**UDC 796.422.14**

**ISSN (English ed. Online) 2311-6374**

**2021. Vol. 9. No. 2, pp. 5-14**

# AUDIO STIMULATION ATHLETES WITH VISUAL IMPAIRMENTS IN RUNNING

**Andrii Yefremenko**

**Svyatoslav Koval**

**Viktor Pavlenko**

**Tetiana Shutieieva**

**Yaroslav Kraynik**

**Svetlana Pyatisotskaya**

*Kharkiv State Academy of Physical Culture,*

*Kharkiv, Ukraine*

**Purpose:** revealed differences in the running characteristics of athletes with visual impairment without and with audio stimulation.

**Material and methods:** test №1: running for 4 minutes with a gradual increase in pace; test №2: running for 4 minutes in the tempo of the metronome (140; 150; 160; 170 bpm).

**Results:** Comparison of test results №1 and №2 in the group of young men revealed the reliability of differences ($p<0,05$) for: the first and fourth minutes of running; average running speed in the second minute. Comparison of the results of tests №1 and №2 in the group of girls revealed the reliability of differences ($p<0,05$) for: the distance of running in the first minute; average running speed in the first and second minutes.

**Conclusions:** similar physiological reactions were recorded in boys and girls on exercise, which increases in steps, regardless of the method of stimulation. At the same time, there are certain differences in the strategy of movement, depending on the method of stimulation. This confirms the complex effect of the imposed rhythm

on the performance of cyclic locomotion. We expected significant differences between running characteristics with and without auditory stimulation. However, a large number of reliable differences between the results, including for boys and girls, were not found. At this stage, we are inclined to think that the selected metronome frequencies are convenient for running with a load that rises stepwise.

**Keywords:** metronome, rhythm, tempo, athletics.

## Introduction

The human body is able to perceive and respond to stimulation of the main senses from the outside [8]. An individual is able to arbitrarily choose a specific (with varying degree of awareness) rhythm of motor activity. Obviously, to effectively solve a specific motor task, the rhythm will be different. For example, cyclic locomotion (walking, running, etc.), which are everyday and simple for a healthy person. They have important practical significance for movement, development and control of preparedness and rehabilitation. We can say that the rhythmic performance of cyclic locomotion indicates their quality (economy and efficiency). Thus, in the area of bimanual coordination isolate rhythmic-auditory stimulation, which can stabilize internal coordination creating an effect called «anchoring». When a particular point in a cycle of movement (for example, placing a foot on a support) is synchronized with a metronome, an effect called anchoring may occur [2, 7], which showed a more stable connection between the characteristics of the musculoskeletal system and the respiratory system during cyclic movements through locomotor respiratory coupling. Rhythmic motor actions can be combined with external acoustic stimuli (metronomes and music). This phenomenon is known as sensorimotor synchronization [16]. At the same time, concentration on an external stimulus distracts from internal experiences (uncertainty, fatigue, laziness). Showed an increase in time to fatigue due to the use of sound stimuli during exercise. It is assumed that this is due to the parallel processing of external and internal signals. That is, the main attention when performing physical work is transferred to external stimuli in an attempt to reduce the perception of signals about the tension of the

musculoskeletal system and cardio-respiratory system. Also, this may be due to an increased level of relaxation as a result of an exact expectation of the upcoming movement. Perhaps there is a certain «rhythmic pattern» as the most effective strategy for solving a motor problem. The frequency of cyclic locomotion in recreational runners between 130 and 200 steps per minute (spm) [10]. Perhaps we should speak only about the individual rhythm of movement. Auditory or visual stimulation is most commonly used in physical exercise.

Thus, the **purpose of the current study** was to revealed differences in the running characteristics of athletes with visual impairment without and with audio stimulation.

## Material and Methods of research

*Object:* athletes with visual impairments (category T13) (boys n=6 and girls n=5). *Ethical Statement.* The study was approved by the Ethics Committee of the Kharkiv State Academy of Physical Culture and all subsequent procedures were consistent with the Helsinki Declaration. To determine the athlete's classification, a Diagnosis Certificate signed by the attending physician was used. This was sufficient evidence of visual impairment. Athletes have given written consent to assign a classification.

*Test №1.* Groups of athletes with visual impairments (girls or boys) at the command «Go!» Performed a run for 1 min. in a free rhythm, which the test person had to independently raise every minute (only 4 m). The benchmark was the average heart rate (HR) and the average running speed (V № … min; m/s), which was reported to the test person at the end of each minute. Each subsequent minute, it was recommended to run at an elevated rhythm based on perceived running speed and physiological sensations. Running was performed on a platform with a ground covering, on a plot of 20 m with bright markings every meter, which was limited by cones. When the athlete reached the cone, the coach gave the command to turn and continue to run the other way. At the end of 1, 2, 3 minutes, HR (bpm) was recorded, the distance covered (Dist. after № … min; m) and Rating of Perceived Exertion (RPE after № … min; score) by Borg «6-20» (from 6 («Easy») to 20 («maximum

effort»). After this, the test person returned to one of the cones for the start of the next minute of the run (a total of 15±5 s were used to record and report the indicators). As soon as all the test participants were ready, a signal was given to start running. At the end of 4 minutes or in case of refusal to continue, HR and Dist. were recorded after 1-4 min. Indicator changes were reported to test person only to select running speed.

Two hours later, the test person proceeded to perform a second test.

*Test №2.* Groups of athletes (groups of 5 people) at the command «Go!» Performed a run for 1 min. (4 min in total) to the rhythm of the metronome, which rises every minute (140, 150, 160, 170 bpm). Running was performed on the same platform as in test № 1. The digital metronome signal was fed through a portable audio system. At the end of 1, 2, 3 minutes record HR, Dist. after № …. min and RPE. At the end of each minute, the test person returned to one of the cones to start the next minute of the run (a total of 15 ± 5 s were used to record the indicators). As soon as all the test participants were ready, the signal was given to start running the race at a given rhythm. Recorded HR and Dist. after 1-4 min: at the end 4 m; in case of refusal to continue running; in case of apparent inconsistency with a given rhythm of running (>10 SPM).

Statistical analysis was performed using the software package Statistica 10 (USA). The analysis of compliance of sample data with the normal distribution law was performed using the Kolmogorov-Smirnov test. Parametric and non-parametric methods of analysis were used to describe, assess interconnections, and differences in results: descriptive statistics; Pearson correlation coefficient; Mann-Whitney U-test; Student's t-test paired samples. For all analyzes, the level of statistical significance was set at $p<0,05$.

**Results of the research**

All participants were able to complete the test №1 and №2. The measured running characteristics and heart rate had a different approximation to the normal distribution law. Based on the results of the Kolmogorov-Smirnov test, an appropriate statistical criterion was chosen to compare the results. The kinematic characteristics

and physiological responses recorded during the run without audio stimulation are presented in Table 1.

*Table 1*

**Results of the research**

| Type of measurement | male | | female | |
|---|---|---|---|---|
| | M±SD | | | |
| | rhythm | no rhythm | rhythm | no rhythm |
| HR start | 105,00±12,73 | 97,46±16,33 | 102,86±8,10 | 100,29±11,39 |
| HR №1 min | 131,46±18,35 | 129,81±19,60 | 151,86±17,60 | 149,29±20,04 |
| HR №2 min | 155,69±16,53 | 154,62±17,00 | 165,86±15,36 | 164,57±19,65 |
| HR №3 min | 166,00±12,47 | 169,15±16,19 | 171,36±17,28 | 170,86±19,86 |
| HR №4 min | 173,42±13,06 | 176,46±13,35 | 173,71±20,14 | 177,43±13,00 |
| Dist. after №1 min | 118,43±16,54* | 108,62±17,43* | 91,98±5,43* | 102,46±15,10* |
| Dist. after №2 min | 129,17±31,08 | 136,28±30,97 | 95,63±8,30 | 101,09±15,59 |
| Dist. after №3 min | 142,70±24,40 | 144,66±24,38 | 142,07±17,22 | 147,53±8,24 |
| Dist. after №4 min | 136,15±16,89* | 148,44±5,26* | 121,37±12,94 | 129,95±23,31 |
| V №1 min | 1,97±0,27 | 1,81±0,29 | 1,53±0,09* | 1,71±0,26* |
| V №2 min | 2,15±0,52* | 2,27±0,52* | 1,60±0,14* | 1,68±0,0,26* |
| V №3 min | 2,38±0,41 | 2,41±0,41 | 2,37±0,29 | 2,46±0,14 |
| V №4 min | 2,27±0,28 | 2,47±0,09 | 2,02±0,21 | 2,17±0,39 |
| RPE after №1 min | 9,54±1,50 | 9,35±1,35 | 9,07±3,69 | 9,00±1,66 |
| RPE after №2 min | 9,81±1,33 | 10,12±2,03 | 10,93±1,27 | 10,14±2,21 |
| RPE after №3 min | 13,62±2,04 | 13,42±1,60 | 14,93±1,69 | 14,36±1,15 |
| RPE after №4 min | 15,92±1,09 | 16,38±0,98 | 15,64±0,74 | 16,36±1,08 |

*Significant differences with the auditory stimulation and without auditory stimulation <0,05

The coefficient of variation of heart rate in the group of young men during 4 minutes of running decreased (CV = 13,96; 10,62; 7,51; 7,53), and in the group of girls it changed in a wave-like manner (CV = 11,59; 9,26 ; 10,09; 11,59). The group variation of the running distance in the group of young men decreased in the third and fourth minutes, and increased in the second minute of the test (CV = 13,97; 24,07;

17,10; 10,66), while in the group of girls it increased (CV = 5,90; 8,67; 12,12; 12,40). The average running speed had a similar dynamics, as well as the running distance of the subjects of both groups. The coefficient of variation for RPE decreased (CV male: 15,76; 13,53; 14,99; 6,86; CV female: 40,67; 11,61; 11,29; 4,76).

The coefficient of variation of heart rate in the groups decreased (CV male: 15.10; 10.99; 9.57; 7.57; 7.39; CV female: 13.42; 11.94; 11.62; 7.32). Group variation of distance running in test groups dynamically changed (CV male: 16,05; 22,72; 16,85; 3,54; CV female: 14,74; 15,42; 5,58; 17,93). The average running speed of the test person of both groups had a similar dynamics, as well as the distance of the run. The coefficient of variation for RPE decreased (CV male: 14,50; 20,03; 11,95; 6,00; CV female: 18,49; 21,83; 8,02; 6,61).

Comparison of test results №1 between groups revealed the reliability of differences ($p < 0,05$) for: heart rate in the first minute of the race; running distance in the second and fourth minutes.

Comparison of the results of test №2 between the groups revealed the reliability of differences ($p < 0.05$) for: heart rate in the first minute of the race; running distance in the first, second and fourth minutes; average run speed in the third minute.

Calculation of the correlation relationship between similar running characteristics performed with and without audio stimulation. In the group of young men revealed a significant correlation for: heart rate at the first (r=0,79), the second (r=0,96), the third (r=0,80) and the fourth (r=0,41) minutes of running; distance running at the second (r=0,84) and the third (r=0,88) minutes. In the group of girls, a significant correlation was found for: heart rate at the first (r=0,56), second (r=0,59) and third (r=0,77) minutes of running; running distance in the fourth (r=0,58) minute. For all other indicators, no significant correlations were found.

## Conclusions / Discussion

In our study, a metronome was used as an auditory stimulation. When choosing rhythms for running, we were guided by data from previous studies. J. Edworthy & H. Waring (2006) suggested 200 or 70 bpm music for running [5]. C. Karageorghis et

al. (2012) investigated walking at a pace of 80, 120 and 140 bpm [10]. F. Styns et al. (2007) argue that people can synchronize with musical tempos in the range 50-190 bpm [18]. We chose a range of rhythms: the transition from fast walking to running (140 bpm) to comfortable and effective running cadence (170 bpm). They also took as a basis the assertions that the transition from walking to running in humans usually occurs at a speed of about 2,1 m/s [11,9,20], which corresponds to the average speed of movement recorded in our study.

We found contradictory reductions in the frequency of the step due to lagging, which is consistent with the recorded changes in other studies [3, 4].

The heart rate increased every subsequent minute in test №1 and №2 for sportsmen with visual impairment of both groups. The difference in the physiological response was only an increase in the variation in the group of girls at the last minute of the run with audio stimulation. Obviously, both versions of the test did not cause difficulties for sportsmen with visual impairment. Most of the sportsmen with visual impairment managed to gradually dose the load and achieve high heart rate. A decrease in the length of the distance in the fourth minute in the subjects of both groups indicates the exhaustive nature of the tests. The increase in the distance of running in the group of young men in the fourth minute of running without audio stimulation can be explained by a motivational factor and greater endurance, unlike girls. However, this contradicts the assumption that the rhythm, which is synchronized with the pace of the individual's work, may contribute to an increase in endurance when performing exercises. The absence of significant differences in the dynamics of the physiological response indicates a similar task of testing to follow the rhythm or gradually independently increase the speed of running. The test person of both sexes demonstrated the ability to mobilize in the process of solving a motor task regardless of the method of stimulation. This confirms the ability of trained individuals to evaluate and dose the amount of exercise. The selected frequency can serve as an exhaustive exertion stimulus for the contingent represented.

No significant differences were found for the test groups between test №1 and №2 in terms of RPE. The coefficient of variation was reduced for two tests in both

groups. This confirms the ability of trained individuals to qualitatively evaluate and dose perceived loads when solving a motor task, regardless of the method of stimulation [6]. Thus, both tests were quite tedious for the subjects of both groups, as indicated by high RPE scores at the end of the test and a decrease in the intro group variation of the score. Our data contradicts the fact that dissociation caused by focusing on the auditory stimulus can change the perception of effort, allowing runners to work more intensively longer [6]. Perhaps with a different character of stimulation (motivational music) we would have recorded other results.

The results of the study confirm the previously stated data by different authors on the effect of the tempo of music on the performance of cyclic exercises. The adjustment of the pace of the run relative to the cadence of the subjects created optimal conditions for sensorimotor synchronization as a whole. This is consistent with the findings of the research of M. Roerdink et al. (2011) for cyclic locomotion.

Similar physiological reactions were recorded in boys and girls on exercise, which increases in steps, regardless of the method of stimulation. At the same time, there are certain differences in the strategy of movement, depending on the method of stimulation. This confirms the complex effect of the imposed rhythm on the performance of cyclic locomotion. We expected significant differences between running characteristics with and without auditory stimulation. However, a large number of reliable differences between the results, including for boys and girls, were not found. This may be due to the visual features of the subjects, as well as indicate the inconsistency of the data, which requires in-depth research. At this stage, we are inclined to think that the selected metronome frequencies are convenient for running with a load that rises stepwise.

**Thanks.** The study was performed in accordance with the plan of scientific work of the Kharkiv State Academy of Physical Culture.

**Conflict of interest.** The authors declare the absence of any conflicts of interest.

**References**

1. Riadova L., & Shesterova L. (2018), «Vikova dynamika rivnia rozvytku statychnoi rivnovahy v uchniv serednikh klasiv z vadamy zoru, Slobozhanskyi naukovo-sportyvnyi visnyk». № 3(65). 52–56. (in Ukr.)

2. Bacon, C. J., Myers, T. R., Karageorghis, C. I. (2012), «Effect of music-movement synchrony on exercise oxygen consumption», J Sports Med Phys Fitness. №52. 359–365. (in Eng.).

3. Edworthy, J., Waring H. (2006), «The effects of music tempo and loudness level on treadmill exercise», Ergonomics. №49. 1597–1610. (in Eng.).

4. Hoffmann, C. P., Torregrosa, G., Bardy, B. G. (2012), «Sound Stabilizes Locomotor-Respiratory Coupling and Reduces Energy Cost», PloS one 7:e45206. (in Eng.).

5. Hove, M. J., Risen J. L. (2009), «It's all in the timing: Interpersonal synchrony increases affiliation», Soc. Cogn. №27. 949–961. (in Eng.).

6. Karageorghis, C. I., Terry, P. C., Lane, A. M., Bishop, D. T., Priest, D. L. (2012), «The BASES expert statement on use of music in exercise», J Sports Sci. №30. 953–956. (in Eng.).

7. Kyröläinen, H., Pullinen, T., Candau, R., Avela, J., Huttunen, P., Komi, P. V. (2000), «Effects of marathon running on running economy and kinematics», Eur J Appl Physiol. №82. 297–304. (in Eng.).

8. Mendonça, C., Oliveira, M., Fontes, L., Santos, J. (2014), «The effect of instruction to synchronize over step frequency while walking with auditory cues on a treadmill», Hum Mov Sci. №33. 33–42. (in Eng.).

9. Place, N., Lepers, R., Deley, G., Millet, G. Y. (2004), «Time course of neuromuscular alterations during a prolonged running exercise», Med Sci Sports Exerc. №36. 1347–1356. (in Eng.).

10. Roerdink, M., Ridderikhoff, A., Peper, C. E., Beek, P. J. (2013), «Informational and neuromuscular contributions to anchoring in rhythmic wrist cycling», Ann Biomed Eng. №41. 1726–39. (in Eng.)

Received: 05.03.2021.

Published: 26.04.2021.

**Information about the Authors**

**Andrii Yefremenko:** PhD (Physical Education and Sport), Associate Professor; Kharkiv State Academy of Physical Culture: Klochkivskastreet 99, Kharkiv, 61058, Ukraine.
**ORCID:** https://orcid.org/0000-0003-0924-0281
**E-mail:** ukrnac@ukr.net

**Svyatoslav Koval:** PhD (Physical Education and Sport), Associate Professor; Kharkiv State Academy of Physical Culture: Klochkivskastreet 99, Kharkiv, 61058, Ukraine.
**ORCID:** https://orcid.org/0000-0001-7140-6276
**E-mail:** Koval.S.S.79@gmail.ru

**Viktor Pavlenko:** PhD (Pedagogical Science), Associate Professor; Kharkiv State Academy of Physical Culture: Klochkivskastreet 99, Kharkiv, 61058, Ukraine.
**ORCID:** https://orcid.org/0000-0003-0888-2485
**E-mail:** pavlenko102@ukr.net

**Tetiana Shutieieva:** Kharkiv State Academy of Physical Culture: Klochkivska str. 99, Kharkiv, 61058, Ukraine.
**ORCID:** https://orcid.org/0000-0002-0217-9505
**E-mail:** polyna71@mail.ru

**Yaroslav Kraynik:** Kharkiv State Academy of Physical Culture: Klochkivskastreet 99, Kharkiv, 61058, Ukraine.
**ORCID:** https://orcid.org/0000-0003-1567-8570
**E-mail:** yaroslavkr2014@gmail.com

**Svetlana Pyatisotskaya:** PhD (Physical Education and Sport), Associate Professor; Kharkiv State Academy of Physical Culture: Klochkivska str. 99, Kharkiv, 61058, Ukraine.
**ORCID:** https://orcid.org/0000-0002-2246-1444
**E-mail:** skharchenko@rambler.ru