

Optimization of Simple and Choice Reaction Time in Adolescent Football Players



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Abstract:

This study examined junior football players aged 12–14 years competing in the U14 category of the National Football Championship during the 2024/2025 competitive season. The purpose of the research was to monitor changes in reaction time following an eight-month structured training program focused on agility-based exercises. Assessment protocols included both physical variables (reaction speed and agility) and cognitive components (reaction time and task accuracy). Simple reaction time and choice reaction time were evaluated using the Cognitrom Assessment System (CAS++). Measurements were conducted at two time points: before and after the training intervention. Data analysis focused on mean reaction time, number of errors, omissions, and reaction time stability. Statistically significant improvements were observed between pre- and post-intervention assessments for both simple reaction time ($t(19) = 9.509$, $p < .001$, Cohen's $d = 1.94$) and choice reaction time ($t(19) = 6.35$, $p < .001$, Cohen's $d = 1.30$). These findings are consistent with existing literature indicating that reaction time in competitive athletes can be enhanced through targeted training programs. The results suggest that sustained, sport-specific training can significantly improve speed, agility, and reaction time in junior football players, contributing to enhanced overall performance.

Keywords:

junior football players; reaction time; training program.

JEL Classification:

Z20; Z29.

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Introduction

A long-term training program for young soccer players should focus on developing motor skills, adapting different functional systems to effort and competition. It should also take into account the unique aspects of the game of soccer. Even at a young age, soccer requires quick reactions to variable and unexpected situations, which trains the child's voluntary attention. During the game, the child focuses on the essential elements – the ball, the position and movements of the opponent – ignoring external stimuli. In this age group (12-14 years), the emphasis is particularly on learning the basic kicks: passing, shooting and dribbling (Fonseca *et al.*, 2023, Ihsan *et al.*, 2022, Ling *et al.*, 2020).

The peculiarities of the football game for 12-14 years old juniors

As a complicated psycho-pedagogical process, sports training aims to influence the complete personality and the entire psycho-behavioral system, which occurs on the basis of biological, functional changes, in addition to the physical development of athletes depending on their degree of motor skills. The reason for this is that the success of performance can only be achieved by carefully examining the determinant components of performance capacity, which has a complex structure combining biological, psychological and social aspects (Lee *et al.*, 2024, Marques *et al.*, 2013). After 10-12 years of consistent practice, it is known that young footballers begin to compete at a high professional level. In other circumstances, the training period is reduced or increased due to the special qualities of cultivating sports education in football (Prasetyo *et al.*, 2019).

The structure and stages of long-term training for junior footballers must be based on solid principles and compliance with the highest sporting standards, so as to fully utilize the natural abilities of the players and ensure the achievement of the maximum level of performance at an optimal age for its manifestation.

It is important to emphasize the importance of coordination in the development of football players and the requirements of football games, as well as to indicate what the basic coordination elements are and in what situations they are used.

Performance capacity has multiple definitions found in the specialized literature, mainly being given by biological parameters, health status and level of training. The priority factors in achieving high performance in the game of football are presented as a combination of individual talent, the skills of each athlete, the collective value of the team, training (including all training factors), individual and collective attitude as well as the social environment (staff attitude, support from fans, media, etc.) but also financial structures.

Physical training represents 'the performance of athletes especially in competitions and training, because maintaining the sports form of players throughout the competitive period, especially for team sports is one of the central problems in the athlete training system' (Khasanah, and Hariyoko, 2023).

Speed and reaction time in football

The increase in sports performance has offered a different vision of speed and agility, which is why França *et al.*, 2022 introduced the term game speed.

Game speed is a 'context-specific ability in which an athlete maximizes sports performance through the application of a sport-specific movement with optimal speed, precision, efficiency, and control - both in anticipation of and in response to major perceptual stimuli and the skill demands of the game' (Buhaş, 2015). This definition implies a series of key elements that affect how we might build an effective game speed development program.

If these responses are not practiced and developed, the player will always risk being slow to respond to the required task and therefore unable to maximize his performance, regardless of the innate speed of the capabilities. In addition, the player's ability to react and respond depends on the ability to assume an efficient body position from which to maximize the next movement.

Regarding modern training methods, the SAQ (Speed, Agility, Quickness) method stands out as one of the most effective and validated in the specialized literature (Pearson, 2001; Polman *et al.*, 2009).

1. Material and Methods

The research used two computerized psychological tests to assess the reaction time: the simple reaction time test and the reaction time test in choices, implemented through the CAS (Cognitrom Assessment System) platform. The simple reaction test measures the speed of basic sensorimotor processing. Procedurally, a single visual stimulus appears on the screen, to which the participant must immediately respond by pressing a predetermined key.

The platform recorded reaction time (the interval between the appearance of the stimulus and the response), response stability (the variation in the times obtained) and any omissions. The choice reaction test assesses the speed and accuracy of decision-making under conditions of discrimination between multiple stimuli. In this test, different stimuli (e.g., colors or geometric shapes) appear on the screen, each associated with a distinct key, and the participant is instructed to select the appropriate response. The parameters analyzed included the average reaction time, the number of errors (incorrect responses), omissions and performance stability. Both tests were administered at two times: before and after the application of the exercise programs. This approach allowed for the comparison of initial and final performances, in order to highlight the effects of the exercises on the processing speed, attention and reaction capacity of the participants.

Participants

The participants in this study were 20 junior football players, registered at a school sports club in the Oltenia area. Their age ranged between 12-14 years, competing in the 2024/2025 competitive season in the U14 category within the National Football Championship. The participants' guardians were informed about the protocol for conducting the experiment and were informed about the method of testing motor capacity as well as the results recorded by the athletes.

Procedure

The aim of the study is to track the evolution of reaction times, following a training program based on agility exercises, based on the SAQ method for developing coordination capacities in speed training in junior footballers (12–14 years old). The program was conducted over an 8-month period.

Both testing sessions (initial testing and final testing) were conducted under the same environmental and organizational conditions, to ensure the comparability of the results. The tests applied targeted both physical parameters (reaction speed, agility, lower limb strength, specific resistance) and cognitive components (reaction time, accuracy in solving tasks).

Throughout the study, ethical principles in research were respected. Participants were informed in advance about the purpose and conduct of the experiment, expressed their consent to participate, and the data obtained were treated confidentially and used exclusively for scientific purposes. The data were subsequently compared between the two evaluation stages, aiming to quantify the progress achieved.

Materials

Reaction time testing (via the CAS platform)

The research used two computerized psychological tests to assess reaction speed: the simple reaction test and the choice reaction test, implemented through the CAS (Computerized Assessment System) platform. The simple reaction test measures the speed of basic sensorimotor processing.

Procedurally, a single visual stimulus appears on the screen, to which the participant must immediately respond by pressing a preset key. The platform recorded the reaction time (the interval between the appearance of the stimulus and the response), the stability of the responses (the variation between the times obtained) and any omissions.

The choice reaction test assesses the speed and accuracy of the decision under conditions of discrimination between multiple stimuli. In this test, different stimuli (for example, colors or geometric shapes) appear on the screen, each associated with a distinct key, and the participant is instructed to select the appropriate response.

The analyzed parameters included the average reaction time, the number of errors (incorrect answers), omissions and the stability of performance. Both tests were administered at two times: before and after the application of the exercise programs.

This approach allowed for the comparison of initial and final performances, in order to highlight the effects of the exercises on the participants' processing speed, attention, and reaction capacity.

Data analysis

In order to organize the data and test the hypotheses, the statistical analysis program IBM.SPSS.25 (IBM Corp, 2016) was used.

2. Results

Analysis of the data obtained from the simple reaction test revealed a significant improvement in the participants' performances after applying the exercise program. The mean initial reaction time (T1) was 420.2 ms (SD = 232.2), while at the final test (T2) an average of 333.4 ms (SD = 199.9) was recorded.

The difference between the two assessment times was 86.87 ms, with a 95% confidence interval between 67.96 and 105.76 ms.

The paired-samples t-test confirmed the significant nature of this difference, $t(19) = 9.509$, $p < .001$, indicating that the result was not due to chance. Also, the effect size calculated by Cohen's d ($d = 1.94$) shows a very large impact of the exercise program on reaction speed.

Table 1. Simple reaction test results

	Min	Max	Mean	Stdv	Skew.	Kurtos.	t	p	Cohen
RT_simple_T1	249.0	1183.	420.2	232.2	1.94	3.945	9.509	.000	1.94
RT_simple_T2	170.5	1005.	333.4	199.85	2.05	4.699			

Source: Compiled by Authors.

In practical terms, these results suggest that the applied program led to a considerable acceleration of response times, which reflects an improvement in sensorimotor processing and attentional capacity.

Although the data distributions showed some asymmetry (Skewness ≈ 1.9 ; Kurtosis ≈ 3.9), the consistency of the differences and the magnitude of the effect provide robustness to the conclusion that the intervention had a clear positive effect on the participants' performance on the simple reaction test.

Table 2. Results of the reaction test in choices

	Min	Max	Mean	Stdv	Skew.	Kurtos.	t	p	Cohen
RT_in choices_T1	421.1	3951.1	1276.1	736.48	2.175	7.017	6.349	.000	1.30
RT_in choices_T2	356.9	2858.	1008.2	577.53	1.723	3.818			

Source: Compiled by Authors.

The analysis of reaction times in elections revealed a significant improvement after the application of the exercise program.

At baseline (T1), reaction times ranged from 421.1 to 3951.1 ms, with a mean of 1276.1 ms (SD = 736.48). The distribution showed positive skewness (Skew = 2.175) and a high flatness index (Kurtosis = 7.017), suggesting the presence of extreme values and a high variability of performances.

At the final time point (T2), after the intervention, reaction times decreased, ranging from 356.9 to 2858 ms, with a mean of 1008.2 ms (SD = 577.53). The distribution remained slightly positively skewed (Skew = 1.723) and leptokurtic (Kurtosis = 3.818), but closer to normality compared to T1.

The paired-samples t-test showed a statistically significant difference between the two time points, $t(19) = 6.35$, $p < .001$, confirming the reduction in reaction times after the exercise program. The effect size, calculated by Cohen's d , was 1.30, corresponding to a very large effect.

3. Discussion

Regarding the CAS platform assessment (Cognitrom Assesment System), the analysis of the results obtained in the simple reaction and choice reaction tests highlights a convergent trend: after applying the exercise program, the participants' response times were significantly reduced in both experimental conditions. In the case of the simple reaction, the reduction was approximately 87 ms, with a very large effect size ($d = 1.94$), indicating a substantial acceleration of basic sensorimotor processing. In the choice reaction test, the difference between the two moments was more pronounced, approximately 268 ms, accompanied by a decrease in interindividual variability and a more balanced distribution of performances. This suggests that the exercise programs not only reduced the average reaction time, but also uniformed the level of performance among the participants.

Conclusions and Further Research

The results obtained confirm the hypothesis that the Work Program applied to junior football players positively influences simple reaction time and reaction time in choices. Thus, the applied exercises had a positive impact on the reaction speed, both in simple situations and in contexts that involve choosing between several options. Overall, it can be concluded that the implemented exercise program contributed significantly to the development of the ability to react quickly and correctly, an essential aspect in activities that require prompt and precise responses to external stimuli.

Football requires the management of a large number of short and repeated high-intensity actions, such as shooting at goal, sprinting, jumping, acceleration and deceleration, often including changes of direction (COD), crucial determinants of success or failure in the game and also good predictors of the level of performance of players (Lockie *et al.*, 2018). However, the specialized literature indicates that studies on the development of

coordination are still insufficiently explored (Liakh and Vitkovskij, 2010), although it plays a determining role in the efficiency of technical executions (Gu, 2021). The development of coordination abilities is closely linked to the growth and maturation of children, and the stages of childhood, puberty and adolescence are favorable periods for perfecting this ability (Burhaein *et al.*, 2020; Gil *et al.*, 2007).

The development of reaction time is also closely linked to the development mechanism of the human body, thus (Kumar, 2017).

Also, according to Rosznay *et al.* (2021), to improve acceleration, it is not enough to introduce a single exercise in training because it cannot constitute the main tool, and no single method is sufficient. It is necessary to develop an integrated approach in which several methods can be combined to streamline the development of speed and agility (Rumf *et al.*, 2016).

Several authors in the literature (Papp *et al.*, 2022) see the central nervous component as the ability to coordinate and regulate subsequent movements of contraction-relaxation cycles.

Morphological indices are not the same in all sports, but are different. The most commonly used are (Prasetyo *et al.*, 2019), but reaction times remain among the most important of them.

Credit Authorship Contribution Statement:

Amalia-Raluca Stepan: write the contribution of the second author choosing the relevant actions, but not limited to (Conceptualization, Investigation, Methodology, Software, Formal analysis, Writing – original draft, Data curation, Validation, Writing – review and editing, Visualization);

Caius-Ionel Drulă: write the contribution of the second author choosing the relevant actions, but not limited to (Conceptualization, Investigation, Methodology, Software, Formal analysis, Writing – original draft, Data curation, Validation, Writing – review and editing, Visualization);

Sebnem Sarvan Cengiz: write the contribution of the second author choosing the relevant actions, but not limited to (Conceptualization, Investigation, Methodology, Software, Formal analysis, Writing – original draft, Data curation, Validation, Writing – review and editing, Visualization);

Ratko Pavlović: write the contribution of first author choosing the relevant actions, but not limited to (Conceptualization, Investigation, Methodology, Software, Formal analysis, Writing – original draft, Supervision, Data curation, Validation, Writing – review and editing, Visualization);

Alexandru-Marian Cosma: write the contribution of the third author choosing the relevant actions, but not limited to (Conceptualization, Investigation, Methodology, Software, Formal analysis, Writing – original draft, Data curation, Validation, Writing – review and editing, Visualization).

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