Assessing Psychomotor Abilities in Handcyclists using Computerized Tests: An Initial Study

Wojciech Pasko[a], Justyna Dydek[b], Janusz Zielinski[c], Tomasz Hulewicz[d], Maciej Śliż[e], Bartosz Dziadek[f] and Krzysztof Przednowek[g]

Institute of Physical Culture Sciences, Medical College of Rzeszów University, Rzeszów, Poland

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Abstract: Psychomotor abilities play an important role in any sport, they affect the speed of decisions made in a given situation, and thus can have a direct impact on the final outcome of sports competition. The study included ten disabled handcyclists who represented Poland internationally in the H2, H3, H4 and H5 categories. The control group consisted of non-disabled 5th year physical education students at the University of Rzeszow. The research methods were psychomotor tests using computer techniques in the Test2Drive system. For the evaluation, the tests performed were: simple reaction time (SIRT), complex reaction time (CHORT), hand-eye coordination (HECOR) and spatial orientation (SPANT). Reaction time (RT), motor time (MT) and correct responses (c.r.) were analyzed. The group of disabled cyclists is characterized by better motor time in each test while no statistical significance was shown. A better reaction time in each psychomotor test was achieved by the control group and the differences are statistically significant. Better motor time may suggest that cycling training has a positive effect on psychomotor abilities.

1 INTRODUCTION

In recent years, there has been an increased interest in the study of cognitive abilities in sport (Moran, 2009). It is assumed that cognitive abilities play an important role in every sporting discipline (Malacko, 2010). Scharfen and Memmert (Scharfen and Memmert, 2019) showed that perceptual-cognitive abilities allow one to perceive one's surroundings and use this perception to make the optimal decision for given actions. These authors also observed that cognitive abilities cannot be clearly separated from perceptual abilities, as they are a crucial part of perception. Shing et al. (Singh and Singh, 2016) showed that psychomotor abilities significantly influence the abilities of selected sport skills in volleyball. On the other hand, Yuksel and Tunc (Yüksel and Tunç, 2018) observed that in a group of badminton players of the national teams competing during the Rumia tournament, reaction time, in addition to technical and tactical training, had a very strong influence on victory. The aforementioned reaction time, which is defined as the time from stimulus onset to response onset (Ciucurel, 2012) is considered the main determinant for assessing psychomotor performance (Ando et al., 2005). However, it is conditioned by a number of factors such as: gender, age, fatigue, nutrition, genetic conditions, individual predispositions or type of stimulus (Szafraniec et al., 2012).

Knowledge regarding the level of psychomotor abilities among disabled athletes is still fragmented and incomplete (Di Russo et al., 2010). Physical disability which is defined as a morphological, permanent or functional impairment of the musculoskeletal system, can to varying degrees, make it difficult or completely impossible to undertake an activity (Tasiemski et al., 2020), so the type of sport practised must be adapted to the type of disability. This has resulted in an elaborate classification system that defines the type and extent of musculoskeletal dysfunction (Sobiecka, 2011), which translates into a diversity of testing opportunities among disabled athletes (DePauw and Gavron, 2005).

Handcycling is a form of mobility for people with

[a] https://orcid.org/0000-0003-4312-6140
[b] https://orcid.org/0000-0002-4608-8840
[c] https://orcid.org/0000-0003-0108-5029
[d] https://orcid.org/0000-0001-9888-9626
[e] https://orcid.org/ 0000-0001-7374-8472
[f] https://orcid.org/0000-0001-5368-0159
[g] https://orcid.org/0000-0002-2128-4116

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lower limb impairments, a competitive sport and a sporting discipline in paracycling and paratriathlon respectively (Stephenson et al., 2021). The discipline can be considered as a combination of perceptual-motor and cognitive tasks (Wierda and Brookhuis, 1991). The progression of elite handcycling and also the competitiveness of the sport, is associated with the need to expand our knowledge of the internal and external factors influencing athletic performance (Stephenson et al., 2021). Handcycling has often been researched in relation to rehabilitation (Kraaijenbrink et al., 2021), but information on the level of psychomotor abilities in the sport training aspect is scarce. Scientific studies have only assessed the relationship between selected factors and stress coping strategies in handcyclists (Turoń-Skrzypińska et al., 2020). Other work has mainly focused on different sporting disciplines (Di Russo et al., 2010), (Chojnacki et al., 2006), (Faber et al., 2019)

Awareness of the leading psychomotor abilities in sport is fundamental in determining appropriate training measures. Developing the components of psychomotor abilities significantly helps both young and skilled athletes in the process of learning to manage their own motor abilities perfectly and to improve the performance of their technical skills (Arifjanovich, 2020), therefore the aim of this study is to evaluate selected psychomotor abilities of handcyclists, measured by the Test2Drive computerized test.

2 MATERIALS AND METHODS

2.1 Materials

The subjects of the study was a group of ten disabled males handcyclists representing Poland internationally, who stratify in the H2, H3, H4 and H5 categories. The athletes were selected from among athletes who practice handcycling in Poland and train at least three times a week. The training seniority of the study group was a minimum of three years. The control group consisted of able-bodied male students who are in their 5th year of graduate studies in physical education at the University of Rzeszow.

2.2 Methods

The research methods were psychomotor tests performed using computer techniques in the Test2Drive system (Tarnowski, 2016). The paper by Tarnowski et al. describes the validity of the tests. The following four tests were used:

- Test SIRT– assesses the speed of the response and its stability. The stimulus signaling field changed its color at appropriate points in time. Response to the stimuli consisted of moving the finger from the START field to the reaction time field marked in blue.
- Test CHORT– assesses the speed and appropriateness of the complex response. The top signaling row displayed horizontal patterns (stimuli) and vertical stimuli, which require a response, and an oblique pattern (neutral stimuli), which does not require a response. Response to the stimuli consisted of moving the finger from the START field to one of the two response fields (vertical or horizontal stimulus field). During the neutral stimulus, the finger remained in the START field.
- Test HECOR– Assesses eye-hand coordination. The test required careful observation of the board and a quick reaction to the red signal box displayed. The test participant had to move their finger from the START box to the blue reaction box and return with the finger again to the START box.
- Test SPANT– assesses eye-hand coordination using complex spatial information. At the top left and right of the test board were signal boxes, two of which (on a row and one on a column) turned red simultaneously. In response to a stimulus, the test participant was to point their finger to the box at the intersection of the illuminated row and column, and then put their finger down on the START box.

Each test was performed in a standing position to facilitate access to the screen area, which was in a horizontal position during the tests. At the beginning, each test participant received detailed instructions on how to perform each test. After the instructions, the test subjects went through a practice stage where they could learn how to perceive stimuli and respond. The subjects then moved on to the actual testing stage, where they had to respond as quickly as possible to the stimuli in all tests. The test stand and the appearance of the tests are shown in Figure 1.

2.3 Statistical Methods

The study used basic statistical measures such as number, arithmetic mean, standard deviation and coefficient of variability. The statistical significance of differences between groups was determined using the Mann-Whitney-Wilcoxon test. The effect size was calculated using the formula (Tomczak and Tomczak,

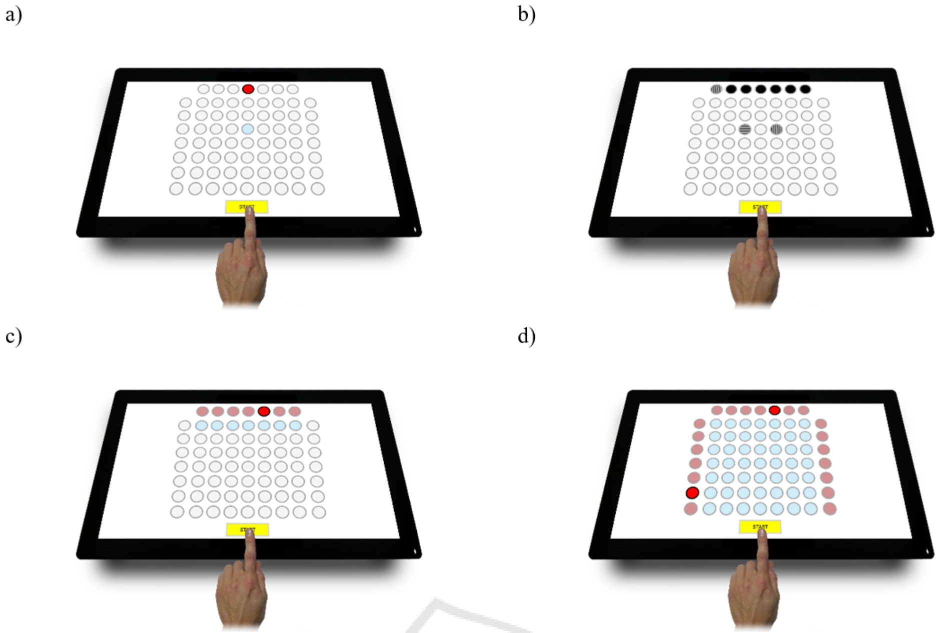

Figure 1: Reaction panel of the Test2Drive system; a) SIRT–Simple Reaction Time Test, b) CHORT–Choice Reaction Time Test, c) HECOR–Hand-Eye Coordination Test, d) SPANT–Spatial Anticipation Test.

2014):

$$r = \frac{Z}{\sqrt{N}} \qquad (1)$$

where: Z–standardized value for the U-value, r–correlation coefficient where r assumes the value ranging from -1.00 to 1.00, N–the total number of observations on which Z is based. Calculations and analyses were performed using the GNU R environment and at the level of significance $\alpha = 0{,}05$ (R Core Team, 2020).

3 RESULTS

Table 1 shows the mean values of the computational psychomotor tests for the group of disabled athletes and the control group. In the SIRT test, the control group obtained a shorter reaction time (329.8 ± 30.5 ms), while the group of disabled athletes obtained a shorter motor time (214.4 ± 48.8 ms). Figure 2 shows a box plot for the SIRT RT test, which shows the results obtained for the disabled athlete group and the control group, where statistical significance was observed for differences (p=0.0041). Also in the CHECOR test, the control group had a shorter reaction time (685.5 ms) and the disabled athletes group achieved a better result in motor time (279.1 ± 67.3 ms). The results of the CHORT RT test, where statistical significance was also observed (p=0.0044), are shown in figure 3. On the other hand, more correct responses in the CHORT test were obtained by the control group (96.1 ± 5.2 %). A better reaction time in the HECOR test was obtained by the control group (390.3 ± 36.2 ms), while in the case of motoric time in the HECOR test, the better result was obtained by the disabled athletes group (284.3 ± 53.9 ms). The statistical significance of the HECOR RT test is shown in figure 4, which was p=0.013. In the final SPANT test, the shorter reaction time was also obtained by the control group (643.3 ± 116 ms) and the disabled athletes group had a shorter motor time (321.3 ± 95.4 ms). A higher rate of correct responses in the SPANT test was obtained by the control group. The last statistically significant difference between the results obtained is shown in figure 5, which relates to reaction time for the SPANT test, and is p=0.043.

4 DISCUSSION

This paper presents the results of psychomotor abilities of handcyclists. The study was conducted using computer tests, and the results were compared with the control group.

The analysis shows that the handcyclists were characterized by worse reaction times in each test than the control group. However, it is worth noting that the control group is non-training able-bodied people. Thus, it seems that lower limb disabilities are characterized by slower reaction times than non-disabled

Table 1: Numeral characteristics of psychomotor abilities of disabled cyclists vs control group.

Variable	Disabled (N = 10)			Control (N = 12)			d	*p*	*r*
	$\bar{x}$	*sd*	*V*	$\bar{x}$	*sd*	*V*	(D-C)		
Simple Reaction Time (SIRT)									
RT [ms]	381,8	39,1	10,2	329,8	30,5	9,2	52,0	0,0041*	0,61
MT [ms]	214,4	46,8	21,8	291,9	131,0	44,9	-77,5	0,0518	-0,41
Choice Reaction Time (CHORT) Test									
RT [ms]	799,6	66,6	8,3	685,5	83,2	12,1	114,1	0,0044*	0,58
MT [ms]	279,1	67,3	24,1	297,8	61,9	20,8	-18,7	0,3390	-0,20
c.r. [%]	88,9	10,8	12,1	96,3	5,2	5,4	-7,3	0,0750	-0,38
Hand-Eye Coordination Test (HECOR)									
RT [ms]	449,3	48,4	10,8	390,3	36,2	9,3	59,1	0,0134*	0,53
MT [ms]	284,3	53,9	19,0	335,1	63,2	18,8	-50,8	0,0865	-0,37
Spatial Anticipation Test (SPANT)									
RT [ms]	706,9	73,6	10,4	643,3	116,0	18,0	63,7	0,0433*	0,43
MT[ms]	321,3	95,4	29,7	331,7	56,7	17,1	-10,4	0,2766	-0,23
c.r. [%]	88,0	11,4	12,9	91,7	13,0	14,2	-3,7	0,2623	-0,24

D– disabled group, C– control group, c.r.–correct responses; *x*–mean value, *sd*–standard deviation, *V*–coefficient of variation, *p*–probability of testing, *r*–effect size for the the Mann-Whitney-Wilcoxon test, *–statistical significance.

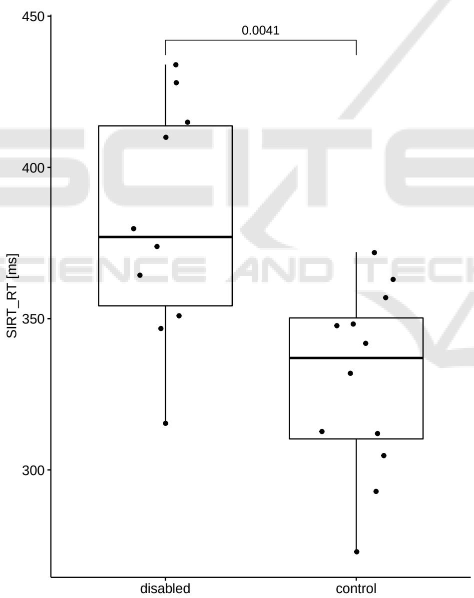

Figure 2: Box plot for SIRT RT for disabled group and control group showing median and interquartile range.

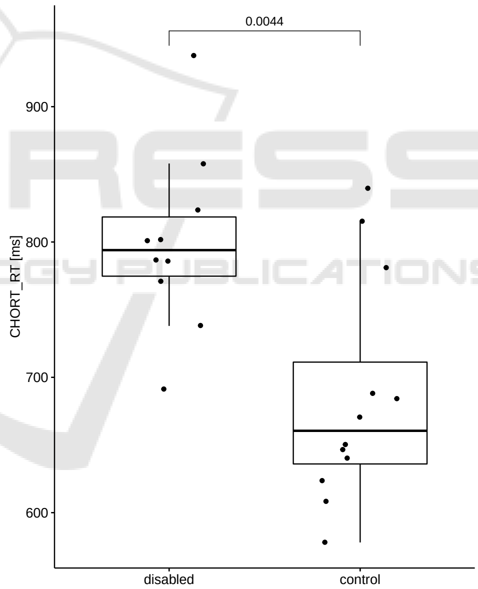

Figure 3: Box plot for CHORT RT for disabled group and control group showing median and interquartile range.

people. Of course, this conclusion is based on a small number of subjects and needs to be confirmed by more extensive research.

The exceptions were the motor times in each test, where the motor time is beter in disabled group, but they did not show statistical significance. The better motor times in coordination tests may suggest that cycling training has a positive effect on hand-eye coordination. Analysis of psychomotor abilities in soldiers and athletes has shown that sports training significantly improves motor time (Paśko et al., 2022).

Similar conclusions were reached by Singh and Amandeep (Singh, 2009), who observed improvements in reaction speed after introducing 6-week plyometric training. Comparisons between young soccer players and non-trained individuals also suggest that sports training has a positive effect on reaction speed (Montés-Micó et al., 2000). Similarly, in a study on handball players, it was observed that those who

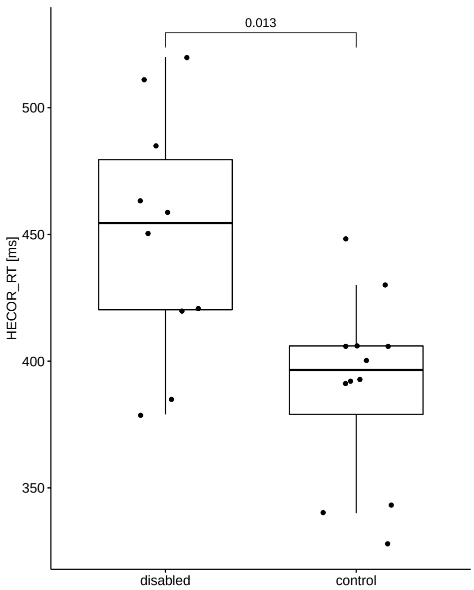

Figure 4: Box plot for HECOR RT for disabled group and control group showing median and interquartile range.

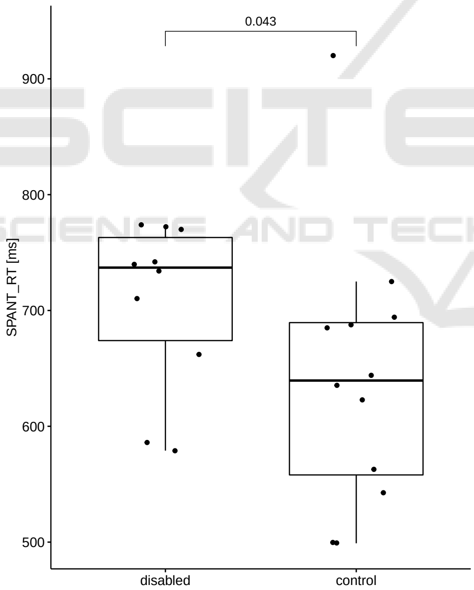

Figure 5: Box plot for SPANT RT for disabled group and control groupshowing median and interquartile range.

trained had better motor time than those who did not train (Przednowek et al., 2019).

The presented research is a pilot study and has a number of limitations. One of the main ones is the small number of people surveyed. It also seems that handcyclists should also be compared with non-training disabled people. Formulating detailed conclusions requires expanding the study to include a larger experimental group, so future work will focus on considering a more handcyclists.

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