)	8	76	50.72 (±17.03)	7	87
Tracking	37.88 (±16.86)	7	81	48.59 (±13.95)	14	76	52.27 (± 17.40)	9	86
Vergence	3.44 (±2.72)	0	15	3.24 (± 3.33)	0	15	3.98 (± 3.32)	0	20
Sequencing	1.50 (± 0.74)	0	4	1.79 (± 0.65)	1	4	1.41 (± 0.73)	0	3
E-H coordination	23.97 (±11.97)	9.53	95.41	18.86 (± 6.96)	8.53	42.97	18.30 (± 7.03)	8.13	37.87
Visualisation	42.63 (± 24.47)	10.2	155.80	37.82 (±15.87)	1.01	89.34	34.57 (±12.70)	14.50	76.63
Reflex test	14.72 (±10.47)	0	42	16.73 (±12.09)	0	41	20.44 (±10.53)	0	44
Colour vision	10.63 (±1.71)	1	11	-	-	-	-	-	-

Table 4: Mean (± SD) of visual skills performance of male recruits (n = 135).

	Mean Values			Week 12	
	Week 1	Week 12	Week 20		
Focusing	40.76	47.56	51.17	Week 1 < week 12 Week 12 < week 20 Week 1< week 20	(p < 0.001) (p = 0.050) (p < 0.001)
Tracking	40.10	49.39	53.12	Week 1 < week 12 Week 12 < week 20 Week 1 < week 20	(p <0.001) (p = 0.023) (p < 0.001)
Vergence	3.87	3.62	4.43	Week 1≈ week 12 Week 12 < week 20 Week 1 < week 20	(p = 0.288) (p < 0.001) (p = 0.009)
Sequencing	1.57	1.84	1.50	Week 1 < week 12 Week 12 > week 20 Week 1 ≈ week 20	(p < 0.001) (p < 0.001) (p = 0.344)
E-H coordination	24.70	20.17	19.39	Week 1> week 12 Week 12 ≈ week 20 Week 1 > week 20	(p < 0.001) (p = 0.256) (p < 0.001)
Visualisation	39.24	35.59	33.14	Week 1 > week 12 Week 12 > week 20 Week 1 > week 20	(p < 0.021) (p = 0.055) (p < 0.001)
Reflex test	12.87	13.79	18.24	Week 1 < week 12 Week 12 < week 20 Week 1 < week 20	(p = 0.098*) (p < 0.001) (p < 0.001)

*p-values > 0.05 but < 0.10 constitute moderate evidence of an intervention effect.

Table 5: Mean performance for total sample (n = 234) and comparison between weeks 1, 12 and 20.

There are also several other factors that influence visual abilities that make testing for the influence of physical exercise quite daunting, namely age, gender, genetic variability and cognitive expertise [35]. Cereatti et al [35] found that these non-modifiable factors affect the relationship between attention and exercise. This is further complicated by the modifiable factors which affect performance such as “strength, technique, fitness, attitude and state of mind” [34].

It is important for military personnel to learn fine motor skills and visualisation so as to allow them to plan their individual performance through mental rehearsal. Recruits will therefore be able to clarify tasks, identify potential performance problems, choose effective tactics, improve gross motor skills to influence grip strength, learn stimulus-coordinated responses so as to learn to respond automatically to and survive deadly force encounters [12, 26,37]. For better performance, the orientation of visual attention and the motor components of a task should be tightly coupled [8].

Conclusion

Despite the fact that BMT aims to prepare conscripts both mentally and physically for the future tasks expected by them, the importance of simultaneous advancement of visual skills should not be overlooked. Whilst the program further intends to equip future soldiers with the necessary skills and combat-readiness to ensure optimal survivability, the superior visual skills gained during the training period can minister to accomplish this objective.

The improvement of various visual skills observed in this research provides evidence that physical exercise, along with an enhanced state of physical fitness, does have a positive effect on visual proficiency. These findings could be elucidated by an alteration in the neuronal architecture, which subsequently leads to faster decision making, as well as a quicker and more efficient motor response [26]. Determining the extent to which visual attributes can be entrained will benefit the recruit by providing an indication of which of these attributes can be improved. This should result in optimal performance in that particular field.

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