

THE RELATIONSHIP BETWEEN ANAEROBIC EXERCISE AND COGNITIVE PERFORMANCE IN THE TRAINING OF FUTURE OFFICERS

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Abstract: *This study explores how short, high-intensity (anaerobic) exercise influences cognitive performance in future military officers. Modern operational environments require rapid adaptability, resilience, and decision-making under stress. A group of 28 military students participated in an experimental protocol including pre- and post-exercise cognitive assessments (verbal and visual memory) and a high-intensity anaerobic training session. Results indicate that anaerobic exertion differentially affects cognitive domains: verbal memory performance tended to decline under fatigue, whereas visual memory showed slight improvement. Statistical analysis using the Wilcoxon Rank Sum Test revealed no significant differences in verbal memory but significant differences in visual memory. Findings suggest that integrating anaerobic training into military preparation can enhance cognitive adaptability, a key requirement for the military environments.*

Keywords: anaerobic exercise, cognitive performance, military training, executive functions

1. Introduction

The military environments are increasingly characterized by volatility and uncertainty. Within such contexts, future officers must demonstrate not only physical readiness but also cognitive resilience, adaptability, and rapid decision-making under stress. Physical activity has long been associated with improvements in cognitive functioning, including attention, memory, and executive control. However, the specific effects of anaerobic exercise—short, high-intensity efforts—remain less consistently understood. Given that military tasks frequently involve bursts of intense activity, examining how anaerobic exertion influences cognition is essential for optimizing training protocols. Physical activity, in general, plays a key role in maintaining overall health and functional capacity. It includes any movement produced by skeletal muscles that results in energy expenditure, whether or not the goal

is to improve fitness [2]. Within this broad category, different types of exercise can have distinct effects on the body and the brain. One important category is anaerobic exercise, which involves short bursts of high-intensity activity performed without sufficient oxygen supply to meet energy demands.

Cognitive performance is essential for effective leadership and operational success, requiring rapid information processing, sustained attention, and accurate decision-making under stress [4]. Physical inactivity has been linked to cognitive decline, whereas exercise may enhance cognitive functioning, although results vary depending on intensity [1, 3]. Therefore, understanding the impact of anaerobic exercise on cognition is crucial for optimizing the training of future officers, particularly in relation to its underlying mechanisms and practical applications.

2. Anaerobic Exercise: Physiological and Functional Aspects

2.1. Anaerobic Exercise and Physiological Mechanisms

Anaerobic exercise consists of short, high-intensity efforts in which energy is produced without sufficient oxygen, primarily through the phosphagen system and anaerobic glycolysis, enabling rapid ATP resynthesis [7]. The phosphagen system supports only a few seconds of maximal effort, while glycolysis sustains slightly longer bursts, such as sprinting or resistance exercise [9]. Although these processes lead to lactate accumulation and fatigue, they are essential for developing speed, strength, and power—key capacities in military performance.

2.2. Cognitive Performance in High-Stress Contexts

Cognitive performance encompasses processes such as attention, memory, and executive functioning [4]. These functions are crucial in military settings, where decision-making often occurs under time pressure and physical strain.

Exercise influences cognition through increased cerebral blood flow, neurotransmitter activity, and neurotrophic factors such as BDNF [6]. However, the relationship between exercise intensity and cognition follows a nonlinear pattern, where moderate intensity may enhance performance while excessive fatigue may impair it [8].

2.3. Anaerobic Exercise

Individuals must function effectively despite instability, anxiety, and unpredictability. Training that combines physical stress with cognitive demands may enhance resilience and adaptability. Anaerobic exercise simulates such conditions by inducing rapid fatigue and requiring immediate cognitive responses, thereby preparing individuals for real-world operational challenges.

2.4. Mechanisms Linking Anaerobic Exercise and Cognitive Function

The relationship between exercise and cognition is multifactorial, with intensity playing a key role. Short bouts of high-

intensity exercise can acutely enhance attention and reaction time through increased cerebral activation, blood flow, and catecholamine release [3]. Lactate may also support neuronal energy use and learning processes [5].

Effects are nonlinear: excessive intensity can induce mental fatigue and impair complex cognition, consistent with an inverted-U pattern [8]. Conversely, insufficient physical activity is associated with poorer cognitive outcomes, while regular, well-dosed exercise supports cognitive health [1].

2.5. Implications for Training Future Officers

Officer training should integrate physical and cognitive demands. Anaerobic exercise mirrors operational conditions requiring rapid responses under stress and, when paired with decision tasks, develops both physical power and cognitive agility. Structured, engaging training further enhances self-regulation and performance [9].

3. Methodology

The study involved 28 third-year military students from the Land Forces Academy. Participation was voluntary, and all subjects were physically fit for high-intensity exercise.

3.1. Procedure

The experimental design included four stages:

- Initial cognitive assessment (Verbal Memory and Visual Memory tests)
- Ruffier Test to assess physical adaptation
- High-intensity anaerobic exercise session (HIIT-based protocol)
- Post-exercise cognitive assessment

The exercise protocol included jumping squats, push-ups, lunges with jumps, Korean get-ups, and sprinting, designed to induce rapid fatigue.

3.2. Measures

Cognitive performance was assessed using two computerized tasks:

- Verbal Memory Test: recognition of previously presented words

- Visual Memory Test: recall of spatial patterns

Figure 1. Verbal Memory

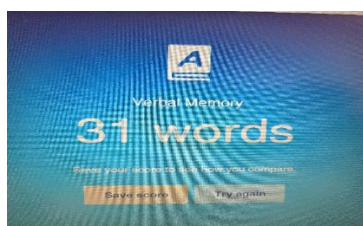
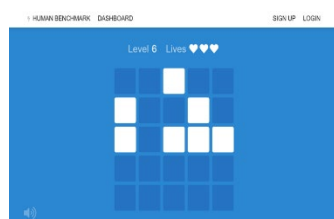


Figure 2. Visual Memory



For the third phase of the test, the students performed a short session of intense exercise, structured along the lines of HIIT workouts, which are known for their ability to rapidly induce an anaerobic energy metabolism. The exercise was structured as follows: Jumping squats (20 seconds), Rest (10 seconds), Push-ups (20 seconds), Rest (10 seconds), Alternating-leg forward lunges with jumps (20 seconds), Rest (10 seconds), Korean get-ups (20 seconds), Sprint (40 meters).

The purpose of this intense effort was to induce fatigue in a short period of time, in order to compare the initial and final test performances.

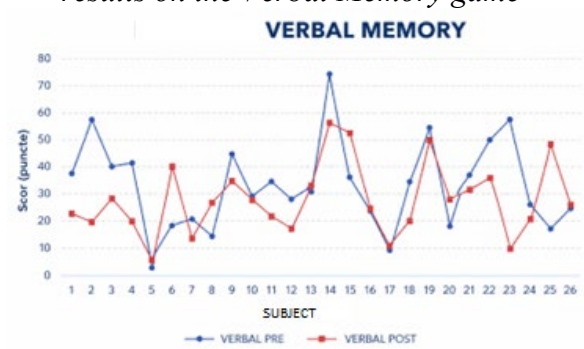
Upon completion of the third phase, the students resumed playing the games, at which point the final phase of the test began. There was no rest period between the exertion phase and the resumption of the games. The order of the games remained the same as in the second phase, namely: Verbal Memory and Visual Memory.

4. Results and Discussion

The results chart (Figure 3) shows that most of the subjects had difficulty retaking the test after exercise, which is why the post-

exercise results tend to be significantly lower than the pre-exercise results.

Figure 3. Chart of pre-test and post-test results on the Verbal Memory game



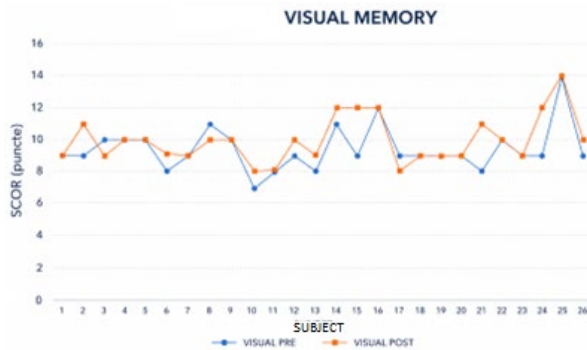
A few students managed to achieve a score close to their initial one, and very few managed to exceed the score obtained in the pre-exercise test.

Table 1 Statistical data on pre- and post-exercise results for the Verbal Memory

NUME	VERBAL PRE	VERBAL POST	Diferenta	Positiv	Abs Dif.	Rank	Signed rank
C. L.	45	34	11	1	11	12	12
F. I.	29	17	12	1	12	14	14
V. A.	28	50	-22	-1	22	24	-24
N. N.	23	25	-2	-1	2	4	-4
C. E.	12	27	-15	-1	15	16	-16
C. V.	19	40	-21	-1	21	22	-22
O. V.	56	51	5	1	5	9	9
P. P.	18	28	-10	-1	10	11	-11
B. C.	40	28	12	1	12	14	14
P. R.	36	32	4	1	4	6	6
B. P.	2	6	-4	-1	4	6	-6
B. I.	37	22	15	1	15	16	16
I. N.	32	33	-1	-1	1	1	-1
N. R.	36	53	-17	-1	17	20	-20
C. R.	22	15	7	1	7	10	10
C. I.	26	27	-1	-1	1	1	-1
N. R.	35	20	15	1	15	16	16
R. C.	58	11	47	1	47	26	26
M. B.	75	55	20	1	20	21	21
P. D.	51	36	15	1	15	16	16
Z. S.	26	30	-4	-1	4	6	-6
N. C.	9	10	-1	-1	1	1	-1
T. A.	26	23	3	1	3	5	5
D. V.	34	23	11	1	11	12	12
B. N.	58	21	37	1	37	25	25
B. A.	41	20	21	1	21	22	22

After applying the Wilcoxon Rank Sum Test, the statistical data recorded and presented in the tables above lead us to the following conclusions regarding the Verbal Memory game: the statistical test value ($W=112$) is greater than the critical value (98). However, these values are close. We can state that there is no statistically significant difference between the indices of the two recorded tests.

Figure 4. Chart of pre- and post-test results on the Visual Memory game



The chart (Figure 4) showing the results for the Visual Memory game suggests that the students' performance on this task is similar. We observe that a large proportion of the students achieved the same score both before and after exerting effort. One reason for this phenomenon may be that post-effort fatigue diminishes, given that this is the last of the games. Another factor that may have contributed to these results is the nature of the game. The initial levels are very easy to complete. However, starting with level 9, the game's difficulty increases considerably. We can see this in the students' results, as most of them did not exceed level 10.

Table 2 Statistical data on pre- and post-exercise results for the Visual Memory

NUME	VISUAL PRE	VISUAL POST	Diferenta	Pozitiv	Abs Dif.	Rank	Signed rank
C. L.	10	10	0	0			
F. I.	10	10	0	0			
V. A.	14	14	0	0			
N. N.	12	12	0	0			
C. E.	11	10	1	1	1	1	1
C. V.	8	9	-1	-1	1	1	-1
O. V.	9	9	0	0			
P. P.	9	9	0	0			
B. C.	10	9	1	1	1	1	1
P. R.	8	11	-3	-1	3	11	-11
B. P.	10	10	0	0			
B. I.	9	9	0	0			
I. N.	8	9	-1	-1	1	1	-1
N. R.	9	12	-3	-1	3	11	-11
C. R.	9	9	0	0			
C. I.	7	8	-1	-1	1	1	-1
N. R.	9	9	0	0			
R. C.	9	9	0	0			
M. B.	11	12	-1	-1	1	1	-1
P. D.	10	10	0	0			
Z. S.	9	10	-1	-1	1	1	-1
N. C.	9	8	1	1	1	1	1
T. A.	9	12	-3	-1	3	11	-11
D. V.	8	8	0	0			
B. N.	9	11	-2	-1	2	10	-10
B. A.	10	9	1	1	1	1	1

Following the application of the Wilcoxon Rank Sum Test, the statistical data recorded and presented in the tables above lead us to the following conclusions regarding the Visual Memory game: the statistical test ($W=4$) is smaller than the critical value (13). Thus, hypothesis H1, according to which there are differences between the two tests (pre-effort and post-effort), is validated. We can conclude that the statistical difference between the scores of the two recorded tests is significant, with the post-effort results being slightly better than those obtained in the first test.

5. Conclusions

The findings highlight that anaerobic exercise affects cognitive domains differently. Verbal memory appears more sensitive to fatigue, possibly due to its reliance on sustained attention and working memory. In contrast, visual memory may benefit from heightened arousal and neural activation induced by intense exercise. These results are particularly relevant to military personnel who must operate under conditions of stress, unpredictability, and cognitive overload.

Training that exposes individuals to combined physical and cognitive stressors may enhance their ability to function effectively in such environments.

Anaerobic exercise plays a significant role in shaping cognitive performance under stress. While it may impair certain cognitive functions such as verbal memory, it can enhance others, particularly visual processing.

Integrating anaerobic training into military education can contribute to develop resilient, adaptable officers capable of performing under pressure.

Future research should explore long-term adaptations and the integration of cognitive training alongside physical conditioning.

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