STUDIA UBB EDUCATIO ARTIS GYMN., LXX, 2, 2025, pp. 5-25
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.70(2).10

Associations Between Effort Capacity and Cognitive Processes in Basketball Players

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Received 2025 May 18; Revised 2025 July 04; Accepted 2025 July 15;
Available online 2025 July 30; Available print 2025 August 30

ABSTRACT. Introduction: The game of basketball often involves making quick and efficient decisions and complex technical-tactical actions, which have been shown by researchers to correlate with certain cognitive processes. **Objective:** We aimed to determine this link in a group of 21 basketball players (14.05±0.86 years old) who qualified for the U14 Final Tournament of the Romanian National Championship. **Methods:** We associated 3 types of visual memory (simple, dynamic and numerical) with 3 agility tests (Lane, Illinois, hexagon with randomized visual stimuli), 1 reaction speed test, 1 aerobic (Vameval shuttle) and 1 anaerobic (8x10+10 m) test and the test for determining the explosive force of the lower limbs. **Results:** Data analysis yielded 2 links between effort capacity and players' cognitive level. Numerical memory was correlated with the Lane agility test (p=0.041), and the reaction speed of the dominant upper limb with the fatigue factor yielded by the anaerobic lactacid capacity test (p=0.05). **Conclusions:** Our study demonstrates that an athlete with a significant exertional capacity does not require a high cognitive level, this aspect needs to be demonstrated by future research.

Keywords: *cognitive development, basketball skills, agility, memory, neurocognition.*

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INTRODUCTION

The executive system, over the ages, has been difficult to fully define. Executive functions include higher cognitive abilities that facilitate the understanding of complex or abstract concepts, help to solve problems and unfamiliar situations, and confer the ability to manage tasks (Cristofori et al., 2019). These higher-level cognitive processes control and regulate basic cognitive processes in order to accomplish complex tasks (Diamond A., 2013). Working memory (temporary storage of information and its later use (Diamond A., 2013), cognitive flexibility (adapting to changes in and from the environment by optimally and efficiently regulating behavior (Dajani & Uddin, 2015), and inhibition (the ability to control actions in response to irrelevant stimuli in the environment, related to behavior and attention (Friedman & Miyake, 2017) are the components of executive functions (Miyake et al., 2000).

Structural plasticity of gray matter and white matter can be enhanced by physical exertion in children and adolescents (Xiong et al., 2018, Migueles et al., 2020). Physical activity may contribute to alter brain activation patterns in the performance of certain tasks (Chaddock-Heyman et al., 2013), help to optimize brain structure and functional networks (Migueles et al., 2020), and subsequently lead to improved executive function (Xue et al., 2019) in children and adolescents.

Zhou et al. (2024) found a link between executive function and physical ability among children, specifically between speed, agility, and lower limb strength with inhibitory control. Likewise, Giuriato et al. (2024) concluded that cognitive factors may hold an important role for physical performance in adolescent soccer players.

Positive correlations between physical activity and the development of executive functions were also found by Li et al. (2020) and Contreras-Osorio et al. (2021). Significant effects were found on working memory and inhibition, moderate effect was found on cognitive flexibility (Li et al., 2020). In contrast, Contreras-Osorio et al. (2021) concluded significant influences on all three components.

The cognitive-perceptual components of decision making, such as reaction time, perception and anticipation, visual processing, and spatial recognition, are significantly involved in the direction-shifting ability, which includes rapid and precise reactions played in response to specific external stimuli (Šimonek et al., 2017, Spasic et al., 2015). The implications of these components in direction changing ability are important in the game of basketball, as they are the basis of players' agility (Popowczak et al., 2021).

Xu et al. (2022) established that playing basketball favors the optimization of cognitive functions, such as cognitive flexibility and working memory. This direction is met if the frequency is a minimum of two practices per week. The game of basketball requires a high level of concentration, especially since it is characterized a sport that requires complex skills, with players performing in a dynamic environment in which they must provide optimal responses to the unpredictable game conditions imposed (Chiu et al., 2020, Ke et al., 2021).

Other researchers have emphasized the significance of the relationship between practicing a more cognitively complex and cognitively engaging physical activity on executive functions compared to one that is not at the same level of complexity (Diamond & Ling, 2016, Ishihara et al., 2017; de Greeff et al., 2018, Vazou et al., 2019).

Four months of physical activity has been shown to improve executive functions, but following an open skills sport, such as basketball, improved inhibition and working memory in young exercisers (Madinabeitia-Cabrera et al., 2023).

Scanlan, Humphries, Tucker & Dalbo (2014) concluded that cognitive measures most influenced the performance acquired on agility testing in basketball players, with the authors suggesting incorporating reaction and decision-making drills into basketball training programs. Khudair, van Biesen, Pérez-Tejero & Hettinga (2021) specified that in the game of basketball players are required to make quick and efficient decisions, this aspect has high cognitive implications (Tenenbaum et al., 1993). Also, in this open-skills sport, memory, selective attention, and inhibitory control in decision making play a very important role (Chiu et al., 2020), Pinilla-Arbex et al. (2021) determined the link between cognition and decision making by using a basketball-specific decision-making task.

MATERIALS AND METHODS

Sample

The tests were conducted in June 2023. A total of 21 basketball players (3 Point Guard, 4 Shooting Guard, 3 Small Forward, 3 Power Forward and 8 Center) were selected who met the requirements of being enrolled in the same sports club, possessed a valid sports card with a valid medical visa and were members of a junior basketball team between the ages of 13 and 15 years. Of the 21 players, 18 had body measurements (176.95±9.27 cm, 73.6±6.08 kg, 21.25±1.48 kg/m2).

The basketball players were born in 2008-2009 (14.05±0.86 years) and had a sports experience of 4.66±2.43 years, with the highest experience of 10 years and the lowest of 1 year (Table 1).

The athletes were evaluated over two days. The first day comprised anthropometric measurements and body analysis, reaction speed, explosive force, cognitive ability (memory) and agility, and the hexagon agility test with random stimuli, anaerobic lactacid capacity and aerobic capacity were on the second day.

The legal representative of each athlete initially signed a voluntary participation agreement, and the research was conducted in accordance with the Declaration of Helsinki.

Table 1. Subject demographics data

Parameter	Mean	Standard deviation (±)	Minimum value	Maximum value
Age (years)	14.05	0.86	13	15
Sports experience (years)	4.66	2.43	1	10
Height (cm)	176.95	9.27	153.00	193.00
Body mass (kg)	64.11	9.73	43.5	77.90
BMI (kg/m^2)	20.57	1.86	16.80	22.90
Body fat (%)	15.85	3.10	11.40	22.20
Muscle mass (%)	41.69	2.35	36.40	45.00
Right upper limb fat (%)	20.09	5.28	3.90	26.20
Left upper limb fat (%)	21.29	5.22	3.70	27.90
Right lower limb fat (%)	20.39	3.18	14.80	27.10
Left lower limb fat (%)	20.91	3.14	15.60	27.10
Basal metabolic rate (kcal)	1733.40	145.24	1416.00	1959.00

Determining variables

Anthropometry: The height of the players, who were not wearing footwear, was determined using a Bosh rangefinder and Handy 10625B LCD digital Handy 10625B LCD digital level to help calibrate the rangefinder laser effectively.

Tanita and Omron analyzers were used to measure body mass (kg), BMI (kg/m^2), body fat (%), segment fat (%), muscle mass (%) and basal metabolic rate (kcal).

Agility: Three tests were applied to determine agility: the Lane test, the Illinois test and the hexagon agility test with randomized visual stimuli.

Lane agility test: marking with cones a rectangle 5.8 m long and 4.9 m wide; speed running on the first length, followed by lateral movement to the right along the width, running backwards in the direction of travel on the second length of the rectangle, then will perform the second lateral movement to the left to the starting point, will touch the cone with the left hand, and will perform the route again to reach the starting point.

The Illinois test: running the course with changes of direction; sprint in a straight line (10 m) and running in a serpentine fashion between 4 cones placed 3.3 m apart.

Hexagon agility test with randomized visual stimuli: formation of a hexagon with 2 m sides, and inside it a square with 40 cm sides is marked; the athlete placed inside the square, at the sound signal played by the Blazepod system, will have to move as quickly as possible towards the unit that has lit up and return after each touch inside the square. The aim is to touch as many Blazepod units as possible in 20 seconds.

Reaction speed: **The reaction speed test** was applied using T-reaction software (Cojocariu A., 2011). The athletes were seated on a chair, in front of them the laptop was positioned on a table, the keyboard with the 3 keys was placed on the thighs and the hands on the side keys. Twenty red circles were randomly displayed on the left or right half of the laptop, and the players had to press the key corresponding to the side on which the circle appeared in the shortest possible time.

Anaerobic lactate capacity was measured using the 8x10+10 m test (Trofin & Abalașei, 2019). The fatigue factor of the 8x10+10 m test was also calculated.

Aerobic capacity was determined by the Vameval shuttle test (Trofin et al., 2018).

Lower limb explosive force was tested by a vertical free-arm jump (Free Jump) on the Just Jump platform. The lower limb explosive power explosive strength factor (LPEF) was measured by applying the protocol of 4 consecutive free-arm vertical jumps.

Cognitive ability (memory): **The simple visual memory** test consisted of selecting one or more squares, depending on the level, which were highlighted for 2 seconds. Using the Human Benchmark online platform, the test displayed 9 squares organized in the shape of a larger square, and for the first level, out of the 9 squares, 3 of the squares were displayed white for 2 seconds, then the athlete had to select the memorized squares that were displayed white.

The dynamic visual memory test, similar to the previous one, except that the white color of a square will last about 0.3 seconds, then the evaluated athlete has to press on the memorized square. At the next levels, where several white squares are lit consecutively, the athlete has to press the squares in the order of their color change.

The numerical memory test was applied using the same platform. A number consisting of a digit appears for a few seconds, then the athlete has to write down the memorized number. The visualization time of the number and the digits of the number increase with each level.

Statistical analysis

Descriptive statistics used mean and standard deviation. Data processing was done with GraphPad Prism 9.3.0 (GraphPad Software Inc.). Pearson correlation was applied and its coefficient (r) was calculated to determine the relationship between effort capacity and cognitive level. The values of r led to the assessment of the level of correlation as follows: 1–perfect, above 0.75–strong, above 0.50 and below 0.75–moderate, above 0.25 and below 0.50–acceptable, and below 0.25–weak (Colton, 1974). The threshold value for statistical significance of the tests used was set at 0.05.

RESULTS

The evaluation of the athletes involved 11 tests to measure their exercise capacity and cognitive level. The data recorded for the cognitive tests by 19 of the 21 players are presented in **Table 2** and for the physical tests in **Table 3**.

Table 2. Mean, standard deviation, and minimum and maximum values of the results obtained on cognitive tests

Parameter	Mean	Standard deviation (±)	Minimum value	Maximum value
Numerical memory	7.21	1.51	4.00	10.00
Simple visual memory	7.79	1.58	5.00	11.00
Dynamic visual memory	6.89	2.62	3.00	13.00
Dominant upper limb reaction speed (ms)	307.98	32.44	254.00	395.33
Non-dominant upper limb reaction speed (ms)	318.85	32.87	277.31	388.75
Average reaction speed (ms)	313.41	29.11	267.70	392.04

*ms - miliseconds

With regard to the arithmetic mean and standard deviation of the numerical memory, 7.21±1.51 levels are highlighted, meaning that the range of values within normal limits is from 5.7 to 8.72. Looking at simple visual memory, the subjects returned an average of 7.79 levels with a dispersion indicator of 1.58, resulting in a range with a minimum limit of 6.21 levels and a maximum limit of 9.37 levels. The central tendency and the deviation from it yield values of 6.89±2.62 levels when testing dynamic visual memory. The minimum threshold being 4.27 levels and the maximum 9.51 levels. The reaction speed of the upper limbs implies a standard deviation from the mean of the results of 307.98±32.44 ms in the dominant hand of the athletes and 318.85±32.87 ms in the non-dominant hand, with a range of values between 275.54 and 340.42 ms, respectively 285.98 and 351.72 ms.

Table 3. Mean, standard deviation, and minimum and maximum values of the results obtained on physical tests

Parameter	Mean	Standard deviation (±)	Minimum value	Maximum value
Free Jump (cm)	50.79	7.43	38.37	64.81
4 jumps - FPEF	1.27	0.46	0.59	2.50
Lane Agility Test (s)	13.17	0.67	11.61	14.55
Illinois Agility Test (s)	17.04	0.67	15.53	18.34
Random Visual Stimulus Hexagon Agility Test (s)	1.85	0.29	1.54	2.79
8x10+10 (s)	30.53	1.48	27.84	33.01
8x10+10 (%)	6.16	2.03	3.77	11.62
F.O.-8x10+10	0.53	0.24	0.28	1.16
VamEval – VO_2max	52.52	4.51	45.35	60.71

The lower limb explosive force is 50.79±7.43. The explosive power factor was recorded as 1.27±0.46. The minimum threshold of the dispersion values is 12.50 s and the maximum threshold is 13.84 s in the Lane test, with a mean and standard deviation of 13.17±0.67 s. In the Illinois test, the minimum threshold is 16.37 s and the maximum threshold is 17.71 s, with a mean and standard deviation of 17.04±0.67. The hexagon agility test with randomized visual stimuli was completed by players in 1.85±0.29 s.

Anaerobic lactate capacity (8x10+10 m test) was determined in players with a mean and standard deviation of the 140 m distance covered times of 30.53±1.48 s. The fatigue factor returned from the test is 0.53±0.24. The maximum volume of oxygen (VO_2max) acquired by the athletes following the VamEval test is 45.01±19.28 ml·kg-1·min-1.

There were 45 associations between the results obtained by the athletes. Considering the data in ***Table* 4**, the association of the cognitive parameter, numerical memory, with the 9 physical parameters can be observed.

Table 4. Pearson correlation (r) between numerical memory and physical parameters

Parameter 1	Parameter 2	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Number of subjects (N)	p
Numerical memory	*Free Jump (cm)*	-0.174	0.03	19	0.475
Numerical memory	*4 jumps – FPEP*	0.262	0.07	19	0.279
Numerical memory	*Illinois (s)*	-0.314	0.10	19	0.190
Numerical memory	*Lane (s)*	**-0.473***	0.22	19	0.041
Numerical memory	*Random Visual Stimulus Hexagon Agility (s)*	-0.103	0.01	16	0.706
Numerical memory	*8x10+10 (s)*	0.187	0.03	16	0.489
Numerical memory	*8x10+10 (%)*	0.434	0.19	16	0.093
Numerical memory	*F.O. 8x10+10*	0.368	0.14	16	0.161
Numerical memory	*VamEval – VO_2max*	0.194	0.04	16	0.471

It can be emphasized that the Pearson correlation coefficients fall within the minimum correlation ranges. Out of the 9 associations, the smallest coefficient is that of the correlation with negative direction between numerical memory and the hexagon agility test with random visual stimuli (r = -0.103), and with positive direction, the smallest correlation coefficient is that of the association of numerical memory with the 8x10+10 anaerobic lactate test (r = 0.187).

As for the association of numerical memory with the Lane agility test, a correlation coefficient of -0.473 was observed, which gives the correlation a negative direction and a moderate magnitude, as it is close to the upper limit of acceptable to moderate degree of association (r = -0.473, p = 0.041).

The correlation between numerical memory and the Lane test measure of agility has a coefficient of determination of 0.22. Thus, there is a probability that 22% of the analyzed memory changes are followed by Lane test changes in the athletes' developmental framework or in a subsequent evaluation. The trend of a change in one parameter will be followed by the other according to the direction of the correlation (inverse).

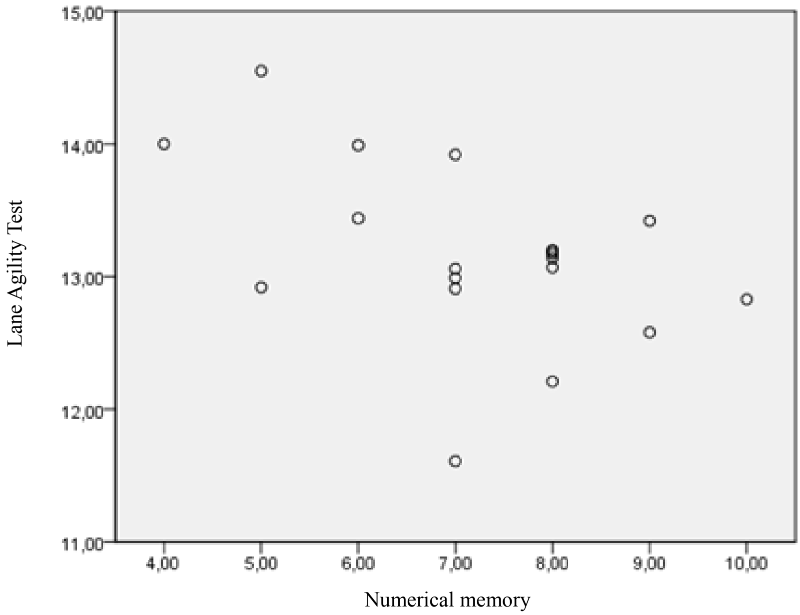

Figure 1. Pearson correlation graph between Lane agility test and numerical memory

Considering the graph presented in **Figure 1**, an acceptable negative to moderate correlation has been defined, determining an inversely proportional relationship between the two parameters. Thus, if the result of the Lane test is good, the result of the numerical memory is with the same tendency.

A significant relationship is established between the two parameters, as the athlete has a high capacity to retain digits in parallel with the movements on the field involving specific changes of direction.

Referring to **Table 5**, we can observe that, among the values of the correlation coefficients between simple visual memory and the nine parameters, the lowest is that of the association of simple visual memory with the Illinois agility test (r = -0.021, p = 0.932).

Table 5. Pearson correlation (r) between simple visual memory and physical parameters

Parameter 1	Parameter 2	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Number of subjects (N)	p
Simple visual memory	*Free Jump (cm)*	-0.172	0.03	19	0.480
Simple visual memory	*4 jumps – FPEP*	-0.270	0.07	19	0.264
Simple visual memory	*Illinois (s)*	-0.021	0.00	19	0.932
Simple visual memory	*Lane (s)*	0.063	0.00	19	0.798
Simple visual memory	*Random Visual Stimulus Hexagon Agility (s)*	-0.428	0.18	16	0.098
Simple visual memory	*8x10+10 (s)*	-0.220	0.05	16	0.412
Simple visual memory	*8x10+10 (%)*	-0.339	0.11	16	0.198
Simple visual memory	*F.O. 8x10+10*	-0.194	0.04	16	0.471
Simple visual memory	*VamEval – VO_2max*	0.091	0.01	16	0.737

As in the previous table, **Table 6** does not show any Pearson correlation coefficient of statistical significance ($p > 0.05$).

Table 6. Pearson correlation (r) between dynamic visual memory and physical parameters

Parameter 1	Parameter 2	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Number of subjects (N)	p
Dynamic visual memory	*Free Jump (cm)*	0.239	0.06	19	0.324
Dynamic visual memory	*4 jumps – FPEP*	0.017	0.00	19	0.946
Dynamic visual memory	*Illinois (s)*	0.056	0.00	19	0.821
Dynamic visual memory	*Lane (s)*	-0.125	0.02	19	0.610
Dynamic visual memory	*Random Visual Stimulus Hexagon Agility (s)*	0.174	0.03	16	0.519

Parameter 1	Parameter 2	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Number of subjects (N)	p
Dynamic visual memory	*8x10+10 (s)*	-0.253	0.06	16	0.345
Dynamic visual memory	*8x10+10 (%)*	-0.358	0.13	16	0.173
Dynamic visual memory	*F.O. 8x10+10*	-0.436	0.19	16	0.091
Dynamic visual memory	*VamEval – VO_2max*	-0.007	0.00	16	0.981

The correlations found between dynamic visual memory and the 9 physical parameters are predominantly low, the p level being statistically insignificant.

The data in **Table 7** show the association of dominant upper limb reaction speed with the 9 physical parameters.

Table 7. Pearson correlation (r) between reaction speed of the dominant upper limb and physical parameters

Parameter 1	Parameter 2	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Number of subjects (N)	p
Dominant upper limb reaction speed	*Free Jump (cm)*	0.182	0.03	19	0.457
Dominant upper limb reaction speed	*4 jumps – FPEP*	0.128	0.02	19	0.601
Dominant upper limb reaction speed	*Illinois (s)*	0.039	0.00	19	0.875
Dominant upper limb reaction speed	*Lane (s)*	-0.243	0.06	19	0.315
Dominant upper limb reaction speed	*Random Visual Stimulus Hexagon Agility (s)*	-0.016	0.00	16	0.954
Dominant upper limb reaction speed	*8x10+10 (s)*	-0.130	0.02	16	0.631
Dominant upper limb reaction speed	*8x10+10 (%)*	-0.467	0.22	16	0.068
Dominant upper limb reaction speed	*F.O. 8x10+10*	**-0.498***	0.25	16	0.050
Dominant upper limb reaction speed	*VamEval – VO_2max*	0.088	0.01	16	0.745

We note that out of the 9 associations, the highest coefficient is that of the acceptable to moderate negative correlation between dominant upper limb reaction velocity and lactate anaerobic fatigue factor (r = -0.498, p = 0.050).

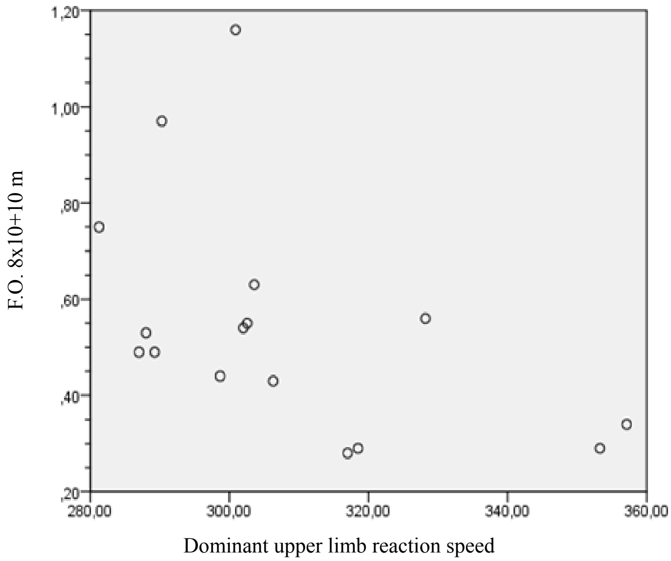

Figure 2. Pearson correlation graph between fatigue factor and reaction speed of the dominant upper limb

Referring to the distribution of values in the graph in **Figure 2**, an inversely proportional relationship can be distinguished, due to the acceptable negative correlation, towards moderate.

Thus, the increase of one parameter causes the decrease of the other, which is unusual for the given significance. We refer to the fact that both reaction speed and fatigue factor have values inversely proportional to performance. According to the correlation relation, it would mean that an athlete with an increased fatigue factor would have a poorer reaction speed, which is contrary to a logic of quick analysis.

It is necessary to keep in mind that this correlation is only valid for 25% of the cases and would require further investigation on other groups of athletes.

On the basis of the data in **Table 8**, we observe the association of the indices of the reaction speed of the non-dominant part of the basketball players with the values of the physical tests.

Table 8. Pearson correlation (r) between reaction speed of the non-dominant upper limb and physical parameters

Parameter 1	Parameter 2	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Number of subjects (N)	p
Non-dominant upper limb reaction speed	*Free Jump (cm)*	0.359	0.13	19	0.132
Non-dominant upper limb reaction speed	*4 jumps – FPEP*	0.348	0.12	19	0.145
Non-dominant upper limb reaction speed	*Illinois (s)*	-0.001	0.00	19	0.998
Non-dominant upper limb reaction speed	*Lane (s)*	-0.215	0.05	19	0.377
Non-dominant upper limb reaction speed	*Random Visual Stimulus Hexagon Agility (s)*	-0.160	0.03	16	0.554
Non-dominant upper limb reaction speed	*8x10+10 (s)*	-0.316	0.10	16	0.234
Non-dominant upper limb reaction speed	*8x10+10 (%)*	-0.205	0.04	16	0.446
Non-dominant upper limb reaction speed	*F.O. 8x10+10*	-0.191	0.04	16	0.478
Non-dominant upper limb reaction speed	*VamEval – VO_2max*	-0.031	0.00	16	0.909

As in the case of the link between dynamic visual memory and physical parameters, the correlations found between the reaction speed of the non-dominant upper limb with the 9 physical parameters are overall low, the p level being statistically insignificant.

DISCUSSIONS

Our research involved two associations between effort and cognitive ability, one of which was unusual. Regular, high-frequency basketball training has considerable effect on working memory and cognitive flexibility in boys aged 6-8 years (Xu et al., 2022). Likewise, in another study, three weeks of massive basketball training increased the efficiency of executive functions and developed motor performance, as determined by the agility T-test and Yo-YoIR1 test, in young players (Silvestri et al., 2023). Also, the implementation of training sessions with FitLight, a system similar to BlazePod, favored cognitive ability.

Specialists, such as Policastro et. al (2018), correlated the coordination ability of basketball players (ages 7-10 years) with cognitive abilities. They administered the Corsi test to 70 basketball players, which is similar to dynamic visual memory testing, the difference between the two is rendered by the typology of the deployment (Corsi presents a faithful repetition of a sequence of squares reached performed by the assessor, while the present test was conducted through a digital application). They found a correlation between children's motor skills with the ability to memorize a sequence and its repetition ($R^2 = 0.06$), showing that the lowest values obtained on the motor test were recorded by the same subjects who also performed poorly on the Corsi test. Whereas, among the players in our study, no correlations were found between the agility tests, which are based on coordination, and the cognitive tests, simple visual, dynamic and numerical memory.

Among students (10-15 years old) in Rio de Janeiro, regression showed that physical tests (Touch test disc (TTD), upper and lower limb explosive strength, agility) were the best predictors of executive functions ($p < 0.001$). Hand-eye motor coordination was found to be the most significant predictor of cognitive outcomes, being more influential than academic skills. Significant associations were observed between the hearts and flowers task (HFT) and agility ($p < 0.001$) and touch test disk ($p < 0.001$) (Fernandes et al., 2024).

Matlák et al. (2022) aimed to determine the relationship between agility and cognitive functions among 12.3±0.4-year-old soccer players, they observed a high significant correlation ($p < 0.05$) between the time of time recorded on the agility test. Zhu et al. (2022) studied the links between nutritional status, cognitive functions and physical fitness also in preadolescents (mean age = 10.8 years), they concluded that subjects with poor nutritional status, if they improve their cardiorespiratory fitness and agility, they can improve executive functions. In contrast, in our athletes, no correlations were found between cognitive ability, as measured by memory tests, and agility, as measured by three tests (Lane, Illinois and Random Visual Stimulus Hexagon Agility Test).

Preschoolers who performed better on the physical tests (PREFIT battery: handgrip strength, standing long jump, speed/agility (4 x 10 m) and cardiorespiratory fitness) showed significantly higher scores on visual-spatial working memory ($p < 0.001$), phonological memory ($p < 0.001$), inhibition ($p < 0.001$) and cognitive shifting ($p < 0.001$) (García-Alonso et al., 2025).

Several experts have demonstrated a strong link between agility and the degree of cognitive and brain development in preadolescents and adolescents (Mora-Gonzalez et al., 2019, Hu et al., 2022). The complex situations that adolescents are exposed to while performing physical activity favor the development of agility and cardiorespiratory fitness, which in turn improve functional activity and cognitive efficiency (Shi & Feng, 2022).

Bazalo et al. (2024) studied the relationship between explosive strength, speed/agility, and fluid reasoning in 129 children, and they found significant associations between physical fitness at these ages and fluid intelligence. Physical fitness could have a positive impact on children's cognitive health.

With regard to the relationship between reaction speed and VO_2max, according to the study by Maghsoudipour et al. (2018), a significant correlation was found, resulting in a $p < 0.05$. The researchers included athletes in the study, whose VO_2max was assessed using the Queen Step Test, and reaction speed was determined using the psychomotor vigilance test (PVT). Our study showed a negative correlation between the reaction speed of the dominant upper limb and the fatigue factor ($r = -0.498$, $R^2 = 0.22$, $p = 0.050$), as measured by the anaerobic lactate test, which is curious. Others have found positive associations between physical condition, tested by ergometry on a PWC-130 bicycle, and some cognitive functions, such as selective attention, verbal memory, working memory, logical reasoning, and interference processing (Gajewski et al., 2023). Aerobic fitness showed a significant but negative association with the dorsal attention network (DAN) (Abbasi et al., 2025), whereas in our research no association was found between aerobic and cognitive capacity, but this may be because we associated another function, namely memory.

In the case of climbers, significant links were observed between their performance and working memory, with high-performance athletes performing much better than lower-level athletes (Garrido-Palomino et al., 2024). Even among boxers, associations were found between their specific work capacity (determined by maximum speed punches in 8 seconds) and the speed of verbal information memorization. Furthermore, a higher level of this working capacity is ensured by the activation of verbal intelligence, logical and operational thinking (Korobeynikov et al., 2022). Among soccer players, the performance of skills acquired in speed dribbling, passing, and shooting at the goal showed a significant positive correlation with the sensorimotor network (SMN) and the attention network (Abbasi et al., 2025).

Using BlazePod technology in their research, as we did in the present study, Hsieh et al. (2025) found a significant correlation between response inhibition measures in the laboratory and on the field. Furthermore, only the go/no-go decision-making ability determined on the field correlated with overall performance on the field.

Li et al. (2020) concluded that physical activity influenced working memory and inhibition and had a moderate effect on cognitive flexibility. Malambo et al. (2024) consider that physical activities involving coordination appear to be significantly associated with conceptual thinking among preschoolers.

Gross motor coordination is correlated with cognitive control, with Liu et al. (2022) demonstrating this relationship with executive functions in preadolescents. Musálek et al. (2024) argue that physical activities focused on improving fine motor control and strength/agility can help improve children's cognitive abilities.

Practitioners and specialists in the field emphasize the interdependent relationship between the cognitive and motor systems, noting a directly proportional relationship between their levels. The complexity of physical tasks has an acute effect on the inhibition of basketball players (Gutiérrez-Capote et al., 2024). Zaichenko Y. (2023) emphasize the importance of the athlete's ability to manipulate physical, technical, mental, and tactical abilities in order to achieve the proposed goal and win in sports.

CONCLUSIONS

This research aimed to determine the degree of association between the ability to sustain prolonged, high-intensity effort and the cognitive processes of young basketball players. To this end, the correlation between anaerobic lactacid effort capacity and mental abilities was analyzed, along with other components of physical effort potential.

The association between effort capacity and the cognitive level of the players is partially demonstrated, as correlations were found only between numerical memory and the Lane agility test ($p = 0.041$) and the reaction speed of the dominant upper limb with the fatigue factor reported by the anaerobic lactacid capacity test ($p = 0.05$). The analysis of the data leads us to believe that an athlete with a high effort capacity does not necessarily have a commensurate cognitive capacity, based on our study group. To confirm this hypothesis, we believe that a larger number of basketball players is needed.

Given the correlation coefficients found in the associations between upper limb reaction speed and physical parameters, especially those related to agility, we recommend the implementation of specific reaction speed exercises in player training.

Due to the characteristics of dynamic sports, the assessment of practitioners' cognitive abilities is necessary to determine the factors that need to be trained or improved, as well as to manipulate them in order to improve sports performance and efficiency.

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