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COMPARATIVE STUDY OF SIMPLE AND CHOICE VISUAL REACTION TIME IN ELITE AND NOVICE TABLE TENNIS PLAYERS

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Abstract: This study has been undertaken to compare the simple and choice visual reaction time in elite and novice table tennis players. Utilizing the Deary-Liewald reaction time task the simple and reaction time was assessed in 25 elite table tennis players and 25 novice table tennis players. Participants were subjected to a series of trials to measure their visual stimuli under both simple (single stimuli) and choice (multiple stimuli) conditions, which was measure in milliseconds. The results showed that elite table tennis players completed the simple reaction time in 249 milliseconds and choice reaction time in 406 milliseconds. Whereas on the other side the novice table tennis players completed the simple reaction time in 277 milliseconds and choice reaction time in 480 milliseconds. This indicates that the elite table tennis players demonstrated faster reaction time as compared to the novice table tennis players. These findings suggest that extensive training and experience in table tennis enhance an individual's visual processing time. This study underscores the importance of reaction time in developing high-level performance in sports.

I. Introduction:

Table tennis is a game renowned for the rapid pace and precision, demand a unique amalgamation of skill, strategy and agility for players to excel. Beyond mastering techniques and equipment nuances, the game hinges significantly on speed with reaction time playing a pivotal role in determining success. [(1)]Table tennis is a rapid sport that demands adaptability to fluctuating environment conditions while under intense pressure. In table tennis a split- second decisions dictate victory or defeat, understanding the nuances of reaction time becomes imperative. Thus, it is crucial to cultivate technical skills and the capacity to swiftly adjust shot techniques, along with quick and varied leg movement to anticipate the ball's speed and direction.[(2)] Reaction time (RT) is defined as the interval between a stimulus and the motor action produced by the brain response to that of the stimulus. It is usually expressed in milliseconds. [(3)] Sensory neurones convert a stimulus into an electrochemical signal, which travels through one or more neurones of the central nervous system, and motor neuron generate a response by contraction of the muscles or gland to secrete substance. [(4)]
The concept of reaction time is segmented into three fundamental components, firstly is the perceptions time encapsulates the duration needed for the brain to perceive and process the stimulus presented, followed by initiating the appropriate reaction. Secondly, decision time represented the clinical interview in which players evaluate the incoming stimuli and formulate a strategic response. Finally, motor time signifies the period allocated for executing the instructed action, translating the decision into physical movement. Together, these components together form the reaction time. [(5)]
There are 3 types of reaction time: (1) Simple reaction time: where there is one stimulus and one reaction. (2) Recognition reaction time: the ability to discern which stimuli require a response and which do not. (3) Choice reaction time: where there are multiple stimuli and multiple responses. It has been reported that the time for motor preparation (eg. tensing muscles) and motor response was the same for all three types of reaction time tests, implying that the difference in reaction time are due to processing time. [(6)]
There are various factors that influence the reaction time: a. Simple vs Complex Reaction time, b. Type of stimuli, c. Stimulus intensity, d. Arousal, e. Age, f. Gender, g. Handedness h. Direct vs Peripheral vision i. Fatigue j. Practice and errors k. Alcohol l. Personality type m. Biological rhythm n. Physical fitness. [(6)] Simple reaction time is faster than the complex reaction time as it consists of one stimulus and one response where as in complex reaction time consists of multiple stimuli and multiple response. [(7)]
Reaction time plays an important role in table tennis as it helps the player to anticipate the ball's speed, spin and trajectory and effectively return shot. With the help of quick reflexes to shift to optimum position and maintain balance. Similarly, it can also help in reducing the errors and increase consistency of the shot. [(8)]
Deary Liewald task is a reaction time test used for assessing the simple and choice reaction time. To assess simple reaction time, the participants must press the spacebar to create a response of stimulus (X) appearing on the screen. Whereas, in the choice reaction time there are 4 different stimuli and the participants must press the button corresponding to the correct response. For both types of reaction time task, the simple reaction time includes eight practice trials and twenty test trials and in the choice reaction time, there are eight practice trails and forty test trails. [(9)]

This study focuses to comparing the simple and choice visual reaction time in elite and novice table tennis players which is a crucial component for the game and postulate the possible reasons for the discrepancies.

II. Need of study:

Table tennis is a fast-paced sport where the ball travels at the speed of 112.5 km/hr. [10] These players are required to have a fast reaction time so that they can anticipate the ball speed and direction. It is a critical component of the game as it helps the athlete to respond to the opponents shot and execute their own shot effectively. [11] A good reaction time can provide a significant advantage and can be the difference between making a winning shot or missing an opportunity. [12, 13]

Main difference between elite, novices and non-players is the experience, which is a crucial factor responsible for the acquisition of effective visual search strategies which may lead to differences in the reaction time. It is postulated that elite players in any sport will have faster reaction time in comparison to their novice counterpart because of the difference in the years of experience, level of play and developed skills.[14] The existing literature on reaction time in table tennis lacks comprehensive comparative analyses between elite and novice groups. [15,16,17] This notable gap underscores the necessity for further research to elucidate the distinct nuance of reaction time performance in these different skill levels.

Hence the present study is targeted to assess the difference in simple and choice reaction times between elite and novice athletes, aiming to uncover any potential variation in their speed of the response. By addressing this lacuna, future studies can contribute significantly in the understanding of the cognitive and physiological factors that underpin expertise development in table tennis players, thereby informing targeted training strategies and performance enhancement interventions.

III. Aim of the Study:

To compare the simple and choice visual reaction time in elite vs novice table tennis players.

Objectives of the study:

1. To assess the simple and choice visual reaction time in elite table tennis players.
2. To assess the simple and choice visual reaction time in novice table tennis players.
3. To compare the simple and choice visual reaction time in elite and novice table tennis players.

IV. Method:

In the present cross-sectional study, the sample size was calculated using a scientific formula. Assuming a significance level of 5% and a power of 85%, it was estimated that 25 table tennis players should be allocated in each group. The elite table tennis having high level of skill and playing national and international level matches and novice table tennis players are players playing in district level and inter-club level matches. These players were recruited in the study from various table tennis association in Mumbai. Each participant signed an informed consent form after being ruling out any player having an upper limb surgery and history of traumatic brain injury.

V. Material:

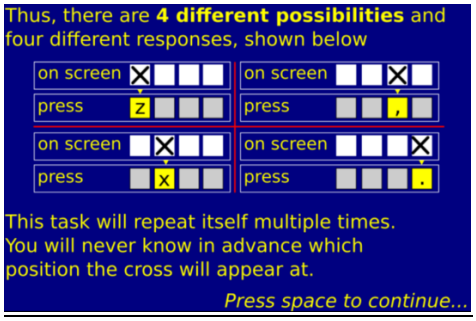
Deary-Liewald Reaction Time Task:

This task was designed by Ian J. Deary and programmed by David Liewald with several iterations between the initial design and the final program used here. The reliability of the Deary-Liewald task was measured using the Cronbach's alpha, yielding a score of 0.94 for the simple reaction time and 0.97 for choice reaction time.

In the simple reaction time task, a white square was positioned approximately in the centre of the computer screen, set against a blue background. The stimulus to be responded was the appearance of a diagonal cross within the square. Each time the cross appeared; participants had to press a key as quickly as possible. The cross remained on the screen until the key was pressed, after which it disappeared and another cross appeared shortly thereafter. The inter-stimulus (the time between each response and the appearance of the next cross) ranged between 1 and 3 seconds and was randomized within these boundaries. The computer program recorded both the response time and the inter-stimulus interval for each trial.

Fig 1 : Simple Reaction Time (Deary Liewald Reaction Time)

For the choice reaction time task, four white squares were arranged in a horizontal line across the middle of the computer screen, set against a blue background. Four keys on a standard computer keyboard corresponded to these squares. The 'Z' key matched the square on the left, the 'X' key matched the second square from the left, the 'Comma' key matched the second square from the right and the 'Full stop' key matched the square on the far right. The stimulus for response was the appearance of a diagonal cross within one of the squares. Participants were instructed to rest the index and middle finger of their left hand on the 'Z' and 'X' keys, and the index and middle of their right hand on 'Comma' and the 'Full stop' keys. A cross remained on the screen until one of the four keys were pressed, after which it disappeared and another cross appeared shortly after. The inter-stimulus interval ranged from 1 to 3 seconds and was randomized within these boundaries. The computer program recorded the response times for each cross, the inter-stimulus interval for each trial, which key was pressed, and, in the case of the four-choice reaction time task, whether the response was correct or incorrect.



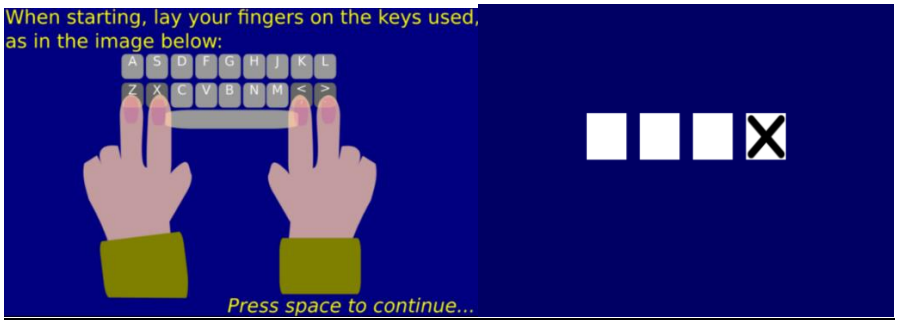


Fig 2: Choice Reaction Time (Deary-Liewald Reaction Time)

The reaction time was recorded in form of milliseconds at the end of the test.

Self-Made Questionnaire:

A self-made questionnaire was meticulously developed to capture relevant information pertaining to participants' demographic details, medical history, surgical history, level of experience and any injury to their dominant hand.

Statistical Analysis:

Mean and standard deviation were used to describe variables. The assumption for normality was verified using the Kolmogorov-Smirnov test which reported that the data was normally distributed and variance was equal between the groups. A paired and unpaired t-test was used to compare the means of simple and choice visual reaction time in elite and novice table tennis players. The p value is <0.05 which indicates statistically significant results in these analyses. The analysis was performed using the Graph Pad Prism software (version. 10.2.1).

VI. Results and Discussion:

Table 1: Comparison of demographic details, simple and choice visual reaction time in elite and novice table tennis players:

REACTION TIME	ELITE TT PLAYERS	NOVICE TT PLAYERS	P VALUE
	MEAN ± SD		
AGE	25.29 ± 15.38	31.16 ± 22.64	-
BMI	22.58 ± 4.53	24.11 ± 4.09	-
SRT:	249.36 ± 29.74	271.75 ± 46.33	0.008013
CRT:	406.72 ± 53.63	480 ± 112.35	0.000789
P VALUE:	0.008540	0.00934	-

*Abbreviation: SRT: Simple Reaction Time, CRT: Choice Reaction Time, TT: Table Tennis

The goal of this study was to compare the simple and choice visual reaction time in elite and novice table tennis players. Deary-Liewald Reaction Time Task was used to assess the reaction time at various table tennis association ensuring an ideal environment which was free of distractions. The result of this study indicates that the reaction time in elite is faster as compared to the novice table tennis players. Similarly, solving simple reaction time task was easier and required lesser time in comparison to choice reaction time task for both the groups.

In simple reaction time task, there is only one stimulus and one response which makes it easier for the individuals to perform it.[18,19] However, in choice reaction time task the individual must give a response corresponding to a stimulus which makes it more challenging and requires more time than simple reaction time task.[20, 21,22] In this study, the simple reaction time task was recorded to be 249 msec in elite table tennis players whereas the novice table tennis players completed it in 271 msec, suggesting that the

elite players had a faster visual processing abilities when reacting to a single stimuli. Similarly, for choice reaction time task, the elite table tennis players demonstrated a faster reaction time of 406 msec, on the other hand the novice table tennis players completed the task in 480 msec. Which indicates that there is a significant difference in the reaction time of both the groups.
The difference between the elite and novice table tennis players in the level of experience which can be an important contributing factor in the reaction time. 96% of all elite players have an experience of more than 5 years of playing table tennis whereas only 40% of the novice players have an experience of more than 5 years. The difference in the game experience might have translated into heightened neural efficiency in the elite players which has helped them execute a faster response.[23] Consequently the novice players have a slower reaction time due to the lack of technique, practice and being at the early stage of skill acquisition they have not developed muscle memory, rapid movements. [24, 25] In a study conducted by Ulysses Fernandes Ervilah, et al, in 2018 stated that the pattern of muscle activation and pre-motor time was shorter in the elite players than the novice player.

Along with the difference in the level of experience, the difference in neural efficiencies have aided in the faster reaction for elite table tennis players. There are various stages in reaction time. Firstly, the stimulus is perceived by the sense organ into a signal consisting of series of nerve impulses which are transmitted to the brain. The signal is then identified and a particular response is chosen. The transmission of these responses from the brain to the effector muscle makes the response by activation of the muscles. Finally, the time taken to make the responding movement is the reaction time. [26, 27] In a study conducted by Donders in 1868 showed that the reaction time is shorter in simple than choice. It is concluded that, since the choice reaction time has multiple stimuli and multiple responses which causes the reaction time to be slower because it is determined by the duration for motor preparation (e.g. muscle contraction) and the interpretation of the response (i.e. the pressing of the keys on the laptop) is different for both the test, simple and choice reaction time task implying the difference in the processing time. [28] The processing time is faster in the simple reaction time than the choice reaction time . The “memory drum theory” of neuromotor reaction which was proposed by Henry and Rogers in 1960 hypothesized the reaction time increases as a response becomes more complex and in-order to complete complex responses, more stored information is required and hence it takes longer duration. [29]

Simple reaction time task involves a unimanual (using one hand) response, whereas Choice reaction time is often a bimanual (involving both hands) response.[30] Unimanual responses simplifies the task and reduced the complexity of the response allowing a faster reaction time. On the other hand, bimanual responses required a coordination of action between both hands allowing the response allowing a slower reaction time. [31] This contributes to a faster reaction especially the simple reaction time task rather than choice reaction time task. Another important factor that influences the simple visual reaction time is handedness. The movements of the left hand is supervised by the right side of the human brain and vice-versa the right hand is controlled by the left side of the brain. [31] Similarly, in the present study 88% of elite and 92% of the novice table tennis players were right-handed.

The result of this study exhibits that the reaction time is slower for the novice table tennis players when compared to the elite table tennis players , hence a structured training regimen focusing on the repetitive movement and cognitive exercises can be reinforced, aiming to bridge the gap and enhance their overall athletic ability in-order to improve the game performance.

VII. Conclusion:

The present study concludes that the Simple and Choice Visual Reaction Time is faster in Elite Table Tennis players than the Novice Table Tennis Players. Moreover, the Simple Reaction Time was faster than Choice Visual Reaction Time in both the groups.

VIII. Reference:

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