RESEARCHING FOR THE OBJECTIVE METER OF THE MOVEMENT RATE ESTIMATION

by

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Introduction

A movement's rate is considered to be one of the qualities describing a correct movement course or its technique. An acquaintance of the essence of the movement's rate is useful during the observation, analysis and correction of them, also during a verbal formulating (describing) the way of a movement action performance. A rate is also one of the criterions of a movement technique estimation in such incommensurable sports like figure skating, gymnastics or aerobic. One can speak about e.g. a good or high rate of exercise, passage or scheme.

An organism base of the movements rate (motor expression) is basically made by co-ordinative capacities of a differentiation of time movement parameters, and on a limited scale also rhythmization and motor adaptation (motor conditioning). Predispositions of above-mentioned capacities basically are: hearing and vision sensations precision, proprioreceptive feeling and movement time precision, nerve and muscle co-ordination, constancy and precision of the remembering process.

Researching for the objective criterions of the movements rate estimation is very important not only for empirical explorations but also for physical education practice and sport training. Finding them can make a description and analysis of movement actions and improving them easier in the teaching process, especially using audio-video mediums enabling to record and analyse many movement parameters.

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The rate is connected with the movement time, more precisely with the speed of movement task realisation (speed of running, rowing, tapping). Some rate characteristics seem to testify that this quality concerns only cyclic movements. According to Dońskі, „Movements rate is a periodic meter of their repeatability. You can measure it with the amount of movements repeated in a time unit" (Dońskі and Zaciorski 1979, p. 25). Such a statement seems to be too narrow, because the rate can also be characterised by acyclic movements course (performance), especially by their combinations e.g. a rate of exercises structure on gymnastic apparatus, acrobatic jumps or skate figures. An example of wider point of view concerning above mentioned quality is a statement of Schnabel, who says that the movements rate is „...a speed of the whole movement performances and their combinations and a speed of body parts movements expressed as their lasting or movements frequency expressed as a repeating speed" (Meinel and Schnabel 1987 p.168).

Acceptation of above mentioned statement complicates a researching of the uniform measurable criterion of characterised parameter of movement course. In the cyclic movements it is quite easy because, according to the Dońskі`s definition, it could be measured with the amount of movements repeated in a time unit (the frequency of movements is a synonym of this quality) but in the acyclic movements and movements combinations, this criterion can not be used without doubts. It does not let for inter-human movements rate comparisons, because e.g. movements combination of two gymnasts is only similar in main element composition, but never the same.

Not accidentally the matter of the movement rate was considered using cyclic movement actions. The precision of a vision rate estimation can be, however, different depending on the lasting time of the move cycle. Also the precision of movements rate change measurement is conditioned by the time of their lasting. If e.g. the whole movement cycle lasts 2s, it is possible to measure the rate of its repeating using a 0,01s time-meter. Search results gathered by bio-mechanic methods indicate that the time of certain cycles lasting e.g. in swimming or canoeing, even in high qualified athletes, are not the same (Kornecki and Reiter 1975; Fiłon 1985, Staniak et al. 1993).

The movement rate is estimated in different conditions and precision level. In rowing or canoeing it could be measured with the number of oar tugs during one minute (this parameter is commonly used in those disciplines training). In scientific research so rough measure does not yield enough information because e.g. two teams can row with the same frequency (40 tugs/min) but the rate of the first team can be steady and the rate of the other team can vary (e.g. to rise up or to slacken). In such a situation the *specific*, also precise and parametric *movements rate meter*, seems to be the similarity of lasting time of certain cycles called the *time repeatability* (Raczek et al. 1994). This parameter at the same time show the possibilities of maintaining the movements rate and it can be a supplement of the traditional estimation expressed by the amount of repeats in a time unit. Maintaining the assumed rate is important in such disciplines as rowing or canoeing (the amount of tugs in a time unit). It is also one of the conditions of movement economics.

By teaching and improving the movement technique, including its rate, an external feedback mechanism is used. It is based on delivering the extra external information about a desired value of chosen movement parameters or about the amount of errors made. In improving of the movement rate there are mainly acoustic impulses used like claps, screams, whistles, but in the scientific research more precise signals are necessary, e.g. coming from instruments (tempo-leaders). The last ones in connection with the recording by various ways of time movements parameters, enable to notice the differences between the rate imposed by e.g. a metronome and realised e.g. during a going up and down the step.

Above mentioned premises enable to work out the research assumptions. Its main aim was to state the usefulness of the *specific movements rate meter* (SMRM) described above for the estimation of the acoustic feedback influence to the rate maintaining of going up and down the step.

Shaping the searches aim, the following hypotheses were adopted:

1. Single cycles of a movement action are never identical in respect of time.
2. The mechanism of the external feedback improves the precision of reproduction of the imposed movement rate and makes its maintaining after stopping the feedback information easier.
3. The earlier suggested specific movements rate meter can be used in the estimation of maintaining precision of this movement course quality.

To verify above-mentioned hypotheses, measurements were conducted using the movement cycle of the Harvard step-test. The feedback mechanism was set in motion using the acoustic impulse coming from the metronome.

Materials and methods

Two groups of second grade students from the Academy of Physical Education in Katowice took part in the research. All of them were put through the effort test similar to the Harvard step-test. Their aim was to maintain the imposed rate of 30 cycles/minute (lasting time of single cycle = 2s) during going up and down the 0,51 m high step.

Measurements were conducted in the experimental form. During each of 5 minutes of the test, for the first 30 seconds, every 0,5 s, the first group (n=30) received the extra acoustic information (impulse from the electronic metronome with the frequency 2 Hz and lasting time 0,08 s, called feedback – FB) concerning the following foot put on the step. During the next 30 seconds of each minute there were no extra acoustic information (no feedback – noFB).

The other group (n=28) received the acoustic feedback only during the first minute of the test. The next 4 minutes were conducted without any feedback information. The main task for all the students was to maintain the imposed movement rate regardless of the presence or the lack of the acoustic signal.

Dynamographical characteristics of the above mentioned movement task were estimated by two tensometric platforms connected with the computer recording the data by mean of the SCOPE program. In the first group force-time characteristics of the movement course were recorded between 20th and 30th s and between 50th and 60th s of each minute, in the second group – between 30th and 40th s the succeeding minutes of the test. Four full cycles were recorded at that time, then the average value was calculated.

The Kolmogorov-Smirnov consistence test showed that the distribution of received measurement data was not normal in all instances. To check if the times of certain cycles differ significantly in FB and noFB trials, the non-parametrical couples order test of Wilcoxon was used. Interpreting the results received, the zero hypotheses were adopted that the rate of going up the step during the FB-cycles does not differ from the rate of noFB ones.

Results

The results of analysis shown graphically indicate that in both groups, either FB and noFB, the students were going up and down the step at a little

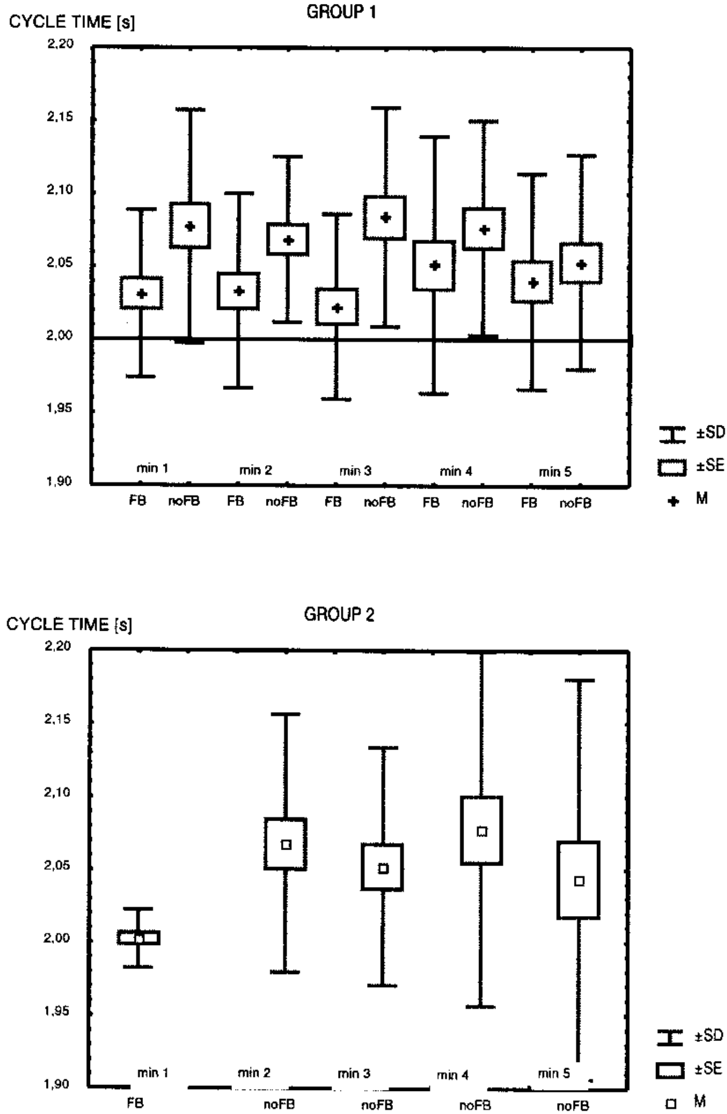

Figure 1. Mean single cycle time in successive minutes of test (explanation in text)

slower rate than imposed by metronome. The time of performing successive recorded cycles was over 2s (Fig. 1). In both groups the FB-cycle lasted shorter than noFB-cycle . It seems to be interesting that during the last 30s of the 5th minute (noFB) in the first group, and during the last 5th minute (noFB) in the other one, the cycle time got shorted. It could be probably explained by the „finish effect" (Zaciorski et al. 1987). Especially interesting is also the best rate reproduction during the 1st minute in the second group. This phenomenon was confirmed by arithmetic mean – the most similar to the standard (the imposed time of the single cycle was 2s) and the lowest standard deviation (Fig. 1). The reason of that effect was probably the fact that the students of this group were then aware that during the next 4 minutes they would reproduce the rate without FB. The situation of first group students was more comfortable, because they were being given the rate information for 30 seconds of each minute of the test.

Table 1. Results of the Wilcoxon test of the mean times of the cycle lasting (*specific movements rate meter* - SMRM) for the first group examined.

Couple of variables	N	Z	P
t_1FB; $t_1$noFB	30	3.218945	0.001288
t_2FB; $t_2$noFB	30	3.597885	0.000321
t_3FB; $t_3$noFB	30	4.782139	0.000002
t_4FB; $t_4$noFB	30	2.313938	0.020677
t_5FB; $t_5$noFB	30	**0.850832**	**0.394869**

$t_1 \div t_5$ - time of the going up and down the step cycle testing.

To determine the influence of the FB information on the precision of reproducing the performance rate, average times of cycles lasting (SMT), FB and noFB, were compared by Wilcoxon test (Tab. 1 and 2). In the first group the FB and noFB attempts were compared in each successive minute of performing, in the second group average FB cycle time during the first minute was compared to the average time of the noFB cycles during the consecutive minutes. The results received are very clear. It turned out that the FB and noFB cycle lasting times in both groups are statistically significantly different during the first 4 minutes and insignificant during the 5th minute (Tab. 1). The last fact can be also explained by the „finish effect". Its influence on the performance was probably stronger than the feedback. It refers particularly to the first group.

Table 2. Results of the Wilcoxon test of the mean times of the cycle lasting (*specific movements rate meter* - SMRM) for the second group examined.

Couple of variables	N	Z	P
t_1FB; $t_2$noFB	28	3.119685	0.001812
t_1FB; $t_3$noFB	28	2.687028	0.007213
t_1FB; $t_4$noFB	28	2.914742	0.003562
t_1FB; $t_5$noFB	28	**1.548457**	**0.121522**

The presented results made that the zero hypothesis (FB cycles do not differ from noFB ones) has to be rejected.

All the data presented testify that the feedback influences to the maintaining of the rate of going up and down the step. The research procedure proved the usefulness of the specific movement rate meter as a criterion of precision of rate maintaining.

Conclusions

1. The acoustic feedback information positively influences the possibilities of maintaining the rate of going up and down the step, according to the Harvard test assumption.
2. The time of particular movement cycles lasting can be accepted as the objective movements rate meter, next to the traditional one expressed by the amount of number of movements in a time unit.
3. In sport disciplines, where the rate is very important (rowing, canoeing, athletics races), the specific acoustic instruments (tempo-leaders) should be used next to the traditional forms making the rate maintaining easier (claps, whistles, screams).

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