

## **Comparative Analysis of Tapping Indexes in Particular Sport Disciplines**

by  
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*The aim of the conducted research was the assessment of possibilities of performance of movements with maximum frequency by subjects who practice various sport disciplines. The examination of this characteristic with the use of four independent tapping tests resulted from an attempt to evaluate the influence of higher activity requirements and also the structure of movements dependent on the trajectory on their durations. The measurement of frequency of movements was conducted by means of specially created research techniques for which we accepted preliminary and final conditions of tests and we distinctly determined realization of variables of trajectory of movements of upper limbs.*

*The examinations were conducted among the young male subjects (aged  $15.6 \pm 0.5$ ) recognized as talented in regard to sport. All the subjects were students of sport classes with a training structure specific for a given sport. In order to obtain additional information, we decided to compare the results of handball players, football players and swimmers with a group of students who were not gifted in this direction. Quantitative elaboration of the results was supplemented by the examination of significance of differences between groups by means of non-parametric rank test by H. Kruskal-Wallis and the analysis of concentrations which shows the similarity between groups with regard to the level of the variables in question.*

*As a result of the analysis of the gathered material we noticed that the type of sports specialization which determines the functional load on the upper limbs influences the level of frequency of movements. The level of this characteristic also determined the shape of the trajectory at which this movement was performed.*

## Introduction

Frequency is a term which is used in order to define human capabilities in the area of performing a maximum number of movements with the whole body or with only a given part of it. The speed of the activities which are repeated many times in short time intervals depends on the efficiency of particular nerve centres governing the antagonist muscle groups leading from quick transfers from the state of stimulation to the state of inhibition and vice versa (Harre and Hauptman 1988; Sozanski *et al.* 1999; Waskiewicz 2002). The concept of frequency is also used in another meaning – as a definition of a component of rhythm of movements. In this particular meaning it is used in the works of these researchers who consequently exclude rhythm of movements among other basic coordination abilities as important (Starosta 2003).

Conducting research on the frequency of movements of the upper limbs is not really difficult with regard to its methodology. Gilbert introduced a scheme of research based on the so called tapping. The introduced attempts to modify the experimental procedure on the whole lead to the employment of natural materials or situations. In the most frequently used experiments, the examiner asks the tested subjects to perform the following activity as quickly as possible: making points or aiming with a pencil into special holes, hitting with a graver in a working plate made of brass, moving tennis balls from one basket to the other, pressing with a tennis ball, spinning a hand-crank, tapping in some plates (dishes) with a hand (plate-tapping) (Koszczyk 1991; Thienes 1999; Waskiewicz 2002).

While interpreting this predisposition, some of the researchers, among others Szopa (1992), Prus (2000), do not go beyond some general statements saying that this ability is controlled genetically in the same degree as other coordination abilities and therefore it is very sensitive to external stimulus. The environmental factor which significantly influences its level could be the type of sports specialization as an expression of the influence of practice. Any reasoning with regard to this issue is made possible by the results of the examinations where players from many various sport disciplines are made to perform tasks of one particular type. The purposes of the conducted examinations were as follows:

1. To compare tapping indexes obtained by players from sports disciplines which are basically different from one another with regard to the functional load on the upper limbs.

2. Recognition of the influence of trajectory on which the movement of the hand during the performance of the tapping-test was performed.
3. Recognition of groups which are the closest to one another with regard to the level of the analysed variables.

## **Material and research methods**

The examinations were performed with young male people (average age  $15.6\pm 0.5$ ) who specialized in three sport disciplines: handball, football, swimming. The subjects were students of sports classes. The control group consisted of their peers – students from traditional schools. Before the examinations, we performed an interview with regard to handedness. We thought it purposeful to treat equally the results of the left limb with the left handed and the right with the right handed.

During the tapping test, the objective of the examined subject was to touch five subsequent sensors which were placed in the four different configuration systems (schemes) as quickly as possible. Sensors were always placed at a distance of 20 cm from one another (fig. 1). The tests were differentiated by the trajectory of movement and not by the way that the limb travelled because it was 80 cm each time. The examinations were conducted in the sitting position and the results were registered and automatically displayed by an electronic counter. The examined subjects decided when to start the test. This method of measurement diminished the time which otherwise would be needed for the perception of the signal stimulus and its processing. Therefore, the variable which was registered with the use of MSR-2 apparatus constituted the real time of performance of tapping.

The collected material was elaborated statistically by calculating mean values and standard deviations. In order to assess the level of differences between groups the non-parametric rank test of *H. Kruskal – Wallis* was applied (Siegel and Castellan 1988). The similarity of groups with regard to the level of the variables in question was determined by means of the taxonomic method.

## **Results**

The research conducted on the human motor system clearly shoes that the prolongation of kinematical chain, that is the inclusion into action of subsequent segments of the limb and then the shoulder girdle and corpus contributes to the prolongation of movement duration. For this reason, in the elaborated schemes we limited the number of joints where the movements were performed to the

following two joints: wrist and elbow. In all of the tests in the initial position the arm of the limb performing the movement was stabilised and slightly abducted in the arm joint. The forearm in relation to the arm was situated in the reverse and bent at the angle of  $90^\circ$ . The activity was concerned only with the muscles which bend the hand in the palmar and dorsal way and the muscles which bend and straighten the elbow joint.

**Table 1**

*Average durations of particular tapping schemes in the four examined groups.*

Scheme	Analyzed group										
	Swimming N=22		Football N=24		Handball N=24		Control N=30		Avarage N=100		
	L	R	L	R	L	R	L	R	L	R	
1	X	0.994	0.970	1.160	1.148	0.812	0.709	1.155	1.071	1.030	0.975
	S <sub>d</sub>	0.083	0.122	0.058	0.167	0.054	0.048	0.205	0.151	0.1	0.125
2	X	1.143	1.148	1.215	1.162	1.057	0.912	1.315	1.264	1.183	1.122
	S <sub>d</sub>	0.215	0.176	0.197	0.172	0.135	0.095	0.232	0.125	0.195	0.142
3	X	1.165	1.104	1.122	1.151	0.910	0.823	1.198	1.177	1.099	1.064
	S <sub>d</sub>	0.179	0.229	0.177	0.202	0.111	0.072	0.200	0.097	0.166	0.15
4	X	0.835	0.823	0.953	0.910	0.753	0.736	1.024	0.022	1.1	0.873
	S <sub>d</sub>	0.045	0.066	0.096	0.080	0.071	0.042	0.129	0.108	0.091	0.092

The data presented in Table 1 shows that the duration of particular tapping depended on the shape of the path (trajectory) at which the movement was performed. The shortest duration was detected with scheme IV and next successively with I, III and II. In scheme IV ( $\bar{x} = 1.973$  s) the alternating movements were performed in the forward-backward direction along the line which was bent at  $45^\circ$  from the straight direction. In the slightly slower scheme I ( $\bar{x} = 2.005$  s) the alternating movements also were performed in the direction out and in, however, along the broken line in the direction towards the right. In the next scheme III ( $\bar{x} = 2.163$ s) the movement was performed along the straight line in the natural direction from the left side to the right side. The duration of the test was effected by too long distance between the buttons situated at the edges. The process of touching required from the examined subjects to make frequent changes in their positions – sudden leaning forward

and backward of the body. Scheme IV was the slowest ( $\bar{x} = 2.305$  s); it required a circular clockwise movements.

**Table 2**

*Sums and mean values of ranks in the analyzed movement sets*

Group	Left		Right	
	Sums values	Mean values	Sums values	Mean values
Swimming	932	42.4	951	43.2
Football	1498	62.4	1517	63.2
Handball	316	13.2	303	12.6
Control	2304	76.8	2279	76.0
Test $H$ Kruskalla-Wallis (df=3p<0.001)		70.18		70,01

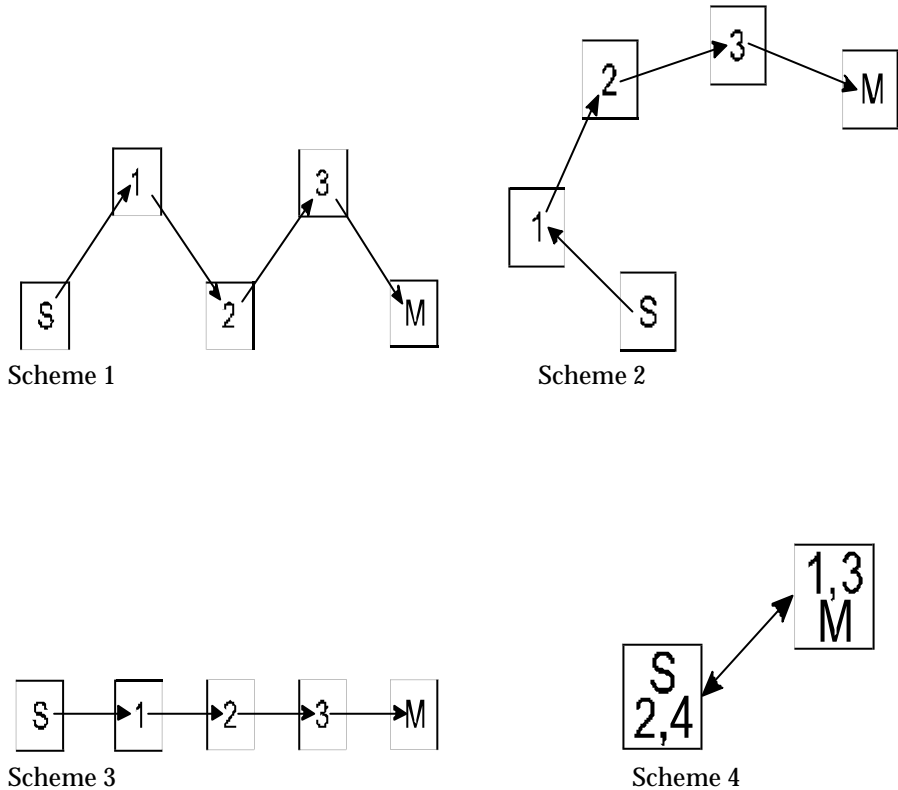
The distribution of results achieved by the examined groups in particular tappings shows that their durations are effected by the system of trajectory and, consequently the structure of the movements of the limb. Generally, better results were achieved in the schemes which required more perpendicular than parallel movements in relation to the body. The speed is foremost influenced by two strong muscles: biceps brachii and triceps brachii. In case of linear movements, mainly the brachialis was involved, which is slightly weaker.

In further stages of analysis we verified the level of significance of the differences of the tapping indexes between groups. In order to achieve this, we treated al. the groups cumulatively and we gave the groups successive ranks starting from the shortest measurements. As ranks are proportional to durations, when their sum is low, it means that the number of movements is higher. The data in the aggregated form was analysed with the use of non-parametric analysis of variance Kruskal - Wallis (Ferguson and Takane 2003). The employed statistics showed that in the level of analysed variables there was a highly significant difference between groups ( $p=0.001$ ).

The natural stage of further analysis was to define the measure of probability in which the concentration of groups was determined. Collectiveness of the concentration was qualified on the basis of Euclidian distances. The rule is that the lower the distance the higher the similarity.

Figures 2 and 3 the groups form hierarchic structures, in which we can differentiate three types of concentration each. The first constitutes footballers

and swimmers who were characterised by similarity of 52% for the left hand and 31% for the right hand of the maximum Euclidian distance. The control group is characterised by the percentage distance of 56 and 46. The group of handball players turned out to be characterised by a different concentration and thus it was least similar to other athletes.



**Fig. 1**

*Location of sensors in the particular schemes of tapping-test*

Research conducted by many authors, among others Jopkiewicz (1998) shows that, among all motor abilities, speed abilities are mostly conditioned genetically. Consequently, it is assumed that speed abilities are not susceptible to training. Our own research does not fully confirm these assumptions; on the other hand, differences in the level of speed of movements was influenced by the sport activity. This dependency was also confirmed by the research of Prus (2000). According to Ljach (2003), in the initial stages of sports practice we can expect a positive transfer of speed in various motor activities.

## Conclusions

1. The speed of movement performance with upper limbs with maximum frequency depends on the shape of the path (trajectory) of the performed movement.
2. The methods of division of concentration in the hierarchic basis show differences, which might be attributed to different requirements for the upper limbs in case of particular sports disciplines.

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