**PSYCHOLOGY & PHYSIOLOGY**

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# Psychophysiological state and decision making in wrestlers

**Abstract**

Background. The investigation of psychophysiological functions in athletes is important to adapt the training process. In this paper, we examine speed perception and decision-making during wrestling fights as a crucial component of performance. We argue that a wrestler must anticipate the situation and speeded choices of response selection are required based on fast and frugal decision-making.
Aim. The approach investigates a psychophysiological test battery to test correlates of fast or slow decision making in wrestlers.
Method. 29 elite Greco-Roman wrestlers were examined. The psychophysiological states of wrestlers were studied by a test battery of vision motor test, non-verbal intelligence, anticipation and heart rate variability. Those competences are correlated to fast or slow decision-making time when choosing between different stimuli.
Results. The analysis revealed correlation between fast decision-making and visual perception, the increase of impulsiveness and level of emotional strain during fights. In addition, faster decision- making was present in those wrestlers with high anticipation ability and balance between processes of arousal and inhibition. The psychophysiological data suggests that fast decision-making correlates with the autonomic regulation of the heart rate.
Conclusions. Fast decision-making in wrestlers seems to be related to a number of parameters in a psychophysiological test battery calling for a causal and experimental approach in the future and specific training of those factors allow wrestlers to improve their decision time.

## Introduction

Modern sport activity characterized the use of new diagnostics and technology for improving the performance of athletes [Barreiros *et al.* 2014; Gullich, Emrich 2014]. Recently training processes of athletes in Olympic and professional sport have been individualized [Kozina *et al.* 2015; Latyshev *et al.* 2021]. In addition test batteries combining data of psychological, physiological, biochemical and genetics methods and a psychophysiological approach have been established [Chernozub *et al.* 2019; Volodchenko *et al.* 2019]. How these new developments adapt training process of elite athletes is promising but requires an understanding of core relations such as when athletes vary in their decision-making and what factors of a psychophysiological test battery correlate with decision-making as well as provide a means for changing the training regime [Davis *et al.* 2022].

We argue that an investigation of psychophysiological functions is needed to understand individual differences in decision-making before we can recommend information for adapting the training process. For instance, evidence suggests that psychophysiological functions indicate the abilities of athletes to perform special skills such as in wrestling the sport that is selected for the current study given its decision-making processes involved. For instance, the decision for a specific movement how to attack the opponent [Podrigalo *et al.* 2019]. Moreover, psychophysiological states are often characterized by the level of functional and psychological reserves of an athlete and partly genetically determined [Lyzohub *et al.* 2021]. When we understand what factors of a test battery correlate with decision-making of athletes it seems plausible to change those that can be adapted for talent development or the training regime in elite sports.

What do we know about the studies sport wrestling and performance-related factors? First, in recent years the developed of Olympic wrestling changed the rules of competition and produced new types of wrestling fights [Tunnemann, Curby 2016; Zadorozhna *et al.* 2021]. During the last ten years the rules of wrestling competitions have changed several times. This produces uncertainly and for the preparation of elite athletes new ways to improve the training process are required such as improving decision times when deciding the next move. This rationale is supported by the increased intensity of moves and dynamics in competition [Dokmanac *et al.* 2018; Markovic *et al.* 2020].

Why decision-making in wrestlers could correlate with psychophysiological factors? The decision-making is a main characteristic of cognitive processes in wrestling competition [Chen *et al.* 2017; Soto *et al.* 2020]. The decision making requires the need of perceiving external information, by anticipating and responding to the actions of the opponents. Those decisions are context specific but, at the same time underly basic processes such as decision speed. Whereas previous research often just diagnosed different outcome variables of decision making in the current study we correlate those outcomes to psychophysiological factors from a larger test battery. Understanding the psychophysiological state in wrestlers may provide new information to coaches about physiological and psychological abilities of athlete which can be used to change the training process and in long-term improves outcome variables such speed in decision-making as a core variable for performance and success [Mirzaei *et al.* 2021; Sciranka *et al.* 2022].

In sum, we argue to fill a gap in research using test batteries that combine data of decision- making and psychophysiological processes of wrestlers. The features of the current psychophysiological states in athletes have been done often in isolation for instance when considering the preparedness of athletes [Cardoso *et al.* 2021; You *et al.* 2022]. Similarly and studied in isolation evidence suggests correlations of cognitive characteristics with the competition performance in wrestling [Isik *et al.* 2017; Frigout *et al.* 2020]. Further, the character of sensory-motor response in wrestling with different age and weight category have been investigated without knowing the underlying processes as aimed for in the current study [Alpay, Isık 2017; Chernenko *et al.* 2020]. Finally, the motivation for the current paper is the need to understand motor-cognitive interactions and performance in sports to establish individualized cognitive strategies and interventions [Causer *et al.* 2013; Musculus, Raab 2022].

## The Rationale of the Study and Hypotheses

Our hypotheses focus on the links between psychophysiological state and decision-making in elite wrestlers. Moreover, we speculate that time of decision-making and reactions on visual stimulus are non-identical properties but mutually related. We explore if components of the psychophysiological state measured by the test battery affect the quality of decision-making in different ways. Whereas some authors believe the cognitive functions and decision making property are identical [Curseu *et al.* 2013; Nweze, Agu, Lange 2020] we rather assume that these concepts are different and can be analyzed in relation of psychophysiological processes. Based on research by Laborde and Raab [Laborde *et al.* 2013] we hypothesize that the higher level of parasympathetic activity of heart rate variability produce faster decision-making.

Finally, we hypothesize that faster decision making in athletes during competition situations correlates with regulatory mechanism of psychophysiological functions. Therefore we assume that decision-making is associated with better cognitive and neurodynamics measures from our test battery and regulated by emotional and internal tension.

**The aim**: The approach correlates performance from a psychophysiological test battery with fast or slow decision-making in wrestlers[1].

## Material and Methods

### Participants

The 29 elite Greco-Roman wrestlers (males, Mean age: 16,54+5,22, Mean sport experience 7,37+5,22) were examined. All athletes were club members of Kremenchuk city and cadets of the Ukraine team.

We separated the athletes into two groups via median split: One group with fast decision- making (n=15) and with slow decision-making (n=14).

The study was approved by Biomedical Research Ethics Committees in accordance with the Ethical Standards of the Declaration of Helsinki. Informed written agreement consent to the research was signed by the athletes in accordance with the recommendations of the Biomedical Research Ethics Committees.

The sample of athletes included all members of cadets Ukraine team and thus no a-priori sample size calculations have been realized.

### Material, decision making and psychophysiological test battery

The decision-making test included the assessment of the threshold for processing external information based on various differentiated stimuli. The different color stimulus was presented on the monitor of computer with the random sequences. The task of person was response on the choice stimuli which correspond of task program. The aim of this test was determine the response quickly and correctly. With the results of the test performance the parameters: dynamism, capacity of visual analyzer, decision-making time and impulsiveness were determined. Athletes' decision-making was studied with a test which estimate the time needed solving decision-making tasks. For the decision-making test a "Multipsychometer-05" hardware-software was used [Tron *et al.* 2018]. Validity and reliability of the test were verified by correlation between psychophysiological parameters of competition and decision-making test among senior elite wrestlers of the Ukrainian team [Korobeinikova *et al.* 2020].

## Procedure

After receiving informed consent, we tested all athletes with a test battery reflecting the psychophysiological state in elite wrestlers. We measured decision-making thereafter as described above.

The neurodynamics functions were studied by standard tests that estimate of time latency of visual motor response and anticipation. These tests indicate the basic property of the abilities of nervous system to perception and information processing from external environment [Raab *et al.* 2019].

Non verbal intelligence was studied by using standard Raven's Progressive Matrices. Non-verbal intelligence was measured for fast behavior given in competitions fast and frugal choices need to be made [Korobeynikov *et al.* 2021].

We measured heart rate variability with an electrocardiography "Fazagraf" (Ukraine) system which registered ECG and cardio intervals [Korobeynikov *et al.* 2021].

The research was carried out in the first part of the day before the wrestling training. Athletes have been asked to refrain from eating an hour before the study. The total testing was about two hours. After testing athletes, coaches received the results of the study and practical recommendations to adapt the training process according to individual characteristics have been discussed.

The time of visual motor reaction was estimated by time latency. The athlete responded to visual stimuli as fast and accurately as possible. Fast responses reflect the possibilities of human to activate neurons [Sherman, Usrey 2021]. Test performance: response latencies and stability of reaction were studied. The stability of the reaction was determined by the coefficient of variation (CV, %), the ratio of the standard deviation to the mean value of the latency response [Loras *et al.* 2012].

As any decision-making requires information processing we tested verbal and non-verbal intelligence. The following parameters: productivity, speed of information processing, accuracy and effectiveness were dependent variables for the current study. Productivity was measured by all correctly completed tasks during execution. The speed of information processing is determined by the ratio of the amount of information to the test execution time. Accuracy is determined by the ratio of correct tasks to the total number of completed tasks. The effectiveness of test performance was studied by the ratio of the correct number of tasks to the total number of tasks.

During a wrestling fight the prediction of the opponent's actions are very important in sports often labeled as anticipation [Gierczuk *et al.* 2018]. The anticipation test determines the balance between arousal and inhibition of the nervous system. The person must respond to the moving object which is presented on a computer monitor. We measured accuracy, stability, arousal and arousal trend.

Further, we measured heart rate variability using standard statistical and spectral characteristics. Specifically, the time-domain and geometric methods analyses of heart rate variability were used. The following parameters NN, SDNN, CV and HRV triangular index were used for data analyses.

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[1] It is an extension of the issue presented in the abstract in the "International Journal of Wrestling Science" [Turlykhanov *et al.* 2022].

In addition, further parameters of heart rate variability (based on Baevsky *et al.* [2007]) were used. The following parameters: Mo (Mode of cardio intervals), AMo (Mode amplitude, number of cardio intervals corresponding with Mode, %), HRV rang (variation range, difference between maximum and minimum cardio intervals) and Stress Index (condition of adaptive ability) were selected for the data analyses.

The frequency-domain method analysis with the estimation of high frequency (HF), low frequency (LF) oscillation and LF/HF ratio of heart rate were used.

## Data analysis

We used "Statistica 12" software for data analyses. Since the analyzed indicators were not normally distributed, the Wilcoxon rank sum test was used to determine the statistically significant difference between the groups. To present the data distribution, an interquartile range was used, indicating the first quartile (25% percentile) and the third quartile (75%).

## Results

Results indicate variance in decision-making times of the applied task. The variables of decision-making time test in wrestlers are presented in Table 1. Decision-making time in wrestlers fluctuates (518,63±83,63 ms) that are meaningful differences to influence performance in wrestling. We used median-split separating wrestlers into two groups: fast decision-making (n=15) and with increased time of slow decision-making (n=14). We argue that wrestlers with fast decision-making characterize dynamic performance of the nervous system by switching from arousal to inhibition. Moreover, dynamic adaptations of nervous system relate to better performance in motor skills [Gierczuk, Ljach 2012; Korobeinikova *et al.* 2020].

In sum, the time reduction of decision-making is related to the increase of the capacity in visual analyzer in wrestlers.

The increase in capacity of visual analyzer links with faster information from the environment.

Simultaneously, wrestlers who are faster at decision-making observe the predominance higher impulsiveness and automaticity in the control of movements [Congdon *et al.* 2008].

The variables of vision motor response in wrestlers with different decision-making time is displayed in Table 1. The decrease of latent reactions in the visual motor response in wrestlers with fast decision-making is understood as an increase of information processing speed.

The stability of the latent period of visual motor response (coefficient of variation, CV) is indicated by the level of emotion strain of an athlete. Lower stability in wrestlers is associated with higher emotional stress. Thus, the increase in visual information processing speed is accompanied by emotional strain in wrestlers.

The results of non-verbal intelligence showed Raven test scores in wrestlers with faster decision-making (Table 1). Improvement of productivity and speed of non-verbal information processing relates to higher quality and quicker decision-making. The results reveal that faster time of decision-making in wrestlers is associated with higher volume, speed and quality of perception and information processing of non-verbal information.

As argued above anticipation is a key property which provides athletes an advantage in wrestling fights. The research of anticipation showed parameters of accuracy and stability in wrestlers correlate with faster decision-making (Table 1). This fact testifies that anticipation links with the balance between arousal and inhibition of the nervous system and correlates with shorter decision-making in wrestlers. This property gives the wrestlers quickly and accurately responses to opponent's actions.

In sum, anticipation links with the balance between arousal and inhibition of nervous system in wrestlers. We established that faster decision-making is accompanied by high arousal in wrestlers. In wrestlers with faster decision-making observed the balance between processes of arousal and inhibition is present. The variable of arousal indicates the ability of athletes to perform their special skills. The current findings corresponded with research that indicates an optimal between level of technical skills of athletes and optimal arousal [Movahedi *et al.* 2010].

One of the main properties which influence the psychophysiological state of a human is heart rate variability. The heart rate variability indicates the activation of autonomics nervous system of the human body. The changes of parameters of heart rate variability characterized are not only states of the cardiovascular system, but likewise the adaptation processes of the whole organism of the athlete [Laborde *et al.* 2007].

The time-domain method of analysis of cardiac intervals shows a decrease in the following variables: SDNN and CV. This indicates increased strain of the autonomic nervous regulation in wrestlers with fast time of decision-making. The tension of autonomic regulation in wrestlers with fast time of decision-making occur for reason of simultaneously effect to influence to the sinus node of sympathetic and parasympathetic divisions [Korobeynikov *et al.* 2016].

Summarizing, the decline of decision making time in wrestlers links with mobilization of the internal resources of the athletes. In contrast, it shows as well an increasing level of tension that requires regulatory mechanisms of the autonomy of the nervous system to counteract the strain.

The analogy results were obtained for geometric method of analysis. The increase of Mo and AMo, as well as the decline of HRV triangular index points to the rise

**Table 1.** The variables of research in wrestlers (median, lower and upper quartiles)

| Variable | Fast time of decision- making (n=15) | Slow time of decision- making (n=14) |
|---|---|---|
| decision-making test | | |
| Dynamism, conventional units | 56.18 51.60; 58.85 | 50.19* 44.15; 58.88 |
| Capacity of visual analyzer, conventional units | 1.34 1.30; 1.37 | 1.12* 1.07; 1.21 |
| Decision-making time, ms | 470,00 410,00; 500,00 | 560,00* 530,00; 620,00 |
| Impulsiveness, conventional units | -0.38 -0.47; -0.36 | -0.42* -0.44; -0.21 |
| visual motor test response | | |
| Latent time of response, ms | 326.31 315.77; 342.17 | 352.83* 315.54; 369.10 |
| Stability, % | 12.12 9.794; 15.36 | 13.87* 12.75; 15.30 |
| non-verbal test Raven | | |
| Productivity, conditional unit | 9.00 4.00; 9.00 | 6.50* 4.00; 7.50 |
| Speed of information processing, conditional unit | 4.15 3.18; 4.63 | 3.63* 3.16; 4.01 |
| Accuracy, conditional unit | 0.75 0.33; 0.75 | 0.54* 0.33; 0.2 |
| Effectiveness, conditional unit | 53.57 7.93; 53.57 | 25.99* 7.93; 35.91 |
| anticipation test | | |
| Accuracy, number of errors | 2.86 2.27; 3.99 | 3.12* 2.68; 4.82 |
| Stability, % | 3.54 3.31; 4.50 | 4.21* 3.47; 5.05 |
| Arousal, conditional unit | 0.29 0.02; 3.22 | 0.09* -0.82; 1.66 |
| Arousal trend, conditional unit | 21.26 -65.64; 128.85 | 61.14* -68.06; 176.37 |
| heart rate variability | | |
| NN, ms | 750.00 654.50; 867.50 | 736.00* 644.00; 922.00 |
| SDNN, ms | 50.50 28.50; 64.50 | 69.00* 35.00; 117.00 |
| CV, % | 6.04 4.48; 7.45 | 9.33* 5.10; 11.53 |
| HRV triangular index, conditional unit | 8.29 6.52; 11.26 | 12.94* 9.37; 18.67 |
| Mo, ms | 725.00 650.00; 850.00 | 700.00* 625.00; 775.00 |
| AMo, % | 39.24 34.80; 52.48 | 32.60* 24.32; 48.00 |
| HRV rang, ms | 236.30 130.85; 339.85 | 361.80* 181.60; 505.90 |
| Stress Index, conditional unit | 112.15 59.73; 325.70 | 62.99* 20.44; 195.70 |
| LF, % | 47.10 36.90; 58.45 | 46.15 27.50; 54.30 |
| HF, % | 38.95 24.25; 44.95 | 37.10 19.40; 50.00 |
| LF/HF | 1.35 0.82; 2.225 | 1.34 0.55; 2.58 |

Legend: * p =.05, for the wrestlers of different times of decision-making

of tension of autonomic regulation through of activation of humoral and central components [Korobeynikov *et al.* 2021]. The Stress Index parameter shows the prevalence of the central regulation over the autonomy regulation of autonomy nervous system in wrestlers with faster decision-making [Bakayev *et al.* 2019].

The frequency-domain method of heart rhythm found no significant of differences between both groups of wrestlers. Obtained results indicate that the spectral analysis in normalized units eliminates the differences between the studied groups of athletes.

Moreover, the low and high-frequency power of heart rate does not fully reflect activity of aperiodic fluctuations [Spiers *et al.* 1993; Lensen *et al.* 2020].

Thus our research observed some links between a property of decision-making and abilities of athletes to anticipate and state of the autonomic nervous system. Moreover, the mechanisms of relation between main parameters of psychophysiological state and decision-making in elite wrestlers has not been devoted. For the study, the Spearman's rank correlation analysis coefficient was used. In Table 2 we present the correlation analysis between decision-making time and values of the psychophysiological state in elite wrestlers (only significant correlation coefficients are displayed).

**Table 2.** Correlation relation between decision-making time and values of the psychophysiological state in elite wrestlers

| Variable | Reduced time of decision- making (n=15) | Increased time of decision-making (n=14) |
|---|---|---|
| Speed of information processing (non-verbal test Raven) | 0.37 | -0.89 |
| Accuracy (anticipation test) | 0,56 | 0.15 |
| Arousal (anticipation test) | 0.42 | 0.52 |
| SDNN | 0.39 | 0.06 |
| HRV rang | 0.40 | 0.08 |
| LF | -0.33 | -0.17 |
| HF | 0.35 | -0.07 |
| LF/HF | -0.50 | 0.01 |

Obtained data of correlation analysis larger numbers of reliable correlation coefficient in wrestlers with faster decision-making. The improvement of decision-making in elite wrestlers carried out by enhanced of anticipation and optimization of autonomic system regulation as indexed by heart rate.

## Discussion

The aim of the study was to examine a set of psychophysiological tests to evaluate the correlation between fast

and slow decision making in wrestlers. For this task, the relationships between decision-making and parameters of neurodynamics, non-verbal intelligence, and heart rate variability were investigated.

The psychophysiological condition is the basis of the functional preparedness of elite athletes. Modern Olympic wrestling is characterized by the increase of intensiveness and motivation from a referee of active performance during fight. This relationship is connected with the changes of rules and increasing spectacularly of competition matches of wrestling [Tunnemann, Curby 2016; Latyshev et al. 2021]. In these difficult conditions of competitive activity arises the needed of quick perception and information processing of external information for responses to the activities from the opponent [Sciranka et al. 2022]. Recent research investigated athletes' performance in regard to decision-making. The decision-making in elite sport activity links with motivation to achieve [Raab et al. 2022]. There is motivation to achieve more advantage in elite athletes [Gustafsson et al. 2018; Ong 2019]. But competitive achievements are limited by personality abilities (psychophysiological functions) to perform decision-making [Konings et al. 2018].

Psychophysiological decision-making mechanisms in wrestling practice are very complex. Our research has shown that fast the decision-making time leads to an increase in the emotional strain of wrestlers. This is indicated by accurate and faster decisions under conditions of emotional strain.

We assume that the emotional stress of athletes provides additional resources for an effective response to situations that arise in a duel [Podrigalo et al. 2017]. This also applies to the perception and processing of non-verbal information. An athlete at a competition is affected by many non-verbal stimulating influences: the place of the competition, the atmosphere in the hall, the behavior of the referees, etc. This situation requires selective and optimized information processing. Therefore, the decision-making time reflects the ability of human potential to respond spatially in competitive situations.

One property that gives a wrestler an advantage during competition is anticipation [Huesmann et al. 2021]. Our study found that anticipation is related to the balance between arousal and inhibition in wrestlers. This leads to faster decision time and responding accurately and quickly to the opponent's actions. In turn, this improves the process of enabling special skills. Obtained results corresponding with the research showed positive relations of special performance of athletes and optimal arousal [Saberi Moghadam et al. 2019].

Heart rate variability has been used as an indicator of the psychophysiological state of an athlete in various studies [Laborde et al. 2017]. In our studies, an increase in the level of tension in the autonomic regulation of the heart rhythm was established due to a decrease in deci-

sion-making time. It has been previously shown that fast and high-quality decision-making leads to the mobilization of resources and, as a result, to emotional stress among wrestlers [Korobeynikov et al. 2021]. Thus, the improvement of decision-making in elite wrestlers is carried out due to the tension of emotional-vegetative regulation.

In a nutshell, correlation analysis showed the relationship between decision-making and psychophysiological state of wrestlers.

## Conclusion

Decision-making performance varies between athletes correlates with visual perception, impulsiveness and level of emotional strain indicate avenues for future causal studies. We conclude that understanding individual differences in decision times of wrestlers underlying psychophysiological processes need to be assessed before a recommendation of training regimes can be provided.

## References

1. Alpay C.B., Isık O. (2017), *Comparison of body components and balance levels among hearing-impaired wrestlers and healthy wrestlers*, "Acta Kinesiologica", vol. 11, no. 1, pp. 79-84.

2. Aydın R., Ersoz G., Ozkan A. (2021), *The relationship of some factors affecting dynamic-static balance and proprioceptive sense in elite wrestlers*, "Physical Education of Students", vol. 25, no. 3, pp. 178-188; doi: 10.15561/20755279.2021.0306.

3. Baevsky R.M., Baranov V.M., Funtova I.I., Diedrich A., Pashenko A.V., Chernikova A.G., Dresche J., Jordan J., Tank J. (2007), *Autonomic cardiovascular and respiratory control during prolonged spaceflights aboard the International Space Station*, "Journal of Applied Physiology", vol. 103, pp. 156–161; doi:10.1152/japplphysiol.00137.2007.

4. Bakayev V., Bolotin A. (2019), *Comparative analysis of the dynamics of heart rhythm variability indicators of long-distance runners in different training conditions*, "Sport Mont", vol. 17, no. 2, pp. 41-46; doi: 10.26773/smj.190607.

5. Barreiros A., Cote J., Fonsec A.M. (2014), *From early to adult sport success: Analysing athletes' progression in national squads*, "European Journal of Sport Science", vol. 14 (supl. 1), pp. S178-S182; doi: 10.1080/17461391.2012.671368.

6. Cardoso F.D.S.L., Afonso J., Roca A., Teoldo I. (2021), *The association between perceptual-cognitive processes and response time in decision making in young soccer players*, "Journal of Sports Sciences", vol. 39, no 8, pp. 926-935; doi: 10.1080/02640414.2020.1851901.

7. Causer J., Williams A.M. (2013), *Improving anticipation and decision making in sport* [in:] *Routledge handbook of sports performance analysis*, Routledge, pp. 21-31.

8. Chernozub A., Danylchenko S., Imas Y., Kochina M., Eremenko N., Korobeynikov G., Gorashchenco A. (2019),

*Peculiarities of correcting load parameters in power training of mixed martial arts athletes*, "Journal of Physical Education and Sport", vol. 19, no. 1, pp. 481-488; doi: 10.7752/jpes.2019.s2070.

9. Chernenko N., Lyzohub V., Korobeynikov G., Syvash I., Korobeynikova L., Korobeinikova I., Potop V. (2020), *Relation between typological characteristics of nervous system and high sport achieving of wrestlers*, "Journal of Physical Education and Sport", vol. 20, no. 3, pp. 1621-1627; doi: 10.7752/jpes.2020.03221.

10. Chen W.Y., Wu S.K., Song T.F., Chou K.M., Wang K.Y., Chang Y.C., Goodbourn P.T. (2017), *Perceptual and motor performance of combat-sport athletes differs according to specific demands of the discipline*, "Perceptual and Motor Skills", vol. 124, no. 1, pp. 293-313; doi: 10.1177/0031512516681342.

11. Congdon E., Canli T. (2008), *A neurogenetic approach to impulsivity*, "Journal of Personality", vol. 76, no. 6, pp. 1447-1484; doi: 10.1111/j.1467-6494.2008.00528.x.

12. Curseu P.L., Jansen R.J., Chappin M.M. (2013), *Decision rules and group rationality: cognitive gain or standstill?*, "Plos One", vol. 8, no. 2, e56454; doi: 10.1371/journal.pone.0056454.

13. Davis P.A., Sorman D., Carlberg A., Rognsvag E., Stenling A. (2022), *The psychophysiological influence of exertion and affect on sport-specific cognitive and physical performance*, "Journal of Science and Medicine in Sport", doi: 10.1016/j.jsams.2022.05.008.

14. Dokmanac M., Slacanec K. (2018), *Analysis of the Most Important Parameters in Wrestling Matches from the Senior World Championship 2017, the Senior European Championship 2018 and the World Championship 2018*, "International Journal of Wrestling Science", vol. 8, no. 2, pp. 18-29.

15. Frigout J., Tasseel-Ponche S., Delafontaine A. (2020), *Strategy and Decision Making in Karate*, "Frontiers in Psychology", vol. 10, pp. 3025; doi: 10.3389/fpsyg.2019.03025, doi: 10.1080/21615667.2017.1422815.

16. Fronso S.D., Robazza C., Bortoli L., Bertollo M. (2017), *Performance Optimization in Sport: A Psychophysiological Approach*, "Motriz: Revista de Educacao Fisica", vol. 23, e1017138-e1017138.

17. Gierczuk D., Bujak Z., Cieslinski I., Lyakh V., Sadowski J. (2018), *Response time and effectiveness in elite greco-roman wrestlers under simulated fight conditions*, "The Journal of Strength & Conditioning Research", vol. 32, no. 12, pp. 3433-3440; doi: 10.1519/JSC.0000000000002868.

18. Gierczuk D., Ljach W. (2012), *Evaluating the coordination of motor abilities in Greco-Roman wrestlers by computer testing*, "Human Movement", vol. 13, no. 4, pp. 323-329; doi:10.2478/v10038-012-0037-y.

19. Gullich A., Emrich E. (2014), *Considering long-term sustainability in the development of world class success*, "European Journal of Sport Science", vol. 14 (supl. 1), pp. S383-S397; doi:10.1080/17461391.2012.706320.

20. Gustafsson H., Carlin M., Podlog L., Stenling A., Lindwall M. (2018), *Motivational profiles and burnout in elite athletes: A person-centered approach*, "Psychology of Sport and Exercise", vol. 35, pp. 118-125; doi: 10.1016/j.psychsport.2017.11.009.

21. Huesmann K., Loffing F., Busch D., Schorer J., Hagemann N. (2021), *Varying Degrees of Perception-Action Coupling and Anticipation in Handball Goalkeeping*, "Journal of Motor Behavior", pp. 1-10; doi: 10.1080/00222895.2021.1984868.

22. Isik O., Cicioglu H.I., Gul M., Alpay C.B. (2017), *Development of the wrestling competition analysis form according to the latest competition rules*, "International Journal of Wrestling Science", vol. 7, no. 1-2, pp. 41-45.

23. Johnson J. (2017), *From technique to way: an investigation into taekwondo's pedagogical process*, "Ido Movement for Culture. Journal of Martial Arts Anthropology", vol. 17, no. 4, pp. 3-13; doi: 10.14589/ido.17.4.2.

24. Konings M.J., Hettinga F.J. (2018), *Pacing decision making in sport and the effects of interpersonal competition: A critical review*, "Sports Medicine", vol. 48, no. 8, pp. 1829-1843; doi: 10.1007/s40279-018-0937-x.

25. Korobeynikov G., Korobeynikova L., Iermakov S., Nosko M. (2016), *Reaction of heart rate regulation to extreme sport activity in elite athletes*, "Journal of Physical Education and Sport", vol. 16, no. 3, pp. 976-981; doi: 10.7752/jpes.2016.03154.

26. Korobeinikova L., Korobeynikov G., Cynarski W.J., Borysova O., Kovalchuk V., Matveev S., Novak V. (2020), *Tactical styles of fighting and functional asymmetry of the brain among elite wrestlers*, "Ido Movement for Culture. Journal of Martial Arts Anthropology", vol. 20, no. 4, pp. 24-30; doi: 10.14589/ido.20.4.4.

27. Korobeynikov G., Imas Y., Korobeynikova L., Ludanov K., Shatskykh V., Tolkunova I., Mishchenko V. (2021), *Body Composition and Heart Rhythm Variability in Elite Wrestlers*, "Sport Mont", vol. 19, no. S2, pp. 147-151; doi: 10.26773/smj.210925.

28. Kozina Z.L., Prusik K., Prusik K. (2015), *The concept of individual approach in sport*, "Pedagogics, psychology, medical-biological problems of physical training and sports", vol. 19, no. 3, pp. 28-37; doi: 10.15561/18189172.2015.0305.

29. Latyshev M., Holovach I. (2021), *Improvement of the Technical and Tactical Preparation of Wrestlers with the Consideration of an Individual Combat Style*, "Sport Mont", vol. 19, pp. 23-28; doi: 10.26773/smj.210604.

30. Laborde S., Raab M. (2013), *The tale of hearts and reason: the influence of mood on decision making*, "Journal of Sport & Exercise Psychology", vol. 35, no. 4, pp. 339-357.

31. Laborde S., Mosley E., Thayer J.F. (2017), *Heart Rate Variability and Cardiac Vagal Tone in Psychophysiological Research-Recommendations for Experiment Planning, Data Analysis, and Data Reporting*, "Frontiers in psychology", vol. 8, pp. 213-213; doi: 10.3389/fpsyg.2017.00213.

32. Laborde S., Mosley E., Mertgen A. (2018), *Vagal tank theory: the three rs of cardiac vagal control functioning – resting, reactivity, and recovery*, "Frontiers in Neuroscience", vol. 12, pp. 458; doi: 10.3389/fnins.2018.00458.

33. Lensen I.S., Monfredi O.J., Andris R.T., Lake D.E., Moorman J.R. (2020), *Heart rate fragmentation gives novel insights into non-autonomic mechanisms governing beat-to-beat control of the heart's rhythm*, "JRSM Cardiovascular Disease", vol. 9; doi: 10.1177/2048004020948732.

34. Loras H., Sigmundsson H., Talcott J.B., Ohberg F., Stensdotter A.K. (2012), *Timing continuous or discontinuous movements across effectors specified by different pacing modalities and intervals*, "Experimental Brain Research", vol. 220, no. 3, pp. 335-347; doi: 10.1007/s00221-012-3142-4.

35. Lyzohub V.S., Shpanyuk V.V., Pustovalov V.O., Kozhemyako T.V., Suprunovich V.O. (2021), *Do the results of the sensomotor response reflect the typological properties of the central nervous system?*, "Cherkasy University Bulletin: Biological Sciences Series", vol. 1, pp. 69-77; doi: 10.31651/2076-5835-2018-1-2021-1-69-77.

36. Markovic M., Kukic F., Zaric I., Toskic L., Kasum G., Dopsaj M. (2020), *Development trend of freestyle wrestling: influence of the rule changes on competitive activity*, "International Journal of Wrestling Science", vol. 10, no. 1, pp. 31-38.

37. Mirzaei B., Faryabi I., Yousefabadi H.A. (2021), *Time-Motion analysis of the 2017 Wrestling World Championships*, "Pedagogy of Physical Culture and Sports", vol. 25, no. 1, 24-30; doi: 10.15561/26649837.2021.0104.

38. Movahedi A., Sheikh M., Bagherzadeh F., Hemayattalab R., Ashayeri H. (2007), *A practice-specificity-based model of arousal for achieving peak performance*, "Journal of motor behavior", vol. 39, no. 6, pp. 457-462; doi: 10.3200/JMBR.39.6.457-462.

39. Musculus L., Raab M. (2022), *A Developmental Perspective on Motor-Cognitive Interactions and Performance in Sports*, "Psychology of Sport and Exercise", no. 102202.

40. Nweze T., Agu E., Lange F. (2020), *Risky decision making and cognitive flexibility among online sports bettors in Nigeria*, "International Journal of Psychology", vol. 55, no. 6, 995-1002; doi: 10.1002/ijop.12663.

41. Ong N.C. (2019), *Assessing objective achievement motivation in elite athletes: A comparison according to gender, sport type, and competitive level*, "International Journal of Sport and Exercise Psychology", vol. 17, no. 4, pp. 397-409; doi: 10.1080/1612197x.2017.1349822.

42. Podrigalo L., Iermakov S., Potop V., Romanenko V., Boychenko N., Rovnaya O., Tropin Y. (2017), *Special aspects of psycho-physiological reactions of different skillfulness athletes, practicing martial arts*, "Journal of Physical Education and Sport", vol. 17, pp. 519-526; doi: 10.7752/jpes.2017.s2078.

43. Raab M., Lobinger B., Hoffmann S., Pizzera A., Laborde S. (2015), *Performance Psychology: Perception, Action, Cognition, and Emotion*, Academic Press.

44. Raab M., Clare M.M., Simcha A., Michael B.E. (2019), *Heuristics, biases, and decision making*, "Anticipation and decision making in sport", Routledge, pp. 215-231.

45. Saberi Moghadam S., Samsami Khodadad F., Khazaeinezhad V. (2019), *An algorithmic model of decision making in the human brain*, "Basic and Clinical Neuroscience", vol. 10, no. 5, pp. 443-450; doi: 10.32598/bcn.9.10.395.

46. Schmausser M., Hoffmann S., Raab M., Laborde S. (2022), *The effects of noninvasive brain stimulation on heart rate and heart rate variability: A systematic review and meta-analysis*, "Journal of Neuroscience Research", vol. 100, pp. 1664–1694; doi: 10.1002/ jnr.25062.

47. Sherman S.M., Usrey W.M. (2021), *Cortical control of behavior and attention from an evolutionary perspective*, "Neuron", vol. 109, no. 19, pp. 3048-3054; doi: 10.1016/j.neuron.2021.06.021.

48. Sciranka J., Augustovicova D., Stefanovsky M. (2022), *Time-motion analysis in freestyle wrestling: Weight category as a factor in different time-motion structures*, "Ido Movement for Culture. Journal of Martial Arts Anthropology", vol. 22, no. 1, pp. 1-9; doi: 10.14589/ido.22.1.1.

49. Sciranka J., Augustovicova D., Stefanovsky M. (2022), *Time-motion analysis in freestyle wrestling: Weight category as a factor in different time-motion structures*, "Ido Movement for Culture. Journal of Martial Arts Anthropology", vol. 22, no. 1, pp. 1-8; doi: 10.14589/ido.22.1.1.

50. Soto D.A.S., Aedo-Munoz E., Brito C.J., Camey S., Miarka B. (2020), *Making decisions and motor actions with technical biomechanical classifications in male judo weight categories*, "Journal of Human Kinetics", vol. 72, no. 1, pp. 241-252; doi: 10.2478/hukin-2019-0110.

51. Spiers J.P., Silke B., McDermott U., Shanks R.G., Harron D.W. (1993), *Time and frequency domain assessment of heart rate variability: a theoretical and clinical appreciation*, "Clinical Autonomic Research", vol. 3, no. 2, pp. 145-158.

52. Tron R., Hruzevych I., Salnykova S., Kormiltsev V., Sarafynyuk P., Kyrychenko Y., Kropta R. (2018), *Psychophysiological conditions and competition in highly qualified combat sambo wrestlers*, "Journal of Physical Education and Sport", vol. 18, no. 2, pp. 600-605; doi:10.7752/jpes.2018.02087.

53. Tunnemann H., Curby D.G. (2016), *Scoring analysis of the wrestling from the 2016 Rio Olympic Games*, "International Journal of Wrestling Science", vol. 6, no. 2, pp. 90-116; doi: 10.1080/21615667.2017.1315197.

54. Turlykhanov D., Korobeynikov G., Korobeinikova L., Raab M., Korobeinikova I. (2022), *Psychophysiological state and decision making in elite wrestlers*, "International Journal of Wrestling Science", vol. 12, no. 1, pp. 28-32.

55. Volodchenko O.A., Podrigalo L.V., Iermakov S.S., Zychowska M.T., Jagiello W. (2019), *The usefulness of performing biochemical tests in the saliva of kickboxing athletes in the dynamic of training*, "BioMed Research International", pp. 2014347; doi: 10.1155/2019/2014347.

56. You M., Laborde S., Salvotti C., Zammit N., Mosley E., Dosseville F. (2022), *Influence of a single slow-paced breathing session on cardiac vagal activity in athletes*, "International Journal of Mental Health and Addiction", vol. 20, no. 3, pp. 1632-1644; doi: 10.1007/s11469-020-00467-x.

57. Zadorozhna O., Briskin Y., Pityn M., Svistelnyk I., Roztorhui M., Vorontsov A. (2021), *The importance of information blocks, which form the basis of tactical knowledge at different stages of long-term development in modern Olympic com-*

bat sports*, "Ido Movement for Culture. Journal of Martial Arts Anthropology", vol. 21, no. 2, pp. 27-40; doi: 10.14589/ido.21.2.5.

## Stan psychofizjologiczny i podejmowanie decyzji u zapaśników

**Słowa kluczowe**: stan psychofizjologiczny, zapaśnicy, podejmowanie decyzji

**Streszczenie**

Tło. Badanie funkcji psychofizjologicznych u sportowców jest ważne dla dostosowania odpowiedniego procesu treningowego. W tym artykule autorzy badali postrzeganie szybkości i podejmowania decyzji podczas walk zapaśniczych jako kluczowego elementu skuteczności. Stwierdzono, że zapaśnik musi przewidywać sytuację, a szybki wybór reakcji jest wymagany w oparciu o szybkie i oszczędne podejmowanie decyzji.

Cel. Zagadnienie to badane było za pomocą serii testów psychofizjologicznych do testowania korelatów szybkiego lub wolnego podejmowania decyzji u zapaśników.

Metoda. Przebadano 29 elitarnych zapaśników stylu klasycznego. Stany psychofizjologiczne zapaśników badano za pomocą serii testowej: testu wzrokowo-ruchowego, inteligencji niewerbalnej, przewidywania i zmienności rytmu serca. Kompetencje te są skorelowane z szybkim lub wolnym czasem podejmowania decyzji przy wyborze między różnymi bodźcami.

Wyniki. Analiza wykazała korelację pomiędzy szybkim podejmowaniem decyzji a percepcją wzrokową, wzrostem impulsywności i poziomem napięcia emocjonalnego podczas walki. Ponadto szybsze podejmowanie decyzji występowało u zapaśników o wysokiej zdolności przewidywania i równowadze między procesami pobudzenia i hamowania. Dane psychofizjologiczne sugerują, że szybkie podejmowanie decyzji koreluje z autonomiczną regulacją tętna.

Wnioski. Szybkie podejmowanie decyzji u zapaśników wydaje się być związane z szeregiem parametrów zestawu testów psychofizjologicznych, które wymagają w przyszłości podejścia przyczynowego i eksperymentalnego, a specyficzny trening tych czynników pozwoli zapaśnikom na poprawę czasu podejmowania decyzji.