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Virtual reality as a means of developing game performance in ice hockey

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1. Introduction

Current sport training is characterized by an efxfort to find adaptive stimuli, methods and training resources that would allow for further increase in sports performance. It is a relatively complex task that limits the possibilities of the human organism and its response to stress and tension. A certain change in the paradigm (especially in the area of cognitive function development) is introduced with new technologies. One of the most expanding ones is virtual reality.
This is generally understood as a three-dimensional environment that is modelled and processed by a computer. Computer simulation of a realistic, illusive 3D environment is perceived by the user as a real-world environment and enabling him to interact with this environment (Human-Computer Interaction (HCI)). In the virtual world, one is represented by a virtual identity (a so-called avatar - the graphical representative of the user in virtual reality).

For sport training, two approaches to interaction are used:
• **Active:**
- The user has the ability to control his own movement, can make decisions about direction.
- However, the user cannot form the environment and interfere with it.
- A typical example of this approach are the so-called 360° videos, where the athlete is going through an opponent's game options in sports games, for example.

• **Interactive**
- The user can shape the world, pick up items and work with them.
- Examples of this approach are exercises to develop techniques or cognitive processes.

2. Goals of the study

The objectives of the thesis were formulated in two basic directions:
1) Create a virtual reality program that would improve the cognitive processes of players and thereby develop selected game performance factors.
2) Assess to what extent this training program develops selected cognitive functions and how it will affect game performance.

3. Research methodology

The entire research was conceived as a pedagogical experiment. An experimental factor was a training program in virtual reality that had focused on two basic areas:
- **Hockey-nonspecific**, focused on the development of cognitive processes (attention, decision making, proprioception, peripheral vision, reaction rate, situational awareness, and others).
- **Hockey-specific**, focused on hockey skills and game situations (linking of motor skills, rhythm development, reading the game, selective (complex) reaction speed to specific stimuli, situational decision making, divergent creative decision making, and more).

A group of children - ice hockey players (n = 16), members of an ice hockey team (aged 10 - 11 years), were selected to carry out the research. The probands were randomly divided into two groups:
- experimental (n = 8)
- control (n = 8)

The experimental group underwent a virtual reality program lasting 3 months. This program was implemented in the form of three training units, each 45-minute long. Thus, the experimental group realized 39 training units in

virtual reality with a total volume of 1740 minutes. None of the experimental group probands had an absence of more than 10 % of the training volume.
At the same time, the control group underwent nonspecific training (versatile preparation) in a similar volume.
Both groups passed two test measurements - before the experiment (pre-test) and after the experiment (post-test).
Each test measurement contained two test batteries:

1) cognitive testing (Vienna test system) - 5 tests (total 28 items)
2) specific hockey performance tests - 3 tests on ice (in real ice hockey)

Ad 1) The individual results in the Vienna test were converted from the gross scores to the normalized values (T-points) and the accumulated result (the sum of all test items) was determined in each test. Based on this, individual research groups were evaluated for improvement or deterioration in the given tests and the differences between the pre and post-test. Subsequently, the total sum was generated for the entire test battery and the changes and deviations were assessed.

Ad 2) In the hockey tests, the players performed two rounds for each test. The result of the individual round was given by the total time, which consisted of the test execution time and the penalty seconds (for an error in execution). The times of both rounds were added and compared to the arithmetic mean of the two groups.

4. Results

When assessing the Vienna test system, 3 tests showed a higher improvement in cognitive abilities in the experimental group. One test resulted equally in both experimental and control groups. In one test, the control group achieved a better result than the experimental group. However, if we take the result of all 28 result items, then we can observe double improvement of the cognitive processes in the experimental group over the control group. The detailed results are shown in table 1.

Table 1: Test results in the Vienna test system (results reported in T-points)

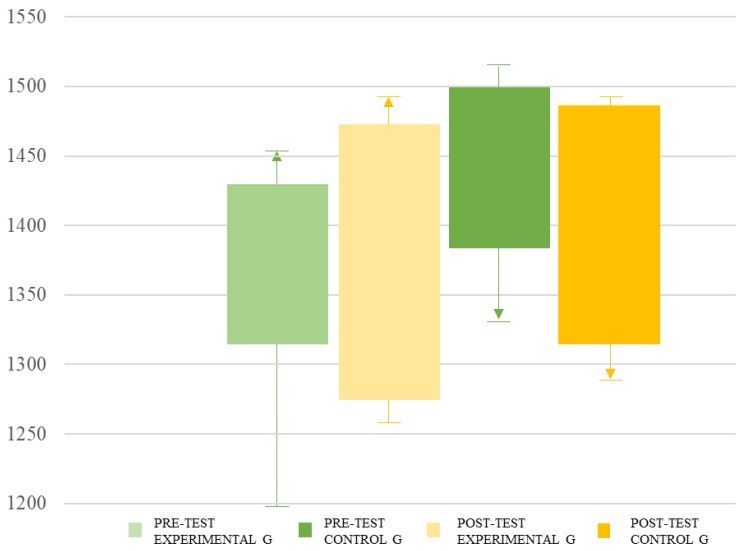
test	group	S1	S2	S4	S5	S7	total
number of result items		6	5	4	8	5	28
pre-test	experimental	290	236	200	385	246	1357
	control	288	249	197	404	229	1367
post-test	experimental	321	249	203	399	266	1437
	control	301	266	198	399	243	1406
differences	experimental	30	13	2	14	21	80
	control	12	18	2	-6	14	40

Legend:

S1: Determination test
S2: Space memory test
S4: Time-space anticipation test
S5: Reaction test
S7: COG attention test

The overall result of all tests is shown in graph 1.

Graph 1: Box graph of the overall difference in the Vienna test system between the experimental and the control group



Specific hockey performance tests have shown improvement in the experimental group in two specific hockey tests. The control group even deteriorated in these tests. In the third test, the experimental group improved by 2.9 s, but the control group improved by 6.7 s. Specific results are shown in table 2.

Table 2: Arithmetic means of experimental and control group tests in each phase of the research (in seconds)

Test	Group	Passes	Puck handling	Puck handling and Shooting
pre-test	experimental	65,9	59,2	93,9
	control	66,1	60,6	98,4
post-test	experimental	64,6	55,1	91,0
	control	69,7	64,3	91,7
differences	experimental	-1,3	-4,0	-2,9
	control	3,6	3,7	-6,7

When evaluating the results, it is advisable to link to the result in the Puck handling and Shooting test, where the control group achieved a better result (faster performance increase), despite the fact that the experimental group achieved an absolute higher performance. The overall result was also influenced by a single proband of the control group, who had the worst result in the pre-test and had the best result in both postings in the post-test. If we did not include the proband in the overall results, then the control group would reach similar values to the experimental group.

5. Discussion

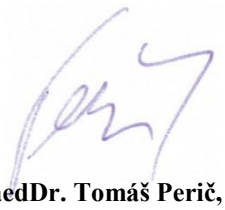
The results in both test groups have shown that the training program created improves selected cognitive processes while positively influencing ice hockey performance. Of course, it is necessary to state that own research was only pilot - with a small number of probands in both research groups. This number could negatively affect the results by causing random limits (whether hard errors or excellent performance) to significantly affect the arithmetic mean of the group and thereby distort the actual state. For this reason, it would be appropriate to repeat the experiment with significantly larger proband groups and thus obtain more valid data and relations.
However, the experience of research executives with children's training in virtual reality has confirmed children's interest in this training tool, and team coaches have been talking about improvements of the children in the experimental group in their own hockey performance.

6. Conclusions

When evaluating research based on the goals of the study, we can state:

1) A virtual reality training program has been developed that focuses on the development of cognitive processes and hockey-specific activities;
2) This program has brought higher development of selected cognitive functions, while also increasing hockey performance of probands in specific hockey tests.

In terms of practical use, the pilot study proved that training program in virtual reality is a possible complement or replacement in some situations of hockey training.



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