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Original Article

Simulation exercises efficiency in skeet shooters' technical training

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Abstract:
The article contains the analysis of the technical training methodology which was developed for skeet shooters using simulation exercises at the stage of previous basic preparation during the training process.
Purpose of the research is to determine the effectiveness of using simulation exercises for the technical training of skeet shooters at the stage of preliminary basic training. The special device to perform the simulation exercise consists of a control unit and two movable lasers to simulate conditions and perceptions of the target closer to reality. It was studied the kinematic parameters of simulation exercises performed at a skeet using the special device that simulates competitive exercise. It was established there was a need to determine the distance to the aiming point of the target center, its horizontal and vertical components, and the corresponding relative and absolute velocity. The article presents the content of improvement methods of athletes' technical training, dynamics of shooters' physical fitness and their sensorimotor reactions during the pedagogical experiment. The teaching experiment covered the shooters during the previous basic training in the preparatory period for the macro-cycle consisted of sixteen macro-cycles. The technique modification consisted in using the special device to perform simulation exercises and proper distribution of training loads. Distribution of the total volume of training loads while technical training was: simulation exercises 53−56%; firing with cartridges 44−47 %. That is, the proportion of simulation exercises prevailed in the shooters' training at the stage of preliminary basic training. Thus, the results of pedagogical experiment demonstrate the superiority and efficiency of skeet shooters' technical training improvement methodology using simulation exercises. These results confirm and extend the scientific views on the problem of skeet shooters' technical training improving using simulation exercises.
Key words: shooting sport, skeet, technical training, simulation exercises.

Introduction

The current stage of the development of the Olympic shooting events is characterized by a high density of sporting results in the world arena, which results in the increased requirements for the technical, tactical, and psychological training of athletes (Naglak, 1991; Yuriy, 2011; Briskin, 2014; Sergiy, 2017). Shotgun shooting is accompanied by a change in the competition rules regarding the range of targets, the sequence of firing in the qualifying series, the conditions for the final series and the definition of the winners, which complicates a shooter's exercises performance (Gulbinskiene, 2006; Briskin, 2013; Ambartsumov, 2014; Hrybovskyy R., 2014, 2016). Therefore, it is important to improve the various sides of the shooters' training, in particular, the technical, which plays a leading role in the skeet shooters' multi-year improvement (Kozyar, 2008; Hrybovskyy V., 2013; Karankovs'kyy, 2013; Korostyl'ova, 2009, 2012).

A high and stable result in shooting can only be achieved through a properly designed training process, which will be optimized through scientifically validated content and structure of exercises, as well as the order and rhythm of their execution (Marochkyn, 1995; Lopat'yev, 2008; Pyatkov, 2010). Shooting technique improvement can be achieved through both increasing the number of shots and using simulation exercises. It is expedient to perform them by using simulators that imitate the conditions of competitive activity, which should ensure the effective performance of tasks related to the exercises technique improvement (Satanovs'kyy, 1999; Peljha, 2014).

A considerable number of scientific works are devoted to the use of technical equipment and related models to improve the training of athletes in shooting (Zhylyna, 1986; Vahner, 2012). However, in the skeet shooters' training process, the use of technical devices is insufficient. There are insufficiently studied problems related to the possibility of further improving the interaction of the elements of the "shooter – gun - target" system, which most skilled experts in shooting sport consider the main reserve of improving the training and competitive activities of an athlete (Marochkyn, 1995; Lopat'yev, 2001; Pavlyuk, 2004;).

Thus, the actual scientific and practical task is aimed at finding ways to improve the technical training of skeet shooters with the use of simulation exercises.

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Purpose of the research is to determine the effectiveness of using simulation exercises for the technical training of skeet shooters at the stage of preliminary basic training.

Materials and Methods.

Theoretical analysis and generalization of library scientific resources allowed to study some modern problems of technical training of athletes in shooting sport; the documentary method enabled us to analyze the documents regulating the activities of the organizations in the field of physical education and sports; the expert evaluation method is used to study the opinion of qualified specialists regarding the use of simulation exercises and technical devices in the training process; instrumental methods are used to perform simulation exercises and fix their indices; pedagogical methods (observation, testing, experiment) is used for the analysis of training and competitive activity of shooters with different levels of athletic skills, detection of physical preparedness and time of simple motor-visual reaction of shooters, and determination of the effectiveness of techniques for improving the skeet shooters' technical training using simulation exercises; the method of modeling is used in determining the kinematic parameters of simulation exercises with the use of a special device; the methods of mathematical statistics made it possible to study and interpret the empirical results of the research.

Organization. At the first stage (October 2013 - September 2014), the data of scientific and methodical literature and the Internet information data concerning the study of modern problems of skeet shooters' technical training are analyzed and summarized; the main directions for further improvement of the interaction elements of the "shooter – gun - target" system are revealed; the analysis of organizational, normative, and regulation documents was done; the purpose, task, object and subject of the research were defined; the methods, corresponding to the tasks, and the study plan were developed.

At the second stage (October 2014 - September 2015), the analysis of scientific and methodical literature data and the Internet information data was supplemented and analyzed; the pedagogical observation of the skeet shooters training and their competitive activity was conducted; the expert evaluation was carried out were 10 people were involved; the special device was improved; the kinematic parameters of simulation exercises performed on a skeet with the use of the special device were determined; the display of motor and sensor reaction of skeet shooters of different age groups and sports qualification (n = 42) was estimated; the way of the skeet shooters technical training improvement at the stage of preliminary basic training with the use of simulation exercises was substantiated.

At the third stage (October 2015 - December 2016), the technique of skeet shooters' technical training at the stage of preliminary basic training was improved; the indices of physical preparedness and skeet shooters' motor and sensor reaction at the stage of preliminary basic training were studied; the pedagogical experiment was conducted to evaluate its effectiveness. Twenty two athletes (stage of preliminary basic training) of Lviv Olympic Reserve Junior Special School "Signal" and Complex Junior Sport School "Kolos", who specialize in skeet shooting, were involved. The analysis and generalization of the obtained results were carried out; the main results of scientific researches were introduced in practical activity.

Results

It was found out that some works are devoted to the scientific substantiation of the skeet shooters' training specifics. It was revealed that all coaches use simulation exercises in the training process, irrespective of the shooter's sporting skill level. According to experts, simulation exercises should prevail in groups of initial and preliminary basic training. In particular, in the groups of the previous basic training, the ratio of the implementation of general, special, and simulation exercises is respectively 27.0, 24.0, and 49.0%. The coefficient of concordance was W = 0.910 and showed positive consensus of the experts.

Experts believe that most of the time (61.0%) for simulation exercises should be given during the preparatory period. During the competitive period, the volume of simulation exercises should be significantly lower (24.0%). None of the experts reported about the use of special devices and simulators during the training sessions at the skeet (W = 0.926, which showed positive consensus among experts). At the same time, experts did not deny the use of technical equipment at training sessions.

The conducted expert evaluation necessitates the introduction of a special device for simulation exercises in the training process, therefore a comprehensive device for skeet shooters training was developed (patent number 112060 issued in Ukraine). For this purpose, a special device was modified to perform simulation exercises on skeet. It consists of a control unit and two modules, which have got moving lasers, which allows you to simulate the target perception conditions that are close to the competition. In addition, the modules are located on tripods, which allow you to regulate the motion of lasers not only in the horizontal, but also in the vertical plane. This makes it possible, by setting the laser at a certain angle to the plane of the conditional target, to more accurately simulate the initial speed of the target takeoff with its subsequent slowing down and the target flight trajectory.

It was determined the kinematic parameters of simulation exercises performed on skeet using a special device simulating a competitive exercise. For this purpose, highly skilled male athletes were involved. A sportsman, during the "blank shot" training session, is in a state of preparedness and gives an order to release the

target, and when he sees an imaginary target to be hit which is projected onto the screen (wall) in the form of a red light dot (T), he shoulders arms and performs aiming which also is fixed in the form of a green light dot (G), aims and presses the trigger. The image on the screen is recorded by the camcorder. The whole monitoring is carried out by the methods of video-computer analysis. Film frequency is f = 25 Hz, time interval between adjacent positions is $\Delta t = 0.04$ s.

When processing the results of simulation training, the reverse direction of the time keeping, that is, from the moment of the shot to the moment of "shoulder arms" position, is taken. The corresponding moments of time are indicated by the numbers i = 0, 1, 2, and 3. The accuracy of the dot coordinates on the desktop of the Paint program is determined by the scale of the image (30 cm by 198 pixels): $\mu = 0.15$ cm / pel. Consequently, the error of determining the aiming point coordinates and the target center is within ± 0.75 mm.

In order to calculate the components of the aiming point movement velocity vector and the target center, we used a numerical differentiation method with approximating the trajectory of motion on a quadratic parabola. A graphic representation of the imaginary target movement velocity and a skeet shooter's performance of "shoulder arms" are shown on Figure 1.

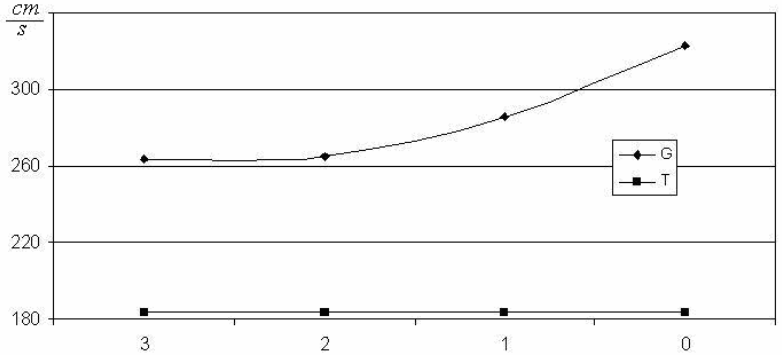

Fig. 1. The aiming point movement velocity (G) and the target center (T)

It is established that it is necessary to determine the distance of the aiming point to the target center, its horizontal and vertical components, as well as the relative and absolute values of velocities. In particular, when performing simulation exercises, the velocity of the imaginary target movement is identical in all four positions. Absolute value of the aiming point movement velocity during the shouldering arms at the beginning of the movement slightly increases - from 881.7 to 887.1 c.u./s. At the moment of approaching of a conditional target and its defeat, this value increases to 1080,0 c.u./s. Horizontally, the aiming point movement velocity all the time smoothly increases from 853.9 to 1061.1 c.u./s. Vertically, there is an oscillatory motion, the magnitude of the corresponding projection of velocity in the four specified positions (0, 1, 2, 3, which were defined during the study) twice changes the sign: –219.8, 119.3, 125.6 and –200.9 c.u./s.

The obtained kinematic parameters of simulation exercises performance are a model of a separate training shot; they can be considered as a criterion for the shooter's technical actions correction during the training process.

It was found that skeet shooting has its own specifics. Thus, the moment of the appearance of a target is expected, but it is not known in advance and, according to the rules of the competition, ranges from zero to three seconds after the order given by a shooter. So, when performing the shouldering arms (an important technical element), the shooter must keep the attention of the optimal intensity level until the target appears. In connection with this, there was a need for scientific study of time indices of simple motor-visual reaction and determination of their informational content to assess the shooter's skill.

The study involved skeet shooters of different age groups and sports qualifications. The standard results distribution of the testing the time of the shooter's simple motor-visual reaction was estimated by the Shapiro-Wilk method. Out of the total number of results, those that went beyond the rules of 3SD were deleted. The homogeneity of the test results was estimated by the magnitude of the variation coefficient. Two-factor dispersion analysis was performed to determine the dispersion value.

It was established that the indices of the average arithmetic time of the simple motor-visual reaction are in the same range among the shooters of both different sports qualifications and the age group, and range from 257.1 to 288.7 m/s.

At the same time, it was found that the value of the variation coefficient for the time of simple motor-visual reaction in ten attempts of highly skilled adult athletes MSIC (Master of Sport of International Class), MS (Master of Sport) (Group I) was in the range of 7.5−29.2%; the adult athletes of the CMS (Candidate Master of Sport) and I category (Group II) was in the range of 8.0−38.6%, the juniors of the CMS-II category (group III) was 12.5−36.2%. That is, the results of all ten attempts of simple motor-visual reaction time among highly

skilled male athletes are more stable, whereas among skilled adult male and junior athletes, a large range of indices fluctuation between test attempts is revealed, which will be displayed while the perception of a target in the process of performing a complex technical element – "shoulder arms".

Thus, the need to develop an identical reaction to a target takeoff is established, which involves observing a certain range of time from the moment of the target takeoff and the shouldering arms.

According to the magnitude of the interclass correlation coefficient (*ICC* = 0,748), the reliability of the test was assessed as satisfactory. Using the Spearman correlation coefficient of rank, a moderate statistical relationship was found between the time of the simple motor-visual reaction and the sporting results in the competitive activity ($r = -0.354$, $p < 0.05$).

The modification of the technique for the skeet shooters' technical training improvement consisted in the use of a special device for performing simulation exercises and the corresponding distribution of the training load amount. The distribution of the total amount of training load, designed for technical training, was the following: for simulation exercises 53−56%; for firing with cartridges − 44−47%. That is, the proportion of simulation exercises prevailed in the shooters' training at the stage of preliminary basic training. The use of a special device made it possible to carry out a significant number of imitation shots (without guns) and to avoid kickback when firing 12 gauge smoothbore guns, which is essential for shooters at the stage of preliminary basic training.

The pedagogical experiment covered the preparatory period of a macro-cycle during sixteen macro-cycles. To hold it the shooters were grouped by 11 people in the experimental and control groups. The distribution of athletes to the groups was conducted randomly and statistically the same performance of these groups was provided at the beginning of the experiment ($p > 0.05$).

The basis for the evidentiary part of the effectiveness of the modified technique was the dynamics of the firing results, sporting results, changes in shooters' fitness indices, and time of motor-visual reaction.

Thus, during the pedagogical experiment, three control firings were performed, each of which consisted of series of fifteen shots − a K-1k exercise. The character of the dynamics of changes in the results of control firings was investigated by linear regression equations. The reliability of the regression coefficients of the control firing results is determined by the value of Student *t*-criterion for the number of degrees of freedom equal to the total number of firing minus 2 ($df = 1$).

Friedman ANOVA was applied to study the results of control firings separately from the control and experimental groups. The Wilcoxon method was used to estimate the magnitude of the difference in the performance between control firings. The statistical significance of the difference in the results of control firings between the experimental and control groups was determined by the Mann-Whitney method.

It was found that the most statistically significant was the growth of the results of the shooters of the experimental group in the third cycle of training relatively to the first cycle. The difference in the results of the shooters of the control group between the firing was not statistically significant (Table 1).

According to the Mann-Whitney method, in the results of all three firings, a statistically significant difference was found between the experimental and control groups: the first control firings − $U = 15.5$, $Z_{adj1} = 3.12$ ($p = 0.0018$), the second firing − $U = 6.0$, $Z_{adj2} = 3.72$ ($p = 0.0002$), and the third firing − $U = 12.5$, $Z_{adj3} = 3.33$ ($p = 0.0009$).

Table 1. Statistics of the results of the athletes' performances in competitions

Parameters	Experimental group (n = 10)			Control group (n = 11)				
	Stage		Δ_E	Stage		Δ_C	Δ_{E1-C1}	Δ_{E2-C2}
	1	2		1	2			
M	9.6	12.6	3.0 (31.3%)	9.0	9.2	0.2 (2.0%)	0.6 (6.5%)	3.4 (37.2%)
SD	1.7	2.6		1.3	2.0			
SW-W	0.875	0.788		0.908	0.903			
p(SW-W)	0.115	0.011		0.231	0.201			
Z		2.67			0.56		0.775	2.676
p(Z)		0.008			0.575		0.439	0.007

Notes: 1 - the beginning of the experiment; 2 - the end of the experiment.

Thus, it was found that during the entire period of training with the use of modified techniques, the number of accurate shots increased by 13.3% (experimental group). During this time, shooters who trained under the traditional method did not improve their results (control group).

However, the control over the effectiveness of the sports technology development should be carried out through the analysis of sporting results demonstrated by the shooters in the competitive activities. In this regard,

an analysis of the best results of the shooters' performances (the largest number of hit targets) was conducted for both the control and experimental groups performing the K-1 exercise.

To compare the results of the shooters of the experimental group with the results of the shooters of the control group (independent groups) Mann-Whitney U-criterion was used. To compare the results of the shooters of each group in two competitions the Wilcoxon W-criterion was used (Sokolowski, 2009).

There was a statistically significant increase (31.3%, $p = 0.008$) of the competition results of shooters of the experimental group after performing simulation exercises using the special device. There was also an improvement in the results of competitions among athletes in the control group, but relatively insignificant (2.0%, $p = 0.575$).

It should be noted that the results of the competitive activities in the K-1k exercise at the end of the pedagogical experiment in the experimental group were 90 % of the sportsmen of the category II and 10 % of the category III, while in the control group the results of the competitions are consistent with the category II among 64% of shooters, and 36% of shooters demonstrated a competitive result at the level of the category III. Also, the average result of the performances in the competitive activity of the shooters in the experimental group was higher compared with the performance of the shooters in the control group.

During the pedagogical experiment, the dynamics of the results of physical fitness of sportsmen was also studied. The probable differences between the experimental and control groups were determined by the following factors: press ups for 30 s ($p = 0.030$), “ten eights” test ($p < 0.001$) and throwing the tennis ball into the target ($p = 0.017$). According to the indices of press ups, there is no statistically significant difference ($p = 0.316$).

In addition, during the pedagogical experiment, it was important and expedient to observe the stability of the shooters' perception of a target. After all, according to scientists (Peljha, 2004; Pyatkov, 2010; O’Donoghue, 2010; Hrybovskyy R., 2015, 2016), the very observance of the same performance of all movement elements allows to improve the technique of firing exercises. Thus, it was found that according to the magnitude of standard deviation at the beginning of the pedagogical experiment, the stability of the time magnitude of the simple motor-visual reaction among the shooters of both the experimental and control groups was statistically the same ($\Delta = 2.9$ ms; $p = 0.190$).

At the end of the experiment (by the value of standard deviation), a statistically significant difference was found between the variation of the results of the time of simple motor-visual reaction of the experimental and control group shooters ($\Delta = 11.3$ ms; $p = 0.002$) indicating its stabilization during the experiment.

Thus, the results of the conducted pedagogical experiment indicate the superiority and effectiveness of the technique of the skeet shooters’ technical training improvement using simulation exercises on the special device. In addition, the use of the special device for performing simulation exercises creates prerequisites for stabilizing the performance of a complex technical element on skeet – shoulder arms.

Discussion

The synthesis of scientific data indicates the need to find ways to improve the technical training of skeet shooters and the need to improve the interaction of elements of the "shooter – gun - target" system. Of particular importance is the stage of preliminary basic training, while the developing of basic firing techniques, which is advisable to conduct not only by increasing the number of shots but also using simulation exercises.

The conducted expert survey confirmed the use of simulation exercises with a rifle at training sessions. According to the experts, the most significant use of simulation exercises is performed by the shooters in the groups of initial and preliminary basic training, where these exercises should dominate. In particular, in the groups of previous basic training, the ratio of the special, general, and simulation exercises is respectively 27.0; 24.0 and 49.0% ($W = 0.910$). Experts also believe that most of the time (61.0%) of simulation exercises performance should be given in the preparatory period. At the same time, experts stressed that all shooters use simulation exercises training, regardless of the athletic skill level.

The expediency of performing simulation exercises in the "blank shot" training of shooters with the use of technical means was found. A special device for simulation exercises was developed to solve actual problems in the system of skeet shooters’ training. The kinematic parameters of simulation exercises performed on skeet with the use of the special device are determined. It is established that it is necessary to determine the distance of the aiming point to the target center, its horizontal and vertical components, as well as the relative and absolute values of velocities. Thus, the absolute value of the aiming point movement velocity during the performance of shoulder arms is virtually unchanged; vertically there is an oscillatory motion and the value of the velocity corresponding projection changes its sign twice.

The effectiveness of the proposed method of skeet shooters technical training improvement at the stage of preliminary basic training using simulation exercises with the special device based on the taking into account the results of the firing and the sporting result in the competitive activity is proved by the results of the pedagogical experiment.

Summarizing the study, it is possible to distinguish three data groups. The scientific propositions on the skeet shooters’ technical training should be further developed (Gulbinskiene, 2004; Karankovs'kyy, 2004;

Ambartsumov, 2014). Scientific information on the skeet shooters' motor-sensor reaction has been improved; information on the significance of observing the same pace of shooting while training of sportsmen has been taken into consideration; the need to take into account the indices of shooters' physical fitness has been proved; information on the effectiveness of the use of simulators in shooting has been considered (Satanovs'kyy, 1999; Pavlyuk, 2004; Kozyar, 2008; Korostyl'ova, 2012; Hrybovskyy, 2014). For the first time, the content of the skeet shooters' technical training improvement at the stage of preliminary basic training with the use of the special device imitating competing exercises on skeet was substantiated; the kinematic parameters of simulation exercises performed on skeet with the use of the special device are determined.

Conclusions

1. Indices of simple motor-visual reaction time actually are in the same range among sportsmen of different sports qualifications and age groups (from 257.1 to 288.7 ms). At the same time, the coefficient of variation for the simple motor-visual reaction time in ten attempts at highly skilled adult sportsmen is more stable (7.5−29.2%) compared to the indices of qualified adult sportsmen (8.0−38.6%) and juniors (12.5−36.2 %), where there are large variations in the range of results between attempts. The reliability of the test on the magnitude of the interclass correlation coefficient (*ICC* = 0.748) was satisfactory. There is a moderate statistical relationship, by Spearman rank correlation coefficient, between the simple motor visual reaction time and sporting results in competitive activity (r =−0,354, $p < 0.05$).

2. The content of the improved technique provides a positive dynamics of indices of the shooters' physical preparedness and stabilization of time indices of simple motor-visual reaction. In particular, this is evidenced by the probable differences between the experimental and control groups according to the following indices: press ups for 30 s ($p = 0.030$), "ten eights" test ($p < 0.001$), and throwing the tennis ball into the target ($p = 0.017$).

According to the standard deviation, a statistically significant reduction in the nonuniformity of the time value of the simple motor-visual reaction during the experiment in the experimental group (Δ_E= 7.9 ms; $p = 0.002$) was recorded, whereas in sportsmen of the control group no statistically significantly changes in this sense Δ_K= 0.5 ms; $p = 0.767$) occurred.

3. According to the results of control firings, the statistically significant growth tendency was established for the experimental group of sportsmen (with the reliability of the regression equation: r^2 = 81%), and no statistically significant changes were detected according to the results of the sportsmen of the control group (r^2 = 15%). According all three cycles of control firing, the performance of the sportsmen of the experimental group was statistically higher than that of the sportsmen in the control group ($p < 0.002$).

A statistically significant increase in the results of the competitive activity of the sportsmen of the experimental group was recorded after performing simulation exercises using the special device (31.3%; $p = 0.008$). The results of the competitive activity of sportsmen in the control group improved insignificantly (2.0%, $p = 0.575$).

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