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Original Article

Evaluation of the speed of a complex visual-motor response in highly skilled female boxers

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Abstract:
Purpose:- determining the peculiarities of complex visual-motor response of female boxers with different types of functional asymmetry. **Material:**50 highly skilled female boxers (masters of sports of international class, masters of sports). The study of female boxer psychomotor functions was designed according to a certain scheme. The motor component of motor response was examined by means of tapping test. The time of a simple and two complex visual-motor responses was determined. The study was completed by determining the identification time for visual stimuli of various degrees of complexity without a motor response. It was assumed that this will allow to consider the visual-gnostic component in a "pure" form. Such a design of the study permitted to evaluate the contribution of each component of psychomotor response to the response speed of female boxers with different types of functional hemispheric asymmetry (FHA) profile. **Results:**the right hand of the right-handers was found to be significantly faster than that of left-handers and, especially, ambidexters. The left hand speed of the right-handers is almost the same as that of the left-handers, whereas in ambidexters it is significantly higher. The right-handers appear to be faster during realization of complex visual-motor response than both the left-handers and ambidexters. As for the asymmetry of the legs, it is not possible to talk about the relationship between the lateralization character and the speed of the choice time. Among most of athletes the right-legged (60.0%) and the left-legged (75.0%) were in the group with a high speed of response. **Conclusions:**A comparison of the responses to the stimulus of the two alternatives shows that the right hand of right-handers is significantly faster than that of the left-handers and, especially, ambidexters. The speed of the left hand of the right-handers is almost the same as that of the left hand of the left-handers, and only in ambidexters it is much higher. Comparison of the responses to the stimulus of the three alternatives indicates that both the right hand and the left hand of the right-handers are significantly faster than those of athletes of the other two groups.Right-handers tend to be faster than left-handers and ambidexters during realization of a complex visual-motor response. The time of complex response in highly skilled female boxers is associated with visual lateralization. Athletes with the right dominant eye are more "speedy".
Keywords: boxing, functionalasymmetry, psychophysiological functions, sensomotorics, technical preparedness

Introduction

The speed of sensorimotor response has always been considered one of the most important qualities determining the success of actions in the ring. Therefore, by no means surprising is the interest in it of numerous researchers. Extensive literature on this subject also addresses sports games and fencing. Sensory responses have been studied both in the conditions of special activity and in laboratories. In laboratories, they were considered as a simplified model of specific responses in simple and complex actions.

A simple response associated with anticipation of a specific signal for a specific response, depends on the specifics of sensory mechanism excitation and the duration of the nervous processes in the centers, as well as on the intensity of the excitation. In complex reactions, disjunctive (with a certain action response to several stimuli of a positive order) and differentiating (with a choice of positive and negative stimuli) ones are distinguished. The time of complex sensorimotor responses depends on the number of neural pathway links, the number of stimuli, and the manifestation character. In addition, it depends on the probabilistic forecasting of this occurrence.

Probabilistic forecasting based on past activities, is closely associated with anticipation responses (forestallings, predictions). Anticipation responses play an important role in combat sport. Anticipation is considered as the ability to act with a certain spatiotemporal outstripping. Perceptual anticipation consists in

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predicting the moment of object appearance in a certain place on the basis of control for the character of its movement. Receptor anticipation leads to a similar result based on the assessment of the object movement time intervals. It may be realized without visual control.

The anticipation mechanisms are also considered in a broader context with five levels of its manifestation - subsensory, sensorimotor, perceptual, apperceptive and verbal-logical – being singled out. The last level is close to tactical thinking according to the class of tasks to be solved.

Actually, three situations arise in a match, which affect the character of the response:

– intentional (when an athlete assumes a certain development of events and prepares appropriate tactical actions);

- deliberately improvisational (in which a pre-planned action runs into opponent's counteraction resulting in a new situation);

- improvisational (which occurs suddenly, at the time of the athlete's insufficient focus on certain actions).

The way of responding is determined not only by external environment, but the athlete's predisposition - the type of response – as well. The sensory type focuses on distinguishing signals in anticipation situation. At that, it does not care about the technique of response. The motor type aims for performing a response action without being particularly concerned with the stimulus character. The neutral type represents a midway between the first and second types. This or other way of athlete responding affects the choice of ways to implement tactical tasks.

In boxing, there is place for various response mechanisms. They form a complex and mobile system, interacting with each other. Through the integration of simple types of response, more complex formations arise. The technico-tactical arsenal of athletes is based on a sensorimotor culture and on the development of diverse forms of response.

A simplified understanding of the response structure leads to conclusions that do not meet contemporary views of this matter. Researchers (Akopyan, 2017; Berdychevskaya, 2004; Gorbachev, 2007; Kolumbet, 2014; Kozina et al., 2017) did not find significant differences in the indices of nonspecific responses among boxers of three different in classification groups (simple response and choice reaction). The authors conclude that the speed of response does not influence sports result. The research data indicate (Kalmykov, 1996; Korobeynikova et al., 2016; Petrov et al., 2009; Taymazov et al., 2004; Chernozubet al., 2019) that the specifics of special activities leaves traces on the formation of the response system, which is confirmed by the characteristic differences in the indices of sensorimotor responses.

The study of a complex visual-motor response speed in boxing is of great importance for identifying the prerequisites determining the peculiarities of motor development, mental and physical state of boxers. It is equally important for individualizing preparation process of athletes.

A complex visual-motor response in athletes was studied in fencing, wrestling and men's boxing (Akopyan et al., 2016; Berdychevskaya et al., 2009; Favre et al., 2007). The speed of a complex visual-motor response in female boxers has not been studied yet.

Objective -determining the peculiarities of complex visual-motor response of female boxers with different types of functional asymmetry.

Material and Methods

Participants. 50 highly skilled female boxers (masters of sports of international class, masters of sports, candidate masters of sports) served as the subjects. Testing was carried out individually.

*Organization of study.*The study of the psychomotor functions of female boxers was organized according to a certain scheme. Initially, the tapping test was used to investigate the motor component of the motor response. It was assumed that the lack of visual stimulus in this test will allow to consider this component in a "pure" form. Then the time of a simple and two complex visual-motor responses was determined. This made it possible to evaluate the specificity of the response in the "eye-hand" system, depending on the complexity of the visual impact. The study culminated in determination of the time of identifying visual stimuli of different complexity degree without a motor response. It was assumed that this will permit to consider the visual-gnostic component in a "pure" form. Such a design of the study allowed to evaluate the contribution of each psychomotor response component to the response speed of female boxers with different types of functional hemispheric asymmetry profile (FHA).

Statistical analysis. During experimental data processing, we determined the average values of indices and their errors (X±m), the degree of difference of averages and the significance of differences (t, p), the dispersion value of variants around the average (σ, CV) as well as the degree of relationship between the studied parameters (r).

While conducting complex pedagogical, biomechanical and biological surveys with the participation of athletes, the legislation of Ukraine on health care, the 2000 Helsinki Declaration, Directive No. 86/609 of the European Society regarding people's participation in biomedical research were adhered to.

Results

The activity of a boxer is a complex visual-motor activity, which requires more than a simple automatic response to any action of the opponent. It necessitates the ability to quickly assess the character of this action and ещ choose the most adequate response among several possible ones. In this regard, it is necessary to consider the peculiarities of the complex visual-motor response of highly skilled female boxers (Table 1).

The response time of the right and the left hands of the right-handers constituted 334.0 ms and 349.0 ms, respectively while choosing among two alternatives. When choosing among three alternatives, both hands reacted slower: the right hand at a speed of 458.0 ms, and the left hand at a speed of 476.0 ms. On average, the response speed of both hands increased by 130.0 ms. In this case, statistically significant differences between the speed of the right and left hands were not observed in any case.

The response time of the right and the left hands of ambidexters constituted 468,0ms and 472,0ms, respectively while choosing among two alternatives. When choosing among three alternatives, the response time increased by 170.0 ms (right hand – up to 618.0 ms, left hand – up to 631.0 ms). Statistically significant differences between the right and the left hands were not revealed as well.

Table 1. Indices of complex visual-motor response speed (ms)

Asymmetry type	Time of choosing among 2 alternatives	Time of choosing among 3 alternatives
Right-handers: - right hand	334,0±11,6	458,0±16,7
- left hand	349,0±13,5	476,0±15,9
Ambidexters: - right hand	468,0±14,3	638,0±21,4
- left hand	472,0±15,6	641,0±18,5
Left-handers: - right hand	351,0±12,4	513,0±17,4
- left hand	344,0±10,8	510,0±14,7

In left-handers, during the first selection the right and the left hands responded at a speed of 351.0 ms and 344.0 ms, respectively. During the second selection, the time increased for the right hand by 162.0 ms and reached 513.0 ms, and for the left hand - by 166.0 ms and reached 510.0 ms, as in the two previous groups. Again, no significant differences between the response speed of the right and left hands were observed.

A comparison of the responses to the stimulus of the two alternatives shows that the right hand of right-handers is significantly faster than that of the left-handers and, especially, ambidexters. The speed of the left hand of the right-handers is almost the same as that of the left hand of the left-handers, and only in ambidexters it is much higher. Comparison of the responses to the stimulus of the three alternatives indicates that both the right hand and the left hand of the right-handers are significantly faster than those of athletes of the other two groups. Right-handers tend to be faster than left-handers and ambidexters during realization of a complex visual-motor response. Comparison with the indices of a simple response indicates that if in that case the left-handers were faster, then in a complex response they lost their leading position to the right-handers. The group of ambidexters, which is the slowest, calls attention to itself. It seems that the situation of choice is problematic for them and significantly slows down their response.

Analysis of the hand, leg, and vision asymmetry representation in groups of female boxers with fast and slow responses to 2 and 3 visual stimuli was conducted to determine the relationship between the asymmetry of different systems and the speed of complex visual-motor response (CVMR). For this purpose, all subjects were divided into two groups: one group with a higher response speed and the other with a lower speed. A comparison of these groups showed the following (Table 2).

Table 2. Representation of various types of manual asymmetry in groups with different time of choosing among 2 alternatives

Asymmetry type	Group with high speed of CVMR, %	Group with low speed of CVMR, %
Right-handers	50,0	50,0
Ambidexters	50,0	50,0
Left-handers	55,5	44,4
Right-legged	46,6	53,3
Two-legged	50,0	50,0
Left-legged	75,0	25,0
Right-eyed	64,7	35,3
Two-eyed	-	100,0
Left-eyed	-	-

While choosing among two visual stimuli (Table 2), athletes with different types of asymmetry were distributed almost equally between the two groups (with high and low speed). Statistical analysis confirmed the lack of relationship between the type of manual asymmetry and the time parameters of the response of choosing among 2 alternatives. This same sort of situation is noted for the lower extremities (Table 2).

There is absolutely another pattern of distributing female athletes with different types of visual lateralization into groups of high and low speed (Table 2): two-thirds of the right-eyed athletes were allocated to the group with high response speed, whereas a third of the left-eyed and all two-eyed athletes were referred to the group with low speed of response.Complication of the choice to 3 alternatives led to a change in the distribution of subjects. In this case, the group with a high response speed included 75% of right-handers and only 25% of ambidexters. Left-handers were distributed almost equally between the groups (Table 3).

Table3. Representation of various types of manual asymmetry in groups with different time of choosing among 3 alternatives

Asymmetry type	Group with high speed of CVMR, %	Group with low speed of CVMR, %
Right-handers	75,0	25,0
Ambidexters	25,0	75,0
Left-handers	44,4	55,5
Righ-legged	60,0	40,0
Two-legged	-	100,0
Left-legged	75,0	25,0
Right-eyed	64,7	35,3
Two-eyed	-	100,0
Left-eyed	-	-

Statistical analysis failed to show a significant correlation between manual lateralization and response speed when choosing among 3 alternatives. Thus, we may only talk about a certain tendency towards faster speed capacities of the right-handers. As for the asymmetry of the legs, it is not possible to talk about the relationship between the lateralization character and the speed of the choice time: both the majority of the right-legged (60.0%) and the majority of the left-legged (75.0%) were in the group with a high speed of response (Table 3). Rather interesting are the data on the relationship between visual asymmetry and CVMR speed when choosing among 3 alternatives (Table 3). The group with a high response speed included only female athletes with the right dominant eye as in the case of choosing among 2 alternatives.

Discussion

One of the objective criteria for the functional state of the central nervous system is the time of the visual-motor reaction (VMR), which characterizes the speed of inhibition and excitation processes in the central nervous system, the capacity for differentiated inhibition and the accuracy of the work performed.

The time of response is considered as an integral index of the central nervous system functional state, which reflects such basic properties as excitability, lability, and reactivity (Berdychevskaya et al., 2007; Kolesnik, 2005; Korobeynikov et al., 2019). A simple sensorimotor reaction is realized through the functional systemformation. The functional systemactivity depends on the consistency, synchronism of its temporal and spatial parameters and the coincidence of excitation rhythms in nerve cells (Berdychevskaya et al., 2008; Korobeynikov et al., 2018; Ouergui et al., 2014; Podrigalo et al., 2017).

One of the most informative methods of human functional state assessment is determining the time of latent period of a simple visual-motor response (SVMR), which characterizes the temporal indices of nervous processes that are fundamental in human psychomotor actions (Gronskaja & Cherenkevich, 2005; Kiprich & Berinchik, 2015; Korobeynikov et al., 2018; Podrigalo et al., 2017). Today, the variational chronoreflexometry based on a statistical analysis of simple sensorimotor response latent periods is used as the most practiced and objective method for determining the functional state of the central nervous system in the psychophysiology of sports and professional activities (Bugaets et al., 2018; Golomazov & Chirva, 2003; Korobeynikov et al., 2019;Savchin, 2013). The relative simplicity of this method, convenience of its use in natural conditions, practical absence of the influence of the training factor status allow to use it as an express method in applied studies dealing with human functional state assessment. The choice reaction time is one of the options for a complex sensorimotor response, since it is necessary to differentiate the signal (one signal needs to be reacted to, whereas the other not). This leads to an increase in the response time at the expense of "central delay", that is, the time spent on signal differentiation, remembering how to respond to this or that signal. This index is the most important in sports games and combat sport, as far as the complexity of choice reaction depends on the variety of possible changes in the situation. In all types of combat sport, an important role in reducing the time of a complex motor response of choice belongs to the factor of situation anticipation when an experienced athlete responds not so much to the movement itself as to opponent's preparatory actions.

In boxing, the ability to effectively fight with preferential usage of one's own asymmetric posture is of crucial importance. The most common are the crossing motor asymmetry profile and left-handed stance (Bleer, 2006; Kiprich, 2014; Malazonia & Gronskaya, 2016). One of the major indices of a boxer's skill is the time of

executing technical actions (Akopyan & Kulagina, 2010; Kiselev, 2006; Zubac et al., 2017). Factors influencing the response time are the human innate peculiarities, his/her current functional state, motivation and emotions, skill level, amount of perceived information (Chen et al., 2013; Leutin & Nikolaeva, 2008). The obtained indices of a short response time indicate a high mobility of nervous processes. This is quite natural for female athletes, whose one of the leading physical qualities is speed (Aksutin & Korobeynikov, 2014). A comparison of the response time index in right-handed and left-handed female boxers revealed a significant advantage in favor of the latter. The response time index envisages the response of the subject to a single signal. Boxing is a situational sports event, which demands from an athlete not only to keep an opponent within eyesight, but to predict his/her actions too(Kozina at al., 2015). The right-handers had a shorter latent period, and the longer motor period (Aksutin & Korobeynikov, 2014; Makarov & Malazonija, 2011). The average index of total time of complex visual-motor response in right-handed and left-handed female athletes is usually absolutely identical (Alexandrov, 2013; Chermit, 1992; Sybil et al., 2018). This indicates a high mobility of nervous processes, which is necessary for very fast information processing in female boxers of the same skill levels, regardless of their motor phenotype.

Conclusions

A comparison of the responses to the stimulus of the two alternatives shows that the right hand of right-handers is significantly faster than that of the left-handers and, especially, ambidexters. The speed of the left hand of the right-handers is almost the same as that of the left hand of the left-handers, and only in ambidexters it is much higher. Comparison of the responses to the stimulus of the three alternatives indicates that both the right hand and the left hand of the right-handers are significantly faster than those of athletes of the other two groups.Right-handers tend to be faster than left-handers and ambidexters during realization of a complex visual-motor response. The time of complex response in highly skilled female boxers is associated with visual lateralization. Athletes with the right dominant eye are more “speedy”.

Conflict of interest The authors declare that there is no conflict of interests.

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