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Brain Jogging: Cognitive Abilities of Beginner Tennis Players

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Abstract Brain-based skills are needed to perform any task from the simple to the most complex, one of which is in sports activities such as tennis. The characteristics of tennis include open skills, namely sports in which players accept to react in a dynamically changing, unpredictable, and externally moving environment. These skills require cognitive abilities to set game strategies to trick and kill the ball in the opponent's area. Therefore, this study aimed to investigate the effect of brain jogging on improving the cognitive abilities of beginner tennis players aged 10-11 years. This study used an experimental method with a pretest-posttest-one-group design. The research instrument used was a memory test using the IST subtest (Instructional structural test) and an attention test using the Digit Symbol Substitution Test (DSST). The research sample was members of the junior tennis club in Tasikmalaya City, with a total model of 35 athletes. The results of this study prove that the brain jogging program can effectively improve athletes' cognitive abilities. This is because the brain jogging program presents games that require coordination, mental training, physical training, and visual training; this exercise can stimulate cells in the brain, directly affecting cognitive function. The limitation of this research lies in the media used in the training process that is not digital-based. So, as the following research develops, researchers try to apply the technology in the life kinetics training program.

Keywords Brain Jogging, Cognitive Abilities, Tennis, Young Athletes

1. Introduction

Cognitive training is a sophisticated mental process beyond the relationship between stimulus and response. A behavior change occurs after mental processes and learning have occurred in the individual. Cognitive training is a type of training that results from understanding what is happening in society and the wider world. Only some actions that the person has in mind can achieve this. In short, cognitive training is a successful mental activity [1]. The cognitive theory states that knowledge can be easily organized and recalled to the extent that it is understood, planned, and regulated [2]. Information configuration is mentioned in the new method, in contrast to the previous cognitive approach, which emphasizes learning through acquiring knowledge.

One of the most critical cognitive techniques is collecting and processing or constructing information [3]. The process approach to information involves four stages. These stages include control, short-term memory, long-term memory, and sensory notes. Stimulus from the environment is transferred to short-term memory, or

working memory, with the help of the senses. This knowledge is retrieved from long-term memory when needed and processed in short-term memory [4]. Cognitive learning theories often emphasize personal traits and internal mechanisms. It argues that learning does not depend on the reaction to stimuli. However, instead, learning occurs due to the proximity of the stimulus to another comparable experience in the brain. The underlying mechanism between performance recognition as performance and information acquisition by sensory organs has been studied by cognitive theorists [5], [6]. Cognitive ability is the mental activity of mind, memory, and information processing that enables a person to acquire memories, solve problems and plan for the future, or all psychological processes related to how individuals learn, pay attention, and observe, imagine, predict, assess and think about the environment [7]–[9]. The cognitive domain is based on its function: Attention, Perception, Language, Memory, Visuospatial, and Executive Function [10].

Practice is defined by cognitive theorists as sensing external impulses, comparing previous knowledge, creating new knowledge, and memorizing and retaining information obtained by people [11]. For example, visualization exercises in tennis may be more beneficial than pull-ups or rope climbing [12], [13]. Tennis is one of the sports included in the open skill category because each player must constantly adjust their movements to the changing field conditions [14]. To move, hit, and recover while waiting for the opponent's next shot, the player must decide where to move, what shot to hit, and where to recover after hitting. It is essential to change player moves and shots every time consistently.

Tennis is one of the biggest sports that increase the ability to develop physical, mental, sensory, and social skills if carried out in a planned and structured manner [15]. Tennis forces human technical, tactical, physiological, and psychological skills. Tennis is a sport that demands more work, education, and training than any other sport. Most coaches combine physical training with cognitive-based learning in coordination exercises to improve performance. Tennis players need cognitive skills to analyze the opponent's game, set a strategy to turn off the ball, and score points from the opponent. In this study, cognitive abilities, especially memory and attention, can be developed through physical activity training through brain jogging exercises. This matter is based on many studies regarding the relationship between physical activity and children's cognitive abilities and brain health.

Brain jogging is a form of physical exercise that uses life kinetics in its movement. This training integrates cognitive activity (concentration, attention, perception), physical activity training (coordination, agility, balance), and visualization training. Most of the movements used in brain jogging are multi-tasking, which stimulates the cooperation of all parts of the body and brain at once. In addition, the movement of brain jogging can stimulate brain cells to form new branches and even new brain cells (neurons) as a result of brain stimulation of new motion tasks [16]. Through this brain jogging exercise, children will not be trained to the automation stage, in contrast to exercises such as brain gymnastics or branching exercises, because there are many variations of the exercise that challenge the brain to work, of course, in a happy state because brain jogging is an interactive and fun exercise.

They are seeing several previous studies limited to only examining the optimization of the coordination of pencak silat athletes through brain jogging [17], brain jogging on students' cognitive abilities and brain jogging on badminton emotional intelligence [18]. Looking at several previous studies, researchers have yet to find research on the involvement of brain jogging in tennis games on cognitive improvement. From the background of the problems above, researchers want to explore further the impact of brain jogging on cognitive abilities, especially on memory and attention skills, considering that there still needs to be more research on using brain jogging to improve cognitive abilities in beginner tennis players.

2. Theoretical Framework

2.1. Tennis

Scores in every tennis game result from a series of strokes made by tennis players. Repetitions of a series of strokes will cumulatively form game patterns. Therefore, tennis coaches must continuously record and practice all technical training materials for each session. The documentation process is beneficial for tennis coaches in choosing materials to improve skills and playing patterns. Departing from the accumulation of training patterns created by coaches for their tennis players, it can be used as a playing strategy and enrich playing tactics in facing potential opponents. This way, all documented playing patterns must be tried during training and competition. One of the main tasks of the coaches is to bring and observe the athletes while participating in a tournament. The things the coach observes are directly related to the aspects that support and hinder the athlete's performance in competition [19].

The basic idea of playing tennis is to hit the ball before or after it bounces on the court using a racket, over the net, and into the opponent's playing field. The basic tennis techniques are used to hit the ball to the opponent's field [20]. The basic hitting techniques in playing tennis include forehand-backhand groundstrokes, serves, volleys, smashes, and other types of strokes for high-level players [21]. Furthermore, G. Mulya et al. [6] classifies hitting techniques in tennis, including forehand, backhand grip one and two hands, serve, volley, overhead smash, transition shots (approach shots, passing shots, the net return of serve, first volley), lobs, and drop shots. Meanwhile, C. J. Raymond et al. [22] divides tennis stroke techniques into groundstrokes (forehand-backhand),

volleys (forehand-backhand), serves, lobs (forehand-backhand), and smashes. In simple terms, Ngatman et al. classify the basic techniques of tennis: groundstrokes (forehand-backhand), serves, and volleys (forehand-backhand) techniques. The primary stroke techniques in tennis include service techniques, groundstrokes, volleys, lobs, and smashes [23].

Several other types of tennis stroke techniques are developments and combinations of the various basic moves of these basic techniques. The main basic movements are inherent movement patterns and form the basis for movements, including (1) locomotor movements, (2) non-locomotor movements, and (3) manipulation movements [24]. The locomotor movements are movement behaviors that change from place to place, such as creeping, crawling, walking, running, jumping, and jumping. Non-locomotor movements are movement behaviors that involve limbs or body parts in motions that circle joints or shafts, such as pulling, pushing, swinging, stooping, bending, and rotating [25], [26]. Meanwhile, manipulation is a behavior usually described as coordinated movements of the feet and hands, such as grasping, cutting, blocking, and requiring skill.

The hitting techniques in the game of tennis combine the three essential elements of motion, and they are carried out in a series of complete and simultaneous movements. Furthermore, essential motion elements are needed to perform hard, consistent, and long-lasting punching techniques. The basic definition of motion is the state of the body (motor component) that underlies a person's movement tasks, including strength, endurance, speed, and flexibility [27].

2.2. Brain Jogging Program

Brain jogging is a program that provides energy, activates the brain through exercise, and synchronizes the body and mind [28]. Brain jogging is a physical activity that combines cognitive and multitasking activities to increase mental fitness [29]. A fun "brain jogging" method combines mental exercise with physical exercise. These mental exercises include brain gymnastics, brain gymnastics, and the kinetics of life.

Judging from the type of brain jogging exercise, this exercise combines physical, cognitive, and visual exercise [30], [31]. It is also a fun exercise because it involves several combinations of tools and various movements, from easy to complex, which requires high concentration. This fun, visual, and coordination training method provides a good stimulus for the brain in creating brain networks and creating new brain cells [5], [32]. This program is very safe for all ages; all ages from 8 to 80 can do all types of this exercise [33]. The objectives of this training are that children become more creative than before, children have better concentration, athletes have more efficient techniques and movements, children are more mature in dealing with stress, and athletes will be more skilled in dealing with situations that are considered dangerous. Meanwhile, H. Duda [34] states that the benefits obtained in brain jogging training are the same as those obtained in kinetic life. The following Table 1 is the explanation in question.

Table 1. Benefits of Brain Jogging

General	**Sports Activity**
Reducing stress and emotions and creating a more relaxed body. Improves concentration, memory, and learning capacity. Improve mentally and physically. Increase efficiency and reduce the error rate. Increase self-confidence and ability to work independently.	Better performance with less energy and effort but maximum results. Increase awareness and orientation. Improve movement skills and harmony of motion. Improve body balance. Improve eye-hand and eye-foot coordination.
Activities at school	**Activities at work**
Easier to find solutions to problems. Understanding and problem-solving questions are more accessible. Improve learning ability and memory. Improve reading, writing, and concentration skills.	Doing multiple jobs like errands and making calls is more accessible. A better understanding of business meeting events. A better understanding of career paths and good at changing innovation goals. Understanding and remembering business conversations just got easier. Improves visual perception and focus of attention. Improve mental perception.

2.3. Cognitive Abilities

The cognitive concept refers to the ability to process information, apply knowledge, and change trends [35], [36]. Meanwhile, cognition is how a person pays attention to and obtains information, how information is stored and processed in the brain, and how to solve problems, think, and formulate language [37]. Cognition refers to a range of high-level brain functions, including learning and remembering, organizing, planning and solving problems, focusing, maintaining and redirecting attention as needed, understanding and using language, accurately understanding the environment, and doing calculations [38]. Cognitive ability is the ability to collect, integrate, interpret information and understand the social sphere [39]. When humans think, cognitive abilities occur internally in the central nervous system [40]. Therefore, cognitive abilities develop gradually, in line with physical development and the nerves in the nervous system's center.

Cognitive abilities are more than just learning information. Instead, it is the ability to think about new information, process it, talk about it, and apply this new information to other previously obtained information [41]. As children become adults, they develop the ability to think at a higher level. They can process information more skillfully and quickly connect to other information. In other words, their thinking ability is getting better. Children should be able to improve their ability to focus, remember information, and think more critically as they get older [42], [43]. Cognitive abilities allow children to understand the relationship between ideas, understand causal processes, and improve their analytical skills. Cognitive abilities are brain-based skills needed to perform any task from the simplest to the most complex. The cognitive structure in a child is high-speed; for example, they will more quickly capture and remember something real to them [44].

3. Materials and Methods

3.1. Research Design

This study uses a quantitative approach with an experimental research design. Experiments are used to determine differences in the cognitive abilities of novice tennis players before and after being treated with brain jogging. The data collection used in this study was in the form of tests carried out twice, namely the initial test before treatment and the final test after treatment through the one-group pretest-posttest design adapted from N. E. Fraenkel et al. [45]. After knowing the results obtained during the initial test, the next step is that the participants are given treatment for 24 meetings. During the treatment period, participants must still be accompanied by a trainer or an assistant trainer; this is done to facilitate observation during the research process and to strengthen the closeness between participants and trainers. Therefore, trainers must have data on the results of each participant's ability development so that it can be seen clearly how far the progress of each process the participant has gone through. This matter can be a reference for making training programs in the future, bearing in mind that each individual's abilities are different; therefore, one needs tips and tricks in compiling training programs based on data from participants obtained beforehand. Then, the next stage is the final test, which aims to determine how far the participants' abilities have been after the brain jogging program treatment.

The samples in this study were beginner tennis athletes aged 11-16 years who joined a junior tennis club in Tasikmalaya City, Indonesia, totaling 35 people, consisting of 23 men and 12 women. The period of growth and development at this age is perfect because, in this period, children begin to learn sports skills, for which they will later choose a specialization in sports that are of their respective interests and talents [46]. The sampling technique used was nonprobability sampling using a purposive sampling approach, namely the sampling technique for a particular purpose only.

3.2. Procedures

In the early stages, before carrying out the initial test, the researcher coordinated with the tennis club participants and their parents because the researcher wanted every research process carried out to be known by each participant's parents; this was also done to maintain the trust of the parties—parents of the research club. Parents will later be asked to be present during the research activities so that their presence can illustrate parental support for the interests and talents of their children. The process of identifying cognitive abilities is by carrying out a series of tests, namely the Intelligenz Structure Test (IST) and the Merk Aufgaben (ME) subtest. The Aufgaben brand subtest is used to measure short-term memory. As for the attention test, the Digit Symbol Substitution Test (DSST) is used. The research lasted 2.5 months and was adjusted to the participants' practice schedule every Tuesday, Thursday, and Saturday at 14:00. In carrying out the research, the brain jogging program was interspersed with other required physical condition programs so that each component of the physical condition and other supports also developed and maintained well.

3.2.1 Brain Jogging Program

The brain jogging exercise program that has been compiled and used in this research can be seen in Table 2 below.

Table 2. Stages of the Brain Jogging Exercise Program

Micro	Brain Jogging Items
Week 1	Ladder A1-A4, Ladder B1-B4, Jumping Line J1, J3 and J4, and Juggling JUG1.
Week 2	Ladder A3-A4, Ladder B1-B4, Ladder C1-C4, and Juggling JUG2.
Week 3	Ladder A1-A4, Ladder B3, and B4, Jumping line J1-J3, and Juggling JUG1-JUG2.
Week 4	Combination Ladder A3, A4, B3, B4, Jumping Line J1-J4, Reaction and Cognition RC1-RC2, and Jumping Cross JC1-JC2.
Week 5	Ladder B2-B4 with the ball, Ladder C1-C3, Jumping Line J3-J5, Reaction and Cognition RC3, and Jumping Cross JC2-JC3.
Week 6	Ladder A1-A4 with Ball, Ladder C2-C4, Jumping Line J3-J5, Reaction, and Cognition RC3-RC4.
Week 7	Jumping Line J4-J5, Reaction and Cognition RC1- RC3, Jumping Cross JC1-JC3, and Juggling JUG1-JUG3.
Week 8	Ladder A3, A4, B3, B4 Ladder C1, C4, Jumping Line J4, J5, Jumping Cross JC1-JC3 with Ball and Partner.
Week 9	Jumping lines J3-J5, Jb3-Jb5, Reaction, Cognition RC1-RC4, and Rainbow Run RR1.
Week 10	Jumping Cross JC2-JC3 with Ball and Partner, Juggling JUG1-JUG5, and Rainbow Run RR1- RR2.
Week 11	Ladder A3, B4, C3 Jumping Cross JC1-JC3 with Ball, Juggling JUG3-JUG5 dan Rainbow Run RR1-RR3.

As a beginner athlete, achieving achievement is an important goal, so training is an absolute prerequisite that must be carried out because systematic training is the primary reference to achieve the expected goals. Various types and variations of movements in the brain jogging program can direct and organize the training process according to the characteristics of the competition at hand. Several activities in brain jogging adopt a leveling system so that each exercise pattern presented has a different difficulty level; the aim is to provide a varied and systematic movement learning experience, from the easiest to the most difficult. All activities start with level 1; at the next stage of the meeting, the activities move to the next level, but first look at the conditions of the participants, whether they can follow each treatment given or experience difficulties. This program can help touch the motion aspects of the sports they are involved in so that it is easy for athletes to adapt well.

Several journal notes regarding the development of participants' abilities are provided to facilitate the researcher's control of the progress of each training process—the data is used as reference material for making other training programs. Athletes can discover their abilities every period, triggering their achievement motivation in carrying out their daily activities as athletes consistently. The trainer provides a thorough evaluation in each training session, both in the training process and after completing the training, during which participants get the reinforcement to be more confident in carrying out each training program.

3.3. Research Instrument

The research instrument for the memory test uses a subtest from the IST (Instructional structural test) [47]. Meanwhile, it conducts an attention test using the Digit Symbol Substitution Test (DSST) [48]. IST has nine subtests with different item characteristics. Each subtest measures aspects of exceptional abilities in humans or aptitude. Psychometrically, the IST belongs to the multiple-aptitude battery tests, a test composed of a series of subtests where each subtest measures different specific abilities. The IQ score in the IST is obtained from the average value of the particular abilities individuals acquire. However, the primary interpretation of the IST does not refer to the total IQ score but to the intelligence profile resulting from the nine subtests on the IST. IST has nine subtests representing the theory of Primary Mental Abilities (PMA). The basic PMA scheme divides it into seven basic capabilities or the main factors. Each factor can be measured by different behavioral dimensions, which subtests can represent. The subtest is a more concrete representation of the central or primary factors. Combining the seven main factors in the PMA theory can still produce an IQ score. However, apart from that, the basic ability profile produced by the PMA theory of the seven main factors has a more critical role in describing human abilities. The following Table 3 is the structure of Primary mental abilities (PMA).

Table 3. Structure of Primary Mental Abilities

Main Factor	Dimensions
Verbal comprehension (V)	Comprehension in reading verbal analogy Understanding unstructured sentences Verbal reasoning
Word fluency (W)	Regarding the name of an object in a given category Recognize word rhymes
Number (N)	Speed and accuracy in math problems
Space (S)	Ability to imagine objects (2 & 3 dimensions) Visually imagine objects with a specific rotation
Associative memory (M)	Remembering objects Remembering words (verbal)
Perceptual speed (P)	Regarding the visual details regarding the similarities and differences of an object
General Reasoning (I)	Think inductively Think deductively

Meanwhile, the DSST is part of the test developed from the "Wechsler Intelligence Scale for Children" (WISC). The DSST test can measure visual motor coordination, including accuracy, speed, concentration, mechanical memory, and recognition. This test is used for individuals aged 11-89 years. The advantages of this test are that it is short, easy to do, and costs much cheaper than other neuropsychiatric tests. This test consists of divided boxes and fields. At the top of the sheet, some symbols and numbers must be seen and listened to carefully as a guide for filling the boxes below. The top box has numbers (numbers), and the boxes below are special marks (geometry drawings). The value obtained is how many symbols are correctly paired with numbers within 90 seconds. The number of correct numbers shows excellent memory and concentration as well.

4. Results

4.1. Test Results of the Validity and Reliability

In the first stage, the researcher conducted several instrument trials, which were then tested for the validity and reliability of the instruments used. Table 4 shows the results of the intended validity and reliability tests.

The data findings are generated with a reasonable level of consistency based on the data from the validity and reliability tests in each of the tests mentioned above; the variables determine this: the total score and the average in that range (Cronbach's 0.710-0.773). The validity test result, table 0.215, indicated that all questions were legitimate. The instrument has validity and reliability it can be said that.

Table 4. Validity and Reliability Test Results Research instruments

Variable	Test (n=105)	Validity Test		Reliability Test					
	Mean (SD)	Item-Total Correlation	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α	ICC (95% CI)	*p*-Value †	SEM	% SEM	MDC
Instructional Structural Test (IST) (score)	2.17 (0.23)	0.122 **	2.44 (0.74)	.172	0.710	0.770 (0.701–0.824)	0.270	0.19	5.31	0.25
Digit Symbol Substitution Test (DSST) (score)	2.08 (0.34)	0.162 **	2.15 (0.68)	.412	0.748	0.791 (0.709–0.842)	0.350	0.21	6.28	0.18
Total domain score	2.71 (0.49)	0.153 **	2.42 (0.37)	.235	0.773	0.788 (0.731–0.811)	0.358	0.29	6.21	0.33

4.2. Data Descriptions

The next stage is to process and analyze the data, using it to evaluate the hypothesis after the data has passed the test. Table 5 below shows all the variable descriptive parameters of the IST and DSST. IST contains structural elements of Primary Mental Abilities (PMA). These variables are Verbal comprehension (V), Word fluency (W), Number (N), Space (S), Associative memory (M), Perceptual speed (P), and General reasoning (I). The following is a statistical description of both tests.

Table 5. Descriptive Statistics of All the Variables

Variable	M	SD	Min	Max
V (points)	30.16	4.64	8.20	32.00
W (points)	22.30	6.73	12.17	36.00
N (points)	17.43	4.26	6.00	24.00
S (points)	24.17	5.56	4.00	33.00
M (%)	28.26	4.31	10.00	24.00
P (%)	40.18	7.46	20.02	62.16
I (points)	18.37	5.62	.87	24.28
DSST (points)	37.54	3.79	9.62	20.59

Based on Table 5 above, the average value on the IST test on variable V is 30.16, W is 22.30, N is 17.43, S is 24.17, M is 28.26, P is 40.18, and I is 18.37. Then, the standard deviation value was obtained for the variable V of 4.64, W of 6.73, N of 4.26, S of 5.56, M of 4.31, P of 7.46, and I of 5.62. While the average value on the DSST test was 37.54, and the standard deviation was 3.79. After knowing the statistical description of the data variables, the next step is the normality test.

4.3. Normality Test Data

The next test step is the normality test using SPSS 19 for Windows to ensure the data can generally be distributed. The Shapiro-Wilk test was chosen as the normality test step because the sample number was below 50 people. The normality test determines the next test step in the testing process. The following are the results of the normality test in question.

Table 6. Normality Test

	Shapiro-Wilk		
	Statistic	df	Sig.
IST	0.247	35	0.807
DSST	0.265	35	0.770

The data in Table 6 above shows the results of the Shapiro-Wilk test with Asymp.Sig (2-Tailed). The score obtained from the IST memory test is 0.807, and the attention test using the DSST is 0.770. Because of the Asymp.Sig data is more significant than 0.05; the two data can be declared normally distributed, so it is feasible to conduct further analysis using parametric tests.

4.4. Results of Hypothesis Testing Using T-test

Based on the normality test results above, the distribution of data on scores of students' memory and attention abilities usually distributes, so the statistical test used is a parametric test. So, to find out the increase in children's cognitive abilities through memory and attention, a hypothesis test was carried out using a paired sample t-test. The test results are shown in Table 7 below.

Based on the calculations in Table 7, the difference in the average pre-test and post-test data from the child's cognitive ability through a memory test using the IST obtained a P-value of 0.001. Then, the attention test using DSST obtained a P-value of 0.000. Because the P-value is smaller than 0.05, that proves that there is a difference between the average score on the pre-test and post-test scores. So, the Brain Jogging program significantly affects the cognitive abilities of novice tennis players.

Table 7. Paired Sample T-test Cognitive Ability Results

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
IST	Post-test – Pre-test	25.838	5.511	2.005	8.75	33.634	4.167	35	.001
DSST	Post-test – Pre-test	37.540	3.791	1.475	9.62	20.594	5.012	35	.000

5. Discussion

Based on the results of the analysis of data calculations, the brain jogging program affects cognitive abilities in beginner tennis athletes. As previously discussed, brain jogging is a training method that combines cognitive training, physical training, and visual training. This exercise can stimulate cells in the brain, directly affecting cognitive function [1]. Cognitive Cognition is needed to be a resource in building the athlete's mentality. Of course, athletes who can streamline their cognitive aspects can improve mental factors and affect exercise performance [49].

Physical exercise through brain jogging can improve brain function and produce new cells in the brain [50]. When doing brain jogging exercises, several body parts are forced to make unusual movements such as throwing, catching, rotating the body, and making other coordinated movements that are the characteristics of the exercises in the game of tennis [6], [26]. Then, the combination of movement or physical activity that moves and forms a relationship with the cortex increases the athlete's efficiency throughout the training process. The new movement task of this brain jogging exercise is activated by each population of neurons or nerves, which increases the training process [51]. Improving this training process increases the athletes' skills because it can make technical movements more effective and efficient.

While providing treatment, athletes carry out motion coordination exercises, but without realizing it, these exercises train athletes' cognitive and visual perception [52]. Brain jogging is a program that can stimulate the nervous system by carrying out motion activities that will improve athletes' intellectual abilities. Tennis players need good cognitive abilities as part of an effort to win matches. Cognitively, athletes become multidimensional thinkers who can consider various sources of information [53].

The player must recognize the actual game situation and choose a position based on his tactical and technical understanding. Many new, unexpected, and unusual game situations can be found in tennis. A player must be nimble in adapting and using new tactical components to deal with the situation [54], [55]. In general, the alignment of perception and action is a component of all human skills. The emphasis that different types of skills place on the needs of perceptual processing, cognitive assessment, and motor control varies [5], [27], [32]. The development of tennis skills is strongly influenced by agility in the operating speed of thinking and perception [56]. Therefore, tennis players will try to analyze the opponent's abilities and adapt during the game to strategize to turn off the ball and add points to win the match. Movement analysis in the game of tennis requires good cognitive abilities, which involve the ability to remember and pay more attention to concentrate on every moment of the game.

6. Conclusions

This study shows that the brain jogging program has been proven effective in improving the cognitive abilities of novice tennis athletes. Utilizing the life kinetics program or other programs oriented towards cognitive improvement is expected to further develop in the future in line with the needs and progress of the times.

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