ORIGINAL ARTICLE

Cognitive functions and special working capacity in elite boxers

Georgiy Korobeynikov[1,2ABCDE], Lesia Korobeinikova[1,2ABCDE], Markus Raab[2,3CDE], Mario Baić[4BCD], Olga Borysova[1BCE], Ivanna Korobeinikova[2,5BCD], Gou Shengpeng[1ABD], Irene Khmelnitska[1CD]

[1]*National University of Ukraine on Physical Education and Sport, Ukraine*
[2]*German Sport University Cologne, Institute of Psychology, Germany*
[3]*School of Applied Sciences London South Bank University, Great Britain*
[4]*University of Zagreb, Faculty at Faculty of Kinesiology, Zagreb, Croatia*
[5]*Institute of Psychology of the National Academy of Educational Sciences of Ukraine, Ukraine*

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim: In the basis of the boxer's power qualities is the ability to perceive and process external information. Therefore, in order to ensure the proper training of qualified boxers, there is a need to monitor the functional state of the boxer's organism. The relationship between cognitive functions and special working capacity of elite boxers were studied.

Material and Methods: The level of special working capacity was studied by the test of punching a boxer for 8 s at maximum speed. Cognitive functions (verbal and nonverbal intelligence, and word memory) were studied using the "Multipsychometer-05" (European-Asian Association of Polygraphologists, Kazakhstan) hardware-software. 26 elite boxers, aged 18-24, were tested.

Results: The research results showed that groups of boxers with different levels of special working capacity differ in terms of accuracy and efficiency when performing a cognitive task with verbal stimuli. The high level of special working capacity of elite boxers is provided by the manifestation of verbal intelligence. Besides, the special working capacity is related with activation of mental functions of attention, speed of visual perception, operational and logical thinking. At the same time, significantly higher values of decision latency in this group of boxers indicate a slowdown in the processing of nonverbal information in boxers with a high level of special working capacity to work. It can be noted that the special working capacity of boxers has a direct relationship with quality and inverse relationship with the speed of information processing. The speed of memorizing verbal information is better in boxers with a high level of special working capacity. This fact indicates the importance of the verbal factor for the assimilation of special information in the training of boxers. The best values of accuracy and efficiency indicate the relationship of special working capacity in skilled boxers with the quality and volume of memorized verbal information.

Conclusions: The special working capacity of elite boxers has a direct relationship with quality and inverse relationship with the speed of information processing. The elite boxers with a high level of special working capacity have a better speed of verbal information memorizing.

Keywords: cognitive functions, boxers, special capacity, verbal, nonverbal, intelligence

Introduction

Modern boxing is characterized by an increase in the intensity of fights and the rate of change of the situation in the ring. Many researchers focus on the speed and strength properties of boxers as necessary factors of efficiency in competitive conditions [1, 2, 3]. However, the basis of the boxer's power qualities is the ability to perceive and process external information [4, 5].

Therefore, in order to ensure the proper training of qualified boxers, there is a need to monitor the functional state of the boxer's organism. After all, the high intensity of the fight requires boxers to maximize the mobilization of psycho-emotional and functional resources. It is known that the functional state of the athlete's body reflects an integrated set of characteristics of the athlete, which are responsible for the effectiveness of training and competitive activities [6, 7]. Among the factors of the functional state of the qualified wrestler's organism, the psychophysiological characteristics are most important [8, 9]. In turn, cognitive functions are components of the athlete's psychophysiological state [10, 11]. Based on this, it is advisable to use the evaluation of the state of cognitive functions to assess the ability of boxers to the training and competitive process.

Analysis of the structure of competitive activity in single combats indicates an important aspect of mental activity aimed at the perception of information and prompt decision-making during the fight [12, 13]. Current research on integrated control in single combats shows that most of the work concerns certain characteristics of athlete's

doi:10.15561/26649837.2023.0110

functional state in different conditions of training and competitive activities [14, 15, 16]. However, many studies do not have a comprehensive approach to assessing the relationship between athlete's cognitive function and special working capacity. From the point of view of the peculiarities of a boxing match, it is important to synchronize between the perception and processing of external information with the motor realization. For effective perception of information, its analysis and decision-making on the appropriate response to the actions of the opponent, it is necessary to activate cognitive functions such as memory and intelligence of the boxer.

Verbal intelligence is associated with the perception of verbal information, primarily from the coach - the second, which allows the athlete to adjust their actions in accordance with appropriate strategies. Non-verbal intelligence is related to the athlete's ability to perceive external factors related to the opponent's actions and to respond quickly to situations that arise in a duel. The memory function is characterized by memorizing and retrieving information from the long-term motor response to counteract the actions of the opponent. In sum, there is a need to study the relationship between the manifestation of cognitive functions and the special working capacity of elite boxers.

The research purpose is to study the relationship between cognitive functions and special working capacity of elite boxers.

Material and Methods

Participants

26 elite boxers, members of the Kyiv city team, aged 18-24, were tested. All athletes agreed to conduct scientific tests and use the research results for scientific purposes, in accordance with the recommendations of the Ethics Committees on biomedical research.

Research Design

Special working capacity

The chronodynamometer "Spuderg" of Savchyn's design was used to assess the athlete's special working capacity [17]. The level of special working capacity was studied by the test of the boxer's blows for 8 s at maximum speed.

Cognitive functions

Cognitive functions were studied using the "Multipsychometer-05" (European-Asian Association of Polygraphologists, Kazakhstan) hardware-software. The following methods have been assessed: verbal, nonverbal intelligence and word memory. The assessment of verbal intelligence was carried out on the "Establishing patterns" test. This test is designed to study the features of the thinking process (activity, intelligence) and random access memory (RAM). The peculiarity of testing is to define in one word out of five, presented in coded form. The athlete is asked to perform 25 tasks in 6 minutes. According to the test results, the following indicators are determined: productivity; speed; precision; efficiency. Nonverbal intelligence was determined by the "Comparison of numbers" test. The task of the "Comparison of numbers" test is to assess the peculiarities of the mobilization of human cognitive resources. The procedure involved a consistent comparison of numbers by size. One by one, numbers from 2 to 9 were displayed in the center of the display. The task was to compare the current number with the previous one. The length of the test is 128 signals; the duration of execution is from 1.5 to 4 minutes, at auto tempo. According to the test results, the following indicators were determined: efficiency, reaction latency, accuracy and stability. The "Memory for words" test was designed to assess the amount and stability of short-term memory for verbal stimuli. The subject had to memorize a set of 30 different words for 1 minute. At the end of the time, numbered combinations of 5 words appeared on the screen. The participant needs to recognize the word that was presented for memorization, and indicate it by pressing the appropriate key. In each proposed combination of words it could be only one word that was memorized. The technique took 4 minutes. Based on the test results, the following indicators were determined: productivity, speed, accuracy and efficiency.

Statistical analysis

Statistical processing of the obtained results was performed using the "Statistica 12" software. Since the analyzed indicators were non normal distributed, the Wilcoxon rank sum test was used to determine the statistically significant difference between the samples. To present the data distribution, an interquartile range was used, indicating the first quartile (25% percentile) and the third quartile (75%).

Results

According to the results of special working capacity, all boxers were divided into two conventional groups. The first group had a high level of working capacity (from 200 conventional units and above), the second group had a low level of special working capacity (below 200 conventional units). The first group included 12 athletes, the second – 14 athletes.

The Table 1 presents the average values of the "Establishing patterns" cognitive test for solving verbal tasks in qualified boxers with different levels of special working capacity. When performing the "Establishing patterns" test, the functions, perception of external information, operational and logical thinking, as well as concentration, are

activated. The higher values of the accuracy index that were identified in terms of performing a verbal test in boxers with a high level of special working capacity indicated the ability to perceive and process information, as well as concentration (Table 1).

The research results showed that groups of boxers with different levels of special working capacity differ in terms of accuracy and efficiency when performing a cognitive task with verbal stimuli. The presence of significant better values of efficiency in boxers with a high level of special working capacity indicated the manifestation of logical and operational thinking in terms of performing a verbal test. Thus, a high level of special working capacity in elite boxers that is indicated by the manifestation of verbal intelligence with the activation of mental functions of attention, speed of visual perception, operational and logical thinking.

Table 2 presents the average values of the "Comparison of numbers" cognitive test in solving nonverbal problems in elite boxers with different levels of special working capacity. The analysis showed the presence of significant differences between groups of boxers with different levels of special working capacity in terms of efficiency, solution latency and stability. The presence of significantly higher values of efficiency in boxers with a high level of special working capacity indicates a better quality of processing of nonverbal information.

At the same time, significantly higher values of solution latency in this group of boxers indicate a slowdown in the speed of nonverbal information processing in boxers with a high level of special working capacity (Table 2). It can be noted that the special working capacity of boxers has a direct relationship with quality and inverse relationship with the speed of information processing.

Significantly higher values of stability in boxers with a high level of working capacity indicate a weakening of mental stress in boxers of this group (Table 2). At the same time, the decrease in

Table 1. The average values of the "Establishing patterns" cognitive test in elite boxers with different levels of special working capacity (median, lower and upper quartiles)

Parameter	High level of working capacity (n = 12)	Low level of working capacity (n = 14)
Productivity, conventional units	19.00	20.00
	17.00; 21.00	16.50; 21.00
Speed, conventional units	4.65	4.26
	3.66; 5.17	3.41; 5.39
Accuracy, conventional units	0.85	0.72*
	0.72; 0.91	0.66; 0.83
Efficiency, conventional units	60.00	43.60*
	46.80; 70.91	36.97; 51.60

Legenda: * - the difference is statistically significant comparing the two groups of boxers of high and low working capacity (p =.05)

Table 2. The average values of the "Comparison of numbers" cognitive test in elite boxers with different levels of special working capacity (median, lower and upper quartiles)

Parameter	High level of working capacity (n = 12)	Low level of working capacity (n = 14)
Efficiency, conventional units	1097.70	944.27*
	891.61; 1357.40	844.91; 1037.60
Solution latency, ms	1080.60	904.13*
	877.68; 1283.20	808.34; 983.96
Accuracy, conventional units	0.97	0.95
	0.93; 0.98	0.94; 0.96
Stability, %	36.03	26.59*
	32.47; 40.76	21.59; 31.06*

Legenda: * - the difference is statistically significant comparing the two groups of boxers of high and low working capacity (p =.05)

Table 3. The average values of the "Word memory" cognitive test in elite boxers with different levels of special working capacity (median, lower and upper quartiles)

Parameter	High level of working capacity (n = 12)	Low level of working capacity (n = 14)
Productivity, conventional units	24.00	21.50
	17.00; 27.00	15.50; 24.50
Speed, conventional units	10.34	8.62*
	8.05; 12.96	7.56; 10.60
Accuracy, conventional units	0.80	0.71*
	0.56; 0.90	0.61; 0.80
Efficiency, conventional units	60.00	46.59*
	25.97; 78.75	26.43; 62.98

Legenda: * - the difference is statistically significant comparing the two groups of boxers of high and low working capacity (p =.05)

the rate of stability in boxers with a slowdown in special working capacity indicates the presence of mental stress against the background of accelerated processing of information.

The Table 3 presents the average values of the "Word memory" cognitive test in elite boxers with different levels of special working capacity. The analysis showed significantly higher values of speed, accuracy and efficiency in qualified boxers with a high level of special working capacity. The speed of verbal information memorizing is better in boxers with a high level of special working capacity. This fact indicates the importance of the verbal factor for the assimilation of special information in the training of boxers. The best values of accuracy and efficiency indicate the relationship of special working capacity in skilled boxers with the quality and volume of memorized verbal information.

Discussion

The development of boxing at the present stage is characterized by changes in the rules of competition aimed at increasing the intensity and spectacle of competitive fighting [18, 19]. The changes taking place in boxing are aimed, firstly, at increasing the safety from athlete's injury, and, secondly, at bringing the boxing scheme closer to the result that is clear to the audience.

In addition, major changes in competition rules are associated with encouraging boxer activity and increasing the intensity of competitive combat [20]. In this regard, there is a need to restructure the training program for qualified boxers, taking into account the modern requirements of competitive activities.

Therefore, in order to ensure the proper training of qualified boxers, it is necessary to monitor the functional state of the body. After all, the high intensity of the fight requires boxers to maximize the mobilization of psycho-emotional and functional resources [21]. It is known that the functional state of the athlete's body reflects an integrated set of characteristics, which are responsible for the effectiveness of training and competitive activities [22, 23]. One of the components of the functional state of the body of qualified athletes is psychophysiological functions [24, 25]. Based on this, it is advisable to use the assessment of psychophysiological functions for the needs of current control for qualified boxers. However, among the components of psychophysiological functions, cognitive characteristics occupy a leading link [26, 27]. After all, due to the cognitive characteristics of the athlete, it is possible to perceive and process adequately the external information for successful activation [28, 29].

The structure of competitive activity in boxing includes elements of neurodynamic, psychomotor and cognitive characteristics [30, 31]. Analysis of modern research on the study of integrated control in single combats shows that most of the work is devoted to the study of certain characteristics of the functional state of athletes in different conditions of training and competitive activities [32]. However, among many studies there is no comprehensive approach to assessing the functional and psychophysiological condition of qualified athletes. In our research, we examined the relationship of special working capacity with cognitive functions in elite boxers.

It has been established that non-verbal intelligence is important for boxers with a reduced level of special working capacity in the training process. Obviously, non-verbal information related to visual perception allows elite boxers to compensate for the decrease in the level of special working capacity. Boxers with a high level of special working capacity have the best values of logical and operational thinking in terms of performing a verbal test. It was found that a high level of special

working capacity in elite boxers is provided by the manifestation of verbal intelligence with the activation of the functions of attention, speed of visual perception, operational and logical thinking.

The quality of non-verbal information processing is better in boxers with a high level of special working capacity. However, this affects the speed of perception of non-verbal information, which is better for boxers with a reduced level of special working capacity. It can be noted that the special working capacity of elite boxers has a direct relationship with quality and inverse relationship with the speed of information processing. The speed of verbal information memorizing is better in boxers with a high level of special working capacity. This result indicates the importance of verbal intelligence for the assimilation of special information in the training of elite boxers.

Conclusions

In conclusion high level of special working capacity of elite boxers is provided by activation of verbal intelligence, logical and operational thinking. In addition, the special working capacity of elite boxers has a direct relationship with quality and inverse relationship with the speed of information processing. Finally, elite boxers with a high level of special working capacity have a better speed of verbal information memorizing.

Acknowledgement

Many thanks from the authors to the coaches and athletes for their help in conducting the study.

Conflict of interest

There is no potential conflict of interest between co-authors.

References

1. Cepulenas A, Bruzas V, Mockus P, Subacius V. Impact of physical training mesocycle on athletic and specific fitness of elite boxers. *Archives of Budo*, 2011;7(1): 33–39.
2. Bu X. Experimental Study on the Effect of Speed Strength Training on the Special Strikes of Chinese Female Boxers. *Journal of Environmental and Public Health*, 2022;2022: 5912231. https://doi.org/10.1155/2022/5912231
3. Wu Q. Boxing speed and muscle scientific training. *Revista Brasileira De Medicina Do Esporte*, 2022;28(2): 82–84. https://doi.org/10.1590/1517-8692202228022021_0428
4. Deochand N, Costello MS, Fuqua RW. Real-Time Contingent Feedback to Enhance Punching Performance. *Psychological Record*, 2020;70(1): 33–45. https://doi.org/10.1007/s40732-019-00357-2
5. Halperin I, Chapman DW, Thompson KG, Abbiss C. False-performance feedback does not affect punching forces and pacing of elite boxers. *Journal of Sports Sciences*, 2019;37(1): 59–66. https://doi.org/10.1080/02640414.2018.1482526
6. Broeker L, Brüning J, Fandakova Y, Khosravani N, Kiesel A, Kubik V, et al. Individual differences fill the uncharted intersections between cognitive structure, flexibility, and plasticity in multitasking. *Psychological Review*, 2022; 129(6): 1486–1494. https://doi.org/10.1037/rev0000376
7. Seidel-Marzi O, Ragert P. Neurodiagnostics in Sports: Investigating the Athlete's Brain to Augment Performance and Sport-Specific Skills. *Frontiers in Human Neuroscience*, 2020;14: 133. https://doi.org/10.3389/fnhum.2020.00133
8. Cirino C, Gobatto CA, Pinto AS, Torres RS, Hartz CS, Azevedo PHSM, et al. Complex network model indicates a positive effect of inspiratory muscles pre-activation on performance parameters in a judo match. *Scientific Reports*, 2021;11(1): 11148. https://doi.org/10.1038/s41598-021-90394-1
9. Korobeinikova L, Korobeynikov G, Cynarski WJ, Borysova O, Kovalchuk V, Matveev S, et al. Tactical styles of fighting and functional asymmetry of the brain among elite wrestlers. *Ido Movement for Culture. Journal of Martial Arts Anthropology*, 2020;20(4):24–30. https://doi.org/10.14589/ido.20.4.4
10. Musculus L, Raab M. A Developmental Perspective on Motor-Cognitive Interactions and Performance in Sports. *Psychology of Sport and Exercise*, 2022;61:102202. https://doi.org/10.1016/j.psychsport.2022.102202
11. Panten J, Loffing F, Baker J, Schorer J. Extending Research on Deception in Sport–Combining Perception and Kinematic Approaches. *Frontiers in Psychology*, 2019;10:2650. https://doi.org/10.3389/fpsyg.2019.02650
12. Drozdovski AK. The connection between typological complexes of properties of the nervous system, temperaments, and personality types in the professions and sports. *Open Access Journal of Sports Medicine,* 2015;6:161–172. https://doi.org/10.2147/OAJSM.S75612
13. Finlay MJ, Page RM, Greig M, Bridge CA. The prevalence of pre-conditioning and recovery strategies in senior elite and non-elite amateur boxing. *The Physician and Sportsmedicine*, 2022;50(4):323–31. https://doi.org/10.1080/00913847.2021.1931525
14. Kalén A, Bisagno E, Musculus L, Raab M, Pérez-Ferreirós A, Williams AM, et al. The role of domain-specific and domain-general cognitive functions and skills in sports performance: A meta-analysis. *Psychological Bulletin,* 2021;147(12):1290–1308. https://doi.org/10.1037/bul0000355
15. Chernozub A, Danylchenko S, Imas Y, Kochina M, Ieremenko N, Korobeynikov G, et al. Peculiarities of correcting load parameters in power training of mixed martial arts athletes. *Journal of Physical Education and Sport*, 2019;19:481–488. https://doi.

org/10.7752/jpes.2019.s2070
16. Korobeynikov G, Bulatova M, Zhirnov O, Cynarski WJ, Wasik J, Korobeinikova L, et al. Links between postural stability and neurodynamic characteristics in kickboxers. *Ido Movement for Cultutre. Journal of Martial Arts Anthropology*, 2021;21(1): 1–5. https://doi.org/10.14589/ido.21.1.1
17. Klychko V, Savchyn M. A system of tests for evaluating special fitness of highly skilled boxers. *Science in Olympic Sport*, 2019;3:138–144.
18. Bianco M, Loosemore M, Daniele G, Palmieri V, Faina M, Zeppilli P. Amateur boxing in the last 59 years. Impact of rules changes on the type of verdicts recorded and implications on boxers' health. *British Journal of Sports Medicine*, 2013;47(7): 452–457. https://doi.org/10.1136/bjsports-2012-091771
19. Dilmurodov SS. Competitive activities of qualified boxers in connection with peculiarities of battle tactics. *Berlin Studies Transnational Journal of Science and Humanities*, 2021;1:617–529. https://doi.org/10.5281/zenodo.5810753
20. Seifert T, Bernick C, Jordan B, Alessi A, Davidson J, Cantu R, et al. Determining brain fitness to fight: Has the time come?. *The Physician and Sportsmedicine*, 2015;43(4):395–402. https://doi.org/10.1080/00913847.2015.1081551
21. Slimani M, Miarka B, Teixeira RPA, Znazen H, Tod D, Nikolaidis PT, et al. Effect of acute boxing training session on cognitive function and psychological states. *Medicina Dello Sport*, 2022;75(3): 404–412. https://doi.org/10.23736/S0025-7826.22.04166-7
22. Korobeynikov G, Potop V, Korobeynikova L, Kolumbet A, Khmelnitska I, Shtanagey D, et al. Research of the hand motion dynamic characteristics of the women boxers with different types of functional asymmetry. *Journal of Physical Education and Sport*, 2019;19:2185–2191. https://doi.org/10.7752/jpes.2019.s6328
23. Schinke RJ, Battochio RC, Dube TV, Lidor R, Tenenbaum G, Lane AM. Adaptation Processes Affecting Performance in Elite Sport. *Journal of Clinical Sport Psychology*, 2012;6(2): 180–195. https://doi.org/10.1123/jcsp.6.2.180
24. Battaglini MP, Pessoa Filho DM, Calais SL, Miyazaki MCOS, Neiva CM, Espada MC, et al. Analysis of Progressive Muscle Relaxation on Psychophysiological Variables in Basketball Athletes. *International Journal of Environmental Research and Public Health*, 2022;19(24): 17065. https://doi.org/10.3390/ijerph192417065
25. Edwards AM, Polman RC. Pacing and awareness: brain regulation of physical activity. Sports Medicine. 2013;43(11):1057-64. https://doi.org/10.1007/s40279-013-0091-4
26. Huaguang G. Complex dynamics of the nervous system for information processing and abnormal functions. *Chinese Journal of Theoretical and Applied Mechanics*, 2017;49(2):410–20. https://doi.org/10.6052/0459-1879-16-315
27. Yongtawee A, Park J, Kim Y, Woo M. Athletes have different dominant cognitive functions depending on type of sport. *International Journal of Sport and Exercise Psychology*, 2022;20(1):1–5. https://doi.org/10.1080/1612197X.2021.1956570
28. Russo G, Ottoboni G. The perceptual–Cognitive skills of combat sports athletes: A systematic review. *Psychology of Sport and Exercise*, 2019;44:60–78. https://doi.org/10.1016/j.psychsport.2019.05.004
29. Harwood-Gross A, Lambez B, Feldman R, Zagoory-Sharon O, Rassovsky Y. The Effect of Martial Arts Training on Cognitive and Psychological Functions in At-Risk Youths. *Front Pediatr*. 2021;9:707047. https://doi.org/10.3389/fped.2021.707047
30. Johnstone A, Marí-Beffa P. The effects of martial arts training on attentional networks in typical adults. *Frontiers in Psychology*, 2018;9:1-9. https://doi.org/10.3389/fpsyg.2018.00080
31. Ashker SE. Technical and tactical aspects that differentiate winning and losing performances in boxing. *International Journal of Performance Analysis in Sport*, 2011;11(2):356–64. https://doi.org/10.1080/24748668.2011.11868555
32. Obmiński Z, Mroczkowska H, Kownacka I, Stabno J. Personality traits and eye-hand coordination in less-and more succesful young male boxers. *Journal of Combat Sports and Martial Arts*, 2011;2(2):83–89.

Information about the authors:

Georgiy Korobeynikov; (Corresponding Author); https://orcid.org/0000-0002-1097-4787; k.george.65.w@gmail.com; National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine); Institute of Psychology, German Sport University Cologne, (Cologne, Germany).

Lesia Korobeinikova; https://orcid.org/0000-0001-8648-316X; korlesia.66@gmail.com; National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine); Institute of Psychology, German Sport University Cologne (Cologne, Germany).

Markus Raab; https://orcid.org/0000-0001-6546-1666; Raab@dshs-koeln.de; Institute of Psychology, German Sport University Cologne (Cologne, Germany); School of Applied Sciences London South Bank University (London, Great Britain).

Mario Baić; https://orcid.org/0000-0003-0581-0590; mario.baic@kif.unizg.hr; Faculty at Faculty of Kinesiology, University of Zagreb; Zagreb, Croatia.

Olga Borysova; https://orcid.org/0000-0002-2311-1921; borisova-nupesu@ukr.net; National University of Ukraine on Physical Education and Sport; Kyiv, Ukraine.

Ivanna Korobeinikova; https://orcid.org/0000-0001-6231-8012; ivakorobeinikova@gmail.com; Institute of Psychology, German Sport University Cologne (Cologne, Germany); Institute of Psychology, National Academy of Educational Sciences of Ukraine (Kyiv, Ukraine).

Gou Shengpeng; https://orcid.org/0000-0003-1456-9962; guoshengpeng1118@126.com; National University of Ukraine on Physical Education and Sport; Kyiv, Ukraine.

Irene Khmelnitska; https://orcid.org/0000-0003-0141-3301; khmeln.irene@gmail.com; National University of Ukraine on Physical Education and Sport; Kyiv, Ukraine.

Cite this article as:

Korobeynikov G, Korobeinikova L, Raab M, Baić M, Borysova O, Korobeinikova I, Shengpeng G, Khmelnitska I. Cognitive functions and special working capacity in elite boxers. *Pedagogy of Physical Culture and Sports,* 2023;27(1):84–90.
https://doi.org/10.15561/26649837.2023.0110

Received: 02.12.2022
Accepted: 28.01.2023; Published: 28.02.2023