The contribution of the accuracy of spatial tracking of moving objects to the competitive efficiency of hockey defenders 13-15 years old

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Abstract

Objective of the study was to quantify the contribution of the accuracy of spatial tracking of moving objects to the effectiveness of the competitive activity of hockey defensemen aged 13-15.

Methods and structure of the study. As part of the sports program of the Sirius Educational Center, 132 hockey defenders, participants in the All-Russian hockey competition "Championship of club teams among boys under 15 years old", were tested. Competitive effectiveness was determined by the indicator of the expected number of team goals, calculated by video analysis of matches. In the course of the study, the task of spatial tracking of moving objects in virtual reality (multiple object tracking task, MOT) and the assessment of special physical fitness (SPT) using the “Complex Test” on ice were performed. The contribution of these factors to competitive efficiency was determined by constructing a multilevel regression model that takes into account the athlete's belonging to the team.

Results and conclusions. The accuracy of spatial tracking of moving objects is significantly correlated with the competitive efficiency of hockey defensemen both with and without taking into account the level of SPT. The ability to track the movement of objects during competitive matches does not depend on the special physical qualities of hockey defensemen. This determines the importance of testing the cognitive functions of athletes along with assessing the level of physical fitness. Further research should be aimed at both expanding the testing battery (to assess executive functions, memory, attention, anticipation, etc.) and determining the physiological parameters that characterize the “biological cost” of performing the tests considered in this paper.

Keywords: *cognitive indicators, spatial tracking of moving objects, virtual reality, hockey defenders, competitive efficiency.*

Introduction. Junior hockey at the level of the best club teams in Russia places high demands not only on the physical qualities and motor skills of athletes, but also on perceptual and cognitive abilities. One of the most important is the *ability to track the movements of players on the field [1, 2], which is studied using the problem of spatial tracking of moving objects (the MOT task, as an abbreviation for the term multiple object tracking* [3]). The relationship between sportsmanship and spatial tracking has been the subject of scientific research for many years [1, 2, 4], but so far no attempts have been made to quantify the contribution of tracking accuracy to competitive performance in team sports. There is also no data on the performance of the MOT task by athletes in virtual reality, which determines the relevance of considering the results of the task in this environment.

Objective of the study was to quantify the contribution of the accuracy of spatial tracking of moving objects to the effectiveness of the competitive activity of hockey defensemen aged 13-15.

Methods and structure of the study. As part of the sports program of the Sirius Educational Center, 132 hockey defensemen aged 13-15 were tested, participants in the All-Russian hockey competition "Championship of club teams among boys under

15" of the 2020/21 and 2021/22 seasons. Before the start of the tournament, hockey players passed testing SPT (special physical fitness), and also performed the MOT task. During the tournament, individual match statistics were recorded; time spent on ice; place of the team at the end of the competition. The data of athletes who spent less than 3% of their team time on the ice were excluded from the analysis (N=8). The total number of participants was 124, age (M (SD)) = 14.93 (3.30) years.

The MOT task was carried out in the HTC VIVE PRO EYE virtual reality helmet, which is part of the Sirin hardware and software complex (Russia). The participant had to track four target objects moving randomly among four identical distractors (yellow balls). The experimental session included 15 levels of 12 seconds. Each level consisted of several stages (Fig. 1). The start of the level was carried out by the participant, the preview time (stage 1) and the selection time (stage 3) were not limited. The speed of the balls at the first level was 1 m/s and increased by 0.2 m/s at each next level under the condition of 100% accuracy of the task. The result was calculated by multiplying the number of correctly tracked objects by the difficulty factor, which depends on the speed of the balls and the distance between them at each level.

(1) demonstration of balls; (2) movement of the balls, where the first four seconds the target balls remain red, and the next eight seconds turn yellow, as do the distractors; (3) stop movement, select target balls; (4) indicating the correct answer

Figure 1. *Stages of the task of spatial tracking of moving objects*

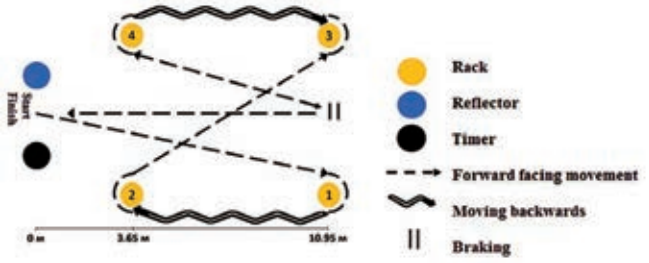

Figure 2. *Scheme of movement in the "Complex test" on ice*

To assess the level of special physical fitness, the "Complex Test" on ice (recommended by the Russian Ice Hockey Federation) was chosen, which includes overcoming several segments by different means of movement (Fig. 2). The test was performed with a stick, without dribbling the puck. The result was determined by the SmartSpeed Timing Gate System (Australia) with an accuracy of 0.001 s.

Competitive efficiency was assessed by the value of the individual parameter xG for, calculated on the basis of video analysis of matches (ICEBERG Sports Analytics, Russia) and indicating the *expected number of team goals for the period when the athlete is on the ice.* This indicator evaluates the "danger" of shots on goal based on a complex model that takes into account several parameters: position relative to the goal during shots, segments of the field from which passes were received, shot accuracy, etc. The circular system of competitions (each of nine teams played one match with each opposing team).

Statistical processing of the results was carried out in Rstudio 2021.09.0. To calculate the contribution of special physical training and spatial tracking to competitive performance, multilevel regression models were built using the maximum likelihood method with Satterthwaite correction. The dependent variable was the xG for parameter, and the predictors (independent variables) were the results of the Integrated Test (ICE) and the MOT task. The choice of the model type is due to the hierarchical organization of data: the xG for parameter has a high degree of similarity among hockey players of the same team. The interclass correlation coefficient of the "zero" model was preliminarily calculated to be 0.12, which gave reason to consider the intergroup variance sufficient for the chosen type of analysis. A likelihood ratio test was performed to evaluate the differences between the models.

Results of the study and their discussion. The obtained results indicate that for 13–15-year-old hockey defensemen from the strongest club teams in Russia, the individual value of the expected number of team goals for the period when the athlete is on the ice (xG for) depends on the accuracy of spatial tracking. The positive nature of this relationship is consistent with the results of intergroup studies [1, 4], which show the advantage of more qualified athletes in tracking accuracy. No significant interaction was found between the results of the "Complex Test" and the tasks of the MOT, from which it can

be concluded that the manifestation of spatial tracking in game situations does not depend on physical qualities. The lack of interaction between players also highlights the independent contribution of spatial tracking to competitive performance and points to the importance of this aspect of cognitive functioning for hockey defensemen. This implies the importance of balancing the content of testing athletes, where today the assessment of physical qualities prevails.

Conclusions. The accuracy of spatial tracking of moving objects is significantly correlated with the competitive effectiveness of hockey defenders, both with and without the level of special physical fitness, and can be used as a criterion for selecting candidates for the Russian U16 national hockey team.

The interaction of spatial tracking and physical fitness as factors of competitive efficiency is not statistically significant, which means that the ability to track the movement of objects during competitive matches does not depend on the special physical qualities of hockey defensemen. This determines the importance of testing the cognitive functions of athletes along with assessing the level of physical fitness.

Thus, the approach used to assess the joint influence of physical and cognitive functions on the competitive effectiveness of hockey defensemen aged 13-15 is promising for science and practice. Further research should be aimed at both expanding the testing battery (to assess executive functions, memory, attention, anticipation, etc.) and determining the physiological parameters that characterize the "biological cost" of performing the tests considered in this paper.

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