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Original Article

Effect of the training program on mental qualities in elite orienteers

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Abstract
Problem Statement and Approach Orienteering represents an independent crossing of a racing or training route in the possible shortest time using a map and compass as navigation tools. The sport requires maximum efficiency when obtaining and processing information from the map and terrain, which depends largely on thought processes, with the goal being adequate and quick decision-making. Relationship between the emotional, cognitive, and psychophysiological factors as well as the changes in the levels of mental and physical load are extremely important in orienteering. The purpose of the study is to research the influence of a training program on some mental qualities in elite orienteers. **Material and Methods** In this sports-pedagogical experiment were included 30 elite orienteering competitors. The period of applying the training tools was 6 months. There were applied 5 tests for determining the level of the mental qualities believed to be key crucial for sports performance in orienteering. **Results** The variability of the results of the tests for assessing the mental qualities decreased in 3 of the 5 tests at the end of the experiment. It can be seen that at the end of the experiment, there was improvement in the levels of all mental qualities studied, with increased mean values in all tests. D**iscussion** The positive changes that occurred, statistically significant in 4 of the 5 tests conducted, were, in our opinion, due to the tools purposefully applied in the training program to improve the technical abilities of the orienteers, and the program greatly influenced their mental qualities. **Conclusions** The subjects' group recorded a statistically significant growth in all tests for determining the levels of mental qualities, except for the memory functions test. To the greatest extent, the systematic use of orienteering tools influenced the concentration and stability of attention followed by span of attention. Memory, as a mental quality, was not influenced by the systematic orienteering training.
Key Words: orienteering, competitors, training tools, mental tests, analysis.

Introduction

According to Ignatov & Petkova (2019) sports activities contribute to a positive mood and physical relaxation, gaining knowledge, developinging skills, maintaining and achieving good physical shape and healthy habits. As T. Pedev (2016) noted, each sport has its own features. Orienteering is about finding and following the best way to cross a certain route through an unfamiliar terrain in the shortest time possible. This requires special orienteering skills such as precise map reading, accurate rout choices, using a compass, keeping concentration under stress, quick decision-making, cross-country running, etc. (Pedev, Garkov, Ilkov & Dimitrov, 2012; Pedev, 2016). The control points marked on the terrain and orienteering map must be visited in the order determined, but the route between them is chosen by the competitors themselves, which depends on their preparation, experience, qualification, preliminary tactical plan, etc. According to Simeonov, D. (2020) contemporary cartography and cartographic researches in Bulgaria are on a high technological level. Thanks to this, good opportunities are created for practicing sports orienteering. The speed of movement along the route is determined by the orienteers' ability to simultaneously run and process information related to the selection and implementation of a route in a specific racing environment (Tsiligirides, 1984; Garkov, 2003; Cych, Krompiewska, & Machowska, 2011).

Today, the International Orienteering Federation is developing 4 official types of orienteering: summer, ski, mountain bike, and precision orienteering (Allen, 2011).

According to V. Garkov (2019), a distinctive feature of modern orienteering is the combination of a high level of functional training, mastery of a wide range of technical skills and habits, and mental qualities. Some authors reports that there is a relationship between the high anaerobic threshold and orienteering errors during competition (r = - 0.64) (Izzo, R.E., Giovannell, M., Cejudo, A. & Varde'I, C.H., 2021). Orienteers are exposed to high stress levels, and that condition affects their immune and endocrine systems, triggering a predominantly anti-inflammatory response, likely an athlete's mechanism of adaptation to the stress imposed by high-intensity physical exercise (Araujo, et al, 2019).

According to other authors, orienteering is a sport that is extremely suitable to practice at school and leads to improved physical shape and health of students (Galan, Zoriy, Briskin, & Pityn, 2016; Blagii, et al.,

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2018; Vaskan, et al., 2019). This is a sport that puts students in close proximity to nature, creates positive emotions, and builds skills to deal with various situations that arise while moving in an unfamiliar area (Belomazheva-Dimitrova & Petkova, 2015).

A study by Galan et al. (2019a) shows that orienteering helps to improve the functional state of the cardiovascular and respiratory systems, strengthens the musculoskeletal system, contributes to the speed of thought processes, the effective development of physical qualities, especially endurance. It was found that under the influence of regular orienteering training, the memory span, and switchability of attention are significantly improved, which contributes to the harmonious development of individuals. Orienteering, as a form of physical activity, enables young people to meet many of the needs of nowadays people. The combination of physical and mental activity, outdoor activity, closeness to nature, the feeling of satisfaction from athletes' realization, and the achievement of good results also predetermine a healthy lifestyle (Galan, et al., 2019b). Orienteering also allows the body and mind to work together while searching for control points along the route. It can be affirmed that orienteering contributes to the development of personal characteristics by keeping the mind active (Deniz, Yoncalikb, Aslan, & Sofid, 2012). According Petrov & Stefanov (2019) the active sports activity creates the personality in a complex way, both in motor and intellectual way.

According to Celestino et al. (2015), the most important factors for a successful sports career in orienteering are the mental qualities and the specific training of athletes. Secondary factors that influence the sports performance are family, socio-cultural aspects, friends, orienteering clubs, school sports, and coaches.
According to Robazza et al. (2018), the relationship between the emotional, cognitive, and psychophysiological factors as well as the changes in the levels of mental and physical load are extremely important in orienteering. From a practical point of view, training to increase cognitive resources offers potential benefits for coping with the challenges of a competition. Mental activity during an orienteering competition is extremely complex and often crucial for the final result. Achieving excellence in this sport requires maximum efficiency in obtaining and processing information from the map and terrain. These processes do not depend only on the situation, but require extensive experience, which is expressed in greater efficiency in the course of thought processes for effective decision-making (Celestino, Leitao, Sarmento, Marques, & Pereira, 2015).

The analysis of all the highlighted facts make us believe that the systematic application of technical training in orienteering athletes will lead to a positive impact on certain mental qualities.
The purpose of the study is to research the effect of a training program on some mental qualities in elite orienteers.

Material & methods

The sports-pedagogical experiment included 30 athletes, candidates for the national orienteering team of Bulgaria, of which 19 men and 11 women, at an average age of 24.4 years (Table 1).

Table 1. Participants of the Study

Subjects	Gender		Total	Average age
	Male	Female		
Number	19	11	30	24.4
Percentage	63.3%	37.7%	100.0%	

The sports-pedagogical experiment was conducted in two stages: the first in March 2019 and the second in September 2019, during which various mental tests were conducted to determine the levels of some mental qualities of the orienteers.

During the study period, the orienteers were prepared following a training program set by the coach of the national team. This program was applied to all the subjects at the local sports clubs as well as the extended camp gatherings of the national team. The training program included tools and methods to improve the level of technical readiness. The selection of funds took into account the methodology of preparation of the French orienteering club of Saint-Etienne which has brought French orienteering to many world awards, ranking it among the best nations in the world (Gueorgiou, 2018). The training program included a wide use of GPS devices and software for tracking the movement of the orienteers during training/ competitions, making an in-depth comparative analysis of their performance and drawing conclusions in order to improve the techniques and their proper and timely application during a competition. They were taken into account in the implementation of the activities to follow. The program also included special technical training and terrain exercises with a map and compass. On weekends or between workouts, the athletes performed additional theoretical exercises on their own as well as mental crossing of orienteering routes as a means of improving their mental readiness.

Meassure methods and test protocol

For the purposes of the study, a meassure instruments were applied which aimed to study the qualities of attention, thinking, and memory as basic mental qualities of utmost importance for the technical performance

during an orienteering competition. Based on the study methods, the tests were selected and modified to serve the purposes of the experiment (Table 2).

Table 2. Psychological tests to assess mental qualities

No.	Tests	Growth Direction	Measuring Unit	Accuracy
1.	Bourdon Test – Numerical Version	+	n	1
2.	Bourdon Test – Version with Figures	+	n	1
3.	Entangled Lines Test by Platonov, K. K.	+	n	1
4.	Attention Span Test by Voronov, Yu. S.	+	n	1
5.	The Ten-Word Memory Test by Luria, Al.	+	n	1

The first two tests were used to assess different indicators of attention: *stability and performance (productivity), concentration, switchability.*

Bourdon Test – Numerical Version

Description: The study was conducted using special forms which represented rows of digits arranged randomly. The subjects examined the forms line by line and were required to strike out / underline certain digits. For the purposes of the experiment, a form with digits was used which had 36 lines, with each line having 30 characters or a total of 1,080 characters for the entire form. The subjects were instructed to examine the form line by line and circle as many adjacent digits as possible amounting to 10, having a time of 5 minutes (Rimskaya & Rimskiy, 1995).

Bourdon Test – Version with Figures

Description: The test was conducted using special forms which represented rows of figures arranged randomly. The subjects examined the forms line by line and were required to strike out / underline certain figures. Each form contained 600 characters - 24 lines with 25 figures on each line (Rimskaya & Rimskiy, 1995). The forms were given to the subjects and they were required to circle all figures that corresponded to the preset instruction of the researcher. Verbal and visual instructions were given as to which figures exactly should be circled. The subjects had 4 minutes. The number of the correctly circled characters was calculated.

Entangled Lines Test by Platonov, K. K. - a method for assessing the concentration and stability of attention (Platonov, 1970).

Description: For the purposes of the test, a form with entangled lines was used. Each line started on the left side of the form (numbered box) and ended on the opposite side (blank box). The subjects were required to trace each line, starting with No. 1 and writing its number in the blank box where the line ended on the right. When line No. 1 was traced, No. 1 was written in the box on the right and so on with all other 25 lines until the end or until expiration of the time limit. The tracing of the lines had to be visual only, without using fingers, pencils, etc. The subjects had 7 minutes. The processing came down to calculating the number of the lines correctly traced.

Attention Span Test by Voronov, Yu. S. – a method for assessing the span of attention (Voronov, 2007).

Description: The attention span test was conducted using special maps that were displayed for a short time (less than a second). Each card consisted of 16 boxes with different images in several of them of simple figures such as a circle, triangle, square, etc. When conducting the test, a map with three figures was shown first, then with four and so on. Once the map was displayed, the subjects had to draw on a blank sheet, within 20 seconds, the figures they had seen. The correct positions of the figures in each task were evaluated and the total number of correct answers was calculated.

The Ten-Word Memory Test by Luria, Al. - a method for diagnosing memory (Ostrow, 2002). The three main memory processes were studied: *a/ memorization (fixation), b/ reproduction, and c/ retention.*

Description: The method included stimulus material developed by the experimenter and representing a set of 10 words that had to be popular and short. After the instruction, the subjects were read the set of 10 words and asked to reproduce them in random order. The experimenter read the pre-prepared list of words without rushing, in a clear and distinct manner, then waited for the answers of the subjects. When the subjects named a word that was not on the list, that word was not taken into account. In his form, the experimenter marked the words reproduced from the list. When the subjects said any of the words a second or third time, it was not marked again. For the purposes of our experiment, the results of one-time reading and reproducing the words from the test were taken into account due to the fact the subjects were orienteers, and it was important for them to remember various elements in quite a dynamic training and competition environm

Results

A variational analysis of the results of the tests for assessing the mental qualities at the beginning of the experiment can be made using the data in Table 3.

Table 3. Variability of the test results at the beginning of the experiment

	n	X min	Xmax	R	X	S	V
Bourdon Test – Numerical Version	30	43	93	50	63.6	12.78	20.09
Bourdon Test – Version with Figures	30	97	135	38	116.70	10.79	9.24
Entangled Lines Test by Platonov, K. K.	30	3	16	13	9.4	3.57	38.08
Attention Span Test by Voronov, Yu. S.	30	20	33	13	27.70	3.98	14.35
The Ten-Word Memory Test by Luria, Al.	30	5	9	4	7.43	1.10	14.86

In the first study, there was a slight variability of the results with respect to the Bourdon Test – Version with Figures - V = 9.24%, and average dispersion of the test results with respect to the Bourdon Test – Numerical Version - V = 20.09%, Attention Span Test by Voronov, Yu. S. - V = 14.35%, and the Ten-Word Memory Test by Luria, Alexander - V = 14.86%. A large dispersion of the results was seen in the Entangled Lines Test by Platonov, K. K. - V = 38.08% (Table 3).

The second study showed that the variability of the results did not decrease with respect to the Bourdon Test – Version with Figures - V = 10.05% and the Ten-Word Memory Test by Luria, Alexander - V = 15.93%. The dispersion in the Entangled Lines Test by Platonov, K. K. significantly decreased, but still remained large - V = 31.81%. The dispersion decreased in the Attention Span Test by Voronov, Yu. S.- V = 8.58% and the Bourdon Test – Numerical Version - V = 17.65% (Table 4).

Table 4. Variability of the test results at the end of the experiment

	n	X min	Xmax	R	X	S	V
Bourdon Test – Numerical Version	30	46	93	47	69.2	12.21	17.65
Bourdon Test – Version with Figures	30	99	137	38	120.33	12.10	10.05
Entangled Lines Test by Platonov, K. K.	30	5	17	12	10.9	3.47	31.81
Attention Span Test by Voronov, Yu. S.	30	23	33	10	29.60	2.54	8.58
The Ten-Word Memory Test by Luria, Al.	30	5	10	5	7.80	1.24	15.93

Figure 1 illustrates the variability of the results of the tests for assessing the mental qualities at the beginning and end of the experiment. It can be seen that it decreased in 3 of the 5 tests applied.

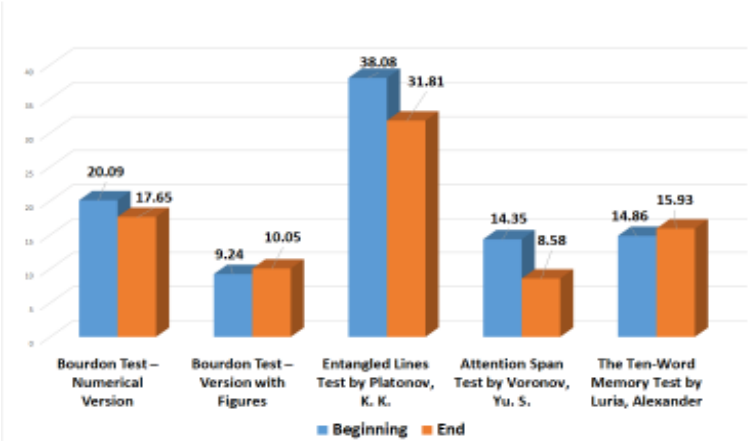

Figure 1. Variability of the test results at the beginning and at the end of the experiment

A comparative analysis of the results of the tests for assessing the mental qualities can be made using the data in Tables 5 and 6.

The assessment of the *Bourdon Test – Numerical Version* was based on the number of the correct answers given. The comparative analysis of the results of the experiment is presented in Table 5. The growth in the indicator analyzed is statistically significant - d = 5.60, supported by high statistical reliability, respectively *p* = 0.00. The subjects achieved 8.81% growth.

In the *Bourdon Test – Version with Figures*, the assessment was based on the number of the correct answers given. The test for statistical significance of the difference between the results at the beginning and end of the experiment was made using the Student's t-criterion for dependent samples. The empirical values of the criterions t = 2.51 and $p = 0.018$ show that the difference of 3.63 is statistically significant. The value of Cohen's coefficient d = 0.46 shows that there is a small difference, from a practical point of view, between the skills shown at the beginning and end of the experiment.

The comparative analysis of the results of the test *Entangled Lines Test by Platonov, K. K.* shows that the growth in the test analyzed was statistically significant at the end of the experiment, with d = 1.53 and $p = 0.04$.

The growth at the end of the experiment in the *Ten-Word Memory Test by Luria, Alexander* was not statistically significant as t_{emp}. was 1.55, and statistical reliability does not support such differences (Table 5). This means that, in relation to this test, the results shown were not significantly influenced by the systematic influence exerted through the orienteering tools. Memory, as a mental quality, was not influenced in this case by the systematic orienteering training.

The comparative analysis of the results of the *Attention Span Test by Voronov, Yu. S.* (Table 6) shows that the subjects had a statistically significant growth - d = 1.90, medium-sized from a practical point of view, with the statistical reliability supporting the difference being $p = 0.001$. In this case, the Z-criterion was used to prove hypotheses due to the As and Ex, found in this test, which exceeded the reference values.

Table 5. Results of the tests for determining the level of mental qualities

Tests	n	1st study		2nd study		Growth			Statistical significance	
		□□□	S_1	□□□	S_2	d	d%	Cohen's d	t_{emp}	p
Bourdon Test – Numerical Version	30	63.60	12.78	69.20	12.21	5.60	8.81	1.05	5.77	0.00
Bourdon Test – Version with Figures	30	116.70	10.79	120.33	12.10	3.63	3.11	0.46	2.51	0.018
Entangled Lines Test by Platonov, K. K.	30	9.37	3.57	10.90	3.47	1.53	16.37	0.73	3.97	0.04
The Ten-Word Memory Test by Luria, Al.	30	7.43	1.10	7.80	1.24	0.37	4.93	0.28	1.55	0.133

Note: p <0.05 the difference in the mean values is statistically significant.

Table 6. Results of the Attention Span Test by Voronov, Yu. S.

Test	n	1st study		2nd study		Growth			Statistical significance	
		□□□	S_1	□□□	S_2	d	d%	Cohen's d	Z	p
Attention Span Test by Voronov, Yu. S.	30	27.70	3.98	29.60	2.54	1.90	6.86	0.63	3.47*	0.001

Note: p <0.05 the difference in the mean values is statistically significant; The statistical significance of the differences in the comparisons was determined using the Z-criterion and its corresponding level of significance.

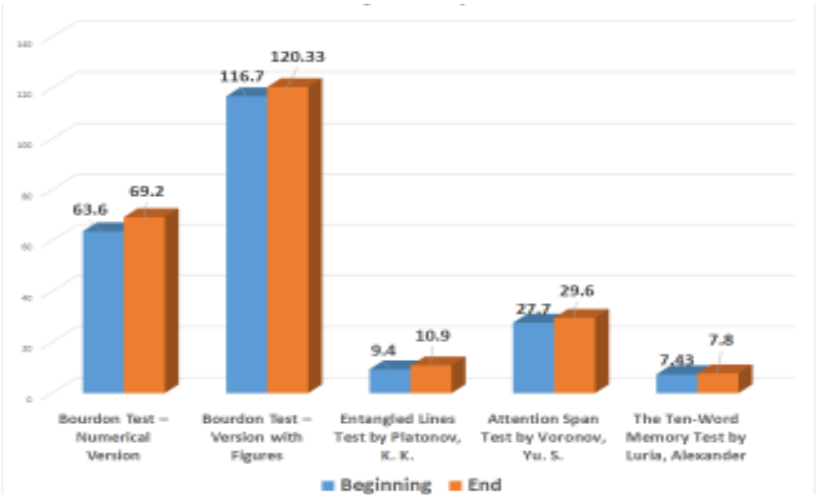

Figure 2. Mean values of the test results at the beginning and end of the experiment

Figure 2 illustrates the mean values of the results of the tests for assessing the mental qualities at the beginning and end of the experiment, from which it can be seen that there was growth in the mean values of each test.

When comparing the growth in % (Figure 3), it can be seen that the subjects' group recorded growth in all the tests for determining the levels of mental qualities.

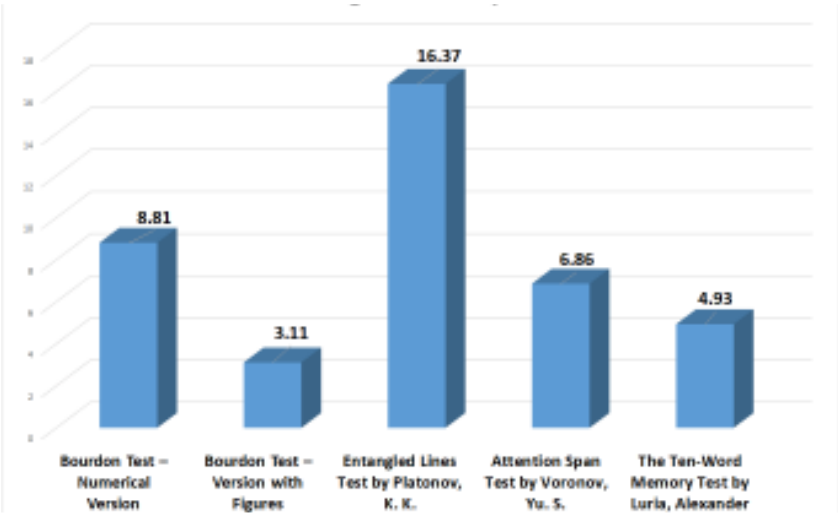

Figure 3. Growth d in % of the results of the tests for assessing mental qualities

Discussion

At the end of the experiment, the variability of the indicators studied decreased in the Bourdon Test – Numerical Version and the Attention Span Test by Voronov, Yu. S., while in the Bourdon Test – Version with Figures and the Ten-Word Memory Test by Luria, Alexander it did not change significantly and varied between low and medium one. The variability remained high in the Entangled Lines Test by Platonov, K. K., although at the end of the experiment it decreased by as much as 6.27%. This shows that the subjects showed different levels of mental qualities at both the beginning and end of the experiment.

At the end of the experiment, there was an improvement in the levels of all the mental qualities studied. Regarding the mean values in the Bourdon Test – Numerical Version, the mean value at the beginning of the experiment was X = 63.6, and at the end X = 69.20. In the Bourdon Test – Version with Figures, the mean value at the beginning was X = 116.70, and at the end X = 120.33.

In the Entangled Lines Test by Platonov, K. K., the mean value of X = 9.37 was X = 10.90 at the end. The Attention Span Test by Voronov, Yu. S. shows that at the beginning the mean value was X = 27.70, and at the end the mean value reached X = 29.60. In the Ten-Word Memory Test by Luria, Alexander, the mean value at the beginning of the experiment was X = 7.43, and at the end X = 7.80.

The subjects' group marked growth in all the tests for determining the levels of mental qualities. At the end of the experiment, this growth was statistically significant for all the indicators studied, except for the test for the memory functions, i.e. the Ten-Word Memory Test by Luria, Alexander.

The growth determined in the various tests varies from statistically unreliable in the Ten-Word Memory Test by Luria, Alexander, through a small one from a practical point of view in the Bourdon Test – Version with Figures, medium one in the Attention Span Test by Voronov, Yu. S., to a large one in the Entangled Lines Test by Platonov, K. K. and the Bourdon Test – Version with Figures.

Conclusions

At the end of the experiment, the variability of the studied indicators decreased in 3 of the 5 used tests, except Bourdon Test – Version with Figures and the Ten-Word Memory Test by Luria, Al. In our opinion, the lack of reduction of the variability of the results of these two tests at the end of the study means that the athletes do not equalize the level of these mental qualities, despite the applied training program.

The positive changes that occurred, statistically significant in 4 of the 5 tests conducted, were, in our opinion, due to the purposefully applied orienteering tools in the training program to improve the technical abilities of the orienteers, and the program greatly influenced their mental qualities except one.

To the greatest extent, the systematic use of orienteering tools influenced the concentration and stability of attention followed by span of attention. Our study showed tah memory, as a mental quality, was not influenced by the systematic orienteering training.

These conclusions would be useful in the future preparation of training programs by orienteering specialists in order to improve the mental qualities of athletes, which are a key factor in sports performance.

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