DE GRUYTER OPEN
Pol. J. Sport Tourism **2017**, *24, 102-105*
DOI: 10.1515/pjst-2017-0011

SELECTED COORDINATION MOTOR ABILITIES OF STUDENTS OF THE UNIVERSITY OF PHYSICAL EDUCATION DURING SURVIVAL TRAINING

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Abstract

Introduction. Taking up emergency actions when fighting various types of natural disasters requires appropriate psychophysical preparation. Thanks to the development of technique, coordination motor abilities have gained greater importance than physical strength and endurance in such activities. The purpose of the present work was to assess the impact of 36 hours of survival activities and sleep deprivation on selected coordination motor abilities in students of the University of Physical Education. ***Material and methods.*** The study involved 12 male students of the University of Physical Education in Warsaw, specialising in "Physical Education in Uniformed Services". The age of the participants was 21.0 ± 0.74 years, their body height was 179.5 ± 5.6 cm, and their body mass was 74.6 ± 8.0 kg. The assessment was performed based on the following coordination motor ability tests: a test measuring the differentiation of the use of forearm muscle strength, a running motor adjustment test, and a measurement of divided attention. A test involving shooting from a pneumatic gun and a measurement of the maximal force of the forearm were also carried out. Tests and trials were conducted before training (P1), after 24 hours of training (P2), after completing the training – that is after 36 hours of training (P3), and after 12 hours of rest (P4). During the training, the participants completed 12 km on foot, paddled for approximately 6 hours, rowed kayaks for about 4 hours, and performed survival tasks. ***Results.*** The analysis of the results of the study of maximal force and the ability to differentiate forearm muscle strength showed that the forearm muscle strength remained at the same level during the entire training. The ability to differentiate forearm muscle strength deteriorated after night training. There were no statistically significant differences in the results of the running motor adjustment tests and in shooting performance between individual measurements. ***Conclusions.*** Participation in long-term survival training with very low intensity, combined with sleep deprivation, caused a temporary deterioration in the ability to differentiate forearm muscle strength. This may indicate that people involved in rescue operations during which the psychophysical load is small will be able to perform tasks correctly for a long time.

Key words: survival, sleep deprivation, coordination motor abilities, University of Physical Education students

Introduction

Many rescue operations require long hours of activity with limited hours of sleep. This causes an increase in fatigue and affects the quality of the tasks performed. Actions undertaken by the fire brigade, emergency medical services, police, mountain rescue services, and crisis management groups may serve as examples. These activities require efforts diversified in terms of movement structure and performance [1].

Due to the development of civilisation and the increasing use of technical equipment and machinery, the importance of physical strength and physical endurance as factors guaranteeing the good performance of a job/mission has diminished. Handling specialised equipment requires, among others, precise action, concentration of attention, the ability to adjust movements, the ability to differentiate movements kinesthetically, the ability to combine movements, spatial orientation skills, fast reaction ability, and balance maintaining ability [2].

The number of works in the literature in which the subject is dealt with is scarce, and most often they concern the actions of soldiers [3, 4, 5, 6, 7, 8]. Several studies show the results of research conducted during survival training involving civilian participation. These civilians mostly carried out tasks related to survival training; the training was performed in a variety of atmospheric conditions, with varying degrees of psychophysical load [9, 10]. Interesting research in this field was conducted by a group of researchers based in Germany, that is Leyk et al. [11]. They assessed the changes in the degree of the forearm muscle differentiation skills in paramedics who were to perform an injection after transporting the injured on a stretcher. This research was one of the first to address practical coordination motor abilities (CMA). It has been recognised that CMA is playing an increasingly important role in the ability to perform tasks efficiently in everyday life and in all utilitarian activities. Utilitarian activities include rescue and crisis activities, which typically last for several or several dozen hours. The above prompted us to undertake research on the subject.

The aim of the study was to assess the effect of 36 hours of survival activities and sleep deprivation on the selected coordination motor abilities of students of the University of Physical Education in Warsaw.

Material and methods

The research included 12 male students of the University of Physical Education specialising in "Physical Education in Uniformed Services". The age of the subjects was 21.0 ± 0.74 years, their body height was 179.5 ± 5.6 cm, and their body mass was 74.6 ± 8.0 kg.

The study took place in summer. The air temperature ranged from 8°C at night to 30°C during the day. During the training, the participants walked about 12 km on foot, rowed boats (about 6 hours in total), and did kayaking (about 4 hours). The whole training lasted 36 hours and was generally characterised by low intensity.

Coordination motor ability tests and trials were performed in the following order:

- divided attention test;
- shooting test (using a pneumatic gun);
- measurement of maximal force and ability to differentiate the use of forearm muscle strength;
- motor adjustment ability test.

The sequence applied followed the rule of incremental physical exercise in every subsequent test/trial. In this way, the impact of physical effort exerted in the preceding test/trial on the result of the test/trial was eliminated.

Description of tests/trials

The differentiation of forearm muscle strength was measured using a PZA/3359 dynamometer (Fabrication Enterprises Inc., USA). The tested person, standing with the arms positioned along the torso, was holding a dynamometer in their hand. In the first repetition, they compressed it with maximum force; in the second, they did so with a force equal to 50% of the maximum force; and in the third, they were asked to correct the result from the previous repetition so that it was close to 50% of the maximum force (or to repeat the compression when they had obtained the required 50%). Such a cycle was repeated 5 times, and the final results were the mean difference between the required value and the value obtained in the first measurement as well as the mean difference obtained during the repetition [12]. The tested person was unable to observe the scale of the dynamometer. The results were reported to them by the person responsible for carrying out the test. Individual repetitions were performed after breaks lasting several seconds.

The reliability coefficient for differentiating forearm muscle force for 50% of maximal force is r = 0.81, and for the differentiation of forearm muscle force in the repetition for 50% of maximal force, it equals r = 0.80 [12].

The ability of motor adjustment was measured in the following runs: 15-m run, 3 × 5-m shuttle run, 15-m slalom run, and 15-m run on all fours [12, 13]. The reliability coefficients for each run were, respectively:

- difference in flat and slalom run (15 m), r = 0.74;
- difference in flat run (15 m) and 3 × 5-m shuttle run, r = 0.82;
- difference in flat run and run on all fours (15 m), r = 0.75 [12].

The measurement of divided attention was performed as follows [14]. The laptop screen (15.6") displayed two types of signals:

- The first type of signals was figures in the centre of the screen: a square, a circle, and a cross. If they were displayed in the right order (i.e. the square, the circle, and then the cross), the person had to press "+" with the thumb of the right hand (or the "Q" key with the thumb of the left hand) when the cross appeared. Every other sequence of figures was incorrect.
- The second type of signals was small squares displayed in the corners of the laptop screen. If one of the corners of the screen displayed four small squares at the same time, the person had to press "-" with the forefinger of the right hand (or the "1" key with the forefinger of the left hand). The better the result was, the more valid signals were observed and "received", while the number of errors (missed signals or incorrect key presses) negatively impacted the test result. At the end of the test, the following results were presented: the number of signals received in the centre and in the corners of the screen, the number of errors (unnoticed signals and incorrect key presses), and indicators showing the ratio of the number of signals received to the number of errors within the range from 0 to 100. The tested person sat in front of the monitor, put their fingers on the keyboard, and then the person who carried out the test initiated it by pressing the button. The test lasted about 90 seconds (it ended automatically). After the test, the attention indicator was calculated. The reliability coefficient for the aforementioned test is r = 0.92 [12].

As far as the shooting test is concerned, each subject shot the ZORAKI HP 01 LIGHT Pistol at sports discs from a distance of 10 m. The tested person made 5 shots which were evaluated. Before the test, the subjects were familiarised with safety and aiming procedures. The subjects were also given the opportunity to make a few test shots.

Tests and trials were conducted immediately before training (P1), after 24 hours of training (P2), after completing the training – that is after 36 hours of training (P3), and after 12 hours of rest (P4).

Statistical calculations were performed using Statistica 6.0. The Kolmogorov-Smirnov test was used to evaluate normality of distribution, and Scheffe's post-hoc test and ANOVA one-way analysis of variance were also performed. Mean results were used. Significance was set at $p < 0.05$.

Results

During the entire training, the maximum force of the forearm muscles remained at a similar level. It was reduced only after about 12 hours of rest (P4 vs. P1, P2, and P3). A similar relationship was observed for 50% of maximal force. However, the ability to differentiate forearm muscle strength deteriorated during the measurement after a night training session (P2, absolute values). During the following day training, this ability improved, as reflected in the third measurement (P3) (Tab. 1).

There were no statistically significant differences in the results of the running motor adjustment test. The indexes of the running motor adjustment test in subsequent measurements were 5.29 ± 0.98 s, 5.54 ± 0.97 s, 5.02 ± 1.19 s, and 5.32 ± 0.92 s, respectively.

Moreover, there were no statistically significant differences in the shooting discipline (39.7 ± 12.6 points, 43.8 ± 16.8 points, 43.4 ± 16.7 points, and 39.1 ± 14.8 points, respectively). Those who were shooting were able to achieve a maximum of 50 points. The results obtained in individual trials ranged from 78.2% to 87.6% of the maximum achievable result.

Finally, there were no differences in the results for divided attention during the training (P1-P3). Scores for divided attention ranged from 47.9% to 57.7% of the maximum score. However, during the study, an improvement of divided attention was observed after 12 hours of rest (P1, P2, and P3 vs. P4) (Tab. 2).

Table 1. Results for ability to differentiate forearm muscle strength [in N] (± SD)

Parameter	P1	P2	P3	P4
Max	402 ± 58*	404 ± 163	403 ± 66	379 ± 65
50% max	230 ± 42^	229 ± 162	211 ± 42	187 ± 32
Corr 50%	225 ± 36	207 ± 144	199 ± 32	184 ± 28
Abs. error 50%	15 ± 14	27 ± 13#	14 ± 14	18 ± 12
Abs. corr	10 ± 12	12 ± 9	10 ± 8	12 ± 9
Error 50% [%]	13 ± 15	14 ± 7	7 ± 6	9 ± 5
Error corr [%]	10 ± 12	6 ± 5	5 ± 4	6 ± 4

* = $p < 0.05$ (P1-P3 vs. P4); # = $p < 0.05$ (P2 vs. P1 and P3); ^ = $p < 0.05$ (P1 vs. P4).

Table 2. Results for divided attention (Attention Indicator) (± SD)

Parameter	P1	P2	P3	P4
Attention indicator [%]	50.83 ± 12.40	47.92 ± 16.25	57.75 ± 13.54	65.67 ± 18.20*

* = $p < 0.05$ (P1 and P2 vs. P4).

Discussion

Nowadays, coordination motor abilities are becoming increasingly important. Their importance was first reflected in the research into these abilities performed in the domain of competitive sports, the results of which have been presented in many publications and during cyclic conferences [15, 16, 17]. For several years now, researchers have been interested in changes which take place in CMA under the influence of more utilitarian and military forms of human activity. This interest is evidenced by scientific studies, among others those of Mikulski, Ziemba, Dąbrowski, and Tomczak [6, 7, 9, 10].

In 2010, research was conducted on the change in CMA among students of the University of Physical Education in Warsaw (AWF) who specialised in "Physical Education in Uniformed Services" and underwent winter survival training [18]. There were no statistically significant differences in psychomotor tests (divided attention, visual-motor coordination, and multiple response times), as was the case in the research study presented in this article. Thus, this is another study confirming that increased concentration lasting one and a half minutes (duration of psychomotor tests) does not deteriorate during long-term moderate physical exertion. Similar results were also obtained during psychomotor tests conducted among soldiers [6, 7]. Another similar feature of the results obtained regarded the level of the ability to differentiate the strength of the forearm muscles: the results in the current study were on the level of the results of the AWF students enrolled in the "Physical Education in Uniformed Services" specialisation measured during winter survival training. Significant differences were also found in the 50% correction test (Error Corr) [18]. It was observed that the deterioration in the ability to differentiate the use of forearm muscle strength occurred after the night training. In the next (daytime) training, there was an improvement in the results. This may have been due to the negative influence of night conditions (biological rhythm) on the ability to differentiate the strength of the forearm muscles.

The fundamental difference between the results obtained in summer and winter is that the deterioration of the index of running motor adjustment was observed after winter night training [18]. There was no such change during summer training. This allows us to suppose that winter conditions affect the deterioration of some CMA to a greater extent than the performance of similar forms of activities and tasks in summer.

Another aim of the study was to determine the effect of long-term survival training on shooting ability. Because of the very scarce number of studies on this subject, we can only make a comparison with the results of the research presented by Dąbrowski et al., where during summer survival training attended by AWF students, shooting using a sports rifle was carried out at the beginning and after the end of the training [9]. Unlike that study, ours did not find any changes in the shooting performance of the subjects. The differences in the the results of the two studies may be due to the type of weapon/gun used to test the ability. In the study by Dąbrowski et al., a rifle was used, and shooting was performed from a lying position, while in our study, shooting was performed from a standing position using a pneumatic gun.

Atmospheric conditions also have an impact on study results, that is on the changes in CMA observed. It was reported in a previous work that under severe weather conditions (in winter), the results of the running motor adjustment test deteriorated [18]. However, when it comes to that particular study, it is difficult to unambiguously determine to what extent atmospheric conditions affected the deterioration of the results and to what extent it was due to the physical and psychological burden associated with sleep deprivation.

Based on the analysis of the results of our study, it can be stated that long-term efforts of low intensity do not significantly affect CMA (except for the ability to differentiate forearm muscle strength). Probably, during a variety of rescue or natural disaster-related activities, long-term activity would not cause a rapid deterioration in the ability to handle precision equipment. It should be remembered, however, that the subjects were not acting in a situation of danger and stress. Students carried out the activities during survival training, which was included elements of the activities performed by various rescue services (e.g. paddling, canoeing, and flood operations). The training was conducted without a significant psychological burden. However, according to the Yerkes-Dodson law, psychological stress can affect performance as follows [19]. First of all, as physical stimulation increases, it becomes easier to perform a given activity, but only to a certain degree; later on, there is only a decrease in efficiency, which may lead – in extreme situations – to complete disintegration of behaviour. Furthermore, for difficult tasks, the optimum level of stimulation is lower than for easy tasks. According to this law, it can be assumed that during the performance of long-lasting and diverse rescue missions which will not require significant physical effort, the tasks should be performed correctly. It is difficult to clearly determine the moment up to which such actions can be expected to be correct and the moment when their performance will become deficient. More research is needed to clarify this issue.

There is a wide range of possible practical applications of the research results presented. This is because relatively recently in Poland there has been an increase in the interest in people who work in pro-defence organisations and who may become potential participants in joint action with the military to combat natural disasters. An example of such collaboration would be the actions carried out in 2016, when civilians from several prodefence organisations took part in the "ANAKONDA" military exercise together with the army. This was the first military exercise which pro-defence organisations took part in. It is worth adding that this was a military exercise involving NATO troops, which undoubtedly enhances the importance of the project. By conducting CMA studies, we can make comparisons between people of all ages, with varying military experience, in order to see the difference in physical fitness between soldiers and civilians and to see to what extent they can work together as soldiers and civilian partners. Furthermore, it is possible to specify when individuals with a lower level of psychophysical fitness should be sent to rest.

Conclusions

Long-term survival training with very low intensity, combined with sleep deprivation, carried out in the summer only resulted in the deterioration of the ability to differentiate the use of forearm muscle strength after night training. At the later stages of training, no differences in the ability to differentiate the use of forearm muscle strength were found. This allows us to assume that people involved in rescue operations during which the psychophysical burden is low should be able to carry out tasks at an optimum level for long periods of time.

Acknowledgements

The research was carried out under research project DS. 202 “The effect of 36-hour survival training and sleep deprivation on changes in selected biochemical indicators and coordination motor skills” implemented by the Józef Piłsudski University of Physical Education in Warsaw, Faculty of Physical Education and Sport in Biała Podlaska, which was financed by the Ministry of Science and Higher Education.

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Submitted: August 2, 2016
Accepted: May 4, 2017