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Effects of Visual Training on the Reaction Time among Badminton Athletes

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Abstract. This study aims to identify the effects of visual training on the reaction time among badminton athletes using two reaction time tests, namely, the Whole-Body Reaction Time (WBRT) and the Finger Reaction Time (FRT). This quasi-experimental study involves 30 badminton athletes (Male = 30, Female = 30). The study involved two groups [treatment group = 30, control group = 30]. The descriptive analysis undertaken shows that the level of reaction time of treatment group for the pre-WBRT test is (M = 0.32, SD = 0.047) and pre-FRT test is (M = 0.48, SD = 0.068). For group control, the pre-WBRT test is (M = 0.33, SD = 0.030) and the pre-FRT test is (M = 0.49, SD = 0.065). On the other hand, the reaction time of treatment group for the post-WBRT test is (M = 0.28, SD = 0.037) and post-FRT test is (M = 0.41, SD = 0.054). Meanwhile, for control group, the post-WBRT test is (M = 0.32, SD = 0.037) and post-FRT test is (M = 0.45, SD = 0.061). Furthermore, for treatment group, there is a significant difference between the pre- and post-WBRT test [t (29) = 8.813, p = .000] and the FRT test [t (29) = 10.329, p = .000]. As for control group, there is also a significant difference between the pre- and post-WBRT test [t (29) = 3.786, p = .001] and the FRT test [t (29) = 4.935, p = .000]. Nevertheless, there is no significant difference between both the two pre-WBRT test group [t (58) = 1.667, p = .101] and the FRT test group [t (58) = 0.546, p = .587]. However, there is a significant difference for both the post-WBRT test group [t (58) = 4.676, p = .000] and the FRT test group [t (58) = 3.056, p = .003]. Overall, this study can help coaches in designing effective training programs which can help to enhance the reaction time level of badminton athletes.

Key words: Badminton, Reaction, Visual Training, Badminton Athletes, Finger Reaction Test, Whole-Body Reaction Time

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INTRODUCTION

In recent years, badminton has undergone developments in terms of the rules of the game as well as the pattern of play of the athletes. The evolution in the performance of this game has caused players to use or perform various gameplay patterns to improve the necessary aspects of the sport, especially in terms of speed and power [1]. There are five types of categories in badminton which are men's singles, women's singles, men's doubles, women's doubles, and mixed doubles. The increase in power and speed is due to the player's skill and physical factors [2]. Badminton is one of the fastest games in the world and is an exciting sport to play. This is due to the fast-paced pattern of play along with constant movement which includes attacking and defending shots in a match that involves a large scoring system in one game [3], Therefore, players need to play continuously to win points in this sport [4][1]. The intermittent action during a game of badminton usually requires both aerobic and anaerobic energy systems. As much as 60-70% aerobic energy and 30% anaerobic energy are required during a high-intensity badminton match [5].

Badminton is an explosive sport in which it requires the players to have power, flexibility, endurance, agility, speed, high energy systems of aerobics and anaerobic [6]. Based on Pérez-Turpin et al [7], badminton is one of the fastest racquet sports in the world as it can reach up to a speed of 260 km/h or 72 m/s. The badminton player who has high power has an advantage in performing movement jumps and quick reactions such as smashes or shortcuts to take down the rally [8]. Therefore, players need to react quickly and additionally be able to decide in a short period of time. There are two ways to measure reaction time through visual and audio [9]. Visual reaction time is the period taken by the individual who gives a reaction towards the visual stimuli [1]. In short, reaction time is one of the important components in the game of badminton. Based on studies that have been conducted by Dane & Pratt [11], it has been suggested that every sports activity is associated with visual reaction time. Thus, the component of reaction time may play an important role in improving the performance of badminton athletes.

Reaction time is defined as the time between a given stimulus and the onset of movement [12]. This reaction time involves a process of receiving stimuli by receptors, the transmission of information through nerves to the brain and from the brain to the muscle to perform a movement [13]. The process which takes place in the central nervous system in the brain is more efficient than the peripheral nervous system [14]. Psychologists have identified three types of reaction time experiments namely simple reaction time, cognitive reaction time, and choice reaction time [15][16]. Auditory reaction time is the time taken by the subject to react to an audio stimulus. Auditory reaction time can be measured in two categories which are simple reaction time and choice reaction time [18]. For simple reaction time, there is only one stimulus and one response. An example of simple reaction time is the subject should respond to the sound stimulus on the manual reaction key [17]. Simple reaction time is the response to sound or audio stimuli and response to light or visual stimuli. As for choice reaction time, the subject must respond to different sound stimuli on the manual reaction key. There are three different sounds and three different buttons on the manual reaction key [19].

Visual reaction time is the time taken by the subjects to react to a visual stimulus. Reaction time is one of the reliable indicators of the processing rate by the sense of stimuli by the central nervous system and its response in the form of motor responses [20]. This can determine a person's level of alertness because a person's speed to respond to a stimulus is dependent on his or her reaction time. However, there are several factors that influence reaction time such as gender, age, dominant hand, central versus peripheral vision, types of exercise, fatigue, exercise, personality types, and health level of a person [21]. In an experiment involving the cognitive reaction time, there are some stimuli that should be responded to (memory set) and other stimuli that need not be responded to (interference set) [17]. Nevertheless, this reaction time still requires the subject to respond to a stimulus that has been set by the researcher. Examples for testing cognitive reaction time are symbol recognition and tone recognition. Subjects need to identify the correct stimuli to respond to [22].

According to Zwierko et al [23], an athlete's reaction time can be improved by visual training. Perhaps, this visual training can help athletes to achieve optimal performance while playing, improve visual muscle, visual perception, enhance their ability to track, their ability to estimate, and helps to focus quickly and accurately on a target [1]. Based on Harrison-Walker [22], coaches, athletes, and researchers are still studying the latest training methods to improve performance and ensure that athletes have an advantage while competing in a match. Visual training is one of the newly introduced techniques in sports and visuals can also lead to performance improvement in various types of sports [2]. According to Appelbaum & Erickson [24], eyes play a very important role in sports activities, especially in racquet sports. There are not many past studies that have studied the relationship between reaction time before and after visual training is given. Along with that, based on past studies, visual abilities among athletes are higher compared to non-athletes [2]. However, the effect of visual training on reaction time among elite athletes and non-elite athletes has not been identified yet. [25].

Based on past studies, training involving visual abilities is not gaining proper attention in the daily training of athletes [26]. However, athletes and coaches often practice training related to visuals inadvertently. Along with that, there are also studies that portray the importance of visual abilities in improving an athlete's performance. This also shows that athletes do have higher visual abilities compared to those who are non-athletes. Therefore, many researchers have noted the possibility of training visual abilities. Moreover, outcomes from several studies have shown positive effects on visual training [27].

Furthermore, in badminton, players need high proficiency in visual abilities to study the position of the opponent and to take a shot at the opponent's court [28]. Visual function can also identify the movement of the opponent and whether they are approaching the net so that the player does not make a shot that should not have been made [2]. Therefore, the purpose of this study conducted is to identify the effects of visual training on the reaction time among badminton athletes.

This reaction time involves the process of receiving stimuli by receptors, transmitting information through nerves to the brain and from the brain to muscles to perform movements [28]. The concepts of information and transmission emerged from electronic communication theory [29] which can be linked to theory in research in the psychology field. This information theory was developed for person - to - person communication using communication tools such as telephones. However, the human mind can be seen as a communication system that processes information from input (sensory and perceptual processes) to output (response). The purpose of the conceptual framework in this study shows the direction of the study which contains 2 independent variables (treatment and control group) and one dependent variable which is the reaction time test (refer to **Figure 1**).

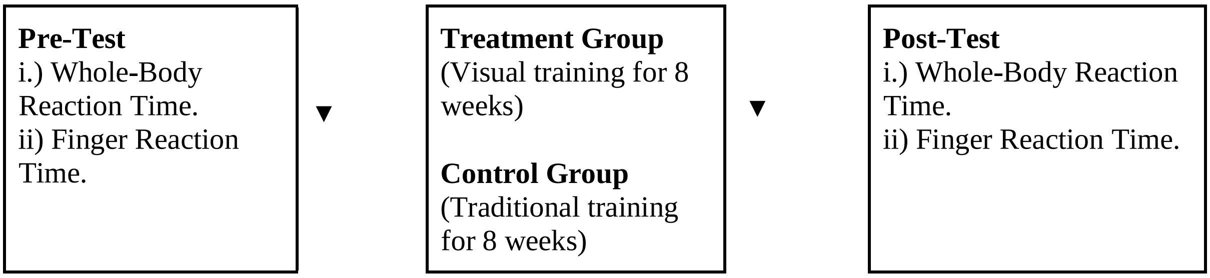

Figure 1. Conceptual framework of the study

METHODS

Research Design

This study is quasi-experimental in nature which involves pre-test scores and post-test scores to identify the difference in the reaction time score between two groups i.e., the treatment group and the control group. This sampling method used in this study was the purposive sampling method involving 60 badminton athletes of which 30 athletes were categorized as the control group (15 men and 15 women) and the remaining 30 athletes were categorized as the treatment group (15 men and 15 women). The number of subjects involved in this study was determined through the G-Power. Along with that, the subjects selected were based on several set criteria such as the subject should be an active badminton athlete who undergoes daily training, and the subject should also have experience playing in competitions at least at the state level. Approval from the Ethical Committee for Research involving Human Subjects of University Putra Malaysia (JKEUPM;002018) was obtained to conduct the research.

Research Instrument

Additionally, in this study, the Whole-Body Reaction Test (Visual Stimulus) and the Finger Reaction Test towards Visual Stimuli were used. The instruments needed and used to run these tests were the Regulator Whole-Body Reaction Time (WBRT), a rubber surge liner, a manual reaction key, stimulus display units, tables, and chairs. Reaction time is one of the reliable indicators of the rate of processing by the sense of stimuli by the central nervous system and its response in the form of motor responses [3]. However, there are several factors that affect the reaction time such as age, gender, dominant hand, central versus peripheral vision, type of exercise, fatigue, exercise, personality type and level of health of a person [26].

Subsequently, the study also used visual training as intervention training for eight weeks which was then implemented and practiced by the treatment group. Indeed, badminton is one of the sports that require short reaction times and visual training was included in this group training program. Visual training serves to help athletes to reach optimal levels while in a match, improve visual muscles, perception and visual tracking, skills to anticipate the movement of an object and improve quick and accurate focus on targets based on opponent’s movements [1]. Based on the study conducted by Hassan El-Gizawy [2] has also given assurance that visual training is a specialized program. The program aims to improve the connection between the eyes and the brain through the development of one’s visual skills and abilities by involving exercises that gradually increase difficulty to improve eye coordination. Apart from that, this training aimed to improve focus, eye speed, and eye-hand coordination. Along with that, this group had their training for 60 minutes daily for four days a week (Monday, Tuesday, Thursday, and Friday) where they had four types of training to do in eight weeks as per the following schedule (**Table 1**).

Table 1. Intervention training for 8 weeks.

Week	Training	Explanation
1 and 5	Reaction Ball	Throw and catch the reaction ball at the wall as much as you can in 1 minute. The distance of the subject and the wall is different in each session and there was a change of the ball being thrown; either up or down the arm.
2 and 6	Juggling	Juggle using tennis balls as long as possible. The number of tennis balls was changed according to the session.
3 and 7	Juggling and kicking a ball	Juggle using a tennis ball while kicking the ball towards the wall. The number of tennis balls were changed according to the session and the foot used to kick the ball was alternated according to the session.
4 and 8	Balancing Catch	The subject stands on a balance board while their partner throws the ball for them to catch. As for the aspect of tolerance progression, the ball was thrown further away from the subject to create a challenging environment for them to catch the ball.

RESULT AND DISCUSSION

Reaction time levels of control and treatment groups before and after intervention training

For the Whole-Body Reaction Test before the intervention training, the control group recorded a mean (SD) of 0.33 ± 0.030 while the treatment group recorded a mean (SD) at 0.32 ± 0.047. As for the Finger Reaction Test before the intervention training, the control group recorded a mean (SD) of 0.49 ± 0.065 while the treatment group recorded a mean (SD) at 0.48 ± 0.068. On the other hand, for the Whole-Body Reaction Test after intervention training, the control group recorded a mean (SD) of 0.32 ± 0.037 while the treatment group recorded a mean (SD) at 0.28 ± 0.037. As for the Finger Reaction Test after the intervention training, the control group recorded a mean (SD) of 0.45 ± 0.061 while the treatment group recorded a mean (SD) at 0.41 ± 0.054 (**Table 2**).

Table 2. Reaction time levels of control and treatment groups before and after intervention Training

Groups		Pre Whole Body Reaction Test	Pre Finger Reaction Test	Post Whole Body Reaction Test	Post Finger Reaction Test
Control	Min ± (SD)	.33 ± .030	.49 ± .065	.32 ± .037	.45 ± .061
Treatment	Min ± (SD)	.32 ± .047	.48 ± .068	.28 ± .037	.41 ± .054
Total	Min ± (SD)	.33 ± .040	.48 ± .066	.30 ± .043	.43 ± .061

Score differences of reaction time before and after intervention training for treatment group

As for the score differences of the reaction time before and after intervention training for the treatment group, there is a significant score difference for the WBRT before and after the intervention training, t (29) = 8.813, p = .000. Also, there is a significant score difference for the finger reaction time before and after intervention training, t (29) = 10.329, p = .000 (**Table 3**).

Table 3. Score differences in reaction time before and after intervention training for the treatment group

Groups			Paired Differences							
			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference *Lower*	95% Confidence Interval of the Difference *Upper*	t	df	Sig. (2-tailed)
Treatment	Pair 1	Pre-Whole-Body Reaction Test – Post-Whole-Body Reaction Test	.0425	.026	.005	.033	.052	8.813	29	.000
	Pair 2	Pre Finger-Reaction Test - Post-Finger Reaction Test	.0730	.039	.007	.059	.087	10.329	29	.000

Score differences of reaction time before and after intervention training for control group

As for the score differences of the reaction time before and after intervention training for the treatment group, there is a significant score difference for the WBRT before and after the intervention training, t (29) = 8.813, p = .000. Also, there is a significant score difference for the finger reaction time before and after intervention training, t (29) = 10.329, p = .000 (**Table 4**)

Table 4. Score differences of reaction time before and after intervention training for the control group.

Groups			Paired Differences							
			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference *Lower*	95% Confidence Interval of the Difference *Upper*	t	df	Sig. (2-tailed)
Control	Pair 1	Pre-Whole - Body Reaction Test – Post-Whole Body Reaction Test	.015	.022	.004	.007	.023	3.786	29	.001

	Pair 2	Pre-Finger Reaction Test – Post-Finger Reaction Test	.037	.041	.008	.022	.052	4.935	29	.001

Score differences of reaction time for treatment and control groups before intervention training

In addition, for the score differences of the reaction time for the treatment and control groups before intervention training, there is no significant score difference for the WBRT, t (58) = 1.667, p = .101 and there is also no significant score difference for the finger reaction time, t (58) = 0.546, p = .587 (**Table 5**).

Table 5. Score differences of reaction time for treatment and control groups before intervention training

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	*Upper*
Pre-Whole-Body Reaction Test	Equal variances assumed	9.751	.003	1.667	58	.101	.017	.010	-.003	.038
	Equal variances not assumed			1.667	49.229	.102	.017	.010	-.004	.038
Pre-Finger-Reaction Test	Equal variances assumed	.028	.868	.546	58	.587	.009	.017	-.025	.044
	Equal variances not assumed			.546	57.850	.587	.009	.017	-.025	.044

Score differences of reaction time for treatment and control groups before intervention training

Besides that, the score differences for the reaction time for the treatment and control groups after intervention training had a significant score difference for the WBRT, t (58) = 4.676, p = .000 and a significant score difference for the finger reaction time, t (58) = 3.056, p = .003 (table 6)

Table 6. Score differences of reaction time for treatment and control groups after intervention training

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference *Lower*	*Upper*
Post-Whole-Body Reaction Test	Equal variances assumed	.075	.785	4.676	58	.000	.045	.010	.025	.064
	Equal variances not assumed			4.676	57.91	.000	.045	.010	.025	.064
Post-Finger Reaction Test	Equal variances assumed	1.751	.191	3.056	58	.003	.045	.015	.016	.075
	Equal variances not assumed			3.056	57.212	.003	.045	. 015	.016	.075

DISCUSSION

The findings of the study showed that there was significant score differences in the reaction time of the whole-body before and after intervention training, in which the available mean difference of reaction time for the treatment group is at 0.425 seconds. On the other hand, for the finger reaction test, there was a significant score difference in the reaction time before and after the intervention training where the mean difference of reaction time for the control group was 0.073 seconds. According to Saber & Kashef [1], visual training serves to help athletes to achieve optimal levels during a match, improve visual muscles, perceptual and visual tracking, develop skills to anticipate the movement of an object and finally, to quickly increase focus and accurately upon a target based on the movement of the opponent.

Badminton is a sport that requires fast movement of the body and arms [31]. Based on the study conducted by Tomporowski [32], an athlete will have the fastest reaction time while they are exercising or when they train enough with an outcome pulse at a rate of 115 beats per minute. The findings of the study show that there is a significant difference in reaction time scores of whole-body reactions for pre and post intervention training in the control group, where the mean difference was at 0.015 seconds. For the Finger Reaction Test, there is a significant difference in the Finger Reaction Time (FRT) score before and after intervention training in the control group, where the mean difference of reaction time is at 0.073 seconds. Hence, this means that traditional training methods influence the reaction times of badminton athletes.

According to Solanki et al [20], an athlete's reaction time can be increased with visual training. However, according to Dube et al [19], experienced athletes have faster reaction time than those who have just begun participating in that respective sport. The findings of the study showed no significant score differences for the WBRT. The homogeneity variance for the score of the WBRT is assessed using Levene's test for equality of variances ($p = .003$). Perhaps, for the Finger Reaction Test, there is no significant score difference for the reaction time. There was homogeneity variance for the score of the WBRT as assessed using Levene's test for equality of variances (p = .868). This difference may be due to the visual training which was given in the past eight weeks. In short, this is because of the level of reaction time for the treatment group and the control group being at the same level before undergoing eight weeks training intervention.

Having said that, visual training helps athletes to achieve optimal performance while playing, improves visual muscles, visual perception and tracking abilities, enhances the ability to make estimations and helps to focus quickly and accurately towards a target [28][30]. The findings showed that there was a significant score difference for the WBRT. There was homogeneity of variance for the score of the WBRT as assessed using the Levene's test for equality of variances (p = .785). Equally, in the same way as the FRT test, there was also a significant score difference for the reaction time. There was homogeneity of variance for the score of the FRT as assessed using Levene's test for equality of variances (p = .191). Thus, owing to that, visual ability is essential in racquet sports, especially in badminton. Based on a study conducted by Hassan El-Gizawy [2], through visuals, athletes can predict and analyze the situation which helps them make clear decisions and serves as an additional advantage. In short, in badminton, players need highly efficient visual functions to estimate and ascertain their opponent's position which then assists in making shots towards the opponent's court.

CONCLUSION

According to the findings of this study, it can be concluded that there is a difference in the reaction time of the treatment group as well as the control group after undergoing intervention training for the past eight weeks. In addition, the findings of the study also indicate that visual training does affect a person's reaction time as well. Before undergoing the intervention training for eight weeks, there was no difference in the mean reaction time between the two groups in the WBRT test and the FRT test. However, after undergoing visual training, the mean reaction time for the treatment group was faster than the control group.

SUGGESTION FOR FUTURE RESEARCH

Furthermore, further studies may also involve the relationship between visual training towards the reaction time and agility. It is crucial to identify the relationship between the subject's performance in the reaction time and the agility score. As such, this test can also be performed on athletes from different sports such as combat sports as this sport also requires a short reaction time and a high agility to both avoid attacks from the opponent and to attack the opponent. In a nutshell, fitness tests such as agility fitness tests can also be added into subsequent studies to determine the performance of an athlete's reaction time and the relationship with the agility assessment tests. In short, the findings of this study can provide knowledge to coaches, sports scientists, and physical educators regarding visual training and its effectiveness on the improvement of the performance of athletes. Finally, university coaches and high school physical educators can also make modifications and various alternative training programs and include the element of visual training daily.

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