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THE EFFECT OF FUTSAL TRAINING PROGRAM ON THE COGNITIVE ABILITIES OF YOUNG FUTSAL PLAYERS AT THE INITIAL BASIC TRAINING STAGE

Резюме. Мета *– дослідити ефективність програми корекції психофізіологічного стану юних футзалістів на етапі попередньої базової підготовки.* ***Матеріали і методи****: аналіз та узагальнення даних наукової літератури; методика вивчення логічної та механічної пам'яті, коректурна проба Бурдона; методи математичної статистики. У дослідженні взяли участь 60 юних футзалістів на етапі початкової базової підготовки віком 13–14 років.* ***Результати****. Отримані результати свідчать про те, що програма психофізіологічної корекції мала позитивний вплив як на механічну, так і на логічну пам'ять у юних гравців у футзал, причому більш виражені зміни спостерігалися у показниках механічної пам'яті; показники уваги продемонстрували стійку позитивну тенденцію за всіма досліджуваними параметрами, окрім коефіцієнта розумової працездатності, який був високим на початку тестування.* ***Висновки****. Отримані результати свідчать про те, що програма психофізіологічної корекції мала позитивний вплив на ефективність уваги, точність, когнітивну стабільність і розумову працездатність у юних гравців у футзал на етапі початкової базової підготовки, причому найбільш виражені зміни спостерігалися у зменшенні кількості помилок, стабільності концентрації та швидкості обробки інформації.*

Ключові слова*: футзал, юні футзалісти, етап початкової базової підготовки, когнітивні здібності, логічна і механічна пам'ять, показники уваги*

Summary*.* ***The aim*** *is to investigate the effectiveness of the program for correcting the psychophysiological state of young futsal players at the stage of preliminary basic training.* ***Materials and methods****: The research methodology encompassed the analysis and synthesis of scientific literature data, methodology for studying logical and mechanical memory, to measure attention productivity, number of errors, attention accuracy, mental efficiency coefficient, attention concentration, concentration stability, visual information capacity, speed of mental processing without fatigue Bourdon correction test (in Ukrainian) was used, mathematical statistics methods. The study involved 60 young futsal players aged 13–14.* ***Results****. The analysis of memory indicators in young futsal players aged 13–14 before and after the implementation of the psychophysiological state correction program revealed a clear positive trend in both mechanical and logical memory components. At the end of the experiment, none of the young futsal players demonstrated a low level, compared to 55.00% before the experiment. Approximately half of the participants (48.33%) showed a below-average level, 50.00% demonstrated an average level, and 1.67% showed a high level, which was statistically significantly better than before the experiment ($p < .000$). Logical memory, aimed at memorizing not the external form but the meaning or content of the game, indicates more meaningful actions when performing motor tasks. It should be noted that only 1.67% of young futsal players demonstrated a below-average level of logical memory after the experiment, whereas before the experiment this proportion was 26.67% ($p < .000$). Attention indicators demonstrated a stable positive trend across all studied parameters, except for the coefficient of mental performance, which was already high at the beginning of testing.* ***Conclusions****. Overall, the obtained results indicate that the psychophysiological correction program had a beneficial effect on attentional efficiency, accuracy, cognitive stability, and mental performance in young futsal players, with the most pronounced changes observed in error reduction, concentration stability, and information processing speed. The results indicate that the use of a psychophysiological state correction program is an effective means of improving cognitive stability in young futsal players during the training process.*

Key words*: futsal, young futsal players, initial basic training stage, cognitive abilities, logical memory, mechanical memory, attention indicators*

Problem statement and analysis of recent research results. According to the International Federation of Football Associations, futsal is the most popular sport in both men's and women's professional and amateur leages [1]. A few researchers [2,3] investigated the cognitive abilities of young athletes who play the game sport and found that they were better at formal thinking.

Recent studies have shown that high-intensity interval training involving sprint accelerations, movement changes, and performance in basketball and football are positively

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associated with cognitive intelligence, especially knowledge level, working memory, and cognitive flexibility [1,4,5].

Additionally, some studies have shown that futsal matches lasting up to 20 minutes at high intensity can improve cognitive intelligence, especially inhibitory control [4]; however, there are no studies on working memory.

A similar study by Verburg et al. [6], showed that improved performance on tasks of memory, inhibition, attention, and information processing speed distinguished a group of elite young soccer players from a group of non-elite players. Westberg et al. [7] investigated executive functions and their connection to success as a function of goals score and resultative passes in soccer, observing higher cognitive abilities in a group of elite young players compared to the general population.

This idea supports the selective enhancement hypothesis, according to which cardiorespiratory improvement positively influences on cognitive skills development [8]. A complementary idea in the same vein is the theory known as component cognitive skills [9,10,11], which suggests that sports training leads to more efficient neural connections and improved neural plasticity.

Sports training itself allows athletes to improve their cognitive functions [12,13], although the natural development of the nervous system gives each athlete a greater ability to meet the demands of sports. For example, various authors have emphasized the importance of myelination processes in childhood, which affects their attention span or their cognitive processing speed [14,15].

It has also been found that the total scores of both cognitive tests and tests of soccer-specific (futsal) motor skills are correlated among elite young players [11,16]. In addition, a correlation has been observed between cognitive flexibility and the number of resultative passes during the season, as well as game intelligence measured by subjective assessments of coaches [17,18].

Thus, previous studies have demonstrated the important role of cognitive abilities, however, few studies have focused on these abilities of futsal athletes [19,20,21]. There is also a few research that would relate to the study of specialized programs effectiveness for futsal sports in relation to the cognitive abilities of futsal athletes, especially those at the stage of basic training are completely absent.

The aim is to investigate the effectiveness of the program for correcting the psychophysiological state of young futsal players at the stage of preliminary basic training.

Research Methods and Organization Studies. *Research Methods*. Methodology for studying logical and mechanical memory. Young athletes are informed that pairs of words will be read, which they must remember. The experimenter reads ten pairs of words of the first row to the experimentals (the interval between the pair is five seconds). After a 10-second break, the left words of the column were read (with an interval of five seconds), and the experimentals wrote down the words of the right column. A similar work was carried out with the words of the second column. The memory coefficient was calculated as the ratio of the sum of correct answers to the initial number of word pairs. Evaluation criteria: 0.1–0.4 – low level, 0.5–0.7 – medium level, 0.8–1.0 – high level.

To study the short-term visual memory and attention indicators of young futsal players aged 13–14, the Bourdon correction test (in Ukrainian) was used. Young athletes crossed out the letters “H”, “A”, “M”, “C”. They worked for 8 minutes as quickly and attentively as possible. Every minute after the work started, the researcher said the word “line”. After 8 minutes of work, the researcher gave the command “end of work”. According to the results of the method, the following indicators were determined: speed (productivity) indicator (A, s^{-1}), work accuracy indicator (T, c. units), mental efficiency coefficient (E, letters), attention concentration (K, %), stability of attention concentration (Ku, s. units), volume of visual information (V, letters), information processing speed (Q, letters) [22].

Statistics Methods. The statistical analysis was preceded by checking the data for missing data, outliers and emissions. The assessment of the normality of the statistical distribution of the data was carried out using the Shapiro-Wilkie and Kolmogorov-Smirnov criteria. Descriptive (sample statistics) analysis included the determination of such indicators as the mean (M), standard error (SE), median (Me), the lower and upper quartiles (25–75%), the confidence interval (CI).

To assess the statistical significance of the differences between the indicators values that were not subject to the normal distribution law, the z-statistic of the non-parametric Wilcoxon test (W) was used (since n > 25) for dependent samples.

To study the impact of the author’s program for correcting the psychophysiological state of young futsal players on the frequency distribution of cognitive ability indicators by gradations, the χ^2 (chi-square) homogeneity criterion was used.

The analyses were performed using SPSS Statistics 17.0.

Participants. The study was conducted in accordance with the World Medical Association Declaration of Helsinki on the Ethical Principles of Scientific and Medical Research, the Universal Declaration on Bioethics and Human Rights, and the Council of Europe Convention on Human Rights and Biomedicine [23]. The study involved 60 young futsal players aged 13–14 from the Youth and Sports School of Ivano-Frankivsk region. The study protocol was subject to mandatory approval by the Bioethics Commission of the Vasyl Stefanyk Carpathian National University.

Research results and discussion. The average statistical indicators of mechanical and logical memory and their dynamics during the experiment are presented in Table 1.

Table 1

Dynamics of memory indicators of young futsal players before and after the implementation of the psychophysiological state correction program

Descriptive Statistics

		Median (25%;75%)	Mean		95% Confidence Interval for Mean	
	Stage	Statistic	Statistic	Std. Error	Lower Bound	Upper Bound
Mechanical memory, c.u.	pre	2.0000 (2.0000; 3.0000)	2.3667	.16969	2.0271	2.7062
	post	5.0000 (4.0000; 6.0000)	4.7167	.13673	4.4431	4.7222
Logical memory, c.u.	pre	6.0000 (3.2500; 7.7500)	6.0167	.26733	5.4817	6.5516
	post	7.0000 (6.0000; 8.0000)	7.3667	.16115	7.0442	7.6891

Since the distribution of memory indicators does not correspond to normal, for a comparative analysis of possible differences in this indicator before and after the experiment, the non-parametric Wilcoxon test was used (Table 2).

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Table 2

Results of a comparative analysis of memory indicators of young futsal players before and after the implementation of the psychophysiological state correction program

Test Statistics[b]

	Logical memory	Mechanical memory
Z	-5.739[a]	-5.678[a]
Asymp. Sig. (2-tailed)	.000	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

The analysis of memory indicators in young futsal players aged 13–14 before and after the implementation of the psychophysiological state correction program revealed a clear positive trend in both mechanical and logical memory components. The maximum possible score for each memory indicator was 10 points.

Regarding mechanical memory, baseline (*pre*) values demonstrated a low level of development – the median score was 2.0 points (IQR: 2.0–3.0). The mean value amounted to 2.37±0.17 points, and the 95% CI: 2.03;2.71 points, indicating limited memory capacity and relatively homogeneous results within the group.

Following the implementation of the correction program (*post*), a substantial improvement in mechanical memory was observed. The median increased to 5.0 points (IQR: 4.0–6.0), while the mean value rose to 4.72±0.14 points ($Z = -5.678$; $p < .000$). The 95% CI for the mean narrowed to 4.44–4.72 points, reflecting both a significant increase in performance and reduced variability of the indicators.

With respect to logical memory, the initial (*pre*) assessment showed moderate performance levels – the median value was 6.0 points (IQR:3.25–7.75), the mean score reached 6.02±0.27 points, and the corresponding 95% CI: 5.48–6.55 points.

After completion of the psychophysiological correction program, the median of logical memory indicators increased to 7.0 points (IQR: 6.0–8.0 points), and the mean value reached 7.37±0.16 points ($Z = -5,739$; $p < .000$). The 95% confidence interval (7.04–7.69 points) indicates a stable and consistent improvement in logical memory performance.

After the experiment, we observed statistically significant changes in the distributions by volume levels of both mechanical ($\chi^2 = 19.375$; $p < .000$) and logical ($\chi^2 = 56.563$; $p < .000$) memory (Table 3).

Table 3

Results of comparative analysis of the distribution by memory indicators levels of young futsal players before and after the implementation of the psychophysiological state correction program

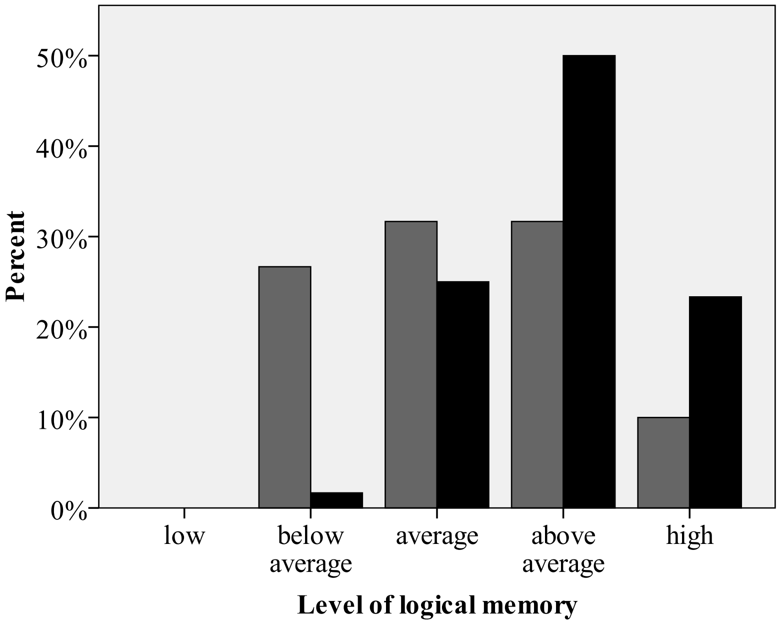
Chi-Square Tests

	Logic			Mechanical (Working)		
	Value	df	Asymp. Sig. (2-sided)	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.375[a]	3	.000	56.563[a]	3	.000
Likelihood Ratio	22.214	3	.000	73.248	3	.000
Linear-by-Linear Association	17.017	1	.000	54.483	1	.000
N of Valid Cases	120			120		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.50.

Overall, the obtained results suggest that the implemented psychophysiological correction program exerted a beneficial effect on both mechanical and logical memory in young futsal players, with more pronounced changes observed in mechanical memory parameters.

The results of the study showed that among young futsal players aged 13–14 years before the start of the experiment there were no players with a low logical memory level, while 55.00% had a low level of mechanical memory (Fig. 1). At the end of the experiment, there was no futsal player with a low level, about half (48.33%) had below average, 50.00% had average and 1.67% high levels, which was statistically significantly better than before the experiment.



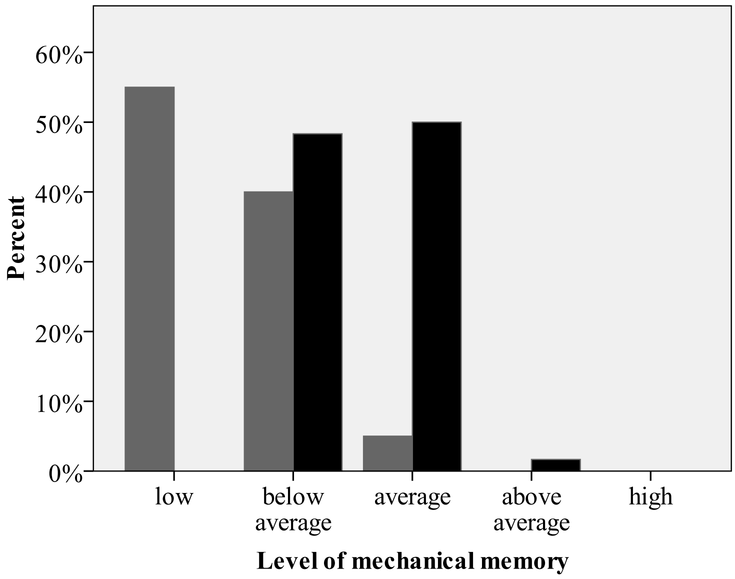


Fig. 1 Dynamics of distribution of young futsal players by level of mechanical and logical memory development: – pre-test, – post-test

Logical memory is aimed at memorizing not the external form, but the very meaning or content of the game, which indicates the fact of their more meaningful actions when performing motor tasks. It should be noted that only 1.67% of young futsal players after the experiment had a below average logical memory development level, while before the experiment the share of such was 26.67%.

Additionally, the attention indicators of young futsal players were studied (Table 4).

Table 4

Dynamics of attention indicators of young futsal players before and after the psychophysiological correction program implementation

Descriptive Statistics

		Median (25%;75%)	Mean		95% Confidence Interval for Mean	
	Stage	Statistic	Statistic	Std. Error	Lower Bound	Upper Bound
Attention performance, letters	pre	839.500 (820.000; 976.000)	843.000	17.1384	808.706	877.294
	post	949.000 (834.000; 998.000)	910.617	19.1612	872.276	948.958
Number of errors, letters	pre	23.000 (9.000; 86.000	40.750	4.5266	31.692	49.808
	post	6.000 (2.000; 24.000)	11.767	1.8671	8.031	15.503
Attention accuracy, c.u.	pre	.495 (.407; .554)	.484	.0110	.462	.507
	post	.641 (.499; .669)	.592	.0140	.571	.627
Mental performance coefficient, letters	pre	445.972 (339.076; 483.071)	417.161	16.1642	384.816	449.505
	post	602.419 (431.815; 693.831)	558.125	21.6984	514.706	601.543
Concentration of attention, %	pre	55.682 (50.758; 61.111)	53.439	1.0851	51.267	55.610
	post	57.828 (50.758; 62.374)	54.623	1.1452	52.332	56.915
oncentration stability, c.u.	pre	19.174 (6.261; 25.000)	27.524	4.0811	19.358	35.691
	post	93.813 (26.347; 174.169)	172.320	26.8279	118.637	226.002
Visual information capacity, letters	pre	498.327 (486.752; 579.354)	500.405	10.1734	480.048	520.762
	post	563.326 (495.062; 592.413)	540.542	11.3740	517.783	563.301
Speed of mental processing, letters	pre	.832 (.669; .912)	.804	.0282	.748	.861
	post	1.101 (.985; 1.186)	1.057	.0218	1.014	1.101

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It should be noted that mechanical memory is based on neural connections mainly of the first signaling system [24]. That is, at the stage of preliminary basic training when learning technical elements, young futsal players have problems with visual or muscular-motor memorization of the movements themselves and their sequence. This is about making decisions, passing the ball, predicting the place where the ball will fall down, or adjusting the position to block attacks. Quick thinking in futsal is not only reflexes, but also recognition. Through repetition, players reduce the time of processing information necessary for decision-making. This shows that at this stage of the training process, the development of strong muscle memory through constant repetition is crucial for young futsal players who strive to achieve success.

As was noted in [25], regular training, firstly, deeply consolidates fundamental skills, allowing them to be performed accurately and quickly during matches in the future; secondly, muscle memory minimizes errors, automating reactions and reducing hesitation at critical moments; thirdly, reliable muscle memory increases confidence, allowing you to instinctively and effectively apply skills under pressure.

Thus, it can be stated that the proposed program allowed to adjust the activity of the central and peripheral parts of the nervous system, that is, young futsal players began to perform motor movements with the disconnection of semantic control over the actions themselves.

The analysis of attention-related indicators and mental performance in young futsal players before (pre) and after (post) the psychophysiological correction program implementation demonstrated a consistent positive trend across all investigated parameters (Table 5).

Table 5

Results of a comparative analysis of attention indicators of young futsal players before and after the psychophysiological state correction program implementation

Test Statistics[c]

	Attention performance	Number of errors	Attention accuracy	Mental performance coefficient	Concentration of attention	Concentration stability	Visual information volume	Speed of mental processing
Z	-4.148[a]	-6.142[b]	-5.920[a]	-5.670[a]	-2.935[a]	-6.414[a]	-4.148[a]	-6.178[a]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.003	.000	.000	.000

a. Based on negative ranks.

b. Based on positive ranks.

c. Wilcoxon Signed Ranks Test

Regarding attention performance, baseline values indicated moderate efficiency, with a median of 839.5 characters (IQR: 820.0–976.0) and a mean of 843.0±17.1 characters. After the intervention, attention performance increased, as evidenced by a higher median (949.0 characters) and mean value (910.6±19.2 characters) with the shifting 95% CI:872.3–949.0 characters (Z = -4,148; p < .000).

A pronounced improvement was observed in the number of errors. At baseline, participants demonstrated a relatively high error rate (median 23.0 characters, IQR: 9.0–86.0; mean 40.75±4.53). Following the correction program, the median number of errors decreased approximately by 4 times (IQR 2.0–24.0), while the mean value declined to 11.77±1.87 ($Z = -6,142$; $p < .000$), indicating a substantial enhancement in attentional control and accuracy.

Consistently, median of attention accuracy coefficient increased from 0.495 (IQR: 0.407–0.554) to 0.641 (IQR: 0.499–0.669), while the mean value increased from 0.484±0.011 to 0.592±0.014 ($Z = -5,920$; $p < .000$).

Significant gains were also recorded in the mental performance coefficient. Pre-intervention values reflected moderate productivity (median 445.97 characters, IQR: 339.08–483.07; mean 417.16±16.16). Post-intervention values showed a marked increase, with the median reaching 602.42 characters and the mean rising to 558.13±21.70 ($Z = -5,670$; $p < .000$), indicating improved cognitive efficiency under the program.

With respect to attention concentration, only a slight increase in mean values was observed (from 53.44±1.09% to 54.62±1.15%), suggesting moderate sensitivity of this parameter to the applied intervention ($Z = -2.935$; $p < .003$).

In contrast, concentration stability demonstrated a substantial post-intervention enhancement. The median value increased from 19.17 units (IQR: 6.26–25.00) to 93.81 units (IQR: 26.35–174.17), while the mean value showed a pronounced rise, indicating a considerable improvement in the ability to maintain attention over time – 27.52±4.08 vs 172.32±26.83 ($Z = -6.414$; $p < .000$).

Finally, positive changes were observed in visual information volume and visual information processing. The mean visual information volume increased from 500.41±10.17 to 540.54±11.37 characters ($Z = -4.148$; $p < .000$), while information processing improved from 0.804±0.028 to 1.057±0.022 characters ($Z = -6.178$; $p < .000$), reflecting enhanced perceptual and cognitive processing capacity.

Regarding the distribution by levels of attention components, statistically significant differences were observed for all indicators, except for the mental performance coefficient, which was high at the beginning of testing (Table 6).

For attention performance (number of processed characters) at baseline, 66.7% of young futsal players were classified at the low level, 33.3% at the above-average level, while no athletes were observed at the average or high levels. After the intervention, the proportion of athletes at the low level decreased to 30.0%, whereas the share of the above-average level increased to 65.0%, and 5.0% of participants reached the high level ($\chi^2 = 17.463$; $p < .000$).

Regarding the number of errors, prior to the intervention 66.7% of athletes were classified at the low performance level, 20.0% at the above-average level, and 13.3% at the high level. Post-intervention analysis demonstrated a pronounced redistribution, with the low level decreasing to 28.3%, while the average, above-average, and high levels increased to 13.3%, 25.0%, and 33.3%, respectively ($\chi^2 = 22.757$; $p < .000$).

For attention accuracy, baseline results showed all 100.0% of participants at the low level. After the intervention, the proportion of athletes at the low level decreased to 60.6%, while 16.7% reached the average level, 21.7% the above-average level, and 1.7% the high level, indicating greater differentiation and stabilization of accuracy indicators ($\chi^2 = 19.375$; $p < .000$).

In contrast, the mental performance coefficient demonstrated minimal changes in percentage distribution. Before the intervention, 15.0% of athletes were classified at the average level, 1.7% at the above-average level, 83.3% at the high level.

Table 6

Dynamics of distribution by levels of attention indicators of young futsal players before and after the psychophysiological state correction program implementation

Crosstab

	Stage	Level				Pearson Chi-Square	Asymp. Sig. (2-sided)
		low	average	above average	high		
Attention performance, letters	pre	40	0	20	0	17.463	.000
	post	18	0	39	3		
Number of errors, letters	pre	40	0	12	8	22.757	.000
	post	17	8	15	20		
Attention accuracy, c.u.	pre	60	0	0	0	19.375	.000
	post	36	10	13	1		
Mental performance coefficient, letters	pre	0	9	1	50	.289	.865
	post	0	7	1	52		
Concentration of attention, %	pre	9	35	16	0	11.534	.009
	post	8	21	25	6		
Concentration stability, c.u.	pre	52	0	8	0	35.789	.000
	post	24	9	11	16		
Speed of mental processing, letters	pre	29	23	8	0	30.069	.000
	post	7	19	33	1		

Post-intervention values remained comparable (11.7%, 1.7%, 86.7% respectively), confirming the absence of substantial qualitative shifts (χ^2 = .289; p < .865).

For attention concentration, baseline measurements revealed 15.0% of participants at the low level, 58.3% at the average level, and 26.7% at the above-average level, with no athletes classified as high. After the intervention, the proportion of low and average levels decreased to 13.3% and 35.0%, respectively, while the above-average and high levels increased to 41.7% and 10.0%, indicating improved concentration capacity (χ^2 = 11.534; p < .009).

A marked redistribution was observed for concentration stability. Prior to the intervention, 86.7% of athletes were classified at the low level and 13.3% at the above-average level. Post-intervention results showed a substantial decrease in the low level to 40.0%, accompanied by increases in the average (15.0%), above-average (18.3%), and high (26.7%) levels (χ^2 = 35.789; p < .000).

Finally, information processing speed demonstrated significant qualitative changes. At baseline, 48.3% of participants were at the low level, 38.3% at the average level, and 13.3% at the above-average level. Following the intervention, the proportion of low performers decreased sharply to 11.7%, while the average and above-average levels increased to 31.7% and 55.0%, respectively, with 1.7% of athletes reaching the high level ($\chi^2 = 30.069$; $p < .000$).

An informative characteristic is not only the value of attention concentration stability, but its dynamics during stated time. The results of the formative experiment showed that the program for psychophysiological state correction had a positive effect on this indicator, contributed to improving the attention concentration stability, reducing the number of errors (Fig. 2).

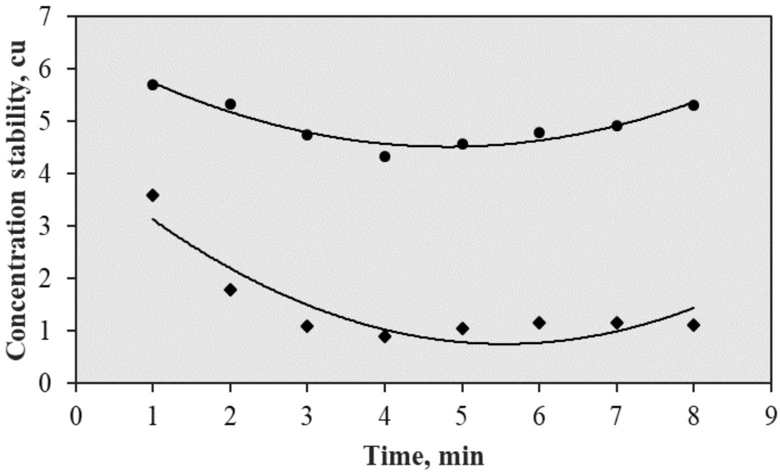

Fig. 2. Dynamics of attention stability coefficient of young futsal players before and after the implementation of the psychophysiological state correcting program: ● – pre-test, ♦ – post-test

The obtained nonlinear dynamics of the stability of attention concentration have direct applied value for training and competitive activities in futsal. Initially, a higher level of attention concentration may reflect the state of optimal readiness of young futsal players at the beginning of the activity, which is typical for the starting minutes of training or a match. Further decrease in performance in the middle of the task, in our opinion and the opinion of a number of researchers [4,26], is associated with the accumulation of psychophysiological fatigue, a decrease in sensorimotor accuracy and a decrease in the effectiveness of cognitive control, which in futsal can manifest itself in the form of the number of technical errors increase, a slowdown in making game decisions, a deterioration in orientation in the game space and a decrease in partner interaction.

Further increase in attention concentration stability at the end of the task may indicate the activation of compensatory mechanisms of self-regulation and adaptation to the load, which is an important characteristic of athletes' preparedness in game sports [27].

Higher values of concentration stability indicator after the implementation of the psychophysiological state correction program indicate an improvement in the ability of young futsal players to maintain stable attention during prolonged activity, which is important for improving the speed of decision-making and reducing errors under the influence of fatigue. In the context of futsal, this can be considered as an increase in the functional reliability of athletes' cognitive activity, which is one of the key factors in the effectiveness of the game in conditions of intense pace and limited time for mental processing

Conclusion. Overall, the obtained results indicate that the psychophysiological correction program had a beneficial effect on attentional efficiency, accuracy, cognitive stability, and mental performance in young futsal players, with the most pronounced changes observed in error reduction, concentration stability, and information processing speed. The results indicate that the use of the psychophysiological correction program is an appropriate means of cognitive stability increasing of young futsal players in the process of training.

Prospects for further research. Further scientific research should be directed at expanding the sample of participants and testing the effectiveness of the psychophysiological correction program among athletes of different ages, qualifications and playing roles. It is also promising to study the long-term impact of the proposed program on cognitive functions and competitive activity of futsal players. The integration of psychophysiological training methods with training programs for the technical, tactical and physical development of athletes requires special attention.

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