

Effectiveness of Upper Extremity Proprioceptive Training on Reaction Time in Table Tennis Players

Chaitrali Bokil¹, Richa Bisen², Khyati Kalra³

¹B.P.Th, SKN College of Physiotherapy, Pune, India

²MPT in Orthopaedics and Manual Therapy, Assistant Professor, Electrotherapy and Electro diagnosis Department, SKN College of Physiotherapy, Pune, India

³Assistant Professor cum Statistician, Department of Community Medicine, SKN Medical College & General Hospital, Pune, India

Corresponding Author: Chaitrali Bokil

ABSTRACT

Background: Table tennis is a dynamic sport and is known to be one of the fastest ball games. It has been proven that table tennis requires a short reaction time for success but there is a lack of evidence on the different types of exercises that can improve reaction time in table tennis players.

Objective: To study the effectiveness of upper extremity proprioceptive training on reaction time in table tennis players.

Methods: 34 Table tennis players, both males and females in the age group of 7-15 were included in the study. They were divided into two groups: Control Group (n=17) and Experimental Group (n=17) by lottery method. The reaction time of all the players was measured using the ruler drop test. The control group underwent a conventional training whereas the experimental group underwent an additional proprioception training along with conventional training for 6 weeks. The reaction times of the players were measured again at the end of 6 weeks.

Results: When compared within the group, the reaction time did not show a significant statistical difference in the Control group ($p>0.05$) whereas the reaction time significantly decreased in the experimental group ($p<0.05$). When compared between the groups, reaction time showed a significant statistical difference between the Control and Experimental group ($p<0.05$) indicating that Experimental group produced a significantly shorter reaction time than the Control group at the end of 6 weeks.

Conclusion: This study shows that upper extremity proprioceptive training along with conventional training helps to improve reaction time in table tennis players.

Keywords: Table tennis, reaction time, proprioceptive training, ruler drop test

INTRODUCTION

Reaction Time (RT) is defined as time between the application of a stimulus & the body's response to the stimulus. Reaction Time can be divided into 3 basic types: ^[1]

- 1) Simple Reaction Time (1 stimulus → 1 response)
- 2) Choice Reaction Time (multiple stimuli → multiple responses)
- 3) Recognition Reaction Time (multiple stimuli → only one will get response)

In simple words, Reaction Time is a measure of how long it takes to initiate and complete an intended movement.

Proprioception is defined as the body's sense of position and motion, which includes body segment static position, displacement, velocity, acceleration, and muscular sense of force and effort. Proprioception is a subsystem of the somatosensory system which also includes touch, pain and temperature sense from the skin and musculoskeletal structures. ^[2] Proprioceptors are sensory endings that

derive various stimuli in response to mechanical deformation. These stimuli are converted into electrical impulses and sent to the brain where they are transformed into relative position and movement parameters. [3] The integrated sensory input from these proprioceptors at multiple joints creates a system for the purpose of accurate sensing and determination of limb position and movements in both open-chain and closed-chain activities.

Sport is referred to as the ability of demonstrating athletic performance in a constant way. Sports practitioners and researchers are in constant search of newer and more efficient training methods to achieve success in modern sports requiring ever-increasing levels of peak physical and mental conditioning. [4]

Reaction Time is one of the important factors that leads to success in sporting competitions. [5] RT can be influenced by various factors like gender, age, physical activity, physical fitness, training and fatigue. Based on these, it has been proven that RT is shorter in athletes as compared to non-athletes. [6] However even among athletes, RT is not caused by performance but can be improved with training. [5,7]

Proprioception is an important sensorimotor function for all mobility actions. [8-10] Proprioception plays an important role in sports and contributes greatly to the performance of athletes. Proprioception Training is defined as a series of exercises or situations that will produce a reaction by the nervous system in response to an external stimulus. [9] The noted dependency between sporting excellence and proprioceptive ability suggests that Proprioceptive training should be incorporated in sports training programs.

Studies show a positive effect of Lower Limb proprioception training on RT measured by the Newtest 1000 device in normal non-athletic individuals. [11] However, there is a lack of evidence of studies on the effect of Upper Extremity proprioception training on RT.

Most sports, especially racket sports require good RT for good performance. Due to lack of evidence, it is suggested that studies should be conducted to study the effect of Proprioception Training on RT in different sports branches and in different age groups. [11]

Table Tennis (TT) is a dynamic sport. TT being one of the fastest ball games, is characterised by perceptual uncertainty and time pressure and hence requires a short RT for success. [12] RT can be improved by exercises. [5,7] However, there is lack of evidence on the different types of exercises that can be used to improve the reaction time in TT players. Table Tennis is a sport in which success depends on many interconnected factors with motor co-ordination abilities indicated as the most important. [13] Studies have shown the significance of motor coordination in table tennis. [14,15] However, little research has been done on the significance of proprioception in table tennis where the role of features like sensing the ball and reacting in time are very important. [16] Hence the lack of evidence showed the need of studying the effect of Proprioceptive Training on reaction time in table tennis players.

In this study, we studied the Effects of Upper extremity proprioceptive training on reaction time in table tennis players. Reaction time was assessed using the ruler drop test.

METHODOLOGY

Objective: To study the effectiveness of upper extremity proprioceptive training on reaction time in table tennis players.

Study Design: A pretest-posttest experimental group design was selected for testing the hypothesis.

Study Population: 34 Novice district level table tennis players from Pune were studied. Both males and females in the age group of 7-15 receiving at least 1 year of regular table tennis training were included in the study. Elite national level players and players with any previous injuries and/or

any other medical conditions or health problems were excluded from the study.

Procedure: The participants of the study were divided into 2 groups - Control group and Experimental group by using the lottery method. Both the groups underwent a pre-test where RT of the participants was measured using the Ruler Drop Test. [17,18] After the pre-test, participants of both the groups were given conventional training and the participants of Experimental group were given additional Upper extremity proprioception training (Table 1) for a period of 6 weeks (4 days/week). After the Proprioception Training, RT of participants of both groups was measured again at the end of 6 weeks.

Measurement of reaction time: In this study, RT was measured using the ruler drop test. The ruler drop test was chosen as the tool of assessment as it is easy to administer, requires minimal assistance, is cheap requiring only materials like a standard ruler, pen and paper and has a moderate to good reliability and validity. [17,18]

The test was explained and demonstrated to the participants. The ruler was held by the researcher between the outstretched index finger and thumb of the participant's dominant hand so that the top of the participant's thumb was level with the zero-centimetre line on the ruler.

The researcher instructed the participant to catch the ruler as soon as possible after it had been released.

The researcher recorded the distance between the bottom of the ruler and the top of the participant's thumb where the ruler has been caught.

Two trials were given to each participant. [19] Three readings were taken from each participant and the mean was calculated as the RT of that participant.

Reaction time was calculated using the formula:

$$t = \sqrt{2d/g}$$

t = reaction time (in seconds)

d = the distance at which the ruler was caught (in metres)

g = force of acceleration of gravity (9.8m/s²)

Exercise Protocol:

Conventional training: Conventional training was given to both Control and Experimental groups. It included lower limb strengthening exercises, core strengthening exercises and agility training exercises.

Proprioception training: Proprioception training was given only to the Experimental group. The following exercises were given as a part of upper extremity proprioceptive training. [20] (Table 1)

Table 1: Proprioception training protocol

Exercise	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Rhythmic stabilization	30 sec hold	1 min hold	2 min hold			
Quadruped	30 sec hold	1 min hold	2 min hold			
Kneel push-up		30 sec hold	1 min hold	2 min hold		
Prone on elbows		30 sec hold	1 min hold	2 min hold		
Push up			30 sec hold	1 min hold	2 min hold	
Full push up feet elevated			30 sec hold	1 min hold	2 min hold	
Hands on wobble board				30 sec hold	1 min hold	2 min hold
Hands on bosu ball				30 sec hold	1 min hold	2 min hold
Elbows on gym ball					1 min hold	2 min hold
Hands on gym ball						1 min hold

RESULTS

In this study 34 Table Tennis players, 17 in each group were studied. The data was analysed using the Epi info software with 95% confidence and the level of significance at p<0.05. The Reaction Time was compared using parametric tests,

the unpaired and paired t-tests. The Reaction time within the groups (pre-test and post-test) was analysed using the Paired t-test. The pre and post-test Reaction time between the groups (Control Group and Experimental Group) was analysed using the unpaired t-test.

Table 2: Within group analysis

Group	Pre-test mean+S.D.	Post-test mean+S.D.	p
Control Group	0.137+0.016	0.137+0.013	p>0.05
Experimental Group	0.138+0.017	0.125+0.017	p<0.05

- When the results were compared (Table 2), RT of the Control Group did not show any significant statistical difference ($p>0.05$) whereas, RT of the Experimental Group showed a statistically significant difference ($p<0.05$).
- The post-test RT of the Experimental Group was significantly shorter when compared to its pre-test values. (GRAPH 1)

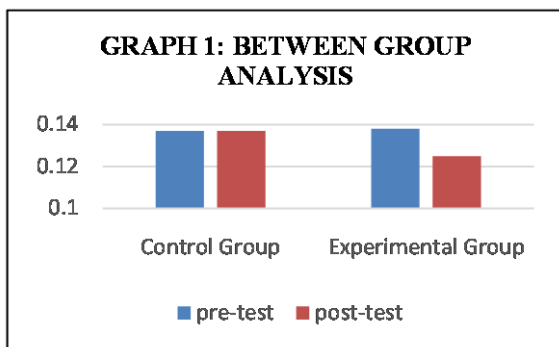
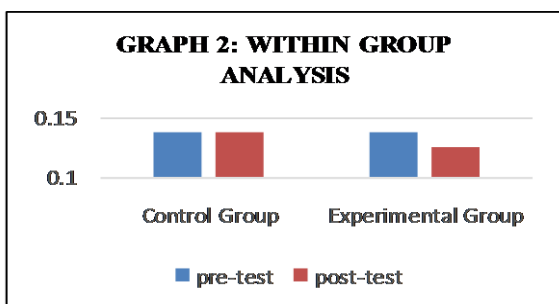


Table 3: Between Group analysis

	Pre-test mean+S.D.	Post-test mean+S.D.
Control Group	0.137+0.016	0.137+0.013
Experimental Group	0.138+0.017	0.125+0.017
p	(p>0.05)	p<0.05

When the results were compared (Table 3), pre-test RT did not show any significant statistical difference between the Control Group and the Experimental Group ($p>0.05$). This signifies that the baseline of reaction time in both groups was matched. When the post-test results were compared, RT showed a statistically significant difference ($p<0.05$). Experimental Group reported a significantly lower reaction time than Control Group when compared at the end of 6 weeks. (GRAPH 2)



DISCUSSION

This study was conducted to find out the effectiveness of upper extremity proprioception training on reaction time in table tennis players. The control group underwent a conventional training whereas the experimental group received upper extremity proprioceptive training in addition to the conventional training.

As per the results, the baselines were matched as the pre-test RT did not show any significant statistical ($p>0.05$) difference between the Control Group and the Experimental Group. According to research, RT is extremely important in sports in which the movements of the athletes are conditioned with the movements of the ball or with the actions of the opponent. In many fast movement sports, the success depends on the speed of the athlete in deciding the counter movements and the speed of the reaction. [21]

Another study suggests that Table Tennis being one of the fastest ball games, is characterised by perceptual uncertainty and time pressure and hence requires a short reaction time for success. [12]

Many studies suggest that RT can be improved by different types of training methods. [6,12,22,23]

According to another study, proprioception plays an important role in sports and contributes greatly to the performance of athletes. [9]

The results of this study show a significant statistical difference between the pre-test and post-test RT of the experimental group after 6 weeks of upper extremity proprioception training. This is in accordance with many studies which proved that proprioception is an important sensorimotor function for all mobility actions. [8,10] Another study stated that the improvement in reaction time may be associated with the development in the process skills of the sensory-motor

performance and central neural system due to the training. [24]

The results of the study show significant statistical difference between the post-test RT of the Control and the Experimental group. The results obtained were similar to a study which showed positive effects of lower limb proprioception training on coincidence anticipation timing and reaction time. [11]

This study used upper extremity proprioception training as an intervention for 6 weeks to improve the RT in table tennis players. The results obtained are similar to a study which used an alternate hand wall toss training for 5 weeks to improve RT. [25] A research done on biofeedback reaction time training supported the findings of this research by proving that a 5 weeks training program showed a positive improvement in RT. [26]

However, there is also a study that observed no changes in RT after a 4 weeks' racket sport visual training program. The unsupportive result observed maybe caused by the shorter duration of the training. [27] Hence, a minimum of 5 weeks of training seems to be required to observe a significant clinical improvement RT.

In literature review, papers which study the effect of proprioception training on reaction time are very few and no evidences could be found that study the effectiveness of upper extremity proprioception training on reaction time.

Therefore, this study shows that upper extremity proprioception training can help to improve the reaction time in table tennis players when trained for a period of 6 weeks.

CONCLUSION

The study showed that the group which underwent an additional upper extremity proprioception training along with conventional training produced a shorter RT as compared to the group which underwent only conventional training. Hence, we conclude that upper extremity proprioceptive training along with

conventional training helps to improve RT in table tennis players.

This type of training is an integral part of the holistic approach to improve performance. Hence, we can encourage coaches and trainers that proprioception training can be incorporated as a significant part of training to improve reaction time in Table Tennis players.

Future Scope of Research

Future research can be attempted to compare the effect of Upper limb and Lower limb proprioception training on reaction time.

Further research should be attempted to extend the training intervention period in order to determine whether this type of training can increase the differences found between the two groups.

Research can also be done to study any significant variations in reaction time between males and females.

In addition, further research can be done to investigate whether proprioceptive training can benefit in improving RT in other racket sports.

REFERENCES

1. Kosinski RJ. A Literature Review on Reaction Time. *Res Q Exercise Sport*. 2013; 42: 405-410.
2. Lundy-Eckman L. *Neuroscience Fundamentals of Rehabilitation*. 4th ed. Missouri: Elsevier inc.; 2007.
3. Reimann BL, Lephart SM. The sensorimotor system part I: the physiologic basis of functional joint stability. *J Athl Train*. 2002; 37(1): 71-79.
4. Starosta W. The concept of modern training in sport. *Studies in Physical Culture & Tourism*. 2006; 13(2): 9-23.
5. Bompa T.O. *Theory and Methodology of training: the key to athletic performance*. 3rd ed. Iowa: Kend/Hunt Pub. Co. 1994.
6. Moka R, Kaur G, Sidhu LG. Effect of Training on The Reaction Time of Indian Female Hockey Players. *J Sports Med Phys Fitness*. 1992; 32: 428-31.
7. Chandra AM, Ghosh S, Barman S, Iqbal R, et.al. Effect of Exercise and Heat-Load On Simple Reaction Time of University

- Students. *Int J Occup Saf Ergon.* 2010; 16(4): 497- 505.
8. Batson G. Proprioception: considerations for dance education. *J Dance Med Sci.* 2009; 13(2): 35-41.
 9. Ogard WK. Proprioception in sports medicine and athletic conditioning. *Strength Cond J.* 2011; 33(3): 111-118. DOI:10.1519/SSC.0b013e31821bf3ae
 10. Hillier S, Immink M, Thewlis D. Assessing proprioception: A systematic review of possibilities. *Neurorehabil Neural Repair.* 2015; 29(10): 933-49. DOI:10.1177/1545968315573055.
 11. Ceylan HI. Examining the effects of Proprioceptive Training on Coincidence Anticipation Timing, Reaction time and Hand-Eye co-ordination. *Anthropologist.* 2015; 20(3): 437-445. DOI:10.1080/09720073.2015.11891747
 12. Paul M, Biswas SK, Sandhu JS. Role of Sports vision and Eye-Hand co-ordination in performance of table tennis players. *Braz J Med Biol Res.* 2011; 5(2): 106-116.
 13. Borysiuk Z. Complex evaluation of fencers predisposition in three stages of sport development. *Biol Sport.* 2006; 23(1): 41–53.
 14. Bańkosz Z. The Kinesthetic Differentiation Ability of Table Tennis Players. *Hum Movement Sci.* 2012; 13 (1): 16–21. DOI: 10.2478/v10038-011-0049-z
 15. Hotz A, Muster M. Table tennis: teaching and learning [in German]. Aachen: Meyer & Meyer Sport. 1993.
 16. Starosta W, Felbur B. Structure and conditioning of “ball feeling” in the opinions of table tennis players and coaches. *Movement Coordination in team sport games and martial art.* 1998; 180-184.
 17. Eckner JT, Kutcher JS, Richardson JK. Between-Seasons Test-Retest Reliability of Clinically Measured Reaction Time in National Collegiate Athletic Association Division I Athletes. *J Athl Train.* 2011; 46(4): 409–414.
 18. Arhana V, Joshi R, Sharma K, et.al. Catching the moving ruler and estimate the Reaction time in Children. *IJMHS.* 2015; 2: 23-26. DOI:10.21088/ijmhs.2347.9981.2115.4
 19. Del Rossi G, Malaguti A, Del Rossi S. Practice Effects Associated With Repeated Assessment of a Clinical Test of Reaction Time. *J Athl Train.* 2014; 49(3): 356-359.
 20. Stone JA, Partin NB, Luekin JS, et.al. Upper Extremity Proprioceptive Training. *J Athl Train.* 1994;29(1): 15-18.
 21. Schmidt RA. Motor Learning and Performance: from Principles to Practice. 5th ed. Virginia: Human Kinetics Books. 1991.
 22. Fragala MS, Beyer KS, Jajtner AR, et.al. Resistance exercise may improve spatial awareness and visual reaction in older adults. *J Strength Cond Res.* 2014; 28(8): 2079-2087.
 23. Dogra DK. Effect of 12 weeks specific conditioning programme on motor fitness of Tripura cricketers. *JIF.* 2015; 6(1): 706-714.
 24. Madan M, Thombre DP, Bharathi B, et.al.. Effect of yoga training on reaction time, respiratory endurance and muscle strength. *J Physiol Pharmacol.* 1992; 36(4): 229-233.
 25. Chong RNR, Taha NS. Effectiveness of an alternate hand wall toss on reaction time among archery, shooting and fencing athletes. Conference paper presented at the International Sport Science Students Conference, University Malaya, Kuala Lumpur. 2013
 26. Harvey RH, Beauchamp MK, Saab M, et.al. Biofeedback Reaction Time Training: Towards Olympic Gold. *Biofeedback.* 2011; 39(1): 7-14. DOI:10.5298/1081-5937-39.1.03
 27. Abernethy B, Wood JM, Parks S. Can the anticipatory skills of experts be learned by novices? *Res Q Exerc Sport.* 1999; 70: 313-318. DOI:10.1080/02701367.1999.10608050

How to cite this article: Bokil C, Bisen R, Kalra K. Effectiveness of upper extremity proprioceptive training on reaction time in table tennis players. *Int J Health Sci Res.* 2020; 10(5):34-39.
